CADIA VALLEY OPERATIONS
REVIEW OF DEPOSITED DUST
JULY 2020 TO JUNE 2021

Cadia Valley Operations

6 September 2021

Job Number 19111036E

Prepared by
Todoroski Air Sciences Pty Ltd
Suite 2B, 14 Glen Street
Eastwood, NSW 2122
Phone: (02) 9874 2123
Fax: (02) 9874 2125
Email: info@airsciences.com.au

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1 INTRODUCTION

Todoroski Air Sciences have investigated the deposited dust monitoring data collected during the July 2020 to June 2021 period for the Cadia Valley Operations. Deposited dust levels are recorded at eight locations surrounding the Cadia Valley Operations and three locations surrounding the Dewatering Facility at Blayney.

Figure 1-1 and **Figure 1-2** show the approximate location of each of the monitoring stations reviewed.

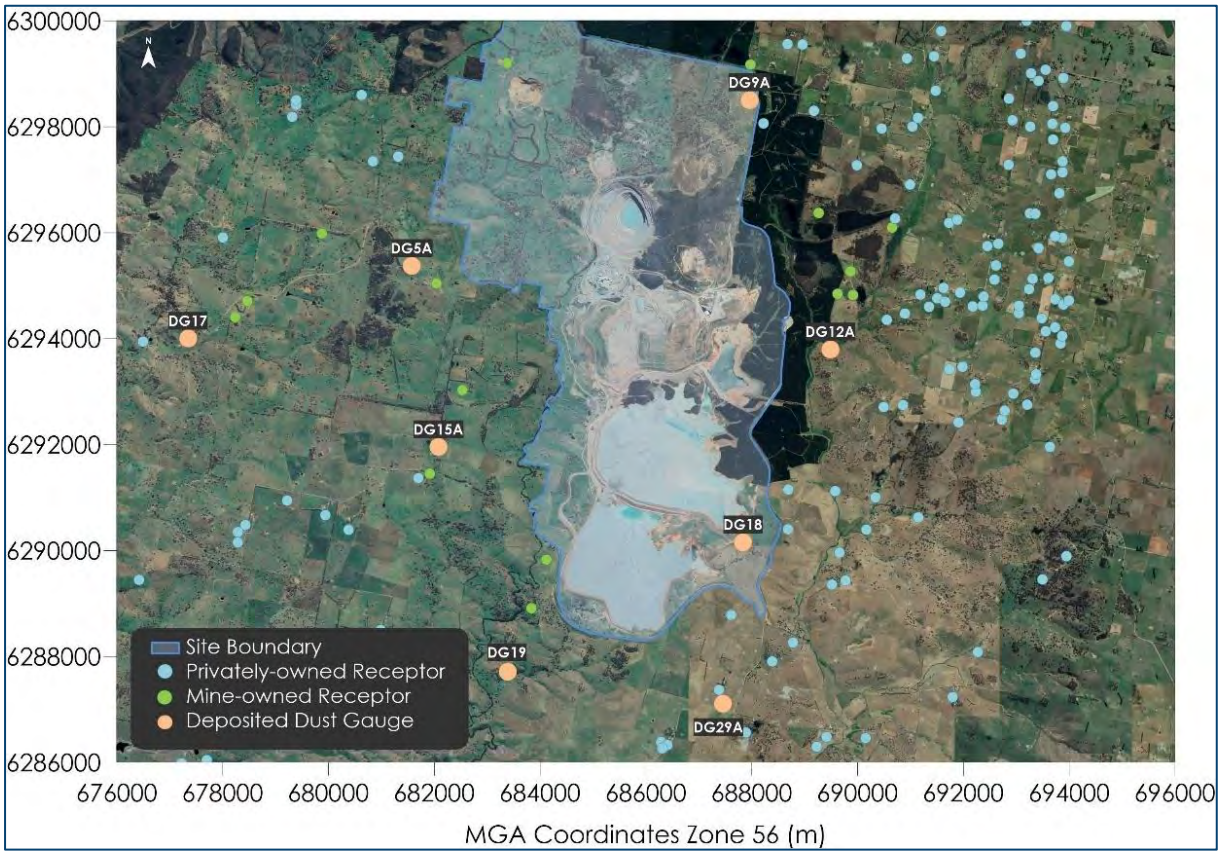

Figure 1-1: Cadia Valley Operations monitoring locations

Figure 1-2: Dewatering facility monitoring locations

2 AIR QUALITY CRITERIA

The applicable annual average deposited dust criteria for Cadia Valley Operations as per **PA 06_0295** is summarised in **Table 2-1**.

Table 2-1: Long term impact assessment/ land acquisition criteria for deposited dust

Pollutant	Averaging period	Maximum increase in deposited dust level	Maximum total deposited dust level
[c] Deposited dust	Annual	[b] 2 g/m²/month	[a] 4 g/m²/month

g/m²/month = grams per square metre per month.

Notes:

a. *Total impact (i.e. incremental increase in concentrations due to the project plus background concentrations due to all other sources).*

b. *Incremental impact (i.e. incremental increase in concentrations due to the project on its own).*

c. *Deposited dust is to be assessed as insoluble solids as defined by Standards Australia, AS/NZS 3580.10.1:2003: Methods for Sampling and Analysis of Ambient Air – Determination of Particulate Matter – Deposited Matter – Gravimetric Method.*

3 DEPOSITED DUST DATA

Table 3-1 summarises the deposited dust monitoring data for the July 2020 to June 2021 period.

Figure 3-1 and **Figure 3-2** graphically present the monthly deposited dust monitoring data for Cadia Valley Operations and the Dewatering Facility, respectively.

It is noted that the annual sampling period for the deposited dust monitoring is not per the standard calendar annual period (1 January to 31 December) with bottle exchanges on approximately the first day of the month. Deposited dust monitoring is assessed for the July to June annual period with collections occurring approximately mid-month.

Also, the exposure times for some of the deposited dust monitoring samples were longer than the typical exposure period of a month. It is recommended that deposited dust gauge monitoring be conducted as per the applicable AS 3580.10.1:2003 standard which states; "*For routine monitoring programs, the period of exposure is typically 30 ±2 days*" and "*Deposit gauges should be changed on the first day of each month or as near as possible to the first day of each month*".

Nevertheless, the sampling procedure would not materially affect the annual deposited dust monitoring results. The variation in the monthly samples would be accounted for in the following month of sampling.

Deposited dust monitoring samples in **Table 3-1** contaminated or deemed invalid due to contamination from insects were excluded from the annual average calculation. The calculated annual average results in **Table 3-1** indicate all monitors were below the relevant criterion of 4g/m^2/month except for the DG9A monitor.

Monthly deposited dust results are presented in **Figure 3-1** and **Figure 3-2** for Cadia Valley Operations and Dewatering Facility, respectively. The monthly measured levels for DG9A in **Figure 3-1** were significantly higher than the other monitors in July, October, November and December with levels ranging from 16.1g/m^2/month to 33.7g/m^2/month. These results are analysed in more detail in **Appendix A**.

Table 3-1: Cadia Valley Operations monthly deposited dust monitoring data – insoluble solids (g/m^2/month)

Month	DG5A	DG9A	DG12A	DG15A	DG17	DG18	DG19	DG29A	DGL06	DGL08	DGL09
Jul-20	0.4	33.7c	0.6	0.8	0.4	6.1	0.3	0.5	0.9	0.4	4.3
Aug-20	3.3	6.6	0.6	1.5	0.6	0.6	0.7	0.5	0.8	0.5	0.3
Sep-20	1.8	7.6	1.5	1.5	1.4	2	2.7	1.7	1.5	1.4	1.1
Oct-20	1.7	32.2c	1.2	1.4	0.7	1.2	2.6	1.7	0.5	0.7	0.6
Nov-20	4.4	19.3c	2.2	2.2	1.5	1.2	2	1.9	0.7	1.4	3.2
Dec-20	21c	16.1c	2	3.6	2.2	2.5	3.4	5.3	1.1	1.8	2.7
Jan-21	8.9	9.6	2.1	2.4	1.3	1.8	4.4	2.5	0.6	4.9	2.5
Feb-21	3.9	1.9	5.4	1.7	1.1	0.8	1.4	1.4	1.2	0.7	2.8
Mar-21	1.9	1.5	2.1	2.9	1.7	1.6	0.9	4	1.5	1.3	1.2
Apr-21	1.1	0.9	1.3	1.6	0.7	1.1	0.6	1.2	0.5	0.6	0.4
May-21	1	0.7	1.5	1.5	0.6	0.5	0.5	1.1	1.2	0.7	0.8
Jun-21	1.2	4.7	2.7	2	0.8	1.6	1.2	1.1	1.2	1.4	1.1
Annual Average	2.7	**4.2**	1.9	1.9	1.1	1.8	1.7	1.9	1.0	1.3	1.8

c - Sample contaminated/ invalid, not included in annual average calculation

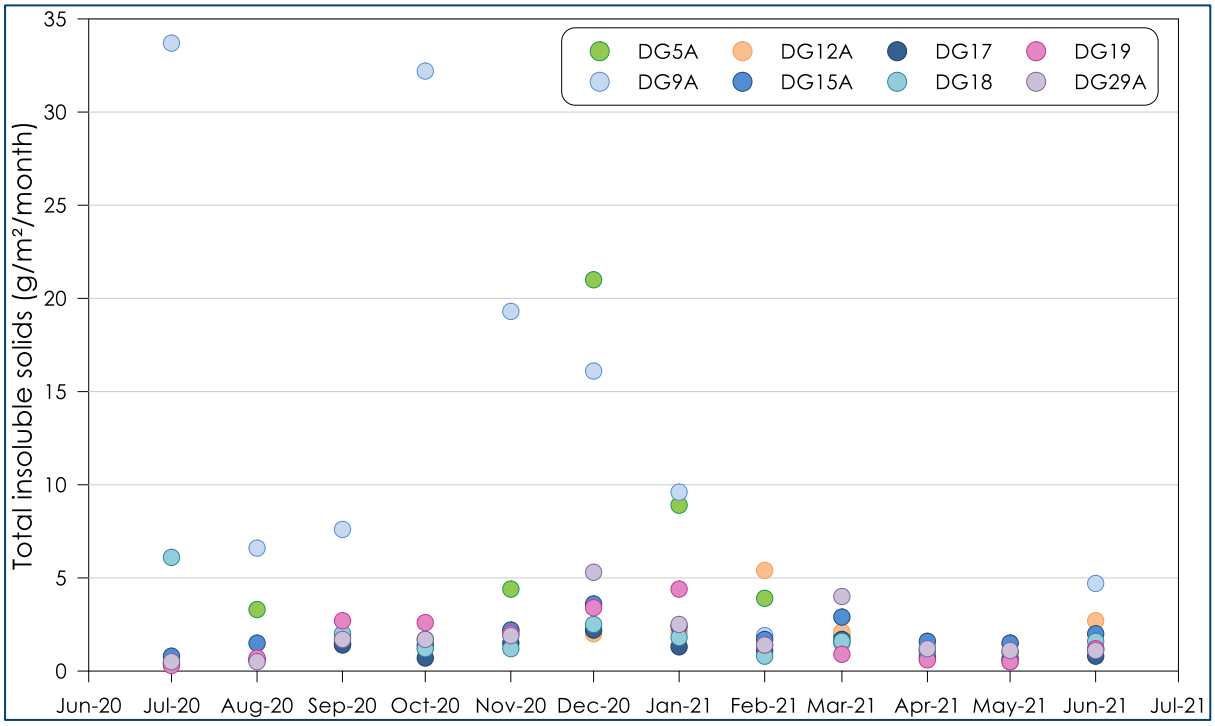

Figure 3-1: Monthly deposited dust results for Cadia Valley Operations

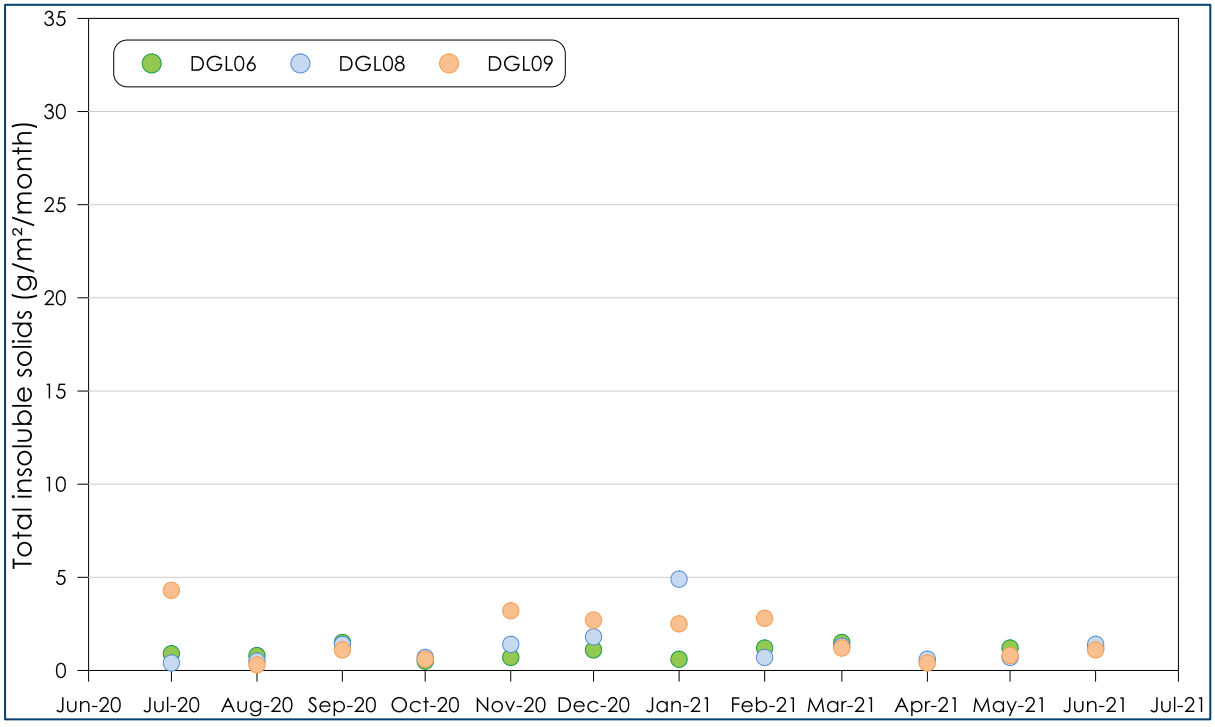

Figure 3-2: Monthly deposited dust results for Dewatering Facility

Figure 3-3 presents annual windrose plots of the meteorological data collected at the Ridgeway and Southern Lease Boundary (SLB) weather stations during the July 2020 to June 2021 period. Winds predominantly originated along a southwest and northeast axis.

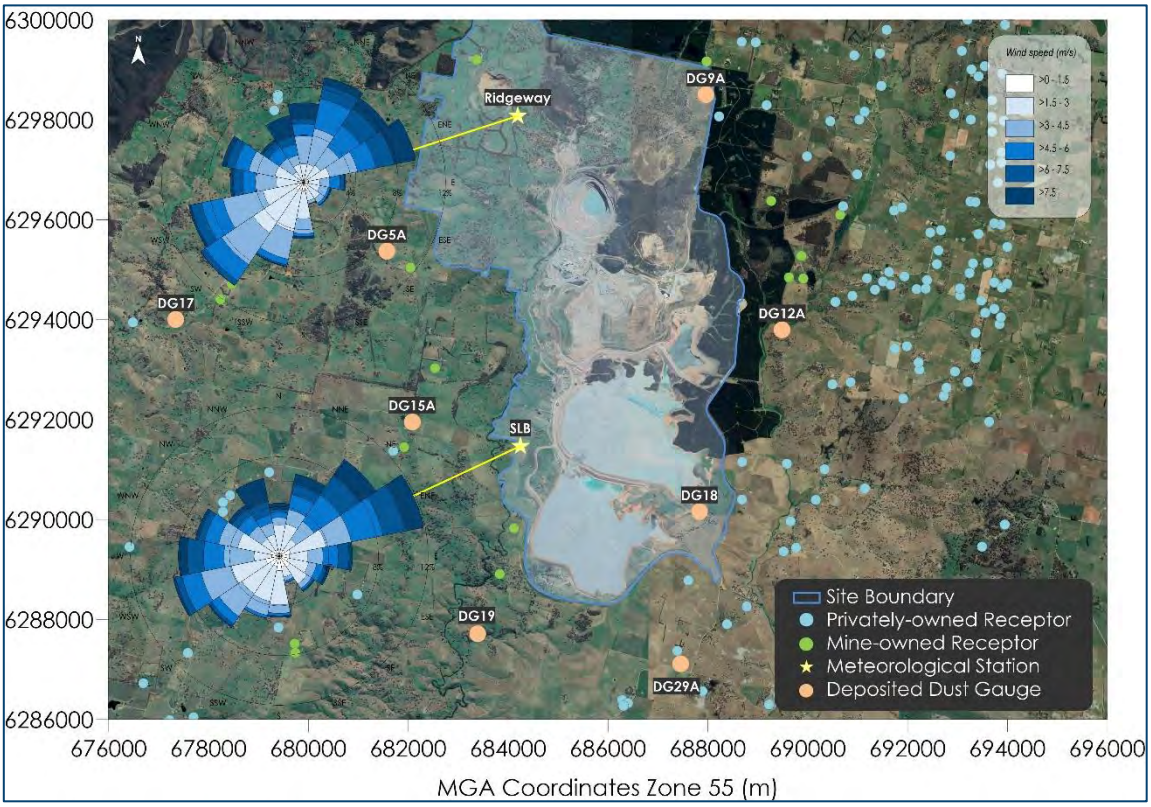

Figure 3-3: Windroses for July 2020 to June 2021

4 ANNUAL AVERAGE DESPOSITED DUST INVESTIGATION

The aim of this investigation is to determine the potential contribution of Cadia Valley Operations to the annual average deposited dust levels recorded at the monitors, and in particular the DG9A monitor. The approach generally follows the evaluation of annual deposited dust monitoring data presented in the *Cadia Valley Operations Air Quality Monitoring Program* (**Cadia Valley Operations, 2018**).

The monthly contribution of Cadia Valley Operations was estimated to be the monthly ash concentrations recorded by each monitor minus the underlying background levels. These levels include the contribution from all sources surrounding the monitors and would also include the contribution associated with regional sources such as dust storms, bushfires, and other extraordinary events.

The background levels for each month were taken to be the average level recorded by the monitors in the network which were upwind of Cadia Valley Operations (or the Dewatering Facility) for more than 80% of the time during each monthly sampling period. That is, these monitors experience wind blowing from the Cadia Valley Operations (or the Dewatering Facility) and transporting dust, for less than 20% of the time. Two different background levels are estimated for Cadia Valley Operations and the Dewatering Facility and applied in the analysis depending on the location of the monitors. The hourly wind direction data from the Cadia Valley Operations on-site weather station were used to calculate the period during which this occurred and would account for the range of different wind conditions experienced.

Table 4-1 shows the percentage of time each monitor is downwind of Cadia Valley Operations (or the Dewatering Facility) the monthly deposited ash content, the calculated monthly background levels for either the Cadia Valley Operations or the Dewatering Facility and the estimated contribution of Cadia Valley Operations (or the Dewatering Facility) to the deposited dust levels recorded at the monitors for each month during the review period.

The measured levels during July, October. November and December at DG9A are likely to be contaminated/invalid and that Cadia Valley Operations would not be a major contributor to the measured dust level. As such, these measured monthly results have been excluded from the incremental contribution analysis and the contribution has been estimated to be less than or equal to the nearest intermediate monitors contribution, in this case DG12A. Further detail regarding the levels at DG9A are presented in **Appendix A**.

The maximum annual average estimated contributions are found to not exceed the incremental criteria of 2g/m^2/month at each of the monitors.

Table 4-1: Cadia Valley Operations contribution to measured deposited dust levels

Month	DG5A	DG9A	DG12A	DG15A	DG17	DG18	DG19	DG29A	DGL06	DGL08	DGL09
	Percentage of time downwind (%)										
Jul-19	10%	-	53%	14%	8%	57%	12%	26%	3%	21%	10%
Aug-19	13%	46%	35%	24%	9%	36%	25%	16%	7%	27%	8%
Sep-19	13%	28%	49%	24%	11%	62%	22%	28%	6%	31%	11%
Oct-19	11%	-	37%	23%	10%	55%	28%	31%	5%	42%	9%
Nov-19	26%	-	26%	39%	22%	32%	38%	19%	14%	38%	8%
Dec-19	-	-	39%	30%	14%	51%	31%	25%	11%	40%	10%
Jan-20	21%	17%	28%	49%	20%	36%	48%	16%	16%	48%	7%
Feb-20	20%	22%	29%	39%	19%	39%	38%	22%	13%	42%	7%
Mar-20	24%	29%	30%	41%	22%	35%	36%	14%	16%	39%	4%
Apr-20	28%	24%	33%	42%	25%	37%	35%	12%	20%	33%	5%
May-20	13%	37%	49%	18%	10%	49%	18%	18%	5%	22%	11%
Jun-20	14%	30%	44%	23%	12%	51%	22%	26%	7%	30%	14%
Month	**Monthly deposited dust monitoring data – ash content (g/m²/month)**										
Jul-19	0.2	-	0.3	0.6	0.2	4.0	0.2	0.3	0.1	0.1	1.6
Aug-19	2.1	5.3	0.3	1.2	0.3	0.2	0.2	0.2	0.3	0.2	0.1
Sep-19	1.0	6.0	0.9	1.1	0.8	1.1	1.6	1.2	0.9	0.9	0.7
Oct-19	0.6	-	0.4	0.8	0.2	0.4	0.5	0.7	0.2	0.4	0.3
Nov-19	0.8	-	0.9	1.2	0.7	0.4	0.7	0.7	0.3	0.4	2.2
Dec-19	-	-	0.6	1.9	0.8	1.2	1.4	1.7	0.5	0.9	1.5
Jan-20	0.9	2.3	0.4	1.3	0.2	0.5	0.8	0.7	0.3	1.0	0.7
Feb-20	0.8	0.6	1.3	1.0	0.4	0.4	0.5	0.7	0.8	0.2	0.9
Mar-20	1.1	1.1	0.9	1.6	0.5	0.7	0.5	1.1	1.0	0.7	0.5
Apr-20	0.4	0.5	0.4	0.7	0.2	0.2	0.2	0.2	0.3	0.2	0.1
May-20	0.6	0.4	0.9	1.2	0.4	0.3	0.3	0.8	1.0	0.5	0.6
Jun-20	0.4	2.2	1.4	1.2	0.4	0.6	0.5	0.6	0.5	1.0	0.5
Month	**Estimated Background***		**Maximum estimated contribution to monitor – ash content (g/m²/month)**								
	CVO	**D. F.**									
Jul	0.3	0.9	0.0	0.0**	0.0	0.3	0.0	3.7	0.0	0.0	0.0	0.8
Aug	0.9	0.2	1.8	5.1	0.0	0.9	0.1	0.0	0.0	0.0	0.0	0.0
Sep	0.9	0.8	0.7	5.7	0.6	0.8	0.5	0.8	1.3	0.9	0.0	0.1	0.0
Oct	0.4	0.2	0.3	0.1**	0.1	0.5	0.0	0.1	0.2	0.4	0.0	0.0	0.0
Nov	0.7	1.3	0.5	0.6**	0.6	1.0	0.4	0.1	0.4	0.4	0.0	0.0	1.4
Dec	0.8	1.0	6.4	0.3**	0.3	1.6	0.5	1.0	1.1	1.4	0.0	0.1	0.6
Jan	1.1	0.5	0.6	2.0	0.1	1.0	0.0	0.2	0.5	0.4	0.0	0.1	0.0
Feb	0.4	0.8	0.5	0.3	1.0	0.7	0.1	0.1	0.2	0.4	0.0	0.0	0.0
Mar	1.1	0.7	0.8	0.8	0.7	1.4	0.3	0.4	0.3	0.8	0.1	0.0	0.0
Apr	0.2	0.2	0.1	0.2	0.1	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
May	0.7	0.8	0.3	0.2	0.6	0.9	0.2	0.0	0.1	0.5	0.0	0.0	0.0
Jun	0.4	0.5	0.2	2.0	1.2	0.9	0.2	0.3	0.2	0.3	0.0	0.1	0.0
Annual average	**0.7**	**0.7**	1.0	1.4	0.5	0.9	0.2	0.6	0.4	0.5	0.0	0.0	0.2

D.F. = Dewatering Facility

* The average of the levels where monitors were downwind of Cadia Valley Operations/ Dewatering Facility for less than 20% of the time in the monitoring period was taken to be the background.

** Contribution assumed to be equal to (or less than) that of intermediate DG12A monitor.

5 SUMMARY AND CONCLUSIONS

This investigation has estimated the contribution due to activity at Cadia Valley Operations to the elevated annual average deposited dust levels recorded during the July 2020 to June 2021 period. The annual average data indicate all monitors recorded total annual average levels below the relevant criterion of 4g/m^2/month during the period except for DG9A.

An investigation of the monthly DG9A deposited dust monitoring data indicates a number of samples are likely contaminated/ invalid and that Cadia Valley Operations would not be a major contributor to the measured dust level and were excluded from the incremental contribution analysis.

The analysis of the incremental contribution has found the estimated annual average contribution due to activity at the Cadia Valley Operations would meet the relevant incremental criterion of 2g/m^2/month as per PA 06_0295.

6 REFERENCES

Cadia Valley Operations (2018)

"Cadia Valley Operations Air Quality Monitoring Program", prepared by Cadia Valley Operations, Version 4, June 2018.

PA 06_0295

Project Approval, Application No. 06_0295 for Cadia Holding Pty Limited, 6 January 2020.

Todoroski Air Sciences (2020)

"Air Quality Impact and Greenhouse Gas Assessment Cadia Valley Operations Processing Rate Modification", prepared for Cadia Holdings Pty Ltd by Todoroski Air Sciences, December 2020.

Appendix A

Investigation of elevated deposited dust levels

Table A-1 outlines the elevated deposited dust levels for the review period.

Table A-1: Elevated deposited dust levels

Monitor	Period	Value			Reason for exclusion
		Insoluble solids (g/m²/month)	Ash content (g/m²/month)	Organic matter in sample (%)	
DG5A	Dec-20	21	6.68	68%	Field notes accompanying sample indicated contamination with lots of insects present. Organic matter in the sample is 68% and confirms field note.
DG9A	Jul-20	33.7	25.3	25%	Organic matter in the sample is 25%. Monitor downwind of CVO for 32% of time and unlikely to that the elevated levels are due to the mining activity alone. Further discussion provided below.
DG9A	Oct-20	32.2	5.9	82%	Organic matter in the sample is 82%. High organic content indicates contamination and level not representative of mining activity. Monitor downwind of CVO for 21% of time and unlikely to that the elevated levels are due to the mining activity alone. Further discussion provided below. Further discussion provided below.
DG9A	Nov-20	19.3	11.9	38%	Organic matter in the sample is 38%. Monitor downwind of CVO for 21% of time and unlikely to that the elevated levels are due to the mining activity alone. Further discussion provided below.
DG9A	Dec-20	16.1	2.65	84%	Organic matter in the sample is 84%. High organic content indicates contamination and level not representative of mining activity. Monitor downwind of CVO for 24% of time and unlikely to that the elevated levels are due to the mining activity alone. Further discussion provided below.

DG9A recorded significantly higher levels compared to the other monitors in the network in July, October, November and December and further analysis was conducted for these periods.

A review of the field notes during these months indicated the DG9A samples contained insects and bird droppings which may have contributed to the elevated readings. We note the measured level in December 16.1g/m²/month is similar to the contaminated reading at DG5A of 21g/m²/month during this period and suggests the samples are contaminated/invalid.

The monthly measured insoluble solids and ash content for DG9A is presented in **Figure A-1**. The difference in insoluble solids and ash content is the amount of organic matter present in the sample. Sources of organic matter can consist of insects or bird droppings or leaf detritus which deposit in the gauge and are included in the measurement of insoluble solids. The sample is then combusted to remove organic matter leaving the residual ash content.

During October and December, the results indicate a high content of organic matter of approximately 82% and 84% in the samples and strongly indicates these samples are contaminated. The organic matter content in July and November is approximately 25% and 38%, respectively, however have similar levels of insoluble content to the other two months.

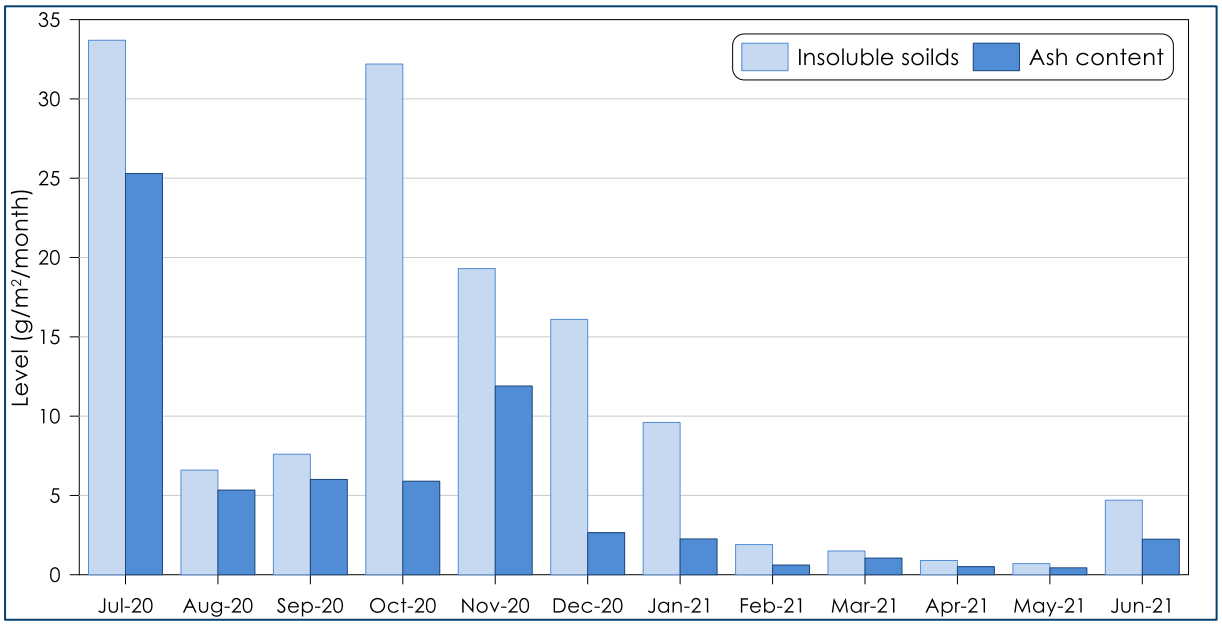

Figure A-1: Insoluble solids and ash content – DG9A

Analysis of the wind data during July, October, November and December show that winds from Cadia Valley Operations to the DG9A monitor would account for 32%, 21%, 21% and 24% of the time respectively. This indicates that the Cadia Valley Operations could generally only impact the DG9A monitor for a low portion of time, and it is unlikely that the elevated levels are due to the mining activity alone. It is likely that other nearby sources of dust (and organic material) are contributing to the elevated levels at other times during these periods.

Figure A-2 presents the monthly wind speed distribution for the Ridgeway weather station. During July and November there is a higher percentage of low wind speeds in the 0.5-2m/s and 2-3m/s categories. Similar percentages are seen in April, May and June when recorded deposited dust levels are low at the DG9A monitor. During December, a high frequency of wind speeds in the 6-8m/s and 8-10m/s categories occur compared to the other months, however high deposited dust levels are also recorded when months have low wind speeds. Whilst increasing wind speeds are attributed to an increase in windblown dust generation, there does not appear to be a clear relationship with the elevated deposited dust levels at DG9A and may be due to the distance of the monitor relative to the mining activities.

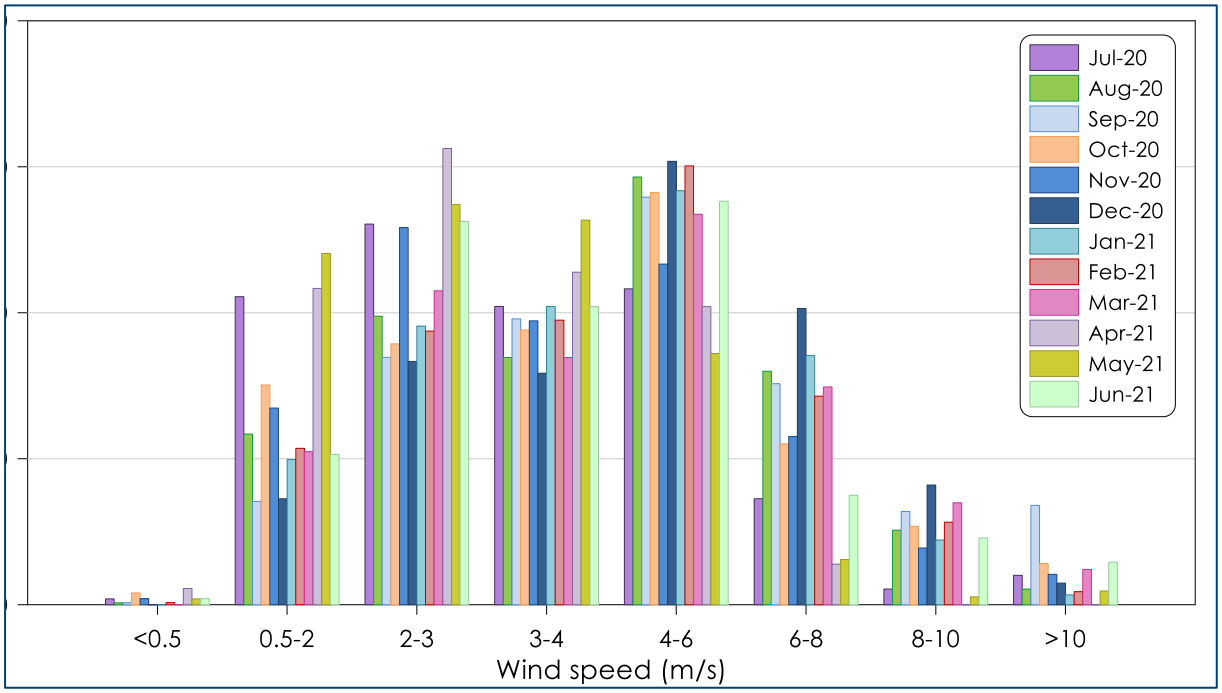

Figure A-2: Monthly wind speed distribution for Ridgeway weather station

The DG9A monitor is located well away from the current active mining operations, approximately 4 kilometres to the north of the ore processing facility. Deposited dusts typically comprise larger particles which do not stay suspended for long periods and hence do not travel far from the source before depositing out. As such dust deposition gauges are particularly sensitive to local sources of dust and can often skew the measured result from the intended purpose of monitoring the mine's impact. The DG9A appears to be located near other local dust sources that could have contributed to the elevated readings and are not representative of the main activities occurring at Cadia Valley Operations. The sources include vehicles travelling on an unsealed driveway, grass cutting occurring near the monitor and cattle grazing in nearby paddocks. This further suggests the measurements are not valid.

The calculated annual average deposited dust results for the July 2020 to June 2021 period have been compared with air dispersion modelling predictions of the Cadia Valley Operations with a contribution from the background dust environment. The air dispersion modelling was setup using the same methodology applied in the *Air Quality Impact and Greenhous Gas Assessment Cadia Valley Operations Processing Rate Modification* (**Todoroski Air Sciences, 2020**).

Figure A-3 presents a comparison of predicted annual average deposited dust with the measured levels. The predicted deposited dust levels show good comparison with the calculated annual average deposited dust results for the gauges located closest to the mining activity. We can see from the predicted deposited dust contours the extent of impacts do not travel far from the dust sources. The predicted level at DG9A is <1.5g/m^2/month considering the key dust generating sources at Cadia Valley Operations and is not a significant contributor at this is monitor.

On the basis of the above analysis, it is considered that the measured levels during July, October, November and December at DG9A are likely to be contaminated/invalid and that Cadia Valley Operations would not be a major contributor to the measured dust level. As such, these measured

monthly results have been excluded from the incremental contribution analysis and the contribution has been estimated to be less than or equal to the nearest intermediate monitor's contribution, in this case DG12A.

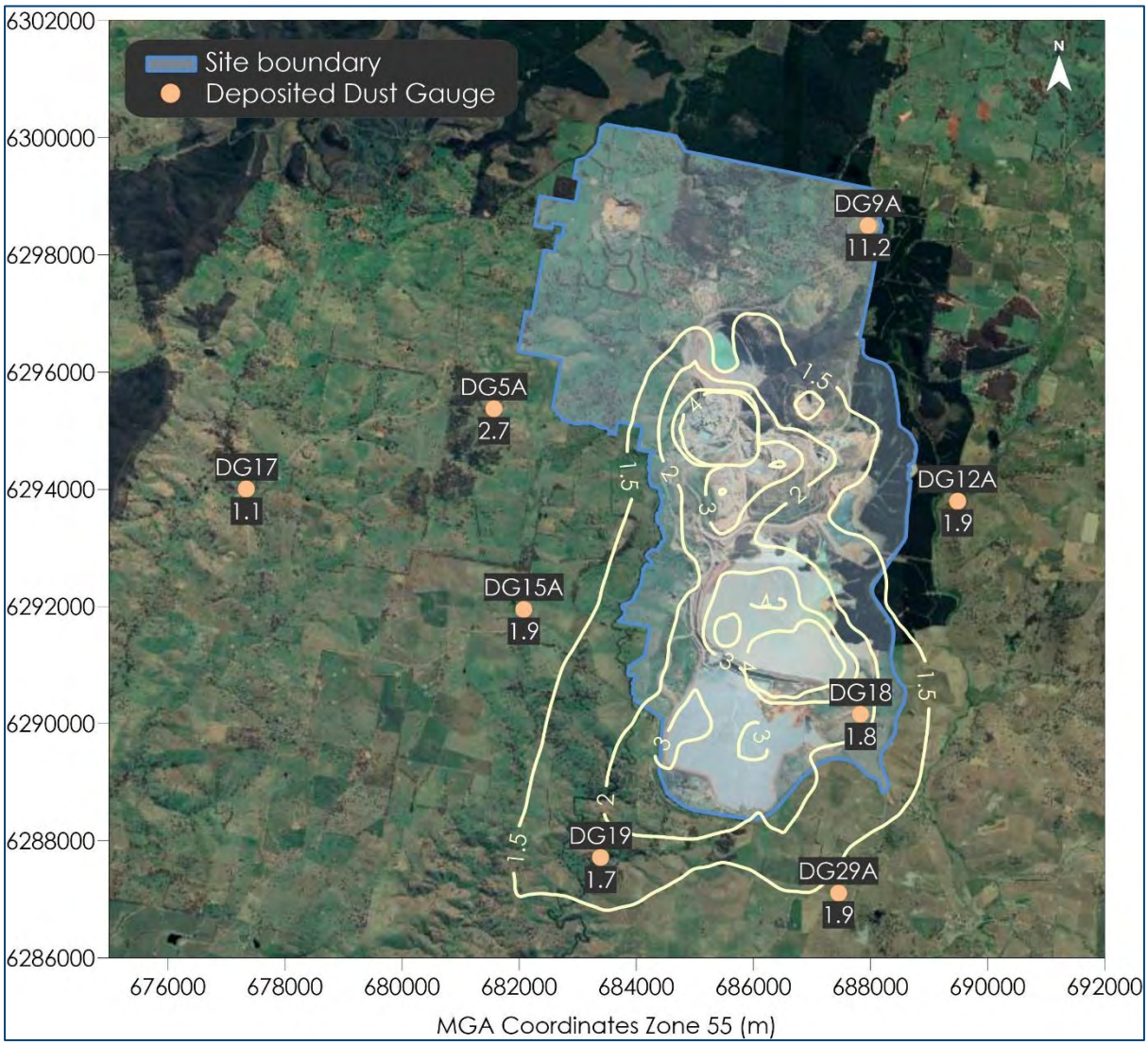

Figure A-3: Comparison of predicted annual average dust deposition with measured levels (g/m²/month)

Fact Sheet

Tailings Dust Environmental Health Assessment and Air Quality Monitoring Study

What was the Tailings Dust Environmental Health Assessment and Air Quality Monitoring Study?

In response to community concerns, Cadia Valley Operations (Cadia) completed a comprehensive Study into the potential environmental health impacts of the tailings dust and commenced additional testing and monitoring. The Study also included assessments on dust emitted from Cadia's mine ventilation system, which ventilates Cadia's underground mining operation.

Through 2020 and early 2021, Cadia engaged a range of specialists to undertake and peer review the Study. This factsheet summarises the key findings of that Study.

What is tailings and tailings dust?

Tailings is the finely-ground rock product, left over once ore processing has been completed and the gold, copper and molybdenum has been extracted. Tailings is pumped as a slurry (i.e. mixed with water) to one of Cadia's Tailings Storage Facilities (TSF) for disposal (refer to the Tailings Fact Sheet for further detail).

Upon deposition of the tailings slurry to the TSF, the slurry separates and some of the water is collected and is re-used for ore processing. Without further deposition or rainfall, the tailings can dry out and under certain windy conditions become airborne dust.

Why is there currently more tailings dust?

The Northern Tailings Storage Facility (NTSF) embankment slump in March 2018 led to the cessation of tailings deposition on the NTSF, and deposition to the Southern Tailings Storage Facility (STSF) is currently limited by a lack of available capacity, with further construction underway to increase the capacity. Without tailings deposition, the NTSF and STSF have progressively dried resulting in an increased occurrence of dust lift-off. Cadia has made significant investment in dust management and continues to pursue multiple management measures to mitigate this complex and challenging issue until normal operation of the TSFs can resume. For further information on Cadia's Tailings Dust management activities, refer to: https://www.cadiavalley.com.au/site/community.

Monitoring of air quality at Cadia

Cadia's Air Quality Monitoring Program is managed in accordance with the Cadia Air Quality Monitoring Program (Cadia AQMP) which was approved by NSW Department of Planning, Industry and Environment (DPIE). Air Quality monitoring is conducted using Tapered Element Oscillating Microbalance (TEOM) monitors (see Figure 1) and Dust Deposition Gauges located in various locations (see Figure 2). Monitoring undertaken includes:

- PM10 Ambient Dust Monitoring,
- Deposited Dust Monitoring,
- Visual Dust Monitoring, and
- Meteorological Monitoring.

For details on Cadia's Air Quality Monitoring Program and monthly Air Quality reports refer to: https://www.cadiavalley.com.au/site/air-quality.

Figure 1: A Tapered Element Oscillating Microbalance (TEOM).

Who was involved in the Study?

Cadia used a range of specialists and specialist laboratory services to undertake the Study, including Todoroski Air Services, Earth Systems Consulting, Callander & Johnson, ALS Laboratory Group and University of Queensland's Central Analytical Research Facility.

Additionally, Cadia engaged Mr. Paul Harrison, from Serinus Health, Safety and Environment, to peer review the program of work and reports. Mr Harrison is a specialist consultant in occupational health and safety and environmental management with more than 30 years of experience and expertise in the field.

What did the Study cover?

The Study work program encompassed:

1. Laboratory testing of the tailings and tailings dust to determine its geochemical and mineralogical composition,
2. Monitoring of ambient air concentrations of respirable crystalline silica (RCS) from vent emissions,
3. Assessment of the exposure risk to the community from RCS based on ambient air monitoring and comparison to relevant guidelines[i],
4. Monitoring of ambient air concentrations of PM10 and PM2.5 particulate matter,
5. Assessment of the exposure risk to the community from PM10 and PM2.5 based on ambient air monitoring and comparison to relevant guidelines[ii],
6. Testing and reporting on drinking water and water from farm dams used for livestock watering at local residences, and
7. Undertaking HSE Materials Hazard Assessment for Cadia's tailings, including a review of ore processing reagents, dust suppression products and potential breakdown by-products of reagents and dust suppression products.

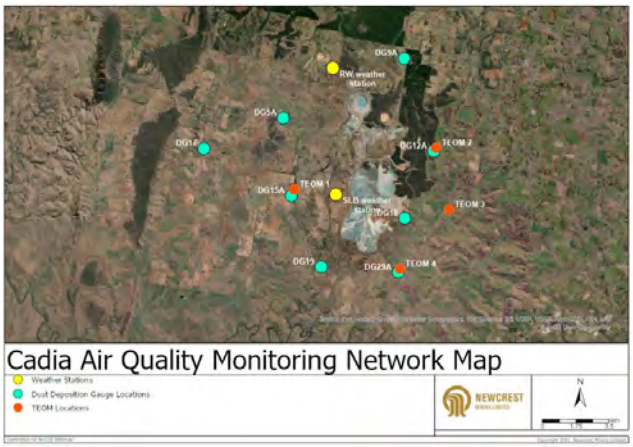

Figure 2: Map insert of Cadia's Air Quality Network.

What did the Study find?

A summary of the key technical findings is provided below.

Tailings mineral and chemical composition and health risk:

- The tailings can be classified as non-hazardous in all categories of classification under the United Nations Globally Harmonised System of Classification and Labelling of Chemicals (GHS) and the European Commission 2008 Regulation (EC) No. 1272/2008.
- The tailings are composed primarily of inert minerals (i.e. non-reactive) comprising mainly aluminosilicates which are one of the most abundant sets of minerals in the earth's crust.
- Secondary minerals (i.e., salts that form on the tailings) are mostly hydrous calcium-sodium-magnesium sulphates (e.g., gypsum, blodite, glauberite) with lesser chlorides (halite) and iron sulphates (rhomboclase).
- Tailings samples were tested for the presence of 26 metals, and none of the metals were found in concentrations that cause adverse health effects based on International Agency for Research on Cancer (IARC) and United Nations GHS classifications.
- All metals were found at levels well below the health criteria for hazardous materials based on the United Nations GHS (used to assess the health, safety and environmental hazard level of all chemicals, mixtures and waste materials).

- No asbestos or asbestiform materials were present.
- Samples of the tailings had quartz concentrations of 14% to 17% by weight. Quartz concentrations in the PM10 fraction of the tailings (the respirable fraction) was found to average 0.23% by weight; well below levels that would classify the tailings as hazardous according to the United Nations GHS.
- The pH of water that was exposed to the tailings in the laboratory was neutral to alkaline (pH results range 7.4 to 8.0).

Dust testing and health risk:

- The monitoring of metals in PM10 particles in ambient air indicated that airborne concentrations were within relevant ambient air quality guidelines[i].
- The monitoring of PM2.5 particulate matter in ambient air, indicated that at community sites, airborne concentrations were trending*[iii] below the relevant ambient air quality guideline[i].
- The monitoring of ambient air Respirable Crystalline Silica (RCS) indicated that airborne concentrations were trending below the relevant ambient air quality guideline[i].

Drinking Water testing results:

- Household water tank testing results met Australian Drinking Water Guidelines.

Livestock water testing results:

- All water sources from the farm dams met the Australian livestock watering guidelines.

Dust Suppressant testing results:

- Dust suppressant chemicals used to coat the surface of the tailings dam are classified as non-hazardous under the United Nations GHS.

Conclusion

At the completion of the Study, Serinus concluded, "Based on the data and information available from the Tailings Dust Environmental Health Assessment and Air Quality Monitoring Study, and the ambient dust levels measured by the Study, there is no current evidence to suggest that dust from the Cadia tailings storage facilities or emissions from the mine ventilation system pose a health risk to the community."

Is Cadia continuing its Study?

Cadia has concluded the Study that was being overseen by Serinus. Cadia will continue with the expanded air quality monitoring to collect data to support ongoing assessment. The community will be periodically updated to maintain confidence in the findings and provide reassurance that tailings dust does not pose a health risk to the community.

For enquiries or further information please contact Matt Armstrong on 1800 063 043 or matthew.armstrong@newcrest.com.au.

[i] A range of air quality criteria guidelines were used. The order of priority given to the air quality criteria used as benchmarks for the Study is listed below. Where a criterion did not exist for the substance of interest or for the averaging time required, one was sought from the next source down in the priority list:

1.NSW Environmental Protection Authority (NSW EPA 2017),
2. Other Australian federal or state jurisdiction, e.g., Queensland Government (2019), Environmental Protection, Authority Victoria (EPA Victoria 2008).
3. Ontario Ministry of Environment (MOE 2012).

[ii] As above.

[iii] To be confirmed when a full dataset is obtained and analysed at the completion of 12 months of continuous monitoring.

SERINUS
HEALTH SAFETY AND ENVIRONMENT

Final Report

Tailings dust environmental health assessment and monitoring study review

Cadia Valley Operations

Prepared for Newcrest Mining Limited Cadia Valley Operations - 2 July 2021

Serinus Pty Ltd

ABN: 69 616 248 081

PO Box 2152
Brookside Centre Qld 4053
Australia

+61 439 892 893
+61 422 954 046

enquiries@serinushse.com.au
www.serinushse.com.au

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Prepared by	Paul Harrison
Approved by	Paul Harrison

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Acknowledgements

Many people at Cadia Valley Operations gave freely of their time and energy to contribute to this Study. Their input was marked by a desire to address the community impact of dust from Cadia Valley Operations. Their contributions are gratefully acknowledged.

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Summary and key findings

Does tailings dust from Cadia Valley Operations pose a community health risk?

Based on the data and information available from the Cadia Tailings Dust Monitoring and Assessment Project (the Study), and the ambient dust levels measured by the Study, there is no current evidence to suggest that dust from the CVO tailings storage facilities or emissions from the mine ventilation system pose a health risk to the community.

Cadia Tailings Dust Monitoring and Assessment Project (the Study)

In March 2018, the Northern Tailings Storage Facility (NTSF) embankment slumped leading to the cessation of tailings deposition into the NTSF. As a consequence, the NTSF dried, resulting in increased dust emissions. To mitigate the dust emissions, application of dust suppression products to the surface of the NTSF commenced.

In November 2019, tailings deposition on the Southern Tailings Storage Facility (STSF) ceased and all tailings was directed to the Open Pit Tailings Storage Facility (PTSF). This was done to preserve STSF storage capacity and improve water recycling. Application of dust suppressant products was extended to the STSF.

Following the embankment slump there were a number of exceedances of the *Cadia East Project Approval Air Quality Short Term Criteria* (NSW Government 2019) and numerous community complaints about dust. The Cadia community expressed concerns about not fully understanding what is in the dust and what potential impacts the dust could have on community health and agricultural enterprises.

Cadia Valley Operations (CVO) undertook an environmental health assessment of the tailings dust to address the community's concerns. This was referred to as *Cadia Tailings Dust Monitoring and Assessment Project* (the Study).

Objectives of the Study

The objectives of the Study were to:

1. address community concerns about the potential health and livelihood impacts from tailings dust
2. deliver against commitments made to community stakeholders
3. work transparently and collaboratively with stakeholders to understand and manage impacts.

Scope of the Study

The Study incorporated a number of different components that were delivered by specialists in their respective fields. The Study work program encompassed:

1. undertaking geochemical and mineralogical analysis of tailings and tailings dust to enable an environmental health assessment of Cadia tailings dust
2. monitoring of ambient air concentrations of respirable crystalline silica (RCS) from vent (air outlet vents from the underground mine) emissions
3. assessment of the exposure risk to the community from RCS based on ambient air monitoring
4. testing and reporting on drinking water and water from farm dams used for livestock watering at local residences
5. development of a safety data sheet for Cadia's tailings, including a review of ore processing reagents, ameliorates (e.g., dust suppression products) and potential breakdown by-products of reagents and ameliorates (the safety data sheet is referred to herein as a *HSE Materials Hazard Assessment*).

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Full details of the Study are documented in *Cadia Tailings Dust Environmental Health Assessment and Monitoring Project Plan for Community Consultation* (Newcrest Mining Limited 2019).

The role of Serinus Health Safety and Environment in the Study was review of the monitoring program; provision of advice about the monitoring program; review of data collected by the monitoring program; and review of the reports provided by specialists engaged for the Study.

Work undertaken for the Study

Earth Systems (Melbourne) undertook a characterisation of the chemical, geochemical and mineralogical fingerprint of the tailings. This was undertaken to assess the potential impact of dust from the tailings storage facilities on the local community. Refer to ***Appendix A*** for the full reports provided by Earth Systems.

Following identification of a chemical, geochemical and mineralogical fingerprint of the tailings, Earth Systems conducted an assessment of deposited dust. They undertook an examination of roof, farm dam and bore water sampled in May 2020 (refer to ***Appendix A***), taking into consideration information gathered during the dust identification and deposition assessment work. Additional water sampling and analysis was conducted by CVO in September/October 2020. In total, 48 water quality samples were collected during the two sampling periods (see Figure 1 for a map of sampling locations). The primary focus of the analysis was on metals as outlined in the Australian Drinking Water Guidelines (NHMRC, NRMMC 2011 updated March 2021). Refer to the health, safety and environmental (HSE) materials hazard assessment in ***Appendix B*** for the results of water analysis conducted by CVO.

Todoroski Air Sciences (Sydney) reviewed CVO's air quality monitoring plan and recommended amendments to assist with quantification of any potential dust emissions generated by the NTSF, STSF and mine vents. Refer to ***Appendix C*** for the full reports provided by Todoroski Air Sciences.

Based on the advice of Todoroski Air Sciences, CVO undertook monitoring for metals in PM_{10} (particulate matter less than 10 micrometres in aerodynamic diameter), $PM_{2.5}$ (particulate matter less than 2.5 micrometres in aerodynamic diameter), and RCS in $PM_{2.5}$. Refer to ***4.4 Airborne dust/PM10 metals*** on page 22 and Table D.1 in ***Appendix D*** for the results of the PM_{10} metals monitoring; and ***4.4 Airborne dust/Respirable crystalline silica*** on page 24 for the results of the $PM_{2.5}$ and RCS monitoring.

Callander & Johnson (Melbourne) conducted an evaluation of the organic chemicals used in the processing of minerals at CVO; and assessed the HSE hazards posed by the generated tailings material against internationally accepted protocols and classification schemes. Refer to ***Appendix B*** for the HSE Materials Hazard Assessment of the tailings and the results of the organic chemicals analysis.

Key findings of the Study

Tailings composition and health risk

1. Surface tailings samples contained a mixture of primary and secondary minerals, with secondary minerals and amorphous components being more concentrated in the PM_{10} fraction.
2. The major primary minerals present were plagioclase feldspar, illite/mica, quartz, chlorite/clinochore and potassium feldspar, making up over 80 wt% of the bulk tailings. Plagioclase feldspar, illite/mica, chlorite/clinochore and potassium feldspar are aluminosilicates which are found widely in the Earth's crust.
3. The secondary minerals were mostly hydrous calcium-sodium-magnesium sulphates (e.g., gypsum, blodite, glauberite) with lesser chlorides (halite) and iron sulphates (rhomboclase). Many of these secondary minerals are soluble to highly soluble in water and have low densities compared to primary tailings mineral phases.
4. Secondary minerals are the most likely tailings component to become airborne, due to their location at the surface of the tailings storage facility and comparatively low density. They are expected to be the first to be mobilised as dust and/or travel the furthest if they become airborne during windy conditions. After deposition, they are also

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the most likely minerals to subsequently dissolve upon contact with water due to their high solubility. Consequently, these phases have the potential to effect down-wind water chemistry. For example, these minerals have the potential to give drinking water a salty and/or bitter taste.

5. Metal concentrations in the tailings material were found to be very low, except for aluminium as aluminosilicate and iron, as iron-sulphur compounds. No metal was found in concentrations which would cause short-term or long-term health effects according to the United Nations Globally Harmonised System of Classification and Labelling of Chemicals (GHS) (see Table 7).

6. Leaching data, which provides an analogue for the leaching of tailings during a rainfall event, indicated the presence of antimony, arsenic, chromium, copper, iron, lead, mercury, molybdenum, selenium and zinc. These are elements which are most likely to be mobilised from soluble tailings components during rainfall events. However, the results of water sampling indicated no significant effect on water quality (see Findings 19 and 21).

7. The pH of leachate water was 7.4 to 8.0, consistent with an excess of carbonate (non-acid forming), low acidity values, and elevated alkalinity values. A slightly negative Net Acid Production Potential calculated from the tailings mineralogy, supported the finding that the tailings material is non-acid forming.

8. Between 1.8 and 4.1 wt% of the tailings was in the PM_{10} size range (averaging 3.3 wt%).

9. The tailings contained significant concentrations of quartz (14 to 17 wt%). Quartz, when in the respirable size range, is usually the major component of RCS. In the PM_{10} component of the tailings, quartz was present at values ranging from 5.0 and 8.7 wt% (averaging 7.1 wt%). This equates to respirable quartz making up 0.23 wt% (on average) of the bulk tailings material. Consequently, the respirable fraction of quartz in the tailings was below levels that would classify the tailings as hazardous according to the United Nations GHS.

10. Amphibole group minerals were identified in two of the tailings samples (see ***Appendix E***). Certain amphibole minerals have the potential to occur in, what is referred to as, a fibrous habit (i.e., they are asbestiform minerals such as asbestos). Subsequent analysis of the tailings indicated that no asbestos or asbestiform materials were present (see Certificate of Analysis ES2016687 in ***Appendix F***).

11. Low levels of hydrocarbon compounds were found to be present in the tailings. There were eight unidentified hydrocarbon compounds reported with a total concentration of 33 ppm. These hydrocarbons were alkanes, which are low hazard hydrocarbons. None of the traditionally carcinogenic hydrocarbon compounds, such as polycyclic aromatic hydrocarbons or benzene, were present (see Certificate of Analysis EB2000591 in ***Appendix F***).

12. The tailings classified as non-hazardous in all categories of classification under the United Nations GHS and the European Commission 2008 Regulation (EC) No. 1272/2008 on classification, labelling and packaging of substances and mixtures (CLP) as it applies to metals and minerals (see Table 8).

Airborne dust and health risk

13. Measurements using dust deposition gauges (DDGs) indicated the presence of some metals in deposited dust. However, the levels were low, and they were not necessarily present in water-soluble form, so their presence does not automatically translate to water quality impacts. Indeed, as detailed in Findings 19 and 21, the results of water sampling indicated no significant effect on water quality.

14. Approximately 10 to 20 wt% of deposited dust reporting to DDGs was in a soluble form, consistent with a theory that highly soluble efflorescent (surface) materials from the tailings would be the most likely to be mobilised as dust in windy conditions and travel the furthest. This suggests, at least to some extent, that deposited dust is influenced by tailings dust. However, the results of water sampling indicated no significant effect on water quality (see Findings 19 and 21).

15. The monitoring of PM_{10} metals in ambient air conducted to date, indicated that airborne concentrations were within relevant ambient air quality guidelines (see Table 4).

16. The monitoring of $PM_{2.5}$ particulate matter in ambient air conducted to date, indicated that airborne concentrations were trending below the relevant ambient air quality guideline (see Table 5).

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17. The monitoring of ambient air RCS to date, indicated that airborne concentrations were trending below the relevant ambient air quality guideline (see Table 5).

18. The current ambient air monitoring trends are indicative of results that will ultimately comply with the relevant air quality guidelines, but this will be confirmed at the end of a twelve-month monitoring program.

Water quality and health risk

19. All tank water samples met the Australian Drinking Water Guidelines for health-based criteria except for one. In one instance, cadmium slightly exceeded the guidelines. This was attributable to contamination from galvanised steel roofing or guttering (Taylor 2021, p. 23). Some samples exceeded the aesthetic criteria. See ***Appendix A*** and ***Appendix B***.

20. All roof water samples had very low sulphate and chloride concentrations which, based on mineralogy of the tailings (i.e., the tailings contain significant amounts of chloride and sulphate), strongly supports the proposition that there is no significant effect from CVO tailings dust on roof water. Consequently, metals in roof water appeared to be primarily influenced by local materials including galvanised steel roofing or guttering materials (sources of zinc and cadmium), rusting of steel roof materials (iron), copper piping (copper), lead flashing (lead) and dust from natural carbonate-bearing sources (e.g., manganese).

21. All water sources from the farm dams met the Australian livestock watering guidelines (see ***Appendix A*** and ***Appendix B***).

Dust suppressants and health risk

22. Dust suppressant chemicals used to coat the surface of the tailings dam were classified as non-hazardous under the United Nations GHS.

Recommendations

CVO proposes to continue the expanded air monitoring program implemented for the Study until a full data set has been collected. The following recommendations are provided to assist in achieving that aim:

1. Continue with the ambient air sampling program recommended by Todoroski Air Sciences until at least 12 months of data are collected for each of the locations.

2. Continue with the low-volume air sampling program at Bundarra and Woodville (locations potentially impacted by mine vent emissions) until 12 months of $PM_{2.5}$ and RCS data are collected.

3. Issue a further report following the completion of Recommendations 1 and 2.

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1. Introduction

In March 2018, the Northern Tailings Storage Facility (NTSF) embankment slumped leading to the cessation of tailings deposition into the NTSF. As a consequence, the NTSF dried, resulting in increased dust emissions. To mitigate the dust emissions, application of dust suppression products to the surface of the NTSF commenced.

In November 2019, tailings deposition on the Southern Tailings Storage Facility (STSF) ceased and all tailings was directed to the Open Pit Tailings Storage Facility (PTSF). This was done to preserve STSF storage capacity and improve water recycling. Application of dust suppressant products was extended to the STSF.

Following the embankment slump there were a number of exceedances of the *Cadia East Project Approval Air Quality Short Term Criteria* (NSW Government 2019) and numerous community complaints about dust. The Cadia community expressed concerns about not fully understanding what is in the dust and what potential impacts the dust could have on community health and agricultural enterprises.

Cadia Valley Operations (CVO) undertook an environmental health assessment of the tailings dust to address the community's concerns. This was referred to as *Cadia Tailings Dust Monitoring and Assessment Project* (the Study).

The objectives of the Study were to:

1. address community concerns about the potential health and livelihood impacts from tailings dust
2. deliver against commitments made to community stakeholders
3. work transparently and collaboratively with stakeholders to understand and manage impacts.

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2. Scope and approach

The Study incorporated a number of different components that were delivered by specialists in their respective fields. The Study work program encompassed:

1. undertaking geochemical and mineralogical analysis of tailings and tailings dust to enable an environmental health assessment of Cadia tailings dust
2. monitoring of ambient air concentrations of respirable crystalline silica (RCS) from vent (air outlet vents from the underground mine) emissions
3. assessment of the exposure risk to the community from RCS based on ambient air monitoring
4. testing and reporting on drinking water and water from farm dams used for livestock watering at local residences
5. development of a safety data sheet (material handling, management and exposure procedures) for Cadia's tailings, including a review of ore processing reagents, ameliorates (e.g., dust suppression products) and potential breakdown by-products of reagents and ameliorates (the safety data sheet is referred to herein as a *HSE Materials Hazard Assessment*).

Full details of the Study are documented in *Cadia Tailings Dust Environmental Health Assessment and Monitoring Project Plan for Community Consultation* (Newcrest Mining Limited 2019).

The role of Serinus Health Safety and Environment in the Study was review of the monitoring program; provision of advice about the monitoring program; review of data collected by the monitoring program; and review of the reports provided by specialists engaged for the Study. This involved visits to site on 30 June 2020 and 1 July 2020 to review the sampling methodology, including siting of air monitoring equipment. It also involved attendance at a meeting with interested members of the community on 1 July 2020. In addition to the site visits, formal communications with site and specialists engaged for the Study were conducted as follows:

- teleconference, 21 January 2020
- videoconference, 27 March 2020
- videoconference, 6 April 2020
- videoconference, 7 April 2020
- videoconference, 21 April 2020
- face to face meeting in Brisbane, 24 June 2020
- face to face meeting in Brisbane, 6 November 2020
- teleconference, 2 December 2020.

These were supplemented by numerous informal telephone and email communications.

This report provides an assessment of the testing and monitoring conducted within the scope of the Study.

The following information and data were examined:

- mineralogical, geochemical and chemical analysis of tailings materials conducted in February 2020
- organic chemical analysis of tailings material conducted in February 2020
- PM_{10} metals concentrations from monitoring commenced in April 2020
- water quality results from testing of tank, farm dam and bore water conducted in May 2020 and September/October 2020

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- asbestos analysis of tailings materials conducted in May 2020
- $PM_{2.5}$ particulate matter and RCS concentrations from monitoring commenced in July 2020.

The following reports were examined:

- Earth Systems – Sampling and Analytical Protocols, Technical Memorandum (Waters and Taylor 2019) (refer to ***Appendix A***)
- Earth Systems – Preliminary assessment of surficial tailings and dust from Cadia Valley Operations, Technical Memorandum (Taylor 2020a) (refer to ***Appendix A***)
- Earth Systems – Relative elemental enrichments in tailings from the Cadia Valley Operations, Technical Memorandum (Taylor 2020b) (refer to ***Appendix A***)
- Earth Systems – Surficial processes in the tailings storage facility at the Cadia Valley Site, Technical Memorandum (Taylor 2020c) (refer to ***Appendix A***)
- Earth Systems – Dust Fingerprinting Study, Assessment of drinking and stock water chemistry from farms surrounding Cadia Valley Operations, New South Wales (Taylor 2021) (refer to ***Appendix A***)
- Callander & Johnson – HSE Materials Hazard Assessment (Johnson 2020) (refer to ***Appendix B***)
- Todoroski Air Sciences – Air quality monitoring plan Cadia Valley Operation - Tailings Storage Facility (Trahair and Henschke 2020) (refer to ***Appendix C***)
- Todoroski Air Sciences – Cadia Valley Operations – Ventilation shaft air dispersion modelling (Henschke 2020) (refer to ***Appendix C***)
- QUT Central Analytical Research Facility – Materials Characterisation Report X20005 (Spratt 2020a) (refer to ***Appendix E***)
- QUT Central Analytical Research Facility – Materials Characterisation Report X20005 [PM_{10}] (Spratt 2020b) (refer to ***Appendix E***)
- Various certificates of analysis from Australian Laboratory Services (ALS) (refer to ***Appendix F***)
- Various certificates of analysis from RCA Australia (refer to ***Appendix G***).

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3.Concepts and terminology

3.1 When a result is below the limit of detection

No matter how sensitive the technique is for chemical analysis of samples, until methods are developed that can detect a single atom, every currently available method has a limit of detection (LOD). The LOD is the smallest amount of the substance being measured that can be detected by the method being used. Since measurements at concentrations around the LOD are subject to considerable variability, it is difficult to obtain the same result for the same sample multiple times when working at the LOD. Consequently, when developing methods of chemical analysis, statistical analysis is done on concentrations around the LOD to arrive at a limit of reporting (LOR). When there is a great deal of variability in the results of analysis around the LOD, the LOR will be a larger number than the LOD. The LOR is then effectively, the lowest quantity the method can measure with any certainty.

Laboratories conducting chemical analysis will not report a result of zero, because they cannot be certain that a sample does not contain the substance of interest. They can only definitively report that the substance could not be detected subject to the limitations imposed by the LOR. Consequently, results where the substance of interest is not detected are reported as being less than the LOR. For example, if the LOR for quartz is 5 µg, the laboratory will report the number <5 µg if no quartz is detected (i.e., less than 5 µg). Some of the results of monitoring and analysis dealt with in this report are below the relevant LOR. Consequently, they are reported as described in this paragraph.

3.2 Dust and particulate matter

Concepts

Dust in the air constitutes a component of airborne particulate matter. Airborne particulate matter is made up of a mixture of small particles and liquid droplets suspended in the air, originating from both natural and anthropogenic sources. The mixture is complex, comprising of components such as sulphates, nitrates, metals, organics and dust. Natural sources include bushfires, pollen, fungal spores, sea spray, crustal dust and volatile organic compounds. Anthropogenic sources include industrial activities, mining, combustion engines, power stations, domestic heating, transportation and agricultural activities (Hime, Cowie and Marks 2015, p. 22).

Particle size is a major determining factor in the potential health effects of airborne dust. Consequently, dust monitoring is conducted using methods that select for target particle size ranges.

Particulate matter in air pollution is generally characterised as follows:

- Total suspended particulates (TSP) refers to all particulate matter in the atmosphere (up to approximately 100 micrometres in aerodynamic diameter).
- PM_{10} is particulate matter less than 10 micrometres in aerodynamic diameter (the size range $PM_{10\text{-}2.5}$ is often referred to as the coarse fraction or coarse particulate matter)[1]. Note that PM_{10} includes $PM_{2.5}$.
- $PM_{2.5}$ is particulate matter less than 2.5 micrometres in aerodynamic diameter (often referred to as the fine fraction or fine particulate matter).
- $PM_{0.1}$ is particulate matter less than 0.1 micrometres in aerodynamic diameter (often referred to as the ultrafine fraction or ultrafine particulate matter).

TSP was the first indicator used to represent suspended particles in ambient air (ambient air is the air in the general outdoors atmosphere). In 1987, the US Environmental Protection Agency (USEPA) introduced PM_{10} as an indicator in the determination of health impacts from airborne particulate matter. This was because PM_{10} was responsible for most of the

[1] Note that, contrary to the generally accepted terminology, the NSW *Protection of the Environment Operations (General) Regulation 2009* defines fine particulate as PM_{10} and coarse particulate as any airborne particulate matter larger than PM_{10}.

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adverse human health effects of airborne particulate matter because these particles were small enough to reach the lower regions of the human respiratory tract. In those early days, PM_{10} was referred to as fine particulate matter or the fine fraction. Today, that term is largely reserved for $PM_{2.5}$, although in same applications fine particulate still means PM_{10}, for example, the NSW *Protection of the Environment Operations (General) Regulation 2009* and the IMA - Europe health hazard criteria (refer to page 25).

Particles in the size range $PM_{10\text{-}2.5}$ are produced by mechanical processes such as mining, wind erosion, re-suspension by transport activities, and agriculture. They include pollen, fungal spores, sea salt and crustal dust. In relative terms, these are large particles and only remain in the atmosphere for hours to a few days, depositing on surfaces close to the source (Hinds 1999, as cited in Hime et al. 2015, p. 25; and USEPA 2009, pp. 3-4).

$PM_{2.5}$ comprises of particles that are produced from emissions from smelters, refineries, steel mills and mining; the cohering together of ultrafine particles; reactions with water droplets in the atmosphere; and condensation of nitrates, sulphates and organic compounds (John et al. 1990, Seinfeld and Pandis 2006, as cited in Hime et al. 2015, p. 25). They include products from combustion processes and photochemical reactions of volatile organic compounds and oxides. These particles can remain suspended in the atmosphere for long periods of time (days to weeks) and can travel hundreds or thousands of kilometres (Hinds 1999, as cited in Hime et al. 2015, p. 25; and USEPA 2009, pp. 3-4).

$PM_{0.1}$ comprises particles produced by high temperature combustion processes or from nucleation of atmospheric gases. They are particles that are short-lived in the atmosphere (minutes to hours), so are not transported over any great distances (USEPA 2009, pp. 3-4).

Dust deposition

Dust deposition (also referred to as dustfall or dust fallout) is used to describe airborne particulate matter that settles out of the air under the influence of gravity. Because it is not particle size selective and generally contains particles in larger size ranges, dust deposition is not used as a measure of the health effects associated with airborne particulate matter. Rather, it is useful as a determinant of sources causing dust nuisance in surrounding areas.

Dust deposition is measured using a dust deposition gauge (DDG), which compromises of a large glass bottle fitted with a funnel of known surface area, mounted two metres above the ground. Dust *falls* out of the air into the funnel over a period of one month and is then collected for analysis. Dust deposition is measured in units of g/m^2/month.

Health impacts

Long-term and short-term exposures to ambient air particulate matter have been associated with detrimental health effects. Long-term exposure contributes to the initiation and progression of disease over months or years. These include conditions such as cardiovascular-related mortality, atherosclerosis, ischaemic heart disease, complications of diabetes, respiratory-related mortality, asthma symptoms, reduced lung function in children, reduced lung function in susceptible adults, and lung cancer, amongst others (Hime et al. 2015, pp. 40-41).

Short-term exposure affects susceptible members of the population because of existing chronic disease, compromised respiratory function in the developing lungs of children, or compromised physiological function in the elderly from the effects of ageing (Brook et al. 2020, as cited in Hime et al. 2015, p. 40).

The human respiratory system is designed to protect itself from particulate matter by preventing larger particles from reaching more sensitive parts of the system. However, smaller particles are able to reach the thoracic respiratory tract. The particles of most concern are the $PM_{2.5}$ particles. Morgan, Broome and Jalaludin (2013, p. 15) found that there was strong evidence for negative impacts on respiratory and cardiovascular systems from both short-term (24-hours) and long-term (annual) exposures to particulate air pollution.

Respirable crystalline silica

Silica is a widely abundant naturally occurring mineral that is a major constituent of most rocks and soils. Silica can occur in both crystalline and non-crystalline (amorphous) forms. Crystalline forms of silica, when ground into small particles, can

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lodge deep into the lungs and cause a range of respiratory illnesses including silicosis. These small particles of crystalline silica are referred to as respirable crystalline silica or RCS.

Quartz is the most common type of crystalline silica. The other major forms of crystalline silica are cristobalite and tridimite. Crystalline silica at CVO is primarily quartz, but occasionally contains a small proportion of cristobalite. The RCS concentrations detailed in this report are based on the analysis of both quartz and cristobalite in the dust sampled.

Several papers found in the literature have reported that freshly fractured quartz leads to increased cytotoxicity. It is theorised that cleavage of crystalline silica particles results in the formation of reactive radical species at the newly generated particle surfaces. This reactivity decays with time leading to *aged* crystalline silica being less cytotoxic. The process occurs slowly in air, but rapidly in water. However, the research conducted has been in the laboratory on rats, mice and dogs. There is no empirical field data to confirm the laboratory work. Humans appear to exhibit the adverse effects of silica exposure at lower levels than animals. Hence, results from animal trials may not be a good predictor of human effect levels (OEHHA 2005, pp. 22-24).

Regardless of the potential variability in toxicity of various forms of RCS, all forms are toxic (OEHHA 2005, p. 38).

Ambient air quality criteria

The key framework for ambient air quality in Australia is established by the *National Environment Protection (Ambient Air Quality) Measure* (NEPM). State jurisdictions enforce the key criteria (or standards) for ambient air quality set by the NEPM and are required to implement programs to measure air quality against the criteria. For air quality criteria not established by the NEPM, each state sets its own standards.

In terms of airborne dust, the NEPM only covers PM_{10}, $PM_{2.5}$ and lead. Since the measurement of other metals and RCS was also relevant to the Study, additional air quality criteria were required to benchmark the metals and RCS concentrations.

Averaging times play a role in the benchmarking. For example, under the NEPM PM_{10} and $PM_{2.5}$ both have 24-hour and annual average criteria, while lead only has an annual average criterion.

Since the NEPM only covers some of the substances relevant to the Study, and it takes a year to determine an annual average, alternative sources were sought for air quality criteria to benchmark against. This was to address substances not listed in the NEPM and to find, where possible, criteria with shorter averaging periods, so a performance assessment of dust control measures could be made in the shorter term. The order of priority given to the air quality criteria used as benchmarks for the Study is listed below. Where a criterion did not exist for the substance of interest or for the averaging time required, one was sought from the next source down in the priority list:

1. NSW Environmental Protection Authority (NSW EPA 2017)
2. Other Australian federal or state jurisdiction, e.g., Queensland Government (2019), Environmental Protection Authority Victoria (EPA Victoria 2008)
3. Ontario Ministry of Environment (MOE 2012).

Criteria set by the Ontario MOE were used on the recommendation of Todoroski Air Sciences, as *Ontario's Ambient Air Quality Criteria* (MOE 2012) is possibly the most comprehensive collection of ambient air quality criteria available.

Table 1 details the air quality criteria used for the Study.

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Table 1: Ambient air quality criteria

Substance	Averaging period	Criteria	Source
PM_{10}	24-hour	50 µg/m³	NSW EPA (NEPM)
	Annual	25 µg/m³	NSW EPA (NEPM)
$PM_{2.5}$	24-hour	25 µg/m³	NSW EPA (NEPM)
	Annual	8 µg/m³	NSW EPA (NEPM)
Antimony (and compounds)	24-hour	25 µg/m³	Ontario MOE
Arsenic (and compounds)	24-hour	0.3 µg/m³	Ontario MOE
	Annual	0.003 µg/m³	Qld Govt
Barium – total water soluble	24-hour	10 µg/m³	Ontario MOE
Beryllium	24-hour	0.01 µg/m³	Ontario MOE
Cadmium (and compounds)	24-hour	0.025 µg/m³	Ontario MOE
	Annual	0.005 µg/m³	Qld Govt
Chromium (III) compounds	24-hour	0.5 µg/m³	Ontario MOE
Cobalt	24-hour	0.1 µg/m³	Ontario MOE
Copper	24-hour	50 µg/m³	Ontario MOE
Lead (and compounds)	24-hour	0.5 µg/m³	Ontario MOE
	Annual	0.5 µg/m³	NSW EPA (NEPM)
Manganese (and compounds)	24-hour	0.2 µg/m³	Ontario MOE
	Annual	0.16 µg/m³	Qld Govt
Mercury	24-hour	2 µg/m³	Ontario MOE
Molybdenum	24-hour	120 µg/m³	Ontario MOE
Nickel (and compounds)	24-hour	0.1 µg/m³	Ontario MOE
	Annual	0.022 µg/m³	Qld Govt
RCS (as $PM_{2.5}$)	Annual	3 µg/m³	EPA Victoria
Selenium	24-hour	10 µg/m³	Ontario MOE
Silver	24-hour	1 µg/m³	Ontario MOE
Tin	24-hour	10 µg/m³	Ontario MOE
Zinc	24-hour	120 µg/m³	Ontario MOE

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Mining and airborne particulate matter

According to Kan, Kellaghan and Roddis (2013, pp. 4-5), typical sources of particulate matter from mining include (in approximate order of volume produced):

- hauling on unsealed roads
- wind erosion on open areas
- material transfer of product and overburden
- bulldozers on product and overburden
- loading stockpiles
- trucks unloading product and overburden
- wind erosion and maintenance of stockpiles
- blasting
- topsoil handling
- drilling
- grading
- train loading.

Consequently, airborne particulate matter produced by mining is generally associated with the larger size fraction ($PM_{10-2.5}$), due to its generation via mechanical processes, as opposed to the smaller size fraction ($PM_{2.5}$ and smaller) generally associated with combustion and high temperature processes (Kan et al. 2013, p. 6 and USEPA 2019, pp. 2-6). That is not to say that there are no smaller size fraction particles in particulate matter generated by mining activities, just that most mining processes produce predominantly larger size fraction particles.

There have been studies undertaken in Australia in relation to coal mining and $PM_{2.5}$ (NSW EPA 2013), and the contribution of non-metallic mineral mining and quarrying to $PM_{2.5}$ is estimated to be small (NSW EPA 2016, p. 20); however, there appears to be little information about the contribution of metal mining activities.

Monitoring methods

There are a range of methods used to measure airborne particulate matter. In this report, reference is made to four methods used at CVO.

High-volume air sampling

This method uses a sampler with a high-volume air pump that draws approximately 1600 m^3 of air through a large rectangular filter paper over a 24-hour period. Particulate matter is collected on the filter paper for weighing and other analysis (e.g., metals). The samplers are run once every six days (rather than every seven days) to avoid coinciding with any regular weekly cycles that might be occurring at any nearby dust generating activities.

At CVO, high volume air samplers (HVAS) were used to collect PM_{10} for determining metal concentrations in ambient air for the Study.

Low-volume air sampling

This method uses a low-volume air pump that draws typically between 5 L/min and 16.7 L/min of air through a small circular filter paper. The sampler may be run for a day, several days or weeks at a time. Particulate matter is collected on the filter paper for weighing and other analysis (e.g., RCS).

At CVO, low volume air samplers (LVAS) were used to collect $PM_{2.5}$ for determination of particulate matter in the $PM_{2.5}$ size range and RCS concentrations in ambient air for the Study.

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Tapered Element Oscillating Microbalances

A Tapered Element Oscillating Microbalance (TEOM) is an electronic air sampler that draws 16.7 L/min of air onto a filter paper mounted on a device that can measure the weight of particulate matter being deposited continuously in real time. The filter paper is changed infrequently and is generally not used for any other analysis.

At CVO, TEOMs are used to continuously monitor PM_{10} for determination of particulate matter concentrations in ambient air in real time as part the mine's Project Approval.

DustTraks

DustTrak is a proprietary name for a type of electronic air sampler that draws 3 L/min of air through a small chamber in which a laser light is present. Light is scattered off any particulate matter in the air stream and the electronics in the sampler convert the scattered light signals to a measurement of the amount of particulate matter present. Like the TEOMs, DustTraks can report the amount of particulate matter present continuously in real time.

Workplace exposure monitoring

Exposure to dust in workplace settings is conducted by fitting purpose-built workplace exposure samplers to potentially exposed workers and sampling in the breathing zone of the potentially exposed individual/s, for a period of time representative of a working shift. The air sampling conducted for this Study used sampling equipment and methodologies purpose-built for sampling dust in ambient air at fixed locations. Consequently, the results reported for the Study are not able to be compared to worker dust exposure standards.

3.3 Water quality

Australian Drinking Water Guidelines

Safe drinking water is essential to sustain life. Therefore, every effort needs to be taken to ensure that drinking water suppliers provide consumers with water that is safe to use.

The Australian Drinking Water Guidelines (NHRMC, NRMMC 2011 updated March 2021) are intended to provide a framework for good management of drinking water supplies that, if implemented, will assure safety at point of use. The guidelines have been developed after consideration of the best available scientific evidence. They are designed to provide an authoritative reference on what defines safe, good quality water, how it can be achieved, and how it can be assured. They are concerned both with safety from a health point of view and with aesthetic quality.

The Australian Drinking Water Guidelines are not mandatory standards; however, they provide a basis for determining the quality of water to be supplied to consumers in all parts of Australia. These determinations need to consider the diverse array of regional or local factors, and take into account economic, political and cultural issues, including customer expectations and willingness and ability to pay.

There are health-based guidelines and aesthetic guidelines (see Table 2). Health-based guidelines relate to the health risk to a water consumer. Aesthetic guidelines relate to the acceptability of water due to, for example, appearance, taste and odour.

Scope of the Australian Drinking Water Guidelines

Drinking water is defined as water intended primarily for human consumption, either directly, as supplied from the tap, or indirectly, in beverages, ice or foods prepared with water. Drinking water is also used for other domestic purposes such as bathing and showering.

With the exception of bottled or packaged water, the Australian Drinking Water Guidelines apply to any water intended for drinking irrespective of the source (municipal supplies, rainwater tanks, bores, etc.) or where it is consumed (the home, restaurants, camping areas, shops, etc.).

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Purpose of the Australian Drinking Water Guidelines

The Australian Drinking Water Guidelines provide the authoritative Australian reference for use within Australia's administrative and legislative framework to ensure the accountability of drinking water suppliers (as managers) and of state and territory health authorities (as auditors of the safety of water supplies). The guidelines are not, however, mandatory legally enforceable standards.

With appropriate consultation with the community, the Australian Drinking Water Guidelines may be used directly as agreed levels of service, or they may form the basis for developing local levels of service. In the case of health-related water quality characteristics, there is less latitude for variation because the safety of drinking water is paramount. However, with regard to aesthetic characteristics, what is acceptable or unacceptable depends on public expectations and can therefore be determined by water authorities in consultation with consumers, taking into account the costs and benefits of further treatment of the water. The Australian Drinking Water Guidelines provide a starting point for that process. The guidelines may also be used by a standards body for defining quality processes suitable for third party accreditation of a quality management system.

The guideline values define water that, based on current knowledge, is safe to drink over a lifetime; that is, it constitutes no significant risk to health. For most of the water quality characteristics discussed, there is a grey area between what is clearly safe and what is clearly unsafe. Often the latter has not been reliably demonstrated and the guideline values always err on the side of safety. Therefore, for most characteristics, occasional excursions beyond the guideline value are not necessarily an immediate threat to health. The amount by which, and the duration for which, any health-related guideline value can be exceeded without raising concerns for public health depends on the particular circumstances. Exceeding a guideline value should be a signal to investigate the cause and, if appropriate, to take remedial action.

Livestock Drinking Water Guidelines

Water quality may have a significant impact on animal production, fertility and general health. Guidelines have been developed for livestock drinking water which include biological, chemical and radiological characteristics that may affect animal health (ANZECC/ARMCANZ 2000) (see Table 2). The guidelines are trigger values below which there should be minimal risk to animal health. If a trigger value is exceeded, investigation is warranted to determine the level of risk.

Guideline values

Drinking water quality guidelines are detailed in Table 2.

Table 2: Drinking water quality guidelines (NHMRC 2011; ANZECC/ARMCANZ 2000)

Parameter	Australian Drinking Water Guidelines (NHMRC 2011 updated March 2021)		Livestock Drinking Water Guidelines (ANZECC/ARMCANZ 2000)
	Health-based (mg/L)	Aesthetic (mg/L)	(mg/L)
Aluminium (Al) - acid-soluble	-	0.2	5
Ammonia (NH_3)	-	0.5	-
Antimony (Sb)	0.003	-	-
Arsenic (As)	0.01	-	0.5; up to 5 see Table 4.3.2 (ANZECC/ARMCANZ 2000)
Cadmium (Cd)	0.002	-	0.01
Calcium (Ca)	-	-	1000
Chloride (Cl^-)	-	250	-

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Parameter	Australian Drinking Water Guidelines (NHMRC 2011 updated March 2021)		Livestock Drinking Water Guidelines (ANZECC/ARMCANZ 2000)
	Health-based (mg/L)	Aesthetic (mg/L)	(mg/L)
Chlorine (Cl)	5	0.6	-
Chromium - total (Cr)	-	-	1
Chromium III (Cr^{3+})	-	-	-
Chromium VI (Cr^{6+})	0.05	-	-
Cobalt (Co)	-	-	1
Copper (Cu)	2	1	0.4 (sheep); 1 (cattle); 5 (pigs); 5 (poultry)
Electrical Conductivity (EC)	-	-	See Table 4.3.1 (ANZECC/ARMCANZ 2000)
Fluoride (F)	1.5	-	2
Iron (Fe)	-	0.3	-
Lead (Pb)	0.01	-	0.1
Magnesium (Mg)	-	-	ID
Manganese (Mn)	0.5	0.1	-
Molybdenum (Mo)	0.05	-	0.15
Nickel (Ni)	0.02	-	1
Nitrate (NO3)	50	-	400
Nitrite (NO2)	3	-	30
pH	-	6.5 - 8.5	-
Selenium (Se)	0.01	-	0.02
Silver (Ag)	0.1	-	-
Sodium (Na)	-	180	-
Sulphate (SO4)	-	250	1000
Turbidity (NTU)	-	5	-
Total Dissolved Solids (TDS)	-	600	2000 (poultry); 2500 (dairy cattle); 4000 (pigs, horses, beef cattle); 5000 (sheep) See Table 4.3.1 (ANZECC/ARMCANZ 2000)
Total Suspended Solids (TSS)	-	-	-
Zinc (Zn)	-	3	20

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4. Results of monitoring and analysis

4.1 Tailings dust characterisation

Earth Systems was engaged by CVO to identify a chemical, geochemical and mineralogical fingerprint for the tailings. This was undertaken to assess the potential impact of dust from the tailings storage facilities on the local community (Waters and Taylor 2019; Taylor 2020a, 2020b, 2020c and 2021). Refer to ***Appendix A*** for the full reports provided by Earth Systems.

Earth Systems is a Melbourne-based environmental consultancy firm that provides a range of environmental and sustainability services throughout the world, including water management and geochemical characterisation.

Four samples of tailings material were collected from the NTSF, and four samples were collected from the STSF by CVO personnel. These eight bulk samples were sieved to obtain 16 subsamples made up of:

- the fraction with particle sizes ten micrometres or greater in diameter, and
- the fraction with particle sizes less than ten micrometres in diameter (PM_{10}).

Sampling was undertaken from the upper most layer of the tailings material (referred to by Earth Systems as *surficial* tailings material), and the PM_{10} samples were produced by sieving, to obtain material which is most likely to become airborne in windy conditions.

The tailings samples were subjected to the following analysis:

- Quantitative X-Ray diffraction analysis (XRD) conducted by QUT to determine the mineralogy of:
  - eight bulk surficial tailings samples (Spratt ,2020a)
  - eight PM_{10} surficial tailings samples (Spratt, 2020b)

  (Refer to ***Appendix E*** for the full reports from QUT).
- Trace element and partial major element chemistry conducted by ALS for the eight bulk surficial tailings samples (see Certificate of Analysis EB2000092 in ***Appendix F***).
- The net acid generation (NAG) suite for the eight bulk surface tailings samples (i.e., NAG pH, and NAG leachate chemistry) (see Certificate of Analysis EB2000092 in ***Appendix F***).
- Australian Standard Leachate Procedure (ASLP) data for the eight bulk surficial tailings samples. This procedure was intended to identify key mobile components in near neutral water – a proxy for leaching during rainfall events (see Certificate of Analysis EB2000092 in ***Appendix F***).
- Data from DDGs:
  - partial bulk chemistry (selected major and trace elements)
  - dust loads (i.e., the mass of dust per volume of air and unit of time)
  - proportions of soluble and insoluble components.

The analysis of the tailings samples indicated the following:

- Surface tailings samples contained a mixture of primary and secondary minerals, with secondary minerals and amorphous components being more concentrated in the PM_{10} fraction.
- Between 1.8 and 4.1 wt% of the tailings was in the PM_{10} size range (averaging 3.3 wt%).

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- The dominant primary minerals were:
  - plagioclase feldspar (23 to 31 wt% [$(Na, Ca)(Si, Al)_4O_8$])
  - illite/mica (16 to 20 wt% [$(K, H_3O)(Al, Mg, Fe)_2(Si, Al)_4O_{10}[(OH)_2, (H_2O)]$])
  - quartz (14 to 17 wt% [SiO_2])
  - clinochlore (10 to 16 wt% [$Mg_5Al(AlSi_3O_{10})(OH)_8$])
  - potassium feldspar (8 to 13 wt% [$KAlSi_3O_8$])
  - calcite (3 to 4 wt% [$CaCO_3$])
  - minor (i.e., generally less than 2 wt%) concentrations of magnetite [Fe_3O_4], pyrite [FeS_2], dolomite [$MgCO_3 \cdot CaCO_3$], and amphibole occurred in many samples.
- Secondary minerals were mostly hydrous calcium-sodium-magnesium sulphates (e.g., gypsum, blodite, glauberite) with lesser chlorides (halite) and iron sulphates (rhomboclase). Many of these secondary phases were soluble to highly soluble in water and had low densities compared to primary tailings mineral phases.
- Secondary minerals are produced from acid neutralisation reactions within the tailings. Fluids percolate upward through the tailings via capillary action, and secondary efflorescence minerals precipitate at the surface due to evaporation.
- Secondary phases are the most likely tailings component to become airborne, due to their location at the surface of the tailings storage facility and comparatively low density. They are expected to be the first to be mobilised as dust and/or travel the furthest if they become airborne during windy conditions. After deposition, they are also the most likely minerals to subsequently dissolve upon contact with water due to their high solubility. Consequently, these phases have the potential to effect down-wind water chemistry. For example, these minerals have the potential to give drinking water a salty and/or bitter taste.
- These surface minerals are expected to be the first to be mobilised as dust and/or travel the furthest if they become airborne during windy conditions. After deposition, they are also the most likely minerals to subsequently dissolve upon contact with water.
- A slightly negative Net Acid Production Potential was calculated from the XRD mineralogy, showing that the tailings material was non-acid forming.
- ASLP data, which provides an analogue for the leaching of tailings during a rainfall event, indicated the presence of antimony, arsenic, chromium, copper, iron, lead, mercury, molybdenum, selenium and zinc. These are elements which are most likely to be mobilised from soluble tailings components during rainfall events.
- The pH of leachate water was 7.4 to 8.0, consistent with an excess of carbonate (non-acid forming), low acidity values, and elevated alkalinity values.
- The bulk samples and the PM_{10} samples contained significant concentrations of quartz (14 to 17 wt% in the bulk samples and 5 to 8.2 wt% in the PM_{10} samples). Quartz, when in the respirable size range, is usually the major component of RCS.
- Amphibole group minerals were identified in two of the eight bulk tailings samples and in one of the eight PM_{10} tailings samples (this was the PM_{10} fraction of one of the two bulk samples containing amphibole). Certain amphibole minerals have the potential to occur in, what is referred to as, a fibrous habit (i.e., they are asbestiform minerals such as asbestos).

  The two bulk samples containing amphibole were submitted to ALS for asbestos analysis. No asbestos or asbestiform material was found (see Certificate of Analysis ES2016687 in ***Appendix F***).

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4.2 Deposited dust

Following identification of a chemical, geochemical and mineralogical fingerprint for the tailings, Earth Systems conducted an assessment of deposited dust (Taylor 2020a and 2021). Refer to ***Appendix A*** for the full reports provided by Earth Systems.

Information from DDGs can be indicative of elements present in CVO tailings dust. However, since the dust deposited in the gauges may also derive from other sources, including non-mining sources, the presence of an element in deposited dust does not necessarily translate to impact on tank or farm water quality. This is dependent upon the mineral phase in which the element occurs and the solubility of that phase.

The DDGs indicated the presence of aluminium, copper, chromium, cobalt, iron, lead, manganese, molybdenum, nickel, zinc and occasionally arsenic, antinomy and selenium in deposited dust. However, the levels were low, and they were not necessarily present in water-soluble form, so their presence does not automatically translate to water quality impacts.

Earth Systems found that approximately 10 to 20 wt% of the dust reporting to the DDGs was in a soluble form. This is consistent with a theory that highly soluble efflorescent (surface) materials from the tailings would be the most likely to be mobilised as dust in windy conditions and travel the furthest. It suggests that, at least to some extent, deposited dust is influenced by tailings dust. Notwithstanding, the results of water testing did not indicate any measurable impact on water quality (see below).

4.3 Water quality

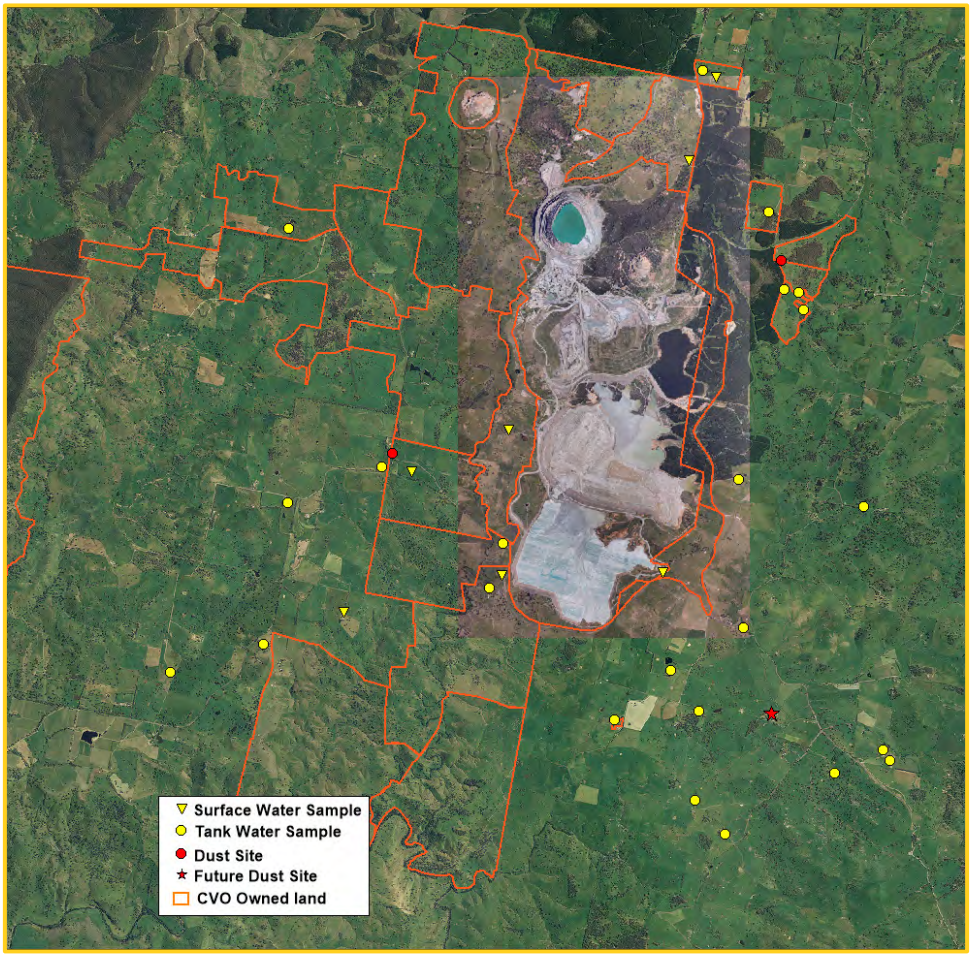

Figure 1: Sampling locations for water quality surveys and additional monitoring sites for $PM_{2.5}$ and RCS

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Using information gathered in the dust identification and dust deposition assessment work, Earth Systems undertook an examination of roof, farm dam and bore water quality (Taylor 2021). Refer to ***Appendix A*** for the full reports provided by Earth Systems.

Due to the COVID 19 pandemic, a decision was taken to initially defer sampling of residents' properties, so the focus of Earth Systems' water quality work was on properties owned by CVO. This water sampling was conducted in May 2020. CVO later conducted sampling of residents' roof water in September/October 2020. The water quality results are included in the HSE Materials Hazard Assessment in ***Appendix B***.

In total, 48 water quality samples were collected from tanks, farm dams and bores (see Certificates of Analysis ES2016298, ES2034662, ES2034663, ES2034993 and ES2100772 in ***Appendix F***). Figure 1 shows the sampling locations. The primary focus was on metals as outlined in the Australian Drinking Water Guidelines.

Drinking water

Earth Systems found for roof water:

- Most samples met the Australian Drinking Water Guidelines (see Table 2), with the following exceptions:
  - pH in most roof water tanks measured 4.5 to 6.3 while the aesthetic guideline range is 6.5 to 8.5
  - total lead in one tank (CHST) measured 0.013 mg/L while the health-based guideline is 0.01 mg/L
  - total zinc in two tanks (SVWT and OCWT) measured 5 to 13 mg/L while the aesthetic guideline is 3 mg/L
  - total iron in one tank (BWWT) measured 0.42 mg/L while the aesthetic guideline is 0.2 mg/L.
- The samples were generally slightly acidic to near-neutral (pH 4.5 to 6.7) and well oxidised, with low salinity (less than 170 µS/cm), low suspended solids (less than 20 mg/L) and low metal and nutrient concentrations.
- The acidity and iron may relate to rusting of the roofing materials and/or organic acids (the lowest pH values and highest iron concentrations may be derived from the oldest or most corroded roofs).
- Despite elevated dissolved (and total) zinc concentrations, all the samples had very low sulphate and chloride concentrations, which strongly suggested no significant effect from CVO tailings dust on roof water. Zinc in the roof water is likely to be predominantly (or exclusively) derived from galvanised steel roofing, guttering or plumbing materials.
- There was significant variability in zinc concentrations in roof water samples. The reasons for this were unclear, but it was possible that older roofs, in poorer condition, were associated with higher zinc concentrations.
- This would be supported by the observed higher zinc concentrations in concrete tanks, and the possibility that concrete tanks (and their associated roof water collection systems) are older than plastic or Zincalume steel tanks.
- The marginally elevated lead concentration in one roof water collection tank (BWWT) could have been related to the use of lead flashing or impurities in plumbing or galvanising materials.
- Salinity and major ion concentrations in roof water were low, particularly compared to dam water, and were likely controlled by concrete dissolution, with lesser contributions from natural sources or agricultural additives.
- The mineral calcite may be derived from dust associated with the application of agricultural lime or dust derived from the weathering of local geological units (i.e., limestone). While dust derived from CVO tailings storage facilities is another potential source of calcite, this is considered less likely based on the above conclusion.
- Other metals that can be detected in some of the roof water include manganese, copper and cadmium, albeit at very low concentrations that fall within drinking water quality guidelines. The dissolved manganese is consistent with the presence of calcite (see above), whereas the copper and (minor) cadmium are probably derived from galvanised steel roofing or plumbing materials.
- Overall, roof water chemistry appears to be primarily influenced by local materials including galvanised steel roofing or guttering materials (sources of zinc and cadmium), rusting of steel roof materials (iron), copper piping

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(copper), lead flashing (lead) and dust from natural carbonate-bearing sources (e.g., manganese). However, as some of these components – zinc, copper, manganese and (minor) cadmium – were also identified in the aqueous fingerprint of CVO tailings dust, further investigation would assist to confirm these assumptions and discount the influence of CVO tailings dust. Further analytical techniques to address this are currently being explored.

The water quality analysis undertaken on the September/October water samples by CVO indicated that all tank water samples, and one bore water sample, met the Australian Drinking Water Guidelines (see Table 2), with the following exceptions (the water quality results are included in the HSE Materials Hazard Assessment in ***Appendix B***):

- total dissolved solids in the bore sampled (EB_BT) measured 1020 mg/L while the aesthetic guideline is 600 mg/L
- total lead in one tank (SHARP_HT) measured 0.014 mg/L while the health-based guideline is 0.01 mg/L
- total cadmium in one tank (EB_HT1) measured 0.0025 mg/L while the health-based guideline is 0.002 mg/L. The zinc concentration in this sample was high (although not more than the aesthetic guideline) at 2.17 mg/L, suggesting zinc and cadmium contamination from galvanised steel roofing
- total zinc in one tank (STOCKTON_HT) measured 3.17 mg/L and in the bore water (EB_BT) measured 7.23 mg/L while the aesthetic guideline is 3 mg/L
- total iron in two tanks (SHARP_HT and SHARP_W) measured 2.02 to 4.77 mg/L while the aesthetic guideline is 0.2 mg/L.

As previously stated, roof water chemistry appears to be primarily influenced by local materials including galvanised steel roofing or guttering materials (sources of zinc and cadmium), rusting of steel roof materials (iron), copper piping (copper), lead flashing (lead) and dust from natural carbonate-bearing sources (e.g., manganese).

As detailed in ***Purpose of the Australian Drinking Water Guidelines*** on page 14, the guideline values define water that, based on current knowledge, is safe to drink over a lifetime; i.e., it constitutes no significant risk to health. For most of the water quality characteristics discussed, there is a grey area between what is clearly safe and what is clearly unsafe. Often the latter has not been reliably demonstrated and the guideline values always err on the side of safety. Therefore, for most characteristics, occasional excursions beyond the guideline value are not necessarily an immediate threat to health.

The amount by which, and the duration for which, any health-related guideline value can be exceeded without raising concerns for public health depends on the particular circumstances. Exceeding a guideline value should be a signal to investigate the cause and, if appropriate, to take remedial action.

Consequently, the two sources of marginally elevated lead levels were resampled and reanalysed. The subsequent samples indicated lead below the Australian Drinking Water Guidelines (see Certificate of Analysis ES2100772 in ***Appendix F***). The instance where cadmium slightly exceeded the guidelines was attributable to contamination from galvanised steel roofing or guttering.

Livestock water

Earth Systems found for farm dam and bore water:

- All dam water samples met ANZECC/ARMCANZ (2000) guidelines for livestock drinking water quality.
- Farm dam water was generally near-neutral (pH 5.1 to 7.7) and sometimes reduced, with low to moderate salinity (up to 533 µS/cm) and suspended solids (up to 41 mg/L) and low metal and nutrient concentrations.
- The chemistry of dam water samples is more complex than roof water samples. This is likely because dam water is exposed to soils containing a wide variety of minerals as well as potential soil amendments compared to the relatively simple roof water collection system.
- The observed higher concentrations of nitrogen and phosphorus-based nutrients in farm dam water, relative to roof water tanks, provides some evidence that soil amendments have been, or are being used, on farmland within the dam catchments.

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- Salinity and major ion concentrations in dam water samples appear to be largely controlled by the carbonate mineral dolomite (and potentially calcite). Possible sources of dolomite include dust from the application of agricultural dolomite, dust from the weathering of the local rocks/soils, or dust derived from CVO tailings storage facilities.
- The dissolution of gypsum / bassanite / anhydrite is suggested by a correlation between dissolved sulphate and calcium concentrations in farm dam water. These minerals could be sourced from soil amendments or dust derived from CVO tailings.
- Potassium could potentially be associated with farm additives, whereas sodium and chloride may relate to the use of stock licks (sodium chloride) on farms and/or saline groundwater inflows to dams (sodium chloride). However, the fugitive dust from CVO tailings storage facilities cannot be discounted as a potential source of potassium and some sodium chloride (halite).
- While of no concern for livestock drinking water, metals that are present in some of the farm dam water include iron and very low concentrations of manganese, aluminium, molybdenum, copper, zinc, arsenic, cobalt and nickel.
- Overall, when comparing the farm dam water chemistry to the tailings ASLP data, the only metals in dam water that were consistent with the aqueous identification of CVO tailings dust were zinc, copper, manganese and molybdenum. However, micro-nutrient fertiliser sources cannot be excluded at this stage. Further investigation is required to clarify any influence of CVO tailings dust on the trace element signature of dam water. Analytical techniques to address this are being explored.
- All water samples from the farm dams met the Australian Livestock Drinking Water Guidelines.

4.4 Airborne dust

Monitoring network

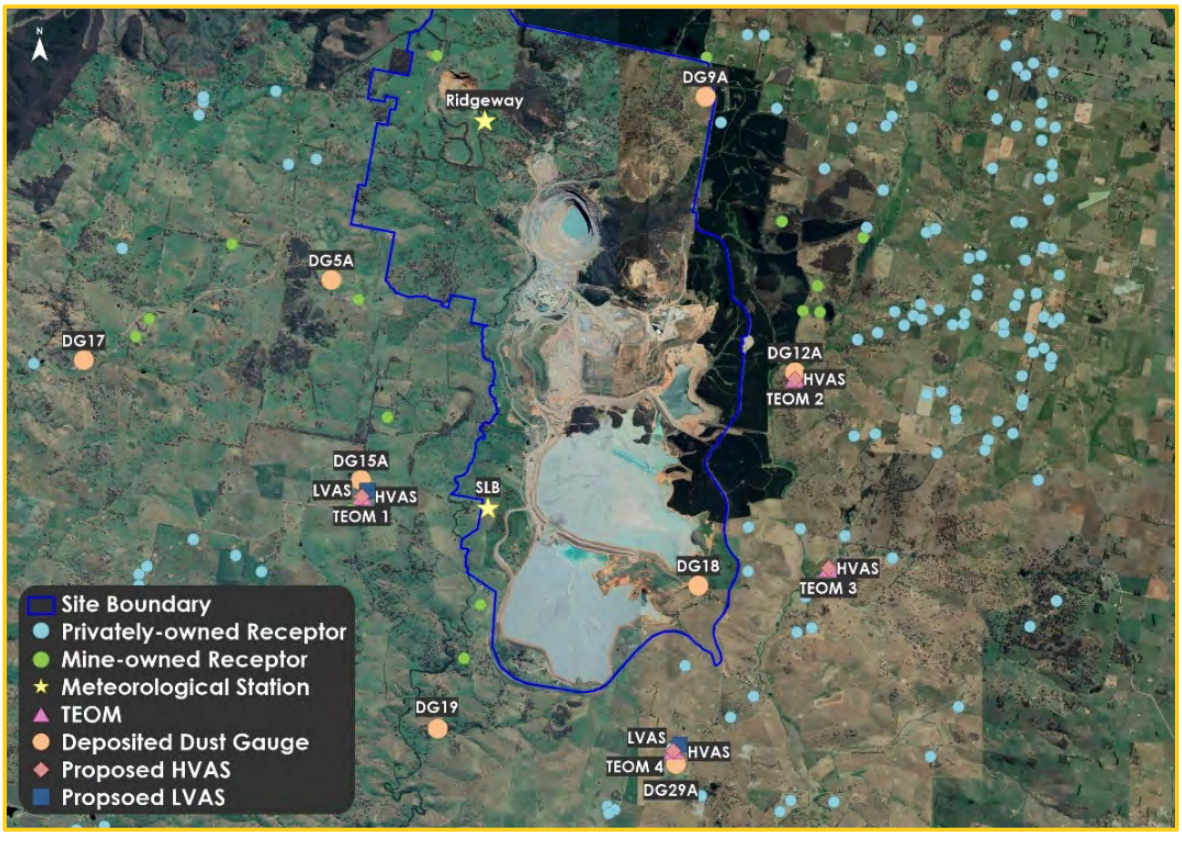

Figure 2: Air quality monitoring network recommended by Todoroski Air Sciences

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Todoroski Air Sciences was engaged to review CVO's air quality monitoring plan and recommend amendments that might be necessary to assist with quantification of any potential dust emissions generated by the NTSF and STSF (Trahair and Henschke 2020). Refer to ***Appendix C*** for the full reports provided by Todoroski Air Sciences.

Todoroski Air Sciences is a Sydney based environmental consulting firm specialising in air quality assessment.

Todoroski recommended some amendments to the existing air quality monitoring program at CVO to meet the objectives of the Study. Figure 2 and Table 3 detail the location of the existing and recommended additional air sampling instruments. Refer to ***4.2 Deposited dust*** on page 18 for a discussion on deposited dust results.

Table 3: Ambient air quality monitoring network recommended by Todoroski Air Sciences

ID	Property name	Monitor type	Parameter monitored	Existing or new
TEOM 1	Flyers Creek Weir	TEOM	PM_{10}	Existing
HVAS 1	Flyers Creek Weir	HVAS	PM_{10}, metals	New
TEOM 2	Bundarra	TEOM	PM_{10}	Existing
HVAS 2	Bundarra	HVAS	PM_{10}, metals	New
LVAS 2	Bundarra	LVAS	RCS	New
TEOM 3	Triangle Flat	TEOM	PM_{10}	Existing
HVAS 3	Triangle Flat	HVAS	PM_{10}, metals	New
TEOM 4	Meribah	TEOM	PM_{10}	Existing
HVAS 4	Meribah	HVAS	PM_{10}, metals	New
LVAS 4	Meribah	LVAS	RCS	New
DG5A	Bundella	Deposited dust gauge	Deposited dust, metals	Existing
DG9A	Exploration	Deposited dust gauge	Deposited dust, metals	Existing
DG12A	Flyers Creek Weir	Deposited dust gauge	Deposited dust, metals	Existing
DG15A	Bundarra	Deposited dust gauge	Deposited dust, metals	Existing
DG17	Ashleigh Park	Deposited dust gauge	Deposited dust, metals	Existing
DG18	Wire Gully	Deposited dust gauge	Deposited dust, metals	Existing
DG19	Oakey Creek	Deposited dust gauge	Deposited dust, metals	Existing
DG29A	Meribah	Deposited dust gauge	Deposited dust, metals	Existing

PM_{10} metals

The results of HVAS PM_{10} particulate matter and metals monitoring (see Certificates of Analysis CA2003791, CA2003799, CA2004913, CA2004914, CA2006086, CA2006106, CA2007418, CA2100246 and CA2100247 in ***Appendix F*** and Table D.1 in

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Appendix D) were reviewed against the ambient air quality criteria in Table 1. The sampling results available at the time of compilation of this report were for the period April 2020 to December 2020.

A summary of the results is shown in Table 4 which compares the maximum 24-hour and long-term average concentrations measured at any monitoring site for the period with 24-hour and annual ambient air quality criteria. None of the 24-hour criteria were exceeded and all were trending under the annual criteria. Indeed, apart from PM_{10} particulate matter, the closest any substance came to its relevant criteria was arsenic which reached 21% of the annual criterion, with the other substances at least an order of magnitude lower than their applicable criteria.

Table 4: Summary of HVAS PM_{10} particulate matter and metals results from April to December 2020

Substance	Maximum 24-hour measurement (µg/m³)	24-hour criterion (µg/m³)	Percent of 24-hr criterion (%)	Maximum average for sampling to date (µg/m³)	Annual criterion (µg/m³)	Percent of annual criterion (%)	Number of exceedances
PM_{10}	32.8	50	65.6	10.9	25	43.6	0
Iron	0.5	Not available			Not available		Not applicable
Aluminium	1.4	Not available			Not available		Not applicable
Antimony	0.00062	25	0.0025				0
Arsenic	0.00061	0.3	0.20	0.00062	0.003	21	0
Barium	0.033	10	0.33				0
Beryllium	<0.00069	0.01	<6.9				0
Cadmium	<0.00069	0.025	<2.8	<0.00062	0.005	<12	0
Chromium	0.0037	0.5	0.74				0
Cobalt	<0.00069	0.1	<0.69				0
Copper	0.053	50	0.11				0
Lead	0.0013	0.5	0.26	0.00093	0.5	0.19	0
Manganese	0.014	0.2	7	0.0037	0.16	2.3	0
Mercury	<0.00069	2	<0.035				0
Molybdenum	0.00061	120	0.00051				0
Nickel	0.0012	0.1	1.2	0.00073	0.022	3.3	0
Selenium	<0.00069	10	<0.0069				0
Silver	<0.00069	1	<0.069				0
Tin	<0.00069	10	<0.0069				0
Zinc	0.036	120	0.030				0
Total number of exceedances							**0**

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$PM_{2.5}$

CVO acquired LVAS equipment, primarily to conduct monitoring for RCS. Since the RCS monitoring involved collection of $PM_{2.5}$ samples, $PM_{2.5}$ particulate matter concentrations were also able to be determined. However, the initial sampling for RCS (and, by inference, $PM_{2.5}$) was not carried out at the two community air monitoring sites recommended by Todoroski Air Sciences for sampling by LVAS (Trahair and Henschke 2020) (see Table 3). Of the community sites, only Bundarra was included. Another community site was selected for the measurement of RCS due to the potential influence of vent emissions on that location, based on plume dispersion modelling (discussed below in ***Respirable crystalline silica***). Figure 1 shows a map of the sampling locations. The results of $PM_{2.5}$ monitoring at these locations are detailed in Table 5. The relevant Certificates of Analysis are 15083-701, 15083-702 and 15083-703 and can be found in ***Appendix G***.

In future, it is proposed to conduct $PM_{2.5}$ monitoring using LVAS at the locations recommended by Todoroski. In addition, A DustTrak will be used to monitor $PM_{2.5}$ continuously, in real time, at Errowanbang (shown in Figure 1).

Respirable crystalline silica

Table 5: Results of LVAS sampling for $PM_{2.5}$ and RCS from July to December

Location	Date	Sample duration (hr)	$PM_{2.5}$ conc. (µg/m³)	Avg. $PM_{2.5}$ conc. (µg/m³)	$PM_{2.5}$ air quality criterion Annual (µg/m³)	RCS conc. (µg/m³)	Avg. RCS conc. (µg/m³)	RCS air quality criterion Annual (µg/m³)
Bundarra	16-Jul-2020 to 17-Jul-2020	24.0	2.50			<0.76		
Bundarra	28-Jul-2020 to 29-Jul-2020	24.0	0.55					
Bundarra	09-Aug-2020 to 10-Aug-2020	24.0	<0.14					
Bundarra	18-Aug-2020 to 31-Aug-2020	313.4	8.20			0.29		
Bundarra	31-Aug-2020 to 11-Sep-2020	262.1	8.87			0.41		
Bundarra	11-Sep-2020 to 23-Sep-2020	285.9	8.08			0.50		
Bundarra	23-Sep-2020 to 06-Oct-2020	312.2	5.32			0.23		
Bundarra	06-Oct-2020 to 03-Nov-2020	670.5	6.59			0.15		
Bundarra	03-Nov-2020 to 15-Dec-2020	1009.2	9.51	5.53	8	0.52	0.41	3
Woodville	16-Jul-2020 to 17-Jul-2020	24.0	<0.14					
Woodville	28-Jul-2020 to 29-Jul-2020	24.0	1.11					
Woodville	09-Aug-2020 to 10-Aug-2020	24.0	<0.14					
Woodville	18-Aug-2020 to 31-Aug-2020	311.1	6.05			0.12		
Woodville	31-Aug-2020 to 11-Sep-2020	264.1	3.71			0.16		
Woodville	18-Nov-2020 to 15-Dec-2020	645.1	7.54	3.12	8	0.68	0.32	3

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Earth Systems reported that the tailings samples contained significant concentrations of quartz (14 to 17 wt% in the bulk tailings and 5.0 to 8.7 wt% in the PM_{10} component of the tailings) (Taylor 2020a). Quartz, when in the respirable size range, is usually the major component in RCS. While there were community concerns about RCS in the dust from CVO's mining operations, there appeared to be most concern about potential emissions of RCS from the mine ventilation system (vent emissions). Consequently, Todoroski Air Sciences was engaged to conduct plume dispersion modelling to determine the most likely location/s that emissions from the mine's ventilation stacks would impact the ground (Henschke 2020). Based on this modelling, an LVAS was located at Woodville (Figure 1 shows a map of the sampling locations), with a second sampler located at Bundarra as a reference sample.

Initially, sampling was only conducted for durations of 24 hours, but the sampling duration was subsequently increased to improve the LOD. Only a selection of the initial samples with higher weights of dust collected on the filter papers were submitted to RCA Australia for silica analysis (refer to ***Appendix G*** for RCA Australia's certificates of analysis). All the later, longer duration samples were submitted.

The results of the sampling are shown in Table 5. The relevant Certificates of Analysis are 250503, 250764 and 260401 and can be found in ***Appendix G***.

The results were trending under the annual ambient air quality criterion for $PM_{2.5}$ and RCS. Since the relevant criteria are annual averages, the sampling program will run for a year to confirm the initial indication of low annual average concentrations.

4.5 HSE Materials Hazard Assessment

Callander & Johnson Consultancy Services was engaged to undertake a HSE hazard assessment of the tailings material (Johnson 2020). Callander & Johnson is a Melbourne-based consulting firm that provides services in occupational health, development of safety data sheets, and product risk assessments.

HSE hazards posed by the tailings material were assessed by Callander & Johnson against internationally accepted protocols and classification schemes. Refer to ***Appendix B*** for a full copy of the HSE Materials Hazard Assessment.

Organic chemicals

The assessment included an examination of the potential for health and environmental impacts from organic chemicals used during mineral processing. It was found that CVO selected the processing reagents based on the use of the least hazardous chemicals, both from a worker health and safety perspective and consideration of the environmental impacts. The chemicals used are recycled in the process circuit and broken down during this processing.

Analysis of organic chemicals was undertaken on tailings samples by ALS. The analysis found low levels of hydrocarbon compounds were present. There were eight unidentified hydrocarbon compounds reported with a total concentration of 33 ppm. These hydrocarbons were alkanes, which are low hazard hydrocarbons. None of the traditionally carcinogenic hydrocarbon compounds, such as polycyclic aromatic hydrocarbons or benzene, were present in the tailings (see Certificate of Analysis EB2000591 in ***Appendix F***)

Dust suppressant chemicals used to coat the surface of the tailings dam were classified as non-hazardous under the United Nations Globally Harmonised System of Classification and Labelling of Chemicals (GHS).

Respirable crystalline silica

International silica classification criteria have been established by IMA - Europe to provide for the classification of products, substances and mixtures containing crystalline silica whether in the form of an identified impurity, additive or individual constituent.

For materials that contain crystalline silica, the United Nations GHS is applied. The GHS includes a classification category referred to as STOT-RE, meaning Specific Target Organ Toxicity - [following] Repeated Exposure. Long term, repeated exposure to RCS can cause silicosis, so RCS fits into this classification category. RCS can include quartz and/or cristobalite.

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The IMA - Europe health hazard criteria based on the GHS for materials containing quartz or cristobalite in the fine fraction (PM_{10}) are:

- STOT-RE 1 – if the quartz or cristobalite concentration is equal to, or greater than 10%.
- STOT-RE 2 – if the quartz or cristobalite concentration is between 1 and 10%.
- If the quartz or cristobalite concentration is below 1%, the substance does not qualify for a hazard classification.

Analysis conducted by QUT and reported earlier (Spratt 2020b) (refer to ***Appendix E***) found that the concentration of quartz in the PM_{10} fraction of the tailings was in the range 5.0 to 8.7 wt%, averaging 7.1 wt%. The PM_{10} fraction of the tailings represented 3.25 wt% of the total material, hence the average RCS content of the total tailings material was 0.23 wt%. Based on this, the tailings material is classified as non-hazardous with respect to RCS.

Carcinogenicity

The International Agency for Research on Cancer (IARC) is an agency of the World Health Organization (WHO) and the leading international expert group that undertakes classification of carcinogens. The IARC classifications of carcinogens are listed in Table 6.

A Group 1 classification means the evidence strongly indicates the substance is a human carcinogen, while Group 2B means the substance is a possible human carcinogen because of limited evidence of carcinogenicity in humans.

Metals that are classified as having the potential to cause cancer are arsenic, cadmium, chromium VI, cobalt, lead and nickel. The criterion used to classify mixtures containing carcinogenic chemicals or metals, is one that contains a concentration of the chemical or metal greater than 0.1 wt% (1000 ppm).

The carcinogenic metals present in the tailings samples were all below 0.1 wt% (see Table 7). In fact, the concentrations were less than 0.001 wt%, except for chromium which was less than 0.01 wt%. Chromium in the environment exists in two forms, trivalent chromium and hexavalent chromium. Only hexavalent chromium, chromium VI (said as chromium six), is carcinogenic. Trivalent chromium, chromium III (said as chromium three), is an essential human dietary element. The form of the chromium present in the tailings material was not determined, only the total amount of chromium present. However, with total chromium (regardless of the form) recording a concentration less than 0.01 wt%, the threshold of 0.1 wt% was not reached. At these concentrations of arsenic, cadmium, chromium, cobalt, lead and nickel, the tailings are not classified as a carcinogenic material.

Aluminium and iron had concentrations greater than 1000 ppm and are shaded dark yellow in the table. These metal complexes, predominately aluminosilicates and iron - sulphur compounds which have low water solubility, are not classified as hazardous to health.

Table 6: IARC Classification of carcinogenicity

Group	Classification	No. of carcinogenic agents classified
1	Carcinogenic to humans	121 agents
2A	Probably carcinogenic to humans	89 agents
2B	Possibly carcinogenic to humans	315 agents
3	Not classifiable as to its carcinogenicity to humans	497 agents

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Table 7: Metal concentrations in CVO tailings and carcinogenicity classification

Metal	IARC classification	Concentration range (ppm)	Average concentration (ppm)
Aluminium	Not Classified	10200 – 14500	**12600**
Arsenic	1	2.4 – 4.4	**3.5**
Barium	Not Classified	16.4 – 38.6	**25.2**
Cadmium	1	<0.1	**<0.1**
Chromium	1	21.4 – 39.4	**30.8**
Cobalt	2B	9.2 – 14	**11.4**
Copper	Not Classified	429 – 601	**498**
Iron	Not Classified	20700 – 28000	**24800**
Lead	2B	2.0 – 5.3	**3.7**
Lithium	Not Classified	2.4 – 16.0	**14.8**
Manganese	Not Classified	254 – 299	**287**
Molybdenum	Not Classified	7.9 – 36.1	**16.7**
Nickel	1	9.1 – 15.3	**12.8**
Strontium	Not Classified	90.4 – 219	**147**
Vanadium	Not Classified	54 – 83	**69.8**
Zinc	Not Classified	19.2 – 26.5	**23.9**

Metals toxicity

The United Nations GHS and the European Commission 2008 Regulation (EC) No. 1272/2008 on classification, labelling and packaging of substances and mixtures (CLP) as it applies to metals and minerals has been used to develop a process referred to as MeClas.

MeClas is a web-based tool used to generate toxicity hazard categories and corresponding classification and labelling information for inorganic metal-containing complex materials such as ores, concentrates, intermediates or alloys for which the manual application of the GHS/CLP rules is very complex (Verdonck et al. 2017). MeClas was designed specifically for classifying ore bodies, mineral concentrates and waste materials based on metals and mineralogy. It accounts for the toxicity of the metals, and the concentration and solubility of the metallic minerals.

Callander & Johnson reported that, using the MeClas assessment process and a comprehensive analysis of the tailings' mineralogy and metal content, the CVO tailings was classified as non-hazardous to the health and safety of people and the aquatic environment. A *not classified* determination indicates that these categories are not triggered for the United Nations GHS and European Union waste hazards properties listed in Table 8.

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Table 8: Classification of CVO tailings against international guidelines

Health and environment legislation	GHS classification	EU waste hazard properties	Classification
Acute toxicity - oral	Not classified	Acute toxicity	Not classified
Acute toxicity - dermal	Not classified	Corrosive	Not classified
Acute toxicity - inhalation	Not classified	Irritant -skin irritation and eye damage	Not classified
Skin corrosion/irritation	Not classified	Sensitising	Not classified
Serious eye damage/eye irritation	Not classified	Mutagenic	Not classified
Respiratory/skin sensitisation	Not classified	Carcinogenic	Not classified
Germ cell mutagenicity	Not classified	Toxic to reproduction	Not classified
Carcinogenicity	Not classified	Specific target organ toxicity (STOT) - Aspiration	Not classified
Reproductive toxicity	Not classified	Ecotoxic	Not classified
Specific target organ toxicity (STOT) - single exposure	Not classified		
Specific target organ toxicity (STOT) - repeated exposure	Not classified		
Aspiration hazard	Not classified		
Hazardous to the aquatic environment - acute	Not classified		
Hazardous to the aquatic environment - chronic	Not classified		

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Appendix A. Earth Systems reports

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EARTH SYSTEMS
Environment · Water · Sustainability

EARTH SYSTEMS
ABN 42 120 062 544
14 Church Street
Hawthorn, Victoria 3122, Australia
Tel: +61 (0)3 9810 7500
Fax: +61 (0)3 9853 5030
Email: enviro@earthsystems.com.au
Web: www.earthsystems.com.au

TECHNICAL MEMORANDUM

DATE	24/07/2019	**REF**	NCCADIA207502
TO	Jack Bowen	**REV**	Rev0
CC	Nicolas Bourgeot	**PROJECT**	Tailings Geochemical Fingerprinting
FROM	John Waters / Jeff Taylor		

SAMPLING AND ANALYTICAL PROTOCOLS

Jack / Nic,

As part of the project to identify distinctive chemical, geochemical and/or mineralogical fingerprints for the Cadia Valley Operation (CVO) tailings, Earth Systems has developed a materials sampling and analytical protocol. The protocol initially focuses on the tailings storage facilities and the dust deposition gauges. Additional protocols for baseline farm soil sampling and analysis are briefly outlined in this document, but they will be improved (before implementation) as initial data becomes available from the tailings and dust gauges.

TAILINGS SAMPLING PROTOCOLS

To establish the chemical/geochemical/mineralogical signature of the tailings dust, samples should be taken from both the North and South Tailings storage facility. The following sampling protocols will be observed:

- A total of 16 tailings samples should be taken for analysis.
    - 5 bulk tailings samples from the Northern Tailings Facility;
    - 5 bulk tailings samples from the Southern Tailings Facility;
    - Minimum of 3 efflorescence-rich samples from the surface of the Northern Tailings Facility,
    - Minimum of 3 efflorescence-rich samples from the surface of the Southern Tailings Facility (if available); and
    - Minimum of 2 windblown tailings adjacent to the North and South Tailings Facilities (if available).

- For the 5 bulk tailings samples to be taken from each of the TSF's (Northern and Southern):
    - Don't conduct sampling following rainfall, as this will impact on the soluble component of the dust. Ensure that it has not rained for at least 10 days before sampling.

  - Photograph sample sites before and after sampling.
  - Record GPS coordinates of site.
  - Collect 2 kg of sample scraped from within 2-5 millimetres of the surface using a trowel or similar suitable tool. This may require scraping a single bulk sample from several square meters of tailings surface area.
  - Samples should be collected in thick plastic sample bags and sealed to prevent contamination.
  - All samples are to be clearly labelled with sample identification number, location, time / date sampled.
  - Tailings samples should be representative of the surface area of the tailings (eg. average colour, texture) and be taken from areas as widely dispersed as possible. For the Northern Tailings Facility this should be from wide spaced sites across the whole surface area. For the Southern Tailings Facility sampling should be widely dispersed from areas safely reachable from the perimeter of the TSF.
  - Collect samples from unsaturated (and relatively dry) tailings ONLY.
  - Where possible collect samples from dry beached areas.
  - Record the colour of tailings being sampled, any changes in colour over the sampled area.
  - Estimate the sample grainsize.
  - Record the presence / absence of layering.
  - Estimate the moisture content.
  - Record any obvious odour emanating from the tailings within the sample site.
  - Record any other measurements take at the site.
  - Make sure all sampling equipment is washed clean after each sample is taken.

- For the 3 efflorescence-rich samples to be taken from each of the TSF's (Northern and Southern):
  - Don't sample following rainfall as efflorescences are likely to be soluble. Ensure that it has not rained for at least 10 days before sampling.
  - Locate a suitable accumulation of the 'white' efflorescence.
  - Photograph sample sites before and after sampling.
  - Record GPS coordinates of site.
  - Collect a minimum of 100g of efflorescence-rich sample scraped from the surface using a trowel or similar suitable tool. Make sure that none (or as little as possible) of the underlying tailings are collected with the sample.
  - Samples can be collected in a plastic sample vial and sealed to prevent contamination.
  - All samples are to be clearly labelled with sample identification number, location, time / date sampled.
  - Make sure all sampling equipment is washed clean after each sample is taken.

- For the windblown tailings samples:
  - Take at least one sample (where possible) from windblown tailings deposits adjacent to both the Northern and Southern Tailings Facilities.
  - Samples should be taken up to 100m away from the tailings dams from obvious windblown tailings deposits (if available).
  - Photograph sample sites before and after sampling.
  - Record GPS coordinates of site.

- Collect a minimum of 2kg of windblown tailings scraped from the surface using a trowel or similar suitable tool. Make sure that none (or as little as possible) of the underlying soils / material / vegetation is collected with the sample.
- Samples should be collected in thick plastic sample bags and sealed to prevent contamination.
- All samples are to be clearly labelled with sample identification number, location, time / date sampled.
- Make sure all sampling equipment is washed clean after each sample is taken.

TAILINGS ANALYTICAL PROTOCOLS

Sample Preparation

- All samples are to be initially oven dried (40°C) to permit the recovery of an initial XRD subsample (ie. avoid thermal decomposition of secondary efflorescences), then the remainder needs to be dried at 105°C for other analytical work (see below). Moisture content of the samples is not essential but would be helpful information.
- Analytical work listed below should proceed on a bulk tailings sample and possibly on a sieved <20 µm (fines) sample. The proposed final grainsize of the fines sample will be determined pending an examination of the grainsize of the dust found within the dust deposition gauges. CVO staff will be advised of the grainsize fraction once it has been determined.

Tailings Samples (in TSF or Wind Blown)

- A sub sample of the bulk sample tailings should be:
  - Sent for Quantitative (high precision) XRD analysis, with LOR of 0.01wt%, with feldspar compositions to be identified where possible.
  - Analysed for major and trace elements (see Table 1-1 for analytes).
  - Analysed for Rare Earth Elements (REE) (see Table 1-1 for analytes).
  - A distilled water leach (see Table 1-1 for analytes).
  - A NAG leachate produced and analysed (see Table 1-1 for analytes).
  - Tested for polyacrylamides (investigation of potential analytical procedures is underway).
- A sub sample of the sieved tailings fines should be:
  - Sent for Quantitative (high precision) XRD analysis, with LOR of 0.01wt%, with feldspar compositions to be identified where possible.
  - Analysed for major and trace elements (see Table 1-1 for analytes).
  - Analysed for Rare Earth Elements (REE) (see Table 1-1 for analytes).
  - A NAG leachate produced and analysed (see Table 1-1 for analytes).
  - Tested for polyacrylamides (investigation of potential analytical procedures is underway).

Tailings Efflorescence Samples

- The following procedures should be performed on the efflorescence samples collected:
  - Quantitative (high precision) XRD analysis, with LOR of 0.01wt%, with feldspar compositions to be identified where possible.
  - Analysed for major and trace elements (see Table 1-1 for analytes).
  - Analysed for Rare Earth Elements (REE) (see Table 1-1 for analytes).

- A distilled water leach (see Table 1-1 for analytes).

NOTE: Remaining bulk and efflorescence samples as well as water samples from leach testwork are to be returned to CVO and stored for additional testwork (if required).

DUPLICATION OF DUST DEPOSITION GAUGES

Earth Systems will use the samples and data collected by the current series of dust deposition gauges, before it is subjected to its normal analytical process. In addition, to assist with obtaining sample quantities required to perform the testwork program, it is proposed that the current dust deposition gauges be duplicated.

Duplication of the dust deposition gauges will require the installation of a second dust deposition gauge at each of the current gauge sites. As the only purpose of this second gauge is to collect additional sample, it is proposed that these duplicate gauges be made larger as deposition rates from these second gauges are not required. Earth Systems proposes that the funnels for these duplicate gauges be larger (up to 0.5m diameter) and the collection/ sample bottles be larger (up to 5 litres). This will speed up the collection of dust samples and address analytical limitations based on sample size.

It is suggested that the funnels for the larger duplicate gauges be covered with nylon mesh (1-3 mm) squares to minimise larger organic objects (insects, leaf litter etc.) falling into the sample containers. This mesh could be stapled over the upper opening of the funnel.

DUST DEPOSITIONAL GAUGE SAMPLING PROTOCOLS

Dust deposition gauges should be checked monthly with all duplicate oversized gauges being subjected to the following sampling protocols to collect both the dust and the water within the sample containers. The chemistry of the water within the dust gauges could be very significant in identifying the provenance of the dust. For example, it is likely that secondary minerals at the surface of the tailings storage facilities (white efflorescences) are both very low density and highly soluble (eg. epsomite: $MgSO_4.7H_2O$). This means that this material may form a significant component of fugitive dust from the TSFs. The high solubility of such materials suggests that we may only identify its presence in soluble form within the water component of the dust deposition gauges.

Sampling protocols should include:

- Photograph the dust deposition gauges before changing the sample containers.
- All visible, non-dust related material covering the funnel mesh is to be cleaned off.
- Any visible dust still within the sample collection funnel washed into the sample container using a minimum amount of distilled / deionised water.
- Sample containers removed from each site will be capped / sealed. Any water present within the sample containers is to be left in the container and sealed in along with dust sample.
- Sample containers are to be labelled with the following information:
  - Sample location, number, date time of sample collection.
- All sample containers are to be replaced with a clean dry sample container.

DUST ANALYTICAL PROTOCOLS

The protocols for undertaking analytical work on the dust sampled from the dust gauges will be partly dependent on the analytical results from the tailings samples. These protocols are therefore subject to change / improvement, based on emerging analytical data from the tailings.

Dust Deposition Gauges

Water

A **filtered** and **unfiltered** sample of the water from within the sample container is to be analysed for:

- Major elements (see Table 1-1 for analytes).
- Trace elements (see Table 1-1 for analytes).
- Additional analytes (see Table 1-1 for analytes).
- Tested for polyacrylamides (investigation of potential analytical procedures is underway).
- The above parameters may vary depending on results from the tailings analytical work.

Dust

Once separated from the water, particulate material (dust) within the sample container is to be dried at 40°C.

The following analytical procedures are to be conducted on the 40°C dried dust samples:

- Approximately 0.5 grams (or the minimum required amount) be sent for Quantitative XRD analysis, with LOR of 0.01wt%, with feldspar compositions to be identified where possible.

Dry the remainder of the sample at 105°C, and analyse the material for:

- Major element analysis (see Table 1-1 for analytes).
- Trace element analysis (see Table 1-1 for analytes).
- Additional analytes (see Table 1-1 for analytes).
- ABA analysis (see Table 1-1).
- NAG leachate (see Table 1-1 for analytes).
- Tested for polyacrylamides (investigation of potential analytical procedures is underway).
- Total sulfur and Total carbon - LECO (Table 1-1).
- The above parameters may vary depending on results from the tailings analytical work.

TAPERED ELEMENT OSCILLATING MICROBALANCE (TEOM) ANALYSERS SAMPLING & ANALYTICAL PROTOCOL

Where possible the filters present in the TEOM's are to be collected and placed in sealer plastic bags for QXRD analysis prior to being sent for the current routine suite of destructive analyses. This should only be conducted if there is no impact on the primary purpose of the TEOM's. An initial test on one filter paper should be trialled to confirm its suitability for QXRD analysis. If the filter papers can be used for this purpose, then;

- Photograph sample sites / filter paper.
- Provide the GPS coordinates of site.
- All samples are to be clearly labelled with sample identification number, location, time / date sampled.

BASELINE FARM SOIL SAMPLE PROTOCOLS

Should the dust deposition gauge testwork prove ambiguous or inconclusive, a baseline farm soil sampling and analytical program should be implemented.

A provisional soil sampling protocol is provided below. This protocol is subject to change based on the outcomes from the sampling and analytical protocols provided above. The finalised protocols will be made in conjunction with CVO staff.

Sampling Protocol

Soil samples are to be collected from up to 15 farm soil sites within 1 kilometre of the tailings storage facility. These sites should be selected based on the prevailing wind directions, as indicated by data from the Ridgeway / Southern Lease Boundary weather station, their proximity to the TSF and their distribution over different basement (soil) types (Silurian (post-mineralisation) and Ordovician (pre-mineralisation) lithologies). The coordinates of the proposed sample sites are to be determined but should be established jointly by CVO and Earth Systems staff.

Small excavations using a small backhoe (or equivalent), should be used to gain access to surface soils (potentially impacted by fugitive tailings dust) and soils immediately below the surface (background, pre TSF development). In addition, these shallow sample sites should allow sampling of materials with minimal organic matter (root material) and permit a close examination of soil characteristics.

All sampling equipment, including backhoe bucket and hand tools, need to be washed, removing all visible loose soil and sediment. This needs to be done both before sampling and between all sample sites. Avoid using hand tools with painted digging surfaces.

- Prior to any excavations with a backhoe, it is important to ensure that all sampling locations are;
    - Clear of utility lines and poles (subsurface as well as above surface).
    - Away from the impacts of roads.
    - Not in areas of recent activity or soil disturbance.
    - Not on or immediately adjacent to outcropping bedrock.
    - Away from areas trafficked by livestock.
    - Away from fence lines.
    - Not within poorly drained or saturated areas.
- Photograph the proposed sample site before excavation, including surrounding area.
- Using a small backhoe (or similar) recover a soil sample from 0-5 cm depth. Place removed or excavated soils on plastic sheets. Remove as much vegetative material as possible (roots / grass) to collect topsoil only. Collect approximately 4 kg of sample.
- Using clean sampling equipment, collect a second sample from a depth of 5-10 cm. Place removed or excavated soils on a plastic sheet. Remove as much vegetative material as possible (roots / grass) to collect soil only. Collect approximately 4 kg of sample.
- All samples should be collected in thick plastic sample bags and sealed to prevent contamination.
- It is important to use clean sampling equipment for each sample to prevent cross contamination.
- Document the sample site by noting:
    - GPS coordinates of site.
    - Colour of soil / sediment being sampled, any changes in colour with depth.
    - Grainsize.
    - Presence of layering and/or organic material.
    - Estimated moisture content (eg. dry, damp, moist).

  - Any obvious odour emanating from the soil / sediment within the test pit.
  - Whether there are any outcrops of basement bedrock nearby (within 10-20 metres).
  - Likely use of the area from where the sample is taken (eg. grazing livestock / sheep / cattle, crops, ..etc).
  - Whether there is a direct line of site to the TSF, if the site is elevated relative to the surrounding area, and whether there are wind breaks between the TSF and sampling site which could impact on the potential for fugitive dust to impact the site (eg. stands of mature trees, significant buildings).
  - The occurrence of visible accumulations of dust / wind-blown material close to the site.
  - Any other measurements taken at the site.
- Carefully and clearly label the sample bags with:
  - Sample number.
  - Location.
  - Time and date sampled.
  - Sample interval depth.
  - Preservation method used (if any).
- Once sampling is complete reinstate the sample site to as near to its original state by replacing soil / sediment removed from the test pit / trench and levelling the surface. Consider spreading typical pasture grass seeds over the affected areas. Photograph the reinstated site once work is complete.

SOIL ANALYTICAL PROTOCOLS

Analytical protocols for the soil samples will be determined based on the outcomes of the tailings analytical work. These protocols will be forwarded separately should they be required.

CONTACT DETAILS

If there are any questions regarding any of the sampling or analytical protocols, please contact either John Waters (0419 876 462) or Jeff Taylor (0402 158 682).

Table 1-1: Analytical procedures and parameters.

Analytical Procedure	Parameters	Method	Possible ALS Method Code	Notes
Dust Gauge and Tailings Sample Solids				
Mineralogy	All crystalline mineral phases present. Bulk Amorphous content.	High precision QXRD	TBA	LOR required 0.01 wt%
Major Elements	Al, Ca, Cl, Fe, K, Mg, Mn, Na, P, Ti, S, Si, LOI	XRF	ME-XRF21n	LOR required 0.01 wt%
Trace Elements	Al, As, Ag, Ba, Be, Bi, Cd, Cs, Ce, Cr, Co, Cu, Ga, Ge, Hf, In, La, Li, Mn, Mo, Ni, Nb, P, Pb, Rb, Sb, Sc, Se, Sn, Sr, Te, Ti, Tl, Th, W, U, V, Y, Zn, Zr Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb B F Hg	ICP-MS	EG020T REE Method? EG005T (B) EK040T (F) EG035T (Hg)	
Carbon / Sulfur	Total S / Total C Total Inorganic C	LECO Analyser by Furnace	ED042T, EP003TC EP003TIC	
NAG Leachate	pH, EC, Acidity (pH<6), Alkalinity(pH>6), Ca, Mg, K, Na, Cl, F, SO_4, Al, Fe, Mn, P, Sb, As, Ba, Be, Bi, B, Cd, Cs, Ce, Cr, Co, Cu, Ga, Ge, Hf, In, La, Pb, Li, Hg, Mn, Mo, Ni, Nb, Rb, Se, Ag, Sr, Te, Tl, Th, Sn, Ti, W, U, V, Y, Zn, Zr.	USEPA 6020	EA005 EA010 ED038 ED037NT-1 ED041G (SO4) ED045 EK040	

Analytical Procedure	Parameters	Method	Possible ALS Method Code	Notes
	Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb		EK067 EG035F (Hg) EG020F	
Acid-Base Accounting (ABA)	Chromium reducible sulfur suite (pH_{KCl},TAA,S_{Cr},ANC,S_{KCl},S_{HCl}, S_{NAS})	Ahern et al (2004)	EA033 EA011	
Water Samples – Dust Gauge Water / ASLP Leach				
Physiochemical parameters	pH EC Acidity (pH<6), Alkalinity(pH>6)	APHA 2310 B	EA005 EA010 ED037 ED038	
Major Elements	Ca, K, Mg, Na	APHA 3120 Ca Mg K Na-B	NT-1	
Trace Elements	Al, As, Ag, B, Ba, Be, Bi, Cd, Cs, Ce, Cr, Co, Cu, Fe, Ga, Ge, Hf, Hg, In, La, Li, Mn, Mo, Ni, Nb, P, Pb, Rb, Sb, Sc, Se, Sn, Sr, Te, Ti, Tl, Th, W, U, V, Y, Zn, Zr Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb	USEPA 6020	EG020F	
Additional Analytes	SO_4 Cl F Total N NO_3 Total Kjeldahl Nitrogen (TKN)		ED041G ED045 EK040 NT-11	

Analytical Procedure	Parameters	Method	Possible ALS Method Code	Notes
	Total P			
Additional Analytical Protocols (To be confirmed)				
Bulk Cyanide Leach (BCL)	*Au, Ag, Co, Cu, Mn, Mo, Ni, Zn*	*Gold Cyanidation (Au, Ag, Cu)*		*30 g sample*
Polyacrylamides	*Organics(?)* *Cyclic hydrocarbons (?)*	*Currently being investigated*	*TBD*	
Stable Isotopic Analysis	*Sulfur isotopes* *Oxygen isotopes* *Carbon Isotopes*	*Stable Isotopes*	*S-ISTP01* *CO-ISTP01 (carbon and oxygen)*	
Petrographic Analysis	*Mineral identification*	*Grain mounts (reflected light microscopy)* *Grain mounts (transmitted light microscopy*	*TBD*	
SEM with EDS	Mineral Identification Grain shapes	Scanning electron microscopy	TBD	

Analytical procedures indicated in blue will be considered following tailings and dust gauge analytical work.

EARTH SYSTEMS
Environment · Water · Sustainability

EARTH SYSTEMS
ABN 42 120 062 544
14 Church Street
Hawthorn, Victoria 3122, Australia
Tel: +61 (0)3 9810 7500
Email: enviro@earthsystems.com.au
Web: www.earthsystems.com.au
www.acidmetalliferousdrainage.com.au

TECHNICAL MEMORANDUM

DATE	17/03/2020	**REF**	NCCADIA207505_Memo_Rev0
TO	Dr Tim Wrigley – Newcrest Mining Ltd	**REV**	Rev0
FROM	Dr Jeff Taylor – Earth Systems	**PROJECT**	Dust Fingerprinting at the Cadia Mine

PRELIMINARY ASSESSMENT OF SURFICIAL TAILINGS AND DUST FROM CADIA VALLEY OPERATIONS

INTRODUCTION

Earth Systems was engaged by Newcrest Mining Limited (hereafter Newcrest) to identify a distinctive chemical, geochemical or mineralogical fingerprint to the site's tailings at their Cadia Valley Operations (CVO) in order to assess the potential for tailings dust to impact on local roof water quality at surrounding farm homesteads. In addition, it is understood that Newcrest staff are also interested in determining if there are any potential impacts posed by respirable components of fugitive dust.

This technical memorandum documents the key findings from an assessment of initial data collected on surficial tailings samples and dust deposition gauges (ie. mineralogy, bulk chemistry, and leachate [water] chemistry). Assessment of this data provides a better understanding of likely dust compositions and the specific components that are likely to be mobilised and solubilised, and therefore have the potential to impact on roof derived water supplies.

DATA PROVIDED

Eight (8) samples of surficial tailings material were collected by Newcrest staff from the Northern TSF (NTSF) and Southern TSF (STSF) at the Cadia mine (ie. four [4] samples from each TSF). From these bulk samples, eight (8) subsamples were produced by sieving to obtain a <10 µm "fines" fraction. Sampling from the upper most veneer of the TSF's and the production of a fines subsample aimed to obtain material which is most likely to become airborne. The tailings were analysed for:

- Trace element and partial major element chemistry for the eight (8) bulk surficial tailings samples.
- Quantitative X-Ray Diffraction (QXRD) data for:
  - eight (8) bulk surficial tailings samples.

  - eight (8) fine fraction (<10 µm) surficial tailings samples.
- The Net Acid Generation (NAG) suite for the eight (8) bulk surface tailings samples (ie. NAG pH, and NAG leachate chemistry).
- Australian Standard Leachate Procedure (ASLP) data for the eight (8) bulk surface tailings samples. This procedure involves dilution in de-ionised (DI) water (20:1, water to sample). The solution is tumbled for ~18 hours, stood for a minimum of 2 hours (for settling of any solids in suspension), and then an unfiltered sample of the solution is analysed. This procedure is intended to identify key mobile components in near neutral water (eg. a proxy for leaching during rainfall events).
- Data from the Dust Deposition Gauges (DDG's):
  - partial bulk chemistry (selected major and trace elements);
  - dust loads (ie., the mass of dust per volume of air and unit of time);
  - proportions of soluble and insoluble components.

INITIAL RESULTS

The initial chemical / geochemical data was assessed and pertinent results are summarised below. There is no systematic or statistically significant difference between the mineralogy or mineralogical abundances of the two sample localities (ie. the NTSF and STSF), hence these results are discussed collectively. However, there are significant differences between the bulk tailings sample and the fines (<10 µm) subsample, hence these results are discussed separately.

Tailings Compositions

The trace element geochemistry of the bulk tailings samples was used to calculate the samples enrichment relative to the average crustal abundance, known as the Geochemical Abundance Index (GIA). The GAI is calculated using the following formula:

$$GAI = Log_2 (Mc / (1.5 \times Ac)).$$

Where *Mc* is the measured concentration of a given element, and Ac is the average [crustal] concentration of that element. The results of this calculation indicate that the tailings are enriched (ie. GAI >2) in selenium (Se), cobalt (Co), copper (Cu), molybdenum (Mo), fluoride (F), and chloride (Cl). It is noteworthy that element enrichments in solids do not necessarily correspond to element mobility in water.

Tailings Mineralogy

- For the eight (8) bulk tailings samples the dominant primary minerals include:
  - Plagioclase feldspar (23-31 wt.%; $[(Na, Ca)(Si, Al)_4O_8]$);
  - Illite/mica (16-20 wt.%; $[(K,H_3O)(Al, Mg, Fe)_2(Si, Al)_4O_{10}[(OH)_2, (H_2O)]]$);
  - Quartz (14-17 wt.%; $[SiO_2]$);
  - Clinochlore (10-16 wt.%; $[Mg_5Al(AlSi_3O_{10})(OH)_8]$);
  - Potassium feldspar (8-13 wt.%; $[KAlSi_3O_8]$);
  - Calcite (3-4 wt.%; $[CaCO_3]$); and

  - Minor (ie. generally <2 wt.%) concentrations of magnetite [Fe_3O_4], pyrite [FeS_2], dolomite [(Ca, Mg)$CaCO_3$], and amphibole occur in many samples.

- All samples contain a mixture of primary and secondary minerals. The secondary minerals are the result of pyrite oxidation (generation of acid), and subsequent neutralisation reactions within the TSF between the acid and carbonate minerals (ie. calcite and dolomite). Fluids that carry dissolved components from these neutralisation reactions percolate upwards through the tailings (via capillary action) and when they reach the surface these fluids undergo evaporative concentration causing surficial efflorescence precipitation. These minerals have likely formed in the last few months, not years.
- For these eight (8) bulk tailings samples the dominant secondary minerals include:
  - Gypsum (in all samples, 0.5-1.5 wt.%; [$CaSO_4 \cdot 2H_2O$]); and
  - Halite (in 2/8 samples, 0.4-0.5 wt%; [NaCl]);
  - Blödite (in 1/8 samples, 12 wt.%; [$Na_2Mg(SO_4)_2 \cdot 4H_2O$]);
  - Rhomboclase (in 1/8 samples, 0.8 wt.%; [$H_5Fe^{3+}O_2(SO_4)_2 \cdot 2(H_2O)$]).
- Most samples contain a significant but variable amorphous content, ie., 1-13 wt.% in the bulk samples, and 6-51 wt.% in the fine fraction (<10 µm) subsamples. This amorphous content represents non-crystalline components that are not recorded by QXRD mineralogy but will be included in bulk chemical analyses. Without further calculations the composition of the amorphous content (as well as the potential impacts, if any) remains unknown.
- The eight (8) fine fraction (<10 µm) tailings subsamples contain the same primary mineralogy as the bulk samples, however, the former is relatively depleted in quartz and feldspars whilst enriched in all other minerals (particularly the amorphous component and secondary minerals).
- For the eight (8) fine fraction (<10 µm) tailings subsamples there is a higher abundance and more diversity in the secondary minerals present, with the dominant components including:
  - Anhydrite (in all samples, 1.4-3.2 wt.%; [$CaSO_4$]);
  - Halite (in 6/8 samples, 0.7-3.0 wt.%);
  - Glauberite (in 1/8 samples, 3.8 wt.%; [$Na_2Ca(SO_4)_2$]);
  - Bassanite (in 1/8 samples, 3.7 wt.%; [$CaSO_4 \cdot 0.5H_2O$]); and
  - Gypsum (in 1/8 samples, 2.5 wt.%; [$CaSO_4 \cdot 2H_2O$]).
- It is possible that the presence of anhydrite and bassanite in these samples is due to thermal decomposition of gypsum during sample preparation (eg. oven drying).
- The proportion of amorphous material in the <10 µm size fraction of each sample is between 2 and 4%.
- All samples have slightly negative Net Acid Production Potential (NAPP) values (calculated from QXRD mineralogy), indicating all of these samples are Non-Acid Forming (NAF).
- The major primary minerals in tailings samples (eg., quartz, feldspars) represent a lower risk of becoming airborne due to their relatively high densities (ie. >2.55 g/cm^3). In addition, these phases are also unlikely to produce significant changes water quality as the minerals are essentially insoluble.
- Many of the secondary minerals have relatively low densities (ie. <2.3 g/cm^3), which combined with their concentration and elevated location at the surface of the TSF makes them more likely to become airborne. This inference is supported by data collected from the DDG's, where ~10-20 wt.% of the dust captured is soluble.

- In addition, these secondary phases are soluble to highly soluble in water (eg, Halite = ~360 g/L at 25°C). Therefore, assuming these secondary minerals occur in significant concentrations down-wind (which has not yet been determined), they could impact on water chemistry / drinking water quality.
- No information exists on the trace element geochemistry of these secondary phases, which have the potential to accommodate a variety of metals (eg. copper, lead, zinc, nickel, arsenic, antimony).

Tailings Leachate (Water) Chemistry

Results of the ASLP (Australian Standard Leach Procedure - a 20:1 leach with DI water) are summarised below. These results provide a qualitative analogue for the leaching of tailings material during a rainfall event. The components released during the ASLP represent compounds likely to be mobilised by water and should be considered by future work.

- The pH of leachate water is 7.4-8.0, consistent with an excess of carbonate (NAF classification), low acidity values, and elevated alkalinity values.
- The presence of detectable soluble metals in near neutral leachate indicates that the surficial tailings represent an NMD (neutral metalliferous drainage) risk.
- The tailings leachate contains high to very high concentrations of sulfate (634-3820 mg/L), chloride (49-373 mg/L), calcium (107-414 mg/L), magnesium (7-365 mg/L) and sodium (145-1000 mg/L). Sulfate, sodium, calcium and magnesium all show a good correlation with electrical conductivity. Elevated sulfate and chloride concentrations means that the tailings leachate has very high salinity. These enrichments are consistent with the soluble secondary (Ca-Mg-Na bearing) sulfate-rich and chloride-bearing mineralogy identified by the QXRD analyses.
- Key soluble trace metals with concentrations above detection limits include antimony (Sb), arsenic (As), chromium (Cr), copper (Cu), fluoride (F), lead (Pb), molybdenum (Mo), mercury (Hg), selenium (Se) and zinc (Zn).

The NAG leachate testwork involves the rapid oxidation of sulfide minerals (through the addition of peroxide) and subsequent measurement of leachate produced. Whilst this leachate chemistry is unlikely to represent real-world water quality it is useful in highlighting potentially mobile elements in leachate from oxidised tailings. The NAG leachate contains the following metals with concentrations above their detection limits.

- Antimony (Sb), boron (B), cadmium (Cd), chromium (Cr), copper (Cu), gallium (Ga), lithium (Li), molybdenum (Mo), selenium (Se), vanadium (V), and zinc (Zn).
- It is noteworthy that the following elements are present above detection in both the ASLP and NAG leachate, suggesting they are very likely to become mobile upon interaction with water: aluminium (Al), antimony (Sb), chromium (Cr), copper (Cu), molybdenum (Mo), selenium (Se) and zinc (Zn).

Potential Risks Associated with Respirable Dust Components

- All samples analysed (ie. both the bulk sample and the <10 µm size fraction) contain significant concentrations of quartz (5-17 wt.%). Therefore, consideration should be given to quantifying the time weighted average concentrations of silica using existing DDG's.

- Amphibole group minerals were identified in 3 of the 16 tailings samples (both bulk and <10 µm size fraction). Certain amphibole minerals have the potential to occur in a fibrous habit (ie. asbestiform). It is currently unclear which specific amphibole minerals are present in the tailings samples, and therefore the potential risks cannot be assessed.

KEY CONCLUSIONS

- Surficial tailings samples contain a mixture of primary and secondary minerals, with secondary minerals and amorphous components being more concentrated in the <10 µm size fraction.
- Secondary minerals are the products of acid neutralisation reactions within the TSF. Whereby, fluids percolate upward through the TSF (via capillary action) and secondary efflorescence minerals precipitate at the surface due to evaporative concentration.
- These secondary minerals are predominantly hydrous Ca-Na-Mg sulfate minerals (eg. gypsum, blodite, glauberite) with lesser chlorides (halite) and Fe-sulfates (rhomboclase). Many of these secondary phases are soluble to highly soluble in water and have low densities compared to primary tailings mineral phases.
- The secondary phases are the most likely TSF component to become airborne, due to their location at the surface of the TSF and their comparatively low density. Moreover, these phases have the potential to effect down-wind water chemistry due to their high solubility. For example, at low concentrations these minerals may impart a salty and/or bitter taste on drinking water.
- The ASLP data provides an analogue for the leaching of tailings during a rainfall event. Although the concentrations are not indicative of actual water quality impacts, the elements present at concentrations above their detection limit (ie. Sb, As, Cr, Cu, F, Pb, Mo, Hg, Se, and Zn) represent elements which will likely be mobilised from soluble tailings components.
- The following remains unclear regarding the mobility and distribution of dust:
  - What is the distribution of airborne dust as a function of distance / direction from the TSF's?
  - How does the composition of this dust change as a function of distance / direction from the TSF (eg. changing mineralogy, or changing proportions of soluble to insoluble components)?

RECOMMENDATIONS

A number of recommendations have been developed based on the above results and conclusions, including:

- Develop a detailed sampling and analytical strategy for the routine collection of water and suspended solids from appropriately distributed dust collectors. This will help clarify the mass of dust landing on a certain area, and the properties of this dust (eg. composition, ratios of soluble to insoluble components) as a function of distance / direction from the TSF's. Dust collectors are a simple low-cost device consisting of a funnel attached to a container for collecting sample (dust, and potentially rainwater).
- Provide a single DDG filter to an XRD laboratory (prior to destructive analysis) to clarify if these filters can be used to provide direct constraints on the mineralogy of airborne dust.
- Collect water samples (and possibly suspended solids) from the drinking water tanks of local farms and analyse these samples for the full analytical water quality suite provided to Dr Tim Wrigley (on 03/03/2020 via email).

- Obtain major element analyses of the existing bulk tailings samples (see Earth Systems, 2019 for analytes). This will allow the calculation of the composition of the amorphous content of the studied samples, which may reach up to ~50 wt.%, and is concentrated in the fine (<10 μm) fraction (ie. a likely component of any airborne and potentially reactive dust).
- Include silica in the list of analytes for the DDG's filters. This will help with calculation of indicative average time weighted exposures to silica.
- Determine the type of amphibole minerals present to clarify the risk posed, if any, by fibrous minerals.

REFERENCES

Earth Systems, 2019. Sampling and analytical protocols – Technical Memorandum. 24th July, 2019.

EARTH SYSTEMS
Environment · Water · Sustainability

EARTH SYSTEMS
ABN 42 120 062 544
14 Church Street
Hawthorn, Victoria 3122, Australia
Tel: +61 (0)3 9810 7500
Email: enviro@earthsystems.com.au
Web: www.earthsystems.com.au
Web: www.acidmetalliferousdrainage.com

TECHNICAL MEMORANDUM

DATE	27 March 2020	**REF**	NCCADIA207507_Memo_Rev0
TO	Dr Tim Wrigley – Newcrest Mining Ltd	**REV**	0
FROM	Jeff Taylor – Earth Systems	**PROJECT**	Tailings Dust Fingerprinting at the Cadia Mine

RELATIVE ELEMENTAL ENRICHMENTS IN TAILINGS SAMPLES FROM THE CADIA VALLEY OPERATIONS

INTRODUCTION

Earth Systems was engaged by Newcrest Mining Limited to identify a distinctive chemical, geochemical or mineralogical fingerprint for tailings at Cadia Valley Operations (CVO), to assess the potential for tailings dust to impact on local receptors (e.g., roof water quality of surrounding farm homesteads). This technical memorandum documents the Geochemical Abundance Index (GAI) of tailings samples, as requested by Dr Tim Wrigley.

RESULTS

The major and trace element geochemistry of all tailings samples is reported in Table 1. These elemental concentrations have been colour coded according to their GAI values, which represent the samples relative enrichment compared to average global crustal abundances. The GAI was calculated using the following formula:

$$GAI = \text{Log}_2 (Mx / (1.5 \times Cx))$$

Where Mx is the measured concentration of a given element in the sample, and Cx is the average global crustal abundance of that element. It is noted that the GAI value of an element does not directly relate to the potential impact of that element on a local receptor, because the GAI calculation does not consider the solubility of the mineral in which the element is bound.

Table 1: Major and Trace element geochemistry (ppm) of tailings samples from Cadia Valley Operations with colour coded GAI enrichment factors.

	STF1	STF2	STF3	STF4	NTSF1	NTSF2	NTSF3	NTSF4
Arsenic	2.6	2.4	3.1	3.7	3.6	4.1	4.4	3.7
Selenium	1	4	1	1	1	2	0.5	2
Silver	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Barium	22.8	16.4	20.9	22.6	38.6	29.6	26.6	23.9
Thallium	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Beryllium	0.3	0.2	0.3	0.4	0.3	0.3	0.3	0.2
Cadmium	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Bismuth	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.1
Cobalt	10.8	9.2	12.9	14	11.4	11.4	11.4	10
Chromium	32.9	21.4	39.4	37.6	30.4	33.7	26.7	24.5
Copper	444	429	457	607	490	458	610	488
Thorium	1.8	1.5	1.6	1.8	1.9	1.8	1.8	1.5
Manganese	294	254	287	299	283	325	283	274
Strontium	101	203	90.4	120	84.1	142	218	219
Molybdenum	7.9	36.1	10.3	9.2	9	15.9	11.6	33.5
Nickel	13.2	9.1	14.5	15.3	12.7	14.6	11.8	11.5
Lead	2.5	2	3.2	4	4.2	5.3	4	4.1
Antimony	0.2	0.2	0.2	0.1	0.1	0.2	0.2	0.2
Uranium	0.4	0.4	0.4	0.4	0.4	0.5	0.4	0.6
Zinc	24.7	19.2	23.4	26.4	22.9	26.5	25.9	21.8
Lithium	16	12.4	15.2	16	14.5	15.7	14.6	14.3
Vanadium	77	54	79	83	68	74	64	59
Tin	0.5	0.3	0.5	0.8	0.6	0.6	0.5	0.5
Fluoride	1250	1080	1280	1360	1130	1310	1260	1160
Aluminium	13700	10200	13700	14500	12700	13200	11900	10900
Boron	25	25	25	25	25	25	25	25
Iron	26100	20700	26900	28000	25200	26000	23800	21700
Chloride	1610	8720	3160	950	1070	4360	2460	4440
Calcium	2450	2270	1780	2170	830	2740	2500	2320
Magnesium	840	6150	920	140	680	2160	2140	7740
Sodium	4890	20700	4320	3640	2270	8540	9660	21300
Potassium	1220	5680	1350	620	750	2130	2270	5790

	Basis	Enrichment Factor				
Sample solids	Geochemical abundance index (GAI)	<3× (GAI: 0)	≥3× (GAI: 1)	≥6× (GAI: 2)	≥24× (GAI: 4)	≥96× (GAI: 6)

EARTH SYSTEMS
Environment · Water · Sustainability

EARTH SYSTEMS
ABN 42 120 062 544
14 Church Street
Hawthorn, Victoria 3122, Australia
Tel: +61 (0)3 9810 7500
Email: enviro@earthsystems.com.au
Web: www.earthsystems.com.au
Web: www.acidmetalliferousdrainage.com

TECHNICAL MEMORANDUM

DATE	12 May 2020	**REF**	NCCADIA207511
TO	Dr Tim Wrigley – Newcrest Mining Ltd	**REV**	0
FROM	Jeff Taylor – Earth Systems Ashton Soltys – Earth Systems	**PROJECT**	Tailings Dust Fingerprinting at the Cadia Mine

SURFICIAL PROCESSES IN THE TAILINGS STORAGE FACILITY AT THE CADIA VALLEY SITE

Tim,

Below is the requested text which explains the processes operating at the surface of the TSF at the Cadia Valley mine site. If required, the chemical formula for all listed minerals can be provided.

The key primary mineral constituents within surficial tailings deposits at the Cadia Valley Operations (CVO) are dominated by quartz, potassium feldspar, plagioclase feldspar, chlorite, potassium mica and calcite, with minor to trace quantities of magnetite, pyrite, amphibole, gypsum, dolomite, anatase and halite. Tailings samples collected on previous occasions (lower down in the tailings profile) also include minor to trace quantities of chalcopyrite, bornite, goethite, limonite, hematite, epidote, biotite, sphene, ilmenite, fluorite, apatite, kaolinite, ankerite, garnet, galena, sphalerite, molybdenite, barite and zircon.

Almost all of these phases are common rock-forming minerals that remain largely unreactive under most conditions at the Earth's surface. A small number of these minerals are less widespread and are specifically associated with the copper mineralisation at CVO. These include pyrite, chalcopyrite, bornite, galena, sphalerite and molybdenite. Pyrite, chalcopyrite and bornite are the main reactive mineral phases in the tailings, and only pyrite is currently detectable in the current surficial tailings material.

Pyrite is considered reactive as it can slowly decompose in the presence of atmospheric oxygen to generate sulfuric acid. The concentration of pyrite in current surficial tailings permits acid to form, but the abundance of neutralising minerals (calcite, ankerite, dolomite, feldspar) ensures that all of the acid is neutralised. Hence, the upper several centimetres of the tailings storage facilities will be undergoing slow and selective decomposition. During a rainfall event, the decomposition products largely dissolve, even in small volumes of water, generally producing near neutral, sulfate-rich saline porewater. Over the succeeding drier days, capillary action causes this water to rise to the tailings surface, evaporatively concentrate and subsequently crystallise into highly soluble, low density (secondary) salts / minerals as fields of crystalline efflorescences. These secondary salts include blodite, rhomboclase, gypsum, bassanite,

anhydrite, glauberite and probably some non-crystalline material. The rate of production of these salts is generally slow and is influenced by how far air can penetrate into the tailings deposits to form acid from pyrite oxidation. As low density, surficial salts, these phases are the most likely to be mobilised into the air during significant wind events, relative to the other rock forming minerals.

Form a chemical perspective, these ultra-thin, temporary crystalline carpets across the surface of the tailings deposits are not inherently dangerous, but if they are mobilised as solids during windy periods, have the potential to contribute sulfate and chloride salinity to local water sources (ie. local waterways, farm dams, drinking water supplies from roofwater).

Some of these secondary salts also have the potential to incorporate trace quantities of heavy metals and metalloids such as copper, zinc, molybdenum, antimony, and arsenic into their crystal structure. The potential for wind mobilised salts to impact on the heavy metal / metalloid content of roofwater on farms surrounding the tailings storage facilities is believed to be very low but is being assessed via water quality monitoring.

Dust Fingerprinting Study

Assessment of drinking and stock water chemistry from farms surrounding Cadia Valley Operations, New South Wales

prepared for

Newcrest Mining Limited

NEWCREST MINING LIMITED

by

Earth Systems

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Earth Systems
ABN 42 120 062 544
14 Church St
Hawthorn, Victoria 3122
Australia
Tel: +61 (0)3 9810 7500
Web: www.earthsystems.com.au

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Attachment D: Distribution of total metal concentrations and comparison with relevant water quality guidelines.

EXECUTIVE SUMMARY

Earth Systems was engaged by Newcrest Mining Limited to identify a distinctive chemical, geochemical or mineralogical fingerprint for tailings at Cadia Valley Operations (CVO), to enable assessment of the potential for tailings dust to impact on local receptors (eg. roof water quality of surrounding farm homesteads).

After review of available tailings characterisation data from CVO, a sampling and analytical program was developed by Earth Systems (2019) with a focus on tailings (surface efflorescence and depth samples) and materials collected in dust deposition gauges (DDG's) located on and around the CVO mine site. Additional protocols for baseline farm soil sampling and analysis were also briefly outlined, pending initial data from the tailings and dust gauges. The tailings and DDG analytical program included an extensive suite of mineralogical and geochemical parameters, as well as leachate chemical analyses to identify potential indicators associated with any water soluble components of the tailings. CVO personnel conducted sampling of the tailings and depositional dust material. Mineralogy, geochemistry (partial suite) and standard leach test data for the tailings samples, as well as selected depositional dust data (partial major and trace element suite; dust loads; proportions of soluble and insoluble components), were provided to Earth Systems for review. Key results of this preliminary work are documented in Earth Systems (2020a, b, c). In particular, the leach test data indicated that the most sensitive (distinctive) fingerprint of CVO tailings is likely to be associated with water-soluble components. This helped to focus subsequent investigation on potential receiving waters surrounding the mine site (such as roof water tanks and farm dams) rather than farm soils.

Accordingly, CVO personnel collected samples of roof water and dam water chemistry data from surrounding farms owned by Newcrest, to investigate whether any fingerprint of tailings dust was evident in regional water samples. The water chemistry data for these samples provided by CVO included field parameters (pH, electrical conductivity, redox potential and dissolved oxygen) and laboratory measurements of alkalinity, major ions, total and dissolved metal concentrations and nutrients (nitrogen speciation and phosphorus). In this report, roof water and dam water samples were assessed to determine the potential source of key chemical components and if a contribution from CVO tailings dust could be definitively ascribed or discounted. In addition, the water chemistry data were compared with relevant guidelines – (human) drinking water in the case of roof water samples and livestock drinking water for dam water samples.

When considering the potential influence of CVO tailings dust on roof water chemistry, it should be noted that:

- The catchment area of a roof is small compared to that of a farm dam catchment (ie. an entire paddock). Hence, a relatively small amount of water and dust can be collected by roof water tanks.
- It is likely that the tank water has a relatively high flow-through rate (ie. due to regular water consumption in farm dwellings and/or seasonal flushing).
- Tanks have very small surface areas and are generally enclosed, limiting the potential for evaporation and associated concentration of the dissolved components.
- Roof water chemistry has the potential to be influenced by galvanised steel roofing or guttering materials (potential source of iron, zinc, or copper), lead flashing (lead), plumbing materials and fittings (eg. copper pipes; brass taps/fittings) or the tank material (concrete, plastic, zincalume steel).

When considering the potential influence of CVO tailings dust on dam water chemistry, it should be noted that:

- The total catchment area of a farm dam is likely to be significantly greater than that of a roof water collection tank, and farm dams will be subject to evaporative concentration and the chance of dam overflow (ie. loss of dissolved components) is unlikely. Hence, farm dams may be more sensitive to potential soluble dust components derived from CVO tailings dams, in comparison with roof water.
- Farm dam water has the potential to be influenced by local soil composition, historical or recent chemical / nutrient additives to farmland within the catchment, or local/regional dust deposition

Hence, throughout this report the chemistry of roof water and farm dam water, and the potential influences on these, are discussed separately.

Roof water was found to be generally slightly acidic to near-neutral (pH 4.5-6.7) and well oxidised, with low salinity (less than 170 µS/cm), low suspended sediments (less than 20 mg/L) and low metal and nutrient concentrations. Most roof water samples met Australian (NHMRC, 2011) and international (WHO, 2017) drinking water guidelines, with the exception of:

- Total zinc in two tanks (12.8 mg/L in tank SVWT and 5.4 mg/L in tank OCWT) which exceeded the aesthetic guideline value of 3 mg/L.
- Total lead in one tank (CHST = 0.013 mg/L) which marginally exceeded the health-based guideline value of 0.01 mg/L.
- pH, which ranged from 4.5-6.3 in most roof water tanks, below the aesthetic guideline range of 6.5-8.5.
- Total iron in one tank (BWWT = 0.42 mg/L which exceeded the aesthetic guideline value of 0.2 mg/L.

Despite elevated dissolved (and total) zinc concentrations, all roof water samples had very low sulfate and chloride concentrations, which strongly supports no significant effect from CVO tailings dust on roof water.

The presence of zinc, acid and iron may relate to highly oxidised (rusted) galvanised (zinc-coated) steel roofing materials and/or organic acids. The lowest pH values and highest iron concentrations may be derived from the oldest / most corroded roofing materials. The marginally elevated lead concentration in one roof water collection tank (BWWT) could be related to impurities in plumbing or galvanising materials, or the use of lead flashing on the roof.

All dam water samples met ANZECC/ARMCANZ (2000) guidelines for livestock drinking water. Water samples from farm dams contained higher concentrations of dissolved metals such as aluminium, arsenic, cobalt, manganese, molybdenum, and iron, than roof water samples. Dissolved iron was up to 7.4 mg/L in farm dam water, but this is of no concern for livestock drinking water, nor does this reflect the CVO mineralisation. The presence of iron likely reflects the influence of natural iron oxide in local soils. As iron is a redox-sensitive element, it may dissolve in water under reducing conditions, which would not be unusual for a farm dam containing naturally decomposing organic matter (eg. animal faeces). The presence of manganese in farm dam water is consistent with the presence of dolomite / calcite (see above) in the local rocks/soils. Of the remaining metals listed above, molybdenum, copper and zinc are the only metals that are potentially indicative of the CVO mineralisation. However, these metals could also be derived from other sources, such as the use of micro-nutrient fertilisers on farms. While of no concern for livestock drinking water, further work is required before discounting fugitive tailings dust as a potential source of these metals in farm dam water.

The salinity was low in roof water and low to moderate in farm dam water samples. In both roof water and dam water, the salinity was dominated by bicarbonate alkalinity, likely caused by the dissolution of the carbonate mineral calcite in roof water collection tank samples, or calcite and dolomite in dam samples. Whilst some contribution from dust is highly likely, it is unclear if this dust is derived from the weathering of local carbonate-bearing geological units, the application of agricultural lime/dolomite to farm soils, or from CVO tailings dust that contains both calcite and dolomite.

1. INTRODUCTION

Newcrest Mining Limited's Cadia Valley Operations (CVO) comprises three mines in central-west New South Wales (ie. Cadia East underground, Ridgeway underground and Cadia Hill). These mines represent gold-copper porphyry intrusions, as well as associated alteration halos and skarns formed in the adjacent calcareous sediments. The mineralisation is late Ordovician (~440 Ma) in age and associated with shoshonitic dykes and stocks of the Cadia intrusive complex. The Cadia orebodies are overlain by thick post-mineralisation sediments of Silurian Age (see section 2.2.3 for details).

Earth Systems was engaged by Newcrest Mining Limited to identify a distinctive chemical, geochemical or mineralogical fingerprint for tailings at Cadia Valley Operations (CVO), to enable assessment of the potential for tailings dust to impact on local receptors (eg. roof water quality of surrounding farm homesteads).

Tailings from CVO were historically deposited into the Northern and Southern tailing storage facilities (ie. the NTSF and STSF, respectively). Surface materials (efflorescences) across CVO tailings dams are likely to comprise soluble, low density secondary minerals. These surface minerals are expected to be the first to be mobilised as dust and/or travel the furthest if they become airborne during windy conditions. After deposition, they are also the most likely minerals to subsequently dissolve upon contact with water.

After review of available tailings characterisation data from CVO, a sampling and analytical program was developed by Earth Systems (2019) with a focus on tailings (surface efflorescence and depth samples) and materials collected in dust deposition gauges (DDG's) located on and around the CVO mine site. Additional protocols for baseline farm soil sampling and analysis were also briefly outlined, pending initial data from the tailings and dust gauges. The tailings and DDG analytical program included an extensive suite of mineralogical and geochemical parameters, as well as leachate chemical analyses to identify potential indicators associated with any water-soluble components of the tailings.

CVO personnel conducted sampling of the tailings and depositional dust material and provided the following data to Earth Systems for review:

- Quantitative X-Ray Diffraction (QXRD) mineralogy data for the tailings samples.
- Geochemistry (partial suite) data for the tailings samples.
- Australian Standard Leach Procedure (ASLP) and Net Acid Generation (NAG) data on tailings leachate samples.
- Depositional dust data including selected major and trace elements, dust loads (mass of dust per volume of air and unit of time) and proportions of soluble and insoluble components.

An assessment of these data resulted in the identification of potential chemical indicators of the presence of CVO dust in water samples (Earth Systems, 2020a, b, c). Leach test data indicated that the most sensitive (distinctive) fingerprint of CVO tailings is likely to be associated with water-soluble components.

Subsequent investigations focussed on potential receiving waters surrounding the mine site (such as roof water tanks and farm dams) rather than farm soils. To assess whether a fingerprint of the CVO tailings dust could be detected in such waters, CVO staff provided water chemistry data for samples collected from local farm tanks (roof water) and paddock dams. This report provides an assessment of this water quality data and discusses the potential origins of specific elements / components.

2. BACKGROUND

2.1 A chemical fingerprint of CVO tailings

Mineralogy of the CVO tailings, ASLP and NAG leachate chemistry, as well as total metal concentrations of dust deposits in DDG's located on and around the CVO mine site were assessed by Earth Systems (2020a, b).

The results of this assessment are summarised below to provide an indication of the aqueous fingerprint of CVO tailings dust dissolved in near-neutral water (eg. rainwater), as context for the review of farm water chemistry data in this study (Section 5).

Mineralogy of CVO tailings

As described by Earth Systems (2020a), all tailings samples collected by Newcrest personnel contain a mixture of primary and secondary minerals. The secondary minerals are the result of pyrite oxidation (generation of acid), and subsequent neutralisation reactions within the TSF between the acid and carbonate minerals (ie. calcite and dolomite). Fluids that carry dissolved components from these neutralisation reactions percolate upwards through the tailings (via capillary action) and when they reach the surface these fluids undergo evaporative concentration causing surficial efflorescence precipitation. These minerals have likely formed in the last few months, not years.

The primary minerals identified in the bulk tailings samples included:

- Plagioclase feldspar (23-31 wt.%; [$(Na, Ca)(Si, Al)_4O_8$]);
- Illite/mica (16-20 wt.%; [$(K,H_3O)(Al, Mg, Fe)_2(Si, Al)_4O_{10}[(OH)_2, (H_2O)]$]);
- Quartz (14-17 wt.%; [SiO_2]);
- Clinochlore (10-16 wt.%; [$Mg_5Al(AlSi_3O_{10})(OH)_8$]);
- Potassium feldspar (8-13 wt.%; [$KAlSi_3O_8$]); and
- Calcite (3-4 wt.%; [$CaCO_3$]).

Minor (ie. generally, <2 wt.%) concentrations of magnetite [Fe_3O_4], pyrite [FeS_2], dolomite [$(Ca, Mg)CaCO_3$], and amphibole occurred in many samples.

The low-density secondary minerals located at the surface of the CVO TSF (ie. those most likely to become air-borne) included:

- Gypsum ($CaSO_4 \cdot 2H_2O$);
- Bassanite ($CaSO_4 \cdot 0.5H_2O$);
- Anhydrite ($CaSO_4$);
- Halite (NaCl);
- Blödite ($Na_2Mg(SO_4)_2 \cdot 4H_2O$);
- Rhomboclase ($H_5Fe^{3+}O_2(SO_4)_2 \cdot 2(H_2O)$); and
- Glauberite ($Na_2Ca(SO_4)_2$).

These secondary minerals are all moderately to highly water-soluble phases containing sulfate (SO_4) or chloride (Cl). Hence, if local water sources were to be influenced by CVO tailings dust, they would likely be initially characterised by elevated sulfate and/or chloride concentrations, potentially charge-balanced with sodium (Na), calcium (Ca) and magnesium (Mg). Trace metal substitution into many of the secondary mineral phases listed above is also possible, and hence they represent a potential influence on local water sources.

CVO tailings leachate chemistry data

The ASLP testwork provides an indication of which tailings components are able to dissolve in neutral water. This test work can therefore be considered a simplistic proxy for leaching of tailings materials by rainwater.

The tailings ASLP leachate contains elevated concentrations of sulfate (634-3820 mg/L), chloride (49-373 mg/L), calcium (107-414 mg/L), magnesium (7-365 mg/L) and sodium (145-1000 mg/L) (Earth Systems, 2020a). These major ions are consistent with the soluble secondary (Ca-Mg-Na bearing) sulfate-chloride mineralogy identified by the QXRD analyses (see above).

Soluble trace elements with concentrations above detection limits in the ASLP leachate included aluminium, antimony, arsenic, barium, boron, lithium, caesium, copper, cadmium, lead, molybdenum, mercury, selenium, manganese, strontium, rubidium and zinc.

Trace elements in dust deposition gauge (DDG) samples

The DDG data can provide an indication of elements that are present in CVO tailings dust, however depositional dust may also be derived from other parts of the mine site or non-mining related sources. Furthermore, the presence of an element in solid form within a depositional dust sample does not necessary mean that it has the potential to influence receiving water, as the solubility of an element in water is controlled by the mineral phase in which it occurs.

An important finding of this testwork was that around 10-20 wt.% of the dust captured in the DDG's is in a soluble form (Earth Systems, 2020a). This result is not inconsistent with the prediction that surface materials (efflorescences) from the CVO tailings would be the first to be mobilised as dust and/or travel the furthest if they become airborne during windy conditions, bearing in mind the highly water-soluble nature of these surface materials as identified from the mineralogy data. A lower percentage of soluble dust material would generally be expected if the DDG's were not influenced by CVO tailing dust to some degree.

Additional findings from the dust deposition data include:

- All depositional dust (solid) samples contained zinc, iron, copper, aluminium and manganese at concentrations above their respective detection limits.
- The DDG's that received the highest mass of dust per unit of time (ie. DGCP1 and DGVR1) had elevated concentrations of chromium, cobalt, lead, molybdenum, nickel and occasionally arsenic, antinomy and selenium.

However, as noted above, these elements are not necessarily present in water-soluble form.

Summary

Pyrite oxidation will continue to occur in the upper layer of tailings that is exposed to atmospheric oxygen, and this will result in ongoing secondary mineral efflorescence formation that is visible across the surface of CVO tailings dams in dry conditions. As the efflorescences are distributed above the uppermost layer of the tailings and have relatively low density, they are the most likely minerals to be mobilised as dust from CVO tailings dams during windy conditions. They are also the most likely minerals to dissolve in water.

Water in contact with CVO tailings dust is therefore likely to contain elevated sulfate and chloride concentrations, charge-balanced with calcium, magnesium and sodium. Based on a combined assessment of the mineralogy data, DDG data and the ASLP data (ie. soluble components in CVO tailings leachate), water influenced by CVO tailings dust may contain detectable concentrations of dissolved zinc, copper, lead, molybdenum, arsenic, antimony, selenium and possibly strontium.

Therefore, the most sensitive fingerprint for dust sourced from CVO tailings dams based on the work completed to date is expected to be some combination of the following components dissolved in water: sulfate, chloride, calcium, magnesium, sodium, dissolved zinc, copper, lead, molybdenum, arsenic, antimony, selenium and possibly strontium.

Further clarity on which elements are both present in CVO tailings dust, and soluble in near-neutral water, could be obtained by collecting the water that accumulates in the DDG's, or if these gauges are dry, perform leach tests on the material within the DDG collection container (see Earth Systems, 2020d).

2.2 Processes affecting farm water chemistry

The local area surrounding the CVO mine site consists predominantly of farmland used for livestock grazing (cattle and sheep). A number of farm dams exist to support this activity. In addition, several dwellings / sheds are located on this farmland. Rainwater runoff from the rooftops of these dwellings / sheds is often collected in farm tanks and used for drinking water and other domestic purposes. Water samples from selected tanks has been collected by CVO personnel for chemistry analysis. In order to accurately detect or rule out contributions from CVO dust to the farm dam and roof water chemistry, all potential sources of different elements must be considered. Some of the key processes and potential sources of chemical contribution are outlined below.

2.2.1 Roof water tanks

Samples from roof water tanks contain rainwater (ie. near neutral pH [~5.3], with sulfate and metal concentrations below conventional detection limits) that runs off the roof of sheds or houses, through guttering and piping, and into the tank. It is assumed here that the majority of roofing / guttering material is constructed of galvanised steel (ie. either steel coated with zinc or zincalume, an aluminium-zinc-magnesium alloy). Lead flashing, which is commonly used as a water-proofing material, may occasionally be present. The water tanks sampled in this study were constructed of three different material types: concrete, plastic, and aluminium-coated steel (assumed to be zincalume steel throughout this report). After residence in the tank, the water passes through steel, copper, polyvinylchloride (PVC) and/or HDPE piping before being consumed (and sampled). Roofing, guttering, waterproofing, piping, plumbing fittings and tank materials all have the potential to affect the water composition. Such effects may vary depending on material composition as well as age and condition.

When considering potential influence of any fugitive dust from CVO tailings dams on samples from roof water tanks, it should be noted that:

- The catchment area of a roof is small compared to that of a farm dam catchment (ie. an entire paddock). Hence, a relatively small amount of water and dust can be collected by roof water tanks.
- It is likely that the tank water has a relatively high flow-through rate (ie. due to regular water consumption in farm dwellings and/or seasonal flushing).
- Tanks have very small surface areas and are generally enclosed, limiting the potential for evaporation and associated concentration of the dissolved components.
- Roof water tanks therefore represent a simple hydrogeochemical system, relative to dam water (see below).
- Roof water chemistry has the potential to be influenced by galvanised steel roofing or guttering materials (potential source of iron, zinc or copper), lead flashing (lead), plumbing materials and fittings (eg. copper pipes; brass taps/fittings) or the tank material (concrete, plastic, zincalume steel).

2.2.2 Farm dams

The total catchment area of a farm dam is likely to be significantly greater than that of a roof water collection tank. In some respects, this may make farm dams a more sensitive tracer of potential soluble dust components derived from CVO tailings. In addition, in the area surrounding the CVO site, net evapotranspiration exceeds net rainfall (eg.1452 mm evapotranspiration *vs* 480 mm rainfall at Orange Airport in 2019 – Bureau of Meteorology). This means that farm dams will be subject to evaporative concentration and the chance of dam overflow (ie. loss of dissolved components) is unlikely.

On the other hand, the dam water may have dissolved various minerals from the soil as well as chemicals / minerals applied to crops and soils within the catchment. For example, the following compounds are commonly used in agriculture and may influence the chemistry of the farm dam water:

- Agricultural limestone [calcite] / dolomite for pH modification and as a source of calcium, magnesium, and trace quantities of manganese (which can substitute for calcium or magnesium in calcite / dolomite).
- Gypsum to assist in the breakup of clay rich soils.
- General fertilisers – phosphorus (eg. triple superphosphate), nitrogen (eg. urea, manure) or potassium-based compounds.
- Micronutrient fertilisers – eg. copper, manganese, nickel, zinc, cobalt, boron, selenium, and molybdenum.
- Stock licks – eg. sodium chloride.

Some of these common soil amendments are minerals that are also present in CVO tailings (eg. calcite, dolomite, and gypsum). Moreover, the high solubility metal-bearing fertilisers contain elements that could also be derived from CVO tailings (see above). This could make it difficult to unambiguously distinguish the contribution from CVO tailings from that of common soil / crop amendments using these elements alone, without knowledge of the specific crop amendments used on the farms studied. However, it is noted that components such as calcite / dolomite, gypsum and many of the general and micro-nutrient fertilisers are unlikely to pose a risk to stock water or soil quality.

When considering the potential influence of any fugitive dust from CVO tailings dams on farm dam water, it should be noted that:

- The total catchment area of a farm dam will be significantly greater than the dam water surface area (and much larger than the catchment of a roof water collection tank).
- Farm dam water will be subject to evaporation, leading to concentration of dissolved components (derived from the entire dam catchment area) in the dam water.
- Dam overflow or flushing (ie. loss of dissolved components) will be relatively uncommon, compared to roof water tank consumption / through-flow.
- Farm dam water will be regularly consumed but much of this water (and dissolved components) will be recycled back into same catchment.
- Hence, farm dams are expected to be more sensitive to potential soluble dust components derived from CVO tailings dams, in comparison with roof water.
- Farm dam water has the potential to be influenced by local soil composition, historical or recent chemical / nutrient additives to farmland within the catchment, or local/regional dust deposition.

2.2.3 Dust from natural sources

Consideration of the local geology and soils is important because the natural weathering of local materials has the potential to contribute to the dust loads received by local farms.

Local Rock Outcrops

The Geological Survey of New South Wales 1:100,000 Map sheet for the Molong area shows that the following geological unit's outcrop at the surface within a ~10 km radius of the CVO mine site:

- Qa - Quaternary alluvium: gravel, sand, silt, and clay;
- Tb – Tertiary basalts, alkali basalts, trachybasalts, trachyandesite;
- Tt – Tertiary trachyte, phonolite, nephelinite, syenite;
- Dtcc – Conglomerate: silt and sandstone – *Carlton Formation*;
- **Dtce** –Mudstone, sandstones, **calcareous gritstones** - *Edinboro Formation*;
- Dtcw – Conglomerate: silt, sandstone, shale – *Warree Creek Formation*;
- Dtbm – sandstone - *Macquarie Park Sandstone*;
- Sco –shale/siltstone - *Gospel Oak shale*;
- Oci – volcanoclastic sandstone/siltstone – *Millambri Formation*;
- **Ocm** – **calcareous / felspathic limestone**, mudstone, **limestone**– *Malongulli Formation*;
- **Obn** – **wackestone**, **limey mudstone**, shale - *Canomodine Limestone*; and
- Okf – basalts and basaltic andesites - *Fairbridge Volcanics*

Importantly, several of the geological formations in the local area (ie. Obn, Ocm, Dtce) are potential sources of dust containing carbonate minerals.

Local Soils

Local soil in the area were developed by either in situ weathering of bedrock, or unconsolidated, transported debris (Scott, 2003). Soils derived from aeolian transport can be readily distinguished from the local geology (volcanics) on the basis of grain size, mineralogy and geochemistry, for example (Scott, 2003):

- The aeolian component consists of quartz, feldspar, hematite, muscovite, kaolinite and anatase, whereas the underlying saprock (weathered bedrock) contains feldspar, amphibole, and ilmenite but no quartz.
- The aeolian material is richer in Si, K, Ti, Ce, Rb, Th, W, U, Y and Zr but poorer in Al, Fe, Mg, Ca, Na, Au, Ba, Cr, Ni, Sr, Sc, V and Zn than the underlying Blayney Volcanics.
- Ti/Zr ratios are much lower in the aeolian material (~13) than in the Blayney or Tertiary Volcanics (~70).

Hence, the local soils that have been transported from other regions could be equally if not more important than the natural / underlying geology of the area in terms of their contribution to dust loads on farmland.

3. SCOPE OF WORKS

This scope of works for this study was to:

- Use the aqueous fingerprint of CVO tailings dust derived from previous ASLP testwork, to assess the water chemistry of tank water (rainwater rooftop runoff) and dam water on farms that surround Cadia Valley Operations (CVO) and are owned by CVO.
- Compare water chemistry data for roof water and farm dams with relevant Australian and international guidelines for (human) drinking water and livestock drinking water.
- Discuss the potential sources of key elements / compounds in roof water and dam water samples.
- Provide a report with conclusions.

4. METHOD

Roof water samples were collected by CVO personnel from thirteen (13) drinking water tanks in total, including six (6) concrete tanks, five (5) plastic tanks and two (2) zincalume steel tanks. The water from each tank was sampled from different locations, including from the tank directly, from outdoor tap fittings or from indoor (eg. kitchen) tap fittings (see Table 5-1).

Water samples were also collected by CVO personnel from seven (7) farm dams, although the sampling details are not known.

The water samples were analysed by Australian Laboratory Services, an external laboratory, for the following water chemistry parameters:

- Electrical conductivity;
- Total dissolved solids;
- Total suspended solids;
- Alkalinity including total hardness as $CaCO_3$, hydroxide alkalinity as $CaCO_3$, carbonate alkalinity as $CaCO_3$, bicarbonate alkalinity as $CaCO_3$ and total alkalinity as $CaCO_3$.
- Sulfate as SO_4;
- Chloride;
- Dissolved major cations including calcium, magnesium, sodium and potassium;
- Dissolved and total metals including aluminium, antimony, arsenic, cadmium, chromium, cobalt, copper, lead, manganese, molybdenum, nickel, selenium, silver, zinc and iron;
- Dissolved and total recoverable mercury;
- Nutrients including Nitrite as N, nitrate as N, total Kjeldahl nitrogen as N, total nitrogen as N and total phosphorus as P.

The data provided by CVO was collated, plotted and analysed to investigate the origin of key elements / compounds, and to enable comparison with relevant Australian and international water quality guidelines (ie. drinking water guidelines for roof water; livestock guidelines for farm dam water).

5. RESULTS AND DISCUSSION

The chemistry of roof water and dam water samples is summarised in Table 5-1 and Table 5-2, respectively. The relevant Australian and international water quality guidelines are provided in Table 5-3. Laboratory chemistry reports are provided in Attachment A.

Attachment B provides charts that show the distribution of salinity, alkalinity, nutrients, and dissolved metals as a function of different tank types (concrete, plastic and zincalume steel), as well as between roof water and dam water.

Attachment C provides a series of graphs that were used to investigate correlations between different elements / compounds in roof water and dam water that were produced to assist with interpreting the data and identifying or predicting the source of these elements / compounds.

Attachment D provides a series of graphs that show the distribution of total metal concentrations between water from different tank types (concrete, plastic and zincalume steel), as well as between roof water and dam water, including comparison with relevant water quality guidelines.

The pertinent results from the roof water and dam water chemistry analyses are outlined in Section 5.1 and Section 5.2, respectively. Elements that were below their detection limits in all samples (eg. dissolved and total mercury, silver and selenium) and not discussed in this report.

Table 5-1. Roof water chemistry grouped by tank type (concrete, plastic and zincalume steel). Values at or above Limits of Resolution (LOR) are shown in bold. Yellow shading indicates exceedance of Australian drinking water quality guidelines based on aesthetic (not health) risk. Red shading indicates exceedance of health-based guidelines (NHMRC, 2011; WHO, 2017).

Sample ID			SVWT	OCWT	BWWT	W1ST	CHST	CHHT-2	EPHW	EPSW	W1HT	W3ST	CHHT-1	W2HT	W3HT
Tank Material			Concrete	Concrete	Concrete	Concrete	Concrete	Concrete	Plastic	Plastic	Plastic	Plastic	Plastic	Zincalume steel	Zincalume steel
Tank Type			House	House	House	Shed	Cottage	Paddock	House	Shed	House	Shed	House	House	House
Outlet			Back door	Garage	Yard	Near tank	Tank	Tank	Kitchen	Tank	Kitchen	Tank	Tank	Back door	Tank
Field Parameters	Unit	LOR													
pH	pH	-	6.51	6.33	6.71	6.22	6.25	6.72	5.89	6.33	5.63	6.22	6.72	4.55	4.73
Electrical Conductivity	µS/cm	-	166.7	33.94	38.45	71.7	33.84	79.9	57.6	7.44	17.07	15.4	18.98	13.16	11.25
Oxidation-Reduction-Potential	mV	-	188	179	166	170	162	185	216	77	203	198	159	242	233
Laboratory Parameters															
Electrical Conductivity	µS/cm	1	168	32	37	72	33	80	58	6	15	14	19	11	10
Total Dissolved Solids	mg/L	10	89	26	30	51	20	47	34	<10	<10	10	<10	<10	<10
Suspended Solids	mg/L	5	<5	5	6	7	18	6	<5	10	7	6	<5	<5	<5
Alkalinity															
Bicarbonate Alkalinity as $CaCO_3$	mg/L	1	74	3	15	33	13	34	25	<1	5	3	4	<1	<1
Dissolved Major Anions															
Sulfate as SO_4	mg/L	1	4	3	1	<1	<1	1	<1	<1	<1	<1	<1	<1	<1
Chloride	mg/L	1	1	<1	<1	2	<1	<1	2	<1	<1	<1	<1	<1	<1
Dissolved Major Cations															
Calcium	mg/L	1	19	<1	6	8	4	11	4	<1	1	2	<1	<1	<1
Magnesium	mg/L	1	<1	<1	<1	<1	<1	<1	2	<1	<1	<1	<1	<1	<1
Sodium	mg/L	1	2	<1	<1	2	<1	1	3	<1	<1	<1	<1	<1	<1
Potassium	mg/L	1	2	<1	<1	2	<1	2	<1	<1	<1	<1	1	<1	<1
Dissolved Metals															
Aluminium	mg/L	0.01	<0.01	<0.01	0.04	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01
Antimony	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	mg/L	0.0001	<0.0001	0.0002	<0.0001	0.001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	0.0001
Chromium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	mg/L	0.001	0.023	0.043	0.002	0.002	0.001	0.001	0.02	0.004	0.187	0.008	0.009	0.045	0.008
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001

Sample ID			SVWT	OCWT	BWWT	W1ST	CHST	CHHT-2	EPHW	EPSW	W1HT	W3ST	CHHT-1	W2HT	W3HT
Tank Material			Concrete	Concrete	Concrete	Concrete	Concrete	Concrete	Plastic	Plastic	Plastic	Plastic	Plastic	Zincalume steel	Zincalume steel
Tank Type			House	House	House	Shed	Cottage	Paddock	House	Shed	House	Shed	House	House	House
Outlet			Back door	Garage	Yard	Near tank	Tank	Tank	Kitchen	Tank	Kitchen	Tank	Tank	Back door	Tank
Manganese	mg/L	0.001	0.019	0.057	0.002	0.021	0.006	0.003	<0.001	0.023	0.005	0.014	0.021	0.047	0.031
Molybdenum	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	mg/L	0.001	0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	0.004
Selenium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	mg/L	0.005	12.5	5.25	0.128	1.48	1.17	0.548	0.031	0.13	0.807	0.242	1.07	0.049	0.092
Iron	mg/L	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Total Metals															
Aluminium	mg/L	0.01	0.01	0.08	0.06	0.02	0.12	0.02	0.02	0.03	0.03	0.01	0.02	0.02	0.04
Antimony	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	mg/L	0.0001	0.0001	0.0002	<0.0001	0.0012	<0.0001	<0.0001	<0.0001	<0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.001	<0.001	0.006	<0.001	<0.001	<0.001	<0.001	0.003	<0.001	<0.001	0.001	<0.001	0.002	0.002
Cobalt	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	mg/L	0.001	0.027	0.05	0.03	0.008	0.008	0.01	0.024	0.008	0.228	0.007	0.01	0.057	0.009
Lead	mg/L	0.001	<0.001	0.002	0.006	0.001	0.013	0.002	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001
Manganese	mg/L	0.001	0.021	0.061	0.005	0.021	0.025	0.022	0.003	0.028	0.006	0.014	0.022	0.049	0.036
Molybdenum	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	mg/L	0.001	0.002	0.002	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	0.001
Selenium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	mg/L	0.005	12.8	5.36	0.244	1.69	1.7	1.14	0.039	0.148	0.873	0.256	1.14	0.053	0.084
Iron	mg/L	0.05	<0.05	0.12	0.42	<0.05	0.15	<0.05	<0.05	0.15	<0.05	<0.05	<0.05	0.09	<0.05
Nutrients															
Nitrite as N	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrate as N	mg/L	0.01	2.22	2.1	0.48	0.7	0.57	1.27	0.62	0.3	0.23	0.63	0.55	0.75	0.57
Total Kjeldahl Nitrogen as N	mg/L	0.1	0.4	0.3	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.5
Total Phosphorus as P	mg/L	0.01	0.03	0.05	0.02	0.01	0.07	0.09	0.03	0.01	0.02	0.02	0.07	0.02	0.03

Table 5-2. Farm dam water chemistry. Values at or above Limits of Resolution (LOR) are shown in bold. All values are within trigger values for livestock drinking water (ANZECC/ARMCANZ, 2000).

Sample ID	Unit	LOR	EPSW	WGSW	WASW	OCSW	TASW	BDSW	EPB2
Field Parameters									
pH	pH	-	5.08	7.39	7.2	7.26	7.72	6.95	-
Electrical Conductivity	µS/cm	-	58.23	334.8	105	532.5	208.6	153.9	-
Oxidation-Reduction-Potential	mV	-	182	170	181	155	201	170	-
Laboratory Parameters									
Electrical Conductivity	µS/cm	1	58	332	109	533	160	156	329
Total Dissolved Solids	mg/L	10	55	270	80	384	133	160	190
Suspended Solids	mg/L	5	22	41	33	18	27	12	6
Alkalinity									
Bicarbonate Alkalinity as $CaCO_3$	mg/L	1	2	112	40	57	63	73	178
Dissolved Major Anions									
Sulfate as SO_4	mg/L	1	6	26	<1	176	24	<1	5
Chloride	mg/L	1	4	14	7	15	6	5	8
Dissolved Major Cations									
Calcium	mg/L	1	1	15	5	42	14	10	31
Magnesium	mg/L	1	<1	6	2	17	6	5	18
Sodium	mg/L	1	3	9	3	24	5	3	14
Potassium	mg/L	1	4	43	13	12	17	8	6
Dissolved Metals									
Aluminium	mg/L	0.01	0.15	0.49	0.07	0.03	0.26	0.23	<0.01
Antimony	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	mg/L	0.001	<0.001	0.005	<0.001	<0.001	0.002	<0.001	<0.001
Cadmium	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	mg/L	0.001	0.001	0.008	0.002	<0.001	0.004	0.002	<0.001
Copper	mg/L	0.001	0.002	0.008	0.004	0.01	0.007	0.006	<0.001
Lead	mg/L	0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.132	1.06	0.104	0.024	0.478	0.321	0.084
Molybdenum	mg/L	0.001	<0.001	0.002	<0.001	0.002	0.001	<0.001	<0.001
Nickel	mg/L	0.001	<0.001	0.005	<0.001	0.001	0.002	0.002	<0.001
Selenium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	mg/L	0.005	<0.005	0.012	0.011	0.078	0.008	0.011	0.007
Iron	mg/L	0.05	0.11	7.37	0.2	0.05	0.78	0.59	0.64
Total Metals									
Aluminium	mg/L	0.01	0.79	1.2	0.2	0.56	0.35	2.44	-
Antimony	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Arsenic	mg/L	0.001	<0.001	0.007	<0.001	<0.001	0.002	0.002	-
Cadmium	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-
Chromium	mg/L	0.001	<0.001	0.002	<0.001	0.001	<0.001	0.002	-
Cobalt	mg/L	0.001	0.002	0.01	0.003	<0.001	0.005	0.004	-
Copper	mg/L	0.001	0.012	0.014	0.002	0.008	0.018	0.014	-
Lead	mg/L	0.001	<0.001	0.003	<0.001	<0.001	<0.001	<0.001	-
Manganese	mg/L	0.001	0.15	1.3	0.265	0.062	0.836	0.426	-
Molybdenum	mg/L	0.001	<0.001	0.003	<0.001	0.003	0.003	<0.001	-
Nickel	mg/L	0.001	<0.001	0.007	<0.001	0.002	0.003	0.002	-
Selenium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-
Silver	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Zinc	mg/L	0.005	0.008	0.031	<0.005	0.082	0.021	0.023	-

Sample ID	Unit	LOR	EPSW	WGSW	WASW	OCSW	TASW	BDSW	EPB2
Iron	mg/L	0.05	0.73	9.1	1.11	0.8	2.42	5.16	-
Nutrients									
Nitrite as N	mg/L	0.01	<0.01	0.08	<0.01	0.07	0.04	0.04	<0.01
Nitrate as N	mg/L	0.01	2.47	0.08	0.41	2.85	0.21	0.28	<0.01
Total Kjeldahl Nitrogen as N	mg/L	0.1	1.6	8.2	3.1	1.6	2.5	2.5	<0.1
Total Phosphorus as P	mg/L	0.01	0.06	1.22	0.22	0.15	0.35	0.19	0.08

Table 5-3. Water quality guidelines (NHMRC, 2011; WHO, 2017; ANZECC/ARMCANZ, 2000).

Parameter	Australian Drinking Water Guidelines (NHMRC, 2011)		World Health Organization Drinking Water Guidelines (WHO, 2017)	Livestock water
	Health (mg/L)	Aesthetic (mg/L)	Health (mg/L)	mg/L
Aluminium (Al); acid-soluble	ID	0.2	-	5
Ammonia (NH_3)	ID	0.5	-	-
Antimony (Sb)	0.003	-	0.02	-
Arsenic (As)	0.01	-	0.01 P	0.5; up to 5 see Table 4.3.2 (ANZECC/ARMCANZ, 2000)
Cadmium (Cd)	0.002	-	0.003	0.01
Calcium (Ca)	-	-	-	1000
Chloride (Cl^-)	-	250	-	-
Chlorine (Cl)	5	0.6	5 C	-
Chromium - total (Cr)	-	-	0.05 P	1
Chromium III (Cr^{3+})	-	-	-	-
Chromium VI (Cr^{6+})	0.05	-	-	-
Cobalt (Co)	-	-	-	1
Copper (Cu)	2	1	2	0.4 (sheep); 1 (cattle); 5 (pigs); 5 (poultry)
Electrical Conductivity (EC)	-	-	-	See Table 4.3.1 (ANZECC/ARMCANZ, 2000)
Fluoride (F)	1.5	-	1.5	2
Iron (Fe)	ID	0.3	-	-
Lead (Pb)	0.01	-	0.01	0.1
Magnesium (Mg)	-	-	-	ID
Manganese (Mn)	0.5	0.1	0.4 C	-
Molybdenum (Mo)	0.05	-	0.07	0.15
Nickel (Ni)	0.02	-	0.02 P	1
Nitrate (NO_3)	50	-	50 (short term exposure)	400
Nitrite (NO_2)	3	-	3 (short term exposure); 0.2 P (long term exposure)	30
pH	ID	6.5 - 8.5	-	-
Selenium (Se)	0.01	-	0.01	0.02
Silver (Ag)	0.1	-	ID	-
Sodium (Na)	-	180		-
Sulfate (SO_4)	ID	250	-	1000
Turbidity (NTU)	ID	5	-	-
Total Dissolved Solids (TDS)	-	600	-	-
Total Suspended Solids (TSS)	-	-	-	-
Zinc (Zn)	ID	3	-	20

P = Provisional guideline value, as there is evidence of a hazard, but the available information on health effects is limited.

C = Concentrations of the substance at or below the health-based guideline value may affect the appearance, taste or odour of the water, leading to consumer complaints.

5.1 Roof water chemistry

5.1.1 Comparison with Guidelines

It is understood that roof water is used for drinking and other domestic uses by farmers. Therefore, the chemistry of the roof water samples was compared with Australian (NHMRC, 2011) and international (WHO, 2017) drinking water guidelines (see Table 5-3; Attachment D).

In general, the roof water chemistry was within the health-based and aesthetic-based drinking water guideline values including chloride, fluoride, sodium, sulfate, turbidity, ammonia, nitrate, nitrite, and a range of metals (eg. aluminium, antimony, arsenic, cadmium, chromium, copper, iron, lead, manganese, molybdenum, nickel, selenium, silver, zinc), with the following minor exceptions noted:

- The pH in most of the roof water tanks (9 out of 13 tanks) was in the range pH 4.5-6.3, below the aesthetic-based drinking water quality guideline range of 6.5-8.5 (NHMRC, 2011), as highlighted in yellow in Table 5-3. This is not surprising for roof water given that rainwater pH is typically around 5.3. The slightly lower pH in two of the roof water samples (ie. 4.55 and 4.73; Table 5-2) could be due to:
  - Organic acids (eg. tannins, humic and fluvic acids) derived from organic matter (eg. leaves);
  - The rusting (oxidation) of steel roofing materials (where the galvanisation has failed). This would occur when soluble iron (Fe^{2+}) is oxidised, hydrolysed and precipitates as $Fe(OH)_3$.
- Total lead in one of the roof water tanks (CHST; 0.013 mg/L Pb) marginally exceeded the Australian drinking water trigger value of 0.01 mg/L. This is most likely related to the interaction of roof water runoff with lead flashing that is a commonly used water-proofing material, or impurities in plumbing or galvanising materials.
- Total zinc in two of the concrete roof water tanks (SVWT and OCWT; 5-13 mg/L, mostly in dissolved form) exceeded the aesthetic-based drinking water quality guideline value of 3 mg/L (NHMRC, 2011). This is most likely related to the degradation of galvanised steel roofing materials (zincalume steel)[1].
- Total iron in one of the roof water tanks (BWWT; 0.42 mg/L Fe) exceeded the aesthetic (taste) drinking water guideline of 0.3 mg/L (NHMRC, 2011). This is most likely associated with rusting of steel roofing materials.

5.1.2 Detailed Review

A more detailed review of the data shown in Table 5-1 is provided below, with supporting graphs in Figure 1 to Figure 6:

- All roof water samples were slightly acidic to near-neural (pH = 4.55-6.71) with very low salinity (Electrical Conductivity [EC] = 6-168 µS/cm). Roof water from concrete tanks tended to have slightly higher pH and EC values relative to plastic or zincalume steel tanks (Table 5-1; Figure 1).
- The (very low) salinity of roof water was primarily associated with bicarbonate alkalinity (HCO_3^-), and there was a clear positive correlation between bicarbonate alkalinity and calcium ion concentrations (Attachment C). The salinity, alkalinity and calcium concentrations were higher for roof water in concrete tanks than plastic or zincalume steel tanks (Table 5-1; Figure 2). These data suggest that dissolution of concrete from the internal tank walls is occurring. Other potential sources of the bicarbonate alkalinity in roof water include depositional dust derived from the natural sources of the carbonate mineral calcite ($CaCO_3$) or agricultural limestone (see Section 2.2), however most non-concrete tanks do not display this signature.

[1] Derivation of zinc from galvanised steel is consistent with reports such as NHMRC (2011), which states that zinc is most commonly elevated in "*galvanised iron rainwater tanks*".

- Based on the observed data for concrete tanks, the slightly higher salinity and alkalinity in roof water from one of the plastic tanks (EPHW) probably reflects interim storage in a concrete tank (or other interaction with concrete) prior to water entering EPHW, although this is speculative at present.
- All roof water had very low sulfate and chloride concentrations (ie. <5 mg/L, and commonly below detection limits [1 mg/L]; Table 5-1; Figure 3).
- The major cations in roof water were dominated by calcium, which again was slightly higher for roof water in concrete tanks (Table 5-1; Attachment B).
- The lack of a significant concentrations of either of the major anions – sulfate and chloride – strongly indicates that roof water chemistry is not influenced by CVO tailings dust. This is supported by the following key findings:
  - All of the soluble secondary minerals identified in the CVO tailings samples contain either sulfate or chloride (refer to Section 2.1).
  - Consistent with the mineralogy data, the tailings ASLP data (Section 2.1; Earth Systems, 2020a) are characterised by elevated sulfate (up to 3,820 mg/L) and chloride concentrations (up to 373 mg/L).
- The very low concentrations of nitrogen in roof water samples – comprising nitrate (0.3-2.2 mg/L) and lesser amounts of Total Kjeldahl Nitrogen (<0.1-0.5 mg/L) (Table 5-1; Attachment B) – are most likely derived from leaf litter, organic dust, bird faeces, dead insects or other dead animals (birds, possums), etc.
- Phosphorus concentrations were also very low (ie 0.01-0.09 mg/L; Table 5-1) and showed no systematic correlation with roof water collection tank type (Attachment B). Small quantities of phosphorus could be derived from dust affected by phosphorus-based fertilisers (eg. superphosphate) and/or the same sources that account for the nitrogen.
- A comparison of total versus dissolved metal concentration data indicates that:
  - Despite the detection of total (ie. particulate) iron and lead (at low concentrations) the dissolved form of these metals was largely below detection limits.
  - The relative proportions of dissolved versus particulate forms were higher for copper (7-89% of total copper was in dissolved form), manganese (0-96% in dissolved form) and zinc (52-98% in dissolved form) than for iron or lead.
  - Total lead, zinc and iron concentrations tended to be higher in roof water samples from concrete tanks.
- The only dissolved metals with detectable concentrations in all roof water samples, were zinc, copper and manganese (Table 5-1; Figure 4 and Figure 5). Of these, zinc and copper were notably higher in roof water than dam water, suggesting local influencing factors.
- The presence of zinc is most likely related to the degradation of galvanised steel roofing materials. Dissolved zinc concentrations were generally higher in roof water from concrete tanks (eg. 0.13-12.5 mg/L) relative to plastic or zincalume steel tanks (eg. 0.03-1.07 mg/L; Figure 4). This may be attributed to the fact that concrete tanks are generally older than plastic or zincalume steel tanks. Assuming that the roofing and guttering material that directs water to these tanks is also older, then the elevated zinc could be due breakdown of the galvanising layer of the roofing or guttering materials. The apparent correlation between dissolved zinc concentrations and the age / condition of roofing and guttering material would require field verification. Copper piping or brass fittings, which may contain zinc as an impurity, could represent another potential source of dissolved zinc in roof water.
- While dissolved copper concentrations were generally very low relative to drinking water standards (below 0.05 mg/L), one anomalous copper concentration (0.19 mg/L; plastic tank W1HT) was sampled from a kitchen tap. Plumbing materials (eg. copper pipes) are considered the most likely source of low level dissolved copper in roof water. Copper piping is most commonly associated with hot water plumbing systems (indicating that W1HT could have been sampled following the use of the hot water kitchen tap), but could potentially also be used for cold water systems on farm properties due to installation

convenience. Other potential but less likely sources of low-level copper include roofing or guttering materials (where copper occurs as impurities in zinc galvanising). Slightly elevated copper concentrations in roof water (eg. OCWT and W2HT) may correspond to greater lengths of copper piping, whereas lower concentrations (eg. BWWT, W1ST, and CHH2) may correspond to the use of PVC or polyethylene piping or shorter lengths of copper piping. Brass fittings could represent another potential source of dissolved copper in roof water. There was no clear correlation between dissolved copper and tank type (Figure 5).

- Consideration was given to the possibility of CVO tailings dust contributing to dissolved zinc and copper concentrations in the roof water tanks, however this would require the metal cations (Zn^{2+} and Cu^{2+}) to be charge-balanced with sulfate anions (SO_4^{2-}) in the roof water. Sulfate concentrations that would be expected in roof water, in the event that zinc, and copper were derived from (sulfate-bearing) CVO tailings dust, are much higher than measured sulfate concentrations, as shown in Figure 6. The measured sulfate concentrations in roof water (generally below 1 mg/L) are clearly insufficient to achieve a charge-balanced solution containing dissolved zinc concentrations up to 12.5 mg/L and dissolved copper concentrations up to 0.19 mg/L. Hence, this provides further evidence to support the interpretation above, indicating that roof water chemistry is very unlikely to be influenced by CVO tailings dust.
- Dissolved manganese concentrations showed no correlation with tank type and were generally lower in roof water samples compared with dam water samples (Attachment B). The source of manganese in roof water samples remains unclear but could potentially be associated with depositional dust derived from the natural sources of the carbonate mineral calcite ($CaCO_3$) or agricultural limestone, which typically contains trace quantities of manganese (where manganese substitutes for calcium).
- Some roof water also contained detectable, albeit very low, concentrations of dissolved nickel, aluminium, cadmium, and lead (Table 5-1). As with the metals discussed above, their presence is most likely attributable to local influencing factors, such as:
  - Interaction of roof water runoff with lead flashing that is commonly used as a water-proofing material.
  - Galvanised roofing materials or guttering materials, which may contain impurities such as cadmium, nickel, and lead, and therefore are a possible source of very low-level concentrations of these metals (as well as zinc).
  - Copper piping or brass fittings, which many contain impurities such as lead and nickel. Old lead-based solder, if present, could be another potential source of this metal.

  Indeed, these minor components are unlikely to be derived from CVO tailings dust based on the tailings leachate (ASLP) data (Section 2.1; Earth Systems, 2020a).
- Overall, roof water chemistry appears to be primarily influenced by local materials including galvanised steel roofing or guttering materials (source of zinc and cadmium), rusting of steel roof materials (source of iron), copper piping (copper), lead flashing (lead) and dust from natural carbonate-bearing sources (eg. manganese). However, as some of these components – zinc, copper, manganese and (minor) cadmium – were also identified in the aqueous fingerprint of CVO tailings dust, further investigation would assist to confirm these assumptions and discount the influence of CVO tailings dust.

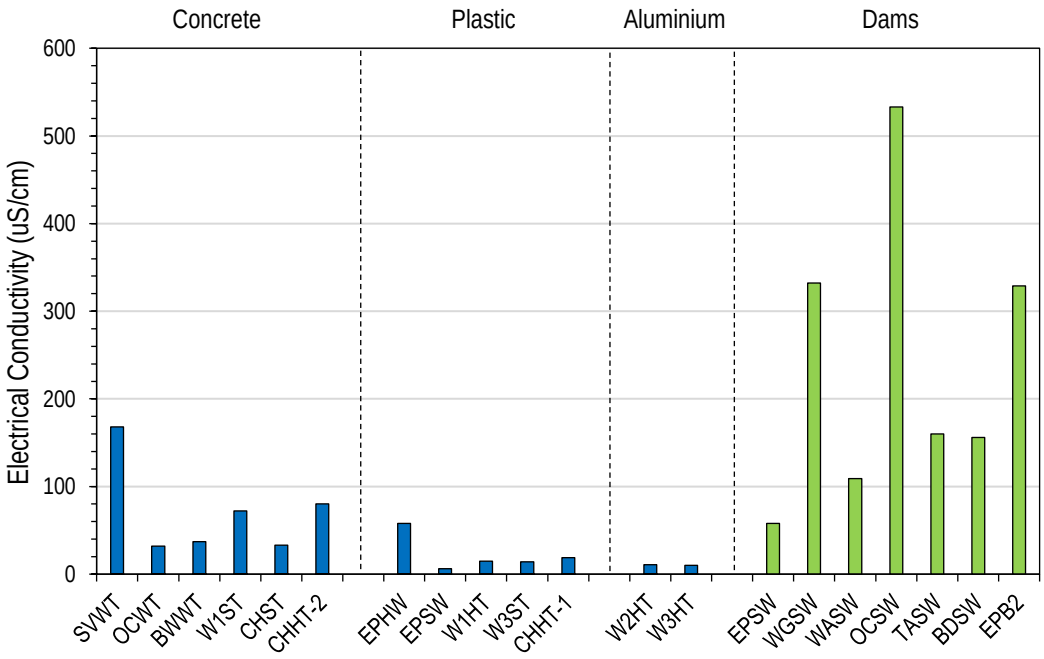

Figure 1. Electrical conductivity (µs/cm) of roof water (from concrete, plastic and zincalume steel tanks) and dam water samples.

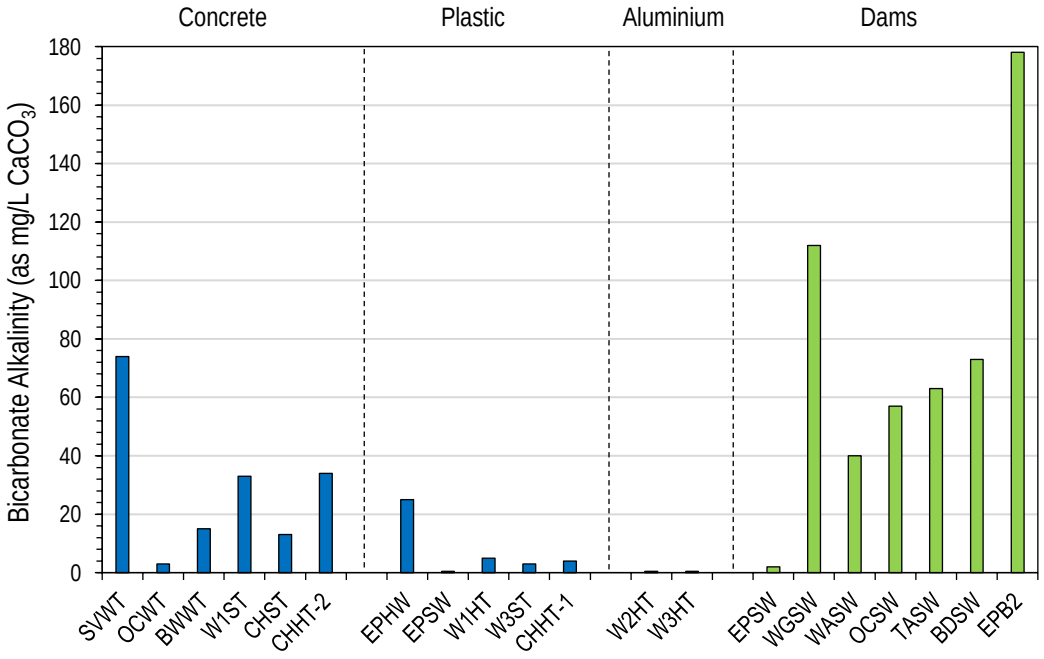

Figure 2. Bicarbonate alkalinity (as mg/L $CaCO_3$) of roof water (from concrete, plastic and zincalume steel tanks) and dam water samples.

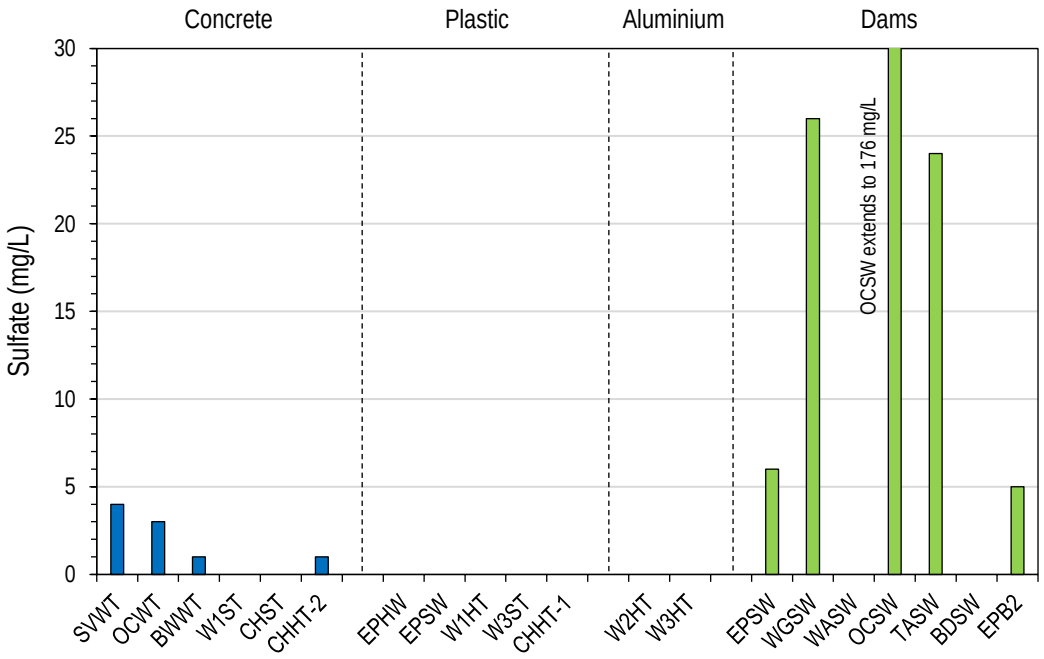

Figure 3 . Sulfate concentrations (mg/L) of roof water (from concrete, plastic and zincalume steel tanks) and dam water samples.

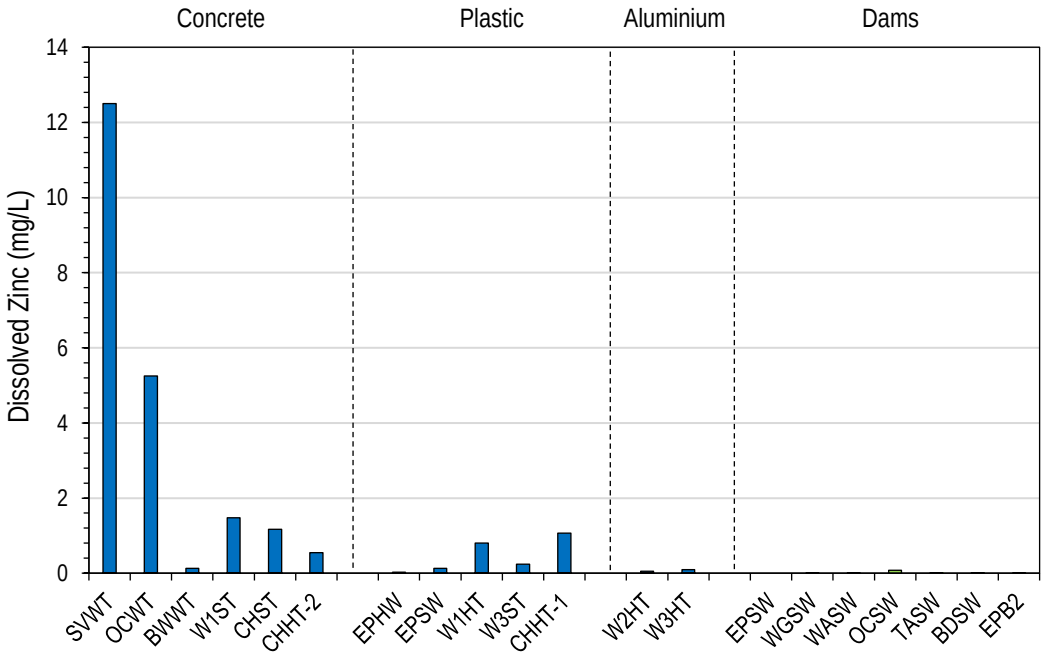

Figure 4. Dissolved zinc concentrations (mg/L) of roof water (from concrete, plastic and zincalume steel tanks) and dam water samples.

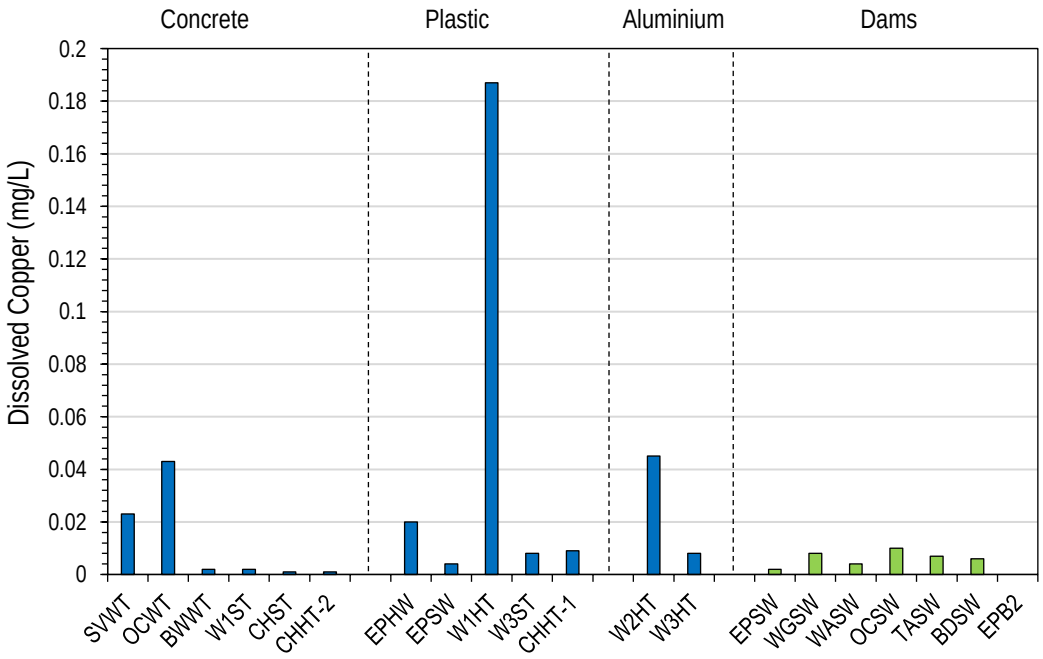

Figure 5. Dissolved copper concentrations (mg/L) of roof water (from concrete, plastic and zincalume steel tanks) and dam water samples.

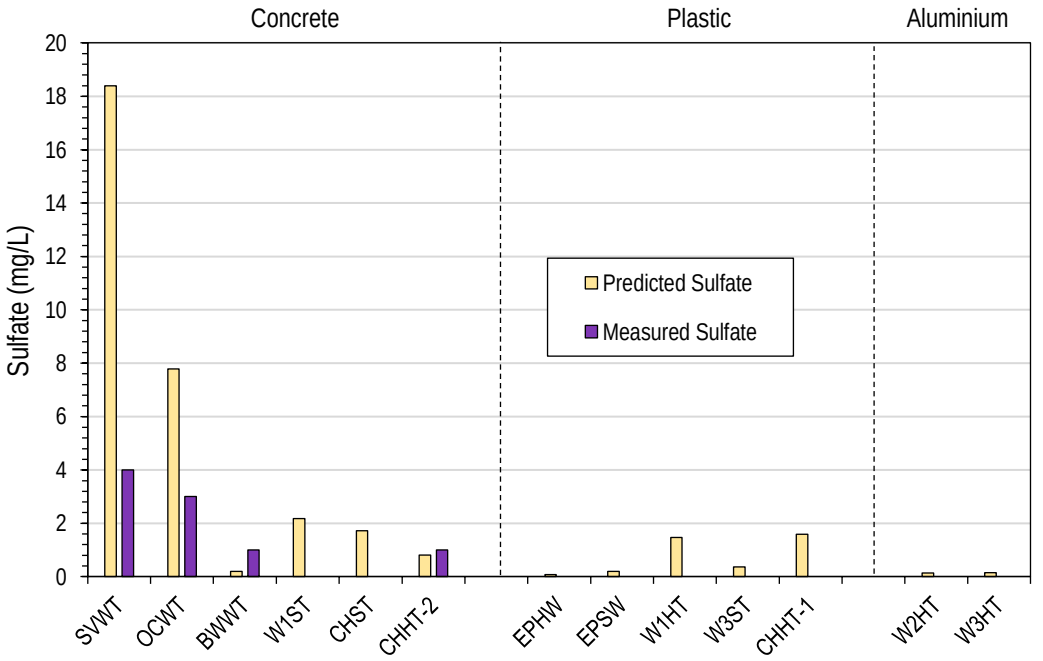

Figure 6. Sulfate concentrations that could be expected if all dissolved copper and zinc was derived from metal-sulfate minerals (ie. potentially CVO tailings) compared with the measured sulfate concentrations in roof water samples.

5.2 Farm dam water chemistry

5.2.1 Comparison with Guidelines

It is assumed that the farm dam water is used for livestock drinking water only, hence dam water chemistry data were compared with livestock guidelines outlined in ANZECC/ARMCANZ (2000).

The dam water chemistry was within these ANZECC/ARMCANZ (2000) livestock drinking water guideline values for all of the parameter suites tested, including guidelines for calcium, fluoride, nitrate, nitrite, sulfate and a range of metals (eg. aluminium, arsenic, cadmium, chromium, cobalt, copper, lead, molybdenum, nickel, selenium and zinc).

5.2.2 Detailed Review

For the purposes of investigating whether a CVO tailings dust fingerprint can be resolved in the dam water, a more detailed review of the data shown in Table 5-2 is provided below:

- Dam water was near neutral to slightly alkaline (pH = 5.08-7.72; Table 5-2) and generally had slightly higher pH values than roof water (eg. 4.55-6.71; Table 5-1).
- The salinity (EC) of dam water was low to moderate (58-533 µS/cm; Figure 1) and also generally higher than roof water. The dam water salinity was primarily associated with bicarbonate alkalinity (HCO_3^-), with minor contributions from chloride and sulfate in most samples.
- Dam water had low to moderate sulfate (<1 mg/L to 176 mg/L) and chloride (4 to 15 mg/L) concentrations that were generally higher than roof water samples (Figure 3; Attachment B).
- The major cations in dam water consisted of variable proportions of calcium, magnesium sodium and potassium, all of which were present at higher concentrations than in roof water samples (cf. Table 5-1 and Table 5-2; Attachment B).
- Correlations between bicarbonate alkalinity, calcium (Ca) and magnesium (Mg) suggest the dissolution of the dolomite ($CaMgCO_3$) and potentially calcite (Attachment C). If this is accurate, potential sources of dolomite / calcite could include:
  - Dust generated during the application of agricultural dolomite, limestone and/or weathering of local soils containing agricultural dolomite / calcite.
  - Dust derived from natural carbonate-bearing geological units, which are known to be widespread in the local area (see Section 2.2.3).
  - Dust derived from CVO tailings, as dolomite (as well as calcite) is present but in relatively low concentrations in the tailings (0.2-1.7 wt.%; Earth Systems, 2020a).
- Concentrations of sodium (Na; 3-24 mg/L) and potassium (K; 4-43 mg/L) were higher in dam water samples than roof water samples (<3 mg/L for both Na and K combined). Natural weathering of local soils / rocks could be sources of these cations in farm dams. However, potential contributions to sodium and chloride concentrations from halite (sodium chloride) derived from CVO tailings dust cannot be discounted, given the presence of halite in surficial tailings samples (ie. 0.4-3.0 wt.%) and the observed sodium and chloride concentrations in the tailings leachate (ASLP) data (Section 2.1; Earth Systems, 2020a).
- Whilst calcium could be partly derived from the dissolution of carbonate minerals (see above), calcium also shows a moderate-strong correlation with sulfate, suggesting the dissolution of gypsum / bassanite / anhydrite ($CaSO_4$ / $CaSO_4 \cdot ½H_2O$ / $CaSO_4 \cdot H_2O$). Potential sources of these minerals include:
  - Farm soils – gypsum is a common amendment used to break up clay-rich soils.
  - CVO tailings – gypsum / anhydrite / bassanite were identified in QXRD analyses of tailings samples (ie. 0.5-3.7 wt.%; Earth Systems, 2020a).

- The total nitrogen and phosphorus concentrations were generally higher in dam water than roof water (Attachment B). Nitrogen speciation was variable between samples, but dam water generally contained a higher proportion of reduced nitrogen species (ie. Total Kjeldahl Nitrogen – <0.01-8.2 mg/L), with lower nitrate (<0.01-2.47 mg/L) compared to roof water. Some dam water also contained detectable but low level nitrite (up to 0.08 mg/L). These observations indicate that:
  - Higher concentrations of total nitrogen concentrations and reduced nitrogen species in dam water samples, relative to roof water samples, could be due to the use of nitrogen-based fertilisers (eg. urea) but is more likely related to stock manure in the dam surrounds and catchment.
  - Higher phosphorus concentrations in dam water, relative to roof water samples, are likely due to the application of fertilisers such as superphosphate. Other potential sources include stock manure. Whilst phosphorus bearing minerals are present in CVO tailings (ie. apatite), such minerals have only very limited solubility in near-neutral water and hence are highly unlikely to be significant sources.
- Hence, it appears likely that farm dam water chemistry has been influenced by the application of soil amendments, such as nitrogen- and phosphorus-based soil nutrients. This is not unexpected for farm land that is used for grazing (or other) purposes, and it raises the likelihood of other common soil amendments having an influence on farm dam water chemistry such as:
  - Potassium-based fertilisers, gypsum or limestone (potential contributors to EC, K, Cl, Ca, SO_4, HCO_3) as considered above); and
  - Micro-nutrients such as copper, manganese, nickel, zinc, cobalt, boron, selenium and molybdenum (see below).
- A review of total metal concentration data indicates that:
  - Overall, the concentrations of total metals in dam water were higher than in roof water, consistent with higher suspended solids.
  - The concentrations of total aluminium, iron and manganese were higher in dam water than roof water.
  - The concentrations of total lead were generally lower in dam water than roof water.
- Dissolved iron concentrations were low relative to guideline values, but above detection limits in all dams. Iron is a natural component of the local soils and the presence of dissolved iron is considered to be a function of the sometimes-reduced nature of the dam water. This is not considered unusual for a farm dam containing naturally decomposing organic matter (eg. animal faeces) as iron is a redox-sensitive element.
- Similarly, dissolved manganese concentrations were low relative to guideline values, but above detection limits in all dams. Dissolved manganese is usually derived from carbonate minerals such as dolomite / calcite. Potential sources therefore include agricultural dolomite / limestone or the weathering of local rocks. However, a possible contribution from CVO tailings dust cannot be discounted based on ASLP data (Section 2.1; Earth Systems, 2020a).
- Some dams also contained detectable, albeit very low, concentrations of dissolved zinc, aluminium, copper, cobalt, nickel, molybdenum, arsenic and lead (Table 5-2). A comparison of farm dam water and roof water indicates that :
  - Dissolved aluminium, arsenic, cobalt, manganese, molybdenum and iron were slightly higher in dam water than roof water (Attachment B).
  - In contrast, zinc, cadmium, and to a lesser extent copper, were slightly lower in dam water than roof water (eg. Figure 4; see also Attachment B).
  - Nickel and lead concentrations showed no systematic variations between roof water or dam water.
- Micro-nutrient fertilisers could be a potential source of dissolved metals such as copper, zinc and molybdenum, that were detected at low levels in the farm dam water. However, potential contributions from CVO tailings dust also cannot be discounted based on ASLP data (Section 2.1; Earth Systems, 2020a).

- Potential sources of other dissolved metals that were detectable at low levels in farm dam water are considered below:
  - Naturally occurring clay or feldspar minerals represent a likely source of dissolved aluminium. These minerals are widespread in soils globally and consistent with knowledge of the local soils (refer to Section 2.2). Hence, the presence of aluminium in farm dam water cannot be directly related to CVO tailings dust.
  - Cobalt may occur naturally in local soils and/or have been added as a micro-nutrient fertiliser. The presence of trace quantities of cobalt in the farm dam water cannot be unequivocally related to CVO tailings dust and was also not detected in the tailings ASLP data (Section 2.1; Earth Systems, 2020a).
  - Arsenic could potentially be derived from farm soils affected by historic arsenic-bearing pesticide use and/or timbers treated with chromated copper arsenate. The presence of trace quantities of arsenic in the farm dam water cannot be directly related to CVO tailings dust as it was largely undetected in the tailings ASLP data (Section 2.1; Earth Systems, 2020a).
  - Potential sources of dissolved lead and nickel in farm dam water remain uncertain, however they do not appear to be related to CVO tailings dust as they were largely undetected in the ASLP data (Section 2.1; Earth Systems, 2020a).
- Overall, when comparing the farm dam water chemistry to the tailings ASLP data (Section 2.1; Earth Systems, 2020a), the only metals in dam water that were consistent with the aqueous fingerprint of CVO tailings dust were zinc, copper, manganese and molybdenum. However, micro-nutrient fertiliser sources cannot be excluded at this stage. Further investigation is required to clarify any influence of CVO tailings dust on the trace element signature of dam water.

6. CONCLUSIONS

Context

- Surface salt efflorescences across CVO tailings dams are likely to comprise soluble, low density secondary minerals - such as gypsum, bassanite, anhydrite, halite, blodite, rhomboclase and glauberite – that are all sulfate- or chloride-bearing. These surface minerals are expected to be the first to be mobilised as dust and/or travel the furthest furthest if they become airborne during windy conditions. After deposition, they are also the most likely minerals to subsequently dissolve upon contact with water.
- Upon dissolution in water, the chemical signature of sulfate- and chloride-bearing minerals (that may be associated with any fugitive dust from CVO tailings dams) would likely be characterised by elevated sulfate and/or chloride, potentially coupled with elevated sodium, calcium and magnesium, as well as a range of mineralisation related trace elements.
- ASLP tests on the tailings surface materials indicate that soluble trace elements with concentrations above detection limits include aluminium, antimony, arsenic, barium, boron, lithium, chromium, copper, cadmium, lead, molybdenum, mercury, selenium, manganese, strontium, rubidium and zinc. Hence, these components may assist with fingerprinting of dust from the CVO tailings dams (if any) in waters downwind of the site.
- There is no significant evidence of metals such as beryllium, bismuth, cobalt, nickel, iron, silver, tellurium, thallium, thorium, tin, uranium, vanadium, zirconium or tungsten, in leachate from surface materials of CVO tailings dams, based on ASLP tests. Hence, if such components were found to be elevated in roof water or farm dam water, other potential sources unrelated to the mine would need to be considered.
- Several dwellings / sheds are located on farmland surrounding the CVO mine site. Rainwater runoff from the rooftops of these dwellings / sheds is often collected in tanks. Water samples were collected from 13 tanks for assessment in this study. When considering the potential influence of any fugitive dust from CVO tailings dams on samples from roof water tanks, it should be noted that:
  - The catchment area of a roof is small compared to that of a farm dam catchment (ie. an entire paddock). Hence, a relatively small amount of water and dust can be collected by roof water tanks.
  - It is likely that the tank water has a relatively high flow-through rate (ie. due to regular water consumption in farm dwellings and/or seasonal flushing).
  - Tanks have very small surface areas and are generally enclosed, limiting the potential for evaporation and associated concentration of the dissolved components.
  - Roof water chemistry has the potential to be influenced by galvanised steel roofing or guttering materials (potential source of iron, zinc or copper), lead flashing (lead), plumbing materials and fittings (eg. copper pipes; brass taps/fittings) or the tank material (concrete, plastic, zincalume steel).
- The local area surrounding the CVO mine site consists predominantly of farmland used for livestock grazing (cattle and sheep). A number of farm dams exist to support this activity. Water samples were collected from 7 of these dams for assessment in this study. When considering the potential influence of any fugitive dust from CVO tailings dams on farm dam water, it should be noted that:
  - The total catchment area of a farm dam is likely to be significantly greater than that of a roof water collection tank, and farm dams will be subject to evaporative concentration and the chance of dam overflow (ie. loss of dissolved components) is unlikely. Hence, farm dams may be more sensitive to potential soluble dust components derived from CVO tailings dams, in comparison with roof water.
  - Farm dam water has the potential to be influenced by local soil composition, historical or recent chemical / nutrient additives to farmland within the catchment, or local/regional dust deposition.

Roof water assessment

- Most roof water samples meet Australian (NHMRC, 2011) and international (WHO, 2017) drinking water guidelines, with the exception of pH in most roof water tanks (pH 4.5-6.3; aesthetic guideline range 6.5-8.5), total lead in one tank (CHST = 0.013 mg/L; health-based guideline 0.01 mg/L), total zinc in two tanks (5-13 mg/L; aesthetic guideline 3 mg/L) and total iron in one tank (BWWT = 0.42 mg/L; aesthetic guideline 0.2 mg/L).
- Roof water is generally slightly acidic to near-neutral (pH 4.5-6.7) and well oxidised, with low salinity (less than 170 µS/cm), low suspended sediments (less than 20 mg/L) and low metal and nutrient concentrations.
- The acidity and iron may relate to rusting of the roofing materials and/or organic acids (the lowest pH values and highest iron concentrations may be derived from the oldest / most corroded rooves).
- Despite elevated dissolved (and total) zinc concentrations, all roof water samples have very low sulfate and chloride concentrations (Table 5-1), which strongly suggests no significant effect from CVO tailings dust on roof water. Zinc in the roof water is likely to be predominantly (or exclusively) derived from galvanised steel roofing / guttering or plumbing materials.
- There is significant variability in zinc concentrations in roof water samples. The reason for this is unclear but it is possible that older rooves, in poorer condition, are associated with higher zinc concentrations. Indeed, this would be supported by the observed higher zinc concentrations in concrete tanks, and the possibility that concrete tanks (and their associated roof water collection systems) are older than plastic or zincalume steel tanks.
- The marginally elevated lead concentration in one roof water collection tank (BWWT) could be related to the use of lead flashing or impurities in plumbing or galvanising materials.
- Salinity and major ion concentrations in roof water are low, particularly compared to dam water, and are likely controlled by concrete dissolution, with lesser contributions from natural sources or agricultural additives.
- The mineral calcite may be derived from dust associated with the application of agricultural lime or dust derived from the weathering of local geological units (ie. limestone). While dust derived from CVO tailings dams is another potential source of calcite, this is considered less likely based on the above conclusion.
- Other metals that can be detected in some of the roof water include manganese, copper and cadmium, albeit at very low concentrations that fall within drinking water quality guidelines. The dissolved manganese is consistent with the presence of calcite (see above), whereas the copper and (minor) cadmium are probably derived from galvanised steel roofing or plumbing materials.
- Overall, roof water chemistry appears to be primarily influenced by local materials including galvanised steel roofing or guttering materials (source of zinc and cadmium), rusting of steel roof materials (iron), copper piping (copper), lead flashing (lead) and dust from natural carbonate-bearing sources (eg. manganese). However, as some of these components – zinc, copper, manganese and (minor) cadmium – were also identified in the aqueous fingerprint of CVO tailings dust, further investigation would assist to confirm these assumptions and discount the influence of CVO tailings dust.

Farm dam water assessment

- All dam water samples meet ANZECC/ARMCANZ (2000) guidelines for livestock drinking water.
- Farm dam water is generally near-neutral (pH 5.1-7.7) and sometimes reduced, with low to moderate salinity (up to 533 µS/cm) and suspended sediments (up to 41 mg/L) and low metal and nutrient concentrations.

- The chemistry of dam water samples is more complex than roof water samples. This is likely because dam water is exposed to soils containing a wide variety of minerals as well as potential soil amendments compared to the relatively simple roof water collection system.
- Indeed, the observed higher concentrations of nitrogen- and phosphorus-based nutrients in farm dam water, relative to roof water tanks, provides some evidence that soil amendments have been or are being used on farmland within the dam catchments.
- Salinity and major ion concentrations in dam water samples appear to be largely controlled by the carbonate mineral dolomite (and potentially calcite). Possible sources of dolomite include dust from the application of agricultural dolomite, dust from the weathering of the local rocks/soils, or dust derived from CVO tailings dams.
- The dissolution of gypsum / bassanite / anhydrite is suggested by a correlation between dissolved sulfate and calcium concentrations in farm dam water. These minerals could be sourced from soil amendments or dust derived from CVO tailings.
- Potassium could potentially be associated with farm additives, whereas sodium and chloride may relate to the use of stock licks (sodium chloride) on farms and/or saline groundwater inflows to dams (sodium chloride). However, the fugitive dust from CVO tailings dams cannot be discounted as a potential source of potassium and some sodium chloride (halite).
- While of no concern for livestock drinking water, metals that are present in some of the farm dam water include iron and very low concentrations of manganese, aluminium, molybdenum, copper, zinc, arsenic, cobalt and nickel.
- Overall, when comparing the farm dam water chemistry to the tailings ASLP data (Section 2.1; Earth Systems, 2020a), the only metals in dam water that were consistent with the aqueous fingerprint of CVO tailings dust were zinc, copper, manganese and molybdenum. However, micro-nutrient fertiliser sources cannot be excluded at this stage. Further investigation is required to clarify any influence of CVO tailings dust on the trace element signature of dam water.

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Attachment A

ALS Laboratory Reports

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES2016298**	Page	: 1 of 14
Amendment	: **1**		
Client	: **NEWCREST MINING LIMITED**	Laboratory	: Environmental Division Sydney
Contact	: MR NICOLAS BOURGEOT	Contact	: Customer Services ES
Address	: 1460 CADIA ROAD ORANGE NSW, AUSTRALIA 2800	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: Cadia Water Monitoring	Date Samples Received	: 13-May-2020 09:45
Order number	: 4500922559	Date Analysis Commenced	: 13-May-2020
C-O-C number	: ----	Issue Date	: 22-May-2020 21:42
Sampler	: Thomas Byron		
Site	: CADIA		
Quote number	: EN/107/17 B V5		
No. of samples received	: 20		
No. of samples analysed	: 20		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EG020: It is recognised that total concentration is less than dissolved for some metal analytes. However, the difference is within experimental variation of the methods.
- TDS by method EA-015 may bias high for various samples due to the presence of fine particulate matter, which may pass through the prescribed GF/C paper.
- Ionic Balance out of acceptable limits for various samples due to analytes not quantified in this report.
- Amendment (20/05/2020): This report has been amended and re-released to allow the reporting of additional analytical data.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	SVWT20200507	OCWT20200507	EPHWT20200506	EPSWT20200506	BWWT20200506
			Client sampling date / time	07-May-2020 00:00	07-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00
Compound	CAS Number	LOR	Unit	ES2016298-001	ES2016298-002	ES2016298-003	ES2016298-004	ES2016298-005
				Result	Result	Result	Result	Result
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	168	32	58	6	37
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	89	26	34	<10	30
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	<5	5	<5	10	6
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	47	<1	18	<1	15
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	74	3	25	<1	15
Total Alkalinity as CaCO3	----	1	mg/L	74	3	25	<1	15
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	4	3	<1	<1	1
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	1	<1	2	<1	<1
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	19	<1	4	<1	6
Magnesium	7439-95-4	1	mg/L	<1	<1	2	<1	<1
Sodium	7440-23-5	1	mg/L	2	<1	3	<1	<1
Potassium	7440-09-7	1	mg/L	2	<1	<1	<1	<1
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	0.04
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.0002	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	0.023	0.043	0.020	0.004	0.002
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L	0.019	0.057	<0.001	0.023	0.002
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	0.001	0.002	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SVWT20200507	OCWT20200507	EPHWT20200506	EPSWT20200506	BWWT20200506
				Client sampling date / time	07-May-2020 00:00	07-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00
Compound	CAS Number	LOR	Unit		ES2016298-001	ES2016298-002	ES2016298-003	ES2016298-004	ES2016298-005
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		**12.5**	**5.25**	**0.031**	**0.130**	**0.128**
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	<0.05	<0.05	<0.05
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.01**	**0.08**	**0.02**	**0.03**	**0.06**
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L		**0.0001**	**0.0002**	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	**0.006**	**0.003**	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		**0.027**	**0.050**	**0.024**	**0.008**	**0.030**
Lead	7439-92-1	0.001	mg/L		<0.001	**0.002**	<0.001	<0.001	**0.006**
Manganese	7439-96-5	0.001	mg/L		**0.021**	**0.061**	**0.003**	**0.028**	**0.005**
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L		**0.002**	**0.002**	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		**12.8**	**5.36**	**0.039**	**0.148**	**0.244**
Iron	7439-89-6	0.05	mg/L		<0.05	**0.12**	<0.05	**0.15**	**0.42**
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**2.22**	**2.10**	**0.62**	**0.30**	**0.48**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**2.22**	**2.10**	**0.62**	**0.30**	**0.48**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.4**	**0.3**	<0.1	<0.1	<0.1
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**2.6**	**2.4**	**0.6**	**0.3**	**0.5**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.03**	**0.05**	**0.03**	**0.01**	**0.02**
EN055: Ionic Balance									

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)				Client sample ID	**SVWT20200507**	**OCWT20200507**	**EPHWT20200506**	**EPSWT20200506**	**BWWT20200506**
				Client sampling date / time	07-May-2020 00:00	07-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00
Compound	*CAS Number*	*LOR*	*Unit*		**ES2016298-001**	**ES2016298-002**	**ES2016298-003**	**ES2016298-004**	**ES2016298-005**
					Result	Result	Result	Result	Result
EN055: Ionic Balance - Continued									
ø **Total Anions**	----	0.01	meq/L		**1.59**	**0.12**	**0.56**	<0.01	**0.32**
ø **Total Cations**	----	0.01	meq/L		**1.82**	**0.15**	**----**	**----**	**----**
ø **Total Cations**	----	0.01	meq/L		**----**	**----**	**0.49**	<0.01	**0.30**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	W1HT20200506	W1ST20200506	W2HT20200506	W3HT20200506	W3ST20200506
			Client sampling date / time	06-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00
Compound	CAS Number	LOR	Unit	ES2016298-006	ES2016298-007	ES2016298-008	ES2016298-009	ES2016298-010
				Result	Result	Result	Result	Result
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	15	72	11	10	14
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	<10	51	<10	<10	10
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	7	7	<5	<5	6
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	2	20	<1	<1	5
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	5	33	<1	<1	3
Total Alkalinity as CaCO3	----	1	mg/L	5	33	<1	<1	3
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	<1	<1	<1	<1
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	<1	2	<1	<1	<1
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	1	8	<1	<1	2
Magnesium	7439-95-4	1	mg/L	<1	<1	<1	<1	<1
Sodium	7440-23-5	1	mg/L	<1	2	<1	<1	<1
Potassium	7440-09-7	1	mg/L	<1	2	<1	<1	<1
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	0.0001	0.0010	<0.0001	0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	0.187	0.002	0.045	0.008	0.008
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L	0.005	0.021	0.047	0.031	0.014
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	<0.001	0.004	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	W1HT20200506	W1ST20200506	W2HT20200506	W3HT20200506	W3ST20200506
				Client sampling date / time	06-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00
Compound	CAS Number	LOR	Unit		ES2016298-006	ES2016298-007	ES2016298-008	ES2016298-009	ES2016298-010
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		**0.807**	**1.48**	**0.049**	**0.092**	**0.242**
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	<0.05	<0.05	<0.05
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.03**	**0.02**	**0.02**	**0.04**	**0.01**
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L		**0.0002**	**0.0012**	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	**0.002**	**0.002**	**0.001**
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		**0.228**	**0.008**	**0.057**	**0.009**	**0.007**
Lead	7439-92-1	0.001	mg/L		<0.001	**0.001**	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L		**0.006**	**0.021**	**0.049**	**0.036**	**0.014**
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	<0.001	**0.001**	<0.001
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		**0.873**	**1.69**	**0.053**	**0.084**	**0.256**
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	**0.09**	<0.05	<0.05
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.23**	**0.70**	**0.75**	**0.57**	**0.63**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.23**	**0.70**	**0.75**	**0.57**	**0.63**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		<0.1	<0.1	<0.1	**0.5**	<0.1
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**0.2**	**0.7**	**0.8**	**1.1**	**0.6**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.02**	**0.01**	**0.02**	**0.03**	**0.02**
EN055: Ionic Balance									

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)				Client sample ID	W1HT20200506	W1ST20200506	W2HT20200506	W3HT20200506	W3ST20200506
				Client sampling date / time	06-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00
Compound	*CAS Number*	*LOR*	*Unit*		**ES2016298-006**	**ES2016298-007**	**ES2016298-008**	**ES2016298-009**	**ES2016298-010**
					Result	Result	Result	Result	Result
EN055: Ionic Balance - Continued									
ø **Total Anions**	----	0.01	meq/L		**0.10**	**0.72**	<0.01	<0.01	**0.06**
ø **Total Cations**	----	0.01	meq/L		**0.05**	**0.54**	<0.01	<0.01	**0.10**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	CHHT20200506	CHST20200506	CHHT20200506	EPSW20200506	WGSW20200507
			Client sampling date / time	06-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00	07-May-2020 00:00
Compound	CAS Number	LOR	Unit	ES2016298-011	ES2016298-012	ES2016298-013	ES2016298-014	ES2016298-015
				Result	Result	Result	Result	Result
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	19	33	80	58	332
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	<10	20	47	55	270
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	<5	18	6	22	41
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	<1	10	27	2	53
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	4	13	34	2	112
Total Alkalinity as CaCO3	----	1	mg/L	4	13	34	2	112
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	<1	1	6	26
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	<1	<1	<1	4	14
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	<1	4	11	1	15
Magnesium	7439-95-4	1	mg/L	<1	<1	<1	<1	6
Sodium	7440-23-5	1	mg/L	<1	<1	1	3	9
Potassium	7440-09-7	1	mg/L	1	<1	2	4	43
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.01	<0.01	<0.01	0.15	0.49
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	0.005
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	0.001	0.008
Copper	7440-50-8	0.001	mg/L	0.009	0.001	0.001	0.002	0.008
Lead	7439-92-1	0.001	mg/L	0.002	<0.001	<0.001	<0.001	0.002
Manganese	7439-96-5	0.001	mg/L	0.021	0.006	0.003	0.132	1.06
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	0.002
Nickel	7440-02-0	0.001	mg/L	0.002	<0.001	<0.001	<0.001	0.005
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	CHHT20200506	CHST20200506	CHHT20200506	EPSW20200506	WGSW20200507
				Client sampling date / time	06-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00	07-May-2020 00:00
Compound	CAS Number	LOR	Unit		ES2016298-011	ES2016298-012	ES2016298-013	ES2016298-014	ES2016298-015
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		**1.07**	**1.17**	**0.548**	<0.005	**0.012**
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	<0.05	**0.11**	**7.37**
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.02**	**0.12**	<0.01	**0.79**	**1.20**
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	**0.007**
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	**0.002**
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	**0.002**	**0.010**
Copper	7440-50-8	0.001	mg/L		**0.010**	**0.008**	**0.007**	**0.012**	**0.014**
Lead	7439-92-1	0.001	mg/L		**0.002**	**0.013**	<0.001	<0.001	**0.003**
Manganese	7439-96-5	0.001	mg/L		**0.022**	**0.025**	**0.004**	**0.150**	**1.30**
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	**0.003**
Nickel	7440-02-0	0.001	mg/L		**0.001**	<0.001	<0.001	<0.001	**0.007**
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		**1.14**	**1.70**	**0.571**	**0.008**	**0.031**
Iron	7439-89-6	0.05	mg/L		<0.05	**0.15**	<0.05	**0.73**	**9.10**
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	**0.08**
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.55**	**0.57**	**1.27**	**2.47**	**0.08**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.55**	**0.57**	**1.27**	**2.47**	**0.16**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		<0.1	<0.1	**0.2**	**1.6**	**8.2**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**0.6**	**0.6**	**1.5**	**4.1**	**8.4**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.07**	**0.07**	**0.09**	**0.06**	**1.22**
EN055: Ionic Balance									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	CHHT20200506	CHST20200506	CHHT20200506	EPSW20200506	WGSW20200507
				Client sampling date / time	06-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00	07-May-2020 00:00
Compound	CAS Number	LOR	Unit		ES2016298-011	ES2016298-012	ES2016298-013	ES2016298-014	ES2016298-015
					Result	Result	Result	Result	Result
EN055: Ionic Balance - Continued									
ø **Total Anions**	----	0.01	meq/L		**0.08**	**0.26**	**0.70**	**0.28**	**3.17**
ø **Total Cations**	----	0.01	meq/L		**----**	**----**	**----**	**----**	**3.13**
ø **Total Cations**	----	0.01	meq/L		**0.02**	**0.20**	**0.64**	**0.28**	**----**
ø **Ionic Balance**	----	0.01	%		**----**	**----**	**----**	**----**	**0.70**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	WASW20200507	OCSW20200507	TASW20200507	BDSW20200507	EPB20200506
			Client sampling date / time	07-May-2020 00:00	07-May-2020 00:00	07-May-2020 00:00	07-May-2020 00:00	06-May-2020 00:00
Compound	CAS Number	LOR	Unit	ES2016298-016	ES2016298-017	ES2016298-018	ES2016298-019	ES2016298-020
				Result	Result	Result	Result	Result
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	109	533	160	156	329
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	80	384	133	160	190
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	33	18	27	12	6
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	21	175	60	46	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	40	57	63	73	178
Total Alkalinity as CaCO3	----	1	mg/L	40	57	63	73	178
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	176	24	<1	5
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	7	15	6	5	8
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	5	42	14	10	31
Magnesium	7439-95-4	1	mg/L	2	17	6	5	18
Sodium	7440-23-5	1	mg/L	3	24	5	3	14
Potassium	7440-09-7	1	mg/L	13	12	17	8	6
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.07	0.03	0.26	0.23	<0.01
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.002	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L	0.002	<0.001	0.004	0.002	<0.001
Copper	7440-50-8	0.001	mg/L	0.004	0.010	0.007	0.006	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L	0.104	0.024	0.478	0.321	0.084
Molybdenum	7439-98-7	0.001	mg/L	<0.001	0.002	0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	<0.001	0.001	0.002	0.002	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WASW20200507	OCSW20200507	TASW20200507	BDSW20200507	EPB20200506
				Client sampling date / time	07-May-2020 00:00	07-May-2020 00:00	07-May-2020 00:00	07-May-2020 00:00	06-May-2020 00:00
Compound	CAS Number	LOR	Unit		ES2016298-016	ES2016298-017	ES2016298-018	ES2016298-019	ES2016298-020
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		**0.011**	**0.078**	**0.008**	**0.011**	**0.007**
Iron	7439-89-6	0.05	mg/L		**0.20**	**0.05**	**0.78**	**0.59**	**0.64**
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.20**	**0.56**	**0.35**	**2.44**	----
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	**0.002**	**0.002**	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	----
Chromium	7440-47-3	0.001	mg/L		<0.001	**0.001**	<0.001	**0.002**	----
Cobalt	7440-48-4	0.001	mg/L		**0.003**	<0.001	**0.005**	**0.004**	----
Copper	7440-50-8	0.001	mg/L		**0.002**	**0.008**	**0.018**	**0.014**	----
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Manganese	7439-96-5	0.001	mg/L		**0.265**	**0.062**	**0.836**	**0.426**	----
Molybdenum	7439-98-7	0.001	mg/L		<0.001	**0.003**	**0.003**	<0.001	----
Nickel	7440-02-0	0.001	mg/L		<0.001	**0.002**	**0.003**	**0.002**	----
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	----
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Zinc	7440-66-6	0.005	mg/L		<0.005	**0.082**	**0.021**	**0.023**	----
Iron	7439-89-6	0.05	mg/L		**1.11**	**0.80**	**2.42**	**5.16**	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		----	----	----	----	<0.0001
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	**0.07**	**0.04**	**0.04**	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.41**	**2.85**	**0.21**	**0.28**	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.41**	**2.92**	**0.25**	**0.32**	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**3.1**	**1.6**	**2.5**	**2.5**	<0.1
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**3.5**	**4.5**	**2.8**	**2.8**	<0.1
EK067G: Total Phosphorus as P by Discrete Analyser									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WASW20200507	OCSW20200507	TASW20200507	BDSW20200507	EPB20200506
				Client sampling date / time	07-May-2020 00:00	07-May-2020 00:00	07-May-2020 00:00	07-May-2020 00:00	06-May-2020 00:00
Compound	CAS Number	LOR	Unit		ES2016298-016	ES2016298-017	ES2016298-018	ES2016298-019	ES2016298-020
					Result	Result	Result	Result	Result
EK067G: Total Phosphorus as P by Discrete Analyser - Continued									
Total Phosphorus as P	----	0.01	mg/L		**0.22**	**0.15**	**0.35**	**0.19**	**0.08**
EN055: Ionic Balance									
ø **Total Anions**	----	0.01	meq/L		**1.00**	**5.23**	**1.93**	**1.60**	**3.89**
ø **Total Cations**	----	0.01	meq/L		**0.88**	**4.84**	**1.84**	**1.24**	**3.79**
ø **Ionic Balance**	----	0.01	%		**----**	**3.78**	**----**	**----**	**1.24**

Attachment B

Water chemistry plots

DISSOLVED MAJOR ANIONS

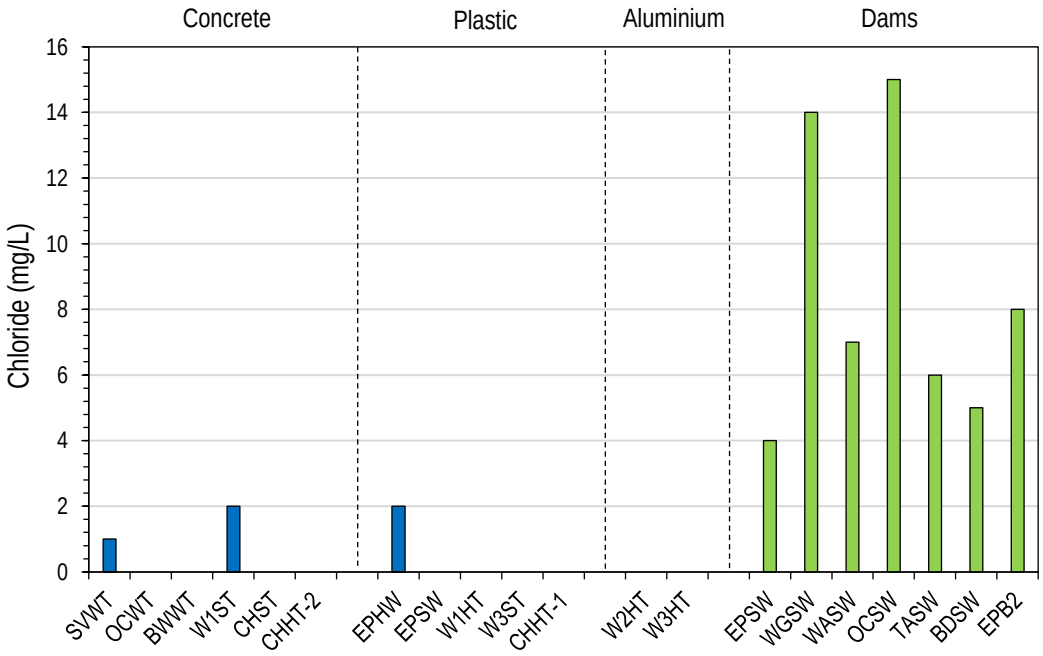

Figure B-7 Chloride concentrations (mg/L) in farm tank and dam water samples.

DISSOLVED MAJOR CATIONS

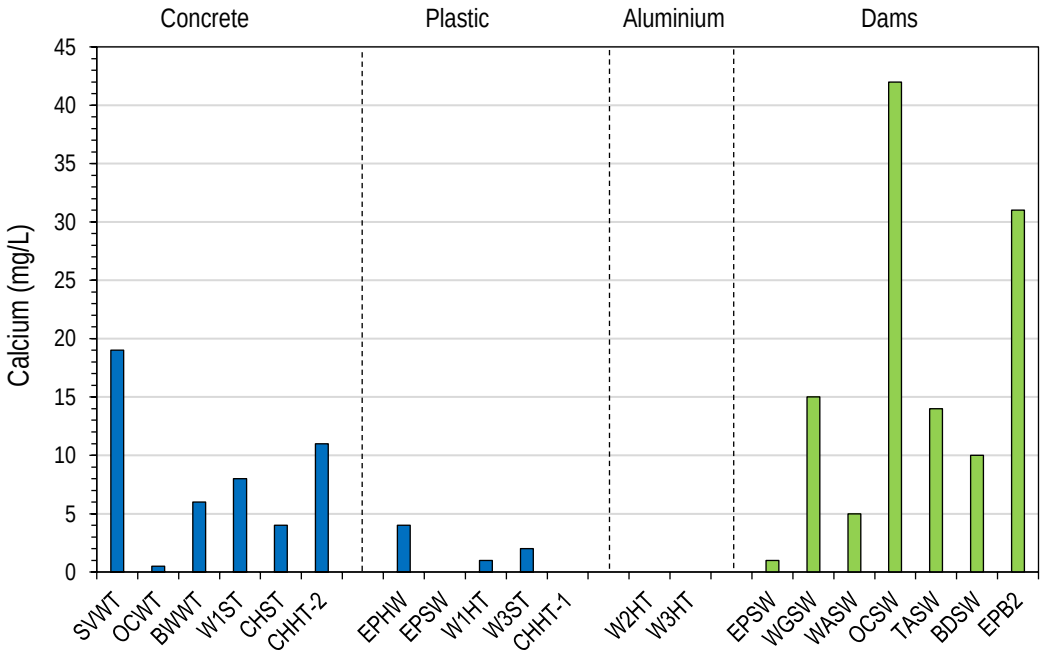

Figure B-8 Calcium concentrations (mg/L) in farm tank and dam water samples.

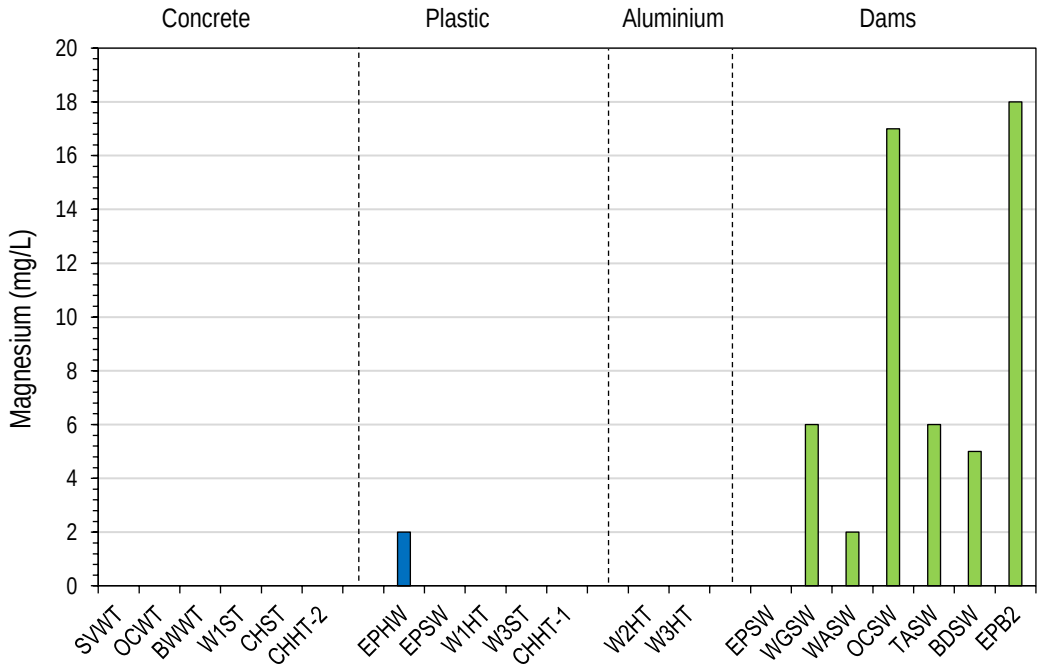

Figure B-9 Magnesium concentrations (mg/L) in farm tank and dam water samples.

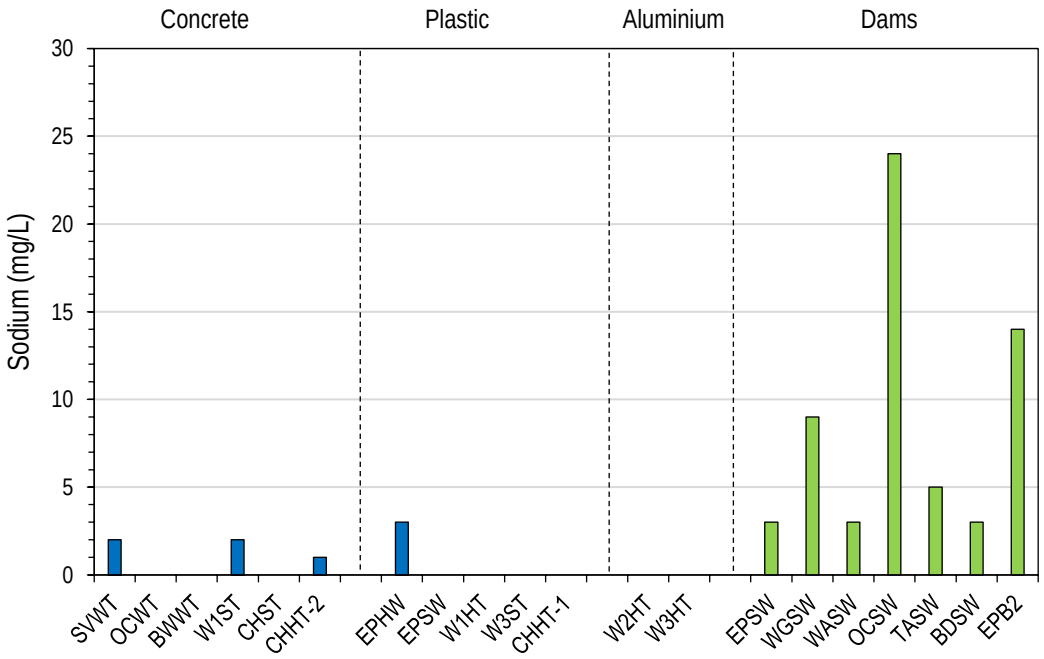

Figure B-10 Sodium concentrations (mg/L) in farm tank and dam water samples.

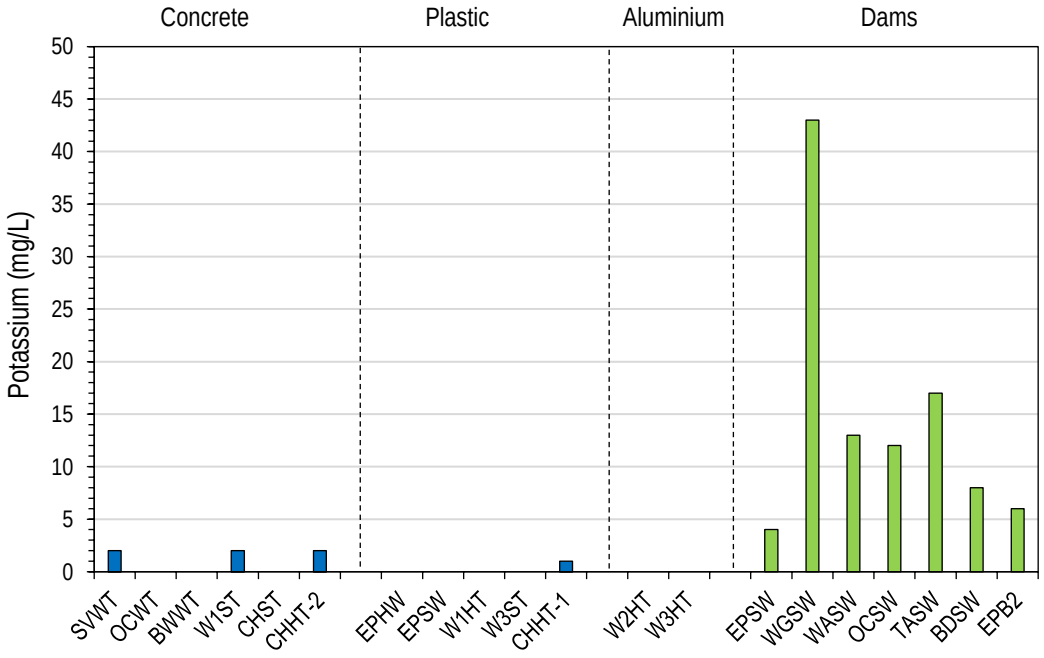

Figure B-11 Potassium concentrations (mg/L) in farm tank and dam water samples.

NUTRIENTS

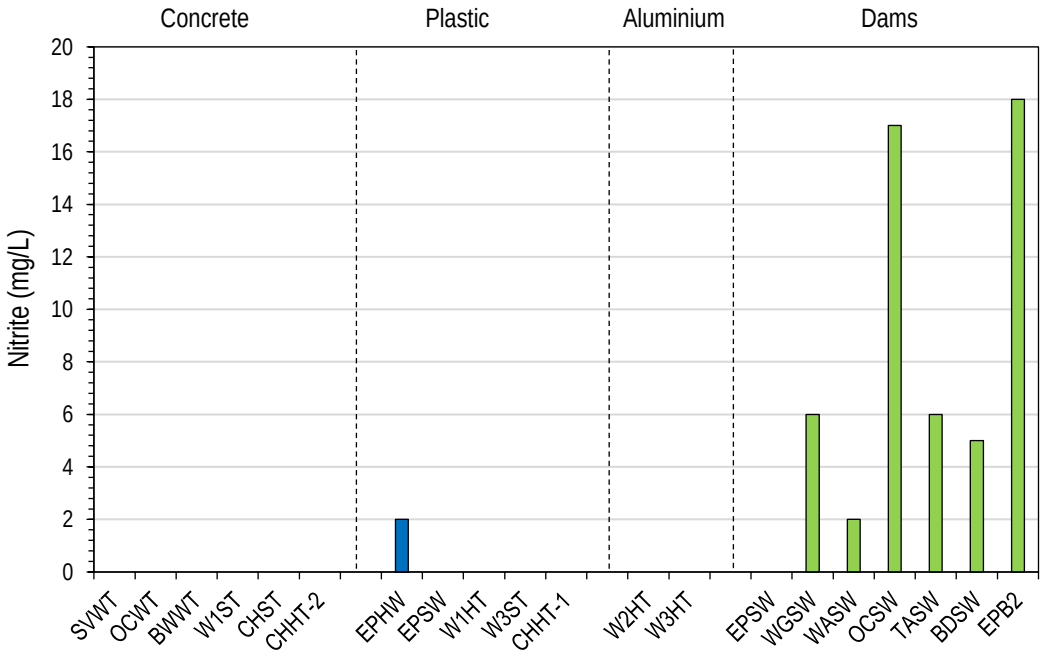

Figure B-12 Nitrite concentrations (mg/L) in farm tank and dam water samples.

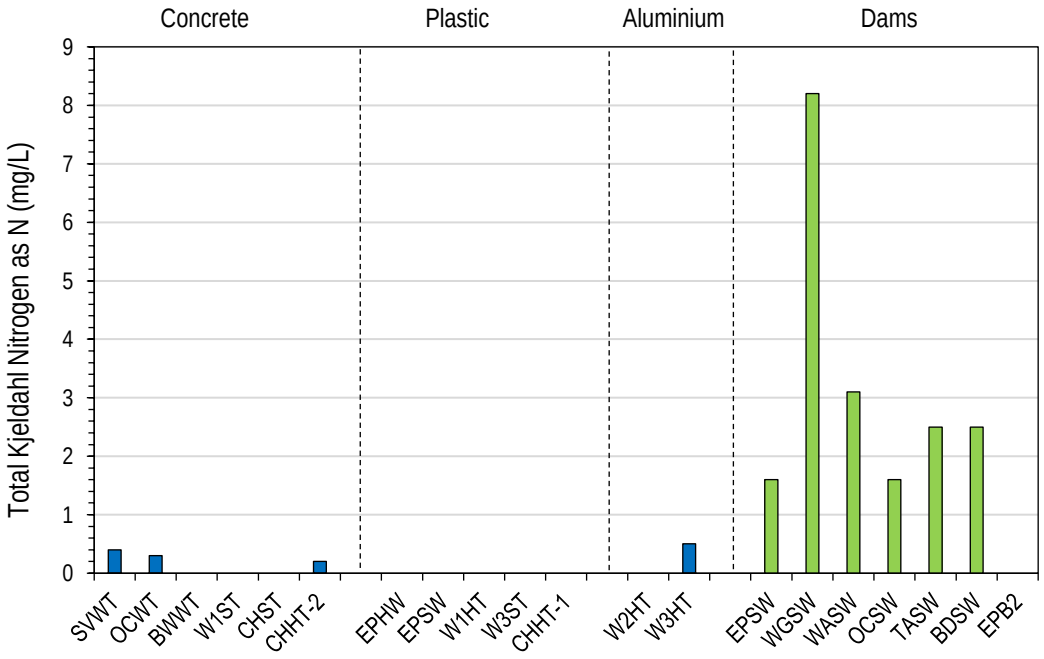

Figure B-13 Total Kjeldahl Nitrogen concentrations (mg/L) in farm tank and dam water samples.

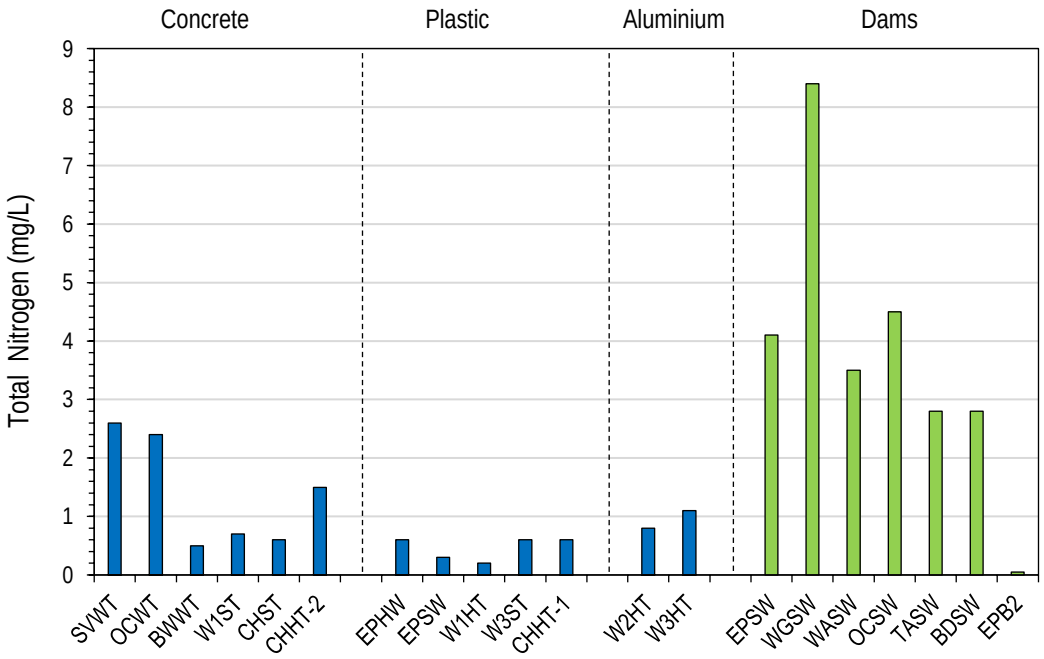

Figure B-14 Total nitrogen concentrations (mg/L) in farm tank and dam water samples.

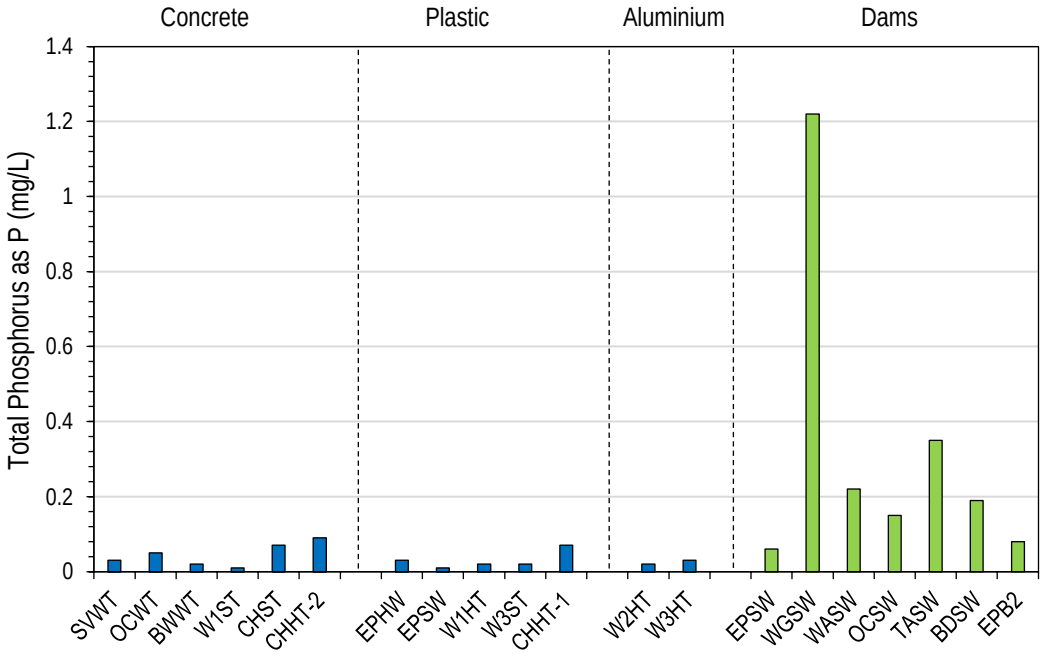

Figure B-15 Total phosphorus concentrations (mg/L) in farm tank and dam water samples.

DISSOLVED METAL(LOID)S

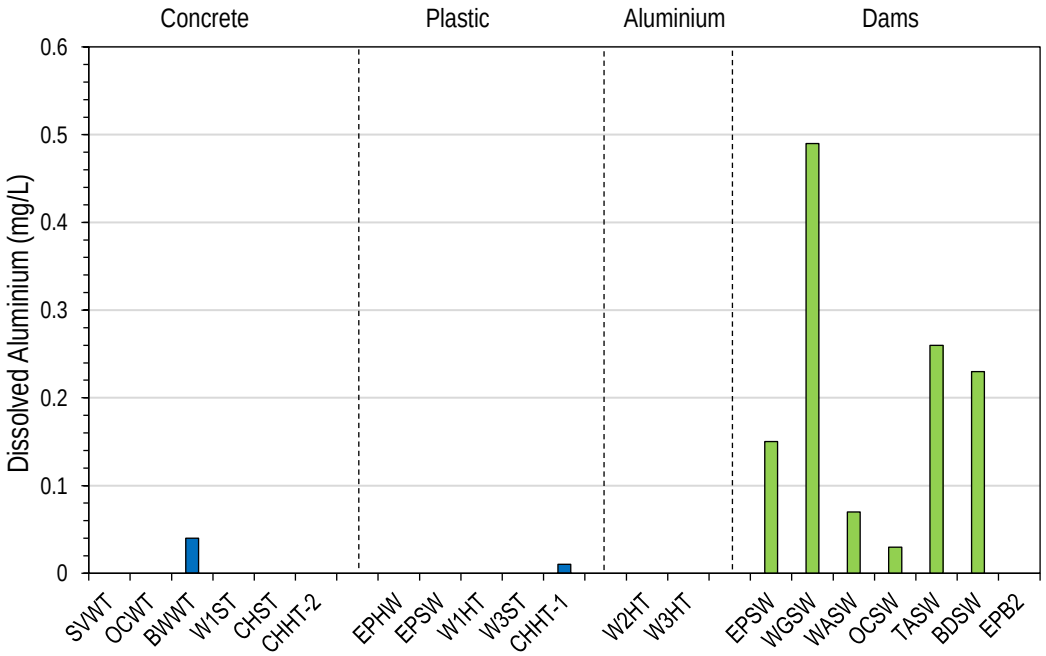

Figure B-16 Dissolved aluminium concentrations (mg/L) in farm tank and dam water samples.

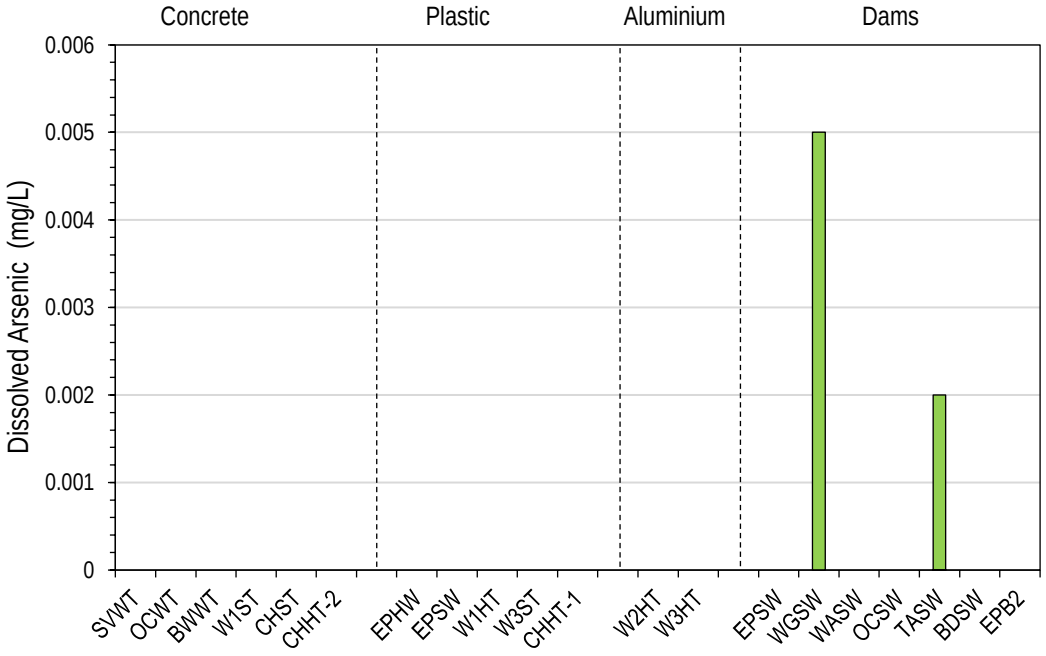

Figure B-17 Dissolved arsenic concentrations (mg/L) in farm tank and dam water samples.

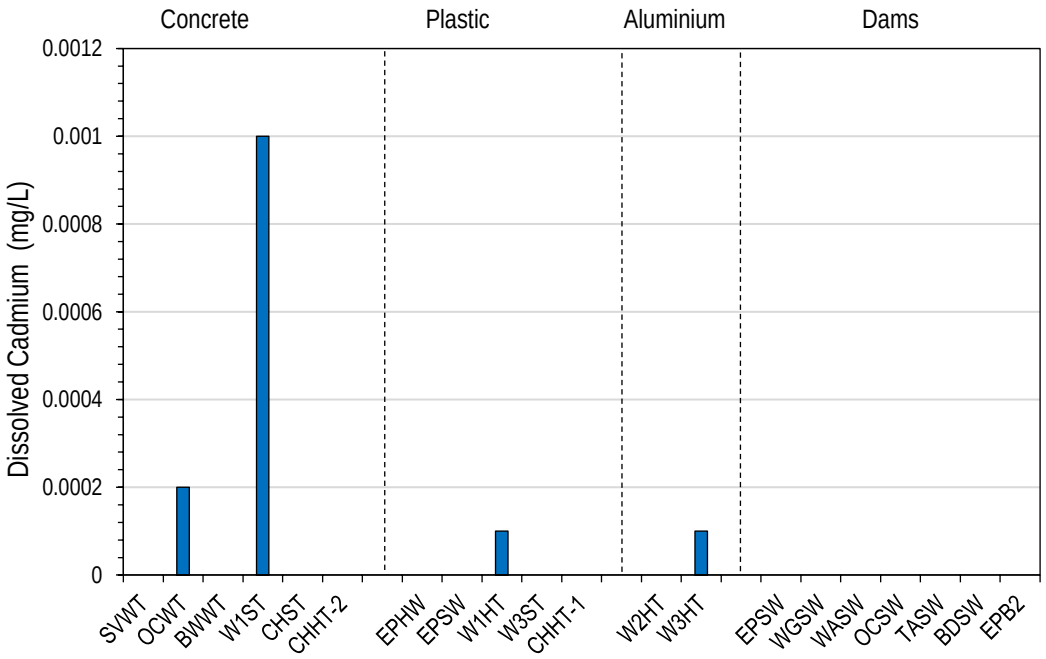

Figure B-18 Dissolved cadmium concentrations (mg/L) in farm tank and dam water samples.

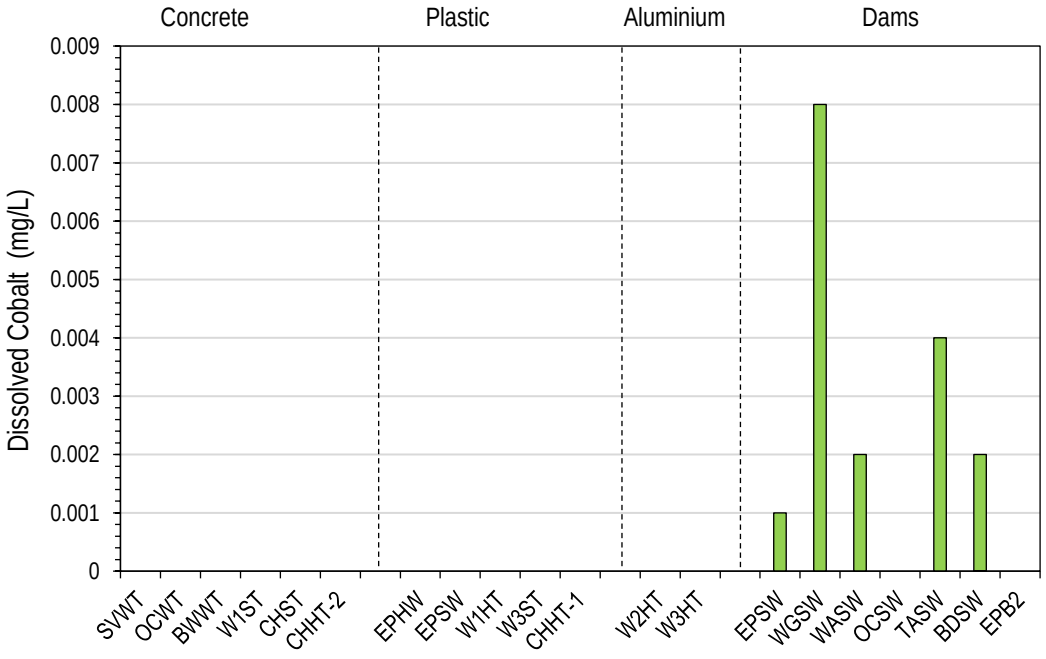

Figure B-19 Dissolved cobalt concentrations (mg/L) in farm tank and dam water samples.

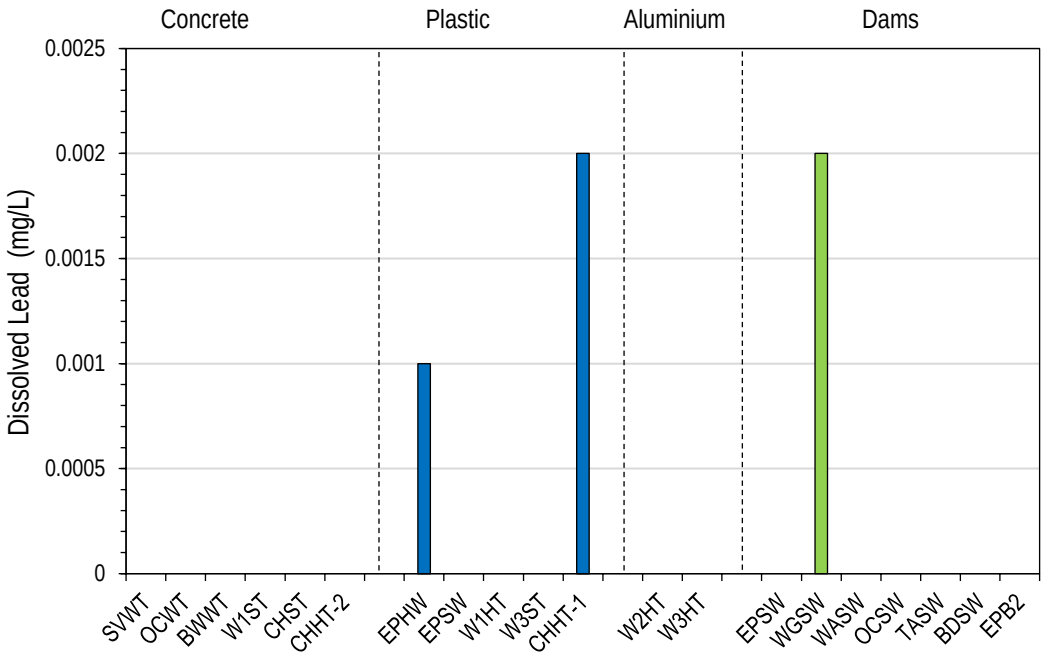

Figure B-20 Dissolved lead concentrations (mg/L) in farm tank and dam water samples.

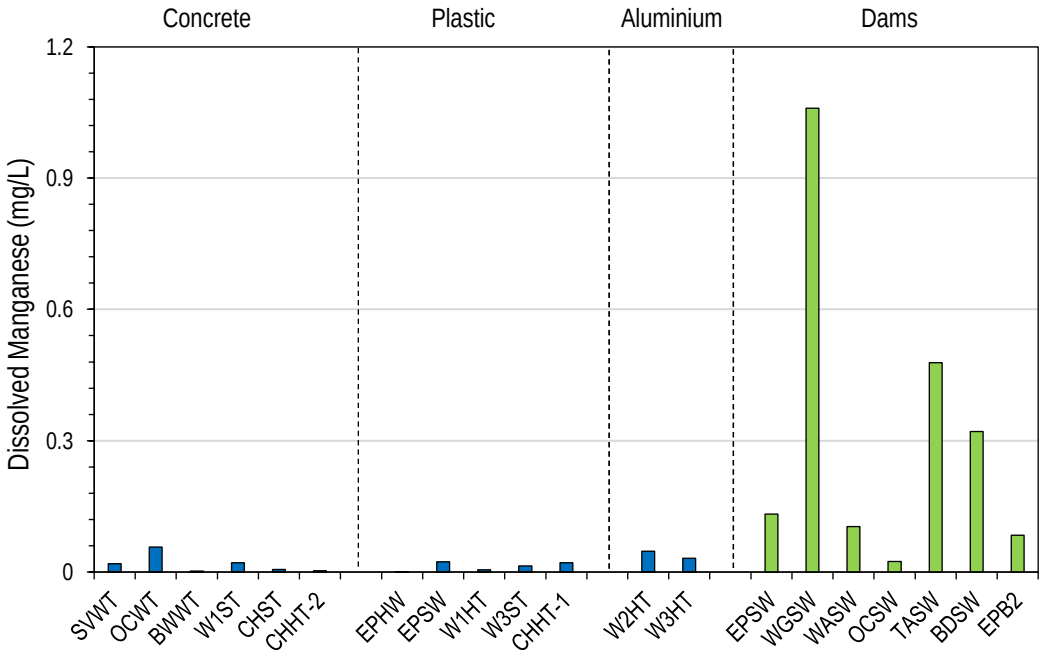

Figure B-21 Dissolved manganese concentrations (mg/L) in farm tank and dam water samples.

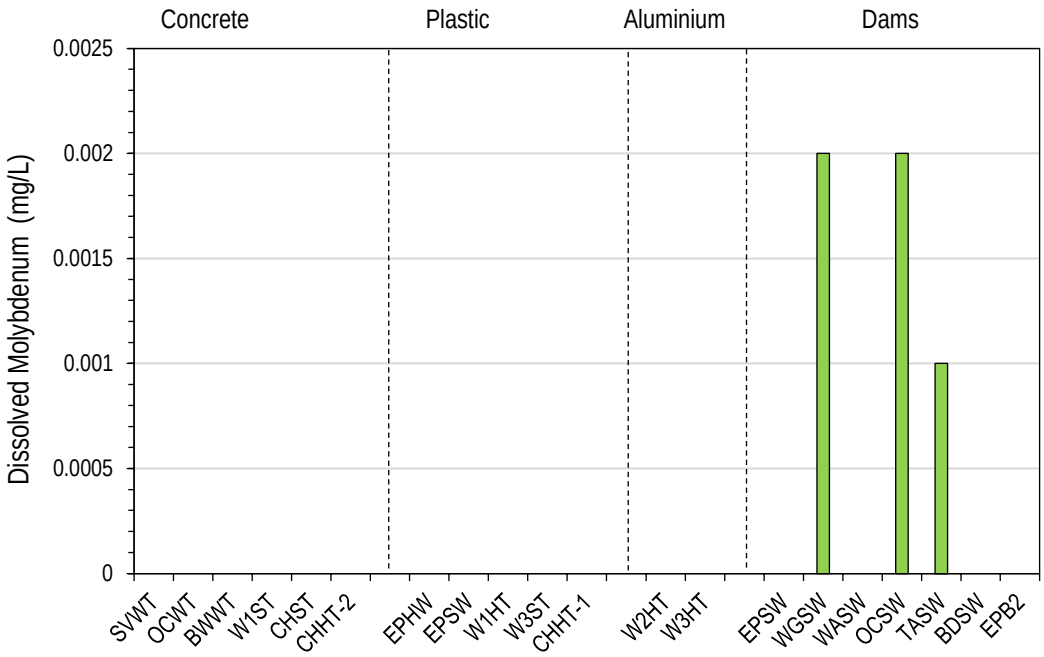

Figure B-22 Dissolved molybdenum concentrations (mg/L) in farm tank and dam water samples.

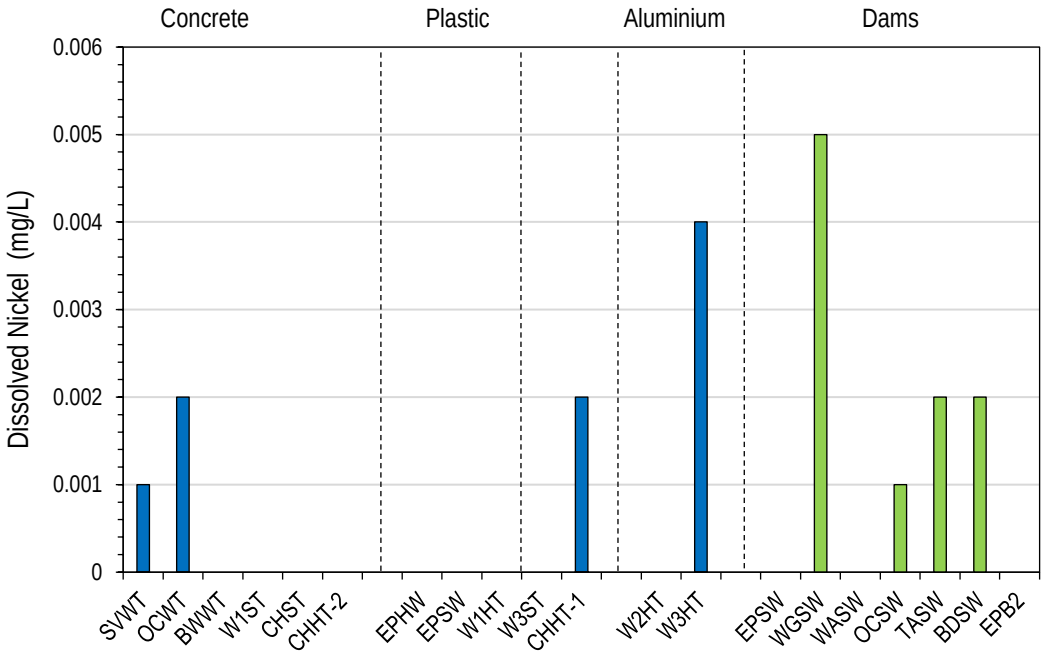

Figure B-23 Dissolved nickel concentrations (mg/L) in farm tank and dam water samples.

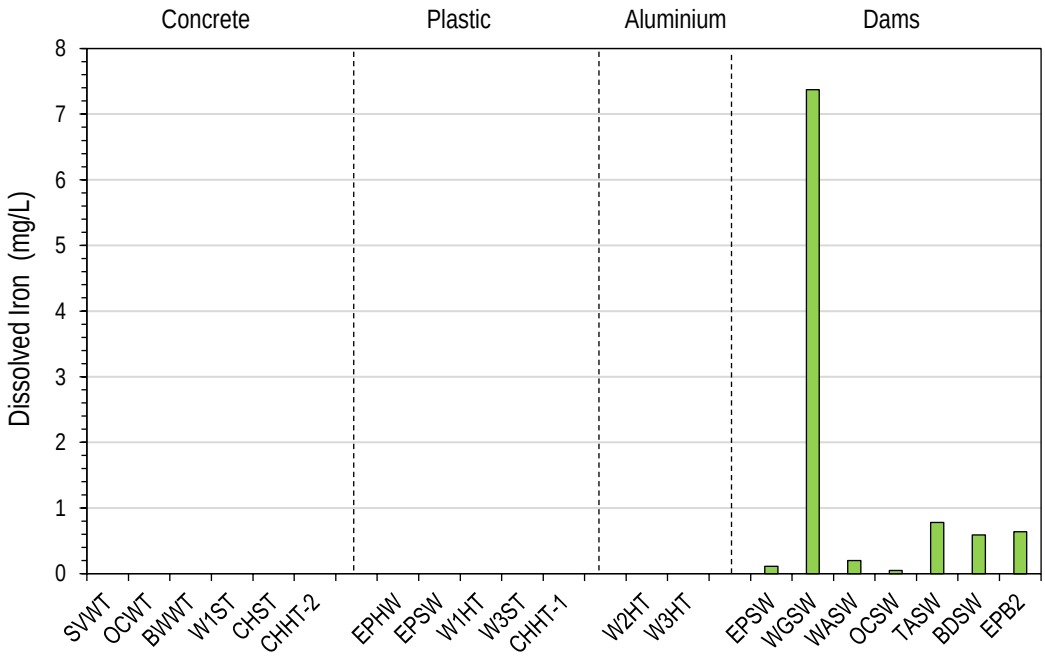

Figure B-24 Dissolved iron concentrations (mg/L) in farm tank and dam water samples.

Attachment C

Correlations between different elements / compounds in tank and dam water

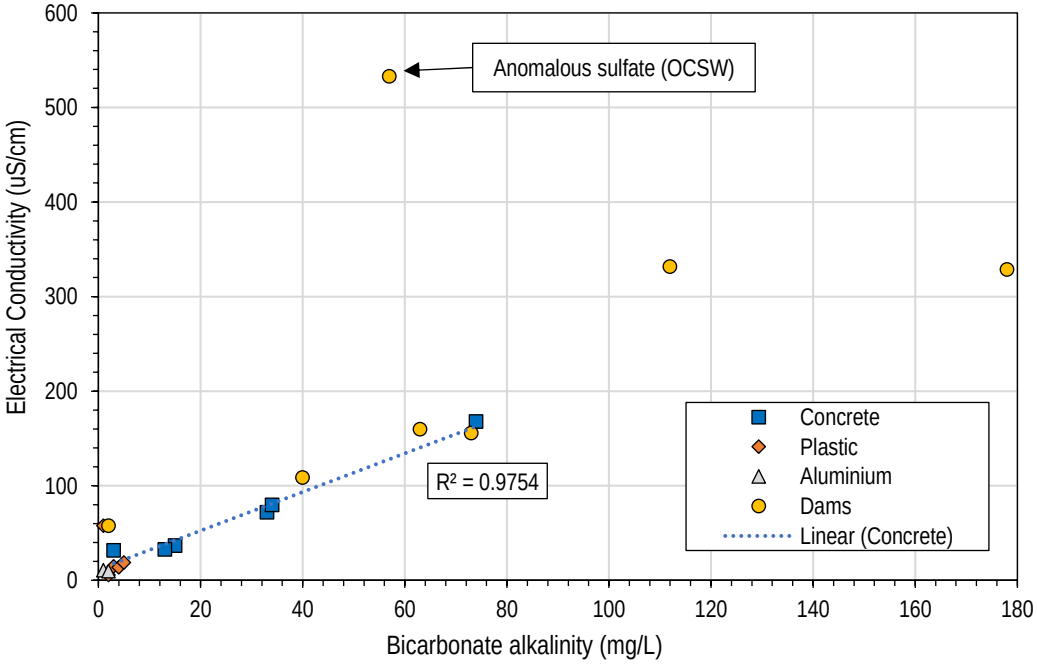

Figure C-25 Bicarbonate alkalinity (mg/L) vs electrical conductivity (µS/cm) of water samples from farm tanks (concrete, plastic, and aluminium) and dams.

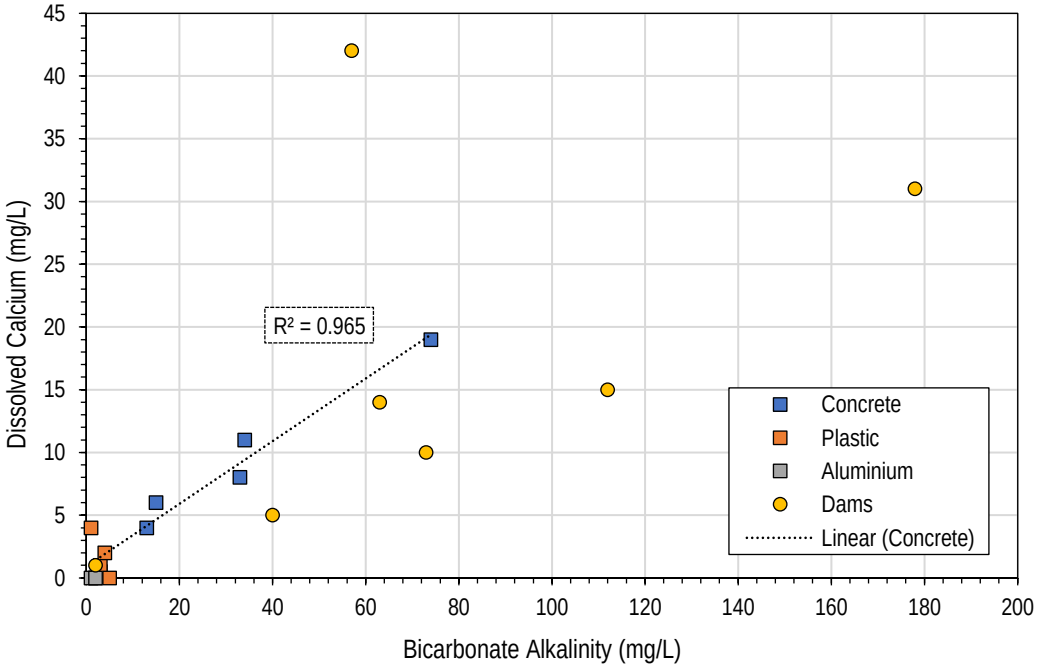

Figure C-26 Bicarbonate alkalinity (mg/L) vs dissolved calcium concentrations (mg/L) of water samples from farm tanks (concrete, plastic, and aluminium) and dams.

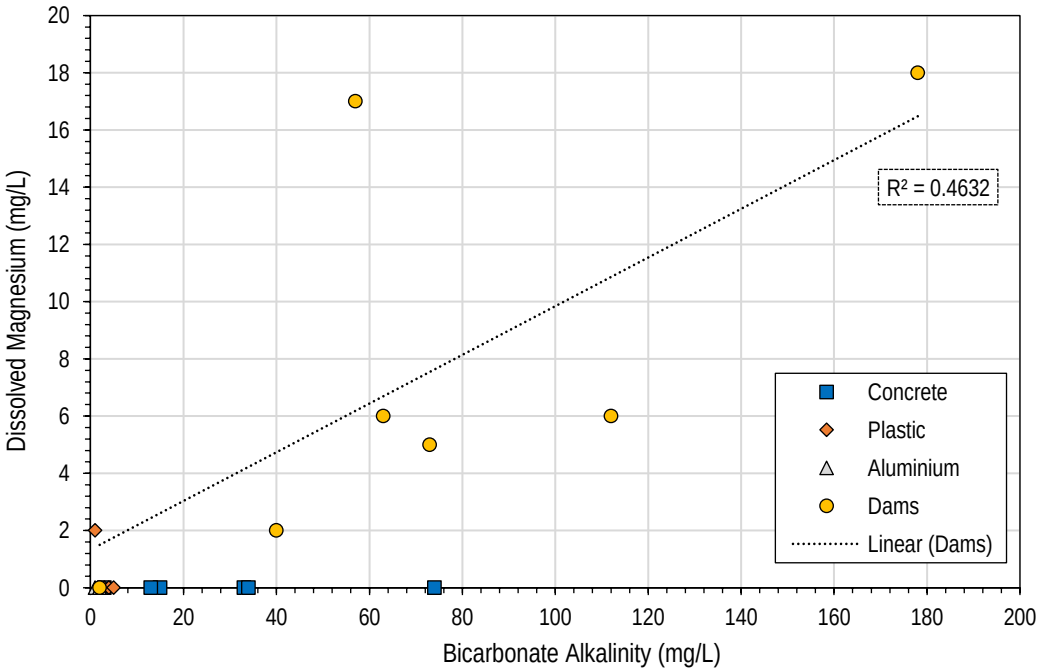

Figure C-27 Bicarbonate alkalinity (mg/L) vs dissolved magnesium concentrations (mg/L) of water samples from farm tanks (concrete, plastic, and aluminium) and dams.

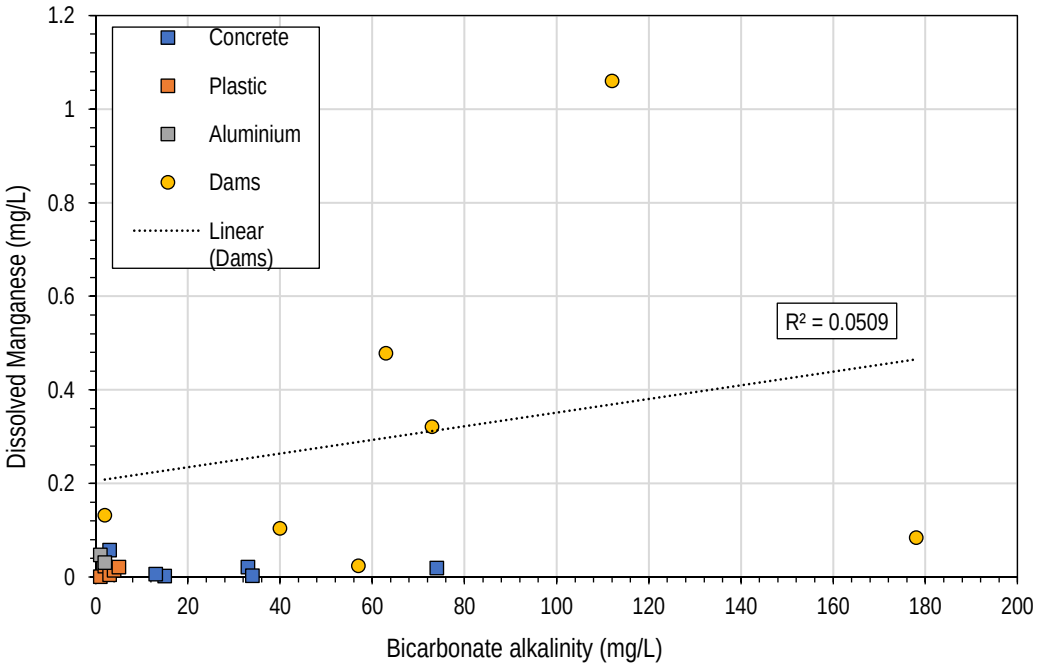

Figure C-28 Bicarbonate alkalinity (mg/L) vs dissolved manganese concentrations (mg/L) of water samples from farm tanks (concrete, plastic, and aluminium) and dams.

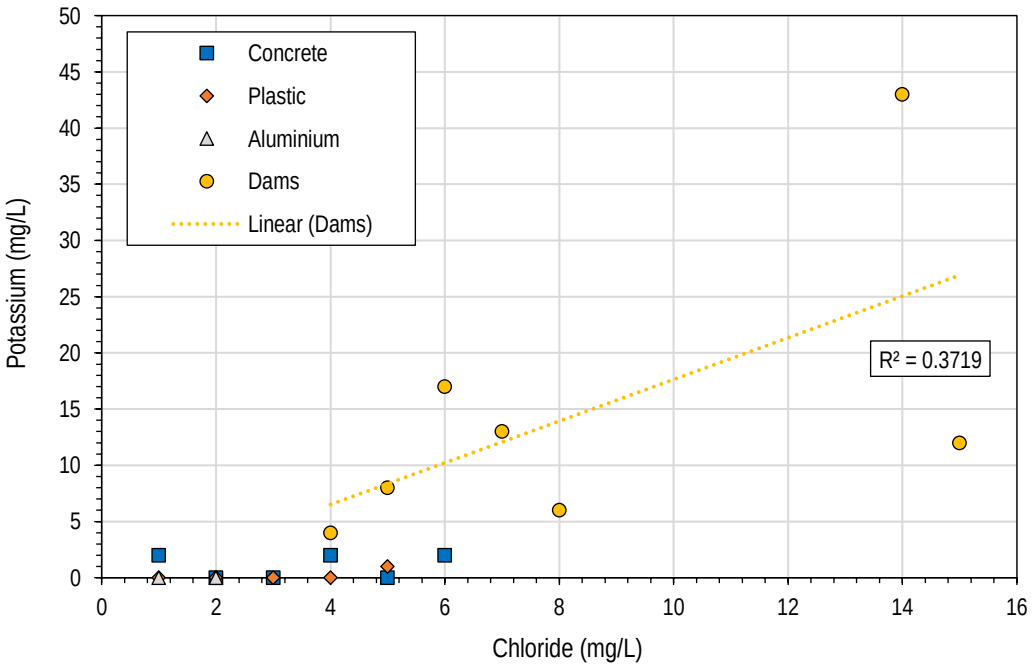

Figure C-29 Potassium (mg/L) vs chloride concentrations (mg/L) of water samples from farm tanks (concrete, plastic, and aluminium) and dams.

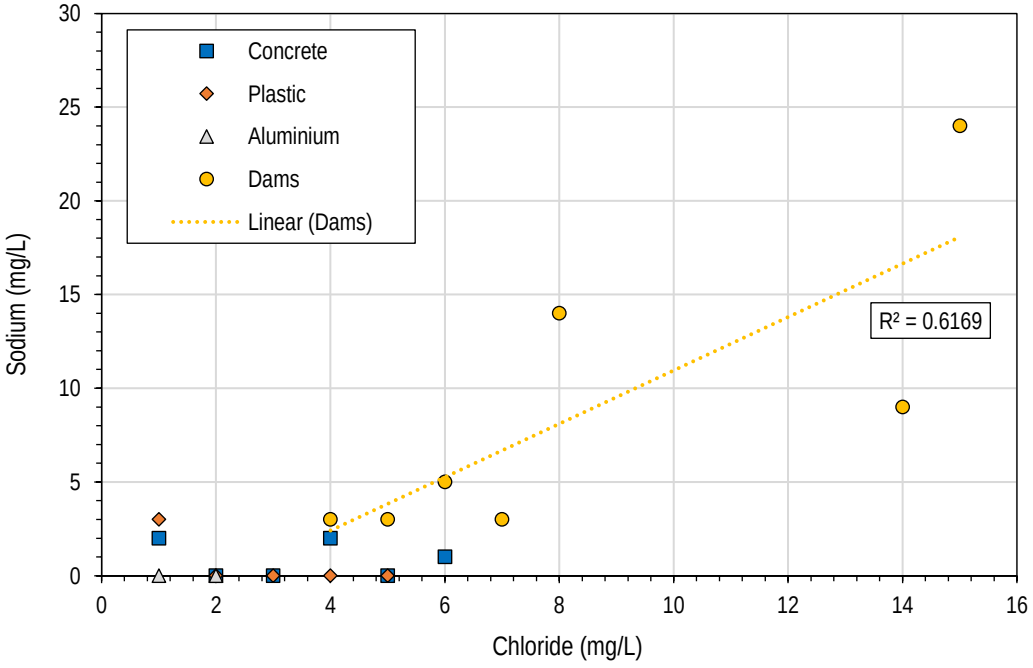

Figure C-30 Sodium (mg/L) vs chloride concentrations (mg/L) of water samples from farm tanks (concrete, plastic, and aluminium) and dams.

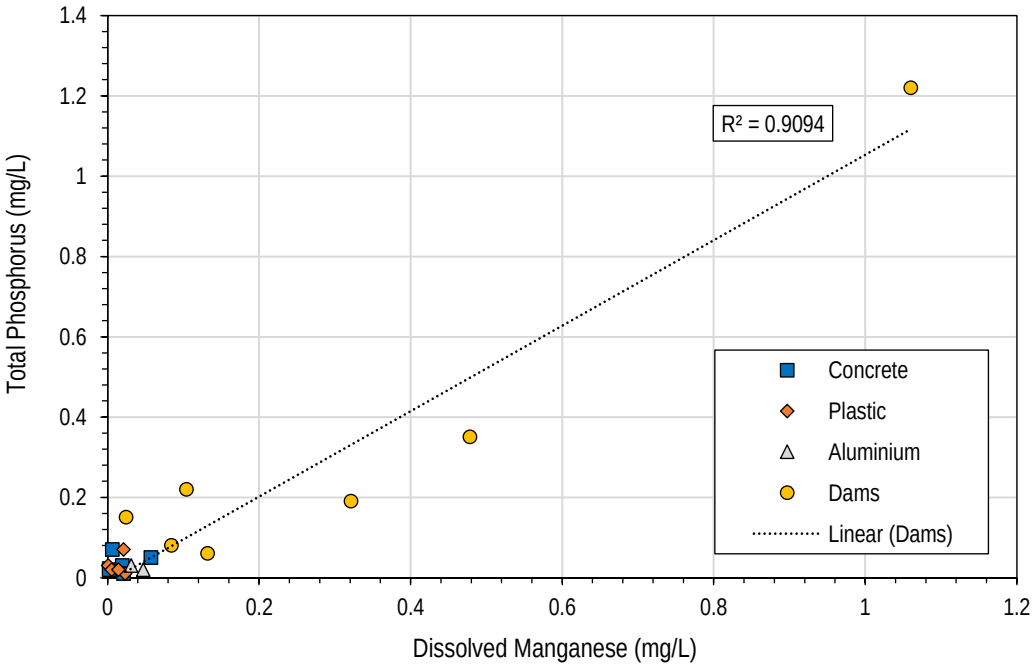

Figure C-31 Total phosphorous concentrations (mg/L) vs dissolved manganese concentrations (mg/L) of water samples from farm tanks (concrete, plastic, and aluminium) and dams.

Attachment D

Distribution of total metal concentrations and comparison with relevant water quality guidelines

TANK WATER SAMPLES

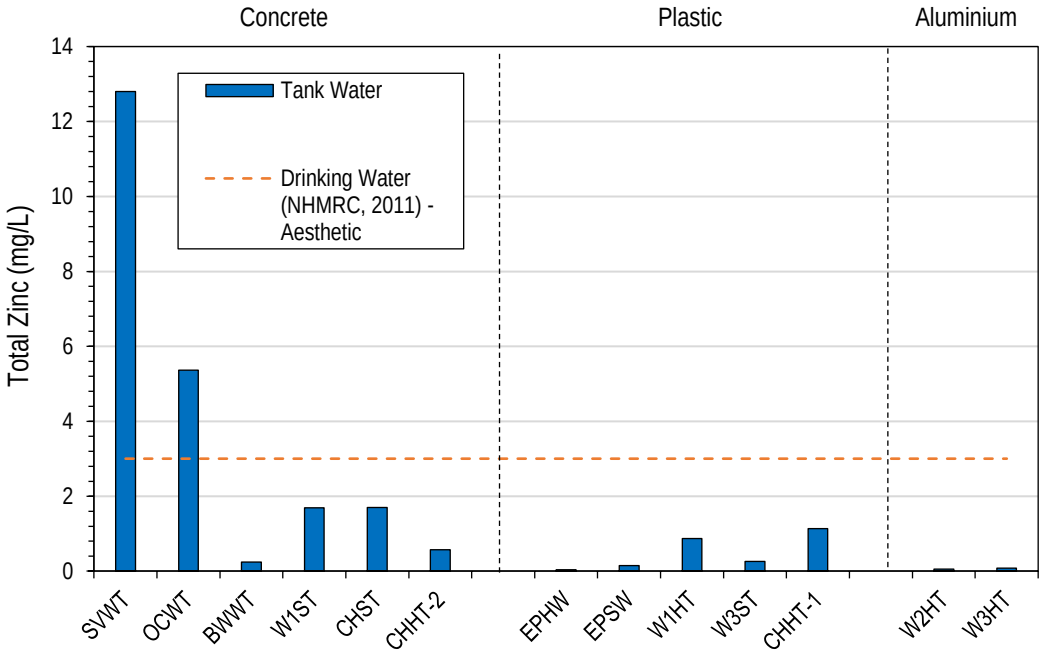

Figure D-32 Total zinc concentrations (mg/L) in tank water samples compared with Australian drinking water aesthetic (taste) guidelines.

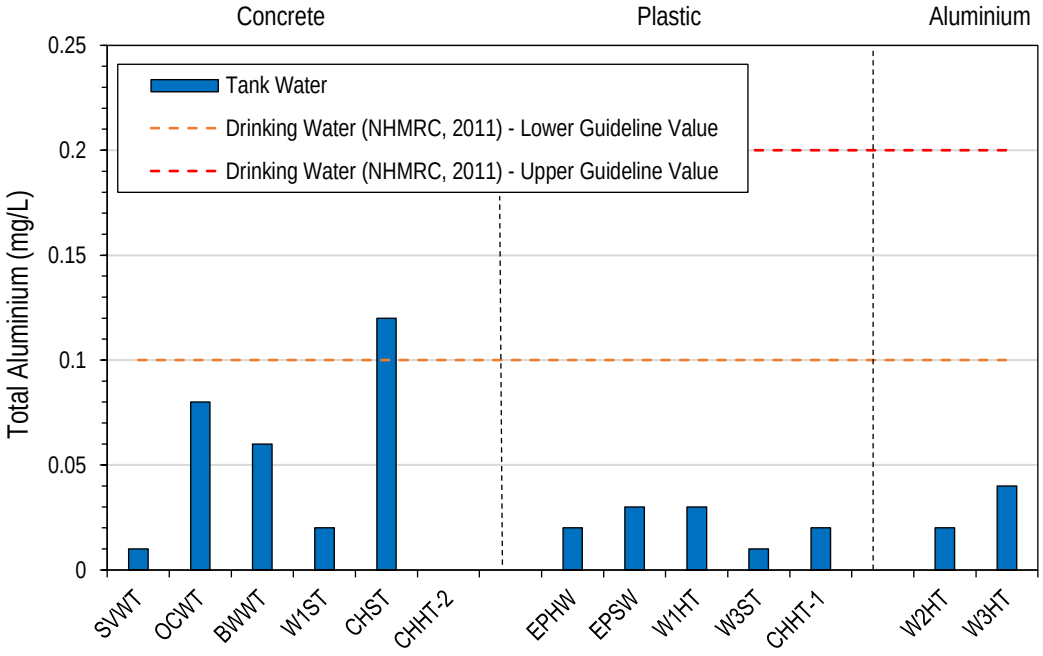

Figure D-33 Total aluminium concentrations (mg/L) in tank water samples compared with Australian drinking water guidelines, see text for details.

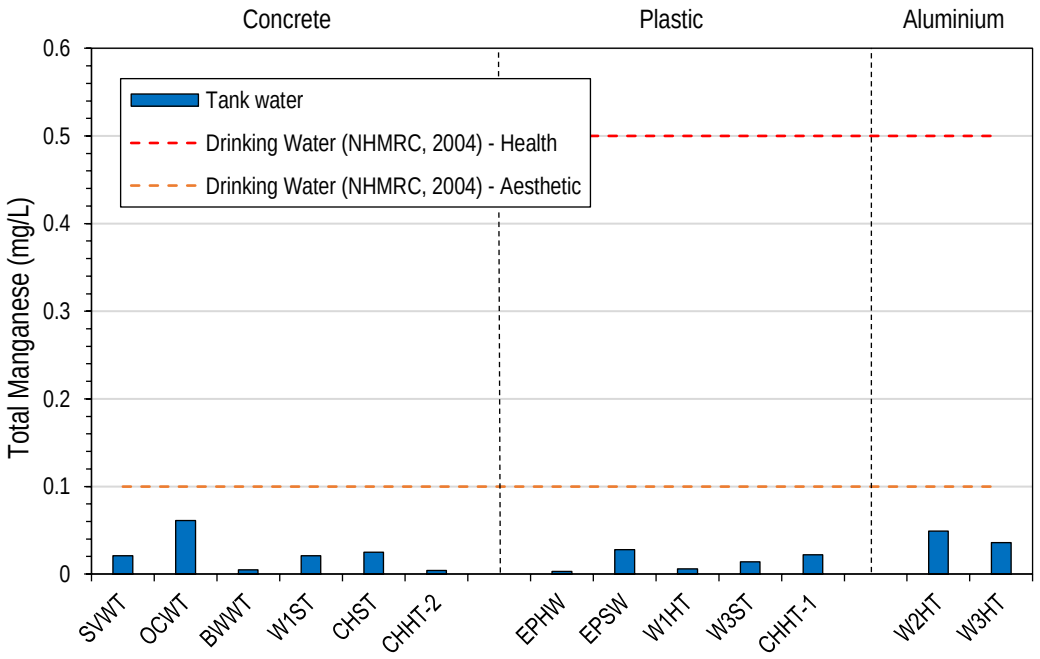

Figure D-34 Total manganese concentrations (mg/L) in tank water samples compared with Australian drinking water aesthetic (taste) and health guidelines.

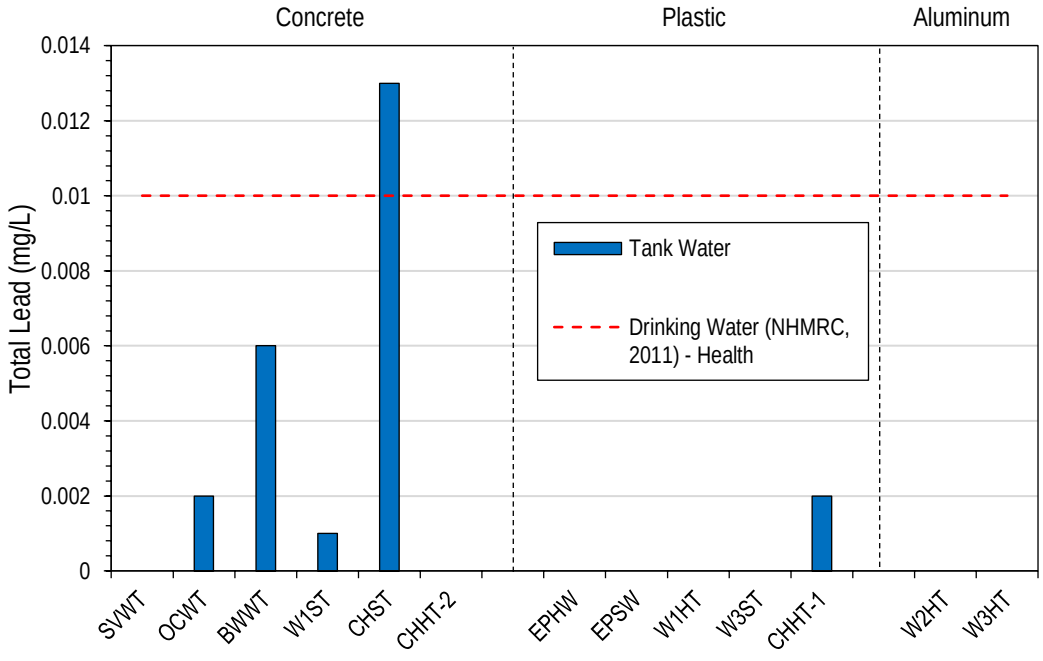

Figure D-35 Total lead concentrations (mg/L) in tank water samples compared with Australian drinking water health guidelines. Note the exceedance in sample CHST.

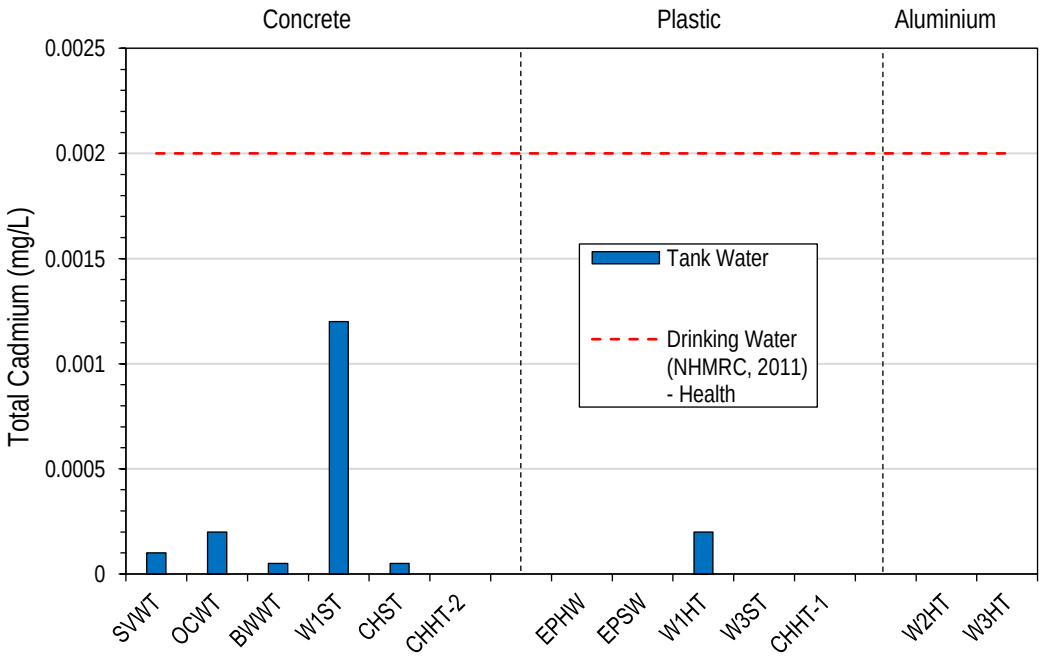

Figure D-36 Total cadmium concentrations (mg/L) in tank water samples compared with Australian drinking water health guidelines.

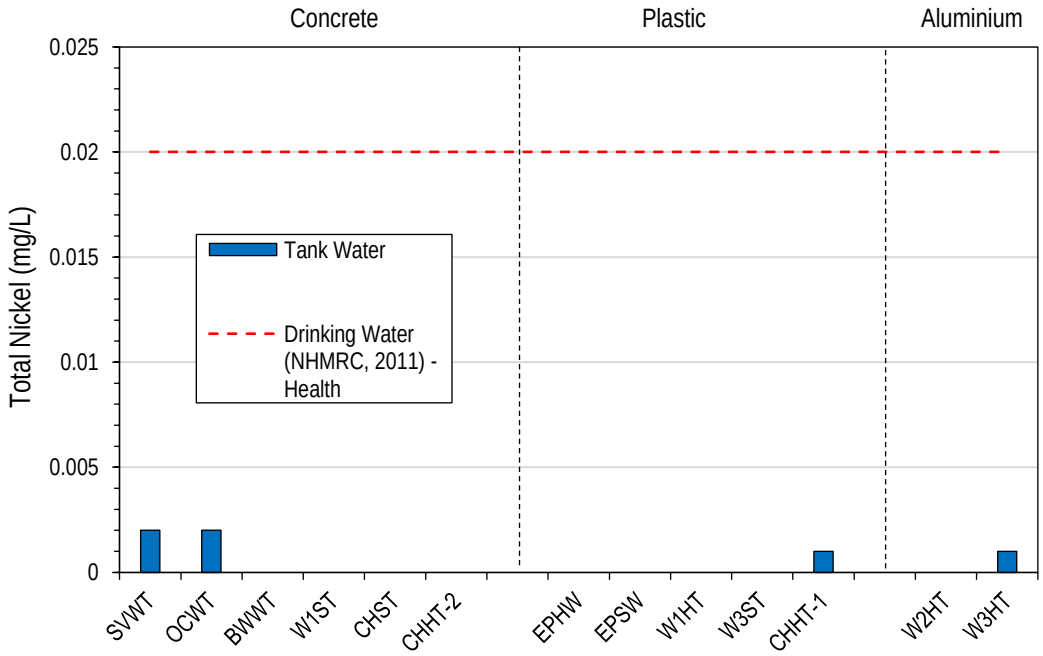

Figure D-37 Total nickel concentrations (mg/L) in tank water samples compared with Australian drinking water health guidelines.

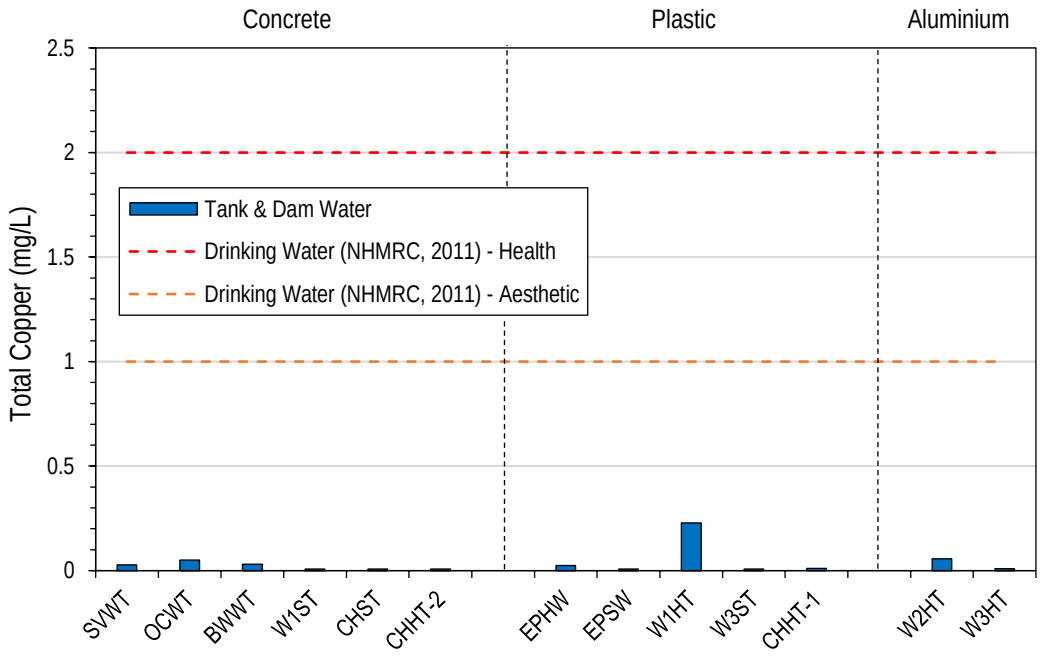

Figure D-38 Total copper concentrations (mg/L) in tank water samples compared with Australian drinking water aesthetic (taste) and health guidelines.

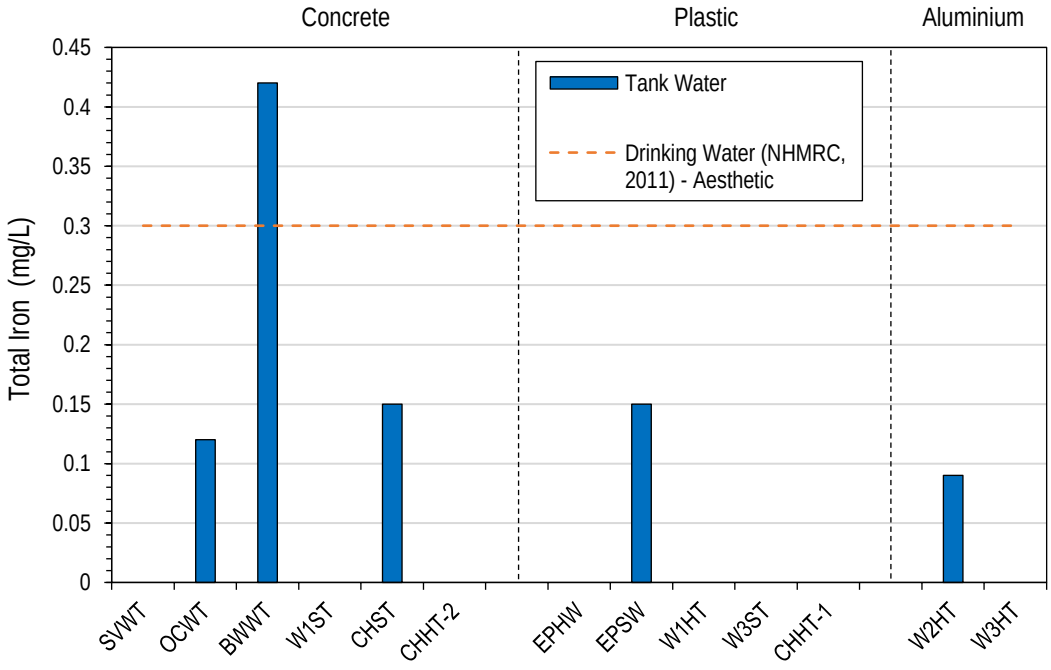

Figure D-39 Total iron concentrations (mg/L) in tank water samples compared with Australian drinking water aesthetic (taste) guidelines.

DAM WATER SAMPLES

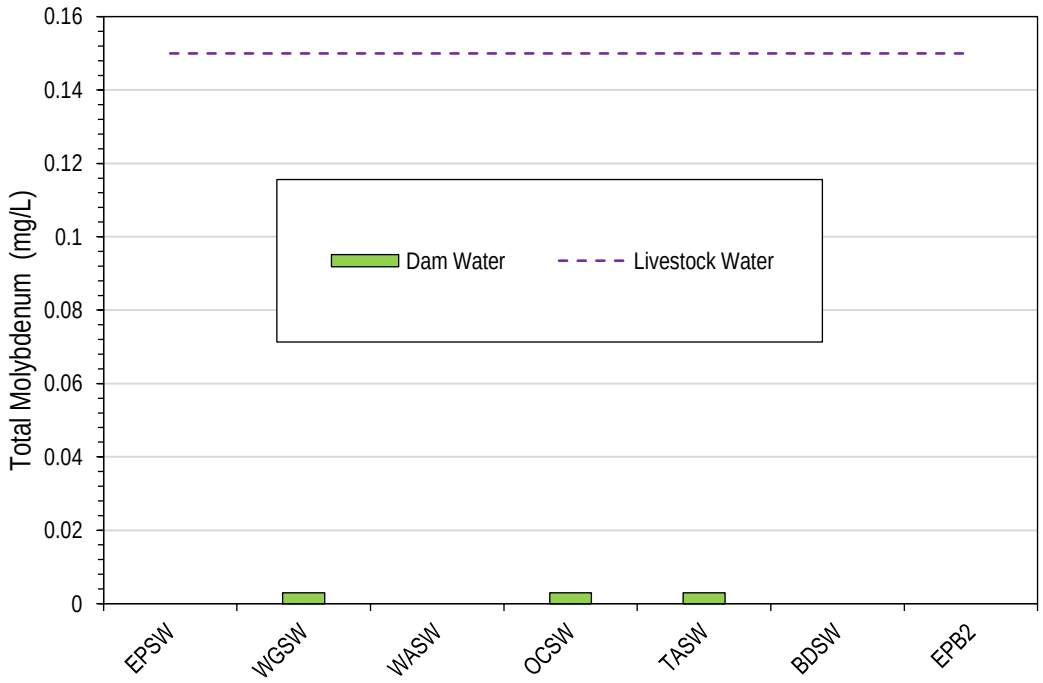

Figure D-40 Total molybdenum concentrations (mg/L) in dam water samples compared with Australian livestock water, and irrigation and general use trigger values.

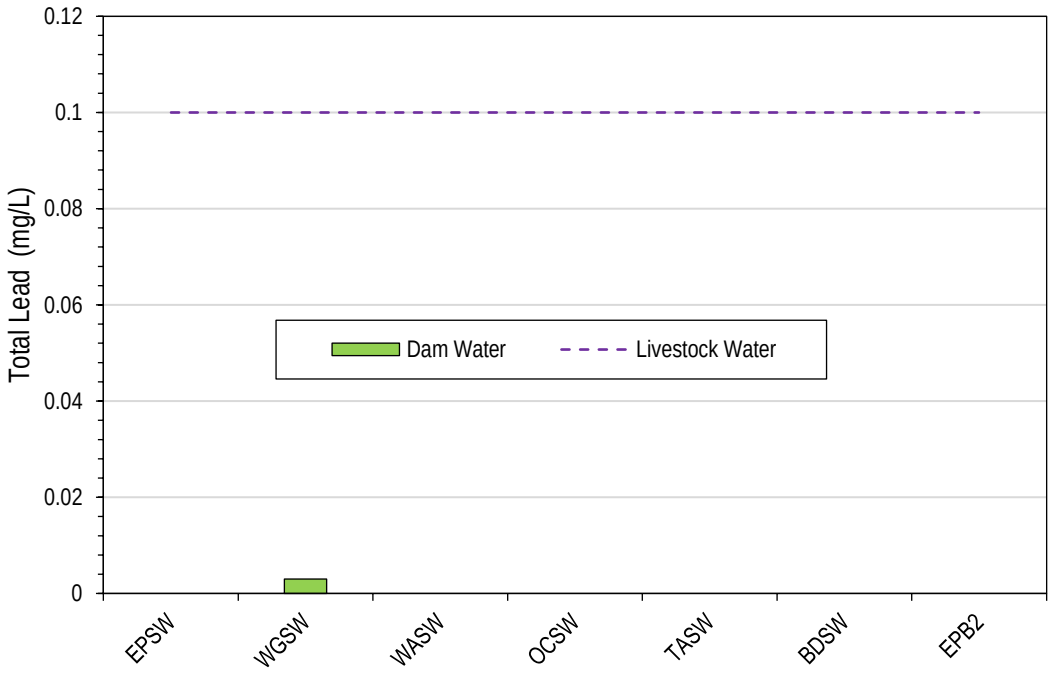

Figure D-41 Total lead concentrations (mg/L) in dam water samples compared with Australian livestock water trigger values (ANZECC, 2000).

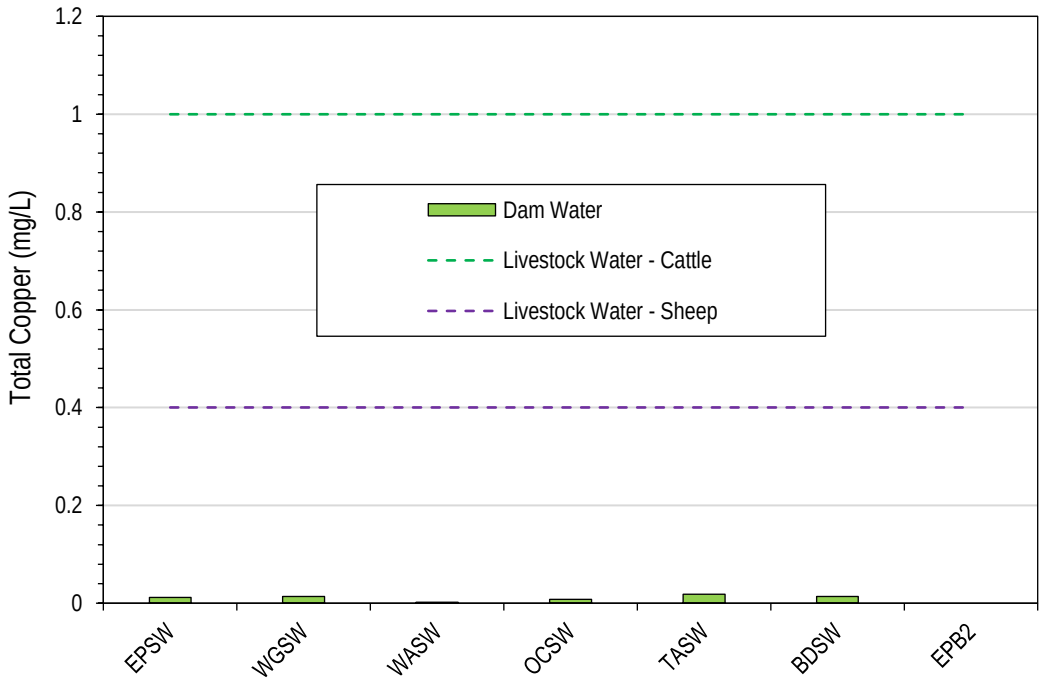

Figure D-42 Total copper concentrations (mg/L) in dam water samples compared with Australian livestock (cattle and sheep) as well as long term irrigation and general use water trigger values.

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Appendix B. HSE Materials Hazard Assessment

THIS DOCUMENT MAY NOT BE REPRODUCED EXCEPT IN FULL

Cadia Valley Operations Tailings HSE Materials Hazard Assessment

Prepared by
Dr Sharann Johnson, PhD, COH, FAIOH
Callander & Johnson Consultancy Services Pty Ltd

May 2020 (updated June 2021 with water quality results)

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1. Introduction

This document was prepared for Cadia Valley Operations (CVO) to inform the Cadia Valley community about the health issues associated with wind-blown dust from the CVO tailings storage facilities.

This document focusses on the mineralogy, metal composition and chemicals present in surface tailings to assist in the understanding of potential impacts on the health of nearby communities.

This document, and a number of associated documents, assessed the health risk within the community by understanding the composition of the source dust from the tailings, the amount and nature of dust received within the community and the mechanisms of community exposure, e.g., via tank drinking water or inhalation of the respirable fraction of the dust.

2. Summary of Hazard Classification

A total of eight samples of the tailings material were collected from the two tailings storage facilities (the Northern Tailings Storage Facility, NTSF, and the Southern Tailings Storage Facility, STSF), with two of the samples being crustal material. The mineralogy, metals and percentage of the material in the respirable size fraction, referred to as PM10 (i.e., particulate matter less than 10 micrometres in aerodynamic diameter) were all assessed.

The United Nations Globally Harmonised System of Classification and Labelling of Chemicals (GHS) was used to determine the health, safety and environmental (HSE) hazards associated with these components of the tailings. The protocols and guidelines of the GHS ensure a consistent approach to identifying hazardous materials, covered by legislation such as International Maritime Organization and road and rail transport codes for dangerous goods.

The findings of the assessment were:

- The metals concentrations in the tailings material were found to be very low, except for aluminum as aluminosilicate and iron, as iron-sulphur compounds. No metal was found in concentrations which would cause long-term or short-term health effects according to the GHS. Ongoing community air quality monitoring for metals will determine whether ambient air values are below community exposure guidelines.
- The PM10 component was within a range between 1.8 and 4.1 wt% of the tailings material, averaging 3.3 wt%. Ongoing community air quality monitoring for PM10 will determine whether ambient air values are below community exposure guidelines.
- In addition, ongoing community air quality monitoring for PM2.5 will further determine whether ambient air values are below community exposure guidelines.
- The respirable crystalline silica (RCS) component in the total tailings material was 0.23 wt%. In the PM10 component, silica was present at values ranging between 5.0 and 8.7 wt%, averaging 7.1 wt%. Ongoing community air quality monitoring for silica will determine whether ambient air values are below community exposure guidelines.
- The tailings material was not classified as hazardous to the health and safety of the aquatic environment using the GHS convention.

3. Tailings at Cadia Valley Operations

At CVO, the ore is mined underground and passes through a series of crushing and grinding units. The crushed ore is combined with water and organic chemicals to help frothing and separation in the flotation process. Cyanide is NOT used at CVO. The flotation process physically separates the copper and gold from the remainder of the processed ore which then goes to the tailings dam. The minerals are not chemically changed during the flotation process.

In summary, tailings are the materials that remain after the minerals (gold and copper) have been processed and removed for further downstream processing.

4. Methodology

Figure 1: Sampling sites for tailings at both Southern and Northern Tailings Storage Facilities at Cadia Valley Operations

Figure 2: Surface of tailings storage facility

Figure 3: Collection of tailings material for analysis

Tailings samples were collected from both tailings storage facilities in December 2019. Eight samples were collected, four samples from each storage facility (see Figure 1).

One crustal sample (20 mm) and three deeper samples (150 mm) were collected from each storage facility (see Figure 2 and Figure 3).

Tailings samples were analysed by X-ray diffraction (XRD) to identify the types of minerals present. This was completed for all samples and the PM10 size fractions by the Queensland University of Technology (QUT) Central Analytical Research Facility (Spratt 2020a and 2020b).

Elemental metal analysis and metal residue leachate analysis were completed by Australian Laboratory Services (ALS), Brisbane (ALS Certificate of Analysis EB2000092).

The results of the mineralogy and metal/elemental analyses have been used as the basis for the HSE hazard assessment in this document.

5. Hazard Assessment of Tailings Using the Globally Harmonised System (GHS)

The United Nations GHS convention specifies a number of testing protocols and the criteria requirements to classify the HSE hazards of chemicals and complex mixtures. It is a global system developed to ensure consistency in hazard classifications of materials, allow comparisons in the selection of chemicals / products, a basis for informed risks assessment and implementation of controls to ensure safe handling by users, including the transportation of dangerous goods. The various GHS HSE categories HSE have been listed in Appendix 1.

Refer to https://unece.org/about-ghs for further information on the GHS.

6. Mineral Composition of the Tailings

The mineral composition of the tailings is reported in Table 1. The two crustal samples, NTSF4 and STSF2, have been shaded in the table.

Table 1: QUT XRD Results on Tailings with % Composition of Minerals

	1	2	3	4	5	6	7	8	
Sample Number	**NTSF1**	**NTSF2**	**NTSF3**	**NTSF4**	**STSF1**	**STSF2**	**STSF3**	**STSF4**	**Average**
Mineral	wt%	wt%	wt%	wt%	wt%	wt%	wt%	wt%	**wt%**
Quartz	16.3	14.0	15.2	14.0	16.7	17.0	16.2	15.1	**15.6**
Anatase?[1]				0.4					
Magnetite	0.7	0.5	0.2	0.4	1.1	0.5	1.0	0.6	**0.6**
Pyrite	0.6	0.5	0.6	0.5	0.4	0.5	0.6	0.6	**0.5**
Calcite	3.7	3.2	3.4	3.3	3.4	3.4	3.8	3.8	**3.5**
Dolomite		0.3		1.7		0.5	0.2		**0.3**
Blodite				11.9					
Rhomboclase				0.9					
Gypsum	0.5	1.3	1.5	0.7	0.7	0.9	0.6	0.7	**0.9**
Amphibole					1.4		2.1		**0.4**
Plagioclase (An0-50)	30.1	26.0	29.3	23.9	30.9	29.3	31.4	29.0	**28.7**
Potassium feldspar	12.8	11.5	11.9	8.0	11.3	9.2	11.4	11.2	**10.9**
Laumontite				1.3					
Halite		0.5		0.4		0.8			**0.2**
Chlorite/Clinochlore	10.5	10.1	11.3	9.5	12.6	10.6	15.7	14.7	**11.9**
Illite/Mica (TOTAL)	19.8	19.8	19.5	15.6	18.9	18.7	16.3	18.7	**18.4**
Amorphous (non-crystalline)	5	12.5	7	7.6	2.7	8.6	0.9	5.7	**6.3**
Total									**98.3**

The major crystalline minerals present were plagioclase feldspar (av. 28.7 wt%), illite/mica (av. 18.4 wt%), quartz (av. 15.6 wt%), chlorite/clinochore (av. 11.9 wt%) and potassium feldspar (av. 10.9 wt%) making up over 80 wt% of each sample. The amorphous component, made of non-crystalline materials such as clays, varied between 0.9 wt% and 12.5 wt% of the tailings.

The major minerals reported, plagioclase feldspar, illite/mica, chlorite/clinochore and potassium feldspar, are aluminosilicates which are found widely in the Earth's crust. A short summary about their properties and uses has been included in Appendix 2. These minerals are not classified as hazardous according to GHS protocols.

The mineral quartz, and in particular crystalline silica (a component of quartz), may be hazardous when people are repeatedly exposed to airborne respirable crystalline silica (RCS) at concentrations which exceed the legislated occupational exposure standard published by Safe Work Australia, http://hcis.safeworkaustralia.gov.au/ExposureStandards. This is discussed in more detail in Section 8.

Amphibole minerals were reported in two samples, STSF1 and STSF3. Further analysis of these samples determined that there were no asbestos or asbestiform minerals present (ALS Certificate of Analysis ES2016687).

[1] QUT reported a weak peak in the X-ray diffraction pattern which they tentatively identified as Anatase.

7. Mineralogical Composition of the PM10 Fraction of the Tailings

The eight tailings samples were separated into a two size fractions – PM10 and larger than PM10. PM10 particles have the potential to travel deep into the lungs effecting health. The PM10 fraction of the tailings samples was in the range of 1.8 to 4.1 wt%, averaging 3.25 wt% (see Table 2).

The two crustal samples, NTSF4 and STSF2, have been shaded in the following tables.

Table 2: QUT Results for the Percentage of PM10 in the Tailings

	1	2	3	4	5	6	7	8	
Sample Number	**NTSF1**	**NTSF2**	**NTSF3**	**NTSF4**	**STSF1**	**STSF2**	**STSF3**	**STSF4**	**Average**
PM10 wt%	3.989	2.773	2.330	1.843	4.003	3.091	3.902	4.105	**3.2545**

The mineralogy of the PM10 fraction as measured by XRD analysis, is reported in Table 3 with a summary of the major components reported in Table 4.

The major components of the PM10 fraction were plagioclase feldspar, illite/mica, chlorite/ clinochore and potassium feldspar, which are major crustal compounds found in soils. These materials can be referred to as aluminosilicates, all containing different forms of aluminium, silica, oxygen with various metals. These minerals are not classified as hazardous.

There were no asbestiform minerals present in this size fraction.

Table 3: QUT XRD Mineral Analysis of the PM10 Fraction of the Tailings

	1	2	3	4	5	6	7	8	
Sample Number	**NTSF1**	**NTSF2**	**NTSF3**	**NTSF4**	**STSF1**	**STSF2**	**STSF3**	**STSF4**	**Average**
Mineral	wt%	wt%	wt%	wt%	wt%	wt%	wt%	wt%	**wt%**
Quartz	6.6	6.5	7.5	5.0	7.4	7.9	8.2	7.7	**7.1**
Hematite	0.8				1.1		1.2	1.1	**0.5**
Magnetite									
Pyrite									
Calcite	2.6	1.0	1.0	0.8	1.8	0.3	1.9	1.9	**1.4**
Anhydrite	1.6	3.2	2.4	2.3	2.2	2.1	1.5	1.4	**2.1**
Glauberite				3.8					
Bassanite						3.7			
Gypsum						2.5			
Amphibole							1.8		
Plagioclase (An0-50)	22.5	19.6	21.1	11.7	25.6	19.7	28.7	23.6	**21.6**
Potassium feldspar	10.1	9.4	8.7	4.2	11.9	6.5	12.7	10.7	**9.3**
Laumontite							0.7		
Halite		3.0	0.7	1.8	0.7	2.4			**1.1**
Chlorite/Clinochlore	9.6	6.8	8.6	6.5	9.9	7.6	10.6	12.4	**9.0**
Illite/Mica (TOTAL)	25	23.5	23.5	12.7	25.6	16.4	26.7	23.7	**22.1**
Amorphous (non-crystalline)	21.2	26.9	26.6	51.2	13.9	31.1	6.1	17.5	**24.3**
Total									**96.4**

Table 4: Major Minerals Present in the PM10 Fraction of the Tailings

Mineral	Type of Compound Present	Range wt%	Average wt%
Quartz	Crystalline Silicon Dioxide	5.0 – 8.2	**7.1**
Hematite	Iron Oxide	0.8 – 1.2	**0.5**
Calcite	Calcium Carbonate	0.3 – 2.6	**1.4**
Anhydrite	Anhydrous Calcium Sulphate	1.4 – 3.2	**2.1**
Plagioclase	Sodium and Calcium Aluminosilicates	11.7 – 28.7	**21.6**
K-Feldspar	Potassium Aluminosilicates	4.2 – 12.7	**9.3**
Halite	Sodium Chloride (Rock salt)	0.7 – 3.0	**1.1**
Chlorite	Iron-Magnesium hydrous aluminosilicates	6.5 – 12.4	**9.0**
Illite / Mica	Iron-Magnesium hydrous aluminosilicates	12.7 – 26.7	**22.1**
Amorphous	Not crystalline	6.1 – 51.2	**24.3**

Metal Sulphide Mineralogy in the Tailings

In Table 1 and Table 3, the key primary mineral constituents within surface tailings deposits were dominated by quartz, potassium feldspar, plagioclase feldspar, chlorite, potassium mica and calcite, with minor to trace quantities of magnetite, pyrite, amphibole, gypsum, dolomite, anatase and halite. Almost all of these phases are common rock-forming minerals that remain largely unreactive under most conditions at the Earth's surface.

A small number of these minerals were less widespread and were specifically associated with the copper mineralisation at CVO. These included the metal sulphur minerals, pyrite, chalcopyrite, bornite, galena, sphalerite and molybdenite, present at very low levels. Pyrite, chalcopyrite and bornite were the main reactive mineral phases in the tailings, and only pyrite was currently detectable in the surface tailings material. Pyrite is considered reactive as it can slowly decompose in the presence of atmospheric oxygen to generate sulfuric acid. The concentration of pyrite in surface tailings permits acid to form, but the abundance of neutralising minerals containing calcium, potassium and magnesium (calcite, ankerite, dolomite, and feldspar) ensures that all of the acid is neutralised. Hence, the upper several centimetres of the tailings storage facilities can undergo slow and selective decomposition.

During a rainfall event, the decomposition products largely dissolve, even in small volumes of water, generally producing near neutral, sulphate-rich saline porewater. Over the following drier days, capillary action can cause the water to rise to the tailings surface, and with evaporation of the water causes concentration and subsequently, crystallisation into highly soluble, low density (secondary) salts / minerals as fields of crystal migration to the surface of the tailings.

These secondary salts include blodite, rhomboclase, gypsum, bassanite, anhydrite, glauberite and probably some non-crystalline material. Information about the chemistry as well as concentrations have been included in Table 5. The levels found were generally low and not present in all samples.

The rate of production of these salts is generally slow and influenced by how far air can penetrate into the tailings deposits to form acid from pyrite oxidation. As low-density surface salts, these phases will be mobilised into the air during significant wind events, relative to the other rock forming minerals.

Table 5: Minor Secondary Salt Minerals Present in the Tailings Minerals Analysis

Mineral	Type of Compound Present	Chemical Formula	Range wt%
Blodite	Sodium Magnesium Sulphate	$Na_2Mg(SO_4).4H_2O$	ND – 11.9
Rhomboclase	Sulphated Iron Oxide	$H_5FeO_2(SO_4)_2.2H_2O$	ND – 0.9
Gypsum	Calcium Sulphate	$CaSO4.2H_2O$	0.5 – 1.5
Bassanite	Calcium Sulphate	$CaSO4.H_2O$	ND – 0.13*
Anhydrite	Calcium Sulphate	$CaSO_4$	0.06 – 0.11*
Glauberite	Sodium, Calcium Sulphate	$Na_2Ca(SO_4)_2$	ND – 0.13*

ND – not detected.
* Calculated from PM10 to complete tailings sample.

From a chemical perspective, these ultra-thin, temporary crystalline carpets across the surface of the tailings deposits are not inherently hazardous. When mobilised as solids during windy periods, they have the potential to contribute sulphate and chloride salinity to local water sources such as local waterways, farm dams and drinking water supplies from roof water.

The metal analyses of the tailing samples have been reported in Table 6, and a number of metals such as copper, zinc, molybdenum, antimony and arsenic were found at trace levels. These may combine with the sulphate and chloride compounds discussed above. Hence, these may be a potential source of low-level contribution of metals to local water sources. To confirm this, a targeted survey of water quality from local water supply tanks and from farm dams was undertaken. The results of the water quality sampling are detailed in Appendix 3.

All metal concentrations levels were below Australian Drinking Water Guidelines[2] and ANZECC livestock drinking water quality guidelines[3] except two values for lead and one value for cadmium marginally higher than the drinking water guidelines. The two locations where the lead values slightly exceeded the guidelines were resampled. Lead was below the drinking water guidelines for the second set of samples. Where cadmium slightly exceeded the drinking water guidelines, this was attributable to contamination from galvanised steel roofing or guttering.

8. Respirable Crystalline Silica (RCS)

For many years, it has been known that prolonged inhalation of RCS dust may cause a specific type of lung damage called silicosis. Although silicosis has been recognised for centuries, its links to lung cancer have become more well understood over the past two decades.

IARC, the International Agency for Research on Cancer, an agency of the World Health Organization (https://www.iarc.fr/), is the premier international expert group which undertakes classification of carcinogens. In 1987, IARC evaluated RCS as a probable human carcinogen for the first time,

[2] *Australian Drinking Water Guidelines Paper 6 National Water Quality Management Strategy*, version 3.6, updated March 2021, National Health and Medical Research Council, National Resource Management Ministerial Council, Commonwealth of Australia, Canberra.

[3] *Australian and New Zealand guidelines for fresh and marine water quality. Volume 1: The guidelines*, Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, October 2000, Canberra.

and in 1997 concluded on the basis of literature review that inhaled RCS from occupational sources is carcinogenic to humans. In 2012, IARC confirmed its conclusions as: '*Crystalline silica in the form of quartz or cristobalite dust is carcinogenic to humans*'.

The industry group, IMA - Europe (https://safesilica.eu/) report that, despite the ubiquitous presence of crystalline silica in the environment, specific health effects of RCS only appear at the workplace not in the general environment. It is widely believed that the risk of developing silicosis from environmental exposure is extremely low. However, despite this widely held view and IMA - Europe's assertion, there have been reported instances in the literature of non-occupational cases of silicosis.[4] Notwithstanding, given the further discussion on RCS below; it is highly unlikely that this is a risk posed by CVO.

The fine fraction of crystalline silica is the relevant fraction which, if made airborne, can potentially reach the deep lung, as defined by EN 481[5]. These are particles less than 10 micrometres in particle size (PM10).

IMA - Europe has established international silica classification criteria to allow manufacturers to classify products, substances and mixtures containing quartz in relation to the hazards of RCS whether in the form of an identified impurity, additive or individual constituent.

Materials with less than 1 % *fine* (PM10) are determined as not requiring a health hazard classification.

The GHS classification system has a category STOT - RE, which refers to *Specific Target Organ Toxicity - Repeated Exposure*. This relates to the health effects of RCS exposure on lung tissue.

The IMA - Europe health hazard criteria are listed below:

- STOT - RE 1, if the quartz (fine fraction) or cristobalite (fine fraction) concentration is equal to, or greater than 10%
- STOT - RE 2, if the quartz (fine fraction) or cristobalite (fine fraction) concentration is between 1 and 10%
- If the quartz (fine fraction) or cristobalite (fine fraction) in mixtures and substances is below 1%, no classification is required.

The concentration of quartz, also referred to as crystalline silica, in the PM10 fraction of the tailings was in the range 5.0 to 8.7 wt%, averaging 7.1 wt%. Using 7.1 wt% of RCS in a fraction that was 3.25 wt% of the total tailings material, the RCS content of the tailings would represent 0.23 wt%, of the total tailings sample – (3.25 X 7.1)/100.

Based upon this review, the tailings material is not classified as a health hazard with respect to RCS.

[4] See Bridge I (2009) Crystalline silica: A review of the dose response relationship and environmental risk, *Air Quality and Climate Change* **43(1)**, pp 17-23.

[5] European Standard EN 481 (1993) *Workplace Atmospheres - Size Fraction Definitions for Measurement of Airborne Particles*.

9. Metals Present in the Tailings

Metal concentrations found in the tailings material are reported in Table 6 (the two crustal samples, NTSF4 and STSF2, have been shaded orange in the table). Thirty metals were analysed using the ICP-MS chemical analysis technique, as well as ICP-AES for aluminium, boron and iron content.

Table 6: Metals Analysis of the Tailings

	1	2	3	4	5	6	7	8	
Sample No.	**STF1**	**STF2**	**STF3**	**STF4**	**NTSF1**	**NTSF2**	**NTSF3**	**NTSF4**	**Average**
Metal	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Aluminium	13700	10200	13700	14500	12700	13200	11900	10900	**12600**
Arsenic	2.6	2.4	3.1	3.7	3.6	4.1	4.4	3.7	**3.5**
Antimony	0.2	0.2	0.2	0.1	0.1	0.2	0.2	0.2	**0.2**
Barium	22.8	16.4	20.9	22.6	38.6	29.6	26.6	23.9	**25.2**
Beryllium	0.3	0.2	0.3	0.4	0.3	0.3	0.3	0.2	**0.3**
Bismuth	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.1	**0.2**
Boron	<50	<50	<50	<50	<50	<50	<50	<50	**<50**
Cadmium	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	**<0.1**
Calcium	2450	2270	1780	2170	830	2740	2500	2320	**2132**
Chromium	32.9	21.4	39.4	37.6	30.4	33.7	26.7	24.5	**30.8**
Cobalt	10.8	9.2	12.9	14	11.4	11.4	11.4	10	**11.4**
Copper	444	429	457	607	490	458	610	488	**498**
Iron	26100	20700	26900	28000	25200	26000	23800	21700	**24800**
Lead	2.5	2	3.2	4	4.2	5.3	4	4.1	**3.7**
Lithium	16	12.4	15.2	16	14.5	15.7	14.6	14.3	**14.8**
Magnesium	840	6150	920	140	680	2160	2140	7740	**2596**
Manganese	294	254	287	299	283	325	283	274	**287**
Molybdenum	7.9	36.1	10.3	9.2	9	15.9	11.6	33.5	**16.7**
Nickel	13.2	9.1	14.5	15.3	12.7	14.6	11.8	11.5	**12.8**
Potassium	1220	5680	1350	620	750	2130	2270	5790	**2476**
Sodium	4890	20700	4320	3640	2270	8540	9660	21300	**9415**
Selenium	1	4	1	1	1	2	<1	2	**1.5**
Silver	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	**0.2**
Strontium	101	203	90.4	120	84.1	142	218	219	**147**
Thallium	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	**<0.1**
Thorium	1.8	1.5	1.6	1.8	1.9	1.8	1.8	1.5	**1.7**
Tin	0.5	0.3	0.5	0.8	0.6	0.6	0.5	0.5	**0.5**
Uranium	0.4	0.4	0.4	0.4	0.4	0.5	0.4	0.6	**0.4**
Vanadium	77	54	79	83	68	74	64	59	**70**
Zinc	24.7	19.2	23.4	26.4	22.9	26.5	25.9	21.8	**24**

The health and environmental effects of the metals found were determined by understanding the toxicity and concentration of the metal complexes present in addition to the solubility of the metal compounds.

Metals which were present at greater than 0.1% (1000 ppm) have been shaded in blue and include: aluminium, calcium, iron, magnesium, potassium and sodium. These metals have a low order of toxicity and are widely found in soil.

Metals considered potentially hazardous from a health consideration are listed in Table 8 in Section 10.

10. Human Health Effects Classification of the Tailings Based on Metals

Table 7: IARC Classification of Carcinogens

Classification	Meaning	Number of Agents Classified
Group 1	Carcinogenic to humans	121 agents
Group 2A	Probably carcinogenic to humans	89 agents
Group 2B	Possibly carcinogenic to humans	315 agents
Group 3	Not classifiable as to its carcinogenicity to humans	497 agents

Table 8: Metal Concentrations in the Tailings and Carcinogenicity Classification

Metal	IARC Classification	Concentration	Range in CVO Tailings	Average
Aluminium	Not Classified	ppm	10200 – 14500	**12600**
Arsenic	Group 1	ppm	2.4 – 4.4	**3.5**
Barium	Not Classified	ppm	16.4 – 38.6	**25.2**
Cadmium	Group 1	ppm	<0.1	**<0.1**
Chromium	Group 1	ppm	21.4 – 39.4	**30.8**
Cobalt	Group 2B	ppm	9.2 – 14	**11.4**
Copper	Not Classified	ppm	429 – 601	**497.9**
Iron	Not Classified	ppm	20700 – 28000	**24800**
Lead	Group 2B	ppm	2.0 – 5.3	**3.7**
Lithium	Not Classified	ppm	2.4 – 16.0	**14.8**
Manganese	Not Classified	ppm	254 – 299	**287.4**
Molybdenum	Not Classified	ppm	7.9 – 36.1	**16.7**
Nickel	Group 1	ppm	9.1 – 15.3	**12.8**
Strontium	Not Classified	ppm	90.4 – 219	**147.2**
Vanadium	Not Classified	ppm	54 – 83	**69.8**
Zinc	Not Classified	ppm	19.2 – 26.5	**23.9**

Blue shading indicates metals present at a concentration greater than 0.1% (1000 ppm).

The classification of carcinogens undertaken by IARC is listed in Table 7.

A Group 1 classification means the evidence strongly indicates the agent is a human carcinogen and Group 2B means the agent is a possible human carcinogen because of limited evidence of carcinogenicity in humans.

Metals classified as having the potential to cause cancer are arsenic (As), cadmium, (Cd) chromium VI (Cr VI), cobalt (Co), lead (Pb) and nickel (Ni). The criterion used to classify mixtures containing carcinogenic chemicals or metals, is a concentration of the chemical or metal greater than 0.1% (1000 ppm).

The metals (As, Cd, Cr VI, Co, Pb and Ni) associated with cancer that were present in the tailings samples were all below 0.1%. The concentrations were less than 0.001%, except chromium (assuming the worst-case chromium VI), which was less than 0.01%. At these concentrations, arsenic, cadmium, chromium, cobalt, lead and nickel would not result in the tailings being classified as a carcinogenic material.

Aluminium and iron were metals with concentrations greater than 1000 ppm and are shaded blue in Table 8. These metal complexes, predominately aluminosilicates and iron - sulphur compounds which have low water solubility, are not classified as hazardous to health.

Table 9: MeClas Results for the Tailings

Health & Environment Legislation	GHS Classification		EU Waste Hazard Properties	Classification
Acute toxicity - oral	Not classified		Acute toxicity	Not classified
Acute toxicity – dermal	Not classified		Corrosive	Not classified
Acute toxicity - inhalation	Not classified		Irritant -skin irritation and eye damage	Not classified
Skin corrosion/irritation	Not classified		Sensitizing	Not classified
Serious eye damage/eye irritation	Not classified		Mutagenic	Not classified
Respiratory/skin sensitization	Not classified		Carcinogenic	Not classified
Germ cell mutagenicity	Not classified		Toxic to reproduction	Not classified
Carcinogenicity	Not classified		Specific target organ toxicity (STOT)/ Aspiration	Not classified
Reproductive toxicity	Not classified		Ecotoxic	Not classified
Specific target organ toxicity (STOT) – single exposure	Not classified			
Specific target organ toxicity (STOT) – repeated exposure	Not classified			
Aspiration hazard	Not classified			
Hazardous to the aquatic environment - ACUTE	Not classified			
Hazardous to the aquatic environment - CHRONIC	Not classified			

The United Nations GHS has established protocols and guidelines for assessing HSE hazards of materials. The GHS and the European Commission 2008 Regulation (EC) No. 1272/2008 on classification, labelling and packaging of substances and mixtures (CLP) as it applies to metals and minerals has been used to develop a process called MeClas (http://www.meclas.eu/), specifically designed for classifying ore bodies, mineral concentrates and waste materials based on metals and mineralogy. It takes into account the toxicity of the metals, and the concentration and solubility of the metallic minerals. The MeClas test results for the tailings material based on the metal composition are listed in Appendix 4. The specific MeClas results are listed in Table 9.

The tailings material, using the MeClas assessment process, was found to be classified as non-hazardous to the health and safety of people and environmental aquatic toxicity categories. A *not classified* determination, indicates that these guidelines are not triggered for the listed United Nations GHS and European Union Waste Hazards Properties in Table 9.

11. Hydrocarbon Compounds Found in the Tailings

The hierarchy of control of risks by eliminating hazardous chemicals is part of the process in selecting any new materials coming onto the Cadia site to protect workers, the community and the environment.

The organic chemicals and the small amount of diesel used in the flotation process are selected to be the least hazardous, both from a worker health and safety perspective and environmental impact consideration. These chemicals are recycled in the process circuit and broken down during this processing.

The organic chemistry analyses undertaken on the tailings samples found low level hydrocarbon compounds were present. There were eight unidentified hydrocarbon compounds reported adding to 33 ppm in total. These hydrocarbons were reported as alkanes, which are considered to be low hazard hydrocarbons. None of the traditionally carcinogenic hydrocarbon compounds were identified as being present, such as polycyclic aromatic hydrocarbons or benzene.

12. Dust Suppressant Chemicals Used to Coat the Surface of the Tailings Storage Facilities

During 2019, a project was undertaken to top coat the surface of the tailings storage facilities with dust suppressant agents to reduce dust generation. According to the GHS, these products (listed below) are non-hazardous. The products used were:

- Erizon - FibreLoc, Wood Mulch Fibre
- Erizon - Ecobond
- Erizon - Product 4000077.

The information extracted from the product information sheets and safety data sheets is listed in Table 10.

Table 10: Summary of Dust Suppressant Product Information and Safety Data Sheets (SDS)

	Product Name	Supplier	Description	Composition	Information	Classification	SDS
1	Product 4000077	Erizon	Dust suppression	Blue/Green emulsion, water soluble polymer surfactant blend	pH 4 to 6 / Opaque white/grey liquid Toxicity to Fish: LC50>96 mg/L Oral Toxicity LD50 (Rat): >5000 mg/kg Acute Bacterial Toxicity: EC0>100 mg/L	Not Classified by GHS / Poison Schedule 5	Yes
2	FibreLoc, Wood Mulch Fibre	Erizon		100% wood fibre Interlocking organic wood fibres incorporated by stronghold environmentally sustainable binders. Phyto-Sanitised to eliminate potential weed seeds and pathogens Natural Green Marker Dye added.	,	Not Classified by GHS	General Product Information Sheet
3	Ecobond	Erizon	Ecobond Hydromulch Binder	100% naturally occurring polymers, nontoxic biopolymers. Binds wood mulch and seeds to the surface.		Not Classified by GHS	General Product Information Sheet

Glossary of Terms and Abbreviations

aerodynamic diameter	the diameter of a hypothetical sphere of density 1 g/cm^3 having the same terminal settling velocity in calm air as the particle in question, regardless of its geometric size, shape and true density.
aesthetic guideline	a value, which is the concentration or measure of a water quality characteristic that is associated with acceptability of water to the consumer; for example, appearance, taste and odour
ALS	Australian Laboratory Services
ambient air	the air in the general outdoors atmosphere
Australian Drinking Water Guidelines	NHMRC, NRMMC (2011) *Australian Drinking Water Guidelines Paper 6 National Water Quality Management Strategy*, version 3.6, updated March 2021, National Health and Medical Research Council, National Resource Management Ministerial Council, Commonwealth of Australia, Canberra.
ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
CLP	Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006.
CVO	Cadia Valley Operations
EC	European Commission
EU	European Union
g/cm^3	grams per cubic centimetre
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
health-based guideline	a value, which is the concentration or measure of a water quality characteristic that, based on present knowledge, does not result in any significant risk to the health of the consumer over a lifetime of consumption
HSE	health, safety and environment
IARC	International Agency for Research on Cancer
IMA - Europe	Industrial Minerals Association – Europe
livestock drinking water guidelines	*Australian and New Zealand guidelines for fresh and marine water quality. Volume 1: The guidelines*, ANZECC and ARMCANZ, October 2000, Canberra.
MeClas	A web-based tool used to generate toxicity hazard categories and corresponding classification and labelling information of inorganic metal-containing complex materials such as ores, concentrates, intermediates or alloys using the GHS/CLP rules.
mg/kg	milligrams per kilogram (same as ppm for solids)
mg/L	milligrams per litre (same as ppm for liquids)
micrometre	one thousandth of a metre
micron	see micrometre
NHMRC	National Health and Medical Research Council

NRMMC	National Resource Management Ministerial Council
NTSF	Northern Tailings Storage Facility
PM10	particulate matter less than 10 micrometres in aerodynamic diameter
PM2.5	particulate matter less than 2.5 micrometres in aerodynamic diameter
ppm	parts per million (by volume for liquids – mg/L – and by weight for solids – mg/kg)
QUT	Queensland University of Technology
RCS	respirable crystalline silica
SDS	safety data sheet
STOT-RE	Specific Target Organ Toxicity - Repeated Exposure
STSF	Southern Tailings Storage Facility
wt%	weight percent – the weight of the thing being measured present in every 100 grams of total material
XRD	X-ray diffraction analysis

References

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Appendix 1. GHS Safety, Health and Environmental Hazard Classification Categories

Physical	Explosives
	Flammable gases/aerosols/liquid/solids
	Oxidizing gases/liquids/solids
	Gases under pressure
	Self-reactive substances and mixtures
	Pyrophoric liquid/solid
	Self-heating substances and mixtures
	Substances and mixtures which on contact with water emit flammable gases
	Organic peroxides
	Corrosive to metal
Human Health	Acute toxicity (via the oral, dermal, inhalation route)
	Skin corrosion/irritation
	Serious eye damage/eye irritation
	Respiratory/skin sensitization
	Germ cell mutagenicity
	Carcinogenicity
	Reproductive toxicity
	Specific target organ toxicity (STOT) – single exposure (SE)
	Specific target organ toxicity (STOT) – repeated exposure (RE)
	Aspiration hazard
Environmental	Hazardous to the aquatic environment
	Hazardous to the ozone layer

Appendix 2. Information about Major Minerals Identified in the Tailings

Feldspar

Feldspar is by far the most abundant group of minerals in the Earth's crust, forming about 60% of terrestrial rocks.

The term feldspar encompasses a whole range of materials. Most of the products we use on a daily basis are made with feldspar: glass for drinking, glass for protection, glass wool for insulation, the floor tiles and shower basin in our bathroom, the tableware from which we eat. Feldspar minerals are essential components in igneous, metamorphic and sedimentary rocks, to such an extent that the classification of a number of rocks is based on feldspar content.

Based on their chemical composition, feldspars can be subdivided into two mineral groups – plagioclase feldspars and potassium feldspars. Plagioclase feldspars are a continuous mineral series in which calcium and sodium substitute for one another in the same crystal structure. Because they share a similar crystal structure, all the plagioclase varieties exhibit very similar properties and in the field are often only identified as *plagioclase*. Plagioclase minerals are typically white or gray, hard blocky crystal masses that exhibit cleavage in two directions that are nearly at right angles. They are particularly common in igneous and metamorphic rocks, where they often form the bulk of the rock's volume.

The mineralogical composition of most feldspars can be expressed in terms of the ternary system orthoclase ($KAlSi_3O_8$), albite ($NaAlSi_3O_8$) and anorthite ($CaAl_2Si_2O_8$). Chemically, the feldspars are silicates of aluminium, containing sodium, potassium, iron, calcium, or barium or combinations of these elements.

Plagioclase

Plagioclase is the name of a group of **feldspar minerals** that form a solid solution series ranging from pure albite, $Na(AlSi_3O_8)$, to pure anorthite, $Ca(Al_2Si_2O_8)$. Plagioclase minerals are important constituents of some building stone and **crushed stone** such as **granite** and **trap rock**. These rocks are also cut and polished for use as countertops, stair treads, wall panels, building facing, monuments, and many other types of decorative and architectural stone.

Many decorative igneous and metamorphic building stones are composed primarily of plagioclase minerals. The plagioclase component of these stones is hard enough, and resistant enough, to maintain a polish and the varied distribution of plagioclase and other minerals creates the patterns prized in these stones. By volume, however, the most significant use of plagioclase is that it comprises much of the sand and gravel used as aggregate in concrete and asphalt. Large volumes of plagioclase are also mined and processed to create a wide variety of ceramics, ranging from pottery to industrial uses. Ground into powder, plagioclases are also used in the manufacture of paints, rubber, glass, plastics, and are even used as a mild cleaning abrasive.

Mica

Mica is a mineral name given to a group of minerals that are physically and chemically similar. They are all silicate minerals, known as sheet silicates, because they form in distinct layers. Micas are fairly light and relatively soft, and the sheets and flakes of mica are flexible. Mica is heat-resistant and does not conduct electricity. There are 37 different mica minerals which differentiate from each other, primarily, by atom substitutions or vacancies in the crystal lattice.

The principal use of ground mica is in gypsum wallboard joint compound, where it acts as a filler and extender, provides a smoother consistency, improves workability, and prevents cracking. In the paint industry, ground mica is used as a pigment extender which also facilitates suspension due to its light weight and platy morphology. The ground mica also reduces checking and chalking, prevents shrinkage and shearing of the paint film, provides increased resistance to water penetration and weathering, and brightens the tone of coloured pigments. Ground mica also is used in the well-drilling industry as an additive to drilling *muds*.

The plastic industry uses ground mica as an extender and filler and also as a reinforcing agent. The rubber industry uses ground mica as an inert filler and as a mould lubricant in the manufacture of moulded rubber products, including tires.

Sheet mica is used principally in the electronic and electrical industries. The major uses of sheet and block mica are as electrical insulators in electronic equipment, thermal insulation, gauge 'glass', windows in stove and kerosene heaters, dielectrics in capacitors, decorative panels in lamps and windows, insulation in electric motors and generator armatures, field coil insulation, and magnet and commutator core insulation.

Illite also includes glauconite (a green clay sand) and are the commonest clay minerals; formed by the decomposition of some micas and feldspars; predominant in marine clays and shales.

Appendix 3. Water Quality Results

Table 11: Drinking water quality guidelines (NHMRC 2011; ANZECC/ARMCANZ 2000)

Parameter	Australian drinking water guidelines (NHMRC 2011 updated March 2021)		Livestock drinking water guidelines (ANZECC/ARMCANZ 2000)
	Health-based (mg/L)	Aesthetic (mg/L)	(mg/L)
Aluminium (Al); acid-soluble	-	0.2	5
Ammonia (NH_3)	-	0.5	-
Antimony (Sb)	0.003	-	-
Arsenic (As)	0.01	-	0.5; up to 5 see Table 4.3.2 (ANZECC/ARMCANZ 2000)
Cadmium (Cd)	0.002	-	0.01
Calcium (Ca)	-	-	1000
Chloride (Cl^-)	-	250	-
Chlorine (Cl)	5	0.6	-
Chromium - total (Cr)	-	-	1
Chromium III (Cr^{3+})	-	-	-
Chromium VI (Cr^{6+})	0.05	-	-
Cobalt (Co)	-	-	1
Copper (Cu)	2	1	0.4 (sheep); 1 (cattle); 5 (pigs); 5 (poultry)
Electrical Conductivity (EC)	-	-	See Table 4.3.1 (ANZECC/ARMCANZ 2000)
Fluoride (F)	1.5	-	2
Iron (Fe)	-	0.3	-
Lead (Pb)	0.01	-	0.1
Magnesium (Mg)	-	-	ID
Manganese (Mn)	0.5	0.1	-
Molybdenum (Mo)	0.05	-	0.15
Nickel (Ni)	0.02	-	1
Nitrate (NO_3)	50	-	400
Nitrite (NO_2)	3	-	30
pH	-	6.5 - 8.5	-
Selenium (Se)	0.01	-	0.02
Silver (Ag)	0.1	-	-
Sodium (Na)	-	180	-
Sulphate (SO_4)	-	250	1000
Turbidity (NTU)	-	5	-
Total Dissolved Solids (TDS)	-	600	2000 (poultry); 2500 (dairy cattle); 4000 (pigs, horses, beef cattle); 5000 (sheep) See Table 4.3.1 (ANZECC/ARMCANZ 2000)
Total Suspended Solids (TSS)	-	-	-
Zinc (Zn)	-	3	20

Table 12: Drinking water quality for individual residences for May 2020

Sample ID			SVWT 20200507	OCWT 20200507	EPHWT 20200506	EPSWT 20200506	BWWT 20200506	W1HT 20200506	W1ST 20200506	W2HT 20200506	W3HT 20200506	W3ST 20200506	CHHT-1 20200506	CHST 20200506	CHHT-2 20200506
Tank material			Concrete	Concrete	Plastic	Plastic	Concrete	Plastic	Concrete	Zincalume steel	Zincalume steel	Plastic	Plastic	Concrete	Concrete
Tank type			House	House	House	Shed	House	House	Shed	House	House	Shed	House	Cottage	Paddock
Sampled from			Back door tap	Garage tap	Kitchen tap	Tank tap	Yard tap	Kitchen tap	Poly outlet near tank	Back door tap	Tank tap	Tank tap	Tank tap	Tank tap	Tank tap
Parameter	***Unit***	***LOR***													
Conductivity, dissolved and suspended solids															
Electrical Conductivity	µS/cm	1	168	32	58	6	37	15	72	11	10	14	19	33	80
Total Dissolved Solids	mg/L	10	89	26	34	<10	30	<10	51	<10	<10	10	<10	20	47
Suspended Solids	mg/L	5	<5	5	<5	10	6	7	7	<5	<5	6	<5	18	6
Alkalinity															
Bicarbonate Alkalinity as $CaCO_3$	mg/L	1	74	3	25	<1	15	5	33	<1	<1	3	4	13	34
Dissolved major anions															
Sulphate as SO_4	mg/L	1	4	3	<1	<1	1	<1	<1	<1	<1	<1	<1	<1	1
Chloride	mg/L	1	1	<1	2	<1	<1	<1	2	<1	<1	<1	<1	<1	<1
Dissolved major cations															
Calcium	mg/L	1	19	<1	4	<1	6	1	8	<1	<1	2	<1	4	11
Magnesium	mg/L	1	<1	<1	2	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Sodium	mg/L	1	2	<1	3	<1	<1	<1	2	<1	<1	<1	<1	<1	1
Potassium	mg/L	1	2	<1	<1	<1	<1	<1	2	<1	<1	<1	1	<1	2
Total metals															
Aluminium	mg/L	0.01	0.01	0.08	0.02	0.03	0.06	0.03	0.02	0.02	0.04	0.01	0.02	0.12	<0.01
Antimony	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	mg/L	0.0001	0.0001	0.0002	<0.0001	<0.0001	<0.0001	0.0002	0.0012	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.001	<0.001	0.006	0.003	<0.001	<0.001	<0.001	<0.001	0.002	0.002	0.001	<0.001	<0.001	<0.001
Cobalt	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

			Sample ID	SVWT 20200507	OCWT 20200507	EPHWT 20200506	EPSWT 20200506	BWWT 20200506	W1HT 20200506	W1ST 20200506	W2HT 20200506	W3HT 20200506	W3ST 20200506	CHHT-1 20200506	CHST 20200506	CHHT-2 20200506
			Tank material	Concrete	Concrete	Plastic	Plastic	Concrete	Plastic	Concrete	Zincalume steel	Zincalume steel	Plastic	Plastic	Concrete	Concrete
			Tank type	House	House	House	Shed	House	House	Shed	House	House	Shed	House	Cottage	Paddock
			Sampled from	Back door tap	Garage tap	Kitchen tap	Tank tap	Yard tap	Kitchen tap	Poly outlet near tank	Back door tap	Tank tap	Tank tap	Tank tap	Tank tap	Tank tap
Parameter	***Unit***	***LOR***														
Copper	mg/L	0.001		0.027	0.05	0.024	0.008	0.03	0.228	0.008	0.057	0.009	0.007	0.01	0.008	0.007
Lead	mg/L	0.001		<0.001	0.002	<0.001	<0.001	0.006	<0.001	0.001	<0.001	<0.001	<0.001	0.002	0.013	<0.001
Manganese	mg/L	0.001		0.021	0.061	0.003	0.028	0.005	0.006	0.021	0.049	0.036	0.014	0.022	0.025	0.004
Molybdenum	mg/L	0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	mg/L	0.001		0.002	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	0.001	<0.001	<0.001
Selenium	mg/L	0.01		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	mg/L	0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	mg/L	0.005		12.8	5.36	0.039	0.148	0.244	0.873	1.69	0.053	0.084	0.256	1.14	1.7	0.571
Iron	mg/L	0.05		<0.05	0.12	<0.05	0.15	0.42	<0.05	<0.05	0.09	<0.05	<0.05	<0.05	0.15	<0.05
Nutrients																
Nitrite as N	mg/L	0.01		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrate as N	mg/L	0.01		2.22	2.1	0.62	0.3	0.48	0.23	0.7	0.75	0.57	0.63	0.55	0.57	1.27
Total Kjeldahl Nitrogen as N	mg/L	0.1		0.4	0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.5	<0.1	<0.1	<0.1	0.2
Total Phosphorus as P	mg/L	0.01		0.03	0.05	0.03	0.01	0.02	0.02	0.01	0.02	0.03	0.02	0.07	0.07	0.09

Yellow shading indicates exceedance of Australian drinking water guidelines based on aesthetic (not health) risk. Orange shading indicates exceedance of health-based guidelines (NHMRC, 2011 updated March 2021).

Table 13: Farm dam and bore water quality for May 2020.

		Sample ID	EPSW 20200506	WGSW 20200507	WASW 20200507	OCSW 20200507	TASW 20200507	BDSW 20200507	EPB 20200506
		Source	Dam	Dam	Dam	Dam	Dam	Dam	Bore
Parameter	***Unit***	***LOR***							
Conductivity, dissolved and suspended solids									
Electrical Conductivity	µS/cm	1	58	332	109	533	160	156	329
Total Dissolved Solids	mg/L	10	55	270	80	384	133	160	190
Suspended Solids	mg/L	5	22	41	33	18	27	12	6
Alkalinity									
Bicarbonate Alkalinity as $CaCO_3$	mg/L	1	2	112	40	57	63	73	178
Dissolved major anions									
Sulphate as SO_4	mg/L	1	6	26	<1	176	24	<1	5
Chloride	mg/L	1	4	14	7	15	6	5	8
Dissolved major cations									
Calcium	mg/L	1	1	15	5	42	14	10	31
Magnesium	mg/L	1	<1	6	2	17	6	5	18
Sodium	mg/L	1	3	9	3	24	5	3	14
Potassium	mg/L	1	4	43	13	12	17	8	6
Total metals									
Aluminium	mg/L	0.01	0.79	1.2	0.2	0.56	0.35	2.44	----
Antimony	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	----
Arsenic	mg/L	0.001	<0.001	0.007	<0.001	<0.001	0.002	0.002	----
Cadmium	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	----
Chromium	mg/L	0.001	<0.001	0.002	<0.001	0.001	<0.001	0.002	----
Cobalt	mg/L	0.001	0.002	0.01	0.003	<0.001	0.005	0.004	----
Copper	mg/L	0.001	0.012	0.014	0.002	0.008	0.018	0.014	----
Lead	mg/L	0.001	<0.001	0.003	<0.001	<0.001	<0.001	<0.001	----
Manganese	mg/L	0.001	0.15	1.3	0.265	0.062	0.836	0.426	----
Molybdenum	mg/L	0.001	<0.001	0.003	<0.001	0.003	0.003	<0.001	----
Nickel	mg/L	0.001	<0.001	0.007	<0.001	0.002	0.003	0.002	----
Selenium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	----
Silver	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	----

	Sample ID		EPSW 20200506	WGSW 20200507	WASW 20200507	OCSW 20200507	TASW 20200507	BDSW 20200507	EPB 20200506
	Source		Dam	Dam	Dam	Dam	Dam	Dam	Bore
Parameter	***Unit***	***LOR***							
Zinc	mg/L	0.005	0.008	0.031	<0.005	0.082	0.021	0.023	----
Iron	mg/L	0.05	0.73	9.1	1.11	0.8	2.42	5.16	----
Nutrients									
Nitrite as N	mg/L	0.01	<0.01	0.08	<0.01	0.07	0.04	0.04	<0.01
Nitrate as N	mg/L	0.01	2.47	0.08	0.41	2.85	0.21	0.28	<0.01
Total Kjeldahl Nitrogen as N	mg/L	0.1	1.6	8.2	3.1	1.6	2.5	2.5	<0.1
Total Phosphorus as P	mg/L	0.01	0.06	1.22	0.22	0.15	0.35	0.19	0.08

All values are within trigger values for livestock drinking water (ANZECC/ARMCANZ, 2000).

Table 14: Drinking water quality for individual residences for Sep/Oct 2020

			Sample ID	SOUTHLOG_HT_20200929	STOCKTON_HT_20200929	STOCKTON_UG_20200929	SHARP_HT_20200929	SHARP_W_20200929	WEEMALLA_HT_20200929	GG_ST_20200929	ARGLE_HT_20200929	EB_HT1_20200929	EB_BT_20200929
			Tank material	Plastic	Plastic	Concrete	Metal	Well	Concrete	Concrete	Concrete	Plastic	
			Tank type	House	House	Underground	House	Well	Above ground	Shed	Underground	House	Bore
			Sampled from	Pump tap	Tank	Manhole	Tank	Garden tap	Manhole	Manhole	Manhole	Pump tap	Garden tap
Parameter	**Unit**	**LOR**											
Conductivity, dissolved and suspended solids													
Electrical Conductivity	µS/cm	1		44	18	20	14	870	30	35	31	15	1680
Total Dissolved Solids	mg/L	10		26	10	12	<10	551	35	28	23	14	1020
Suspended Solids	mg/L	5		<5	<5	<5	<5	20	<5	<5	<5	<5	<5
Alkalinity													
Bicarbonate Alkalinity as $CaCO_3$	mg/L	1		21	7	16	9	299	16	16	13	6	570
Major dissolved anions													
Sulphate as SO_4	mg/L	1		<1	<1	<1	<1	158	<1	<1	<1	<1	160
Chloride	mg/L	1		<1	<1	<1	<1	74	<1	<1	<1	<1	174
Major dissolved cations													
Calcium	mg/L	1		6	<1	1	<1	72	4	4	4	<1	135
Magnesium	mg/L	1		<1	<1	<1	<1	61	<1	<1	<1	<1	78
Sodium	mg/L	1		1	1	<1	<1	31	<1	<1	<1	<1	105
Potassium	mg/L	1		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Total metals													
Aluminium	mg/L	0.01		0.01	0.03	<0.01	0.08	<0.01	0.02	<0.01	0.02	0.03	<0.01
Antimony	mg/L	0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	mg/L	0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002
Cadmium	mg/L	0.0001		<0.0001	<0.0001	<0.0001	0.0004	<0.0001	<0.0001	0.0002	<0.0001	0.0025	<0.0001
Chromium	mg/L	0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	mg/L	0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	mg/L	0.001		0.004	0.071	0.002	0.237	0.033	<0.001	0.001	0.002	0.005	0.004
Lead	mg/L	0.001		0.002	0.003	<0.001	0.014	<0.001	<0.001	0.001	<0.001	0.003	<0.001
Manganese	mg/L	0.001		0.004	0.004	0.006	0.007	0.445	0.006	0.003	0.008	0.006	0.039
Molybdenum	mg/L	0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	mg/L	0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001

	Sample ID		SOUTHLOG_ HT_20200929	STOCKTON_HT_ 20200929	STOCKTON _UG_20200929	SHARP_HT_ 20200929	SHARP_W_ 20200929	WEEMALLA_HT _20200929	GG_ST_ 20200929	ARGLE_HT_ 20200929	EB_HT1_ 20200929	EB_BT_ 20200929
	Tank material		Plastic	Plastic	Concrete	Metal	Well	Concrete	Concrete	Concrete	Plastic	
	Tank type		House	House	Underground	House	Well	Above ground	Shed	Underground	House	Bore
	Sampled from		Pump tap	Tank	Manhole	Tank	Garden tap	Manhole	Manhole	Manhole	Pump tap	Garden tap
Parameter	**Unit**	**LOR**										
Selenium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	mg/L	0.005	1.46	3.17	1.77	0.819	0.737	0.123	1.78	0.441	2.17	7.23
Iron	mg/L	0.05	<0.05	<0.05	<0.05	2.02	4.77	<0.05	<0.05	<0.05	<0.05	<0.05
Nutrients												
Nitrite as N	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	0.01
Nitrate as N	mg/L	0.01	0.46	0.33	0.47	0.65	0.47	0.48	0.8	1.39	0.31	7.45
Total Kjeldahl Nitrogen as N	mg/L	0.1	<0.1	<0.1	0.1	0.2	<0.1	<0.1	0.3	0.2	0.2	0.5
Total Phosphorus as P	mg/L	0.01	0.01	<0.01	<0.01	0.08	<0.01	<0.01	<0.01	0.02	0.02	0.02

Yellow shading indicates exceedance of Australian drinking water guidelines based on aesthetic (not health) risk. Orange shading indicates exceedance of health-based guidelines (NHMRC, 2011 updated March 2021).

Table 15: Drinking water quality for individual residences for Sep/Oct 2020

		Sample ID	RV_HT_ 20201001	RV_KT_ 20201001	RV_KTHOT_ 20201001	MERIBAH_HT_ 20201001	NW_HT_ 20201001	NW_TAP_ 20201001	WALLABY_T1_ 20201002	WALLABY_T2_ 20201002	TP_HT_ 20201002	TP_ST_ 20201002
		Tank material	Concrete			Metal	Metal	Metal	Concrete	Plastic	Metal	Concrete
		Tank location	Towards shed			House	House	House	Garage	Garage	House	Shed
		Sampled from	House tap	Kitchen cold tap	Kitchen hot tap	Pump tap	Manhole	House tap	Manhole	Pump tap	Tank tap	Manhole
Parameter	**Unit**	**LOR**										
Conductivity, dissolved and suspended solids												
Electrical Conductivity	µS/cm	1	24	30	26	62	25	26	20	14	12	28
Total Dissolved Solids	mg/L	10	15	17	20	36	19	14	12	11	<10	16
Suspended Solids	mg/L	5	<5	<5	<5	<5	<5	<5	<5	<5	37	<5
Alkalinity												
Bicarbonate Alkalinity as $CaCO_3$	mg/L	1	9	11	10	29	14	11	8	2	<1	11
Major dissolved anions												
Sulphate as SO_4	mg/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chloride	mg/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Major dissolved cations												
Calcium	mg/L	1	3	4	3	11	3	3	2	2	<1	3
Magnesium	mg/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Sodium	mg/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Potassium	mg/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Total metals												
Aluminium	mg/L	0.01	<0.01	0.02	<0.01	0.06	0.01	0.01	0.03	0.02	0.12	0.01
Antimony	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	mg/L	0.0001	0.0001	<0.0001	0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0005
Chromium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	<0.001
Cobalt	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	mg/L	0.001	0.002	1.13	0.128	0.013	<0.001	0.01	0.002	0.009	0.016	0.002
Lead	mg/L	0.001	<0.001	<0.001	<0.001	0.003	<0.001	<0.001	<0.001	0.001	0.006	<0.001
Manganese	mg/L	0.001	0.003	0.001	0.003	0.013	0.008	0.007	0.012	0.005	0.014	0.003
Molybdenum	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

	Sample ID		RV_HT_ 20201001	RV_KT_ 20201001	RV_KTHOT_ 20201001	MERIBAH_HT_ 20201001	NW_HT_ 20201001	NW_TAP_ 20201001	WALLABY_T1_ 20201002	WALLABY_T2_ 20201002	TP_HT_ 20201002	TP_ST_ 20201002
	Tank material		Concrete			Metal	Metal	Metal	Concrete	Plastic	Metal	Concrete
	Tank location		Towards shed			House	House	House	Garage	Garage	House	Shed
	Sampled from		House tap	Kitchen cold tap	Kitchen hot tap	Pump tap	Manhole	House tap	Manhole	Pump tap	Tank tap	Manhole
Parameter	**Unit**	**LOR**										
Selenium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	mg/L	0.005	0.663	0.106	0.685	0.223	0.135	0.128	0.208	0.224	0.069	1.43
Iron	mg/L	0.05	<0.05	0.11	<0.05	0.08	0.09	0.1	0.05	<0.05	0.13	<0.05
Nutrients												
Nitrite as N	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrate as N	mg/L	0.01	0.49	0.21	0.43	0.36	0.23	0.23	0.25	0.25	0.15	0.41
Total Kjeldahl Nitrogen as N	mg/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	0.3	0.3
Total Phosphorus as P	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	0.01	0.12

Yellow shading indicates exceedance of Australian drinking water guidelines based on aesthetic (not health) risk. Orange shading indicates exceedance of health-based guidelines (NHMRC, 2011 updated March 2021).

Table 16: Drinking water quality for individual residences for Sep/Oct 2020

			Sample ID	BRAEBURN_HT_20200930	CARRAMAR_HT1_20200930	CARRAMAR_HT2_20200930	CHESNEY_HT_20200930	MIAWARRA_HT_20201001	MIAWARRA_T2_20201001	MIAWARRA_T3_20201001	MIAWARRA_ST_20201001
			Tank material		Plastic	Plastic	Concrete	Concrete	Concrete	Concrete	Plastic
			Tank location		House	Shearing shed	Underground	House	On hill - left	On hill - right	Shed
			Sampled from	Kitchen tap	Hose from tank	Manhole	Manhole	Manhole	Manhole	Manhole	Manhole
Parameter	***Unit***	***LOR***									
Conductivity, dissolved and suspended solids											
Electrical Conductivity	µS/cm	1	63	11	10	26	34	49	34	12
Total Dissolved Solids	mg/L	10	48	<10	<10	13	22	29	22	<10
Suspended Solids	mg/L	5	<5	8	<5	<5	<5	<5	<5	<5
Alkalinity											
Bicarbonate Alkalinity as $CaCO_3$	mg/L	1	31	2	2	10	15	22	15	<1
Major dissolved anions											
Sulphate as SO_4	mg/L	1	2	1	<1	<1	<1	<1	<1	<1
Chloride	mg/L	1	<1	<1	<1	<1	<1	<1	<1	<1
Major dissolved cations											
Calcium	mg/L	1	10	<1	<1	3	4	6	3	<1
Magnesium	mg/L	1	<1	<1	<1	<1	<1	<1	<1	<1
Sodium	mg/L	1	<1	<1	<1	<1	<1	1	<1	<1
Potassium	mg/L	1	<1	<1	<1	<1	<1	1	<1	<1
Total metals											
Aluminium	mg/L	0.01	0.01	0.02	<0.01	<0.01	0.01	0.02	<0.01	0.04
Antimony	mg/L	0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	mg/L	0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.001	<0.001	0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	mg/L	0.001	0.014	0.007	<0.001	0.001	0.003	0.001	0.001	0.004
Lead	mg/L	0.001	0.003	<0.001	0.002	<0.001	0.004	<0.001	0.002	<0.001
Manganese	mg/L	0.001	0.004	0.016	0.003	0.01	0.003	0.003	0.004	0.011
Molybdenum	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

		Sample ID	BRAEBURN_HT_20200930	CARRAMAR_HT1_20200930	CARRAMAR_HT2_20200930	CHESNEY_HT_20200930	MIAWARRA_HT_20201001	MIAWARRA_T2_20201001	MIAWARRA_T3_20201001	MIAWARRA_ST_20201001
		Tank material		Plastic	Plastic	Concrete	Concrete	Concrete	Concrete	Plastic
		Tank location		House	Shearing shed	Underground	House	On hill - left	On hill - right	Shed
		Sampled from	Kitchen tap	Hose from tank	Manhole	Manhole	Manhole	Manhole	Manhole	Manhole
Parameter	Unit	LOR								
Selenium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	mg/L	0.005	1.03	0.553	2.01	2.3	0.316	1.32	2.57	0.177
Iron	mg/L	0.05	0.13	0.11	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Nutrients										
Nitrite as N	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrate as N	mg/L	0.01	0.21	0.47	0.43	0.31	0.59	0.58	0.39	0.41
Total Kjeldahl Nitrogen as N	mg/L	0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1
Total Phosphorus as P	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.04	<0.01	<0.01

Yellow shading indicates exceedance of Australian drinking water guidelines based on aesthetic (not health) risk. Orange shading indicates exceedance of health-based guidelines (NHMRC, 2011 updated March 2021).

Table 17: Drinking water quality for individual residences for repeat samples (Dec 2020 and Jan 2021)

			Sample ID	SHARP_W _20210108	SHARP_HT _20210108	CHHT _20201223	CHPT _20201223	CHCT _20201223
			Tank material	Well	Metal	Plastic	Concrete	Concrete
			Tank location	Well	House	House	Paddock	Cottage
			Sampled from	Garden tap	Tank	Tank tap	Tank tap	Tank tap
Parameter	Unit	LOR						
Total metals								
Aluminium	mg/L	0.01		<0.01	<0.01	0.01	<0.01	<0.01
Antimony	mg/L	0.001		<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	mg/L	0.001		<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	mg/L	0.0001		<0.0001	0.0002	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.001		<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	mg/L	0.001		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	mg/L	0.001		0.008	0.039	0.018	<0.001	<0.001
Lead	mg/L	0.001		<0.001	0.001	0.005	<0.001	<0.001
Manganese	mg/L	0.001		0.016	0.009	0.043	0.004	0.023
Molybdenum	mg/L	0.001		<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	mg/L	0.001		<0.001	<0.001	0.087	<0.001	<0.001
Selenium	mg/L	0.01		<0.01	<0.01	<0.01	<0.01	<0.01
Silver	mg/L	0.001		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	mg/L	0.005		0.043	0.441	1.51	0.465	1.46
Iron	mg/L	0.05		0.11	0.06	0.05	<0.05	<0.05

Appendix 4. MeClas Classification of the Tailings Based on Metal Composition

MeClas

METALS CLASSIFICATION TOOL
version V5.3

(Reference) composition name	**20CJ-001**
Adapted reference composition name	20CJ-001
Tier	1
Date printing	2020.04.09
User	

Principles: The classification is based on GHS/CLP Mixture toxicity rules using MECLAS http://www.meclas.eu, with - in Tier 2 assessment- corrections related to the bio-availability of the materials, assessed from Transformation Dissolution tests, Bio-elution tests and long term environmental fate assessments.
Please visit www.meclas.eu for more information on Meclas.
For more information on copper concentrates and IMO regulations, please visit: http://www.copperalliance.eu/industry/voluntary-initiatives/imo-marpol-ghs

Input values:

Element	Concentration% (user input)	Distribution%	Species / Classification entry	Source	
Ag	0.00002	100	Ag (other not classified compounds/species)	not classified	
As	0.00035	100	As2O3 / AsO3	Annex VI	
Ba	0.00252	100	BaS	Annex VI + self classification for acute toxicity oral, skin corrosion and eye damage (source: ECHA dissemination website)	
Be	0.00003	100	beryllium oxide	Annex VI	
Bi	0.00002	100	Bi (other not classified compounds/species, e.g. Bi2S3)	not classified	
Co	0.00114	100	CoS	1st ATP + CDI self-classification	
Cr	0.00308	100	CrS	self classification	
Cu	0.04979	100	Chalcopyrite	Not classified - ECI	
Li	0.00148	100	Li	Annex VI	
Mn	0.02874	100	Mn/Mn compounds not classified, e.g. MnCO3, MnO)	not classified	
Mo	0.00167	100	MoS2	not classified	
Ni	0.00128	100	NiS	1st ATP	
Pb	0.00037	100	lead compounds with the exception of those specified elsewhere in Annex VI	Annex VI + self classification for carcinogenicity + STOT	
Sb	0.00002	100	Sb2S3	self classification (i2a)	
Se	0.00015	100	Se (other not classified compounds/species)	not classified	
Se	0.00015	100	Selenium compounds except cadmium sulphoselenide	Annex VI	
Si	7.3	0.2	SiO2 crystalline & respirable	self classification IMA europe	
					bio-accessibility (inhalation) =
Si	7.3	99.8	SiO2 non-crystalline	not classified	
Sn	0.00005	100	Sn compounds	self classification	
V	0.00698	100	V2O5; VO5	Annex VI + self classification eye damage (source: V consortium)	
Zn	0.00239	100	ZnS	not classified	
Sr	0.01472	100	Sr	self classification	

Tier 1: Classification based on speciation/mineralogy of elements

LEGISLATION

Endpoint	Classification		
	EU-CLP	GHS	US/Canada
signal word			
pictogram			
Acute toxicity-oral	Not classified	Not classified	Not classified
Acute toxicity-dermal	Not classified	Not classified	Not classified
Acute toxicity-inhalation	Not classified	Not classified	Not classified
Skin corrosion/irritation	Not classified	Not classified	Not classified

Page 1 of 2

Serious eye damage/eye irritation	Not classified	Not classified	Not classified
Respiratory or skin sensitisation	Not classified	Not classified	Not classified
Germ cell mutagenicity	Not classified	Not classified	Not classified
Carcinogenicity	Not classified	Not classified	Not classified
Reproductive toxicity	Not classified	Not classified	Not classified
Specific target organ toxicity - single exposure	Not classified	Not classified	Not classified
Specific target organ toxicity - repeated exposure	Not classified	Not classified	Not classified
Aspiration hazard	Not classified	Not classified	Not classified
Hazardous to aquatic environment - ACUTE	Not classified	Not classified	
Hazardous to aquatic environment - CHRONIC	Not classified	Not classified	

EU waste hazard properties

Endpoint	Classification
Acute toxicity	Not classified
Corrosive	Not classified
Irritant - skin irritation and eye damage	Not classified
Sensitising	Not classified
Mutagenic	Not classified
Carcinogenic	Not classified
Toxic for reproduction	Not classified
Specific Target Organ Toxicity (STOT) / Aspiration toxicity	Not classified
Ecotoxic	Not classified

SEVESO III

Endpoint	Classification
upper tier tonnage	Not Classified
lower tier tonnage	Not Classified

IMSBC

Endpoint	Classification
Materials hazardous only in bulk (MHB) - part toxic solid	Not classified

MARPOL

Endpoint	Classification
Harmful to the marine environment (HME)	Not classified

Disclaimer: The MeClas tool aims to reproduce the classification for complex metal mixtures. Although prepared with great care, flawless operation cannot be guaranteed. Users of the MeClas tool need to be aware of this. By using the MeClas tool, users accept full responsibility for their calculations. Neither Arche, Eurometaux or the data providers can take liability for (mis)use of the results.

Disclaimer

This report is specifically intended for the use of the Newcrest Mining Limited, CVO. The advice and recommendations contained in this report are based on advice and information obtained during the consultancy at CVO. Callander and Johnson Consultancy Services believe that the information herein is accurate and reliable as well as provided in good faith.

May 2020

Appendix C. Todoroski Air Sciences reports

THIS DOCUMENT MAY NOT BE REPRODUCED EXCEPT IN FULL

TODOROSKI AIR SCIENCES
Suite 2B, 14 Glen Street Eastwood, NSW 2122
Phone: 02 9874 2123
Fax: 02 9874 2125
Email: info@airsciences.com.au
Web: www.airsciences.com.au
ACN: 151 202 765 | ABN: 74 955 076 914

26 May 2020

Tim Wrigley
Environmental Specialist – Cadia Valley Operations
Newcrest Mining
Via email: Tim.Wrigley@newcrest.com.au

RE: Cadia Valley Operations – Ventilation shaft air dispersion modelling

Dear Tim,
Todoroski Air Sciences has completed air dispersion modelling of the ventilation shafts at Cadia Valley Operations. The aim of the air dispersion modelling is to identify potential areas of off-site impact to locate ambient air quality monitors.

The CALPUFF air dispersion model was used in conjunction with meteorological data for the 2018 calendar period. The ventilation shaft modelling parameters are outlined in **Table 1**. Additional assumptions applied include an exit temperature of 25 degrees Celsius and a dust concentration of 4.715mg/m^3 to estimate the mass emission rate from each ventilation shaft.

Table 1: Summary of ventilation shaft parameters

Ventilation shaft ID	Height (m)	Diameter (m)	Exit velocity (m/s)
VR3-0	5.6	4.5	18.86
VR5-0	5.6	5	20.37
VR7-0	5.6	6	15.91
VR8-0	5.6	6	15.91

The modelling predictions are presented as isopleth diagrams in **Figure 1** to **Figure 3** showing the maximum 1-hour, 24-hour and annual average concentrations. The modelling indicates that the greatest off-site impacts occur to the east-northeast and northeast of the ventilation sources.

Please feel free to contact us if you would like to clarify any aspect of this letter.

Yours faithfully,
Todoroski Air Sciences

Philip Henschke

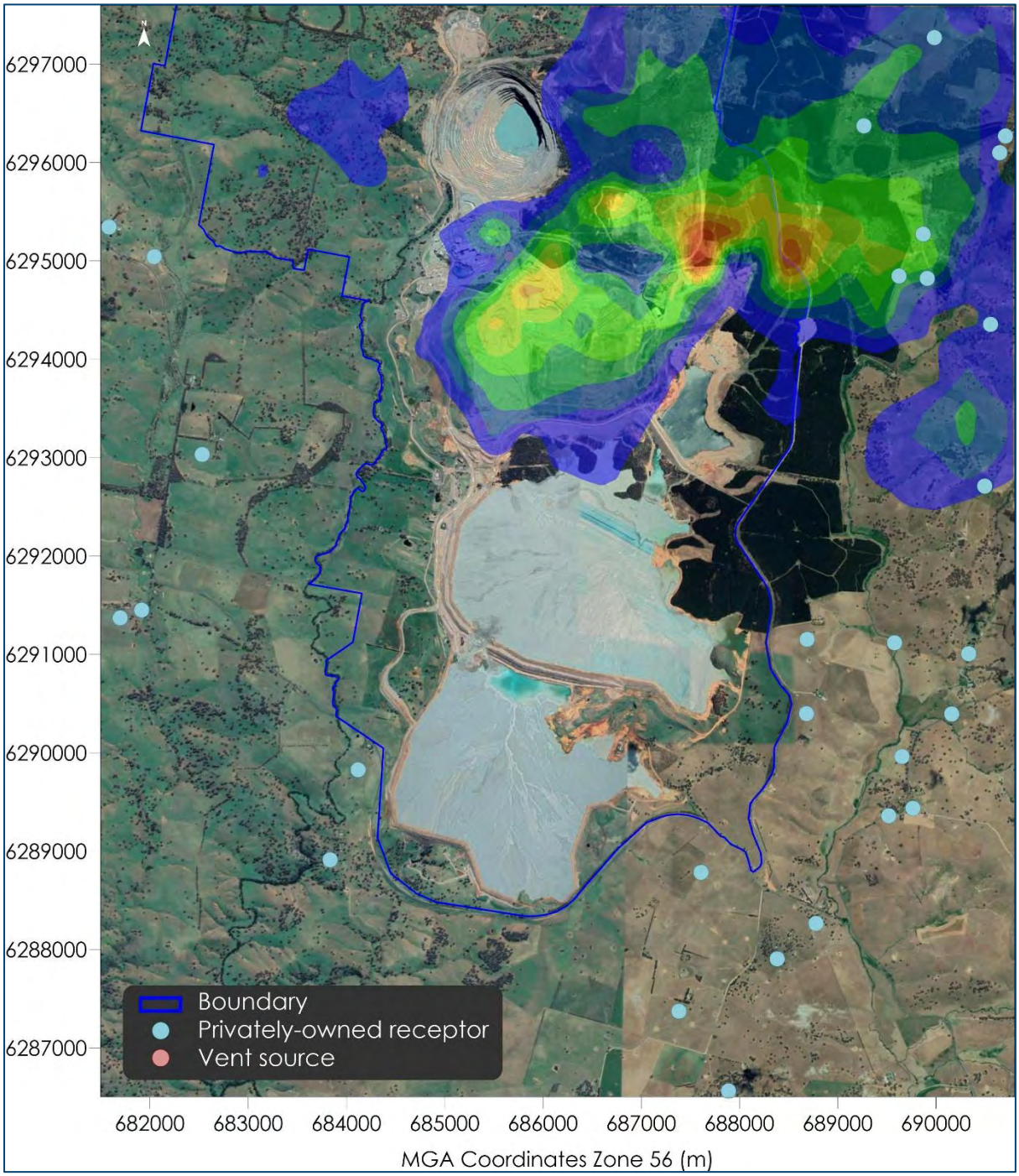

Figure 1: Predicted maximum 1-hour average levels

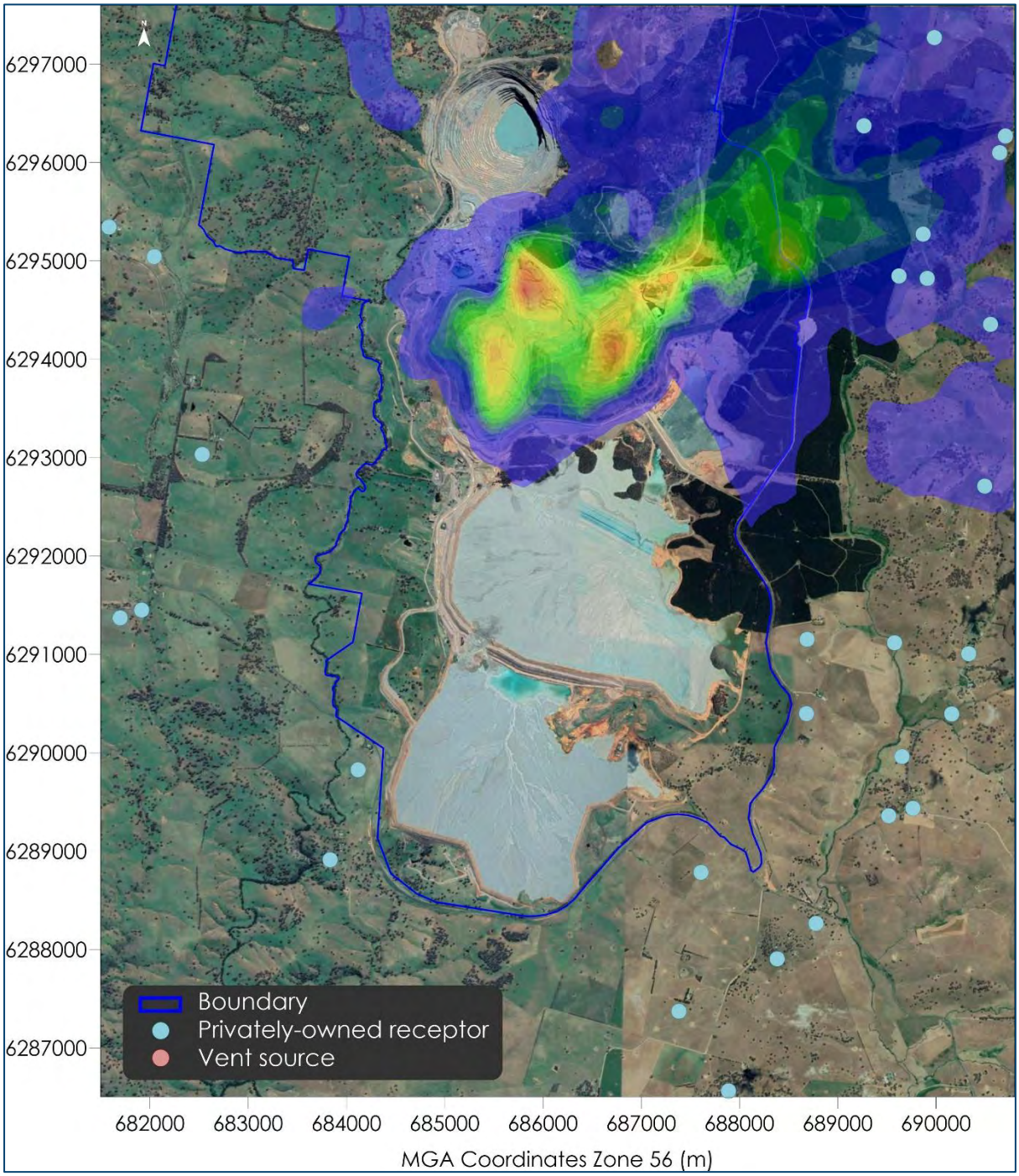

Figure 2: Predicted maximum 24-hour average levels

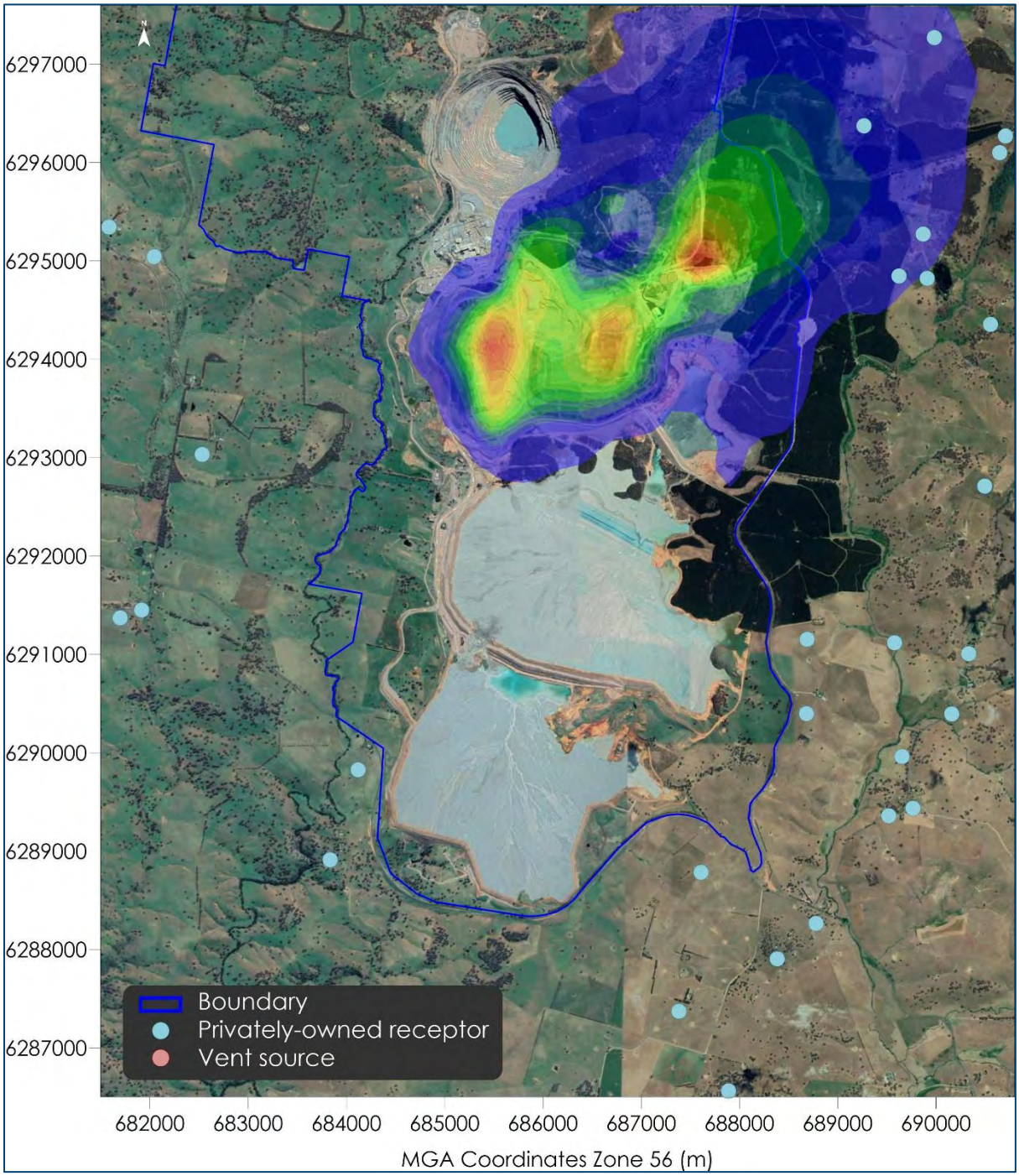

Figure 3: Predicted annual average levels

AIR QUALITY MONITORING PLAN

CADIA VALLEY OPERATION - TAILINGS STORAGE FACILITY

Newcrest Mining Limited

9 June 2020

Job Number 19111036

Prepared by
Todoroski Air Sciences Pty Ltd
Suite 2B, 14 Glen Street
Eastwood, NSW 2122
Phone: (02) 9874 2123
Fax: (02) 9874 2125
Email: info@airsciences.com.au

Air Quality Monitoring Plan

Cadia Valley Operations –Tailings Storage Facility

DOCUMENT CONTROL

Report Version	Date	Prepared by	Reviewed by
DRAFT - 001	03/03/2020	K Trahair & P Henschke	
FINAL - 001	09/06/2020	P Henschke	

This report has been prepared in accordance with the scope of works between Todoroski Air Sciences Pty Ltd (TAS) and the client. TAS relies on and presumes accurate the information (or lack thereof) made available to it to conduct the work. If this is not the case, the findings of the report may change. TAS has applied the usual care and diligence of the profession prevailing at the time of preparing this report and commensurate with the information available. No other warranty or guarantee is implied in regard to the content and findings of the report. The report has been prepared exclusively for the use of the client, for the stated purpose and must be read in full. No responsibility is accepted for the use of the report or part thereof in any other context or by any third party.

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1 INTRODUCTION

Todoroski Air Sciences has prepared this air quality monitoring plan on behalf of Newcrest Mining Limited (hereafter referred to as the Proponent). It outlines a monitoring plan to measure potential air emissions arising from the Tailings Storage Facility (TSF) located at Cadia Valley Operations (hereafter referred to as the Project).

In February 2018, a section of the Northern TSF wall slumped making the tailing storage facility unusable. Due to the inactivity the tailing storage facility has dried out and it is now susceptible to dust lift off during periods of elevated winds.

This air quality monitoring plan aims to assist with the quantification of dust emissions generated from the TSF.

2 LOCAL SETTING

Cadia Valley Operations is a gold and copper mining operation which involves both open pit and underground mining methods. The site is located approximately 22 kilometres (km) to the southwest of Orange and approximately 25km west-northwest of Blayney.

Figure 2-1 presents the Cadia Valley Operations indicating the location of the TSF, nearest mine-owned and privately owned residences.

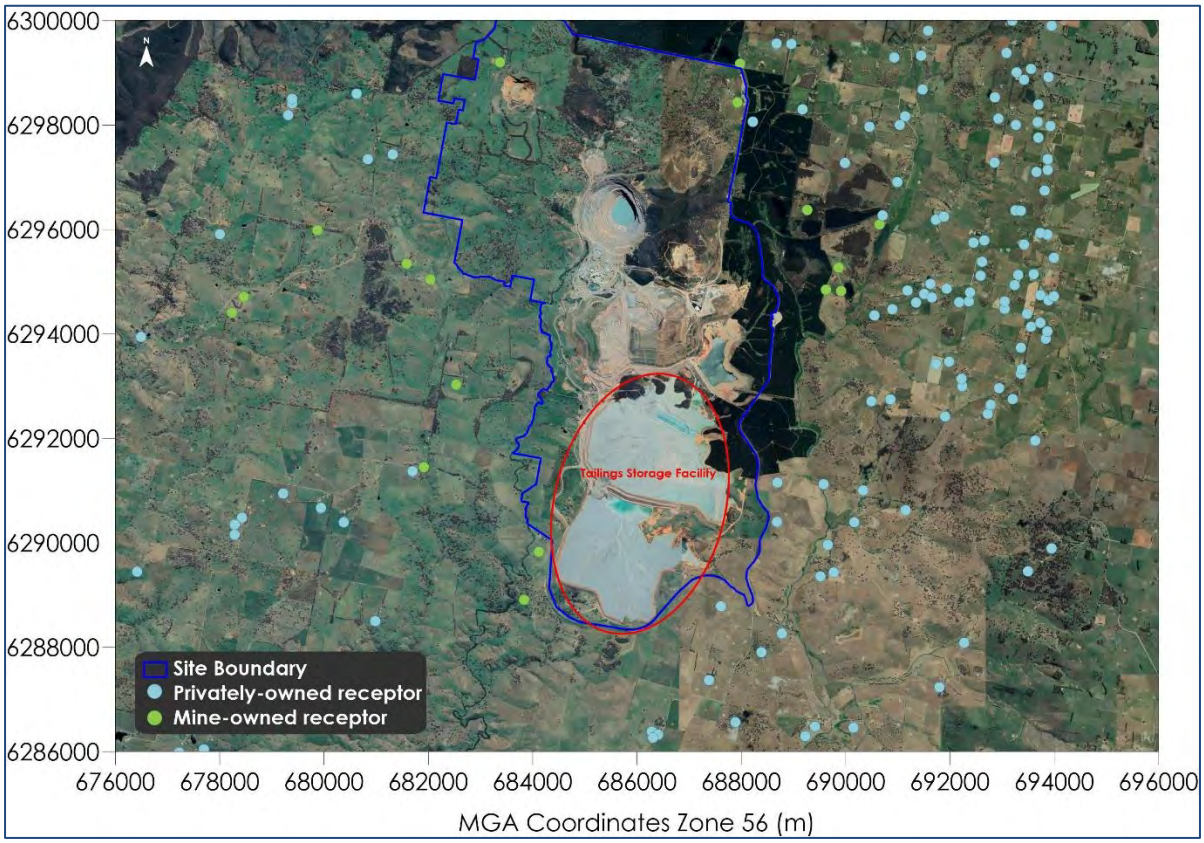

Figure 2-1: TSF location and nearest receptors

3 EXISTING ENVIRONMENT

This section reviews the available meteorological monitoring data and ambient air quality monitoring data sourced from the Cadia Valley Operations monitoring network. **Figure 3-1** shows the approximate location of each of the monitoring stations reviewed.

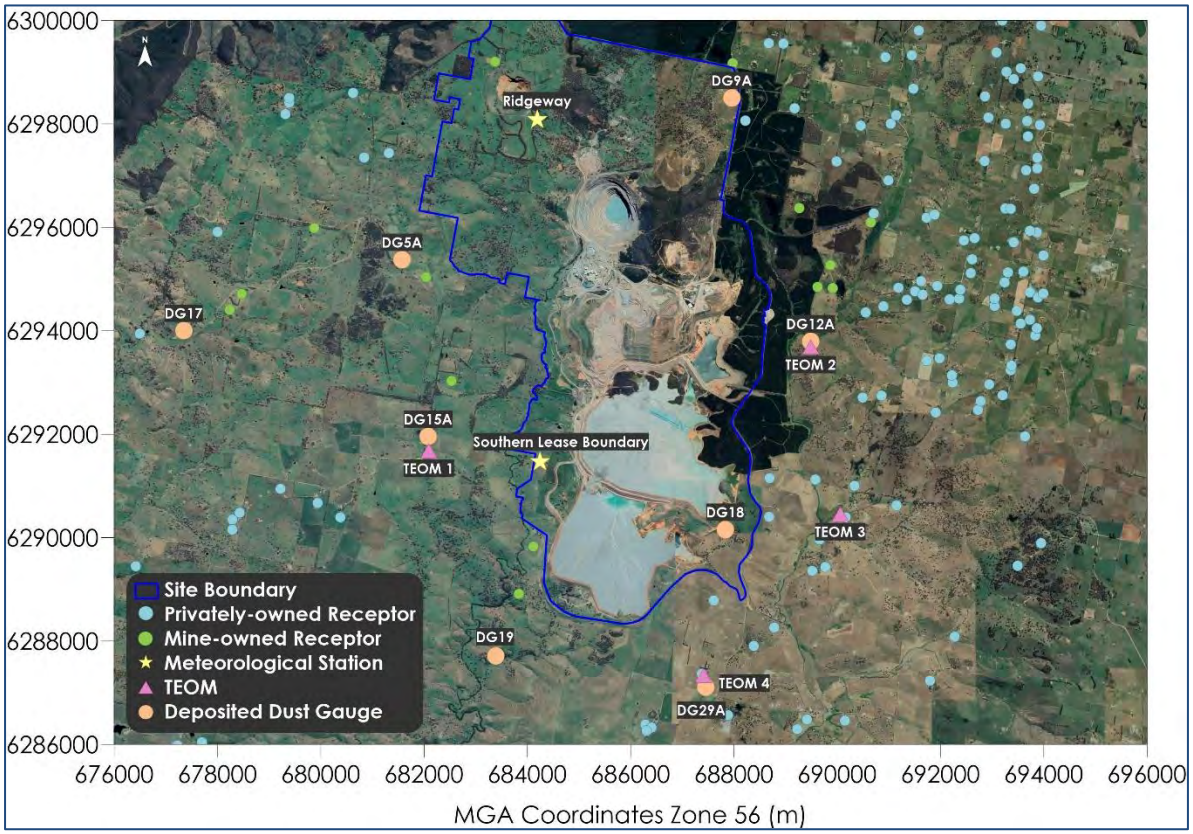

Figure 3-1: Existing air quality monitoring network

3.1 Local meteorological conditions

Cadia Valley Operations operate two on-site meteorological stations, Ridgeway and Southern Lease Boundary (SLB). The location of the meteorological stations is shown in **Figure 3-1**.

Figure 3-2 and **Figure 3-3** presents annual and seasonal windroses for the Ridgeway and SLB meteorological stations for the 2018 period, respectively. Analysis of the windroses show that on an annual basis the dominant wind at both stations is from the north, with both stations showing the predominant wind flows typically along a southwest to northeast axis.

At the Ridgeway station, the summer winds are predominately from the north and north-northeast. The autumn and spring wind distribution is similar to the annual distribution with winds from the north, southwest and northeast quadrant. During winter, winds are primarily from the north and west-southwest.

Wind from the north is a feature in all seasons at the SLB station. During summer winds from the northeast are most predominant. Similar to the Ridgeway station, the autumn and spring wind distribution is similar to the annual distribution. In winter winds occur from the north and northwest quadrants.

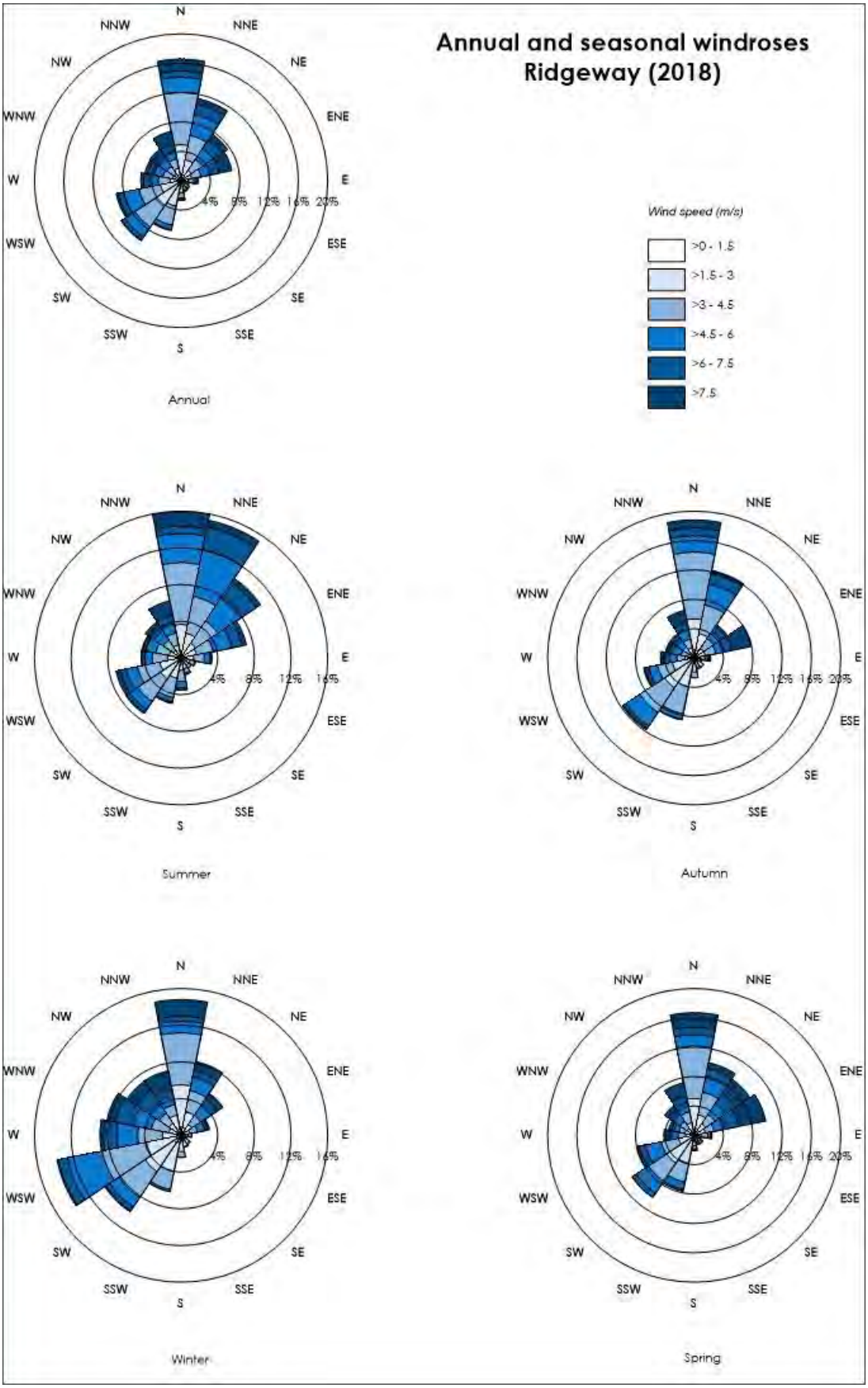

Figure 3-2: Ridgeway annual and seasonal windroses (2018)

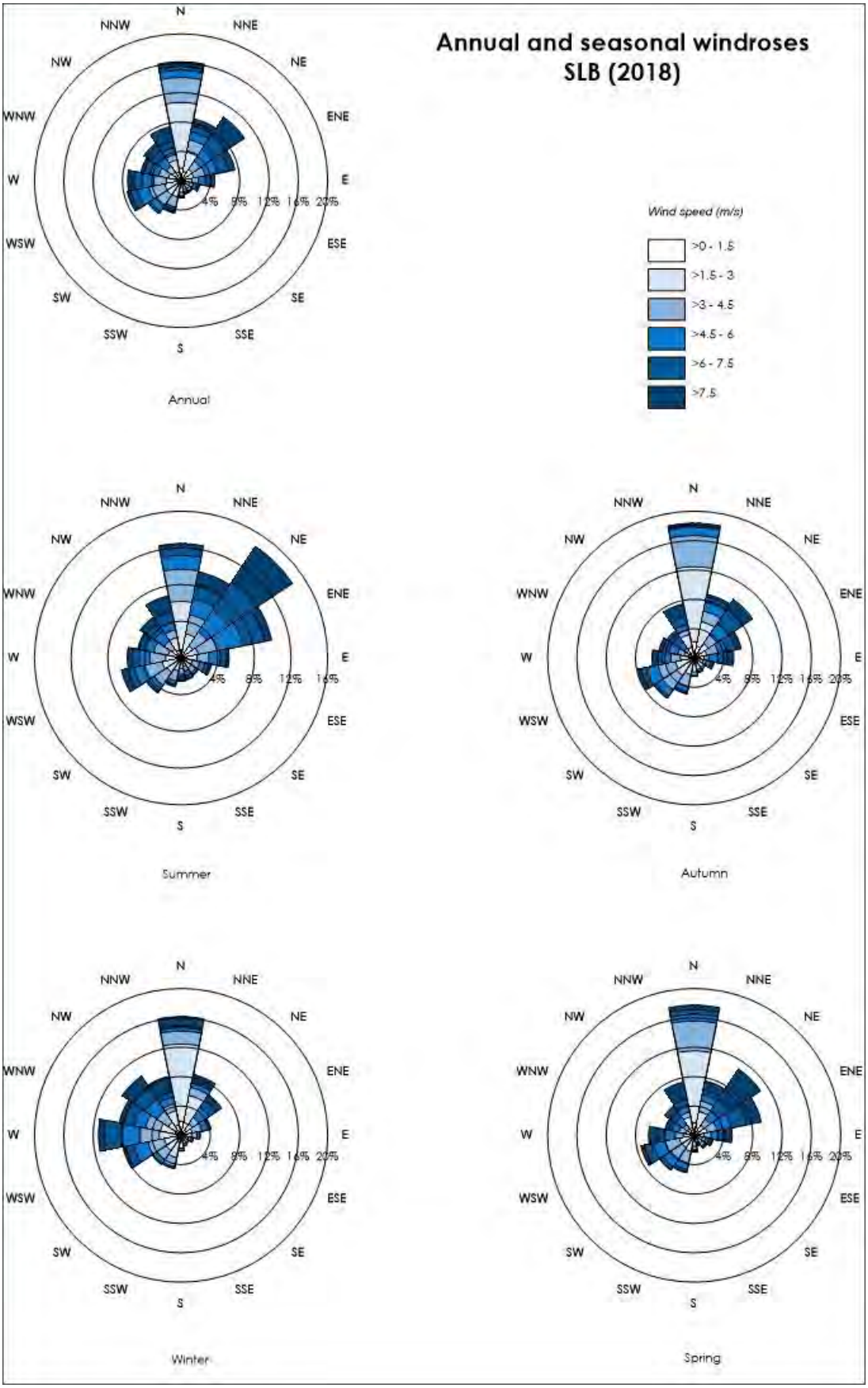

Figure 3-3: Southern Lease Boundary annual and seasonal windroses (2018)

3.2 Local air quality monitoring

Cadia Valley Operations operate a range of ambient air quality monitors that assist with the ongoing environmental management of the operations.

Table 3-1 lists the monitoring stations reviewed in this section. The air quality monitors include Tapered Element Oscillating Microbalances (TEOMs) and dust deposition gauges. **Figure 3-1** shows the approximate location of each of the monitoring stations reviewed.

Table 3-1: Existing ambient air quality monitors

ID	Property name	Monitor type	Parameter monitored
TEOM 1	Flyers Creek Weir	TEOM	PM_{10}
TEOM 2	Bundarra	TEOM	PM_{10}
TEOM 3	Triangle Flat	TEOM	PM_{10}
TEOM 4	Meribah	TEOM	PM_{10}
DG5A	Bundella	Deposited dust gauge	Deposited dust, metals
DG9A	Exploration	Deposited dust gauge	Deposited dust, metals
DG12A	Flyers Creek Weir	Deposited dust gauge	Deposited dust, metals
DG15A	Bundarra	Deposited dust gauge	Deposited dust, metals
DG17	Ashleigh Park	Deposited dust gauge	Deposited dust, metals
DG18	Wire Gully	Deposited dust gauge	Deposited dust, metals
DG19	Oakey Creek	Deposited dust gauge	Deposited dust, metals
DG29A	Meribah	Deposited dust gauge	Deposited dust, metals

Recorded 24-hour average PM_{10} concentrations are presented graphically in **Figure 3-4**. The figure shows that the monitors typically record similar levels which suggest they are predominantly influenced by regional events. At other times, potential localised sources (such as mining activity) may have contributed to periods of elevated PM_{10} levels at individual monitors.

We note that dust levels appear to increase during 2018 and 2019 periods. During this time, NSW experienced drought conditions which would have contributed to the regional dust levels.

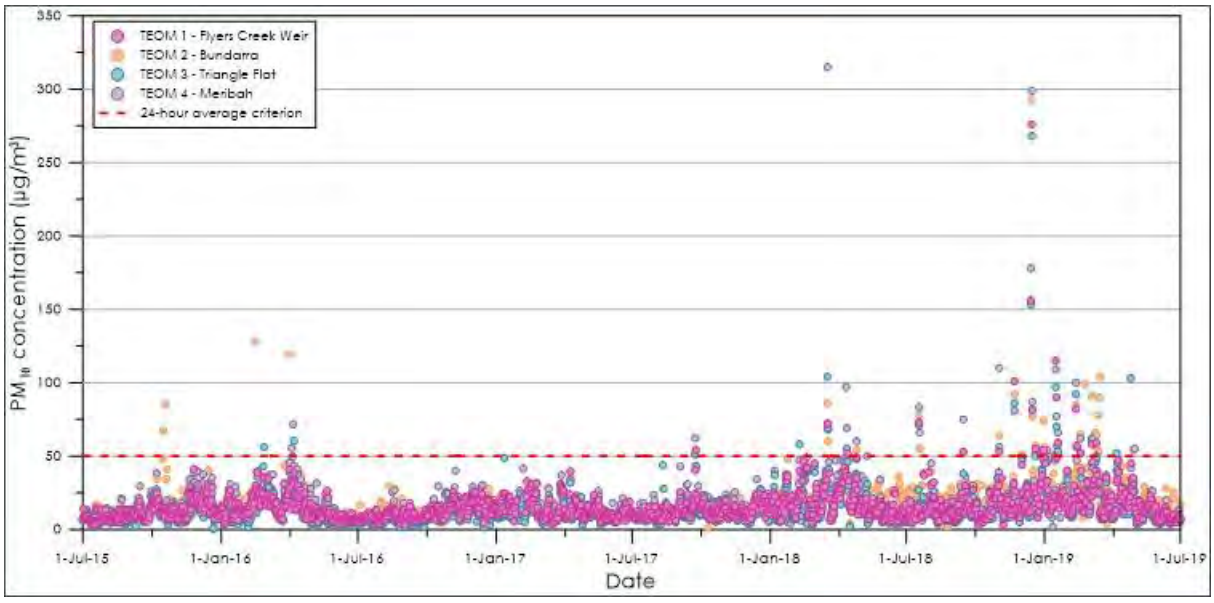

Figure 3-4: TEOM 24-hour average PM_{10} monitoring data (µg/m³)

Figure 3-5 presents the monthly deposited dust levels recorded between July 2018 and June 2019. The graph indicates the dust deposition gauges typically recorded similar levels and suggests the monitors are subject to similar levels of monthly dust fallout.

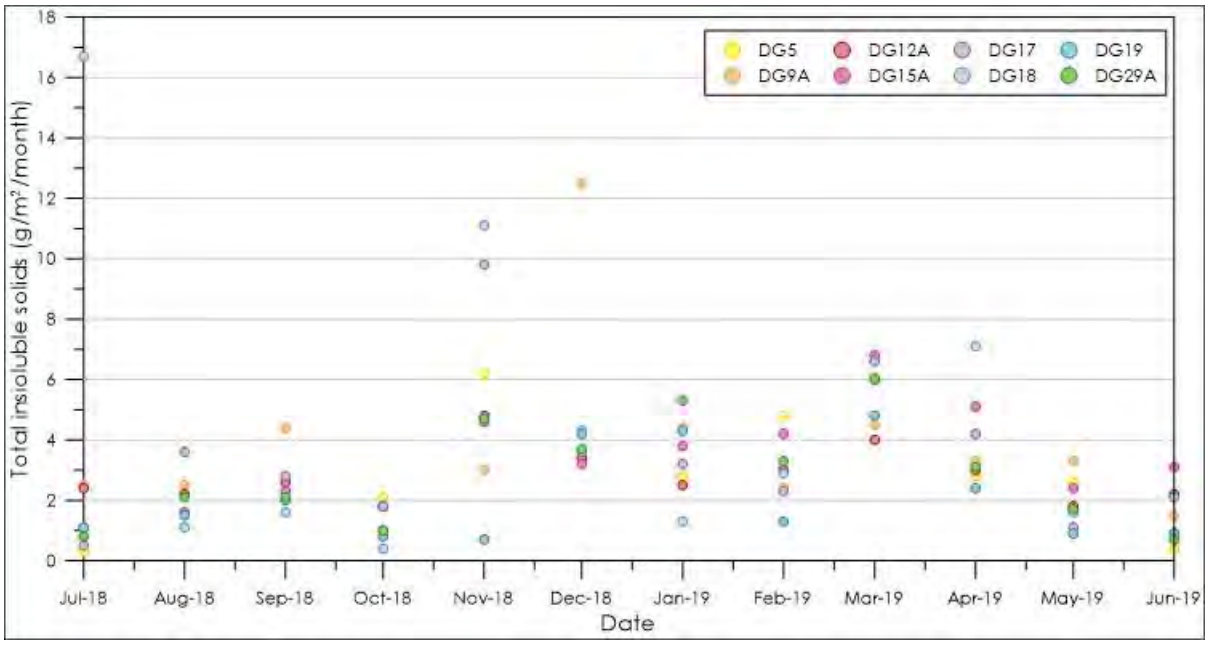

Figure 3-5: Deposited dust as insoluble solids monitoring data (g/m²/month)

Figure 3-6 presents the available copper levels measured in the monthly deposited dust levels. Data are available for December 2015, early 2017 and from mid-2018. The recorded copper levels in early 2017 are noticeable higher than the other periods reviewed. The results from mid-2018 do not show any clear trend in copper levels.

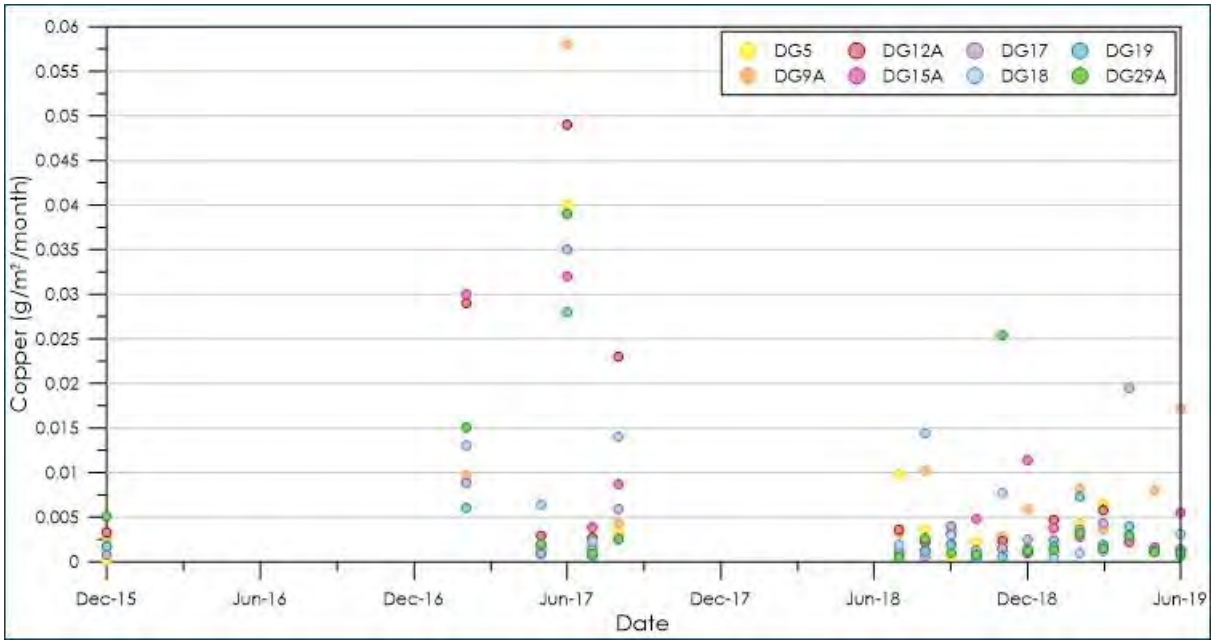

Figure 3-6: Copper levels in deposited dust monitoring data (g/m²/month)

4 RECOMMENDED AIR QUALITY MONITORING FOR THE TSF

The purpose of the air quality monitoring for the TSF is the measure the contribution of air emissions arising from the TSF and identify the constituents of the air emissions. The air quality monitoring would also be used to verify the environmental performance of any management measures adopted.

4.1 Monitoring methods and sampling instruments

Monitoring methods are to be undertaken per the *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales* (**NSW DEC, 2007**) where applicable.

4.1.1 TEOM

The TEOM monitors are used to continuously measure concentrations of PM_{10}, as per the Australian Standard AS 3580.9.8: *Methods for sampling and analysis of ambient air – Determination of suspended particulate matter – PM_{10} continuous direct mass method using a tapered element oscillating microbalance analyser*.

4.1.2 Deposited dust gauges

Deposited dust is assessed as insoluble solids as defined by Standards Australia AS/NZS 3580.10.1: *Methods for sampling and analysis of ambient air – Determination of particulate matter – Deposited matter – Gravimetric Method*. Gravimetric analysis of the material collected in the dust gauge is conducted by a NATA accredited analytical laboratory to determine the total insoluble matter in g/m^2/month.

The samples are subsequently analysed for the determination of total base metal concentrations present in the insoluble matter.

4.1.3 HVAS

A HVAS is used to measure PM_{10} concentrations in the ambient air. HVAS monitoring is conducted approximately every 6 days for a 24-hour monitoring period in accordance with Australian Standard 3580.9.6: *Methods for sampling and analysis of ambient air – Determination of suspended particulate matter – PM_{10} high volume sampler with size selective inlet – gravimetric method*.

The samples are subsequently analysed for the determination of total base metal concentrations present in the captured particulate. The following analytes are recommended for the HVAS sample:

- Antimony
- Arsenic
- Barium
- Beryllium
- Boron
- Chromium
- Cobalt
- Copper
- Iron
- Lead
- Lithium
- Manganese
- Molybdenum
- Nickel
- Tin
- Selenium
- Silver
- Strontium
- Uranium
- Vanadium
- Zinc

4.1.4 Low Volume Air Sampler

A Low Volume Air Sampler (LVAS) is used to measure PM_4 and $PM_{2.5}$ concentrations in the ambient air. LVAS monitoring is conducted in accordance with Australian Standard 3580.9.9: *Methods for sampling and analysis of ambient air – Determination of suspended particulate matter – $PM_{2.5}$ low volume sampler with size selective inlet – gravimetric method*.

The LVAS samples are subsequently analysed for the determination of silica concentrations present in the captured particulate.

4.2 Monitoring locations

The recommended air quality monitoring locations for the TSF would be supplemented by the existing air quality monitoring network for Cadia Valley Operations.

In addition to the existing monitoring network, it is recommended to co-locate HVAS monitors at the existing TEOM monitoring stations. The HVAS monitors would be used to measure total base metal concentrations in the ambient air. The installation of the HVAS monitors in these locations will enable the upwind/ downwind assessment of contributions from the TSF. Co-locating these monitors with the TEOM will provide an indication of the hourly dust trends and can also be used to identify the potential origin of the measured base metals in the HVAS.

Two LVAS are recommended to be co-located with TEOM 2 and TEOM 4. These monitors will measure silica dust in the ambient air and will enable upwind/ downwind assessment of contributions from the TSF.

Metals analysed from the deposited dust gauges are recommended to be ongoing and will be used for analysis of any trends.

Table 4-1 outlines the recommended ambient air quality monitoring network. **Figure 4-1** shows the approximate location of each of the monitoring stations.

Table 4-1: Recommended ambient air quality monitoring network

ID	Property name	Monitor type	Parameter monitored
TEOM 1	Flyers Creek Weir	TEOM	PM_{10}
HVAS 1	Flyers Creek Weir	HVAS	PM_{10}, metals
TEOM 2	Bundarra	TEOM	PM_{10}
HVAS 2	Bundarra	HVAS	PM_{10}, metals
LVAS 2	Bundarra	LVAS	Silica
TEOM 3	Triangle Flat	TEOM	PM_{10}
HVAS 3	Triangle Flat	HVAS	PM_{10}, metals
TEOM 4	Meribah	TEOM	PM_{10}
HVAS 4	Meribah	HVAS	PM_{10}, metals
LVAS 4	Meribah	LVAS	Silica
DG5A	Bundella	Deposited dust gauge	Deposited dust, metals
DG9A	Exploration	Deposited dust gauge	Deposited dust, metals
DG12A	Flyers Creek Weir	Deposited dust gauge	Deposited dust, metals
DG15A	Bundarra	Deposited dust gauge	Deposited dust, metals
DG17	Ashleigh Park	Deposited dust gauge	Deposited dust, metals
DG18	Wire Gully	Deposited dust gauge	Deposited dust, metals
DG19	Oakey Creek	Deposited dust gauge	Deposited dust, metals

ID	Property name	Monitor type	Parameter monitored
DG29A	Meribah	Deposited dust gauge	Deposited dust, metals

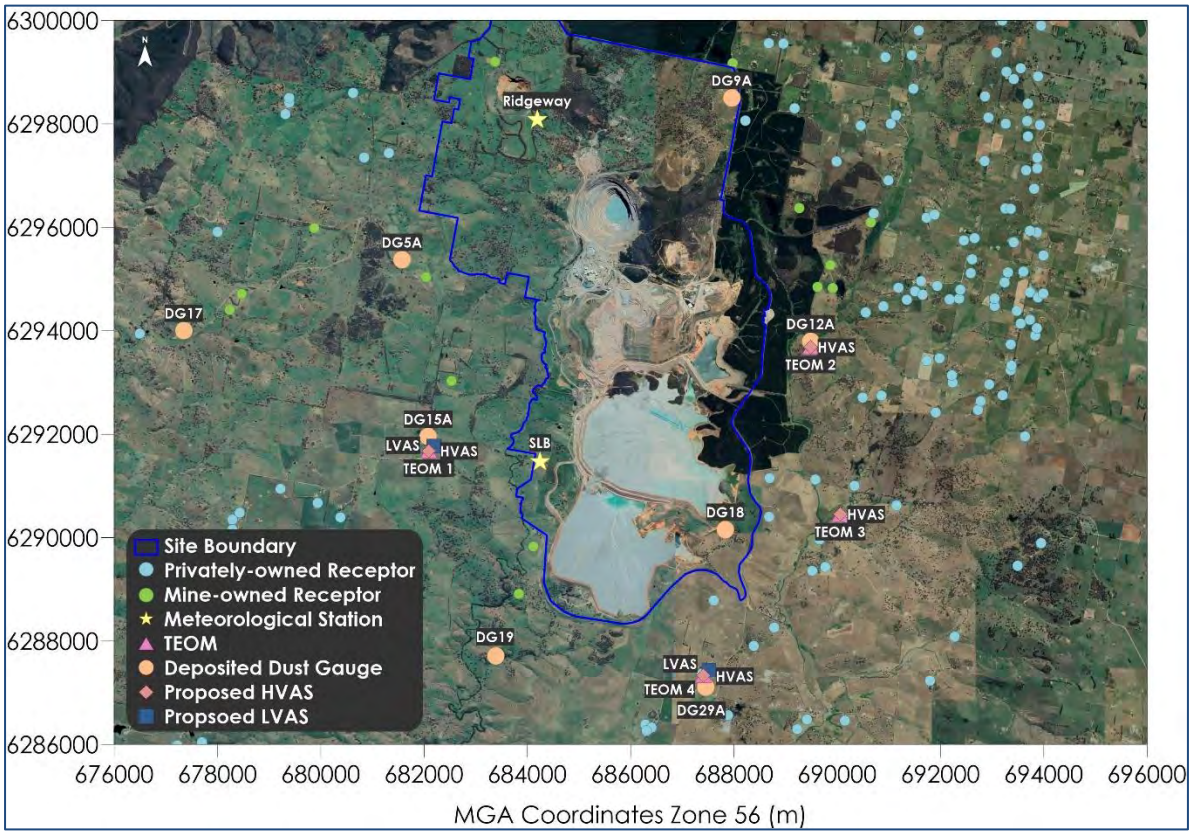

Figure 4-1: Recommended air quality monitoring network

4.3 Benchmarking of monitoring data

Table 4-2 presents the air quality criteria recommended to be used to benchmark the measured ambient air quality levels.

The NSW EPA document *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW EPA, 2017**) provides applicable criteria for ambient 24-hour average PM_{10} and $PM_{2.5}$ concentrations and annual average TSP, PM_{10}, $PM_{2.5}$ and deposited dust levels.

We note that the recommended air quality monitoring does not include measurement of TSP. In this situation, levels of TSP can be estimated from the measured PM_{10} concentrations assuming the relationship of the annual average TSP criteria of 90µg/m³ corresponds to an annual average PM_{10} criteria of 25µg/m³.

The air quality criteria for metals are obtained from the Ontario Ministry of the Environment (MOE) document *Ontario's Ambient Air Quality Criteria* (**MOE, 2012**). The Approved Methods (**NSW EPA, 2017**) also has criteria for metals, however these are assessed on a 1-hour averaging period. When sampling ambient air quality, it is necessary to sample for a long enough period to capture a suitable amount of material for analysis. This can be achieved by sampling for a 24-hour period and be benchmarked against 24-hour average criteria, sampling for a 1-hour period will not provide enough sample for analysis.

Table 4-2: Ambient air quality criteria

Substance	Averaging period	Limit	Source
TSP	Annual	90µg/m³	NSW EPA
PM_{10}	24-hour	50µg/m³	NSW EPA
	Annual	25µg/m³	NSW EPA
$PM_{2.5}$	24-hour	25µg/m³	NSW EPA
	Annual	8µg/m³	NSW EPA
Deposited dust	Annual	4g/m²/month	NSW EPA
Antimony and compounds	24-hour	25 µg/m³	MOE
Arsenic and compounds	24-hour	0.3 µg/m³	MOE
Barium – total water soluble	24-hour	10 µg/m³	MOE
Beryllium	24-hour	0.01 µg/m³	MOE
Boron	24-hour	120 µg/m³	MOE
Chromium (III) compounds	24-hour	0.5 µg/m³	MOE
Chromium VI compounds	24-hour	0.00035 µg/m³	MOE
Cobalt	24-hour	0.1 µg/m³	MOE
Copper	24-hour	50 µg/m³	MOE
Iron (metallic)	24-hour	4 µg/m³	MOE
Lead (and compounds)	24-hour	0.5 µg/m³	MOE
Lithium (other than hydrides)	24-hour	20 µg/m³	MOE
Manganese and compounds	24-hour	0.2 µg/m³	MOE
Molybdenum	24-hour	120 µg/m³	MOE
Nickel (and compounds) in PM_{10}	24-hour	0.1 µg/m³	MOE
Tin	24-hour	10 µg/m³	MOE
Selenium	24-hour	10 µg/m³	MOE
Silica – respirable (<10 µg diameter)	24-hour	5 µg/m³	MOE
Silver	24-hour	1 µg/m³	MOE
Strontium	24-hour	120 µg/m³	MOE
Uranium	24-hour	0.15 (U in PM_{10})	MOE
Vanadium	24-hour	2 µg/m³	MOE
Zinc	24-hour	120 µg/m³	MOE

4.4 Reporting of monitoring data

Reporting of ambient air quality monitoring data should be conducted at least monthly and include the following:

- A description of all activities occurring at the TSF during the month;
- An analysis of any air quality related complaints recorded during the month;
- A review of the measured levels against relevant benchmark levels for the period;
- Identification of any trends in the ambient monitoring data; and,
- A description of management measures applied during the period and an estimation recorded of the performance of the measures.

4.5 Period for monitoring

Monitoring is recommended for a minimum period of approximately three months and would be reviewed following this period.

4.6 Review of monitoring plan

It is recommended that the air quality monitoring for the TSF is reviewed and updated on a regular basis to ensure the performance of the plan and incorporate any improvements identified.

5 REFERENCES

MOE (2012)

"Ontario's Ambient Air Quality Criteria", Standards Development Branch Ontario Ministry of the Environment (MOE), April 2012.

NSW DEC (2007)

"Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales", NSW Department of Environment and Conservation [DEC], January 2007.

NSW EPA (2017)

"Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales", January 2017.

Appendix D. Results of PM_{10} metals monitoring

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Table D.1: Results of PM_{10} metals monitoring

Location	Date	PM_{10} (µg/m³)	Iron (µg/m³)	Aluminium (µg/m³)	Antimony (µg/m³)	Arsenic (µg/m³)	Barium (µg/m³)	Beryllium (µg/m³)	Cadmium (µg/m³)	Chromium (µg/m³)	Cobalt (µg/m³)	Copper (µg/m³)	Lead (µg/m³)	Manganese (µg/m³)	Mercury (µg/m³)	Molybdenum (µg/m³)	Nickel (µg/m³)	Selenium (µg/m³)	Silver (µg/m³)	Tin (µg/m³)	Zinc (µg/m³)
Bundarra	23-Apr-2020	14.2	0.26	0.74	<0.0006	<0.0006	0.0066	<0.0006	<0.0006	0.003	<0.0006	0.014	0.0006	0.006	<0.0006	<0.0006	0.0006	<0.0006	<0.0006	<0.0006	0.0096
Bundarra	29-Apr-2020	6	0.12	0.64	<0.00061	<0.00061	0.0055	<0.00061	<0.00061	0.0025	<0.00061	0.0049	0.00061	0.0055	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.0098
Bundarra	05-May-2020	9	0.2	0.63	<0.00061	<0.00061	0.0055	<0.00061	<0.00061	0.0024	<0.00061	0.023	0.00061	0.0037	<0.00061	<0.00061	0.00061	<0.00061	<0.00061	<0.00061	0.0079
Bundarra	17-May-2020	7.6	0.22	0.74	<0.00061	<0.00061	0.0067	<0.00061	<0.00061	0.0031	<0.00061	0.018	0.00061	0.0037	<0.00061	<0.00061	0.00061	<0.00061	<0.00061	<0.00061	0.0086
Bundarra	23-May-2020	3.8	0.076	1.2	<0.00061	<0.00061	0.012	<0.00061	<0.00061	0.003	<0.00061	0.0043	0.0012	0.0018	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.011
Bundarra	29-May-2020	19.8	0.42	1.4	<0.00061	<0.00061	0.011	<0.00061	<0.00061	0.0037	<0.00061	0.047	0.0012	0.0067	<0.00061	0.00061	0.00061	<0.00061	<0.00061	<0.00061	0.01
Bundarra	04-Jun-2020	24.8	0.37	1.3	<0.00061	<0.00061	0.011	<0.00061	<0.00061	0.003	<0.00061	0.045	0.0012	0.0067	<0.00061	0.00061	0.00061	<0.00061	<0.00061	<0.00061	0.012
Bundarra	10-Jun-2020	9.7	0.17	1.1	<0.00061	<0.00061	0.011	<0.00061	<0.00061	0.0031	<0.00061	0.017	0.0012	0.0037	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.0098
Bundarra	16-Jun-2020	7.1	0.048	0.8	<0.00061	<0.00061	0.0073	<0.00061	<0.00061	0.0018	<0.00061	0.003	0.00061	0.0012	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.0049
Bundarra	22-Jun-2020	3	0.062	0.95	<0.00061	<0.00061	0.0098	<0.00061	<0.00061	0.0031	<0.00061	0.0025	0.00061	0.0025	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.017
Bundarra	28-Jun-2020	20	0.3	0.88	<0.00061	<0.00061	0.0073	<0.00061	<0.00061	0.0018	<0.00061	0.038	0.0012	0.0049	<0.00061	0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.0067
Bundarra	04-Jul-2020	4.9	0.036	0.61	<0.00061	<0.00061	0.0061	<0.00061	<0.00061	0.0012	<0.00061	0.003	<0.00061	0.0012	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.0043
Bundarra	10-Jul-2020	15.7	0.21	0.85	<0.00061	<0.00061	0.0074	<0.00061	<0.00061	0.0018	<0.00061	0.023	0.00061	0.0037	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.0067
Bundarra	16-Jul-2020	8.4	0.14	0.66	<0.00061	<0.00061	0.0067	<0.00061	<0.00061	0.0018	<0.00061	0.013	0.00061	0.0025	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.0061
Bundarra	22-Jul-2020	15.5	0.34	0.75	<0.00061	<0.00061	0.0074	<0.00061	<0.00061	0.0025	<0.00061	0.029	0.00061	0.0049	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.0061
Bundarra	28-Jul-2020	2	0.075	0.94	<0.00061	<0.00061	0.0098	<0.00061	<0.00061	0.0037	<0.00061	0.0037	0.0012	0.0018	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.0098
Bundarra	03-Aug-2020	12.9	0.43	1	<0.00061	<0.00061	0.0098	<0.00061	<0.00061	0.0037	<0.00061	0.034	0.0012	0.0055	<0.00061	<0.00061	0.00061	<0.00061	<0.00061	<0.00061	0.0098
Bundarra	09-Aug-2020	2.9	0.063	1	<0.00061	<0.00061	0.022	<0.00061	<0.00061	0.0031	<0.00061	0.0037	0.00061	0.0012	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.013
Bundarra	27-Aug-2020	18.8	0.5	0.85	<0.00061	<0.00061	0.016	<0.00061	<0.00061	0.0025	<0.00061	0.053	0.0012	0.0061	<0.00061	0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.012
Bundarra	02-Sep-2020	17.1	0.15	0.78	<0.00061	<0.00061	0.013	<0.00061	<0.00061	0.0024	<0.00061	0.0049	0.00061	0.0037	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.0092
Bundarra	14-Sep-2020	13.1	0.21	0.8	<0.00061	<0.00061	0.0061	<0.00061	<0.00061	0.0018	<0.00061	0.019	<0.00061	0.0037	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.008
Bundarra	20-Sep-2020	7	0.086	0.72	<0.00061	<0.00061	0.0055	<0.00061	<0.00061	0.0018	<0.00061	0.0061	<0.00061	0.0018	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.0067
Bundarra	08-Oct-2020	7.7	0.077	0.81	<0.00061	<0.00061	0.0061	<0.00061	<0.00061	0.0018	<0.00061	0.0049	<0.00061	0.0025	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.0067

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Location	Date	PM_{10} (µg/m³)	Iron (µg/m³)	Aluminium (µg/m³)	Antimony (µg/m³)	Arsenic (µg/m³)	Barium (µg/m³)	Beryllium (µg/m³)	Cadmium (µg/m³)	Chromium (µg/m³)	Cobalt (µg/m³)	Copper (µg/m³)	Lead (µg/m³)	Manganese (µg/m³)	Mercury (µg/m³)	Molybdenum (µg/m³)	Nickel (µg/m³)	Selenium (µg/m³)	Silver (µg/m³)	Tin (µg/m³)	Zinc (µg/m³)
Flyer Creek	22-Jun-2020	7	0.16	0.97	<0.00058	<0.00058	0.0099	<0.00058	<0.00058	0.0029	<0.00058	0.012	0.0012	0.0035	<0.00058	<0.00058	0.0012	<0.00058	<0.00058	<0.00058	0.02
Flyer Creek	28-Jun-2020	6.9	0.043	0.6	<0.0006	<0.0006	0.006	<0.0006	<0.0006	0.0012	<0.0006	0.003	0.0012	0.0012	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	0.011
Flyer Creek	04-Jul-2020	6.7	0.076	0.8	<0.0006	<0.0006	0.0077	<0.0006	<0.0006	0.0018	<0.0006	0.0054	0.0006	0.0018	<0.0006	<0.0006	0.0006	<0.0006	<0.0006	<0.0006	0.011
Flyer Creek	10-Jul-2020	8	0.06	0.79	<0.0006	<0.0006	0.0071	<0.0006	<0.0006	0.0018	<0.0006	0.003	0.0012	0.0018	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	0.0083
Flyer Creek	16-Jul-2020	3.6	0.076	1.1	<0.0006	<0.0006	0.011	<0.0006	<0.0006	0.003	<0.0006	0.003	0.0012	0.0024	<0.0006	<0.0006	0.0006	<0.0006	<0.0006	<0.0006	0.015
Flyer Creek	22-Jul-2020	10.4	0.15	0.8	<0.00059	<0.00059	0.0083	<0.00059	<0.00059	0.0024	<0.00059	0.0065	0.00059	0.003	<0.00059	<0.00059	<0.00059	<0.00059	<0.00059	<0.00059	0.0083
Flyer Creek	28-Jul-2020	4.4	0.11	1.1	<0.0006	<0.0006	0.011	<0.0006	<0.0006	0.0036	<0.0006	0.0071	0.0012	0.0024	<0.0006	<0.0006	0.0006	<0.0006	<0.0006	<0.0006	0.015
Flyer Creek	03-Aug-2020	9.1	0.16	0.8	<0.0006	<0.0006	0.0083	<0.0006	<0.0006	0.0024	<0.0006	0.0077	0.0006	0.003	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	0.0083
Flyer Creek	09-Aug-2020	5.8	0.12	0.83	<0.0006	<0.0006	0.0072	<0.0006	<0.0006	0.0024	<0.0006	0.0084	0.0006	0.0018	<0.0006	<0.0006	0.0012	<0.0006	<0.0006	<0.0006	0.01
Meribah	17-May-2020	9.2	0.23	0.76	<0.00061	0.00061	0.008	<0.00061	<0.00061	0.0031	<0.00061	0.0055	0.00061	0.0049	<0.00061	<0.00061	0.00061	<0.00061	<0.00061	<0.00061	0.015
Meribah	23-May-2020	6.6	0.053	1.2	<0.00061	<0.00061	0.011	<0.00061	<0.00061	0.003	<0.00061	0.0024	0.0012	0.0018	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.013
Meribah	29-May-2020	9.2	0.13	1.2	<0.00061	<0.00061	0.011	<0.00061	<0.00061	0.0031	<0.00061	0.0031	0.0012	0.0037	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.013
Meribah	04-Jun-2020	8.7	0.058	1.1	<0.00061	<0.00061	0.0098	<0.00061	<0.00061	0.0025	<0.00061	0.0031	0.0012	0.0025	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.014
Meribah	10-Jun-2020	4.9	0.066	0.98	<0.00061	<0.00061	0.0092	<0.00061	<0.00061	0.0025	<0.00061	0.0025	0.00061	0.0018	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.012
Meribah	16-Jun-2020	12	0.074	0.89	<0.00061	<0.00061	0.0074	<0.00061	<0.00061	0.0018	<0.00061	0.0061	0.0012	0.0018	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.013
Meribah	22-Jun-2020	7	0.042	0.91	<0.00061	<0.00061	0.008	<0.00061	<0.00061	0.0018	<0.00061	0.0025	<0.00061	0.0012	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.0092
Meribah	28-Jun-2020	7.8	0.048	0.69	<0.00061	<0.00061	0.0067	<0.00061	<0.00061	0.0012	<0.00061	0.0031	0.00061	0.0012	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.01
Meribah	04-Jul-2020	6.5	0.035	0.74	<0.00061	<0.00061	0.0067	<0.00061	<0.00061	0.0012	<0.00061	0.0025	<0.00061	0.0012	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.036
Meribah	10-Jul-2020	11.9	0.1	0.84	<0.00069	<0.00069	0.0083	<0.00069	<0.00069	0.0021	<0.00069	0.0028	0.00069	0.0028	<0.00069	<0.00069	<0.00069	<0.00069	<0.00069	<0.00069	0.013
Meribah	16-Jul-2020	5.6	0.052	0.74	<0.00061	<0.00061	0.0079	<0.00061	<0.00061	0.0018	<0.00061	0.0037	0.00061	0.0012	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.013
Meribah	22-Jul-2020	6.5	0.13	0.91	<0.00061	<0.00061	0.01	<0.00061	<0.00061	0.0037	<0.00061	0.0049	0.0012	0.003	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.01
Meribah	28-Jul-2020	2	0.064	0.9	0.00061	<0.00061	0.0092	<0.00061	<0.00061	0.0031	<0.00061	0.0037	0.0012	0.0018	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.017
Meribah	03-Aug-2020	12.9	0.27	0.7	<0.00062	<0.00062	0.0074	<0.00062	<0.00062	0.0025	<0.00062	0.012	0.00062	0.0043	<0.00062	<0.00062	<0.00062	<0.00062	<0.00062	<0.00062	0.0056
Meribah	15-Aug-2020	6	0.074	0.9	<0.00061	<0.00061	0.02	<0.00061	<0.00061	0.0025	<0.00061	0.0031	0.00061	0.0012	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.012
Meribah	21-Aug-2020	9.8	0.066	0.76	<0.00066	<0.00066	0.0079	<0.00066	<0.00066	0.002	<0.00066	0.0046	0.00066	0.002	<0.00066	<0.00066	<0.00066	<0.00066	<0.00066	<0.00066	0.0072

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Location	Date	PM_{10} (µg/m³)	Iron (µg/m³)	Aluminium (µg/m³)	Antimony (µg/m³)	Arsenic (µg/m³)	Barium (µg/m³)	Beryllium (µg/m³)	Cadmium (µg/m³)	Chromium (µg/m³)	Cobalt (µg/m³)	Copper (µg/m³)	Lead (µg/m³)	Manganese (µg/m³)	Mercury (µg/m³)	Molybdenum (µg/m³)	Nickel (µg/m³)	Selenium (µg/m³)	Silver (µg/m³)	Tin (µg/m³)	Zinc (µg/m³)
Meribah	27-Aug-2020	7.8	0.17	0.77	<0.00061	<0.00061	0.018	<0.00061	<0.00061	0.0025	<0.00061	0.0074	0.0012	0.0031	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.012
Meribah	14-Sep-2020	13.1	0.19	0.81	<0.00061	<0.00061	0.0067	<0.00061	<0.00061	0.0018	<0.00061	0.0098	<0.00061	0.0049	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.012
Meribah	20-Sep-2020	7.2	0.096	0.72	<0.00061	<0.00061	0.0055	<0.00061	<0.00061	0.0018	<0.00061	0.0055	<0.00061	0.0025	<0.00061	<0.00061	0.00061	<0.00061	<0.00061	<0.00061	0.0067
Meribah	26-Sep-2020	5.2	0.048	0.71	<0.00061	<0.00061	0.0061	<0.00061	<0.00061	0.0018	<0.00061	0.0037	<0.00061	0.0012	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.0055
Meribah	02-Oct-2020	11.7	0.11	1	<0.00061	<0.00061	0.018	<0.00061	<0.00061	0.0024	<0.00061	0.0043	<0.00061	0.0031	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.014
Meribah	08-Oct-2020	7.1	0.075	0.84	<0.00061	<0.00061	0.016	<0.00061	<0.00061	0.0024	<0.00061	0.0037	0.00061	0.0024	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.011
Meribah	26-Oct-2020	9.1	0.043	0.5	0.00062	<0.00062	0.0099	<0.00062	<0.00062	0.0019	<0.00062	0.0037	<0.00062	0.0019	<0.00062	<0.00062	<0.00062	<0.00062	<0.00062	<0.00062	0.018
Meribah	01-Nov-2020	10.4	0.058	0.48	<0.00061	<0.00061	0.0098	<0.00061	<0.00061	0.0018	<0.00061	0.0037	<0.00061	0.0018	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.0098
Meribah	19-Nov-2020	26.5	0.38	0.76	<0.00061	<0.00061	0.029	<0.00061	<0.00061	0.0024	<0.00061	0.0049	0.00061	0.0085	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.022
Meribah	25-Nov-2020	15.9	0.15	0.71	<0.00061	<0.00061	0.026	<0.00061	<0.00061	0.0025	<0.00061	0.0061	0.00061	0.0037	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.021
Meribah	01-Dec-2020	32.8	0.49	0.86	<0.00062	<0.00062	0.027	<0.00062	<0.00062	0.0025	<0.00062	0.0068	0.0012	0.014	<0.00062	<0.00062	0.00062	<0.00062	<0.00062	<0.00062	0.022
Meribah	07-Dec-2020	14.4	0.18	0.65	<0.00062	<0.00062	0.023	<0.00062	<0.00062	0.0025	<0.00062	0.0031	<0.00062	0.0056	<0.00062	<0.00062	<0.00062	<0.00062	<0.00062	<0.00062	0.019
Meribah	13-Dec-2020	12.5	0.14	0.58	<0.00061	<0.00061	0.0098	<0.00061	<0.00061	0.0018	<0.00061	0.0037	<0.00061	0.0037	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.0086
Meribah	19-Dec-2020	10.2	0.1	0.62	<0.00062	<0.00062	0.0099	<0.00062	<0.00062	0.0019	<0.00062	0.0037	<0.00062	0.0037	<0.00062	<0.00062	<0.00062	<0.00062	<0.00062	<0.00062	0.012
Meribah	25-Dec-2020	12.5	0.11	0.58	<0.00061	<0.00061	0.0098	<0.00061	<0.00061	0.0018	<0.00061	0.0049	<0.00061	0.0031	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.0092
Meribah	31-Dec-2020	10.9	0.12	0.71	<0.00061	<0.00061	0.011	<0.00061	<0.00061	0.0025	<0.00061	0.0067	0.00061	0.0037	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.012
Meribah	06-Jan-2021	10.1	0.14	0.6	<0.00062	<0.00062	0.0099	<0.00062	<0.00062	0.0019	<0.00062	0.0074	<0.00062	0.0031	<0.00062	<0.00062	<0.00062	<0.00062	<0.00062	<0.00062	0.011
Triangle Flat	17-May-2020	3.5	0.058	0.63	<0.00061	<0.00061	0.0061	<0.00061	<0.00061	0.0024	<0.00061	0.0036	0.0012	0.0018	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.011
Triangle Flat	23-May-2020	2.9	0.05	0.99	<0.00061	<0.00061	0.008	<0.00061	<0.00061	0.0031	<0.00061	0.0031	0.0012	0.0018	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.014
Triangle Flat	29-May-2020	4.6	0.065	1.1	<0.00061	<0.00061	0.0086	<0.00061	<0.00061	0.0031	<0.00061	0.0031	0.0012	0.0025	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.015
Triangle Flat	04-Jun-2020	8	0.06	0.99	<0.00061	<0.00061	0.0085	<0.00061	<0.00061	0.003	<0.00061	0.0043	0.00061	0.0024	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.013
Triangle Flat	10-Jun-2020	3.8	0.052	1	<0.00061	<0.00061	0.0092	<0.00061	<0.00061	0.0031	<0.00061	0.0031	0.00061	0.0018	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.015
Triangle Flat	16-Jun-2020	8.4	0.071	0.75	<0.00061	<0.00061	0.0061	<0.00061	<0.00061	0.0018	<0.00061	0.0073	0.00061	0.0018	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.012
Triangle Flat	22-Jun-2020	4.4	0.051	0.62	<0.00061	<0.00061	0.0055	<0.00061	<0.00061	0.0012	<0.00061	0.0061	<0.00061	0.0012	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.0085
Triangle Flat	28-Jun-2020	8.4	0.052	0.77	<0.00061	<0.00061	0.0067	<0.00061	<0.00061	0.0018	<0.00061	0.0031	0.00061	0.0012	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.011

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Location	Date	PM_{10} (µg/m³)	Iron (µg/m³)	Aluminium (µg/m³)	Antimony (µg/m³)	Arsenic (µg/m³)	Barium (µg/m³)	Beryllium (µg/m³)	Cadmium (µg/m³)	Chromium (µg/m³)	Cobalt (µg/m³)	Copper (µg/m³)	Lead (µg/m³)	Manganese (µg/m³)	Mercury (µg/m³)	Molybdenum (µg/m³)	Nickel (µg/m³)	Selenium (µg/m³)	Silver (µg/m³)	Tin (µg/m³)	Zinc (µg/m³)
Triangle Flat	04-Jul-2020	4	0.035	0.58	<0.00061	<0.00061	0.0049	<0.00061	<0.00061	0.0012	<0.00061	0.0025	<0.00061	0.0012	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.0092
Triangle Flat	10-Jul-2020	8.3	0.056	0.71	<0.00061	<0.00061	0.0061	<0.00061	<0.00061	0.0018	<0.00061	0.0025	0.00061	0.0018	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.0098
Triangle Flat	16-Jul-2020	5.1	0.04	0.67	<0.00061	<0.00061	0.0061	<0.00061	<0.00061	0.0018	<0.00061	0.0031	<0.00061	0.0012	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.0092
Triangle Flat	22-Jul-2020	8.8	0.087	0.69	<0.00061	<0.00061	0.008	<0.00061	<0.00061	0.0025	<0.00061	0.0043	0.00061	0.0025	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.0061
Triangle Flat	28-Jul-2020	6.2	0.064	0.72	<0.00061	<0.00061	0.008	<0.00061	<0.00061	0.0025	<0.00061	0.0043	<0.00061	0.0018	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.0061
Triangle Flat	03-Aug-2020	11.2	0.23	0.72	<0.00061	<0.00061	0.0067	<0.00061	<0.00061	0.0018	<0.00061	0.014	0.00061	0.0037	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.0061
Triangle Flat	09-Aug-2020	3.6	0.04	0.49	<0.00061	<0.00061	0.0061	<0.00061	<0.00061	0.0018	<0.00061	0.0037	<0.00061	0.0012	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.0049
Triangle Flat	27-Aug-2020	6.1	0.16	0.81	<0.00062	<0.00062	0.019	<0.00062	<0.00062	0.0025	<0.00062	0.0086	0.0012	0.0031	<0.00062	<0.00062	<0.00062	<0.00062	<0.00062	<0.00062	0.012
Triangle Flat	02-Sep-2020	0.7	0.2	0.97	<0.00061	<0.00061	0.0086	<0.00061	<0.00061	0.0031	<0.00061	0.0037	0.0012	0.0067	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.008
Triangle Flat	14-Sep-2020	9.5	0.13	0.79	<0.00061	<0.00061	0.0074	<0.00061	<0.00061	0.0018	<0.00061	0.0068	<0.00061	0.0031	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.0055
Triangle Flat	20-Sep-2020	7.5	0.11	0.77	<0.00061	<0.00061	0.0061	<0.00061	<0.00061	0.0018	<0.00061	0.0074	<0.00061	0.0025	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.0055
Triangle Flat	26-Sep-2020	5	0.048	0.91	<0.00066	<0.00066	0.0072	<0.00066	<0.00066	0.002	<0.00066	0.0033	<0.00066	0.0013	<0.00066	<0.00066	<0.00066	<0.00066	<0.00066	<0.00066	0.0066
Triangle Flat	02-Oct-2020	8.6	0.072	0.92	<0.00061	<0.00061	0.018	<0.00061	<0.00061	0.0025	<0.00061	0.0031	<0.00061	0.0018	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.012
Triangle Flat	08-Oct-2020	8.3	0.09	0.85	<0.00061	<0.00061	0.015	<0.00061	<0.00061	0.0018	<0.00061	0.0049	0.00061	0.0025	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.0098
Triangle Flat	26-Oct-2020	7.5	0.046	0.48	<0.00062	<0.00062	0.01	<0.00062	<0.00062	0.0019	<0.00062	0.0037	<0.00062	0.0019	<0.00062	<0.00062	<0.00062	<0.00062	<0.00062	<0.00062	0.011
Triangle Flat	01-Nov-2020	10	0.068	0.57	<0.00061	<0.00061	0.012	<0.00061	<0.00061	0.0018	<0.00061	0.0037	<0.00061	0.0024	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.01
Triangle Flat	07-Nov-2020	13.6	0.087	0.61	<0.00061	<0.00061	0.012	<0.00061	<0.00061	0.0024	<0.00061	0.0043	<0.00061	0.0024	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.014
Triangle Flat	13-Nov-2020	13.8	0.13	0.53	<0.00059	<0.00059	0.01	<0.00059	<0.00059	0.0018	<0.00059	0.0071	<0.00059	0.0041	<0.00059	<0.00059	<0.00059	<0.00059	<0.00059	<0.00059	0.0095
Triangle Flat	19-Nov-2020	26.4	0.29	0.81	<0.00063	<0.00063	0.033	<0.00063	<0.00063	0.0025	<0.00063	0.0057	0.0013	0.011	<0.00063	<0.00063	<0.00063	<0.00063	<0.00063	<0.00063	0.025
Triangle Flat	25-Nov-2020	13.2	0.15	0.75	<0.00061	<0.00061	0.031	<0.00061	<0.00061	0.0025	<0.00061	0.0092	0.00061	0.0037	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.024
Triangle Flat	01-Dec-2020	26.4	0.25	0.77	<0.00061	<0.00061	0.029	<0.00061	<0.00061	0.0025	<0.00061	0.0043	0.00061	0.008	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.023
Triangle Flat	07-Dec-2020	13.2	0.16	0.73	<0.00061	<0.00061	0.03	<0.00061	<0.00061	0.0024	<0.00061	0.0061	0.00061	0.0049	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.023
Triangle Flat	13-Dec-2020	8.5	0.088	0.62	<0.00062	<0.00062	0.013	<0.00062	<0.00062	0.0025	<0.00062	0.0037	<0.00062	0.0037	<0.00062	<0.00062	<0.00062	<0.00062	<0.00062	<0.00062	0.01
Triangle Flat	19-Dec-2020	7.9	0.11	0.7	<0.00062	<0.00062	0.013	<0.00062	<0.00062	0.0025	<0.00062	0.0037	<0.00062	0.0049	<0.00062	<0.00062	<0.00062	<0.00062	<0.00062	<0.00062	0.01
Triangle Flat	25-Dec-2020	11.2	0.1	0.72	<0.00062	<0.00062	0.03	<0.00062	<0.00062	0.0025	<0.00062	0.0049	0.00062	0.0037	<0.00062	<0.00062	<0.00062	<0.00062	<0.00062	<0.00062	0.023

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Location	Date	PM_{10} (µg/m³)	Iron (µg/m³)	Aluminium (µg/m³)	Antimony (µg/m³)	Arsenic (µg/m³)	Barium (µg/m³)	Beryllium (µg/m³)	Cadmium (µg/m³)	Chromium (µg/m³)	Cobalt (µg/m³)	Copper (µg/m³)	Lead (µg/m³)	Manganese (µg/m³)	Mercury (µg/m³)	Molybdenum (µg/m³)	Nickel (µg/m³)	Selenium (µg/m³)	Silver (µg/m³)	Tin (µg/m³)	Zinc (µg/m³)
Triangle Flat	31-Dec-2020	6	0.071	0.69	<0.00061	<0.00061	0.012	<0.00061	<0.00061	0.0024	<0.00061	0.0049	<0.00061	0.0024	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.0098
Triangle Flat	06-Jan-2021	7.2	0.12	0.66	<0.00061	<0.00061	0.011	<0.00061	<0.00061	0.0024	<0.00061	0.0079	<0.00061	0.003	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	<0.00061	0.012

Notes:

Results that were invalid are not included in this table (e.g., due to excess or insufficient sampling time or volume, or laboratory errors).

Results below the limit of reporting are in black font.

Results above the limit of reporting are in coloured font.

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Appendix E. QUT reports

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QUT Central Analytical Research Facility

QUT Central Analytical Research Facility
Materials Characterisation Report

CLIENT	Kathryn Stewart & Tim Wrigley Newcrest
REPORT DATE	2020-02-10
PREPARED BY	Henry Spratt
ANALYSIS REQUESTED	Sizing (sieve), Quantitative XRD, Clay Analysis
OUR REFERENCE	X20005
YOUR REFERENCE	PO4500983185 – Cadia Enviro/Dust *8x Tailings Samples*
QUT CONTACTS	Mr Ashley Locke, X-ray Analysis Coordinator Ph: 0400128230 | email: a.locke@qut.edu.au Dr Henry Spratt, Senior X-ray Technologist (Geoscience) Ph: 07 3138 9526 | email: henry.spratt@qut.edu.au **X-ray and Particles Laboratory enquiries: xandp@qut.edu.au**

RESULTS

Sizing

The table below summarises the particle sizing (via sieve) of the 8 powder samples.

Sample	+300 µm (wt%)	-300/+0 µm (wt%)
NTSF1	41.3	58.7
NTSF2	47.0	53.0
NTSF3	55.2	44.8
NTSF4	59.5	40.5
STSF1	39.2	60.8
STSF2	21.3	78.7
STSF3	40.5	59.5
STSF4	37.4	62.6

Phase Identification / Quantification

The powder X-ray diffraction patterns show the presence of crystalline phases. Graphics of the collected diffraction patterns along with the phases identified are included at the end of this report. The estimated normalised abundance of the corundum internal standard in the samples is higher than 20 wt%. This means there is an unaccounted for component in the samples (i.e., the samples contain non-diffracting and/or unidentified material). This component is frequently referred to as amorphous.

Trace pyrite could be successfully modelled in all samples. The presence of magnetite was confirmed by passing a strong magnet over the samples and noting particle movement. Chlorite/clinochlore and illite/micas (specifically illite, muscovite and phengite) were the only clay phases detected in all samples. Cordierite or an amphibole member were detected in samples 5 and 7; amphibole was modelled in the absence of other information. A sharp but weak peak at 50.57 °2θ in sample 8 could be due to trace FeS phases such as pyrrhotite or troilite, but the data does not support the modelling of these phases. A weak but sharp peak at 30.1 °2θ is tentatively modelled as anatase in sample 4: this peak is only observed in this particular sample. Sample 4 is also the most different sample out of the 8 submitted as it was the only sample which was found to contain laumontite, rhomboclase and blodite. There is an unidentified peak at 10.56 °2θ in sample 6 which could be a different mica phase that is not in our reference database.

Table of phase abundances (nominal wt%, absolute)

X20005 8x Tailings Samples	1 NTSF1	2 NTSF2	3 NTSF3	4 NTSF4
Quartz	16.3	14.0	15.2	14.0
Anatase?				0.4
Magnetite	0.7	0.5	0.2	0.4
Pyrite	0.6	0.5	0.6	0.5
Calcite	3.7	3.2	3.4	3.3
Dolomite		0.3		1.7
Blodite				11.9
Rhomboclase				0.9
Gypsum	0.5	1.3	1.5	0.7
Plagioclase (An0-50)	30.1	26.0	29.3	23.9
K-Feldsdpar	12.8	11.5	11.9	8.0
Laumontite				1.3
Halite		0.5		0.4
Chlorite/clinochlore	10.5	10.1	11.3	9.5
Illite/mica (TOTAL)	19.8	19.8	19.5	15.6
Amorphous	5.0	12.5	7.0	7.6

X20005 8x Tailings Samples	5 STSF1	6 STSF2	7 STSF3	8 STSF4
Quartz	16.7	17.0	16.2	15.1
Magnetite	1.1	0.5	1.0	0.6
Pyrite	0.4	0.5	0.6	0.6
Calcite	3.4	3.4	3.8	3.8
Dolomite		0.5	0.2	
Gypsum	0.7	0.9	0.6	0.7
Amphibole	1.4		2.1	
Plagioclase (An0-50)	30.9	29.3	31.4	29.0
K-Feldsdpar	11.3	9.2	11.4	11.2
Halite		0.8		
Chlorite/clinochlore	12.6	10.6	15.7	14.7
Illite/mica (TOTAL)	18.9	18.7	16.3	18.7
Amorphous	2.7	8.6	0.9	5.7

Table of fine fraction (clay phases) identifications (qualitative, nominal)

8x Tailings Samples	NTSF1	NTSF2	NTSF3	NTSF4
Chlorite	major	major	major	major
Illite/mica	major	major	major	major

X20005 8x Tailings Samples	5 STSF1	6 STSF2	7 STSF3	8 STSF4
Quartz	major	major	major	major
Magnetite	major	major	major	major

Abundant – nominally > 40 wt%

Major – nominally > 10 wt% but < 40 wt%

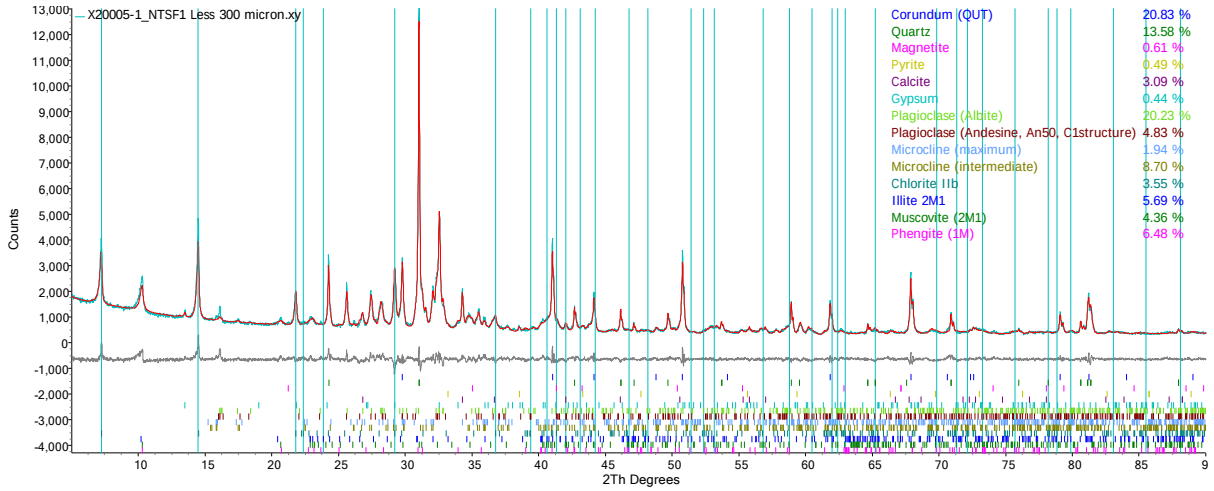
Minor – nominally > 1 wt% but < 10 wt%

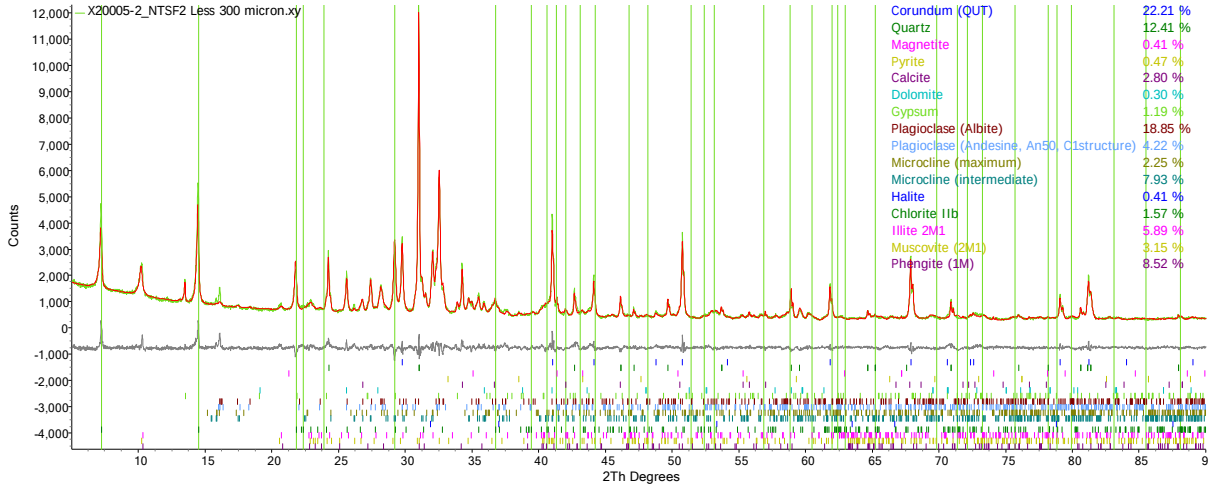
Trace – nominally < 1 wt%

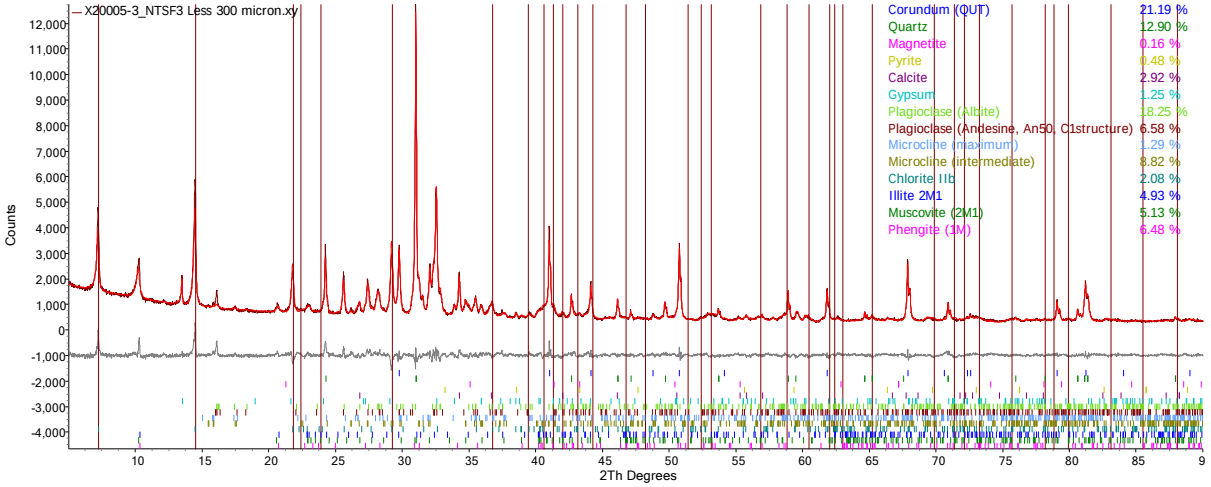
APPENDIX 1 – X-RAY DIFFRACTION DATA AND GRAPHICS

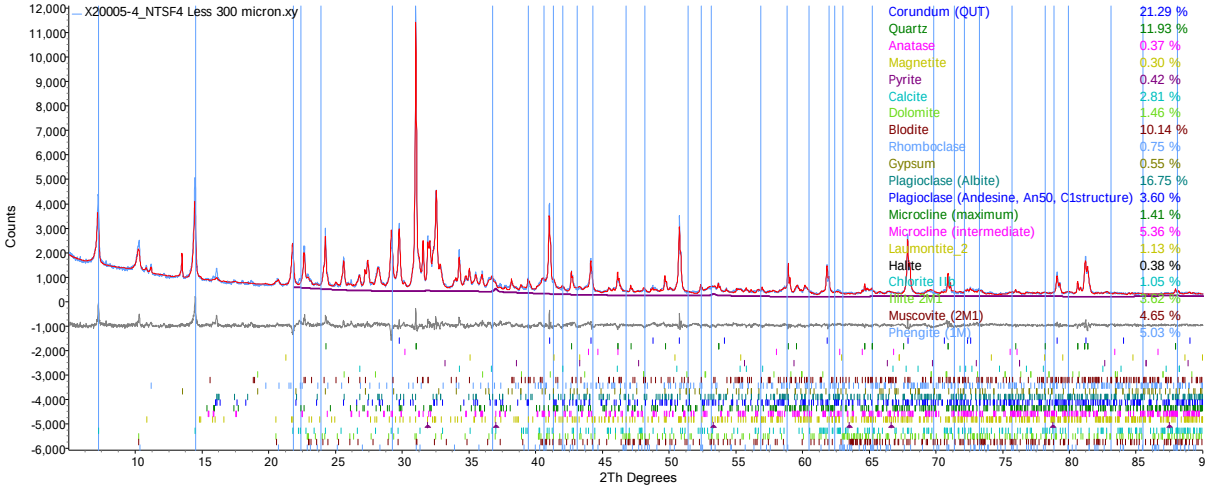
Powder X-ray Diffraction Patterns

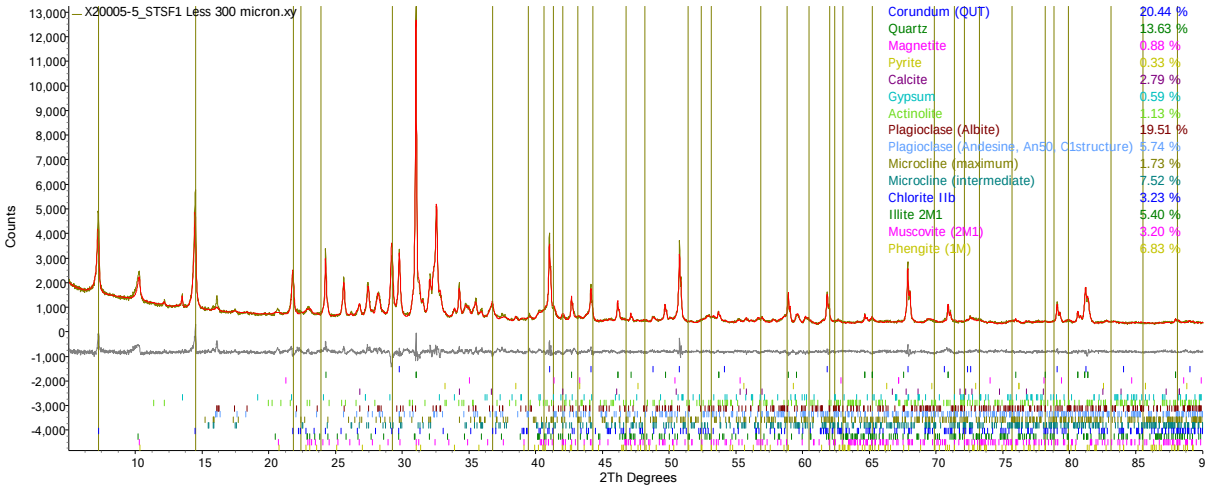
In the graphics below the red line is the Rietveld refinement model, the coloured line is the collected data, and the grey line is the difference. The abundances on the graphics are before taking into account the known addition of corundum standard. Please use the tabulated abundances (wt% in original sample) which require no further manipulation. Vertical lines are the expected peak positions of an in-house model for ripidolite.

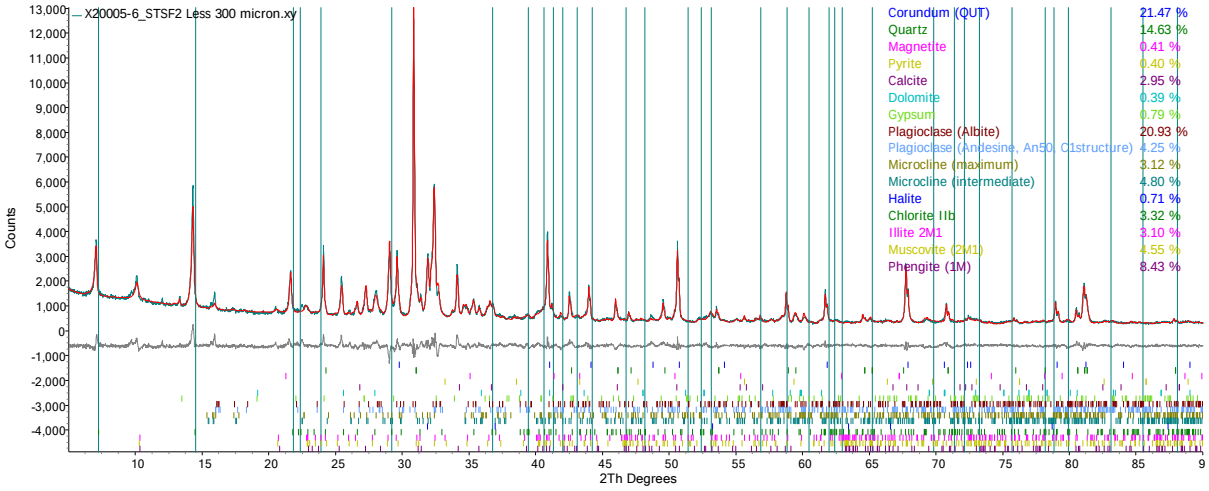


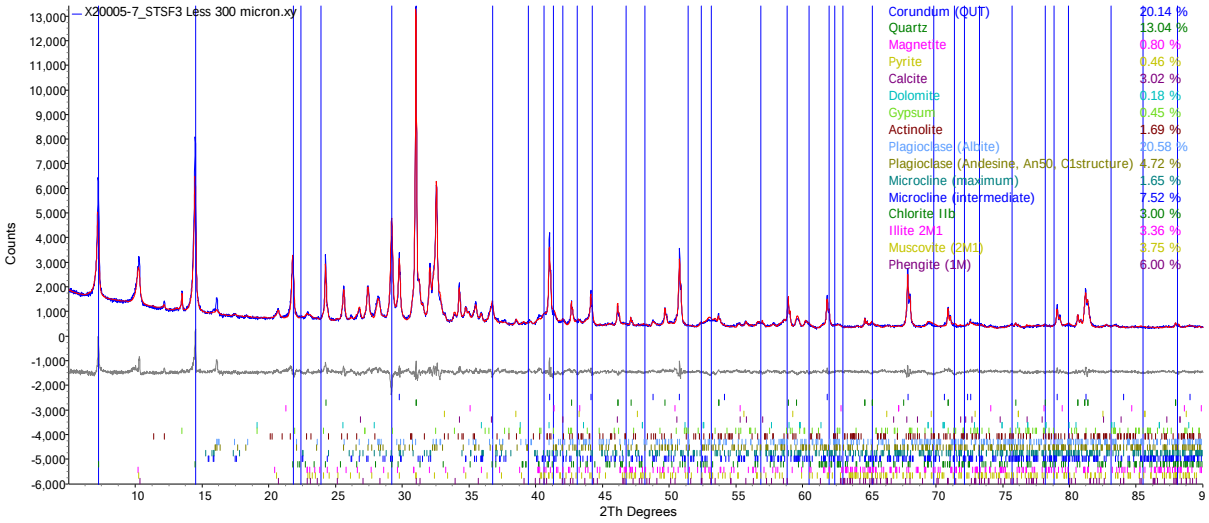


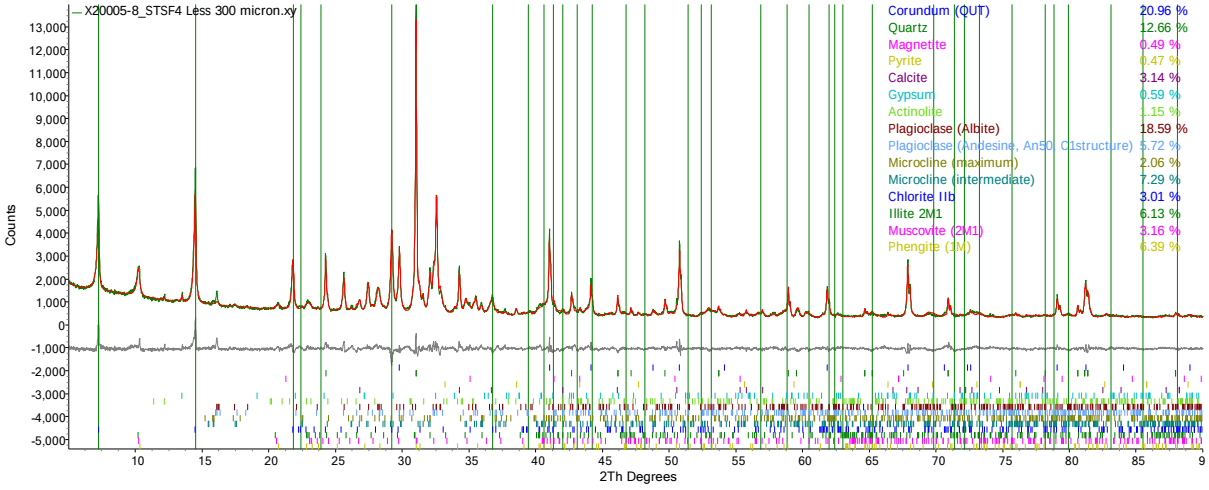

X20005-3_NTSF3 Less 300 micron.xy
Corundum (QUT) 21.19 %
Quartz 12.90 %
Magnetite 0.16 %
Pyrite 0.48 %
Calcite 2.92 %
Gypsum 1.25 %
Plagioclase (Albite) 18.25 %
Plagioclase (Andesine, An50, C1structure) 6.58 %
Microcline (maximum) 1.29 %
Microcline (intermediate) 8.82 %
Chlorite IIb 2.08 %
Illite 2M1 4.93 %
Muscovite (2M1) 5.13 %
Phengite (1M) 6.48 %
Counts
2Th Degrees


X20005-4_NTSF4 Less 300 micron.xy
Corundum (QUT) 21.29 %
Quartz 11.93 %
Anatase 0.37 %
Magnetite 0.30 %
Pyrite 0.42 %
Calcite 2.81 %
Dolomite 1.46 %
Blodite 10.14 %
Rhomboclase 0.75 %
Gypsum 0.55 %
Plagioclase (Albite) 16.75 %
Plagioclase (Andesine, An50, C1structure) 3.60 %
Microcline (maximum) 1.41 %
Microcline (intermediate) 5.36 %
Laumontite_2 1.13 %
Halite 0.38 %
Chlorite IIb 1.05 %
Illite 2M1 5.02 %
Muscovite (2M1) 4.65 %
Phengite (1M) 5.03 %
Counts
2Th Degrees

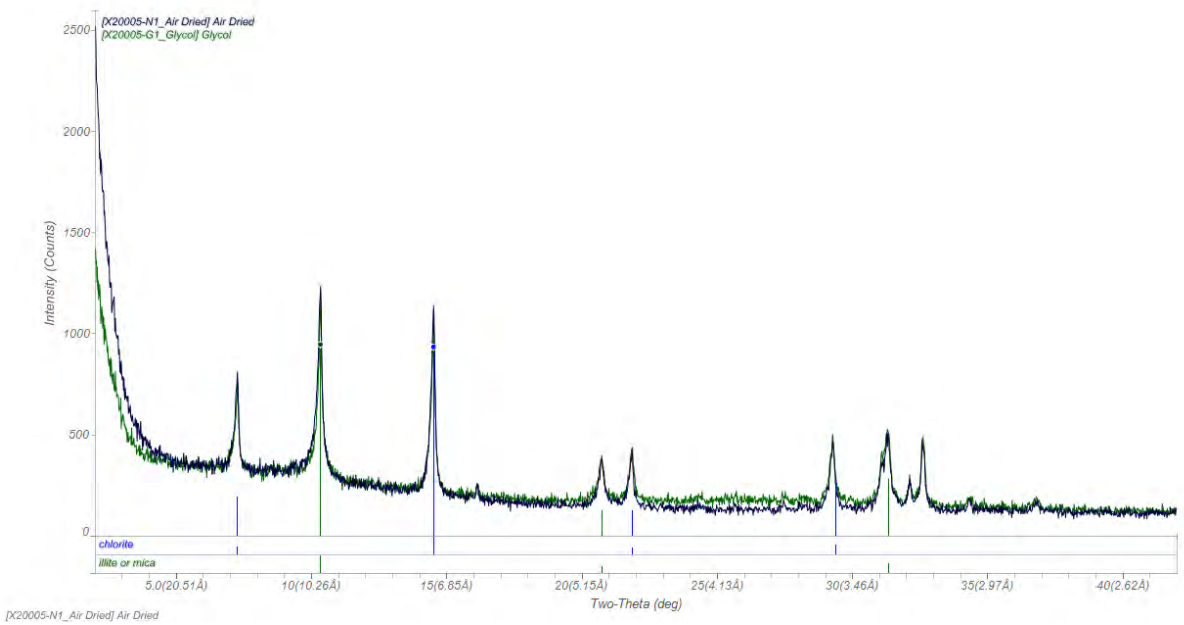

X20005-5_STSF1 Less 300 micron.xy
Corundum (QUT) 20.44 %
Quartz 13.63 %
Magnetite 0.88 %
Pyrite 0.33 %
Calcite 2.79 %
Gypsum 0.59 %
Actinolite 1.13 %
Plagioclase (Albite) 19.51 %
Plagioclase (Andesine, An50, C1structure) 5.74 %
Microcline (maximum) 1.73 %
Microcline (intermediate) 7.52 %
Chlorite IIb 3.23 %
Illite 2M1 5.40 %
Muscovite (2M1) 3.20 %
Phengite (1M) 6.83 %
Counts
2Th Degrees


X20005-6_STSF2 Less 300 micron.xy
Corundum (QUT) 21.47 %
Quartz 14.63 %
Magnetite 0.41 %
Pyrite 0.40 %
Calcite 2.95 %
Dolomite 0.39 %
Gypsum 0.79 %
Plagioclase (Albite) 20.93 %
Plagioclase (Andesine, An50, C1structure) 4.25 %
Microcline (maximum) 3.12 %
Microcline (intermediate) 4.80 %
Halite 0.71 %
Chlorite IIb 3.32 %
Illite 2M1 3.10 %
Muscovite (2M1) 4.55 %
Phengite (1M) 8.43 %
Counts
2Th Degrees

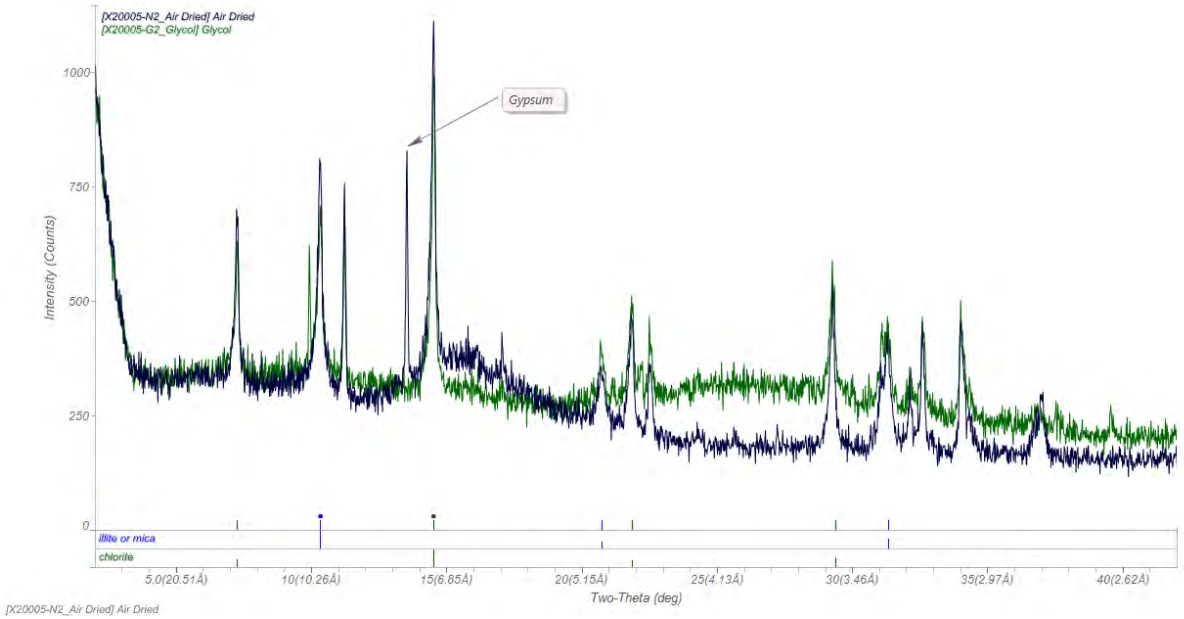

X20005-7_STSF3 Less 300 micron.xy
Corundum (QUT) 20.14 %
Quartz 13.04 %
Magnetite 0.80 %
Pyrite 0.46 %
Calcite 3.02 %
Dolomite 0.18 %
Gypsum 0.45 %
Actinolite 1.69 %
Plagioclase (Albite) 20.58 %
Plagioclase (Andesine, An50, C1structure) 4.72 %
Microcline (maximum) 1.65 %
Microcline (intermediate) 7.52 %
Chlorite IIb 3.00 %
Illite 2M1 3.36 %
Muscovite (2M1) 3.75 %
Phengite (1M) 6.00 %
Counts
2Th Degrees


X20005-8_STSF4 Less 300 micron.xy
Corundum (QUT) 20.96 %
Quartz 12.66 %
Magnetite 0.49 %
Pyrite 0.47 %
Calcite 3.14 %
Gypsum 0.59 %
Actinolite 1.15 %
Plagioclase (Albite) 18.59 %
Plagioclase (Andesine, An50, C1structure) 5.72 %
Microcline (maximum) 2.06 %
Microcline (intermediate) 7.29 %
Chlorite IIb 3.01 %
Illite 2M1 6.13 %
Muscovite (2M1) 3.16 %
Phengite (1M) 6.39 %
Counts
2Th Degrees

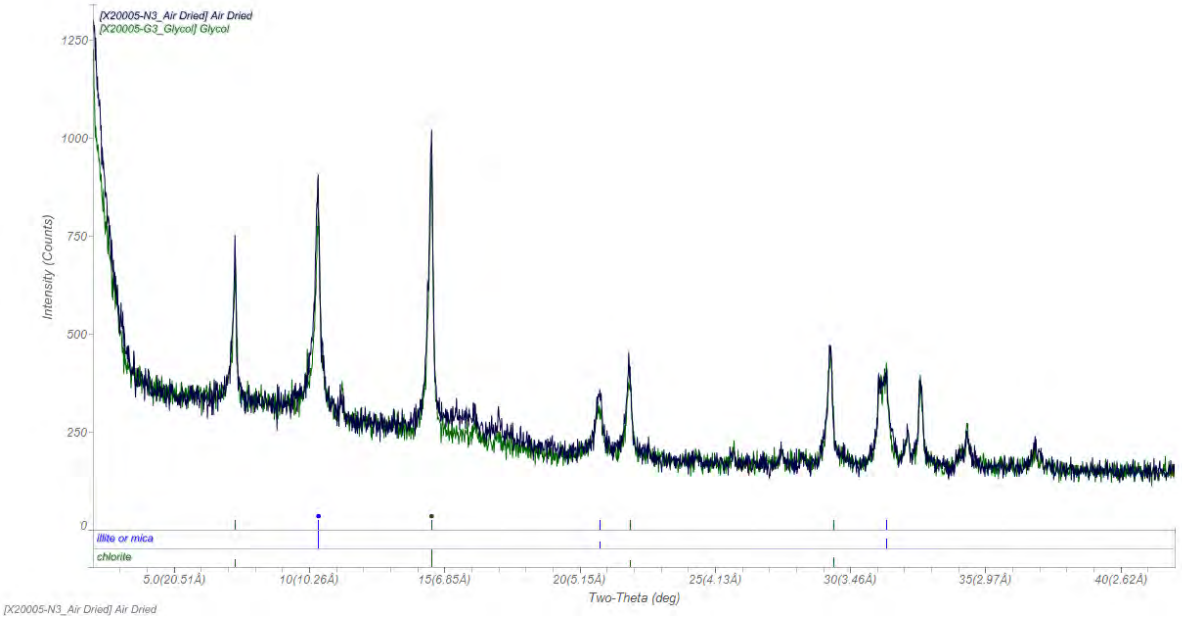
Fine Fraction (Clay) X-ray Diffraction Patterns

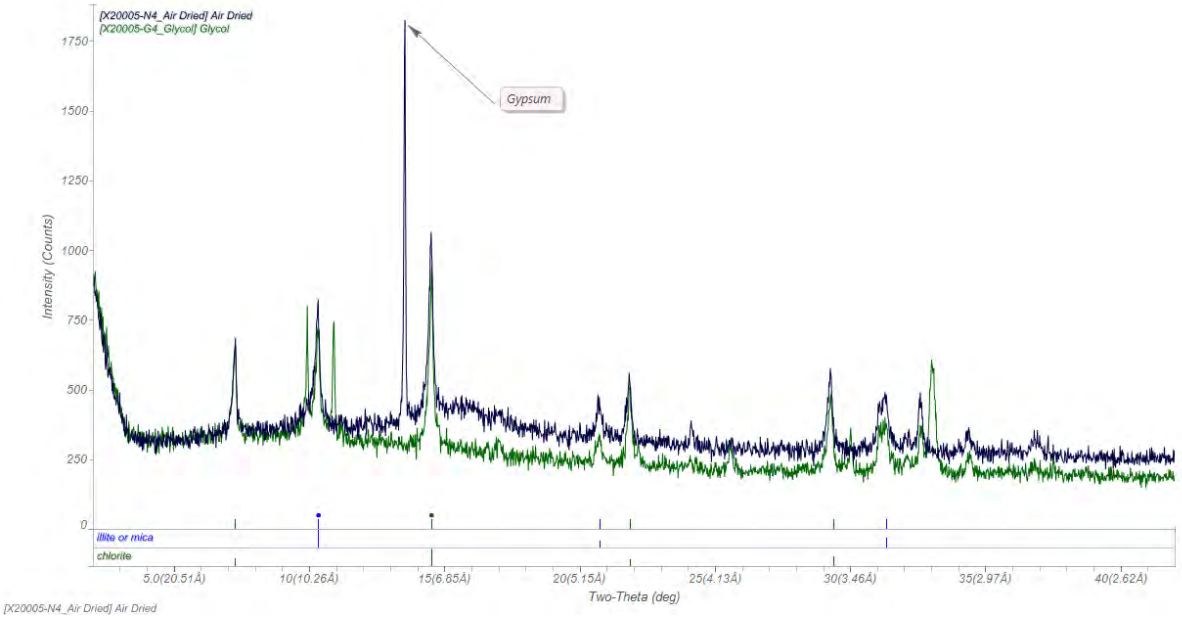


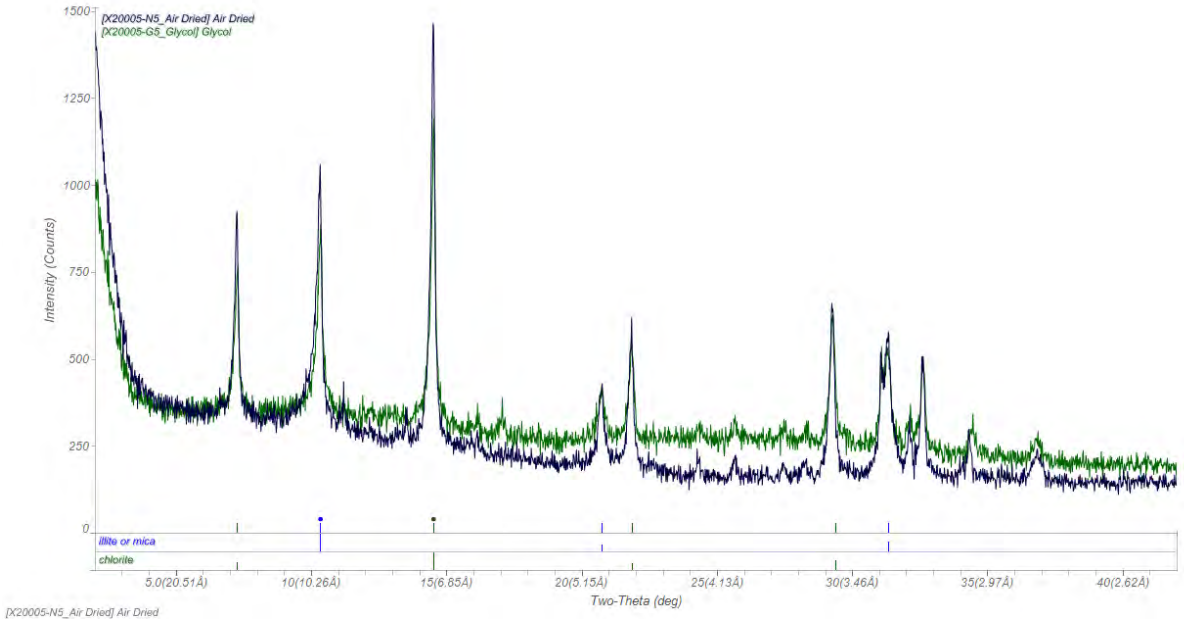
[X20005-N1_Air Dried] Air Dried



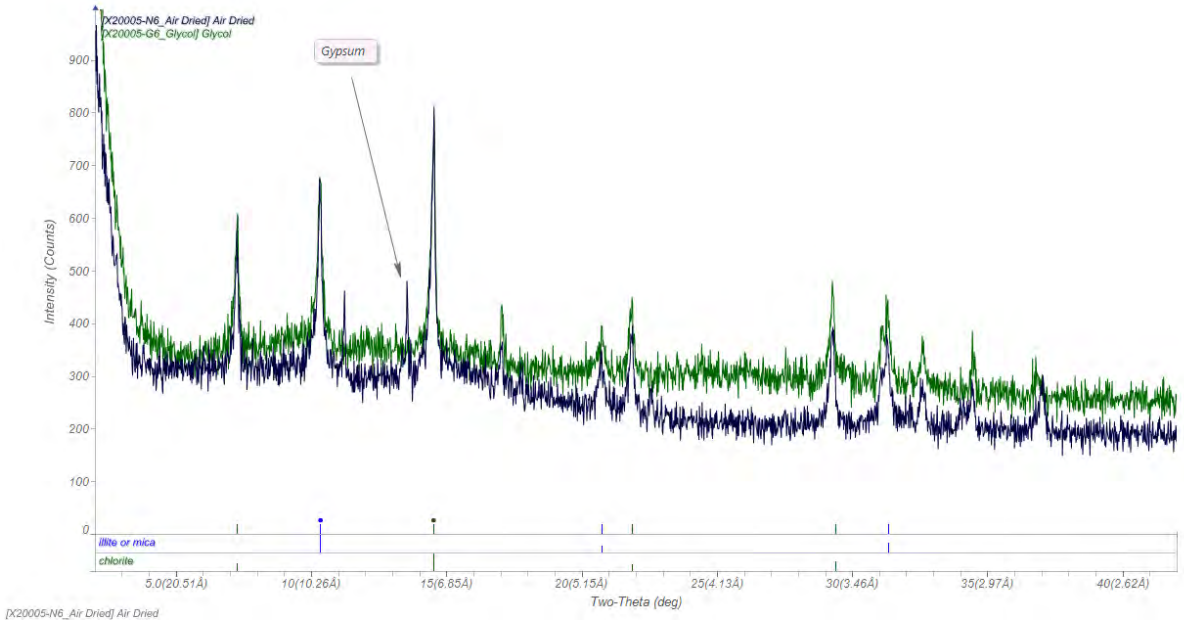
[X20005-N2_Air Dried] Air Dried


[X20005-N3_Air Dried] Air Dried
[X20005-G3_Glycol] Glycol
Intensity (Counts)
1250
1000
750
500
250
0
illite or mica
chlorite
5.0(20.51Å)
10(10.26Å)
15(6.85Å)
20(5.15Å)
25(4.13Å)
30(3.46Å)
35(2.97Å)
40(2.62Å)
Two-Theta (deg)
[X20005-N3_Air Dried] Air Dried

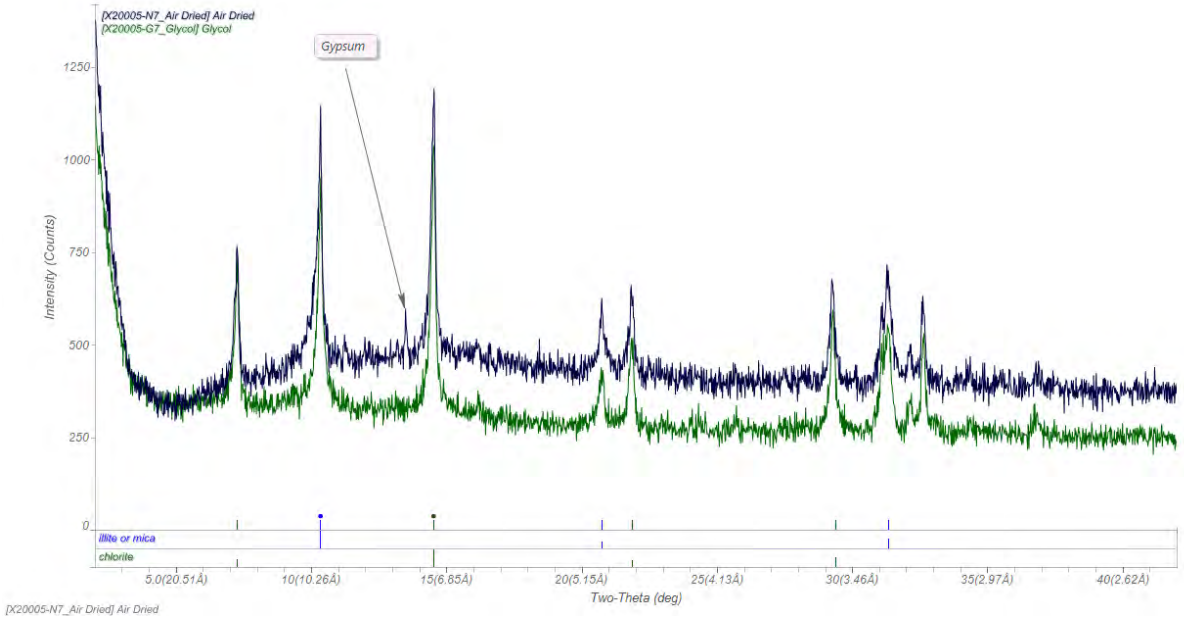

[X20005-N4_Air Dried] Air Dried
[X20005-G4_Glycol] Glycol
Gypsum
Intensity (Counts)
1750
1500
1250
1000
750
500
250
0
illite or mica
chlorite
5.0(20.51Å)
10(10.26Å)
15(6.85Å)
20(5.15Å)
25(4.13Å)
30(3.46Å)
35(2.97Å)
40(2.62Å)
Two-Theta (deg)
[X20005-N4_Air Dried] Air Dried

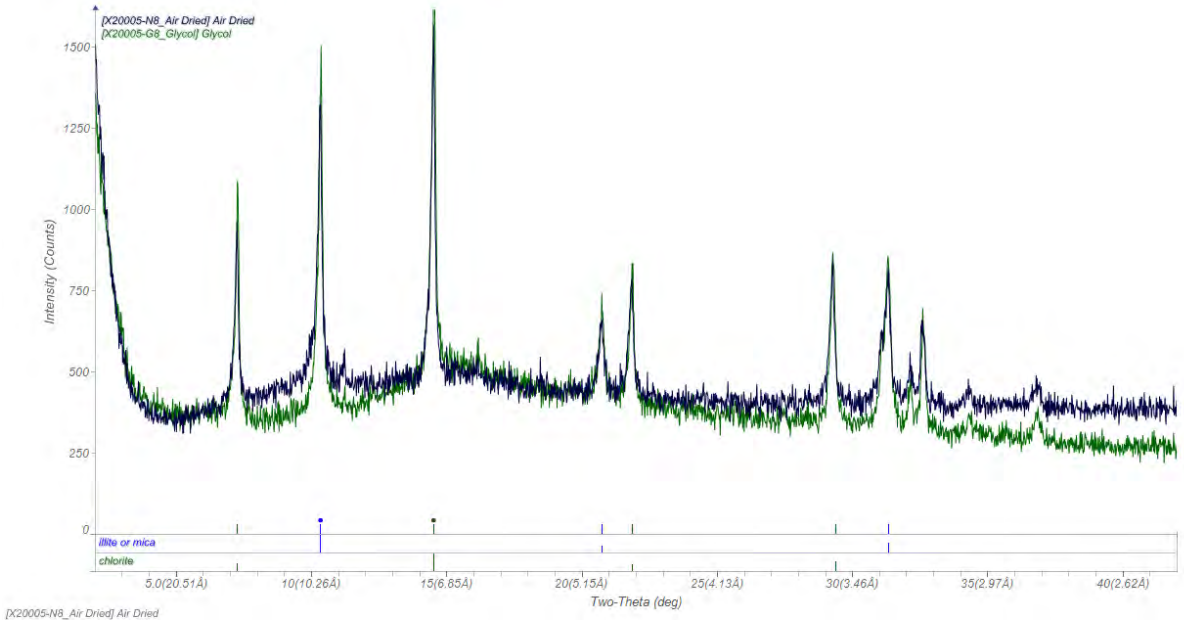


[X20005-N5_Air Dried] Air Dried



[X20005-N6_Air Dried] Air Dried


[X20005-N7_Air Dried] Air Dried
[X20005-G7_Glycol] Glycol
Gypsum
Intensity (Counts)
1250
1000
750
500
250
0
illite or mica
chlorite
5.0(20.51Å)
10(10.26Å)
15(6.85Å)
20(5.15Å)
25(4.13Å)
30(3.46Å)
35(2.97Å)
40(2.62Å)
Two-Theta (deg)
[X20005-N7_Air Dried] Air Dried


[X20005-N8_Air Dried] Air Dried
[X20005-G8_Glycol] Glycol
Intensity (Counts)
1500
1250
1000
750
500
250
0
illite or mica
chlorite
5.0(20.51Å)
10(10.26Å)
15(6.85Å)
20(5.15Å)
25(4.13Å)
30(3.46Å)
35(2.97Å)
40(2.62Å)
Two-Theta (deg)
[X20005-N8_Air Dried] Air Dried

APPENDIX 2 – ANALYTICAL TECHNIQUES

Sample preparation

The as-received samples were sieved to < 300 µm. Sub-samples were accurately weighed from the < 300 µm fraction, and specimens prepared for X-ray diffraction analysis by the addition of a corundum (Al_2O_3) internal standard at 20 wt%. The specimens were micronised in a McCrone mill using zirconia beads and ethanol, then dried in an oven overnight at 40 °C. The resultant homogenous powders were back-pressed into sample holders.

A small portion of the crushed samples were dispersed in water. After sonication (5 min) and settling for 5 min, the fine fraction (nominally < 5 µm in suspension) was transferred via pipette to a low background plate and allowed to settle and dry (these samples have the label N in this report). This preparation is used to concentrate the fine (clay dominant) fraction and aids identification of the clays present. This means ratios of the clays and other phases present in this extract may vary from the bulk sample: the fine fraction result is qualitative. The air dried slides were further treated in an ethylene glycol atmosphere (60 °C) for several hours, then immediately re-examined. The ethylene glycol treated samples have the label G in this report.

Sample analysis

Step scanned X-ray diffraction patterns were collected for an hour per sample using a PANalytical X'Pert Pro powder diffractometer and cobalt Kα radiation operating in Bragg-Brentano geometry. The collected data was analysed using JADE (V2010, Materials Data Inc.), EVA (V5, Bruker) and X'Pert Highscore Plus (V4, PANalytical) with various reference databases (PDF4+, AMCSD, COD) for phase identification. Rietveld refinement was performed using TOPAS (V6, Bruker). The known addition of corundum facilitates reporting of absolute phase abundances for the modelled phases. The sum of the absolute abundances is subtracted from 100 wt% to obtain a residual (called non-diffracting/unidentified, also known as "amorphous"). The residual represents the unexplained portion of the pattern: it may be non-diffracting content but will also contain unidentified phases and the error from poorly modelled phases. It is the least accurate measure as its error is the sum of the errors of the modelled phases. The estimated uncertainties in the reported phase abundances are 20 wt% relative or better for every modelled phase. Due to propagation of errors the uncertainty in the amorphous (non-diffracting/unidentified) content is higher at approximately 30 wt% relative. The detection limit and limit of quantification using our method is approximately 1 wt% or less depending on the phase in question and sample matrix.

Powder X-ray diffraction is bulk phase analysis, it is not bulk chemical analysis. Phase abundances may be mis-estimated if an incorrect chemical formula is assigned to a phase. Therefore, the closest matches in the reference phase identification databases were used in the Rietveld refinement model, but other members of the identified mineral groups may be present.

Central Analytical Research Facility

QUT Central Analytical Research Facility
Materials Characterisation Report

CLIENT	Kathryn Stewart / Tim Wrigley Newcrest
REPORT DATE	2020-02-21
PREPARED BY	Henry Spratt (
ANALYSIS REQUESTED	Stokes' law size separation (< 10 µm) Quantitative XRD on yield from Stokes' law size fraction
OUR REFERENCE	X20005
YOUR REFERENCE	PO4500983185; 8x Tailings Samples
QUT CONTACTS	Mr Ashley Locke, X-ray Analysis Coordinator Ph: 0400128230 | email: a.locke@qut.edu.au Dr Henry Spratt, Senior X-ray Technologist (Geoscience) Ph: 07 3138 9526 | email: henry.spratt@qut.edu.au **X-ray and Particles Laboratory enquiries: xandp@qut.edu.au**

RESULTS

All results below refer to the yield from Stokes' law size separation.

Stokes' Law Size Separation

The percentage of the submitted samples that is < 10 µm (spherical equivalent) is given in the table below.

Table of < 10 micron yields

X20005 8 Tailings Samples	1 < 10 micron	2 < 10 micron	3 < 10 micron	4 < 10 micron
Mass used (g)	5.4679	5.4843	5.5534	5.2084
Mass < 10 micron (g)	0.2181	0.1521	0.1294	0.096
Yield < 10 micron (%)	3.989	2.773	2.330	1.843

X20005 8 Tailings Samples	5 < 10 micron	6 < 10 micron	7 < 10 micron	8 < 10 micron
Mass used (g)	5.4679	5.4843	5.5534	5.2084
Mass < 10 micron (g)	0.2189	0.1695	0.2167	0.2138
Yield < 10 micron (%)	4.003	3.091	3.902	4.105

XRD Phase Identification / Quantification

The powder X-ray diffraction patterns show the presence of crystalline phases. Graphics of the collected diffraction patterns along with the phases identified are included in Appendix 1.

Table of phase abundances (nominal wt%, absolute)

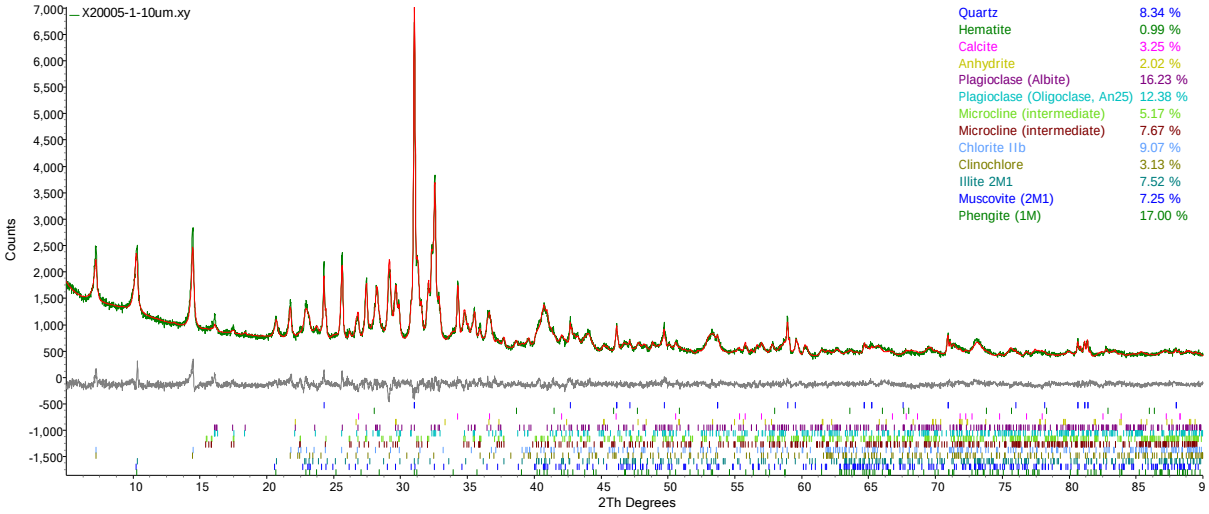
X20005 8 Tailings Samples	1 < 10 micron NTSF1	2 < 10 micron NTSF2	3 < 10 micron NTSF3	4 < 10 micron NTSF4
Quartz	6.6	6.5	7.5	5.0
Hematite	0.8			
Calcite	2.6	1.0	1.0	0.8
Anhydrite	1.6	3.2	2.4	2.3
Glauberite				3.8
Plagioclase (An0-25)	22.5	19.6	21.1	11.7
K-Feldspar	10.1	9.4	8.7	4.2
Halite		3.0	0.7	1.8
Chlorite/clinochlore	9.6	6.8	8.6	6.5
Illite/mica	25.0	23.5	23.5	12.7
Amorphous	21.2	26.9	26.6	51.2

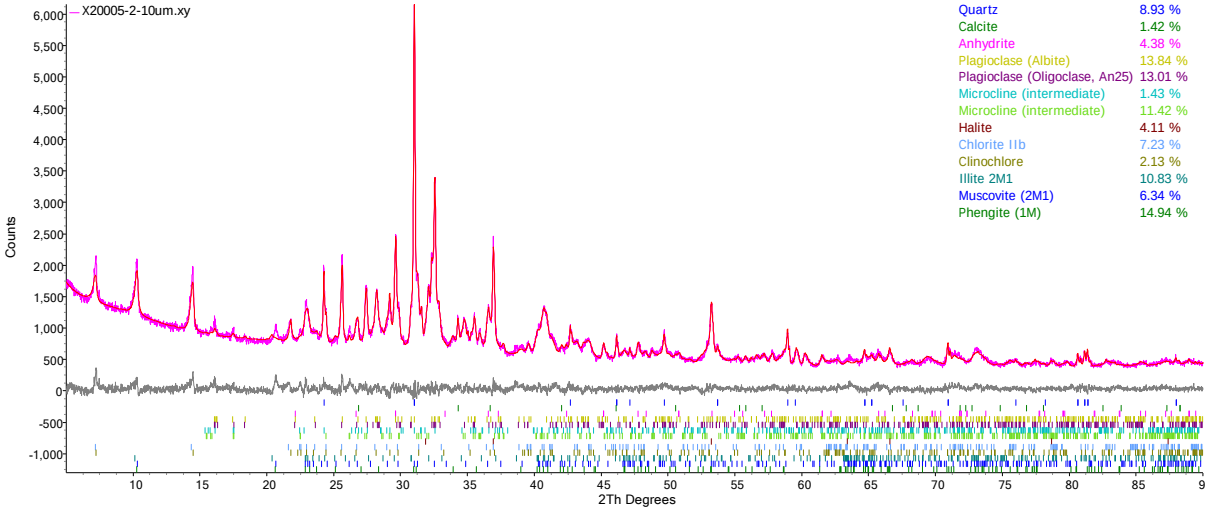
X20005 8 Tailings Samples	5 < 10 micron STSF1	6 < 10 micron STSF2	7 < 10 micron STSF3	8 < 10 micron STSF4
Quartz	7.4	7.9	8.2	7.7
Hematite	1.1		1.2	1.1
Calcite	1.8	0.3	1.9	1.9
Anhydrite	2.2	2.1	1.5	1.4
Bassanite		3.7		
Gypsum		2.5		
Amphibole			1.8	
Plagioclase (An0-25)	25.6	19.7	28.7	23.6
K-Feldspar	11.9	6.5	12.7	10.7
Halite	0.7	2.4	0.7	
Chlorite/clinochlore	9.9	7.6	10.6	12.4
Illite/mica	25.6	16.4	26.7	23.7
Amorphous	13.9	31.1	6.1	17.5

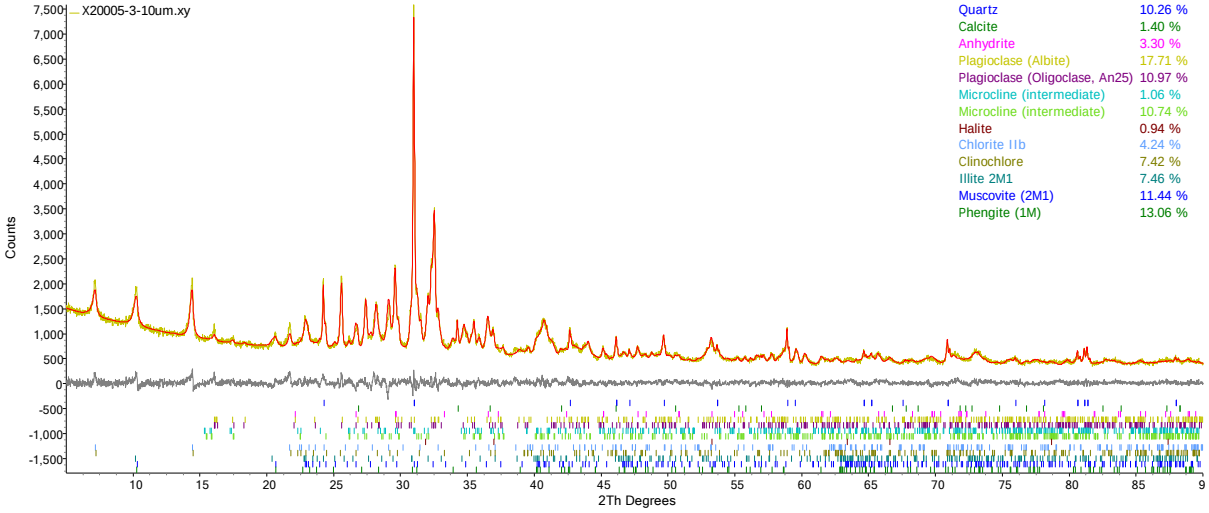
APPENDIX 1 – X-RAY DIFFRACTION DATA AND GRAPHICS

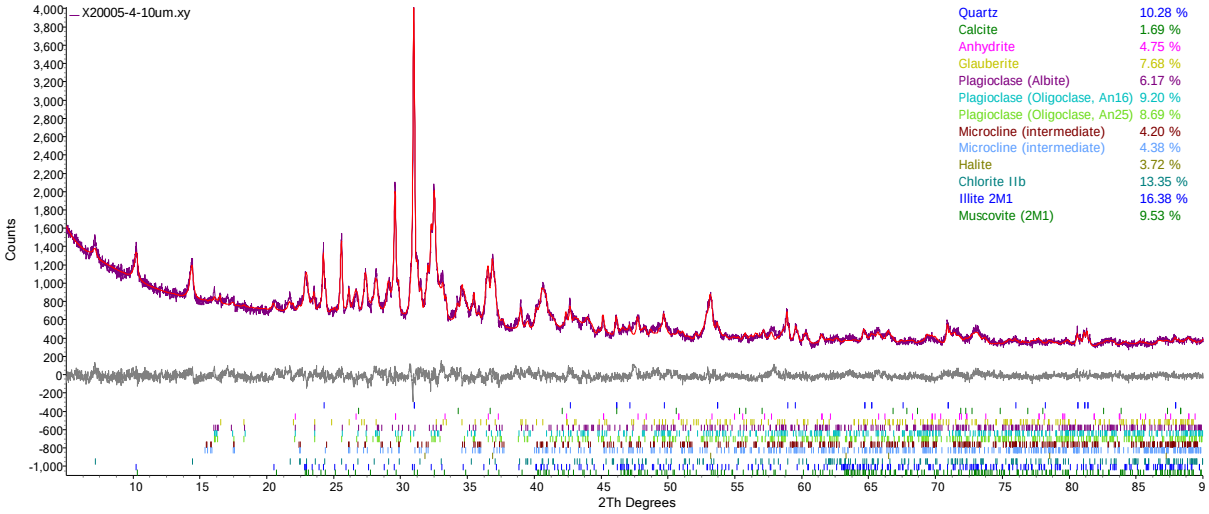
Powder X-ray Diffraction Patterns

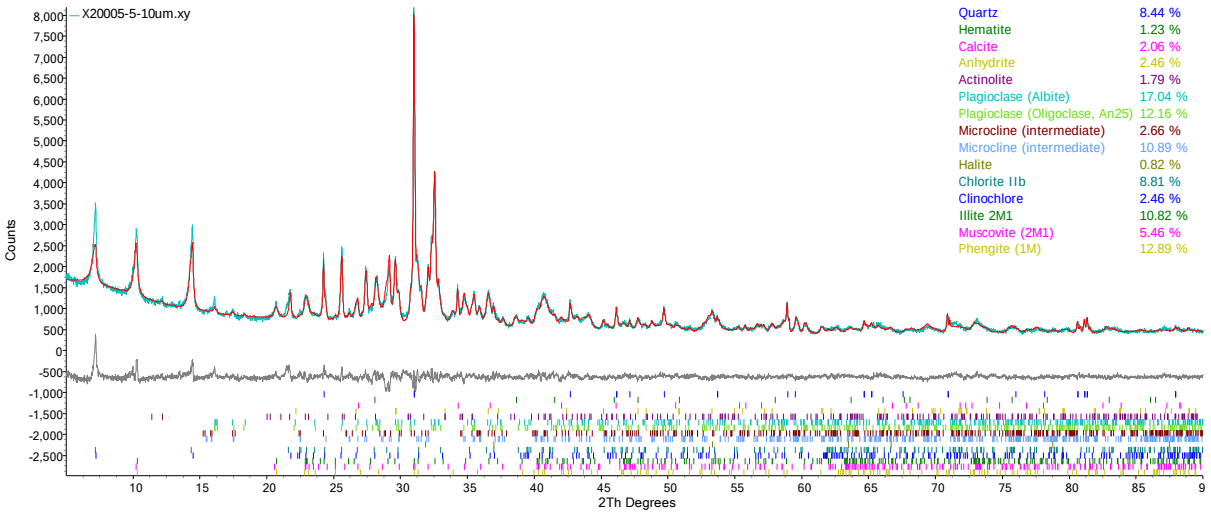
In the graphics below the coloured line is the collected data, the red line is the Rietveld refinement model, and the grey line is the difference. Note that the phase abundances on the graphics are before taking into account the external standard. Please use the tabulated abundances which require no further manipulation.

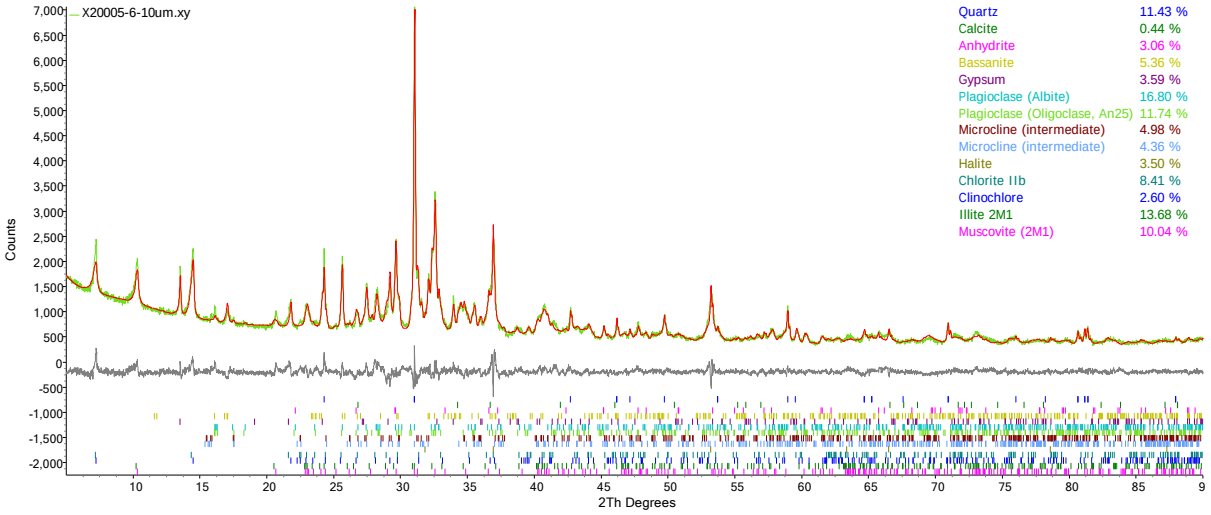


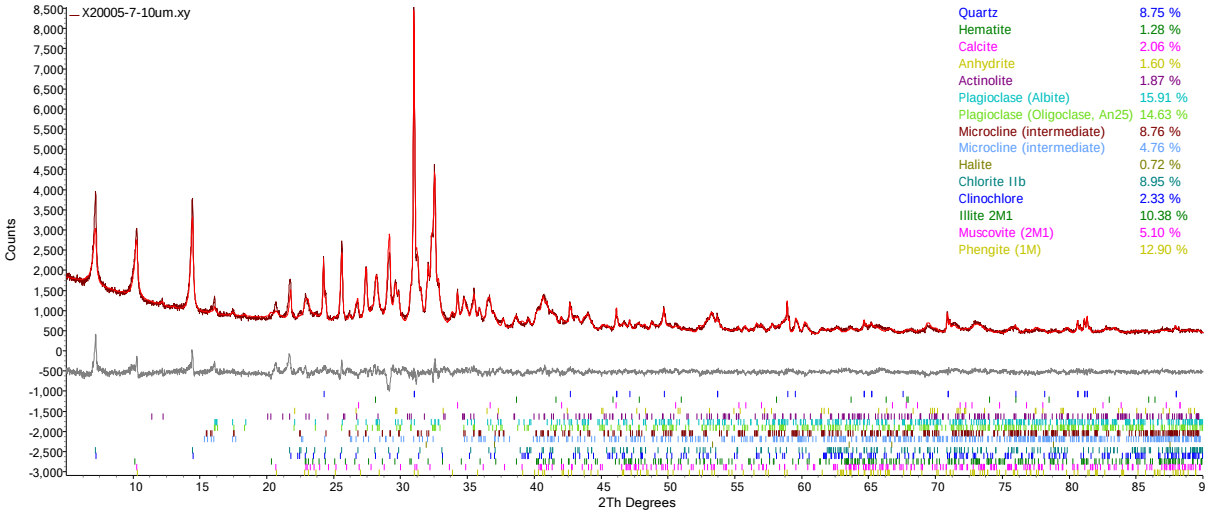

X20005-2-10um.xy
Counts
2Th Degrees
Quartz 8.93 %
Calcite 1.42 %
Anhydrite 4.38 %
Plagioclase (Albite) 13.84 %
Plagioclase (Oligoclase, An25) 13.01 %
Microcline (intermediate) 1.43 %
Microcline (intermediate) 11.42 %
Halite 4.11 %
Chlorite IIb 7.23 %
Clinochlore 2.13 %
Illite 2M1 10.83 %
Muscovite (2M1) 6.34 %
Phengite (1M) 14.94 %

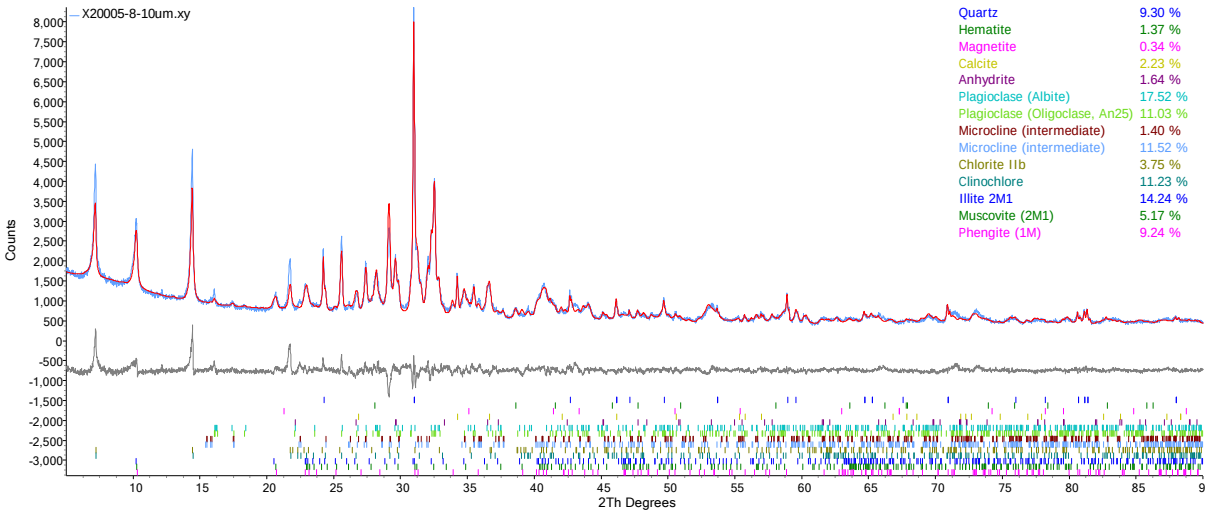

X20005-3-10um.xy
Counts
2Th Degrees
Quartz 10.26 %
Calcite 1.40 %
Anhydrite 3.30 %
Plagioclase (Albite) 17.71 %
Plagioclase (Oligoclase, An25) 10.97 %
Microcline (intermediate) 1.06 %
Microcline (intermediate) 10.74 %
Halite 0.94 %
Chlorite IIb 4.24 %
Clinochlore 7.42 %
Illite 2M1 7.46 %
Muscovite (2M1) 11.44 %
Phengite (1M) 13.06 %


X20005-4-10um.xy
Counts
2Th Degrees
Quartz 10.28 %
Calcite 1.69 %
Anhydrite 4.75 %
Glauberite 7.68 %
Plagioclase (Albite) 6.17 %
Plagioclase (Oligoclase, An16) 9.20 %
Plagioclase (Oligoclase, An25) 8.69 %
Microcline (intermediate) 4.20 %
Microcline (intermediate) 4.38 %
Halite 3.72 %
Chlorite IIb 13.35 %
Illite 2M1 16.38 %
Muscovite (2M1) 9.53 %


X20005-5-10um.xy
Counts
2Th Degrees
Quartz 8.44 %
Hematite 1.23 %
Calcite 2.06 %
Anhydrite 2.46 %
Actinolite 1.79 %
Plagioclase (Albite) 17.04 %
Plagioclase (Oligoclase, An25) 12.16 %
Microcline (intermediate) 2.66 %
Microcline (intermediate) 10.89 %
Halite 0.82 %
Chlorite IIb 8.81 %
Clinochlore 2.46 %
Illite 2M1 10.82 %
Muscovite (2M1) 5.46 %
Phengite (1M) 12.89 %


X20005-6-10um.xy
Counts
2Th Degrees
Quartz 11.43 %
Calcite 0.44 %
Anhydrite 3.06 %
Bassanite 5.36 %
Gypsum 3.59 %
Plagioclase (Albite) 16.80 %
Plagioclase (Oligoclase, An25) 11.74 %
Microcline (intermediate) 4.98 %
Microcline (intermediate) 4.36 %
Halite 3.50 %
Chlorite IIb 8.41 %
Clinochlore 2.60 %
Illite 2M1 13.68 %
Muscovite (2M1) 10.04 %


X20005-7-10um.xy
Counts
2Th Degrees
Quartz 8.75 %
Hematite 1.28 %
Calcite 2.06 %
Anhydrite 1.60 %
Actinolite 1.87 %
Plagioclase (Albite) 15.91 %
Plagioclase (Oligoclase, An25) 14.63 %
Microcline (intermediate) 8.76 %
Microcline (intermediate) 4.76 %
Halite 0.72 %
Chlorite IIb 8.95 %
Clinochlore 2.33 %
Illite 2M1 10.38 %
Muscovite (2M1) 5.10 %
Phengite (1M) 12.90 %



APPENDIX 2 – ANALYTICAL TECHNIQUES

Stokes' Law Size Separation

Samples were accurately weighed into a plastic beaker and dispersed in ethanol via sonication (5 min) and vigorous swirling with 90 mg of Calgon as dispersing agent. The sample dispersed in ethanol was then transferred into a cylindrical vessel and enough ethanol added to bring the total volume to 500 mL. The suspension was allowed to settle for a certain amount of time which leaves the < 10 µm *spherical equivalent* particles in the first 5 cm of suspension. This technique uses Stokes' law which shows that the time taken for a particle to settle a specific distance is a function of its size:

$$t = 305.9\eta H / \left[(d_p - d_f) D^2 \right]$$

Where:

- η is the viscosity of the fluid in centipoise
- H is the travel distance in cm
- $d_{p/f}$ are the particle and fluid density (g/cm^3)
- D is the desired *spherical equivalent* particle diameter in µm

The density of quartz (2.65 g/cm^3) was used to calculate the settling time required. The < 10 µm aliquot was transferred out of the container via siphoning off the meniscus then dried in an oven overnight at 40 °C. The < x µm aliquot was then accurately weighed.

XRD Sample Preparation

The size separated < 10 µm by Stokes' law aliquot were front-pressed into sample holders following drying. An XRD pattern was acquired from pure corundum using the same scan conditions as the samples to facilitate quantification using the external standard method.

XRD Sample Analysis

Step scanned X-ray diffraction patterns were collected for an hour per sample using a PANalytical X'Pert Pro powder diffractometer and cobalt Kα radiation operating in Bragg-Brentano geometry. The collected data was analysed using JADE (V2010, Materials Data Inc.) and X'Pert Highscore Plus (V4, PANalytical) with various reference databases (PDF4+, AMCSD, COD) for phase identification. Rietveld refinement was performed using TOPAS (V5, Bruker) or Siroquant (Sietronics, V3) for quantitative phase analysis. Siroquant is typically used for those samples which contain significant clay in the bulk powder patterns. An absorption contrast correction (Brindley) was made on the basis that the average size of the particles in the specimens is approximately 5 µm. The more absorbing phases will be under estimated if their actual average particle size is greater than 5 µm. The estimated uncertainties in the reported phase abundances are 20 wt% relative or better for every modelled phase. Due to propagation of errors the uncertainty in the amorphous (non-diffracting/unidentified) content is higher at approximately 30 wt% relative. The detection limit and limit of quantification using our method is approximately 1 wt% or less depending on the phase in question and sample matrix.

Powder X-ray diffraction is bulk phase analysis, it is not bulk chemical analysis. Phase abundances may be mis-estimated if an incorrect chemical formula is assigned to a phase. Therefore, the closest matches in the reference phase identification databases were used in the Rietveld refinement model, but other members of the identified mineral groups may be present.

Appendix F. ALS certificates of analysis

THIS DOCUMENT MAY NOT BE REPRODUCED EXCEPT IN FULL

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2000092**	Page	: 1 of 18
Client	: **NEWCREST MINING LIMITED**	Laboratory	: Environmental Division Brisbane
Contact	: TIM WRIGLEY	Contact	: John Pickering
Address	: LEVEL 32 400 GEORGE STREET BRISBANE QLD, AUSTRALIA 4000	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: ----	Telephone	: +61 7 3552 8634
Project	: Tailings	Date Samples Received	: 31-Dec-2019 09:20
Order number	: 4500922559	Date Analysis Commenced	: 06-Jan-2020
C-O-C number	: ----	Issue Date	: 14-Jan-2020 17:34
Sampler	: TIM WRIGLEY		
Site	: ----		
Quote number	: BN/346/19		
No. of samples received	: 16		
No. of samples analysed	: 16		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Alison Graham	Supervisor - Inorganic	Newcastle - Inorganics, Mayfield West, NSW
Dave Gitsham	Metals Instrument Chemist	Brisbane Inorganics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Santusha Pandra	Senior Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- Ionic Balances out of acceptable limits for some samples due to analytes not quantified in this report.
- EG035W (Water Leachable Mercury): Positive mercury results have been confirmed by re-extraction and re-analysis.
- ED093S (Cations - soluble by ICP-AES): Sample NTSF1 (EB12000092-003) shows poor duplicate results due to sample heterogeneity. Confirmed by visual inspection.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: ASLP LEACHATE (Matrix: WATER)				Client sample ID	STF1	STF2	STF3	STF4	NTSF1
				Client sampling date / time	30-Dec-2019 09:30	30-Dec-2019 09:30	30-Dec-2019 09:30	30-Dec-2019 09:30	30-Dec-2019 09:30
Compound	CAS Number	LOR	Unit		EB2000092-001	EB2000092-002	EB2000092-003	EB2000092-004	EB2000092-005
					Result	Result	Result	Result	Result
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		7.93	7.90	7.44	7.52	7.60
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		2140	7480	2220	1620	1590
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		13	24	21	27	26
Total Alkalinity as CaCO3	----	1	mg/L		13	24	21	27	26
ED038A: Acidity									
Acidity as CaCO3	----	1	mg/L		2	5	2	1	2
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		826	3820	789	641	634
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		71	373	151	49	51
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		145	319	164	136	107
Magnesium	7439-95-4	1	mg/L		38	279	46	7	48
Sodium	7440-23-5	1	mg/L		239	1000	227	188	145
Potassium	7440-09-7	1	mg/L		64	278	78	34	47
EG020W: Water Leachable Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		0.03	<0.01	0.03	0.04	0.02
Germanium	7440-56-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Antimony	7440-36-0	0.001	mg/L		0.001	0.004	<0.001	<0.001	0.008
Niobium	7440-03-1	0.001	mg/L		0.002	0.002	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L		0.001	0.002	<0.001	<0.001	<0.001
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L		0.047	0.065	0.051	0.045	0.061
Bismuth	7440-69-9	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	0.0006	<0.0001	<0.0001	<0.0001
Cerium	7440-45-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Caesium	7440-46-2	0.001	mg/L		0.002	0.004	0.002	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L		<0.001	0.001	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		0.004	0.012	0.003	0.004	0.001

Analytical Results

Sub-Matrix: ASLP LEACHATE (Matrix: WATER)				Client sample ID	STF1	STF2	STF3	STF4	NTSF1
				Client sampling date / time	30-Dec-2019 09:30	30-Dec-2019 09:30	30-Dec-2019 09:30	30-Dec-2019 09:30	30-Dec-2019 09:30
Compound	CAS Number	LOR	Unit		EB2000092-001	EB2000092-002	EB2000092-003	EB2000092-004	EB2000092-005
					Result	Result	Result	Result	Result
EG020W: Water Leachable Metals by ICP-MS - Continued									
Dysprosium	7429-91-6	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Erbium	7440-52-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Europium	7440-53-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Gadolinium	7440-54-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Gallium	7440-55-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Hafnium	7440-58-6	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Holmium	7440-60-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Indium	7440-74-6	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lanthanum	7439-91-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L		**0.002**	<0.001	<0.001	<0.001	<0.001
Lithium	7439-93-2	0.001	mg/L		**0.008**	**0.026**	**0.009**	**0.005**	**0.010**
Manganese	7439-96-5	0.001	mg/L		**0.010**	**0.007**	**0.020**	**0.020**	**0.017**
Molybdenum	7439-98-7	0.001	mg/L		**0.185**	**1.70**	**0.284**	**0.209**	**0.200**
Neodymium	7440-00-8	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Praseodymium	7440-10-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Rubidium	7440-17-7	0.001	mg/L		**0.056**	**0.218**	**0.065**	**0.027**	**0.038**
Samarium	7440-19-9	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L		**0.02**	**0.17**	**0.01**	<0.01	<0.01
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	mg/L		**3.49**	**9.29**	**2.57**	**2.48**	**2.47**
Tellurium	22541-49-7	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
Terbium	7440-27-9	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Thallium	7440-28-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Thorium	7440-29-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Thulium	7440-30-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-31-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Titanium	7440-32-6	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Ytterbium	7440-64-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Yttrium	7440-65-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		**0.021**	**0.034**	**0.035**	**0.036**	**0.024**
Zirconium	7440-67-7	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
Boron	7440-42-8	0.05	mg/L		**0.13**	**0.23**	**0.12**	**0.11**	**0.14**

Analytical Results

Sub-Matrix: ASLP LEACHATE (Matrix: WATER)				Client sample ID	STF1	STF2	STF3	STF4	NTSF1
				Client sampling date / time	30-Dec-2019 09:30	30-Dec-2019 09:30	30-Dec-2019 09:30	30-Dec-2019 09:30	30-Dec-2019 09:30
Compound	CAS Number	LOR	Unit		EB2000092-001	EB2000092-002	EB2000092-003	EB2000092-004	EB2000092-005
					Result	Result	Result	Result	Result
EG020W: Water Leachable Metals by ICP-MS - Continued									
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	<0.05	<0.05	<0.05
Tungsten	7440-33-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
EG035W: Water Leachable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	**0.0002**	**0.0004**	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**1.2**	**4.5**	**1.5**	**1.6**	**1.2**
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**19.5**	**90.5**	**21.1**	**15.3**	**15.2**
ø Total Cations	----	0.01	meq/L		**22.4**	**89.5**	**23.8**	**16.4**	**16.8**
ø Ionic Balance	----	0.01	%		**7.01**	**0.58**	**6.08**	**3.60**	**5.13**

Analytical Results

Sub-Matrix: ASLP LEACHATE (Matrix: WATER)			Client sample ID	NTSF2	NTSF3	NTSF4	----	----
			Client sampling date / time	30-Dec-2019 09:30	30-Dec-2019 09:30	30-Dec-2019 09:30	----	----
Compound	CAS Number	LOR	Unit	EB2000092-006	EB2000092-007	EB2000092-008	--------	--------
				Result	Result	Result	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.80**	**7.81**	**7.98**	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**3820**	**3890**	**7390**	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**43**	**25**	**22**	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**43**	**25**	**22**	----	----
ED038A: Acidity								
Acidity as CaCO3	----	1	mg/L	**4**	**8**	**5**	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**1340**	**1720**	**3380**	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**326**	**121**	**297**	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**196**	**223**	**414**	----	----
Magnesium	7439-95-4	1	mg/L	**108**	**110**	**365**	----	----
Sodium	7440-23-5	1	mg/L	**477**	**499**	**952**	----	----
Potassium	7440-09-7	1	mg/L	**122**	**123**	**238**	----	----
EG020W: Water Leachable Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	**0.02**	**0.01**	----	----
Germanium	7440-56-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Antimony	7440-36-0	0.001	mg/L	**0.069**	**0.005**	<0.001	----	----
Niobium	7440-03-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	**0.001**	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Barium	7440-39-3	0.001	mg/L	**0.049**	**0.041**	**0.042**	----	----
Bismuth	7440-69-9	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Cadmium	7440-43-9	0.0001	mg/L	**0.0002**	**0.0001**	**0.0005**	----	----
Cerium	7440-45-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Caesium	7440-46-2	0.001	mg/L	**0.002**	**0.003**	**0.006**	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Copper	7440-50-8	0.001	mg/L	**0.005**	**0.007**	**0.013**	----	----

Analytical Results

Sub-Matrix: ASLP LEACHATE (Matrix: WATER)				Client sample ID	NTSF2	NTSF3	NTSF4	----	----
				Client sampling date / time	30-Dec-2019 09:30	30-Dec-2019 09:30	30-Dec-2019 09:30	----	----
Compound	CAS Number	LOR	Unit		EB2000092-006	EB2000092-007	EB2000092-008	--------	--------
					Result	Result	Result	----	----
EG020W: Water Leachable Metals by ICP-MS - Continued									
Dysprosium	7429-91-6	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Erbium	7440-52-0	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Europium	7440-53-1	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Gadolinium	7440-54-2	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Gallium	7440-55-3	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Hafnium	7440-58-6	0.01	mg/L		<0.01	<0.01	<0.01	----	----
Holmium	7440-60-0	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Indium	7440-74-6	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Lanthanum	7439-91-0	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Lithium	7439-93-2	0.001	mg/L		**0.017**	**0.021**	**0.053**	----	----
Manganese	7439-96-5	0.001	mg/L		**0.007**	**0.006**	**0.011**	----	----
Molybdenum	7439-98-7	0.001	mg/L		**0.509**	**0.301**	**1.38**	----	----
Neodymium	7440-00-8	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Praseodymium	7440-10-0	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Rubidium	7440-17-7	0.001	mg/L		**0.089**	**0.076**	**0.182**	----	----
Samarium	7440-19-9	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Selenium	7782-49-2	0.01	mg/L		**0.02**	<0.01	**0.06**	----	----
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Strontium	7440-24-6	0.001	mg/L		**4.51**	**6.53**	**9.81**	----	----
Tellurium	22541-49-7	0.005	mg/L		<0.005	<0.005	<0.005	----	----
Terbium	7440-27-9	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Thallium	7440-28-0	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Thorium	7440-29-1	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Thulium	7440-30-4	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Tin	7440-31-5	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Titanium	7440-32-6	0.01	mg/L		<0.01	<0.01	<0.01	----	----
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	----	----
Ytterbium	7440-64-4	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Yttrium	7440-65-5	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Zinc	7440-66-6	0.005	mg/L		**0.035**	**0.031**	<0.005	----	----
Zirconium	7440-67-7	0.005	mg/L		<0.005	<0.005	<0.005	----	----
Boron	7440-42-8	0.05	mg/L		**0.13**	**0.15**	**0.20**	----	----

Analytical Results

Sub-Matrix: ASLP LEACHATE (Matrix: WATER)				Client sample ID	NTSF2	NTSF3	NTSF4	----	----
				Client sampling date / time	30-Dec-2019 09:30	30-Dec-2019 09:30	30-Dec-2019 09:30	----	----
Compound	CAS Number	LOR	Unit		EB2000092-006	EB2000092-007	EB2000092-008	--------	--------
					Result	Result	Result	----	----
EG020W: Water Leachable Metals by ICP-MS - Continued									
Iron	7439-89-6	0.05	mg/L		**0.10**	<0.05	<0.05	**----**	**----**
Tungsten	7440-33-7	0.001	mg/L		<0.001	**0.005**	**0.001**	**----**	**----**
EG035W: Water Leachable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	**----**	**----**
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**1.6**	**1.9**	**4.5**	**----**	**----**
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**38.0**	**39.7**	**79.2**	**----**	**----**
ø Total Cations	----	0.01	meq/L		**42.5**	**45.0**	**98.2**	**----**	**----**
ø Ionic Balance	----	0.01	%		**5.69**	**6.26**	**10.7**	**----**	**----**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	STF1	STF2	STF3	STF4	NTSF1
			Client sampling date / time	30-Dec-2019 09:30	30-Dec-2019 09:30	30-Dec-2019 09:30	30-Dec-2019 09:30	30-Dec-2019 09:30
Compound	CAS Number	LOR	Unit	EB2000092-001	EB2000092-002	EB2000092-003	EB2000092-004	EB2000092-005
				Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	12.0	1.9	12.7	18.7	19.0
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	19000	71400	14800	13000	8920
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	1610	8720	3160	950	1070
ED093S: Soluble Major Cations								
Calcium	7440-70-2	10	mg/kg	2450	2270	1780	2170	830
Magnesium	7439-95-4	10	mg/kg	840	6150	920	140	680
Sodium	7440-23-5	10	mg/kg	4890	20700	4320	3640	2270
Potassium	7440-09-7	10	mg/kg	1220	5680	1350	620	750
EG005(ED093)T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	13700	10200	13700	14500	12700
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	<50
Iron	7439-89-6	50	mg/kg	26100	20700	26900	28000	25200
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.1	mg/kg	2.6	2.4	3.1	3.7	3.6
Selenium	7782-49-2	1	mg/kg	1	4	1	1	1
Silver	7440-22-4	0.1	mg/kg	0.2	0.2	0.2	0.2	0.2
Barium	7440-39-3	0.1	mg/kg	22.8	16.4	20.9	22.6	38.6
Thallium	7440-28-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Beryllium	7440-41-7	0.1	mg/kg	0.3	0.2	0.3	0.4	0.3
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Bismuth	7440-69-9	0.1	mg/kg	0.1	0.2	0.2	0.2	0.2
Cobalt	7440-48-4	0.1	mg/kg	10.8	9.2	12.9	14.0	11.4
Chromium	7440-47-3	0.1	mg/kg	32.9	21.4	39.4	37.6	30.4
Copper	7440-50-8	0.1	mg/kg	444	429	457	607	490
Thorium	7440-29-1	0.1	mg/kg	1.8	1.5	1.6	1.8	1.9
Manganese	7439-96-5	0.1	mg/kg	294	254	287	299	283
Strontium	7440-24-6	0.1	mg/kg	101	203	90.4	120	84.1
Molybdenum	7439-98-7	0.1	mg/kg	7.9	36.1	10.3	9.2	9.0
Nickel	7440-02-0	0.1	mg/kg	13.2	9.1	14.5	15.3	12.7
Lead	7439-92-1	0.1	mg/kg	2.5	2.0	3.2	4.0	4.2
Antimony	7440-36-0	0.1	mg/kg	0.2	0.2	0.2	0.1	0.1
Uranium	7440-61-1	0.1	mg/kg	0.4	0.4	0.4	0.4	0.4

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	STF1	STF2	STF3	STF4	NTSF1
				Client sampling date / time	30-Dec-2019 09:30	30-Dec-2019 09:30	30-Dec-2019 09:30	30-Dec-2019 09:30	30-Dec-2019 09:30
Compound	CAS Number	LOR	Unit		EB2000092-001	EB2000092-002	EB2000092-003	EB2000092-004	EB2000092-005
					Result	Result	Result	Result	Result
EG020T: Total Metals by ICP-MS - Continued									
Zinc	7440-66-6	0.5	mg/kg		24.7	19.2	23.4	26.4	22.9
Lithium	7439-93-2	0.1	mg/kg		16.0	12.4	15.2	16.0	14.5
Vanadium	7440-62-2	1	mg/kg		77	54	79	83	68
Tin	7440-31-5	0.1	mg/kg		0.5	0.3	0.5	0.8	0.6
EK040T: Fluoride Total									
Fluoride	16984-48-8	40	mg/kg		1250	1080	1280	1360	1130
EN60: ASLP Leaching Procedure									
Extraction Fluid pH	----	0.1	pH Unit		6.0	6.0	6.0	6.0	6.0
Final pH	----	0.1	pH Unit		8.4	8.6	8.5	8.4	8.6

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	NTSF2	NTSF3	NTSF4	----	----
				Client sampling date / time	30-Dec-2019 09:30	30-Dec-2019 09:30	30-Dec-2019 09:30	----	----
Compound	CAS Number	LOR	Unit		EB2000092-006	EB2000092-007	EB2000092-008	--------	--------
					Result	Result	Result	----	----
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	1.0	%		12.0	10.4	8.5	----	----
ED040S : Soluble Sulfate by ICPAES									
Sulfate as SO4 2-	14808-79-8	10	mg/kg		29500	33800	85300	----	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	10	mg/kg		4360	2460	4440	----	----
ED093S: Soluble Major Cations									
Calcium	7440-70-2	10	mg/kg		2740	2500	2320	----	----
Magnesium	7439-95-4	10	mg/kg		2160	2140	7740	----	----
Sodium	7440-23-5	10	mg/kg		8540	9660	21300	----	----
Potassium	7440-09-7	10	mg/kg		2130	2270	5790	----	----
EG005(ED093)T: Total Metals by ICP-AES									
Aluminium	7429-90-5	50	mg/kg		13200	11900	10900	----	----
Boron	7440-42-8	50	mg/kg		<50	<50	<50	----	----
Iron	7439-89-6	50	mg/kg		26000	23800	21700	----	----
EG020T: Total Metals by ICP-MS									
Arsenic	7440-38-2	0.1	mg/kg		4.1	4.4	3.7	----	----
Selenium	7782-49-2	1	mg/kg		2	<1	2	----	----
Silver	7440-22-4	0.1	mg/kg		0.2	0.2	0.2	----	----
Barium	7440-39-3	0.1	mg/kg		29.6	26.6	23.9	----	----
Thallium	7440-28-0	0.1	mg/kg		<0.1	<0.1	<0.1	----	----
Beryllium	7440-41-7	0.1	mg/kg		0.3	0.3	0.2	----	----
Cadmium	7440-43-9	0.1	mg/kg		<0.1	<0.1	<0.1	----	----
Bismuth	7440-69-9	0.1	mg/kg		0.2	0.2	0.1	----	----
Cobalt	7440-48-4	0.1	mg/kg		11.4	11.4	10.0	----	----
Chromium	7440-47-3	0.1	mg/kg		33.7	26.7	24.5	----	----
Copper	7440-50-8	0.1	mg/kg		458	610	488	----	----
Thorium	7440-29-1	0.1	mg/kg		1.8	1.8	1.5	----	----
Manganese	7439-96-5	0.1	mg/kg		325	283	274	----	----
Strontium	7440-24-6	0.1	mg/kg		142	218	219	----	----
Molybdenum	7439-98-7	0.1	mg/kg		15.9	11.6	33.5	----	----
Nickel	7440-02-0	0.1	mg/kg		14.6	11.8	11.5	----	----
Lead	7439-92-1	0.1	mg/kg		5.3	4.0	4.1	----	----
Antimony	7440-36-0	0.1	mg/kg		0.2	0.2	0.2	----	----
Uranium	7440-61-1	0.1	mg/kg		0.5	0.4	0.6	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	NTSF2	NTSF3	NTSF4	----	----
				Client sampling date / time	30-Dec-2019 09:30	30-Dec-2019 09:30	30-Dec-2019 09:30	----	----
Compound	CAS Number	LOR	Unit		EB2000092-006	EB2000092-007	EB2000092-008	--------	--------
					Result	Result	Result	----	----
EG020T: Total Metals by ICP-MS - Continued									
Zinc	7440-66-6	0.5	mg/kg		**26.5**	**25.9**	**21.8**	**----**	**----**
Lithium	7439-93-2	0.1	mg/kg		**15.7**	**14.6**	**14.3**	**----**	**----**
Vanadium	7440-62-2	1	mg/kg		**74**	**64**	**59**	**----**	**----**
Tin	7440-31-5	0.1	mg/kg		**0.6**	**0.5**	**0.5**	**----**	**----**
EK040T: Fluoride Total									
Fluoride	16984-48-8	40	mg/kg		**1310**	**1260**	**1160**	**----**	**----**
EN60: ASLP Leaching Procedure									
Extraction Fluid pH	----	0.1	pH Unit		**6.0**	**6.0**	**6.0**	**----**	**----**
Final pH	----	0.1	pH Unit		**8.6**	**8.7**	**8.7**	**----**	**----**

Analytical Results

Sub-Matrix: WATER LEACHATE (Matrix: WATER)				Client sample ID	STF1 NAG LEACHATE	STF2 NAG LEACHATE	STF3 NAG LEACHATE	STF4 NAG LEACHATE	NTSF1 NAG LEACHATE
				Client sampling date / time	30-Dec-2019 09:30	30-Dec-2019 09:30	30-Dec-2019 09:30	30-Dec-2019 09:30	30-Dec-2019 09:30
Compound	CAS Number	LOR	Unit		EB2000092-009	EB2000092-010	EB2000092-011	EB2000092-012	EB2000092-013
					Result	Result	Result	Result	Result
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		10.9	8.67	10.8	10.9	10.9
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		890	1940	842	736	734
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		53	<1	40	52	50
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		73	7	67	62	61
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		<1	20	<1	<1	<1
Total Alkalinity as CaCO3	----	1	mg/L		126	27	107	114	110
ED038A: Acidity									
Acidity as CaCO3	----	1	mg/L		<1	<1	<1	<1	<1
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		235	679	184	151	157
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		16	119	30	9	11
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		98	162	92	80	86
Magnesium	7439-95-4	1	mg/L		<1	2	<1	<1	<1
Sodium	7440-23-5	1	mg/L		76	234	68	57	51
Potassium	7440-09-7	1	mg/L		20	62	25	14	17
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		1.46	<0.01	1.44	2.21	1.25
Dysprosium	7429-91-6	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth	7440-69-9	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Erbium	7440-52-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Boron	7440-42-8	0.05	mg/L		0.45	1.03	0.47	0.36	0.62
Europium	7440-53-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	mg/L		0.707	1.77	0.498	0.444	0.588
Barium	7440-39-3	0.001	mg/L		0.249	0.220	0.023	0.024	0.025
Gadolinium	7440-54-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Titanium	7440-32-6	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Gallium	7440-55-3	0.001	mg/L		0.001	<0.001	0.001	0.002	<0.001

Analytical Results

Sub-Matrix: **WATER LEACHATE** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	STF1 NAG LEACHATE	STF2 NAG LEACHATE	STF3 NAG LEACHATE	STF4 NAG LEACHATE	NTSF1 NAG LEACHATE
				Client sampling date / time	30-Dec-2019 09:30	30-Dec-2019 09:30	30-Dec-2019 09:30	30-Dec-2019 09:30	30-Dec-2019 09:30
					EB2000092-009	EB2000092-010	EB2000092-011	EB2000092-012	EB2000092-013
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Cadmium	7440-43-9	0.0001	mg/L		**0.0001**	**0.0004**	<0.0001	<0.0001	<0.0001
Hafnium	7440-58-6	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Tellurium	22541-49-7	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Holmium	7440-60-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Caesium	7440-46-2	0.001	mg/L		<0.001	**0.002**	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L		**0.041**	**0.062**	**0.075**	**0.074**	**0.074**
Indium	7440-74-6	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		<0.001	<0.001	**0.002**	**0.004**	**0.002**
Lanthanum	7439-91-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Rubidium	7440-17-7	0.001	mg/L		**0.025**	**0.059**	**0.033**	**0.026**	**0.023**
Lithium	7439-93-2	0.001	mg/L		<0.001	**0.008**	<0.001	<0.001	<0.001
Lutetium	7439-94-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Thorium	7440-29-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cerium	7440-45-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L		<0.001	**0.003**	<0.001	**0.002**	<0.001
Neodymium	7440-00-8	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Molybdenum	7439-98-7	0.001	mg/L		**0.073**	**0.339**	**0.099**	**0.110**	**0.093**
Praseodymium	7440-10-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L		<0.001	**0.003**	<0.001	<0.001	<0.001
Samarium	7440-19-9	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Terbium	7440-27-9	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Antimony	7440-36-0	0.001	mg/L		<0.001	**0.001**	<0.001	**0.001**	<0.001
Thulium	7440-30-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L		<0.01	**0.04**	<0.01	<0.01	<0.01
Ytterbium	7440-64-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-31-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Yttrium	7440-65-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Thallium	7440-28-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zirconium	7440-67-7	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
Vanadium	7440-62-2	0.01	mg/L		**0.05**	<0.01	**0.05**	**0.04**	**0.03**
Zinc	7440-66-6	0.005	mg/L		**0.064**	**0.099**	<0.005	<0.005	<0.005

Analytical Results

Sub-Matrix: **WATER LEACHATE** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	STF1 NAG LEACHATE	STF2 NAG LEACHATE	STF3 NAG LEACHATE	STF4 NAG LEACHATE	NTSF1 NAG LEACHATE
				Client sampling date / time	30-Dec-2019 09:30	30-Dec-2019 09:30	30-Dec-2019 09:30	30-Dec-2019 09:30	30-Dec-2019 09:30
					EB2000092-009	EB2000092-010	EB2000092-011	EB2000092-012	EB2000092-013
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	<0.05	<0.05	<0.05
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.5**	**1.0**	**0.5**	**0.5**	**0.4**
EN055: Ionic Balance									
ø **Total Anions**	----	0.01	meq/L		**7.86**	**18.0**	**6.82**	**5.68**	**5.78**
ø **Total Cations**	----	0.01	meq/L		**8.71**	**20.0**	**8.19**	**6.83**	**6.94**
ø **Ionic Balance**	----	0.01	%		**5.10**	**5.20**	**9.15**	**9.23**	**9.18**

Analytical Results

Sub-Matrix: WATER LEACHATE (Matrix: WATER)				Client sample ID	NTSF2 NAG LEACHATE	NTSF3 NAG LEACHATE	NTSF4 NAG LEACHATE	----	----
				Client sampling date / time	30-Dec-2019 09:30	30-Dec-2019 09:30	30-Dec-2019 09:30	----	----
Compound	CAS Number	LOR	Unit		EB2000092-014	EB2000092-015	EB2000092-016	--------	--------
					Result	Result	Result	----	----
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**10.3**	**10.4**	**8.12**	----	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**1140**	**1140**	**1980**	----	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		**19**	**25**	<1	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		**59**	**57**	<1	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		<1	<1	**26**	----	----
Total Alkalinity as CaCO3	----	1	mg/L		**78**	**83**	**26**	----	----
ED038A: Acidity									
Acidity as CaCO3	----	1	mg/L		<1	<1	**3**	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**376**	**411**	**800**	----	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		**52**	**26**	**52**	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		**116**	**119**	**185**	----	----
Magnesium	7439-95-4	1	mg/L		<1	<1	**24**	----	----
Sodium	7440-23-5	1	mg/L		**109**	**115**	**200**	----	----
Potassium	7440-09-7	1	mg/L		**30**	**30**	**54**	----	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.43**	**0.53**	<0.01	----	----
Dysprosium	7429-91-6	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Bismuth	7440-69-9	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Erbium	7440-52-0	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Boron	7440-42-8	0.05	mg/L		**0.83**	**0.97**	**0.67**	----	----
Europium	7440-53-1	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Strontium	7440-24-6	0.001	mg/L		**1.03**	**1.28**	**2.05**	----	----
Barium	7440-39-3	0.001	mg/L		**0.040**	**0.036**	**0.088**	----	----
Gadolinium	7440-54-2	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Titanium	7440-32-6	0.01	mg/L		<0.01	<0.01	<0.01	----	----
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Gallium	7440-55-3	0.001	mg/L		<0.001	<0.001	<0.001	----	----

Analytical Results

Sub-Matrix: WATER LEACHATE (Matrix: WATER)				Client sample ID	NTSF2 NAG LEACHATE	NTSF3 NAG LEACHATE	NTSF4 NAG LEACHATE	----	----
				Client sampling date / time	30-Dec-2019 09:30	30-Dec-2019 09:30	30-Dec-2019 09:30	----	----
Compound	CAS Number	LOR	Unit		EB2000092-014	EB2000092-015	EB2000092-016	--------	--------
					Result	Result	Result	----	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	----	----
Hafnium	7440-58-6	0.01	mg/L		<0.01	<0.01	<0.01	----	----
Tellurium	22541-49-7	0.005	mg/L		<0.005	<0.005	<0.005	----	----
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Holmium	7440-60-0	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Caesium	7440-46-2	0.001	mg/L		<0.001	<0.001	**0.001**	----	----
Chromium	7440-47-3	0.001	mg/L		**0.054**	**0.054**	**0.034**	----	----
Indium	7440-74-6	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Copper	7440-50-8	0.001	mg/L		<0.001	**0.001**	<0.001	----	----
Lanthanum	7439-91-0	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Rubidium	7440-17-7	0.001	mg/L		**0.034**	**0.034**	**0.051**	----	----
Lithium	7439-93-2	0.001	mg/L		**0.002**	**0.002**	**0.019**	----	----
Lutetium	7439-94-3	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Thorium	7440-29-1	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Cerium	7440-45-1	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Manganese	7439-96-5	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Neodymium	7440-00-8	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Molybdenum	7439-98-7	0.001	mg/L		**0.143**	**0.125**	**0.276**	----	----
Praseodymium	7440-10-0	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Samarium	7440-19-9	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Terbium	7440-27-9	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Antimony	7440-36-0	0.001	mg/L		**0.001**	**0.001**	**0.001**	----	----
Thulium	7440-30-4	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	**0.02**	----	----
Ytterbium	7440-64-4	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Tin	7440-31-5	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Yttrium	7440-65-5	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Thallium	7440-28-0	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Zirconium	7440-67-7	0.005	mg/L		<0.005	<0.005	<0.005	----	----
Vanadium	7440-62-2	0.01	mg/L		**0.03**	**0.03**	<0.01	----	----
Zinc	7440-66-6	0.005	mg/L		<0.005	<0.005	<0.005	----	----

Analytical Results

Sub-Matrix: WATER LEACHATE (Matrix: WATER)				Client sample ID	NTSF2 NAG LEACHATE	NTSF3 NAG LEACHATE	NTSF4 NAG LEACHATE	----	----
				Client sampling date / time	30-Dec-2019 09:30	30-Dec-2019 09:30	30-Dec-2019 09:30	----	----
Compound	CAS Number	LOR	Unit		EB2000092-014	EB2000092-015	EB2000092-016	--------	--------
					Result	Result	Result	----	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	<0.05	**----**	**----**
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.5**	**0.5**	**0.7**	**----**	**----**
EN055: Ionic Balance									
ø **Total Anions**	----	0.01	meq/L		**10.8**	**10.9**	**18.6**	**----**	**----**
ø **Total Cations**	----	0.01	meq/L		**11.3**	**11.7**	**21.3**	**----**	**----**
ø **Ionic Balance**	----	0.01	%		**2.00**	**3.35**	**6.62**	**----**	**----**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2000591**	Page	: 1 of 10
Client	: **NEWCREST MINING LIMITED**	Laboratory	: Environmental Division Brisbane
Contact	: TIM WRIGLEY	Contact	: John Pickering
Address	: LEVEL 32 400 GEORGE STREET BRISBANE QLD, AUSTRALIA 4000	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: ----	Telephone	: +61 7 3552 8634
Project	: TSF CADIA	Date Samples Received	: 10-Jan-2020 13:15
Order number	: 4500922559	Date Analysis Commenced	: 13-Jan-2020
C-O-C number	: ----	Issue Date	: 17-Jan-2020 14:55
Sampler	: TIM WRIGLEY		
Site	: CADIA		
Quote number	: EN/222		
No. of samples received	: 2		
No. of samples analysed	: 2		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Diana Mesa	2IC Organic Chemist	Brisbane Organics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EP075: 'Sum of PAH' is the sum of the USEPA 16 priority PAHs
- Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero, for 'TEQ 1/2LOR' are treated as half the reported LOR, and for 'TEQ LOR' are treated as being equal to the reported LOR. Note: TEQ 1/2LOR and TEQ LOR will calculate as 0.6mg/Kg and 1.2mg/Kg respectively for samples with non-detects for all of the eight TEQ PAHs.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	NTSF 4	STSF 2	----	----	----
			Client sampling date / time	10-Jan-2020 00:00	10-Jan-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EB2000591-001	EB2000591-002	--------	--------	--------
				Result	Result	----	----	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	**9.3**	<1.0	----	----	----
EP074A: Monocyclic Aromatic Hydrocarbons								
Benzene	71-43-2	0.2	mg/kg	<0.2	<0.2	----	----	----
Toluene	108-88-3	0.5	mg/kg	<0.5	<0.5	----	----	----
Ethylbenzene	100-41-4	0.5	mg/kg	<0.5	<0.5	----	----	----
meta- & para-Xylene	108-38-3 106-42-3	0.5	mg/kg	<0.5	<0.5	----	----	----
Styrene	100-42-5	0.5	mg/kg	<0.5	<0.5	----	----	----
ortho-Xylene	95-47-6	0.5	mg/kg	<0.5	<0.5	----	----	----
Isopropylbenzene	98-82-8	0.5	mg/kg	<0.5	<0.5	----	----	----
n-Propylbenzene	103-65-1	0.5	mg/kg	<0.5	<0.5	----	----	----
1.3.5-Trimethylbenzene	108-67-8	0.5	mg/kg	<0.5	<0.5	----	----	----
sec-Butylbenzene	135-98-8	0.5	mg/kg	<0.5	<0.5	----	----	----
1.2.4-Trimethylbenzene	95-63-6	0.5	mg/kg	<0.5	<0.5	----	----	----
tert-Butylbenzene	98-06-6	0.5	mg/kg	<0.5	<0.5	----	----	----
p-Isopropyltoluene	99-87-6	0.5	mg/kg	<0.5	<0.5	----	----	----
n-Butylbenzene	104-51-8	0.5	mg/kg	<0.5	<0.5	----	----	----
EP074B: Oxygenated Compounds								
Vinyl Acetate	108-05-4	5	mg/kg	<5	<5	----	----	----
2-Butanone (MEK)	78-93-3	5	mg/kg	<5	<5	----	----	----
4-Methyl-2-pentanone (MIBK)	108-10-1	5	mg/kg	<5	<5	----	----	----
2-Hexanone (MBK)	591-78-6	5	mg/kg	<5	<5	----	----	----
EP074C: Sulfonated Compounds								
Carbon disulfide	75-15-0	0.5	mg/kg	<0.5	<0.5	----	----	----
EP074D: Fumigants								
2.2-Dichloropropane	594-20-7	0.5	mg/kg	<0.5	<0.5	----	----	----
1.2-Dichloropropane	78-87-5	0.5	mg/kg	<0.5	<0.5	----	----	----
cis-1.3-Dichloropropylene	10061-01-5	0.5	mg/kg	<0.5	<0.5	----	----	----
trans-1.3-Dichloropropylene	10061-02-6	0.5	mg/kg	<0.5	<0.5	----	----	----
1.2-Dibromoethane (EDB)	106-93-4	0.5	mg/kg	<0.5	<0.5	----	----	----
EP074E: Halogenated Aliphatic Compounds								
Dichlorodifluoromethane	75-71-8	5	mg/kg	<5	<5	----	----	----
Chloromethane	74-87-3	5	mg/kg	<5	<5	----	----	----
Vinyl chloride	75-01-4	5	mg/kg	<5	<5	----	----	----
Bromomethane	74-83-9	5	mg/kg	<5	<5	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	NTSF 4	STSF 2	----	----	----
				Client sampling date / time	10-Jan-2020 00:00	10-Jan-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit		EB2000591-001	EB2000591-002	--------	--------	--------
					Result	Result	----	----	----
EP074E: Halogenated Aliphatic Compounds - Continued									
Chloroethane	75-00-3	5	mg/kg		<5	<5	----	----	----
Trichlorofluoromethane	75-69-4	5	mg/kg		<5	<5	----	----	----
1.1-Dichloroethene	75-35-4	0.5	mg/kg		<0.5	<0.5	----	----	----
Iodomethane	74-88-4	0.5	mg/kg		<0.5	<0.5	----	----	----
trans-1.2-Dichloroethene	156-60-5	0.5	mg/kg		<0.5	<0.5	----	----	----
1.1-Dichloroethane	75-34-3	0.5	mg/kg		<0.5	<0.5	----	----	----
cis-1.2-Dichloroethene	156-59-2	0.5	mg/kg		<0.5	<0.5	----	----	----
1.1.1-Trichloroethane	71-55-6	0.5	mg/kg		<0.5	<0.5	----	----	----
1.1-Dichloropropylene	563-58-6	0.5	mg/kg		<0.5	<0.5	----	----	----
Carbon Tetrachloride	56-23-5	0.5	mg/kg		<0.5	<0.5	----	----	----
1.2-Dichloroethane	107-06-2	0.5	mg/kg		<0.5	<0.5	----	----	----
Trichloroethene	79-01-6	0.5	mg/kg		<0.5	<0.5	----	----	----
Dibromomethane	74-95-3	0.5	mg/kg		<0.5	<0.5	----	----	----
1.1.2-Trichloroethane	79-00-5	0.5	mg/kg		<0.5	<0.5	----	----	----
1.3-Dichloropropane	142-28-9	0.5	mg/kg		<0.5	<0.5	----	----	----
Tetrachloroethene	127-18-4	0.5	mg/kg		<0.5	<0.5	----	----	----
1.1.1.2-Tetrachloroethane	630-20-6	0.5	mg/kg		<0.5	<0.5	----	----	----
trans-1.4-Dichloro-2-butene	110-57-6	0.5	mg/kg		<0.5	<0.5	----	----	----
cis-1.4-Dichloro-2-butene	1476-11-5	0.5	mg/kg		<0.5	<0.5	----	----	----
1.1.2.2-Tetrachloroethane	79-34-5	0.5	mg/kg		<0.5	<0.5	----	----	----
1.2.3-Trichloropropane	96-18-4	0.5	mg/kg		<0.5	<0.5	----	----	----
Pentachloroethane	76-01-7	0.5	mg/kg		<0.5	<0.5	----	----	----
1.2-Dibromo-3-chloropropane	96-12-8	0.5	mg/kg		<0.5	<0.5	----	----	----
EP074F: Halogenated Aromatic Compounds									
Chlorobenzene	108-90-7	0.5	mg/kg		<0.5	<0.5	----	----	----
Bromobenzene	108-86-1	0.5	mg/kg		<0.5	<0.5	----	----	----
2-Chlorotoluene	95-49-8	0.5	mg/kg		<0.5	<0.5	----	----	----
4-Chlorotoluene	106-43-4	0.5	mg/kg		<0.5	<0.5	----	----	----
1.2.3-Trichlorobenzene	87-61-6	0.5	mg/kg		<0.5	<0.5	----	----	----
EP074G: Trihalomethanes									
Chloroform	67-66-3	0.5	mg/kg		<0.5	<0.5	----	----	----
Bromodichloromethane	75-27-4	0.5	mg/kg		<0.5	<0.5	----	----	----
Dibromochloromethane	124-48-1	0.5	mg/kg		<0.5	<0.5	----	----	----
Bromoform	75-25-2	0.5	mg/kg		<0.5	<0.5	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	NTSF 4	STSF 2	----	----	----
			Client sampling date / time	10-Jan-2020 00:00	10-Jan-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EB2000591-001	EB2000591-002	--------	--------	--------
				Result	Result	----	----	----
EP075A: Phenolic Compounds								
Phenol	108-95-2	0.5	mg/kg	<0.5	<0.5	----	----	----
2-Chlorophenol	95-57-8	0.5	mg/kg	<0.5	<0.5	----	----	----
2-Methylphenol	95-48-7	0.5	mg/kg	<0.5	<0.5	----	----	----
3- & 4-Methylphenol	1319-77-3	0.5	mg/kg	<0.5	<0.5	----	----	----
2-Nitrophenol	88-75-5	0.5	mg/kg	<0.5	<0.5	----	----	----
2.4-Dimethylphenol	105-67-9	0.5	mg/kg	<0.5	<0.5	----	----	----
2.4-Dichlorophenol	120-83-2	0.5	mg/kg	<0.5	<0.5	----	----	----
2.6-Dichlorophenol	87-65-0	0.5	mg/kg	<0.5	<0.5	----	----	----
4-Chloro-3-methylphenol	59-50-7	0.5	mg/kg	<0.5	<0.5	----	----	----
2.4.6-Trichlorophenol	88-06-2	0.5	mg/kg	<0.5	<0.5	----	----	----
2.4.5-Trichlorophenol	95-95-4	0.5	mg/kg	<0.5	<0.5	----	----	----
Pentachlorophenol	87-86-5	1	mg/kg	<1	<1	----	----	----
EP075B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	0.5	mg/kg	<0.5	<0.5	----	----	----
2-Methylnaphthalene	91-57-6	0.5	mg/kg	<0.5	<0.5	----	----	----
2-Chloronaphthalene	91-58-7	0.5	mg/kg	<0.5	<0.5	----	----	----
Acenaphthylene	208-96-8	0.5	mg/kg	<0.5	<0.5	----	----	----
Acenaphthene	83-32-9	0.5	mg/kg	<0.5	<0.5	----	----	----
Fluorene	86-73-7	0.5	mg/kg	<0.5	<0.5	----	----	----
Phenanthrene	85-01-8	0.5	mg/kg	<0.5	<0.5	----	----	----
Anthracene	120-12-7	0.5	mg/kg	<0.5	<0.5	----	----	----
Fluoranthene	206-44-0	0.5	mg/kg	<0.5	<0.5	----	----	----
Pyrene	129-00-0	0.5	mg/kg	<0.5	<0.5	----	----	----
N-2-Fluorenyl Acetamide	53-96-3	0.5	mg/kg	<0.5	<0.5	----	----	----
Benz(a)anthracene	56-55-3	0.5	mg/kg	<0.5	<0.5	----	----	----
Chrysene	218-01-9	0.5	mg/kg	<0.5	<0.5	----	----	----
Benzo(b+j) & Benzo(k)fluoranthene	205-99-2 207-08-9	1	mg/kg	<1	<1	----	----	----
7.12-Dimethylbenz(a)anthracene	57-97-6	0.5	mg/kg	<0.5	<0.5	----	----	----
Benzo(a)pyrene	50-32-8	0.5	mg/kg	<0.5	<0.5	----	----	----
3-Methylcholanthrene	56-49-5	0.5	mg/kg	<0.5	<0.5	----	----	----
Indeno(1.2.3.cd)pyrene	193-39-5	0.5	mg/kg	<0.5	<0.5	----	----	----
Dibenz(a.h)anthracene	53-70-3	0.5	mg/kg	<0.5	<0.5	----	----	----
Benzo(g.h.i)perylene	191-24-2	0.5	mg/kg	<0.5	<0.5	----	----	----
^ Sum of PAHs	----	0.5	mg/kg	<0.5	<0.5	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	NTSF 4	STSF 2	----	----	----
				Client sampling date / time	10-Jan-2020 00:00	10-Jan-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit		EB2000591-001	EB2000591-002	--------	--------	--------
					Result	Result	----	----	----
EP075B: Polynuclear Aromatic Hydrocarbons - Continued									
^ Benzo(a)pyrene TEQ (zero)	----	0.5	mg/kg		<0.5	<0.5	----	----	----
^ Benzo(a)pyrene TEQ (half LOR)	----	0.5	mg/kg		**0.6**	**0.6**	----	----	----
^ Benzo(a)pyrene TEQ (LOR)	----	0.5	mg/kg		**1.2**	**1.2**	----	----	----
EP075C: Phthalate Esters									
Dimethyl phthalate	131-11-3	0.5	mg/kg		<0.5	<0.5	----	----	----
Diethyl phthalate	84-66-2	0.5	mg/kg		<0.5	<0.5	----	----	----
Di-n-butyl phthalate	84-74-2	0.5	mg/kg		<0.5	<0.5	----	----	----
Butyl benzyl phthalate	85-68-7	0.5	mg/kg		<0.5	<0.5	----	----	----
bis(2-ethylhexyl) phthalate	117-81-7	5.0	mg/kg		<5.0	<5.0	----	----	----
Di-n-octylphthalate	117-84-0	0.5	mg/kg		<0.5	<0.5	----	----	----
EP075D: Nitrosamines									
N-Nitrosomethylethylamine	10595-95-6	0.5	mg/kg		<0.5	<0.5	----	----	----
N-Nitrosodiethylamine	55-18-5	0.5	mg/kg		<0.5	<0.5	----	----	----
N-Nitrosopyrrolidine	930-55-2	1.0	mg/kg		<1.0	<1.0	----	----	----
N-Nitrosomorpholine	59-89-2	0.5	mg/kg		<0.5	<0.5	----	----	----
N-Nitrosodi-n-propylamine	621-64-7	0.5	mg/kg		<0.5	<0.5	----	----	----
N-Nitrosopiperidine	100-75-4	0.5	mg/kg		<0.5	<0.5	----	----	----
N-Nitrosodibutylamine	924-16-3	0.5	mg/kg		<0.5	<0.5	----	----	----
N-Nitrosodiphenyl & Diphenylamine	86-30-6 122-39-4	1.0	mg/kg		<1.0	<1.0	----	----	----
Methapyrilene	91-80-5	0.5	mg/kg		<0.5	<0.5	----	----	----
EP075E: Nitroaromatics and Ketones									
2-Picoline	109-06-8	0.5	mg/kg		<0.5	<0.5	----	----	----
Acetophenone	98-86-2	0.5	mg/kg		<0.5	<0.5	----	----	----
Nitrobenzene	98-95-3	0.5	mg/kg		<0.5	<0.5	----	----	----
Isophorone	78-59-1	0.5	mg/kg		<0.5	<0.5	----	----	----
2.6-Dinitrotoluene	606-20-2	1.0	mg/kg		<1.0	<1.0	----	----	----
2.4-Dinitrotoluene	121-14-2	1.0	mg/kg		<1.0	<1.0	----	----	----
1-Naphthylamine	134-32-7	0.5	mg/kg		<0.5	<0.5	----	----	----
4-Nitroquinoline-N-oxide	56-57-5	0.5	mg/kg		<0.5	<0.5	----	----	----
5-Nitro-o-toluidine	99-55-8	0.5	mg/kg		<0.5	<0.5	----	----	----
Azobenzene	103-33-3	1	mg/kg		<1	<1	----	----	----
1.3.5-Trinitrobenzene	99-35-4	0.5	mg/kg		<0.5	<0.5	----	----	----
Phenacetin	62-44-2	0.5	mg/kg		<0.5	<0.5	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	NTSF 4	STSF 2	----	----	----
				Client sampling date / time	10-Jan-2020 00:00	10-Jan-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit		EB2000591-001	EB2000591-002	--------	--------	--------
					Result	Result	----	----	----
EP075E: Nitroaromatics and Ketones - Continued									
4-Aminobiphenyl	92-67-1	0.5	mg/kg		<0.5	<0.5	----	----	----
Pentachloronitrobenzene	82-68-8	0.5	mg/kg		<0.5	<0.5	----	----	----
Pronamide	23950-58-5	0.5	mg/kg		<0.5	<0.5	----	----	----
Dimethylaminoazobenzene	60-11-7	0.5	mg/kg		<0.5	<0.5	----	----	----
Chlorobenzilate	510-15-6	0.5	mg/kg		<0.5	<0.5	----	----	----
EP075F: Haloethers									
Bis(2-chloroethyl) ether	111-44-4	0.5	mg/kg		<0.5	<0.5	----	----	----
Bis(2-chloroethoxy) methane	111-91-1	0.5	mg/kg		<0.5	<0.5	----	----	----
4-Chlorophenyl phenyl ether	7005-72-3	0.5	mg/kg		<0.5	<0.5	----	----	----
4-Bromophenyl phenyl ether	101-55-3	0.5	mg/kg		<0.5	<0.5	----	----	----
EP075G: Chlorinated Hydrocarbons									
1.3-Dichlorobenzene	541-73-1	0.5	mg/kg		<0.5	<0.5	----	----	----
1.4-Dichlorobenzene	106-46-7	0.5	mg/kg		<0.5	<0.5	----	----	----
1.2-Dichlorobenzene	95-50-1	0.5	mg/kg		<0.5	<0.5	----	----	----
Hexachloroethane	67-72-1	0.5	mg/kg		<0.5	<0.5	----	----	----
1.2.4-Trichlorobenzene	120-82-1	0.5	mg/kg		<0.5	<0.5	----	----	----
Hexachloropropylene	1888-71-7	0.5	mg/kg		<0.5	<0.5	----	----	----
Hexachlorobutadiene	87-68-3	0.5	mg/kg		<0.5	<0.5	----	----	----
Hexachlorocyclopentadiene	77-47-4	2.5	mg/kg		<2.5	<2.5	----	----	----
Pentachlorobenzene	608-93-5	0.5	mg/kg		<0.5	<0.5	----	----	----
Hexachlorobenzene (HCB)	118-74-1	1.0	mg/kg		<1.0	<1.0	----	----	----
EP075H: Anilines and Benzidines									
Aniline	62-53-3	0.5	mg/kg		<0.5	<0.5	----	----	----
4-Chloroaniline	106-47-8	0.5	mg/kg		<0.5	<0.5	----	----	----
2-Nitroaniline	88-74-4	1.0	mg/kg		<1.0	<1.0	----	----	----
3-Nitroaniline	99-09-2	1.0	mg/kg		<1.0	<1.0	----	----	----
Dibenzofuran	132-64-9	0.5	mg/kg		<0.5	<0.5	----	----	----
4-Nitroaniline	100-01-6	0.5	mg/kg		<0.5	<0.5	----	----	----
Carbazole	86-74-8	0.5	mg/kg		<0.5	<0.5	----	----	----
3.3`-Dichlorobenzidine	91-94-1	0.5	mg/kg		<0.5	<0.5	----	----	----
EP075I: Organochlorine Pesticides									
alpha-BHC	319-84-6	0.5	mg/kg		<0.5	<0.5	----	----	----
beta-BHC	319-85-7	0.5	mg/kg		<0.5	<0.5	----	----	----
gamma-BHC	58-89-9	0.5	mg/kg		<0.5	<0.5	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	NTSF 4	STSF 2	----	----	----
				Client sampling date / time	10-Jan-2020 00:00	10-Jan-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit		EB2000591-001	EB2000591-002	--------	--------	--------
					Result	Result	----	----	----
EP075I: Organochlorine Pesticides - Continued									
delta-BHC	319-86-8	0.5	mg/kg		<0.5	<0.5	----	----	----
Heptachlor	76-44-8	0.5	mg/kg		<0.5	<0.5	----	----	----
Aldrin	309-00-2	0.5	mg/kg		<0.5	<0.5	----	----	----
Heptachlor epoxide	1024-57-3	0.5	mg/kg		<0.5	<0.5	----	----	----
alpha-Endosulfan	959-98-8	0.5	mg/kg		<0.5	<0.5	----	----	----
4.4`-DDE	72-55-9	0.5	mg/kg		<0.5	<0.5	----	----	----
Dieldrin	60-57-1	0.5	mg/kg		<0.5	<0.5	----	----	----
Endrin	72-20-8	0.5	mg/kg		<0.5	<0.5	----	----	----
beta-Endosulfan	33213-65-9	0.5	mg/kg		<0.5	<0.5	----	----	----
4.4`-DDD	72-54-8	0.5	mg/kg		<0.5	<0.5	----	----	----
Endosulfan sulfate	1031-07-8	0.5	mg/kg		<0.5	<0.5	----	----	----
4.4`-DDT	50-29-3	1.0	mg/kg		<1.0	<1.0	----	----	----
EP075J: Organophosphorus Pesticides									
Dichlorvos	62-73-7	0.5	mg/kg		<0.5	<0.5	----	----	----
Dimethoate	60-51-5	0.5	mg/kg		<0.5	<0.5	----	----	----
Diazinon	333-41-5	0.5	mg/kg		<0.5	<0.5	----	----	----
Chlorpyrifos-methyl	5598-13-0	0.5	mg/kg		<0.5	<0.5	----	----	----
Malathion	121-75-5	0.5	mg/kg		<0.5	<0.5	----	----	----
Fenthion	55-38-9	0.5	mg/kg		<0.5	<0.5	----	----	----
Chlorpyrifos	2921-88-2	0.5	mg/kg		<0.5	<0.5	----	----	----
Pirimphos-ethyl	23505-41-1	0.5	mg/kg		<0.5	<0.5	----	----	----
Chlorfenvinphos	470-90-6	0.5	mg/kg		<0.5	<0.5	----	----	----
Prothiofos	34643-46-4	0.5	mg/kg		<0.5	<0.5	----	----	----
Ethion	563-12-2	0.5	mg/kg		<0.5	<0.5	----	----	----
EP074S: VOC Surrogates									
1.2-Dichloroethane-D4	17060-07-0	0.5	%		**110**	**110**	----	----	----
Toluene-D8	2037-26-5	0.5	%		**99.1**	**109**	----	----	----
4-Bromofluorobenzene	460-00-4	0.5	%		**111**	**127**	----	----	----
EP075S: Acid Extractable Surrogates									
2-Fluorophenol	367-12-4	0.5	%		**109**	**108**	----	----	----
Phenol-d6	13127-88-3	0.5	%		**101**	**103**	----	----	----
2-Chlorophenol-D4	93951-73-6	0.5	%		**106**	**104**	----	----	----
2.4.6-Tribromophenol	118-79-6	0.5	%		**69.5**	**61.4**	----	----	----
EP075T: Base/Neutral Extractable Surrogates									

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	NTSF 4	STSF 2	----	----	----
				Client sampling date / time	10-Jan-2020 00:00	10-Jan-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit		EB2000591-001	EB2000591-002	--------	--------	--------
					Result	Result	----	----	----
EP075T: Base/Neutral Extractable Surrogates - Continued									
Nitrobenzene-D5	4165-60-0	0.5	%		**102**	**100**	**----**	**----**	**----**
1.2-Dichlorobenzene-D4	2199-69-1	0.5	%		**89.0**	**88.4**	**----**	**----**	**----**
2-Fluorobiphenyl	321-60-8	0.5	%		**98.4**	**98.0**	**----**	**----**	**----**
Anthracene-d10	1719-06-8	0.5	%		**93.3**	**97.0**	**----**	**----**	**----**
4-Terphenyl-d14	1718-51-0	0.5	%		**94.4**	**89.4**	**----**	**----**	**----**

Surrogate Control Limits

Sub-Matrix: **SOIL**

Compound	CAS Number	Recovery Limits (%) Low	High
EP074S: VOC Surrogates			
1.2-Dichloroethane-D4	17060-07-0	53	134
Toluene-D8	2037-26-5	60	131
4-Bromofluorobenzene	460-00-4	59	127
EP075S: Acid Extractable Surrogates			
2-Fluorophenol	367-12-4	10	150
Phenol-d6	13127-88-3	19	134
2-Chlorophenol-D4	93951-73-6	21	127
2.4.6-Tribromophenol	118-79-6	17	143
EP075T: Base/Neutral Extractable Surrogates			
Nitrobenzene-D5	4165-60-0	10	147
1.2-Dichlorobenzene-D4	2199-69-1	10	154
2-Fluorobiphenyl	321-60-8	10	128
Anthracene-d10	1719-06-8	10	137
4-Terphenyl-d14	1718-51-0	10	157

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES2016687**	Page	: 1 of 3
Client	: **NEWCREST MINING LIMITED**	Laboratory	: Environmental Division Sydney
Contact	: MR NICOLAS BOURGEOT	Contact	: Customer Services ES
Address	: 1460 CADIA ROAD ORANGE NSW, AUSTRALIA 2800	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: Cadia Water Monitoring	Date Samples Received	: 15-May-2020 08:33
Order number	: 4500922559	Date Analysis Commenced	: 20-May-2020
C-O-C number	: ----	Issue Date	: 22-May-2020 14:58
Sampler	: THOMAS BYRON		
Site	: CADIA		
Quote number	: EN/107/17 B V5		
No. of samples received	: 2		
No. of samples analysed	: 2		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Descriptive Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Alexander Ristoski	Laboratory Technican	Newcastle - Asbestos, Mayfield West, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EA200N: Asbestos weights and percentages are not covered under the Scope of NATA Accreditation.
  Weights of Asbestos are based on extracted bulk asbestos, fibre bundles, and/or ACM and do not include respirable fibres (if present)
  The Asbestos (Fines and Fibrous) weight is calculated from the extracted Fibrous Asbestos and Asbestos Fines as an equivalent weight of 100% Asbestos
  Percentages for Asbestos content in ACM are based on the 2013 NEPM default values.
  All calculations of percentage Asbestos under this method are approximate and should be used as a guide only.
- EA200 'Am' Amosite (brown asbestos)
- EA200 'Cr' Crocidolite (blue asbestos)
- EA200 'Trace' - Asbestos fibres ("Free Fibres") detected by trace analysis per AS4964. The result can be interpreted that the sample contains detectable 'respirable' asbestos fibres
- EA200: Asbestos Identification Samples were analysed by Polarised Light Microscopy including dispersion staining.
- EA200 Legend
- EA200 'Ch' Chrysotile (white asbestos)
- EA200: 'UMF' Unknown Mineral Fibres. "-" indicates fibres detected may or may not be asbestos fibres. Confirmation by alternative techniques is recommended.
- EA200N: ALS laboratory procedures and methods used for the identification and quantitation of asbestos are consistent with AS4964-2004 and the requirements of the 2013 NEPM for Assessment of Site Contamination
- EA200: For samples larger than 30g, the <2mm fraction may be sub-sampled prior to trace analysis as outlined in ISO23909:2008(E) Sect 6.3.2-2
- EA200: 'Yes' - Asbestos detected by polarised light microscopy including dispersion staining.
- EA200: 'No*' - No asbestos found, at the reporting limit of 0.1g/kg, by polarised light microscopy including dispersion staining. Asbestos material was detected and positively identified at concentrations estimated to be below 0.1g/kg.
- EA200: 'No' - No asbestos found at the reporting limit 0.1g/kg, by polarised light microscopy including dispersion staining.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	STSF1_Soil_20200512	STSF3_Soil_20200512	----	----	----
			Client sampling date / time	16-Jan-2020 00:00	16-Jan-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit	ES2016687-001	ES2016687-002	--------	--------	--------
				Result	Result	----	----	----
EA200: AS 4964 - 2004 Identification of Asbestos in Soils								
Asbestos Detected	1332-21-4	0.1	g/kg	**No**	**No**	----	----	----
Asbestos Type	1332-21-4	-	--	**-**	**-**	----	----	----
Asbestos (Trace)	1332-21-4	5	Fibres	**No**	**No**	----	----	----
Sample weight (dry)	----	0.01	g	**1250**	**1130**	----	----	----
Synthetic Mineral Fibre	----	0.1	g/kg	**No**	**No**	----	----	----
Organic Fibre	----	0.1	g/kg	**No**	**No**	----	----	----
APPROVED IDENTIFIER:	----	-	--	**A. RISTOSKI**	**A. RISTOSKI**	----	----	----
EA200N: Asbestos Quantification (non-NATA)								
ø **Asbestos (Fines and Fibrous <7mm)**	1332-21-4	0.0004	g	<0.0004	<0.0004	----	----	----
ø **Asbestos (Fines and Fibrous FA+AF)**	----	0.001	% (w/w)	<0.001	<0.001	----	----	----
ø **Weight Used for % Calculation**	----	0.0001	kg	**1.25**	**1.13**	----	----	----
ø **Fibrous Asbestos >7mm**	----	0.0004	g	<0.0004	<0.0004	----	----	----

Analytical Results

Descriptive Results

Sub-Matrix: **SOIL**

Method: Compound	Client sample ID - Client sampling date / time	Analytical Results
EA200: AS 4964 - 2004 Identification of Asbestos in Soils		
EA200: Description	STSF1_Soil_20200512 - 16-Jan-2020 00:00	Mid brown soil.
EA200: Description	STSF3_Soil_20200512 - 16-Jan-2020 00:00	Mid brown soil.

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES2016298**	Page	: 1 of 14
Amendment	: **1**		
Client	: **NEWCREST MINING LIMITED**	Laboratory	: Environmental Division Sydney
Contact	: MR NICOLAS BOURGEOT	Contact	: Customer Services ES
Address	: 1460 CADIA ROAD ORANGE NSW, AUSTRALIA 2800	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: Cadia Water Monitoring	Date Samples Received	: 13-May-2020 09:45
Order number	: 4500922559	Date Analysis Commenced	: 13-May-2020
C-O-C number	: ----	Issue Date	: 22-May-2020 21:42
Sampler	: Thomas Byron		
Site	: CADIA		
Quote number	: EN/107/17 B V5		
No. of samples received	: 20		
No. of samples analysed	: 20		

Accreditation No. 825
Accredited for compliance with
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Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

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Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

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LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EG020: It is recognised that total concentration is less than dissolved for some metal analytes. However, the difference is within experimental variation of the methods.
- TDS by method EA-015 may bias high for various samples due to the presence of fine particulate matter, which may pass through the prescribed GF/C paper.
- Ionic Balance out of acceptable limits for various samples due to analytes not quantified in this report.
- Amendment (20/05/2020): This report has been amended and re-released to allow the reporting of additional analytical data.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	SVWT20200507	OCWT20200507	EPHWT20200506	EPSWT20200506	BWWT20200506
			Client sampling date / time	07-May-2020 00:00	07-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00
Compound	CAS Number	LOR	Unit	ES2016298-001	ES2016298-002	ES2016298-003	ES2016298-004	ES2016298-005
				Result	Result	Result	Result	Result
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	168	32	58	6	37
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	89	26	34	<10	30
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	<5	5	<5	10	6
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	47	<1	18	<1	15
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	74	3	25	<1	15
Total Alkalinity as CaCO3	----	1	mg/L	74	3	25	<1	15
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	4	3	<1	<1	1
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	1	<1	2	<1	<1
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	19	<1	4	<1	6
Magnesium	7439-95-4	1	mg/L	<1	<1	2	<1	<1
Sodium	7440-23-5	1	mg/L	2	<1	3	<1	<1
Potassium	7440-09-7	1	mg/L	2	<1	<1	<1	<1
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	0.04
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.0002	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	0.023	0.043	0.020	0.004	0.002
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L	0.019	0.057	<0.001	0.023	0.002
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	0.001	0.002	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SVWT20200507	OCWT20200507	EPHWT20200506	EPSWT20200506	BWWT20200506
				Client sampling date / time	07-May-2020 00:00	07-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00
Compound	CAS Number	LOR	Unit		ES2016298-001	ES2016298-002	ES2016298-003	ES2016298-004	ES2016298-005
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		**12.5**	**5.25**	**0.031**	**0.130**	**0.128**
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	<0.05	<0.05	<0.05
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.01**	**0.08**	**0.02**	**0.03**	**0.06**
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L		**0.0001**	**0.0002**	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	**0.006**	**0.003**	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		**0.027**	**0.050**	**0.024**	**0.008**	**0.030**
Lead	7439-92-1	0.001	mg/L		<0.001	**0.002**	<0.001	<0.001	**0.006**
Manganese	7439-96-5	0.001	mg/L		**0.021**	**0.061**	**0.003**	**0.028**	**0.005**
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L		**0.002**	**0.002**	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		**12.8**	**5.36**	**0.039**	**0.148**	**0.244**
Iron	7439-89-6	0.05	mg/L		<0.05	**0.12**	<0.05	**0.15**	**0.42**
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**2.22**	**2.10**	**0.62**	**0.30**	**0.48**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**2.22**	**2.10**	**0.62**	**0.30**	**0.48**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.4**	**0.3**	<0.1	<0.1	<0.1
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**2.6**	**2.4**	**0.6**	**0.3**	**0.5**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.03**	**0.05**	**0.03**	**0.01**	**0.02**
EN055: Ionic Balance									

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)				Client sample ID	**SVWT20200507**	**OCWT20200507**	**EPHWT20200506**	**EPSWT20200506**	**BWWT20200506**
				Client sampling date / time	07-May-2020 00:00	07-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00
Compound	*CAS Number*	*LOR*	*Unit*		**ES2016298-001**	**ES2016298-002**	**ES2016298-003**	**ES2016298-004**	**ES2016298-005**
					Result	Result	Result	Result	Result
EN055: Ionic Balance - Continued									
ø **Total Anions**	----	0.01	meq/L		**1.59**	**0.12**	**0.56**	<0.01	**0.32**
ø **Total Cations**	----	0.01	meq/L		**1.82**	**0.15**	**----**	**----**	**----**
ø **Total Cations**	----	0.01	meq/L		**----**	**----**	**0.49**	<0.01	**0.30**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	W1HT20200506	W1ST20200506	W2HT20200506	W3HT20200506	W3ST20200506
			Client sampling date / time	06-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00
Compound	CAS Number	LOR	Unit	ES2016298-006	ES2016298-007	ES2016298-008	ES2016298-009	ES2016298-010
				Result	Result	Result	Result	Result
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	15	72	11	10	14
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	<10	51	<10	<10	10
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	7	7	<5	<5	6
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	2	20	<1	<1	5
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	5	33	<1	<1	3
Total Alkalinity as CaCO3	----	1	mg/L	5	33	<1	<1	3
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	<1	<1	<1	<1
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	<1	2	<1	<1	<1
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	1	8	<1	<1	2
Magnesium	7439-95-4	1	mg/L	<1	<1	<1	<1	<1
Sodium	7440-23-5	1	mg/L	<1	2	<1	<1	<1
Potassium	7440-09-7	1	mg/L	<1	2	<1	<1	<1
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	0.0001	0.0010	<0.0001	0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	0.187	0.002	0.045	0.008	0.008
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L	0.005	0.021	0.047	0.031	0.014
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	<0.001	0.004	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	W1HT20200506	W1ST20200506	W2HT20200506	W3HT20200506	W3ST20200506
				Client sampling date / time	06-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00
Compound	CAS Number	LOR	Unit		ES2016298-006	ES2016298-007	ES2016298-008	ES2016298-009	ES2016298-010
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		**0.807**	**1.48**	**0.049**	**0.092**	**0.242**
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	<0.05	<0.05	<0.05
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.03**	**0.02**	**0.02**	**0.04**	**0.01**
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L		**0.0002**	**0.0012**	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	**0.002**	**0.002**	**0.001**
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		**0.228**	**0.008**	**0.057**	**0.009**	**0.007**
Lead	7439-92-1	0.001	mg/L		<0.001	**0.001**	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L		**0.006**	**0.021**	**0.049**	**0.036**	**0.014**
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	<0.001	**0.001**	<0.001
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		**0.873**	**1.69**	**0.053**	**0.084**	**0.256**
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	**0.09**	<0.05	<0.05
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.23**	**0.70**	**0.75**	**0.57**	**0.63**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.23**	**0.70**	**0.75**	**0.57**	**0.63**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		<0.1	<0.1	<0.1	**0.5**	<0.1
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**0.2**	**0.7**	**0.8**	**1.1**	**0.6**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.02**	**0.01**	**0.02**	**0.03**	**0.02**
EN055: Ionic Balance									

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)				Client sample ID	W1HT20200506	W1ST20200506	W2HT20200506	W3HT20200506	W3ST20200506
				Client sampling date / time	06-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00
Compound	*CAS Number*	*LOR*	*Unit*		**ES2016298-006**	**ES2016298-007**	**ES2016298-008**	**ES2016298-009**	**ES2016298-010**
					Result	Result	Result	Result	Result
EN055: Ionic Balance - Continued									
ø **Total Anions**	----	0.01	meq/L		**0.10**	**0.72**	<0.01	<0.01	**0.06**
ø **Total Cations**	----	0.01	meq/L		**0.05**	**0.54**	<0.01	<0.01	**0.10**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	CHHT20200506	CHST20200506	CHHT20200506	EPSW20200506	WGSW20200507
			Client sampling date / time	06-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00	07-May-2020 00:00
Compound	CAS Number	LOR	Unit	ES2016298-011	ES2016298-012	ES2016298-013	ES2016298-014	ES2016298-015
				Result	Result	Result	Result	Result
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	19	33	80	58	332
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	<10	20	47	55	270
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	<5	18	6	22	41
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	<1	10	27	2	53
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	4	13	34	2	112
Total Alkalinity as CaCO3	----	1	mg/L	4	13	34	2	112
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	<1	1	6	26
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	<1	<1	<1	4	14
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	<1	4	11	1	15
Magnesium	7439-95-4	1	mg/L	<1	<1	<1	<1	6
Sodium	7440-23-5	1	mg/L	<1	<1	1	3	9
Potassium	7440-09-7	1	mg/L	1	<1	2	4	43
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.01	<0.01	<0.01	0.15	0.49
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	0.005
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	0.001	0.008
Copper	7440-50-8	0.001	mg/L	0.009	0.001	0.001	0.002	0.008
Lead	7439-92-1	0.001	mg/L	0.002	<0.001	<0.001	<0.001	0.002
Manganese	7439-96-5	0.001	mg/L	0.021	0.006	0.003	0.132	1.06
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	0.002
Nickel	7440-02-0	0.001	mg/L	0.002	<0.001	<0.001	<0.001	0.005
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	CHHT20200506	CHST20200506	CHHT20200506	EPSW20200506	WGSW20200507
				Client sampling date / time	06-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00	07-May-2020 00:00
Compound	CAS Number	LOR	Unit		ES2016298-011	ES2016298-012	ES2016298-013	ES2016298-014	ES2016298-015
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		**1.07**	**1.17**	**0.548**	<0.005	**0.012**
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	<0.05	**0.11**	**7.37**
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.02**	**0.12**	<0.01	**0.79**	**1.20**
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	**0.007**
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	**0.002**
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	**0.002**	**0.010**
Copper	7440-50-8	0.001	mg/L		**0.010**	**0.008**	**0.007**	**0.012**	**0.014**
Lead	7439-92-1	0.001	mg/L		**0.002**	**0.013**	<0.001	<0.001	**0.003**
Manganese	7439-96-5	0.001	mg/L		**0.022**	**0.025**	**0.004**	**0.150**	**1.30**
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	**0.003**
Nickel	7440-02-0	0.001	mg/L		**0.001**	<0.001	<0.001	<0.001	**0.007**
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		**1.14**	**1.70**	**0.571**	**0.008**	**0.031**
Iron	7439-89-6	0.05	mg/L		<0.05	**0.15**	<0.05	**0.73**	**9.10**
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	**0.08**
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.55**	**0.57**	**1.27**	**2.47**	**0.08**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.55**	**0.57**	**1.27**	**2.47**	**0.16**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		<0.1	<0.1	**0.2**	**1.6**	**8.2**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**0.6**	**0.6**	**1.5**	**4.1**	**8.4**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.07**	**0.07**	**0.09**	**0.06**	**1.22**
EN055: Ionic Balance									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	CHHT20200506	CHST20200506	CHHT20200506	EPSW20200506	WGSW20200507
				Client sampling date / time	06-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00	06-May-2020 00:00	07-May-2020 00:00
Compound	CAS Number	LOR	Unit		ES2016298-011	ES2016298-012	ES2016298-013	ES2016298-014	ES2016298-015
					Result	Result	Result	Result	Result
EN055: Ionic Balance - Continued									
ø **Total Anions**	----	0.01	meq/L		**0.08**	**0.26**	**0.70**	**0.28**	**3.17**
ø **Total Cations**	----	0.01	meq/L		**----**	**----**	**----**	**----**	**3.13**
ø **Total Cations**	----	0.01	meq/L		**0.02**	**0.20**	**0.64**	**0.28**	**----**
ø **Ionic Balance**	----	0.01	%		**----**	**----**	**----**	**----**	**0.70**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	WASW20200507	OCSW20200507	TASW20200507	BDSW20200507	EPB20200506
			Client sampling date / time	07-May-2020 00:00	07-May-2020 00:00	07-May-2020 00:00	07-May-2020 00:00	06-May-2020 00:00
Compound	CAS Number	LOR	Unit	ES2016298-016	ES2016298-017	ES2016298-018	ES2016298-019	ES2016298-020
				Result	Result	Result	Result	Result
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	109	533	160	156	329
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	80	384	133	160	190
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	33	18	27	12	6
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	21	175	60	46	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	40	57	63	73	178
Total Alkalinity as CaCO3	----	1	mg/L	40	57	63	73	178
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	176	24	<1	5
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	7	15	6	5	8
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	5	42	14	10	31
Magnesium	7439-95-4	1	mg/L	2	17	6	5	18
Sodium	7440-23-5	1	mg/L	3	24	5	3	14
Potassium	7440-09-7	1	mg/L	13	12	17	8	6
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.07	0.03	0.26	0.23	<0.01
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.002	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L	0.002	<0.001	0.004	0.002	<0.001
Copper	7440-50-8	0.001	mg/L	0.004	0.010	0.007	0.006	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L	0.104	0.024	0.478	0.321	0.084
Molybdenum	7439-98-7	0.001	mg/L	<0.001	0.002	0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	<0.001	0.001	0.002	0.002	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WASW20200507	OCSW20200507	TASW20200507	BDSW20200507	EPB20200506
				Client sampling date / time	07-May-2020 00:00	07-May-2020 00:00	07-May-2020 00:00	07-May-2020 00:00	06-May-2020 00:00
Compound	CAS Number	LOR	Unit		ES2016298-016	ES2016298-017	ES2016298-018	ES2016298-019	ES2016298-020
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		**0.011**	**0.078**	**0.008**	**0.011**	**0.007**
Iron	7439-89-6	0.05	mg/L		**0.20**	**0.05**	**0.78**	**0.59**	**0.64**
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.20**	**0.56**	**0.35**	**2.44**	----
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	**0.002**	**0.002**	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	----
Chromium	7440-47-3	0.001	mg/L		<0.001	**0.001**	<0.001	**0.002**	----
Cobalt	7440-48-4	0.001	mg/L		**0.003**	<0.001	**0.005**	**0.004**	----
Copper	7440-50-8	0.001	mg/L		**0.002**	**0.008**	**0.018**	**0.014**	----
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Manganese	7439-96-5	0.001	mg/L		**0.265**	**0.062**	**0.836**	**0.426**	----
Molybdenum	7439-98-7	0.001	mg/L		<0.001	**0.003**	**0.003**	<0.001	----
Nickel	7440-02-0	0.001	mg/L		<0.001	**0.002**	**0.003**	**0.002**	----
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	----
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Zinc	7440-66-6	0.005	mg/L		<0.005	**0.082**	**0.021**	**0.023**	----
Iron	7439-89-6	0.05	mg/L		**1.11**	**0.80**	**2.42**	**5.16**	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		----	----	----	----	<0.0001
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	**0.07**	**0.04**	**0.04**	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.41**	**2.85**	**0.21**	**0.28**	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.41**	**2.92**	**0.25**	**0.32**	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**3.1**	**1.6**	**2.5**	**2.5**	<0.1
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**3.5**	**4.5**	**2.8**	**2.8**	<0.1
EK067G: Total Phosphorus as P by Discrete Analyser									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WASW20200507	OCSW20200507	TASW20200507	BDSW20200507	EPB20200506
				Client sampling date / time	07-May-2020 00:00	07-May-2020 00:00	07-May-2020 00:00	07-May-2020 00:00	06-May-2020 00:00
Compound	CAS Number	LOR	Unit		ES2016298-016	ES2016298-017	ES2016298-018	ES2016298-019	ES2016298-020
					Result	Result	Result	Result	Result
EK067G: Total Phosphorus as P by Discrete Analyser - Continued									
Total Phosphorus as P	----	0.01	mg/L		**0.22**	**0.15**	**0.35**	**0.19**	**0.08**
EN055: Ionic Balance									
ø **Total Anions**	----	0.01	meq/L		**1.00**	**5.23**	**1.93**	**1.60**	**3.89**
ø **Total Cations**	----	0.01	meq/L		**0.88**	**4.84**	**1.84**	**1.24**	**3.79**
ø **Ionic Balance**	----	0.01	%		**----**	**3.78**	**----**	**----**	**1.24**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES2034662**	Page	: 1 of 11
Amendment	: **1**		
Client	: **NEWCREST MINING LIMITED**	Laboratory	: Environmental Division Sydney
Contact	: MR NICOLAS BOURGEOT	Contact	: Customer Services ES
Address	: 1460 CADIA ROAD ORANGE NSW, AUSTRALIA 2800	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: Cadia Water Monitoring	Date Samples Received	: 02-Oct-2020 09:20
Order number	: 45000922559	Date Analysis Commenced	: 02-Oct-2020
C-O-C number	: ----	Issue Date	: 19-Oct-2020 19:50
Sampler	: Martin Englert		
Site	: CADIA		
Quote number	: EN/107/17 B V5		
No. of samples received	: 13		
No. of samples analysed	: 13		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EG020: It has been confirmed by re-digestion and re-analysis that total Copper and Manganese concentration is less than dissolved for sample ES2034662-#013. For all other samples and analytes where dissolved is greater than total, the difference is within experimental variation of the methods.
- EG020: It has been confirmed by re-digestion and re-analysis that total Copper concentration is less than dissolved for sample ES2034662-#009.
- EG020: It has been confirmed by re-digestion and re-analysis that total Zinc concentration is less than dissolved for sample ES2034662-#005.
- TDS by method EA-015 may bias high for various samples due to the presence of fine particulate matter, which may pass through the prescribed GF/C paper.
- Amendment (14/10/20): This report has been amended and re-released to allow the reporting of additional analytical data.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SOUTHLOG_HT_20200929	STOCKTON_HT_20200929	STOCKTON_UG_20200929	SHARP_HT_20200929	SHARP_W_20200929
				Client sampling date / time	29-Sep-2020 00:00	29-Sep-2020 00:00	29-Sep-2020 00:00	29-Sep-2020 00:00	29-Sep-2020 00:00
Compound	CAS Number	LOR	Unit		ES2034662-001	ES2034662-002	ES2034662-003	ES2034662-004	ES2034662-005
					Result	Result	Result	Result	Result
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		44	18	20	14	870
EA015: Total Dissolved Solids dried at 180 ± 5 °C									
Total Dissolved Solids @180°C	----	10	mg/L		26	10	12	<10	551
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		<5	<5	<5	<5	20
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		21	7	16	9	299
Total Alkalinity as CaCO3	----	1	mg/L		21	7	17	9	299
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		<1	<1	<1	<1	158
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		<1	<1	<1	<1	74
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		6	<1	1	<1	72
Magnesium	7439-95-4	1	mg/L		<1	<1	<1	<1	61
Sodium	7440-23-5	1	mg/L		1	1	<1	<1	31
Potassium	7440-09-7	1	mg/L		<1	<1	<1	<1	<1
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	0.0002	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		0.002	0.032	<0.001	0.030	<0.001
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L		0.001	0.004	0.006	0.006	0.408
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	0.001
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		1.42	2.86	1.62	0.540	2.43

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	SOUTHLOG_HT_20200929	STOCKTON_HT_20200929	STOCKTON_UG_20200929	SHARP_HT_20200929	SHARP_W_20200929
				Client sampling date / time	29-Sep-2020 00:00	29-Sep-2020 00:00	29-Sep-2020 00:00	29-Sep-2020 00:00	29-Sep-2020 00:00
					ES2034662-001	ES2034662-002	ES2034662-003	ES2034662-004	ES2034662-005
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	<0.05	<0.05	**0.53**
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.01**	**0.03**	<0.01	**0.08**	<0.01
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	**0.0004**	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		**0.004**	**0.071**	**0.002**	**0.237**	**0.033**
Lead	7439-92-1	0.001	mg/L		**0.002**	**0.003**	<0.001	**0.014**	<0.001
Manganese	7439-96-5	0.001	mg/L		**0.004**	**0.004**	**0.006**	**0.007**	**0.445**
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		**1.46**	**3.17**	**1.77**	**0.819**	**0.737**
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	<0.05	**2.02**	**4.77**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.46**	**0.33**	**0.47**	**0.65**	**0.47**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.46**	**0.33**	**0.47**	**0.65**	**0.47**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		<0.1	<0.1	**0.1**	**0.2**	<0.1
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ **Total Nitrogen as N**	----	0.1	mg/L		**0.5**	**0.3**	**0.6**	**0.8**	**0.5**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.01**	<0.01	<0.01	**0.08**	<0.01

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	SOUTHLOG_HT_20200929	STOCKTON_HT_20200929	STOCKTON_UG_20200929	SHARP_HT_20200929	SHARP_W_20200929
				Client sampling date / time	29-Sep-2020 00:00	29-Sep-2020 00:00	29-Sep-2020 00:00	29-Sep-2020 00:00	29-Sep-2020 00:00
					ES2034662-001	ES2034662-002	ES2034662-003	ES2034662-004	ES2034662-005
					Result	Result	Result	Result	Result
EN055: Ionic Balance									
ø **Total Anions**	----	0.01	meq/L		**0.42**	**0.14**	**0.34**	**0.18**	**11.4**
ø **Total Cations**	----	0.01	meq/L		**----**	**----**	**0.13**	**----**	**----**
ø **Total Cations**	----	0.01	meq/L		**0.34**	**0.04**	**----**	<0.01	**9.96**
ø **Ionic Balance**	----	0.01	%		**----**	**----**	**----**	**----**	**6.52**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WEEMALLA_HT_20200929	GG_ST_20200929	ARGLE_HT_20200929	EB_HT1_20200929	EB_BT_20200929
				Client sampling date / time	29-Sep-2020 00:00	29-Sep-2020 00:00	29-Sep-2020 00:00	29-Sep-2020 00:00	29-Sep-2020 00:00
Compound	CAS Number	LOR	Unit		ES2034662-006	ES2034662-007	ES2034662-008	ES2034662-009	ES2034662-010
					Result	Result	Result	Result	Result
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		30	35	31	15	1680
EA015: Total Dissolved Solids dried at 180 ± 5 °C									
Total Dissolved Solids @180°C	----	10	mg/L		35	28	23	14	1020
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		<5	<5	<5	<5	<5
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		16	16	13	6	570
Total Alkalinity as CaCO3	----	1	mg/L		16	16	13	6	570
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		<1	<1	<1	<1	160
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		<1	<1	<1	<1	174
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		4	4	4	<1	135
Magnesium	7439-95-4	1	mg/L		<1	<1	<1	<1	78
Sodium	7440-23-5	1	mg/L		<1	<1	<1	<1	105
Potassium	7440-09-7	1	mg/L		<1	<1	<1	<1	<1
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	0.001
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	0.0002	<0.0001	0.0022	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		<0.001	<0.001	<0.001	0.012	0.001
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L		0.002	<0.001	0.001	0.004	0.044
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		0.110	1.60	0.406	2.01	7.26

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WEEMALLA_HT_20200929	GG_ST_20200929	ARGLE_HT_20200929	EB_HT1_20200929	EB_BT_20200929
				Client sampling date / time	29-Sep-2020 00:00	29-Sep-2020 00:00	29-Sep-2020 00:00	29-Sep-2020 00:00	29-Sep-2020 00:00
Compound	CAS Number	LOR	Unit		ES2034662-006	ES2034662-007	ES2034662-008	ES2034662-009	ES2034662-010
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	<0.05	<0.05	<0.05
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.02**	<0.01	**0.02**	**0.03**	<0.01
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	**0.002**
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	**0.0002**	<0.0001	**0.0025**	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		<0.001	**0.001**	**0.002**	**0.005**	**0.004**
Lead	7439-92-1	0.001	mg/L		<0.001	**0.001**	<0.001	**0.003**	<0.001
Manganese	7439-96-5	0.001	mg/L		**0.006**	**0.003**	**0.008**	**0.006**	**0.039**
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	<0.001	**0.001**	<0.001
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		**0.123**	**1.78**	**0.441**	**2.17**	**7.23**
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	<0.05	<0.05	<0.05
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	**0.01**	**0.01**	**0.01**
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.48**	**0.80**	**1.39**	**0.31**	**7.45**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.48**	**0.80**	**1.40**	**0.32**	**7.46**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		<0.1	**0.3**	**0.2**	**0.2**	**0.5**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**0.5**	**1.1**	**1.6**	**0.5**	**8.0**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		<0.01	<0.01	**0.02**	**0.02**	**0.02**

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	WEEMALLA_HT_20200929	GG_ST_20200929	ARGLE_HT_20200929	EB_HT1_20200929	EB_BT_20200929
				Client sampling date / time	29-Sep-2020 00:00	29-Sep-2020 00:00	29-Sep-2020 00:00	29-Sep-2020 00:00	29-Sep-2020 00:00
					ES2034662-006	ES2034662-007	ES2034662-008	ES2034662-009	ES2034662-010
					Result	Result	Result	Result	Result
EN055: Ionic Balance									
ø **Total Anions**	----	0.01	meq/L		**0.32**	**0.32**	**0.26**	**0.12**	**19.6**
ø **Total Cations**	----	0.01	meq/L		**0.20**	**0.20**	**0.20**	<0.01	**17.7**
ø **Ionic Balance**	----	0.01	%		**----**	**----**	**----**	**----**	**5.10**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	BRAEBURN_HT_20200930	CARRAMAR_HT1_20200930	CARRAMAR_HT2_20200930	----	----
			Client sampling date / time	30-Sep-2020 00:00	30-Sep-2020 00:00	30-Sep-2020 00:00	----	----
Compound	CAS Number	LOR	Unit	ES2034662-012	ES2034662-013	ES2034662-014	--------	--------
				Result	Result	Result	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**63**	**11**	**10**	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**48**	<10	<10	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	<5	**8**	<5	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**31**	**2**	**2**	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**31**	**2**	**2**	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**2**	**1**	<1	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	<1	<1	<1	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**10**	<1	<1	----	----
Magnesium	7439-95-4	1	mg/L	<1	<1	<1	----	----
Sodium	7440-23-5	1	mg/L	<1	<1	<1	----	----
Potassium	7440-09-7	1	mg/L	<1	<1	<1	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	**0.002**	<0.001	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Copper	7440-50-8	0.001	mg/L	**0.006**	**0.037**	<0.001	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	**0.002**	<0.001	----	----
Manganese	7439-96-5	0.001	mg/L	**0.005**	**0.021**	<0.001	----	----
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Zinc	7440-66-6	0.005	mg/L	**0.410**	**0.464**	**1.78**	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	BRAEBURN_HT_20200930	CARRAMAR_HT1_20200930	CARRAMAR_HT2_20200930	----	----
				Client sampling date / time	30-Sep-2020 00:00	30-Sep-2020 00:00	30-Sep-2020 00:00	----	----
Compound	CAS Number	LOR	Unit		ES2034662-012	ES2034662-013	ES2034662-014	--------	--------
					Result	Result	Result	----	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	<0.05	----	----
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.01**	**0.02**	<0.01	----	----
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Cadmium	7440-43-9	0.0001	mg/L		**0.0002**	<0.0001	<0.0001	----	----
Chromium	7440-47-3	0.001	mg/L		<0.001	**0.004**	<0.001	----	----
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Copper	7440-50-8	0.001	mg/L		**0.014**	**0.007**	<0.001	----	----
Lead	7439-92-1	0.001	mg/L		**0.003**	<0.001	**0.002**	----	----
Manganese	7439-96-5	0.001	mg/L		**0.004**	**0.016**	**0.003**	----	----
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	----	----
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Zinc	7440-66-6	0.005	mg/L		**1.03**	**0.553**	**2.01**	----	----
Iron	7439-89-6	0.05	mg/L		**0.13**	**0.11**	<0.05	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	----	----
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.21**	**0.47**	**0.43**	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.21**	**0.47**	**0.43**	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		<0.1	<0.1	<0.1	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**0.2**	**0.5**	**0.4**	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		<0.01	<0.01	<0.01	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	BRAEBURN_HT_20200930	CARRAMAR_HT1_20200930	CARRAMAR_HT2_20200930	----	----
				Client sampling date / time	30-Sep-2020 00:00	30-Sep-2020 00:00	30-Sep-2020 00:00	----	----
Compound	CAS Number	LOR	Unit		ES2034662-012	ES2034662-013	ES2034662-014	--------	--------
					Result	Result	Result	----	----
EN055: Ionic Balance									
ø **Total Anions**	----	0.01	meq/L		**0.66**	**0.06**	**0.04**	**----**	**----**
ø **Total Cations**	----	0.01	meq/L		**0.50**	<0.01	<0.01	**----**	**----**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES2034663**	Page	: 1 of 5
Amendment	: **1**		
Client	: **NEWCREST MINING LIMITED**	Laboratory	: Environmental Division Sydney
Contact	: MR NICOLAS BOURGEOT	Contact	: Customer Services ES
Address	: 1460 CADIA ROAD ORANGE NSW, AUSTRALIA 2800	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: Cadia Water Monitoring	Date Samples Received	: 02-Oct-2020 09:20
Order number	: 45000922559	Date Analysis Commenced	: 02-Oct-2020
C-O-C number	: ----	Issue Date	: 16-Oct-2020 13:02
Sampler	: Martin Englert		
Site	: CADIA		
Quote number	: EN/107/17 B V5		
No. of samples received	: 1		
No. of samples analysed	: 1		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- Amendment (14/10/20): This report has been amended and re-released to allow the reporting of additional analytical data.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	CHESNEY_HT_20200930	----	----	----	----
				Client sampling date / time	30-Sep-2020 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		ES2034663-001	--------	--------	--------	--------
					Result	----	----	----	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**26**	----	----	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C									
Total Dissolved Solids @180°C	----	10	mg/L		**13**	----	----	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		<5	----	----	----	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**10**	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L		**10**	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		<1	----	----	----	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		<1	----	----	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		**3**	----	----	----	----
Magnesium	7439-95-4	1	mg/L		<1	----	----	----	----
Sodium	7440-23-5	1	mg/L		<1	----	----	----	----
Potassium	7440-09-7	1	mg/L		<1	----	----	----	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		<0.01	----	----	----	----
Antimony	7440-36-0	0.001	mg/L		<0.001	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L		<0.001	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L		<0.001	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L		<0.001	----	----	----	----
Copper	7440-50-8	0.001	mg/L		<0.001	----	----	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	----	----	----	----
Manganese	7439-96-5	0.001	mg/L		**0.009**	----	----	----	----
Molybdenum	7439-98-7	0.001	mg/L		<0.001	----	----	----	----
Nickel	7440-02-0	0.001	mg/L		<0.001	----	----	----	----
Selenium	7782-49-2	0.01	mg/L		<0.01	----	----	----	----
Silver	7440-22-4	0.001	mg/L		<0.001	----	----	----	----
Zinc	7440-66-6	0.005	mg/L		**2.27**	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	CHESNEY_HT_20200930	----	----	----	----
				Client sampling date / time	30-Sep-2020 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		ES2034663-001	--------	--------	--------	--------
					Result	----	----	----	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Iron	7439-89-6	0.05	mg/L		<0.05	----	----	----	----
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		<0.01	----	----	----	----
Antimony	7440-36-0	0.001	mg/L		**0.001**	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L		<0.001	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L		<0.001	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L		<0.001	----	----	----	----
Copper	7440-50-8	0.001	mg/L		**0.001**	----	----	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	----	----	----	----
Manganese	7439-96-5	0.001	mg/L		**0.010**	----	----	----	----
Molybdenum	7439-98-7	0.001	mg/L		<0.001	----	----	----	----
Nickel	7440-02-0	0.001	mg/L		<0.001	----	----	----	----
Selenium	7782-49-2	0.01	mg/L		<0.01	----	----	----	----
Silver	7440-22-4	0.001	mg/L		<0.001	----	----	----	----
Zinc	7440-66-6	0.005	mg/L		**2.30**	----	----	----	----
Iron	7439-89-6	0.05	mg/L		<0.05	----	----	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	----	----	----	----
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	----	----	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	----	----	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.31**	----	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.31**	----	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.1**	----	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**0.4**	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		<0.01	----	----	----	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)				Client sample ID	**CHESNEY_HT_20200930**	----	----	----	----
				Client sampling date / time	30-Sep-2020 00:00	----	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*		**ES2034663-001**	--------	--------	--------	--------
					Result	----	----	----	----
EN055: Ionic Balance									
ø **Total Anions**	----	0.01	meq/L		**0.20**	**----**	**----**	**----**	**----**
ø **Total Cations**	----	0.01	meq/L		**0.15**	**----**	**----**	**----**	**----**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES2034993**	Page	: 1 of 8
Client	: **NEWCREST MINING LIMITED**	Laboratory	: Environmental Division Sydney
Contact	: MR NICOLAS BOURGEOT	Contact	: Customer Services ES
Address	: 1460 CADIA ROAD ORANGE NSW, AUSTRALIA 2800	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: Cadia Water Monitoring	Date Samples Received	: 07-Oct-2020 09:00
Order number	: 4501043447	Date Analysis Commenced	: 07-Oct-2020
C-O-C number	: ----	Issue Date	: 13-Oct-2020 14:21
Sampler	: Martin Engler		
Site	: CADIA		
Quote number	: EN/107/17 B V5		
No. of samples received	: 14		
No. of samples analysed	: 14		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MIAWARRA_HT_20201001	MIAWARRA_T2_20201001	MIAWARRA_T3_20201001	MIAWARRA_ST_20201001	RV_HT_20201001
			Client sampling date / time	01-Oct-2020 00:00	01-Oct-2020 00:00	01-Oct-2020 00:00	01-Oct-2020 00:00	01-Oct-2020 00:00
Compound	CAS Number	LOR	Unit	ES2034993-001	ES2034993-002	ES2034993-003	ES2034993-004	ES2034993-005
				Result	Result	Result	Result	Result
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	34	49	34	12	24
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	22	29	22	<10	15
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	<5	<5	<5	<5	<5
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	15	22	15	<1	9
Total Alkalinity as CaCO3	----	1	mg/L	15	22	15	<1	9
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	<1	<1	<1	<1
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	<1	<1	<1	<1	<1
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	4	6	3	<1	3
Magnesium	7439-95-4	1	mg/L	<1	<1	<1	<1	<1
Sodium	7440-23-5	1	mg/L	<1	1	<1	<1	<1
Potassium	7440-09-7	1	mg/L	<1	1	<1	<1	<1
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.01	0.02	<0.01	0.04	<0.01
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	0.003	0.001	0.001	0.004	0.002
Lead	7439-92-1	0.001	mg/L	0.004	<0.001	0.002	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L	0.003	0.003	0.004	0.011	0.003
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L	0.316	1.32	2.57	0.177	0.663

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MIAWARRA_HT_20201001	MIAWARRA_T2_20201001	MIAWARRA_T3_20201001	MIAWARRA_ST_20201001	RV_HT_20201001
				Client sampling date / time	01-Oct-2020 00:00	01-Oct-2020 00:00	01-Oct-2020 00:00	01-Oct-2020 00:00	01-Oct-2020 00:00
Compound	CAS Number	LOR	Unit		ES2034993-001	ES2034993-002	ES2034993-003	ES2034993-004	ES2034993-005
					Result	Result	Result	Result	Result
EG020T: Total Metals by ICP-MS - Continued									
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	<0.05	<0.05	<0.05
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.59**	**0.58**	**0.39**	**0.41**	**0.49**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.59**	**0.58**	**0.39**	**0.41**	**0.49**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		<0.1	<0.1	<0.1	<0.1	<0.1
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**0.6**	**0.6**	**0.4**	**0.4**	**0.5**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		<0.01	**0.04**	<0.01	<0.01	<0.01
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**0.30**	**0.44**	**0.30**	<0.01	**0.18**
ø Total Cations	----	0.01	meq/L		**0.20**	**0.37**	**0.15**	<0.01	**0.15**

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	RV_KT_20201001	RV_KTHOT_20201001	MERIBAH_HT_20201001	NW_HT_20201001	NW_TAP_20201001
				Client sampling date / time	01-Oct-2020 00:00	01-Oct-2020 00:00	01-Oct-2020 00:00	01-Oct-2020 00:00	01-Oct-2020 00:00
					ES2034993-006	ES2034993-007	ES2034993-008	ES2034993-009	ES2034993-010
					Result	Result	Result	Result	Result
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**30**	**26**	**62**	**25**	**26**
EA015: Total Dissolved Solids dried at 180 ± 5 °C									
Total Dissolved Solids @180°C	----	10	mg/L		**17**	**20**	**36**	**19**	**14**
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		<5	<5	<5	<5	<5
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**11**	**10**	**29**	**14**	**11**
Total Alkalinity as CaCO3	----	1	mg/L		**11**	**10**	**29**	**14**	**11**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		<1	<1	<1	<1	<1
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		<1	<1	<1	<1	<1
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		**4**	**3**	**11**	**3**	**3**
Magnesium	7439-95-4	1	mg/L		<1	<1	<1	<1	<1
Sodium	7440-23-5	1	mg/L		<1	<1	<1	<1	<1
Potassium	7440-09-7	1	mg/L		<1	<1	<1	<1	<1
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.02**	<0.01	**0.06**	**0.01**	**0.01**
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	**0.0001**	**0.0002**	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		**1.13**	**0.128**	**0.013**	<0.001	**0.010**
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	**0.003**	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L		**0.001**	**0.003**	**0.013**	**0.008**	**0.007**
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		**0.106**	**0.685**	**0.223**	**0.135**	**0.128**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	RV_KT_20201001	RV_KTHOT_20201001	MERIBAH_HT_20201001	NW_HT_20201001	NW_TAP_20201001
				Client sampling date / time	01-Oct-2020 00:00	01-Oct-2020 00:00	01-Oct-2020 00:00	01-Oct-2020 00:00	01-Oct-2020 00:00
Compound	CAS Number	LOR	Unit		ES2034993-006	ES2034993-007	ES2034993-008	ES2034993-009	ES2034993-010
					Result	Result	Result	Result	Result
EG020T: Total Metals by ICP-MS - Continued									
Iron	7439-89-6	0.05	mg/L		**0.11**	<0.05	**0.08**	**0.09**	**0.10**
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.21**	**0.43**	**0.36**	**0.23**	**0.23**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.21**	**0.43**	**0.36**	**0.23**	**0.23**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		<0.1	<0.1	<0.1	<0.1	<0.1
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**0.2**	**0.4**	**0.4**	**0.2**	**0.2**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**0.22**	**0.20**	**0.58**	**0.28**	**0.22**
ø Total Cations	----	0.01	meq/L		**0.20**	**0.15**	**0.55**	**0.15**	**0.15**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	WALLABY_T1_20201002	WALLABY_T2_20201002	TP_HT_20201002	TP_ST_20201002	----
			Client sampling date / time	01-Oct-2020 00:00	02-Oct-2020 00:00	02-Oct-2020 00:00	02-Oct-2020 00:00	----
Compound	CAS Number	LOR	Unit	ES2034993-011	ES2034993-012	ES2034993-013	ES2034993-014	--------
				Result	Result	Result	Result	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**20**	**14**	**12**	**28**	**----**
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**12**	**11**	<10	**16**	**----**
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	<5	<5	**37**	<5	**----**
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	**----**
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	**----**
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**8**	**2**	<1	**11**	**----**
Total Alkalinity as CaCO3	----	1	mg/L	**8**	**2**	<1	**11**	**----**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	<1	<1	<1	**----**
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	<1	<1	<1	<1	**----**
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**2**	**2**	<1	**3**	**----**
Magnesium	7439-95-4	1	mg/L	<1	<1	<1	<1	**----**
Sodium	7440-23-5	1	mg/L	<1	<1	<1	<1	**----**
Potassium	7440-09-7	1	mg/L	<1	<1	<1	<1	**----**
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.03**	**0.02**	**0.12**	**0.01**	**----**
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	**----**
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	**----**
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	**0.0005**	**----**
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	**0.003**	<0.001	**----**
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	**----**
Copper	7440-50-8	0.001	mg/L	**0.002**	**0.009**	**0.016**	**0.002**	**----**
Lead	7439-92-1	0.001	mg/L	<0.001	**0.001**	**0.006**	<0.001	**----**
Manganese	7439-96-5	0.001	mg/L	**0.012**	**0.005**	**0.014**	**0.003**	**----**
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	**----**
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	**----**
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	**----**
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	**----**
Zinc	7440-66-6	0.005	mg/L	**0.208**	**0.224**	**0.069**	**1.43**	**----**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WALLABY_T1_20201002	WALLABY_T2_20201002	TP_HT_20201002	TP_ST_20201002	----
				Client sampling date / time	01-Oct-2020 00:00	02-Oct-2020 00:00	02-Oct-2020 00:00	02-Oct-2020 00:00	----
Compound	CAS Number	LOR	Unit		ES2034993-011	ES2034993-012	ES2034993-013	ES2034993-014	--------
					Result	Result	Result	Result	----
EG020T: Total Metals by ICP-MS - Continued									
Iron	7439-89-6	0.05	mg/L		**0.05**	<0.05	**0.13**	<0.05	**----**
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	**----**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	**----**
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.25**	**0.25**	**0.15**	**0.41**	**----**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.25**	**0.25**	**0.15**	**0.41**	**----**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.2**	<0.1	**0.3**	**0.3**	**----**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**0.4**	**0.2**	**0.4**	**0.7**	**----**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.01**	<0.01	**0.01**	**0.12**	**----**
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**0.16**	**0.04**	<0.01	**0.22**	**----**
ø Total Cations	----	0.01	meq/L		**0.10**	**0.10**	<0.01	**0.15**	**----**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES2100772**	Page	: 1 of 18
Client	: **NEWCREST MINING LIMITED**	Laboratory	: Environmental Division Sydney
Contact	: MR NICOLAS BOURGEOT	Contact	: Customer Services ES
Address	: 1460 CADIA ROAD ORANGE NSW, AUSTRALIA 2800	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: Cadia Water Monitoring	Date Samples Received	: 12-Jan-2021 09:00
Order number	: 4501043447	Date Analysis Commenced	: 12-Jan-2021
C-O-C number	: ----	Issue Date	: 18-Jan-2021 18:58
Sampler	: Liam Brindle		
Site	: CADIA		
Quote number	: EN/107/17 B V5		
No. of samples received	: 30		
No. of samples analysed	: 30		

This certificate included results from other sampling which were not relevant to the Study. The pages containing these results have been removed.

Accreditation No. 825
Accredited for compliance with ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Ashesh Patel	Senior Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Dian Dao	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW
Edwandy Fadjar	Organic Coordinator	Sydney Organics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW
Sunitha Kannampilli	Phycologist	Sydney Phycology, Smithfield, NSW
Wisam Marassa	Inorganics Coordinator	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EP080: Where reported, Total Xylenes is the sum of the reported concentrations of m&p-Xylene and o-Xylene at or above the LOR.
- TDS by method EA-015 may bias high for various samples due to the presence of fine particulate matter, which may pass through the prescribed GF/C paper.
- MW024: Under microscopic observation, debris present in sample #08
- KEY: PTP=Potential Toxin Producers
; ND=Not Detected; NS=Not Specified
; cf. = comparable form
- Results apply to sample(s) as submitted.
- Samples were preserved with Lugols Iodine solution.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: **SURFACE WATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Sample ID	CAWS62_WS_20210108	CAWS59_WS_20210108	CAWS61_WS_20210108	QAQC_FD_20210108	SHARP_W_20210108
				Sampling date / time	08-Jan-2021 14:15	08-Jan-2021 14:30	08-Jan-2021 15:15	08-Jan-2021 15:15	08-Jan-2021 14:15
					ES2100772-021	ES2100772-022	ES2100772-023	ES2100772-024	ES2100772-025
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	----
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Zinc	7440-66-6	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	----
Iron	7439-89-6	0.05	mg/L		**0.06**	<0.05	**0.08**	**0.08**	----
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		----	----	----	----	<0.01
Antimony	7440-36-0	0.001	mg/L		----	----	----	----	<0.001
Arsenic	7440-38-2	0.001	mg/L		----	----	----	----	<0.001
Cadmium	7440-43-9	0.0001	mg/L		----	----	----	----	<0.0001
Chromium	7440-47-3	0.001	mg/L		----	----	----	----	<0.001
Cobalt	7440-48-4	0.001	mg/L		----	----	----	----	<0.001
Copper	7440-50-8	0.001	mg/L		----	----	----	----	**0.008**
Lead	7439-92-1	0.001	mg/L		----	----	----	----	<0.001
Manganese	7439-96-5	0.001	mg/L		----	----	----	----	**0.016**
Molybdenum	7439-98-7	0.001	mg/L		----	----	----	----	<0.001
Nickel	7440-02-0	0.001	mg/L		----	----	----	----	<0.001
Selenium	7782-49-2	0.01	mg/L		----	----	----	----	<0.01
Silver	7440-22-4	0.001	mg/L		----	----	----	----	<0.001
Zinc	7440-66-6	0.005	mg/L		----	----	----	----	**0.043**
Iron	7439-89-6	0.05	mg/L		----	----	----	----	**0.11**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.02**	<0.01	**0.07**	**0.09**	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.02**	<0.01	**0.07**	**0.09**	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.3**	**0.6**	**0.3**	**0.3**	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**0.3**	**0.6**	**0.4**	**0.4**	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.01**	**0.26**	<0.01	<0.01	----
EN055: Ionic Balance									

Analytical Results

Sub-Matrix: SURFACE WATER (Matrix: WATER)				Sample ID	CAWS62_WS_20210108	CAWS59_WS_20210108	CAWS61_WS_20210108	QAQC_FD_20210108	SHARP_W_20210108
				Sampling date / time	08-Jan-2021 14:15	08-Jan-2021 14:30	08-Jan-2021 15:15	08-Jan-2021 15:15	08-Jan-2021 14:15
Compound	CAS Number	LOR	Unit		ES2100772-021	ES2100772-022	ES2100772-023	ES2100772-024	ES2100772-025
					Result	Result	Result	Result	Result
EN055: Ionic Balance - Continued									
ø **Total Anions**	----	0.01	meq/L		**7.63**	**21.3**	**6.34**	**6.30**	**----**
ø **Total Cations**	----	0.01	meq/L		**7.00**	**19.5**	**5.89**	**5.89**	**----**
ø **Ionic Balance**	----	0.01	%		**4.34**	**4.59**	**3.67**	**3.36**	**----**

Analytical Results

Sub-Matrix: **SURFACE WATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Sample ID	SHARP_HT_20210108	CHHT_20201223	CHPT_20201223	CHCT_20201223	----
				Sampling date / time	08-Jan-2021 14:15	23-Dec-2020 10:30	23-Dec-2020 10:30	23-Dec-2020 10:30	----
					ES2100772-026	ES2100772-027	ES2100772-028	ES2100772-029	--------
					Result	Result	Result	Result	----
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		<0.01	**0.01**	<0.01	<0.01	----
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Cadmium	7440-43-9	0.0001	mg/L		**0.0002**	<0.0001	<0.0001	<0.0001	----
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Copper	7440-50-8	0.001	mg/L		**0.039**	**0.018**	<0.001	<0.001	----
Lead	7439-92-1	0.001	mg/L		**0.001**	**0.005**	<0.001	<0.001	----
Manganese	7439-96-5	0.001	mg/L		**0.009**	**0.043**	**0.004**	**0.023**	----
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Nickel	7440-02-0	0.001	mg/L		<0.001	**0.087**	<0.001	<0.001	----
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	----
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Zinc	7440-66-6	0.005	mg/L		**0.441**	**1.51**	**0.465**	**1.46**	----
Iron	7439-89-6	0.05	mg/L		**0.06**	**0.05**	<0.05	<0.05	----

Surrogate Control Limits

Sub-Matrix: **GROUNDWATER**		Recovery Limits (%)	
Compound	*CAS Number*	*Low*	*High*
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	71	137
Toluene-D8	2037-26-5	79	131
4-Bromofluorobenzene	460-00-4	70	128

ALS Water

CERTIFICATE OF ANALYSIS

Work Order	: **CA2003791**	Page	: 1 of 4
Client	: **Newcrest Mining**	Laboratory	: ALS Water Resources Group
Contact	: Group Email	Contact	: Client Services
Address	: 1460 Cadia Road Orange NSW 2800	Address	: 16B Lithgow Street Fyshwick ACT Australia 2609
Telephone	: ----	Telephone	: +61 2 6202 5404
Project	: CVO Hi-Vol Sampling and Analysis	Date Samples Received	: 28-May-2020 12:03
Order number	:	Date Analysis Commenced	: 10-Jun-2020
C-O-C number	: ----	Issue Date	: 10-Jun-2020 15:08
Sampler	: ----		
Site	: CADIA		
Quote number	: ----		
No. of samples received	: 7		
No. of samples analysed	: 7		

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Signatories

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Signatories	*Position*	*Accreditation Category*
Clare Kennedy	Analyst	Inorganics, Fyshwick, ACT

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

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LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- **For samples collected by ALS WRG, sampling was carried out in accordance with Procedure EN67**
- Metals conducted on seperate workorder: CA2003799

Analytical Results

Sub-Matrix: **SOLID** (Matrix: **SOLID**)			Client sample ID	**010230 Bundarra**	**010229 Bundarra**	**010228 Bundarra**	**010227 Bundarra**	**010219 Bundarra**
			Client sampling date / time	23-Apr-2020 00:00	29-Apr-2020 00:00	05-May-2020 00:00	11-May-2020 00:00	17-May-2020 00:00
Compound	*CAS Number*	*LOR*	*Unit*	**CA2003791-001**	**CA2003791-002**	**CA2003791-003**	**CA2003791-004**	**CA2003791-005**
				Result	Result	Result	Result	Result
EA143CA: Total Suspended Particulates								
ø **Paper Number**	----	1	-	**0230**	**0229**	**0228**	**0227**	**0219**
ø **Sampling Period**	----	1.00	hours	**24.6**	**24.1**	**24.2**	**10.0**	**24.1**
ø **Volume**	----	1.00	m^3	**1670**	**1630**	**1640**	**679**	**1630**
ø **PM10**	----	1.0	$\mu g/m^3$	**14.2**	**6.0**	**9.0**	**11.8**	**7.6**

Analytical Results

Sub-Matrix: **SOLID** (Matrix: **SOLID**)			Client sample ID	**010226 Meribah**	**010225 Triangle Flat**	**----**	**----**	**----**
			Client sampling date / time	17-May-2020 00:00	17-May-2020 00:00	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**CA2003791-006**	**CA2003791-007**	**--------**	**--------**	**--------**
				Result	Result	----	----	----
EA143CA: Total Suspended Particulates								
ø **Paper Number**	----	1	-	**0226**	**0225**	**----**	**----**	**----**
ø **Sampling Period**	----	1.00	hours	**24.2**	**24.2**	**----**	**----**	**----**
ø **Volume**	----	1.00	m^3	**1630**	**1650**	**----**	**----**	**----**
ø **PM10**	----	1.0	$\mu g/m^3$	**9.2**	**3.5**	**----**	**----**	**----**

ALS Water

CERTIFICATE OF ANALYSIS

Work Order	: **CA2003799**	Page	: 1 of 4
Amendment	: **1**		
Client	: **Newcrest Mining**	Laboratory	: ALS Water Resources Group
Contact	: Mr Nicolas Bourgeot	Contact	: Client Services
Address	: 1460 Cadia Road Orange NSW 2800	Address	: 16B Lithgow Street Fyshwick ACT Australia 2609
Telephone	: ----	Telephone	: +61 2 6202 5404
Project	: CVO Hi-Vol Sampling and Analysis	Date Samples Received	: 04-Jun-2020 13:08
Order number	: ----	Date Analysis Commenced	: 16-Jun-2020
C-O-C number	: ----	Issue Date	: 04-May-2021 14:43
Sampler	: ----		
Site	: CADIA		
Quote number	: ----		
No. of samples received	: 7		
No. of samples analysed	: 7		

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Signatories

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Signatories	*Position*	*Accreditation Category*
Titus Vimalasiri	Metals Teamleader	Inorganics, Fyshwick, ACT

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

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LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- **For samples collected by ALS WRG, sampling was carried out in accordance with Procedure EN67**
- Amended Workorder - CA2003799: Incorrect sampled dates on all samples. Refer to CA2003791. JN 04/05/21

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Sample ID	010230 Bundarra	010229 Bundarra	010228 Bundarra	010227 Bundarra	010219 Bundarra
				Sampling date / time	23-Apr-2020 00:00	29-Apr-2020 00:00	05-May-2020 00:00	11-May-2020 00:00	17-May-2020 00:00
					CA2003799-001	CA2003799-002	CA2003799-003	CA2003799-004	CA2003799-005
					Result	Result	Result	Result	Result
EG005CA: Total Metals by ICP-OES									
ø **Iron**	7439-89-6	1	µg/filter		**426**	**189**	**324**	**292**	**352**
EG020CA: Total Metals by ICP-MS									
ø **Aluminium**	7429-90-5	1	µg/filter		**1230**	**1040**	**1040**	**1150**	**1210**
ø **Antimony**	7440-36-0	1	µg/filter		<1	<1	<1	<1	<1
ø **Arsenic**	7440-38-2	1	µg/filter		<1	<1	<1	<1	<1
ø **Barium**	7440-39-3	1	µg/filter		**11**	**9**	**9**	**10**	**11**
ø **Beryllium**	7440-41-7	1	µg/filter		<1	<1	<1	<1	<1
ø **Cadmium**	7440-43-9	1	µg/filter		<1	<1	<1	<1	<1
ø **Chromium**	7440-47-3	1	µg/filter		**5**	**4**	**4**	**5**	**5**
ø **Cobalt**	7440-48-4	1	µg/filter		<1	<1	<1	<1	<1
ø **Copper**	7440-50-8	1	µg/filter		**23**	**8**	**37**	**28**	**30**
ø **Lead**	7439-92-1	1	µg/filter		**1**	**1**	**1**	**1**	**1**
ø **Manganese**	7439-96-5	1	µg/filter		**10**	**9**	**6**	**5**	**6**
ø **Molybdenum**	7439-98-7	1	µg/filter		<1	<1	<1	<1	<1
ø **Nickel**	7440-02-0	1	µg/filter		**1**	<1	**1**	<1	**1**
ø **Selenium**	7782-49-2	1	µg/filter		<1	<1	<1	<1	<1
ø **Silver**	7440-22-4	1	µg/filter		<1	<1	<1	<1	<1
ø **Tin**	7440-31-5	1	µg/filter		<1	<1	<1	<1	<1
ø **Mercury**	7439-97-6	1	µg/filter		<1	<1	<1	<1	<1
ø **Zinc**	7440-66-6	1	µg/filter		**16**	**16**	**13**	**14**	**14**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	010226 Meribah	010225 Triangle Flat	----	----	----
				Sampling date / time	17-May-2020 00:00	17-May-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit		CA2003799-006	CA2003799-007	--------	--------	--------
					Result	Result	----	----	----
EG005CA: Total Metals by ICP-OES									
ø **Iron**	7439-89-6	1	µg/filter		**370**	**95**	----	----	----
EG020CA: Total Metals by ICP-MS									
ø **Aluminium**	7429-90-5	1	µg/filter		**1240**	**1040**	----	----	----
ø **Antimony**	7440-36-0	1	µg/filter		<1	<1	----	----	----
ø **Arsenic**	7440-38-2	1	µg/filter		**1**	<1	----	----	----
ø **Barium**	7440-39-3	1	µg/filter		**13**	**10**	----	----	----
ø **Beryllium**	7440-41-7	1	µg/filter		<1	<1	----	----	----
ø **Cadmium**	7440-43-9	1	µg/filter		<1	<1	----	----	----
ø **Chromium**	7440-47-3	1	µg/filter		**5**	**4**	----	----	----
ø **Cobalt**	7440-48-4	1	µg/filter		<1	<1	----	----	----
ø **Copper**	7440-50-8	1	µg/filter		**9**	**6**	----	----	----
ø **Lead**	7439-92-1	1	µg/filter		**1**	**2**	----	----	----
ø **Manganese**	7439-96-5	1	µg/filter		**8**	**3**	----	----	----
ø **Molybdenum**	7439-98-7	1	µg/filter		<1	<1	----	----	----
ø **Nickel**	7440-02-0	1	µg/filter		**1**	<1	----	----	----
ø **Selenium**	7782-49-2	1	µg/filter		<1	<1	----	----	----
ø **Silver**	7440-22-4	1	µg/filter		<1	<1	----	----	----
ø **Tin**	7440-31-5	1	µg/filter		<1	<1	----	----	----
ø **Mercury**	7439-97-6	1	µg/filter		<1	<1	----	----	----
ø **Zinc**	7440-66-6	1	µg/filter		**24**	**18**	----	----	----

ALS Water

CERTIFICATE OF ANALYSIS

Work Order	: **CA2004913**	Page	: 1 of 9
Client	: **Newcrest Mining**	Laboratory	: ALS Water Resources Group
Contact	: Zac Zhang	Contact	: Client Services
Address	: 1460 Cadia Road Orange NSW 2800	Address	: 16B Lithgow Street Fyshwick ACT Australia 2609
Telephone	: ----	Telephone	: +61 2 6202 5404
Project	: CVO Hi-Vol Sampling and Analysis	Date Samples Received	: 24-Jul-2020 16:00
Order number	: ----	Date Analysis Commenced	: 30-Jul-2020
C-O-C number	: ----	Issue Date	: 30-Jul-2020 14:39
Sampler	: Zac Zhang		
Site	: CADIA		
Quote number	: ----		
No. of samples received	: 35		
No. of samples analysed	: 35		

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Clare Kennedy	Analyst	Inorganics, Fyshwick, ACT

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LOR = Limit of reporting
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ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- **For samples collected by ALS WRG, sampling was carried out in accordance with Procedure EN67**

Analytical Results

Sub-Matrix: SOLID (Matrix: SOLID)			Client sample ID	010253 Flyer Creek	003981 Flyer Creek	003995 Flyer Creek	003971 Flyer Creek	010256 Flyer Creek
			Client sampling date / time	22-Jun-2020 00:00	28-Jun-2020 00:00	04-Jul-2020 00:00	10-Jul-2020 00:00	16-Jul-2020 00:00
Compound	CAS Number	LOR	Unit	CA2004913-001	CA2004913-002	CA2004913-003	CA2004913-004	CA2004913-005
				Result	Result	Result	Result	Result
EA143CA: Total Suspended Particulates								
ø Paper Number	----	1	-	0253	3981	3995	3971	0256
ø Initial Weight	----	0.00001	g	3.53	3.54	3.54	3.54	3.52
ø Final Weight	----	0.00001	g	3.54	3.55	3.55	3.55	3.53
ø Sampling Period	----	1.00	hours	24.5	24.1	24.1	24.1	24.1
ø Volume	----	1.00	m^3	1710	1680	1680	1680	1660
ø PM10	----	1.0	$\mu g/m^3$	7.0	6.9	6.7	8.0	3.6

Analytical Results

Sub-Matrix: **SOLID**
(Matrix: **SOLID**)

Compound	CAS Number	LOR	Unit	Client sample ID	010224 Bundarra	010222 Bundarra	010216 Bundarra	010214 Bundarra	03978 Bundarra
				Client sampling date / time	23-May-2020 00:00	29-May-2020 00:00	04-Jun-2020 00:00	10-Jun-2020 00:00	16-Jun-2020 00:00
					CA2004913-006	CA2004913-007	CA2004913-008	CA2004913-009	CA2004913-010
					Result	Result	Result	Result	Result
EA143CA: Total Suspended Particulates									
ø **Paper Number**	----	1	-		**0224**	**0222**	**0216**	**0214**	**3978**
ø **Initial Weight**	----	0.00001	g		**3.48**	**3.48**	**3.48**	**3.48**	**3.54**
ø **Final Weight**	----	0.00001	g		**3.48**	**3.51**	**3.52**	**3.49**	**3.55**
ø **Sampling Period**	----	1.00	hours		**24.2**	**24.1**	**24.2**	**24.0**	**24.2**
ø **Volume**	----	1.00	m^3		**1640**	**1630**	**1640**	**1630**	**1640**
ø **PM10**	----	1.0	$\mu g/m^3$		**3.8**	**19.8**	**24.8**	**9.7**	**7.1**

Analytical Results

Sub-Matrix: **SOLID**
(Matrix: **SOLID**)

Compound	CAS Number	LOR	Unit	Client sample ID	010257 Bundarra	03980 Bundarra	03973 Bundarra	03993 Bundarra	03970 Bundarra
				Client sampling date / time	22-Jun-2020 00:00	28-Jun-2020 00:00	04-Jul-2020 00:00	10-Jul-2020 00:00	16-Jul-2020 00:00
					CA2004913-011	CA2004913-012	CA2004913-013	CA2004913-014	CA2004913-015
					Result	Result	Result	Result	Result
EA143CA: Total Suspended Particulates									
ø **Paper Number**	----	1	-		**0257**	**3980**	**3973**	**3993**	**3970**
ø **Initial Weight**	----	0.00001	g		**3.53**	**3.54**	**3.54**	**3.54**	**3.54**
ø **Final Weight**	----	0.00001	g		**3.53**	**3.57**	**3.55**	**3.56**	**3.55**
ø **Sampling Period**	----	1.00	hours		**24.1**	**24.1**	**24.1**	**24.1**	**24.1**
ø **Volume**	----	1.00	m^3		**1630**	**1640**	**1640**	**1630**	**1630**
ø **PM10**	----	1.0	$\mu g/m^3$		**3.0**	**20.0**	**4.9**	**15.7**	**8.4**

Analytical Results

Sub-Matrix: **SOLID**
(Matrix: **SOLID**)

Compound	CAS Number	LOR	Unit	Client sample ID	010218 Meribah	010220 Meribah	010217 Meribah	010213 Meribah	03977 Meribah
				Client sampling date / time	23-May-2020 00:00	29-May-2020 00:00	04-Jun-2020 00:00	10-Jun-2020 00:00	16-Jun-2020 00:00
					CA2004913-016	CA2004913-017	CA2004913-018	CA2004913-019	CA2004913-020
					Result	Result	Result	Result	Result
EA143CA: Total Suspended Particulates									
ø **Paper Number**	----	1	-		**0218**	**0220**	**0217**	**0213**	**3977**
ø **Initial Weight**	----	0.00001	g		**3.49**	**3.47**	**3.48**	**3.47**	**3.53**
ø **Final Weight**	----	0.00001	g		**3.50**	**3.48**	**3.49**	**3.48**	**3.55**
ø **Sampling Period**	----	1.00	hours		**24.2**	**24.1**	**24.1**	**24.1**	**24.2**
ø **Volume**	----	1.00	m^3		**1640**	**1630**	**1630**	**1630**	**1630**
ø **PM10**	----	1.0	$\mu g/m^3$		**6.6**	**9.2**	**8.7**	**4.9**	**12.0**

Analytical Results

Sub-Matrix: SOLID (Matrix: SOLID)			Client sample ID	03976 Meribah	03975 Meribah	03974 Meribah	03972 Meribah	03992 Meribah
			Client sampling date / time	22-Jun-2020 00:00	28-Jun-2020 00:00	04-Jul-2020 00:00	10-Jul-2020 00:00	16-Jul-2020 00:00
Compound	CAS Number	LOR	Unit	CA2004913-021	CA2004913-022	CA2004913-023	CA2004913-024	CA2004913-025
				Result	Result	Result	Result	Result
EA143CA: Total Suspended Particulates								
ø **Paper Number**	----	1	-	**3976**	**3975**	**3974**	**3972**	**3992**
ø **Initial Weight**	----	0.00001	g	**3.54**	**3.54**	**3.54**	**3.54**	**3.54**
ø **Final Weight**	----	0.00001	g	**3.55**	**3.55**	**3.55**	**3.55**	**3.54**
ø **Sampling Period**	----	1.00	hours	**24.1**	**24.0**	**24.1**	**24.1**	**24.1**
ø **Volume**	----	1.00	m^3	**1630**	**1630**	**1630**	**1450**	**1640**
ø **PM10**	----	1.0	$\mu g/m^3$	**7.0**	**7.8**	**6.5**	**11.9**	**5.6**

Analytical Results

Sub-Matrix: **SOLID**
(Matrix: **SOLID**)

Compound	CAS Number	LOR	Unit	Client sample ID	010223 Triangle Flat	010221 Triangle Flat	010215 Triangle Flat	010212 Triangle Flat	03979 Triangle Flat
				Client sampling date / time	23-May-2020 00:00	29-May-2020 00:00	04-Jun-2020 00:00	10-Jun-2020 00:00	16-Jun-2020 00:00
					CA2004913-026	CA2004913-027	CA2004913-028	CA2004913-029	CA2004913-030
					Result	Result	Result	Result	Result
EA143CA: Total Suspended Particulates									
ø Paper Number	----	1	-		**0223**	**0221**	**0215**	**0212**	**3979**
ø Initial Weight	----	0.00001	g		**3.48**	**3.48**	**3.48**	**3.48**	**3.54**
ø Final Weight	----	0.00001	g		**3.49**	**3.48**	**3.49**	**3.49**	**3.55**
ø Sampling Period	----	1.00	hours		**24.2**	**24.1**	**24.1**	**24.0**	**24.2**
ø Volume	----	1.00	m^3		**1630**	**1630**	**1640**	**1630**	**1640**
ø PM10	----	1.0	$\mu g/m^3$		**2.9**	**4.6**	**8.0**	**3.8**	**8.4**

Analytical Results

Sub-Matrix: SOLID (Matrix: SOLID)				Client sample ID	03982 Triangle Flat	03994 Triangle Flat	03985 Triangle Flat	03991 Triangle Flat	03990 Triangle Flat
				Client sampling date / time	22-Jun-2020 00:00	28-Jun-2020 00:00	04-Jul-2020 00:00	10-Jul-2020 00:00	16-Jul-2020 00:00
Compound	CAS Number	LOR	Unit		CA2004913-031	CA2004913-032	CA2004913-033	CA2004913-034	CA2004913-035
					Result	Result	Result	Result	Result
EA143CA: Total Suspended Particulates									
ø **Paper Number**	----	1	-		**3982**	**3994**	**3985**	**3991**	**3990**
ø **Initial Weight**	----	0.00001	g		**3.54**	**3.54**	**3.53**	**3.54**	**3.54**
ø **Final Weight**	----	0.00001	g		**3.55**	**3.55**	**3.54**	**3.56**	**3.54**
ø **Sampling Period**	----	1.00	hours		**24.1**	**24.1**	**24.1**	**24.1**	**24.1**
ø **Volume**	----	1.00	m^3		**1640**	**1630**	**1630**	**1630**	**1630**
ø **PM10**	----	1.0	$\mu g/m^3$		**4.4**	**8.4**	**4.0**	**8.3**	**5.1**

ALS Water

CERTIFICATE OF ANALYSIS

Work Order	: **CA2004914**	Page	: 1 of 9
Client	: **Newcrest Mining**	Laboratory	: ALS Water Resources Group
Contact	: Zac Zhang	Contact	: Client Services
Address	: 1460 Cadia Road Orange NSW 2800	Address	: 16B Lithgow Street Fyshwick ACT Australia 2609
Telephone	: ----	Telephone	: +61 2 6202 5404
Project	: CVO Hi-Vol Sampling and Analysis	Date Samples Received	: 24-Jul-2020 16:00
Order number	: ----	Date Analysis Commenced	: 30-Jul-2020
C-O-C number	: ----	Issue Date	: 05-Aug-2020 17:02
Sampler	: Zac Zhang		
Site	: CADIA		
Quote number	: ----		
No. of samples received	: 35		
No. of samples analysed	: 35		

Accreditation No. 992
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Titus Vimalasiri	Metals Teamleader	Inorganics, Fyshwick, ACT

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- **For samples collected by ALS WRG, sampling was carried out in accordance with Procedure EN67**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	010253 Flyer Creek	003981 Flyer Creek	003995 Flyer Creek	003971 Flyer Creek	010256 Flyer Creek
				Client sampling date / time	22-Jun-2020 00:00	28-Jun-2020 00:00	04-Jul-2020 00:00	10-Jul-2020 00:00	16-Jul-2020 00:00
Compound	CAS Number	LOR	Unit		CA2004914-001	CA2004914-002	CA2004914-003	CA2004914-004	CA2004914-005
					Result	Result	Result	Result	Result
EG005CA: Total Metals by ICP-OES									
ø **Iron**	7439-89-6	1	µg/filter		**276**	**73**	**127**	**100**	**126**
EG020CA: Total Metals by ICP-MS									
ø **Aluminium**	7429-90-5	1	µg/filter		**1660**	**1000**	**1350**	**1330**	**1840**
ø **Antimony**	7440-36-0	1	µg/filter		<1	<1	<1	<1	<1
ø **Arsenic**	7440-38-2	1	µg/filter		<1	<1	<1	<1	<1
ø **Barium**	7440-39-3	1	µg/filter		**17**	**10**	**13**	**12**	**18**
ø **Beryllium**	7440-41-7	1	µg/filter		<1	<1	<1	<1	<1
ø **Cadmium**	7440-43-9	1	µg/filter		<1	<1	<1	<1	<1
ø **Chromium**	7440-47-3	1	µg/filter		**5**	**2**	**3**	**3**	**5**
ø **Cobalt**	7440-48-4	1	µg/filter		<1	<1	<1	<1	<1
ø **Copper**	7440-50-8	1	µg/filter		**20**	**5**	**9**	**5**	**5**
ø **Lead**	7439-92-1	1	µg/filter		**2**	**2**	**1**	**2**	**2**
ø **Manganese**	7439-96-5	1	µg/filter		**6**	**2**	**3**	**3**	**4**
ø **Molybdenum**	7439-98-7	1	µg/filter		<1	<1	<1	<1	<1
ø **Nickel**	7440-02-0	1	µg/filter		**2**	<1	**1**	<1	**1**
ø **Selenium**	7782-49-2	1	µg/filter		<1	<1	<1	<1	<1
ø **Silver**	7440-22-4	1	µg/filter		<1	<1	<1	<1	<1
ø **Tin**	7440-31-5	1	µg/filter		<1	<1	<1	<1	<1
ø **Mercury**	7439-97-6	1	µg/filter		<1	<1	<1	<1	<1
ø **Zinc**	7440-66-6	1	µg/filter		**35**	**18**	**18**	**14**	**25**

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	010224 Bundarra	010222 Bundarra	010216 Bundarra	010214 Bundarra	03978 Bundarra
				Client sampling date / time	23-May-2020 00:00	29-May-2020 00:00	04-Jun-2020 00:00	10-Jun-2020 00:00	16-Jun-2020 00:00
					CA2004914-006	CA2004914-007	CA2004914-008	CA2004914-009	CA2004914-010
					Result	Result	Result	Result	Result
EG005CA: Total Metals by ICP-OES									
ø **Iron**	7439-89-6	1	µg/filter		**124**	**686**	**613**	**280**	**79**
EG020CA: Total Metals by ICP-MS									
ø **Aluminium**	7429-90-5	1	µg/filter		**2010**	**2240**	**2140**	**1850**	**1310**
ø **Antimony**	7440-36-0	1	µg/filter		<1	<1	<1	<1	<1
ø **Arsenic**	7440-38-2	1	µg/filter		<1	<1	<1	<1	<1
ø **Barium**	7440-39-3	1	µg/filter		**19**	**18**	**18**	**18**	**12**
ø **Beryllium**	7440-41-7	1	µg/filter		<1	<1	<1	<1	<1
ø **Cadmium**	7440-43-9	1	µg/filter		<1	<1	<1	<1	<1
ø **Chromium**	7440-47-3	1	µg/filter		**5**	**6**	**5**	**5**	**3**
ø **Cobalt**	7440-48-4	1	µg/filter		<1	<1	<1	<1	<1
ø **Copper**	7440-50-8	1	µg/filter		**7**	**76**	**73**	**28**	**5**
ø **Lead**	7439-92-1	1	µg/filter		**2**	**2**	**2**	**2**	**1**
ø **Manganese**	7439-96-5	1	µg/filter		**3**	**11**	**11**	**6**	**2**
ø **Molybdenum**	7439-98-7	1	µg/filter		<1	**1**	**1**	<1	<1
ø **Nickel**	7440-02-0	1	µg/filter		<1	**1**	**1**	<1	<1
ø **Selenium**	7782-49-2	1	µg/filter		<1	<1	<1	<1	<1
ø **Silver**	7440-22-4	1	µg/filter		<1	<1	<1	<1	<1
ø **Tin**	7440-31-5	1	µg/filter		<1	<1	<1	<1	<1
ø **Mercury**	7439-97-6	1	µg/filter		<1	<1	<1	<1	<1
ø **Zinc**	7440-66-6	1	µg/filter		**18**	**17**	**19**	**16**	**8**

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	010257 Bundarra	03980 Bundarra	03973 Bundarra	03993 Bundarra	03970 Bundarra
				Client sampling date / time	22-Jun-2020 00:00	28-Jun-2020 00:00	04-Jul-2020 00:00	10-Jul-2020 00:00	16-Jul-2020 00:00
					CA2004914-011	CA2004914-012	CA2004914-013	CA2004914-014	CA2004914-015
					Result	Result	Result	Result	Result
EG005CA: Total Metals by ICP-OES									
ø **Iron**	7439-89-6	1	µg/filter		**101**	**491**	**59**	**349**	**227**
EG020CA: Total Metals by ICP-MS									
ø **Aluminium**	7429-90-5	1	µg/filter		**1550**	**1440**	**1000**	**1380**	**1080**
ø **Antimony**	7440-36-0	1	µg/filter		<1	<1	<1	<1	<1
ø **Arsenic**	7440-38-2	1	µg/filter		<1	<1	<1	<1	<1
ø **Barium**	7440-39-3	1	µg/filter		**16**	**12**	**10**	**12**	**11**
ø **Beryllium**	7440-41-7	1	µg/filter		<1	<1	<1	<1	<1
ø **Cadmium**	7440-43-9	1	µg/filter		<1	<1	<1	<1	<1
ø **Chromium**	7440-47-3	1	µg/filter		**5**	**3**	**2**	**3**	**3**
ø **Cobalt**	7440-48-4	1	µg/filter		<1	<1	<1	<1	<1
ø **Copper**	7440-50-8	1	µg/filter		**4**	**62**	**5**	**37**	**22**
ø **Lead**	7439-92-1	1	µg/filter		**1**	**2**	<1	**1**	**1**
ø **Manganese**	7439-96-5	1	µg/filter		**4**	**8**	**2**	**6**	**4**
ø **Molybdenum**	7439-98-7	1	µg/filter		<1	**1**	<1	<1	<1
ø **Nickel**	7440-02-0	1	µg/filter		<1	<1	<1	<1	<1
ø **Selenium**	7782-49-2	1	µg/filter		<1	<1	<1	<1	<1
ø **Silver**	7440-22-4	1	µg/filter		<1	<1	<1	<1	<1
ø **Tin**	7440-31-5	1	µg/filter		<1	<1	<1	<1	<1
ø **Mercury**	7439-97-6	1	µg/filter		<1	<1	<1	<1	<1
ø **Zinc**	7440-66-6	1	µg/filter		**27**	**11**	**7**	**11**	**10**

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	010218 Meribah	010220 Meribah	010217 Meribah	010213 Meribah	03977 Meribah
				Client sampling date / time	23-May-2020 00:00	29-May-2020 00:00	04-Jun-2020 00:00	10-Jun-2020 00:00	16-Jun-2020 00:00
					CA2004914-016	CA2004914-017	CA2004914-018	CA2004914-019	CA2004914-020
					Result	Result	Result	Result	Result
EG005CA: Total Metals by ICP-OES									
ø **Iron**	7439-89-6	1	µg/filter		**87**	**220**	**95**	**107**	**121**
EG020CA: Total Metals by ICP-MS									
ø **Aluminium**	7429-90-5	1	µg/filter		**1920**	**1900**	**1730**	**1590**	**1450**
ø **Antimony**	7440-36-0	1	µg/filter		<1	<1	<1	<1	<1
ø **Arsenic**	7440-38-2	1	µg/filter		<1	<1	<1	<1	<1
ø **Barium**	7440-39-3	1	µg/filter		**18**	**18**	**16**	**15**	**12**
ø **Beryllium**	7440-41-7	1	µg/filter		<1	<1	<1	<1	<1
ø **Cadmium**	7440-43-9	1	µg/filter		<1	<1	<1	<1	<1
ø **Chromium**	7440-47-3	1	µg/filter		**5**	**5**	**4**	**4**	**3**
ø **Cobalt**	7440-48-4	1	µg/filter		<1	<1	<1	<1	<1
ø **Copper**	7440-50-8	1	µg/filter		**4**	**5**	**5**	**4**	**10**
ø **Lead**	7439-92-1	1	µg/filter		**2**	**2**	**2**	**1**	**2**
ø **Manganese**	7439-96-5	1	µg/filter		**3**	**6**	**4**	**3**	**3**
ø **Molybdenum**	7439-98-7	1	µg/filter		<1	<1	<1	<1	<1
ø **Nickel**	7440-02-0	1	µg/filter		<1	<1	<1	<1	<1
ø **Selenium**	7782-49-2	1	µg/filter		<1	<1	<1	<1	<1
ø **Silver**	7440-22-4	1	µg/filter		<1	<1	<1	<1	<1
ø **Tin**	7440-31-5	1	µg/filter		<1	<1	<1	<1	<1
ø **Mercury**	7439-97-6	1	µg/filter		<1	<1	<1	<1	<1
ø **Zinc**	7440-66-6	1	µg/filter		**21**	**21**	**23**	**20**	**22**

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	03976 Meribah	03975 Meribah	03974 Meribah	03972 Meribah	03992 Meribah
				Client sampling date / time	22-Jun-2020 00:00	28-Jun-2020 00:00	04-Jul-2020 00:00	10-Jul-2020 00:00	16-Jul-2020 00:00
					CA2004914-021	CA2004914-022	CA2004914-023	CA2004914-024	CA2004914-025
					Result	Result	Result	Result	Result
EG005CA: Total Metals by ICP-OES									
ø **Iron**	7439-89-6	1	µg/filter		**68**	**79**	**57**	**151**	**85**
EG020CA: Total Metals by ICP-MS									
ø **Aluminium**	7429-90-5	1	µg/filter		**1480**	**1130**	**1210**	**1220**	**1220**
ø **Antimony**	7440-36-0	1	µg/filter		<1	<1	<1	<1	<1
ø **Arsenic**	7440-38-2	1	µg/filter		<1	<1	<1	<1	<1
ø **Barium**	7440-39-3	1	µg/filter		**13**	**11**	**11**	**12**	**13**
ø **Beryllium**	7440-41-7	1	µg/filter		<1	<1	<1	<1	<1
ø **Cadmium**	7440-43-9	1	µg/filter		<1	<1	<1	<1	<1
ø **Chromium**	7440-47-3	1	µg/filter		**3**	**2**	**2**	**3**	**3**
ø **Cobalt**	7440-48-4	1	µg/filter		<1	<1	<1	<1	<1
ø **Copper**	7440-50-8	1	µg/filter		**4**	**5**	**4**	**4**	**6**
ø **Lead**	7439-92-1	1	µg/filter		<1	**1**	<1	**1**	**1**
ø **Manganese**	7439-96-5	1	µg/filter		**2**	**2**	**2**	**4**	**2**
ø **Molybdenum**	7439-98-7	1	µg/filter		<1	<1	<1	<1	<1
ø **Nickel**	7440-02-0	1	µg/filter		<1	<1	<1	<1	<1
ø **Selenium**	7782-49-2	1	µg/filter		<1	<1	<1	<1	<1
ø **Silver**	7440-22-4	1	µg/filter		<1	<1	<1	<1	<1
ø **Tin**	7440-31-5	1	µg/filter		<1	<1	<1	<1	<1
ø **Mercury**	7439-97-6	1	µg/filter		<1	<1	<1	<1	<1
ø **Zinc**	7440-66-6	1	µg/filter		**15**	**17**	**58**	**19**	**21**

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	010223 Triangle Flat	010221 Triangle Flat	010215 Triangle Flat	010212 Triangle Flat	03979 Triangle Flat
				Client sampling date / time	23-May-2020 00:00	29-May-2020 00:00	04-Jun-2020 00:00	10-Jun-2020 00:00	16-Jun-2020 00:00
					CA2004914-026	CA2004914-027	CA2004914-028	CA2004914-029	CA2004914-030
					Result	Result	Result	Result	Result
EG005CA: Total Metals by ICP-OES									
ø **Iron**	7439-89-6	1	µg/filter		**82**	**106**	**98**	**85**	**116**
EG020CA: Total Metals by ICP-MS									
ø **Aluminium**	7429-90-5	1	µg/filter		**1620**	**1740**	**1620**	**1680**	**1230**
ø **Antimony**	7440-36-0	1	µg/filter		<1	<1	<1	<1	<1
ø **Arsenic**	7440-38-2	1	µg/filter		<1	<1	<1	<1	<1
ø **Barium**	7440-39-3	1	µg/filter		**13**	**14**	**14**	**15**	**10**
ø **Beryllium**	7440-41-7	1	µg/filter		<1	<1	<1	<1	<1
ø **Cadmium**	7440-43-9	1	µg/filter		<1	<1	<1	<1	<1
ø **Chromium**	7440-47-3	1	µg/filter		**5**	**5**	**5**	**5**	**3**
ø **Cobalt**	7440-48-4	1	µg/filter		<1	<1	<1	<1	<1
ø **Copper**	7440-50-8	1	µg/filter		**5**	**5**	**7**	**5**	**12**
ø **Lead**	7439-92-1	1	µg/filter		**2**	**2**	**1**	**1**	**1**
ø **Manganese**	7439-96-5	1	µg/filter		**3**	**4**	**4**	**3**	**3**
ø **Molybdenum**	7439-98-7	1	µg/filter		<1	<1	<1	<1	<1
ø **Nickel**	7440-02-0	1	µg/filter		<1	<1	<1	<1	<1
ø **Selenium**	7782-49-2	1	µg/filter		<1	<1	<1	<1	<1
ø **Silver**	7440-22-4	1	µg/filter		<1	<1	<1	<1	<1
ø **Tin**	7440-31-5	1	µg/filter		<1	<1	<1	<1	<1
ø **Mercury**	7439-97-6	1	µg/filter		<1	<1	<1	<1	<1
ø **Zinc**	7440-66-6	1	µg/filter		**23**	**24**	**22**	**24**	**20**

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	03982 Triangle Flat	03994 Triangle Flat	03985 Triangle Flat	03991 Triangle Flat	03990 Triangle Flat
				Client sampling date / time	22-Jun-2020 00:00	28-Jun-2020 00:00	04-Jul-2020 00:00	10-Jul-2020 00:00	16-Jul-2020 00:00
					CA2004914-031	CA2004914-032	CA2004914-033	CA2004914-034	CA2004914-035
					Result	Result	Result	Result	Result
EG005CA: Total Metals by ICP-OES									
ø **Iron**	7439-89-6	1	µg/filter		**84**	**84**	**57**	**92**	**66**
EG020CA: Total Metals by ICP-MS									
ø **Aluminium**	7429-90-5	1	µg/filter		**1020**	**1250**	**946**	**1160**	**1090**
ø **Antimony**	7440-36-0	1	µg/filter		<1	<1	<1	<1	<1
ø **Arsenic**	7440-38-2	1	µg/filter		<1	<1	<1	<1	<1
ø **Barium**	7440-39-3	1	µg/filter		**9**	**11**	**8**	**10**	**10**
ø **Beryllium**	7440-41-7	1	µg/filter		<1	<1	<1	<1	<1
ø **Cadmium**	7440-43-9	1	µg/filter		<1	<1	<1	<1	<1
ø **Chromium**	7440-47-3	1	µg/filter		**2**	**3**	**2**	**3**	**3**
ø **Cobalt**	7440-48-4	1	µg/filter		<1	<1	<1	<1	<1
ø **Copper**	7440-50-8	1	µg/filter		**10**	**5**	**4**	**4**	**5**
ø **Lead**	7439-92-1	1	µg/filter		<1	**1**	<1	**1**	<1
ø **Manganese**	7439-96-5	1	µg/filter		**2**	**2**	**2**	**3**	**2**
ø **Molybdenum**	7439-98-7	1	µg/filter		<1	<1	<1	<1	<1
ø **Nickel**	7440-02-0	1	µg/filter		<1	<1	<1	<1	<1
ø **Selenium**	7782-49-2	1	µg/filter		<1	<1	<1	<1	<1
ø **Silver**	7440-22-4	1	µg/filter		<1	<1	<1	<1	<1
ø **Tin**	7440-31-5	1	µg/filter		<1	<1	<1	<1	<1
ø **Mercury**	7439-97-6	1	µg/filter		<1	<1	<1	<1	<1
ø **Zinc**	7440-66-6	1	µg/filter		**14**	**18**	**15**	**16**	**15**

ALS Water

CERTIFICATE OF ANALYSIS

Work Order	: **CA2006086**	Page	: 1 of 7
Amendment	: **1**		
Client	: **Newcrest Mining**	Laboratory	: ALS Water Resources Group
Contact	: Zac Zhang	Contact	: Client Services
Address	: 1460 Cadia Road Orange NSW 2800	Address	: 16B Lithgow Street Fyshwick ACT Australia 2609
Telephone	: ----	Telephone	: +61 2 6202 5404
Project	: CVO Hi-Vol Sampling and Analysis	Date Samples Received	: 09-Sep-2020 15:35
Order number	: 4501057533	Date Analysis Commenced	: 18-Sep-2020
C-O-C number	: ----	Issue Date	: 27-Nov-2020 11:45
Sampler	: John Ford, Martin Englert, Zac Zhang		
Site	: CADIA		
Quote number	: ----		
No. of samples received	: 25		
No. of samples analysed	: 25		

Accreditation No. 992
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

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- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Geetha Ramasundara	Chemistry Teamleader	Inorganics, Fyshwick, ACT

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- **For samples collected by ALS WRG, sampling was carried out in accordance with Procedure EN67**
- **General Amend: Client requested results reported to 5 decimal places**

Analytical Results

Sub-Matrix: **SOLID**
(Matrix: **SOLID**)

Compound	CAS Number	LOR	Unit	Sample ID	003983 Flyer Creek	010208 Flyer Creek	003984 Flyer Creek	003903 Flyer Creek	003969 Bundarra
				Sampling date / time	22-Jul-2020 00:00	28-Jul-2020 00:00	03-Aug-2020 00:00	09-Aug-2020 00:00	22-Jul-2020 00:00
					CA2006086-001	CA2006086-002	CA2006086-003	CA2006086-004	CA2006086-005
					Result	Result	Result	Result	Result
EA143CA: Total Suspended Particulates									
ø Paper Number	----	1	-		**3983**	**0208**	**3984**	**3903**	**3969**
ø Initial Weight	----	0.00001	g		**3.54962**	**3.47747**	**3.54735**	**3.52520**	**3.54769**
ø Final Weight	----	0.00001	g		**3.56717**	**3.48486**	**3.56261**	**3.53491**	**3.57295**
ø Sampling Period	----	1.00	hours		**24.1**	**24.1**	**24.1**	**24.1**	**24.1**
ø Volume	----	1.00	m^3		**1690**	**1680**	**1680**	**1660**	**1630**
ø PM10	----	1.0	$\mu g/m^3$		**10.4**	**4.4**	**9.1**	**5.8**	**15.5**

Analytical Results

Sub-Matrix: **SOLID**
(Matrix: **SOLID**)

Compound	CAS Number	LOR	Unit	Sample ID	010209 Bundarra	010211 Bundarra	003901 Bundarra	001900 Bundarra	001896 Bundarra
				Sampling date / time	28-Jul-2020 00:00	03-Aug-2020 00:00	09-Aug-2020 00:00	15-Aug-2020 00:00	21-Aug-2020 00:00
					CA2006086-006	CA2006086-007	CA2006086-008	CA2006086-009	CA2006086-010
					Result	Result	Result	Result	Result
EA143CA: Total Suspended Particulates									
ø **Paper Number**	----	1	-		**0209**	**0211**	**3901**	**1900**	**1896**
ø **Initial Weight**	----	0.00001	g		**3.48317**	**3.48580**	**3.52742**	**3.62863**	**3.63631**
ø **Final Weight**	----	0.00001	g		**3.48643**	**3.50684**	**3.53216**	**3.62863**	**3.64378**
ø **Sampling Period**	----	1	hours		**----**	**----**	**----**	**0.083**	**----**
ø **Sampling Period**	----	1.00	hours		**24.1**	**24.0**	**24.1**	**----**	**22.5**
ø **Volume**	----	1.00	m^3		**1630**	**1630**	**1630**	**5.65**	**1520**
ø **PM10**	----	1.0	$\mu g/m^3$		**2.0**	**12.9**	**2.9**	<1.0	**4.9**

Analytical Results

Sub-Matrix: **SOLID**
(Matrix: **SOLID**)

Compound	CAS Number	LOR	Unit	Sample ID	001893 Bundarra	010255 Meribah	010210 Meribah	003967 Meribah	001888 Meribah
				Sampling date / time	27-Aug-2020 00:00	22-Jul-2020 00:00	28-Jul-2020 00:00	03-Aug-2020 00:00	09-Aug-2020 00:00
					CA2006086-011	CA2006086-012	CA2006086-013	CA2006086-014	CA2006086-015
					Result	Result	Result	Result	Result
EA143CA: Total Suspended Particulates									
ø **Paper Number**	----	1	-		**1893**	**0255**	**0210**	**3967**	**1888**
ø **Initial Weight**	----	0.00001	g		**3.62853**	**3.52681**	**3.47690**	**3.54047**	**3.59452**
ø **Final Weight**	----	0.00001	g		**3.65917**	**3.53753**	**3.48009**	**3.56142**	**3.72676**
ø **Sampling Period**	----	1.00	hours		**24.1**	**24.1**	**24.1**	**24.0**	**24.1**
ø **Volume**	----	1.00	m^3		**1630**	**1640**	**1630**	**1620**	**1630**
ø **PM10**	----	1.0	$\mu g/m^3$		**18.8**	**6.5**	**2.0**	**12.9**	**81.0**

Analytical Results

Sub-Matrix: **SOLID**
(Matrix: **SOLID**)

Compound	CAS Number	LOR	Unit	Sample ID	001898 Meribah	001895 Meribah	001892 Meribah	003966 Triangle Flat	003988 Triangle Flat
				Sampling date / time	15-Aug-2020 00:00	21-Aug-2020 00:00	27-Aug-2020 00:00	22-Jul-2020 00:00	28-Jul-2020 00:00
					CA2006086-016	CA2006086-017	CA2006086-018	CA2006086-019	CA2006086-020
					Result	Result	Result	Result	Result
EA143CA: Total Suspended Particulates									
ø Paper Number	----	1	-		**1898**	**1895**	**1892**	**3966**	**3988**
ø Initial Weight	----	0.00001	g		**3.62152**	**3.57584**	**3.63872**	**3.53846**	**3.54011**
ø Final Weight	----	0.00001	g		**3.63132**	**3.59071**	**3.65139**	**3.55275**	**3.55017**
ø Sampling Period	----	1.00	hours		**24.1**	**22.5**	**24.1**	**24.1**	**24.1**
ø Volume	----	1.00	m^3		**1630**	**1520**	**1630**	**1630**	**1630**
ø PM10	----	1.0	$\mu g/m^3$		**6.0**	**9.8**	**7.8**	**8.8**	**6.2**

Analytical Results

Sub-Matrix: **SOLID**
(Matrix: **SOLID**)

Compound	CAS Number	LOR	Unit	Sample ID	003968 Triangle Flat	003904 Triangle Flat	001899 Triangle Flat	001894 Triangle Flat	001891 Triangle Flat
				Sampling date / time	03-Aug-2020 00:00	09-Aug-2020 00:00	15-Aug-2020 00:00	21-Aug-2020 00:00	27-Aug-2020 00:00
					CA2006086-021	CA2006086-022	CA2006086-023	CA2006086-024	CA2006086-025
					Result	Result	Result	Result	Result
EA143CA: Total Suspended Particulates									
ø Paper Number	----	1	-		**3968**	**3904**	**1899**	**1894**	**1891**
ø Initial Weight	----	0.00001	g		**3.54042**	**3.53000**	**3.64000**	**3.62508**	**3.64245**
ø Final Weight	----	0.00001	g		**3.55876**	**3.53585**	**3.64659**	**3.63279**	**3.65233**
ø Sampling Period	----	1.00	hours		**24.0**	**24.1**	**24.0**	**22.6**	**24.1**
ø Volume	----	1.00	m^3		**1630**	**1640**	**1620**	**1520**	**1620**
ø PM10	----	1.0	$\mu g/m^3$		**11.2**	**3.6**	**4.0**	**5.0**	**6.1**

ALS Water

CERTIFICATE OF ANALYSIS

Work Order	: **CA2006106**	Page	: 1 of 7
Client	: **Newcrest Mining**	Laboratory	: ALS Water Resources Group
Contact	: Mr Nicolas Bourgeot	Contact	: Client Services
Address	: 1460 Cadia Road Orange NSW 2800	Address	: 16B Lithgow Street Fyshwick ACT Australia 2609
Telephone	: ----	Telephone	: +61 2 6202 5404
Project	: CVO Hi-Vol Sampling and Analysis	Date Samples Received	: 09-Sep-2020 15:35
Order number	: 4501057533	Date Analysis Commenced	: 21-Sep-2020
C-O-C number	: ----	Issue Date	: 28-Sep-2020 15:37
Sampler	: Martin Englert, Zac Zhang		
Site	: CADIA		
Quote number	: ----		
No. of samples received	: 25		
No. of samples analysed	: 25		

ilac-MRA NATA
Accreditation No. 992
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Titus Vimalasiri	Metals Teamleader	Inorganics, Fyshwick, ACT

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- **For samples collected by ALS WRG, sampling was carried out in accordance with Procedure EN67**

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	003983 Flyer Creek	010208 Flyer Creek	003984 Flyer Creek	003903 Flyer Creek	003969 Bundarra
				Client sampling date / time	22-Jul-2020 00:00	28-Jul-2020 00:00	03-Aug-2020 00:00	09-Aug-2020 00:00	22-Jul-2020 00:00
					CA2006106-001	CA2006106-002	CA2006106-003	CA2006106-004	CA2006106-005
					Result	Result	Result	Result	Result
EG005CA: Total Metals by ICP-OES									
ø **Iron**	7439-89-6	1	µg/filter		**260**	**190**	**262**	**198**	**554**
EG020CA: Total Metals by ICP-MS									
ø **Aluminium**	7429-90-5	1	µg/filter		**1360**	**1790**	**1350**	**1380**	**1220**
ø **Antimony**	7440-36-0	1	µg/filter		<1	<1	<1	<1	<1
ø **Arsenic**	7440-38-2	1	µg/filter		<1	<1	<1	<1	<1
ø **Barium**	7440-39-3	1	µg/filter		**14**	**18**	**14**	**12**	**12**
ø **Beryllium**	7440-41-7	1	µg/filter		<1	<1	<1	<1	<1
ø **Cadmium**	7440-43-9	1	µg/filter		<1	<1	<1	<1	<1
ø **Chromium**	7440-47-3	1	µg/filter		**4**	**6**	**4**	**4**	**4**
ø **Cobalt**	7440-48-4	1	µg/filter		<1	<1	<1	<1	<1
ø **Copper**	7440-50-8	1	µg/filter		**11**	**12**	**13**	**14**	**48**
ø **Lead**	7439-92-1	1	µg/filter		**1**	**2**	**1**	**1**	**1**
ø **Manganese**	7439-96-5	1	µg/filter		**5**	**4**	**5**	**3**	**8**
ø **Molybdenum**	7439-98-7	1	µg/filter		<1	<1	<1	<1	<1
ø **Nickel**	7440-02-0	1	µg/filter		<1	**1**	<1	**2**	<1
ø **Selenium**	7782-49-2	1	µg/filter		<1	<1	<1	<1	<1
ø **Silver**	7440-22-4	1	µg/filter		<1	<1	<1	<1	<1
ø **Tin**	7440-31-5	1	µg/filter		<1	<1	<1	<1	<1
ø **Mercury**	7439-97-6	1	µg/filter		<1	<1	<1	<1	<1
ø **Zinc**	7440-66-6	1	µg/filter		**14**	**26**	**14**	**17**	**10**

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	010209 Bundarra	010211 Bundarra	003901 Bundarra	001900 Bundarra	001896 Bundarra
				Client sampling date / time	28-Jul-2020 00:00	03-Aug-2020 00:00	09-Aug-2020 00:00	15-Aug-2020 00:00	21-Aug-2020 00:00
					CA2006106-006	CA2006106-007	CA2006106-008	CA2006106-009	CA2006106-010
					Result	Result	Result	Result	Result
EG005CA: Total Metals by ICP-OES									
ø **Iron**	7439-89-6	1	µg/filter		**122**	**700**	**102**	**103**	**104**
EG020CA: Total Metals by ICP-MS									
ø **Aluminium**	7429-90-5	1	µg/filter		**1540**	**1710**	**1640**	**1630**	**1210**
ø **Antimony**	7440-36-0	1	µg/filter		<1	<1	<1	<1	<1
ø **Arsenic**	7440-38-2	1	µg/filter		<1	<1	<1	<1	<1
ø **Barium**	7440-39-3	1	µg/filter		**16**	**16**	**36**	**36**	**29**
ø **Beryllium**	7440-41-7	1	µg/filter		<1	<1	<1	<1	<1
ø **Cadmium**	7440-43-9	1	µg/filter		<1	<1	<1	<1	<1
ø **Chromium**	7440-47-3	1	µg/filter		**6**	**6**	**5**	**4**	**4**
ø **Cobalt**	7440-48-4	1	µg/filter		<1	<1	<1	<1	<1
ø **Copper**	7440-50-8	1	µg/filter		**6**	**56**	**6**	**6**	**5**
ø **Lead**	7439-92-1	1	µg/filter		**2**	**2**	**1**	**1**	**1**
ø **Manganese**	7439-96-5	1	µg/filter		**3**	**9**	**2**	**2**	**2**
ø **Molybdenum**	7439-98-7	1	µg/filter		<1	<1	<1	<1	<1
ø **Nickel**	7440-02-0	1	µg/filter		<1	**1**	<1	<1	<1
ø **Selenium**	7782-49-2	1	µg/filter		<1	<1	<1	<1	<1
ø **Silver**	7440-22-4	1	µg/filter		<1	<1	<1	<1	<1
ø **Tin**	7440-31-5	1	µg/filter		<1	<1	<1	<1	<1
ø **Mercury**	7439-97-6	1	µg/filter		<1	<1	<1	<1	<1
ø **Zinc**	7440-66-6	1	µg/filter		**16**	**16**	**21**	**20**	**17**

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	001893 Bundarra	010255 Meribah	010210 Meribah	003967 Meribah	001888 Meribah
				Client sampling date / time	27-Aug-2020 00:00	22-Jul-2020 00:00	28-Jul-2020 00:00	03-Aug-2020 00:00	09-Aug-2020 00:00
					CA2006106-011	CA2006106-012	CA2006106-013	CA2006106-014	CA2006106-015
					Result	Result	Result	Result	Result
EG005CA: Total Metals by ICP-OES									
ø **Iron**	7439-89-6	1	µg/filter		**807**	**216**	**105**	**432**	**96**
EG020CA: Total Metals by ICP-MS									
ø **Aluminium**	7429-90-5	1	µg/filter		**1390**	**1500**	**1470**	**1130**	**1350**
ø **Antimony**	7440-36-0	1	µg/filter		<1	<1	**1**	<1	**1**
ø **Arsenic**	7440-38-2	1	µg/filter		<1	<1	<1	<1	<1
ø **Barium**	7440-39-3	1	µg/filter		**26**	**17**	**15**	**12**	**30**
ø **Beryllium**	7440-41-7	1	µg/filter		<1	<1	<1	<1	<1
ø **Cadmium**	7440-43-9	1	µg/filter		<1	<1	<1	<1	<1
ø **Chromium**	7440-47-3	1	µg/filter		**4**	**6**	**5**	**4**	**4**
ø **Cobalt**	7440-48-4	1	µg/filter		<1	<1	<1	<1	<1
ø **Copper**	7440-50-8	1	µg/filter		**86**	**8**	**6**	**20**	**6**
ø **Lead**	7439-92-1	1	µg/filter		**2**	**2**	**2**	**1**	**1**
ø **Manganese**	7439-96-5	1	µg/filter		**10**	**5**	**3**	**7**	**2**
ø **Molybdenum**	7439-98-7	1	µg/filter		**1**	<1	<1	<1	<1
ø **Nickel**	7440-02-0	1	µg/filter		<1	<1	<1	<1	<1
ø **Selenium**	7782-49-2	1	µg/filter		<1	<1	<1	<1	<1
ø **Silver**	7440-22-4	1	µg/filter		<1	<1	<1	<1	<1
ø **Tin**	7440-31-5	1	µg/filter		<1	<1	<1	<1	<1
ø **Mercury**	7439-97-6	1	µg/filter		<1	<1	<1	<1	<1
ø **Zinc**	7440-66-6	1	µg/filter		**19**	**17**	**27**	**9**	**31**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	001898 Meribah	001895 Meribah	001892 Meribah	003966 Triangle Flat	003988 Triangle Flat
			Client sampling date / time	15-Aug-2020 00:00	21-Aug-2020 00:00	27-Aug-2020 00:00	22-Jul-2020 00:00	28-Jul-2020 00:00
Compound	CAS Number	LOR	Unit	CA2006106-016	CA2006106-017	CA2006106-018	CA2006106-019	CA2006106-020
				Result	Result	Result	Result	Result
EG005CA: Total Metals by ICP-OES								
ø Iron	7439-89-6	1	µg/filter	121	101	272	141	104
EG020CA: Total Metals by ICP-MS								
ø Aluminium	7429-90-5	1	µg/filter	1470	1150	1250	1130	1170
ø Antimony	7440-36-0	1	µg/filter	<1	<1	<1	<1	<1
ø Arsenic	7440-38-2	1	µg/filter	<1	<1	<1	<1	<1
ø Barium	7440-39-3	1	µg/filter	33	12	30	13	13
ø Beryllium	7440-41-7	1	µg/filter	<1	<1	<1	<1	<1
ø Cadmium	7440-43-9	1	µg/filter	<1	<1	<1	<1	<1
ø Chromium	7440-47-3	1	µg/filter	4	3	4	4	4
ø Cobalt	7440-48-4	1	µg/filter	<1	<1	<1	<1	<1
ø Copper	7440-50-8	1	µg/filter	5	7	12	7	7
ø Lead	7439-92-1	1	µg/filter	1	1	2	1	<1
ø Manganese	7439-96-5	1	µg/filter	2	3	5	4	3
ø Molybdenum	7439-98-7	1	µg/filter	<1	<1	<1	<1	<1
ø Nickel	7440-02-0	1	µg/filter	<1	<1	<1	<1	<1
ø Selenium	7782-49-2	1	µg/filter	<1	<1	<1	<1	<1
ø Silver	7440-22-4	1	µg/filter	<1	<1	<1	<1	<1
ø Tin	7440-31-5	1	µg/filter	<1	<1	<1	<1	<1
ø Mercury	7439-97-6	1	µg/filter	<1	<1	<1	<1	<1
ø Zinc	7440-66-6	1	µg/filter	20	11	19	10	10

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	003968 Triangle Flat	003904 Triangle Flat	001899 Triangle Flat	001894 Triangle Flat	001891 Triangle Flat
				Client sampling date / time	03-Aug-2020 00:00	09-Aug-2020 00:00	15-Aug-2020 00:00	21-Aug-2020 00:00	27-Aug-2020 00:00
					CA2006106-021	CA2006106-022	CA2006106-023	CA2006106-024	CA2006106-025
					Result	Result	Result	Result	Result
EG005CA: Total Metals by ICP-OES									
ø **Iron**	7439-89-6	1	µg/filter		**375**	**65**	**85**	**108**	**259**
EG020CA: Total Metals by ICP-MS									
ø **Aluminium**	7429-90-5	1	µg/filter		**1170**	**796**	**1270**	**1190**	**1310**
ø **Antimony**	7440-36-0	1	µg/filter		<1	<1	<1	<1	<1
ø **Arsenic**	7440-38-2	1	µg/filter		<1	<1	<1	<1	<1
ø **Barium**	7440-39-3	1	µg/filter		**11**	**10**	**29**	**30**	**31**
ø **Beryllium**	7440-41-7	1	µg/filter		<1	<1	<1	<1	<1
ø **Cadmium**	7440-43-9	1	µg/filter		<1	<1	<1	<1	<1
ø **Chromium**	7440-47-3	1	µg/filter		**3**	**3**	**4**	**4**	**4**
ø **Cobalt**	7440-48-4	1	µg/filter		<1	<1	<1	<1	<1
ø **Copper**	7440-50-8	1	µg/filter		**23**	**6**	**5**	**6**	**14**
ø **Lead**	7439-92-1	1	µg/filter		**1**	<1	**1**	**1**	**2**
ø **Manganese**	7439-96-5	1	µg/filter		**6**	**2**	**2**	**2**	**5**
ø **Molybdenum**	7439-98-7	1	µg/filter		<1	<1	<1	<1	<1
ø **Nickel**	7440-02-0	1	µg/filter		<1	<1	<1	<1	<1
ø **Selenium**	7782-49-2	1	µg/filter		<1	<1	<1	<1	<1
ø **Silver**	7440-22-4	1	µg/filter		<1	<1	<1	<1	<1
ø **Tin**	7440-31-5	1	µg/filter		<1	<1	<1	<1	<1
ø **Mercury**	7439-97-6	1	µg/filter		<1	<1	<1	<1	<1
ø **Zinc**	7440-66-6	1	µg/filter		**10**	**8**	**16**	**17**	**19**

ALS Water

CERTIFICATE OF ANALYSIS

Work Order	: **CA2007418**	Page	: 1 of 7
Client	: **Newcrest Mining**	Laboratory	: ALS Water Resources Group
Contact	: Mr Nicolas Bourgeot	Contact	: Client Services
Address	: 1460 Cadia Road Orange NSW 2800	Address	: 16B Lithgow Street Fyshwick ACT Australia 2609
Telephone	: ----	Telephone	: +61 2 6202 5404
Project	: CVO Hi-Vol Sampling and Analysis	Date Samples Received	: 02-Nov-2020 09:00
Order number	: 4501057533	Date Analysis Commenced	: 09-Nov-2020
C-O-C number	: ----	Issue Date	: 19-Nov-2020 14:03
Sampler	: ----		
Site	: CADIA		
Quote number	: ----		
No. of samples received	: 21		
No. of samples analysed	: 21		

ilac-MRA NATA
Accreditation No. 992
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Titus Vimalasiri	Metals Teamleader	Inorganics, Fyshwick, ACT

General Comments

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Where moisture determination has been performed, results are reported on a dry weight basis.

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Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- **For samples collected by ALS WRG, sampling was carried out in accordance with Procedure EN67**
- Split TAT - Prelim report sent 18/11/20. Due to a delay on metal analysis, the final report will be send on or before 20/11/20. Apologies for any inconvenience

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	001890 Bundarra	003914 Bundarra	003916 Bundarra	003921 Bundarra	003915 Meribah
				Client sampling date / time	02-Sep-2020 00:00	14-Sep-2020 00:00	20-Sep-2020 00:00	08-Oct-2020 00:00	14-Sep-2020 00:00
Compound	CAS Number	LOR	Unit		CA2007418-001	CA2007418-002	CA2007418-003	CA2007418-004	CA2007418-005
					Result	Result	Result	Result	Result
EG005CA: Total Metals by ICP-OES									
ø **Iron**	7439-89-6	1	µg/filter		**241**	**344**	**141**	**126**	**314**
EG020CA: Total Metals by ICP-MS									
ø **Aluminium**	7429-90-5	1	µg/filter		**1270**	**1300**	**1180**	**1320**	**1320**
ø **Antimony**	7440-36-0	1	µg/filter		<1	<1	<1	<1	<1
ø **Arsenic**	7440-38-2	1	µg/filter		<1	<1	<1	<1	<1
ø **Barium**	7440-39-3	1	µg/filter		**22**	**10**	**9**	**10**	**11**
ø **Beryllium**	7440-41-7	1	µg/filter		<1	<1	<1	<1	<1
ø **Cadmium**	7440-43-9	1	µg/filter		<1	<1	<1	<1	<1
ø **Chromium**	7440-47-3	1	µg/filter		**4**	**3**	**3**	**3**	**3**
ø **Cobalt**	7440-48-4	1	µg/filter		<1	<1	<1	<1	<1
ø **Copper**	7440-50-8	1	µg/filter		**8**	**31**	**10**	**8**	**16**
ø **Lead**	7439-92-1	1	µg/filter		**1**	<1	<1	<1	<1
ø **Manganese**	7439-96-5	1	µg/filter		**6**	**6**	**3**	**4**	**8**
ø **Molybdenum**	7439-98-7	1	µg/filter		<1	<1	<1	<1	<1
ø **Nickel**	7440-02-0	1	µg/filter		<1	<1	<1	<1	<1
ø **Selenium**	7782-49-2	1	µg/filter		<1	<1	<1	<1	<1
ø **Silver**	7440-22-4	1	µg/filter		<1	<1	<1	<1	<1
ø **Tin**	7440-31-5	1	µg/filter		<1	<1	<1	<1	<1
ø **Mercury**	7439-97-6	1	µg/filter		<1	<1	<1	<1	<1
ø **Zinc**	7440-66-6	1	µg/filter		**15**	**13**	**11**	**11**	**20**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	003918 Meribah	003919 Meribah	001883 Meribah	001885 Meribah	003905 Meribah
			Client sampling date / time	20-Sep-2020 00:00	26-Sep-2020 00:00	02-Oct-2020 00:00	08-Oct-2020 00:00	14-Oct-2020 00:00
Compound	CAS Number	LOR	Unit	CA2007418-006	CA2007418-007	CA2007418-008	CA2007418-009	CA2007418-010
				Result	Result	Result	Result	Result
EG005CA: Total Metals by ICP-OES								
ø **Iron**	7439-89-6	1	µg/filter	**156**	**78**	**185**	**123**	**1330**
EG020CA: Total Metals by ICP-MS								
ø **Aluminium**	7429-90-5	1	µg/filter	**1180**	**1160**	**1630**	**1370**	**1340**
ø **Antimony**	7440-36-0	1	µg/filter	<1	<1	<1	<1	<1
ø **Arsenic**	7440-38-2	1	µg/filter	<1	<1	<1	<1	**2**
ø **Barium**	7440-39-3	1	µg/filter	**9**	**10**	**30**	**26**	**16**
ø **Beryllium**	7440-41-7	1	µg/filter	<1	<1	<1	<1	<1
ø **Cadmium**	7440-43-9	1	µg/filter	<1	<1	<1	<1	<1
ø **Chromium**	7440-47-3	1	µg/filter	**3**	**3**	**4**	**4**	**4**
ø **Cobalt**	7440-48-4	1	µg/filter	<1	<1	<1	<1	<1
ø **Copper**	7440-50-8	1	µg/filter	**9**	**6**	**7**	**6**	**9**
ø **Lead**	7439-92-1	1	µg/filter	<1	<1	<1	**1**	**4**
ø **Manganese**	7439-96-5	1	µg/filter	**4**	**2**	**5**	**4**	**28**
ø **Molybdenum**	7439-98-7	1	µg/filter	<1	<1	<1	<1	<1
ø **Nickel**	7440-02-0	1	µg/filter	**1**	<1	<1	<1	**1**
ø **Selenium**	7782-49-2	1	µg/filter	<1	<1	<1	<1	<1
ø **Silver**	7440-22-4	1	µg/filter	<1	<1	<1	<1	<1
ø **Tin**	7440-31-5	1	µg/filter	<1	<1	<1	<1	<1
ø **Mercury**	7439-97-6	1	µg/filter	<1	<1	<1	<1	<1
ø **Zinc**	7440-66-6	1	µg/filter	**11**	**9**	**23**	**18**	**17**

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	001899 Triangle Flat	010254 Triangle Flat	039113 Triangle Flat	003917 Triangle Flat	003920 Triangle Flat
				Client sampling date / time	15-Aug-2020 00:00	02-Sep-2020 00:00	08-Sep-2020 00:00	14-Sep-2020 00:00	20-Sep-2020 00:00
					CA2007418-011	CA2007418-012	CA2007418-013	CA2007418-014	CA2007418-015
					Result	Result	Result	Result	Result
EG005CA: Total Metals by ICP-OES									
ø **Iron**	7439-89-6	1	µg/filter		**934**	**329**	**532**	**209**	**179**
EG020CA: Total Metals by ICP-MS									
ø **Aluminium**	7429-90-5	1	µg/filter		**1390**	**1580**	**1420**	**1290**	**1260**
ø **Antimony**	7440-36-0	1	µg/filter		<1	<1	<1	<1	<1
ø **Arsenic**	7440-38-2	1	µg/filter		**1**	<1	<1	<1	<1
ø **Barium**	7440-39-3	1	µg/filter		**29**	**14**	**10**	**12**	**10**
ø **Beryllium**	7440-41-7	1	µg/filter		<1	<1	<1	<1	<1
ø **Cadmium**	7440-43-9	1	µg/filter		<1	<1	<1	<1	<1
ø **Chromium**	7440-47-3	1	µg/filter		**4**	**5**	**3**	**3**	**3**
ø **Cobalt**	7440-48-4	1	µg/filter		<1	<1	<1	<1	<1
ø **Copper**	7440-50-8	1	µg/filter		**18**	**6**	**53**	**11**	**12**
ø **Lead**	7439-92-1	1	µg/filter		**2**	**2**	**2**	<1	<1
ø **Manganese**	7439-96-5	1	µg/filter		**22**	**11**	**10**	**5**	**4**
ø **Molybdenum**	7439-98-7	1	µg/filter		<1	<1	<1	<1	<1
ø **Nickel**	7440-02-0	1	µg/filter		<1	<1	<1	<1	<1
ø **Selenium**	7782-49-2	1	µg/filter		<1	<1	<1	<1	<1
ø **Silver**	7440-22-4	1	µg/filter		<1	<1	<1	<1	<1
ø **Tin**	7440-31-5	1	µg/filter		<1	<1	<1	<1	<1
ø **Mercury**	7439-97-6	1	µg/filter		<1	<1	<1	<1	<1
ø **Zinc**	7440-66-6	1	µg/filter		**18**	**13**	**28**	**9**	**9**

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	003922 Triangle Flat	001884 Triangle Flat	001880 Triangle Flat	003910 Triangle Flat	003911 Meribah
				Client sampling date / time	26-Sep-2020 00:00	02-Oct-2020 00:00	08-Oct-2020 00:00	22-Oct-2020 00:00	11-Sep-2020 00:00
					CA2007418-016	CA2007418-017	CA2007418-018	CA2007418-019	CA2007418-020
					Result	Result	Result	Result	Result
EG005CA: Total Metals by ICP-OES									
ø **Iron**	7439-89-6	1	µg/filter		**73**	**117**	**146**	**348**	**175**
EG020CA: Total Metals by ICP-MS									
ø **Aluminium**	7429-90-5	1	µg/filter		**1390**	**1500**	**1380**	**1260**	**1010**
ø **Antimony**	7440-36-0	1	µg/filter		<1	<1	<1	<1	<1
ø **Arsenic**	7440-38-2	1	µg/filter		<1	<1	<1	<1	<1
ø **Barium**	7440-39-3	1	µg/filter		**11**	**29**	**25**	**12**	**8**
ø **Beryllium**	7440-41-7	1	µg/filter		<1	<1	<1	<1	<1
ø **Cadmium**	7440-43-9	1	µg/filter		<1	<1	<1	<1	<1
ø **Chromium**	7440-47-3	1	µg/filter		**3**	**4**	**3**	**3**	**2**
ø **Cobalt**	7440-48-4	1	µg/filter		<1	<1	<1	<1	<1
ø **Copper**	7440-50-8	1	µg/filter		**5**	**5**	**8**	**9**	**9**
ø **Lead**	7439-92-1	1	µg/filter		<1	<1	**1**	**4**	**1**
ø **Manganese**	7439-96-5	1	µg/filter		**2**	**3**	**4**	**10**	**5**
ø **Molybdenum**	7439-98-7	1	µg/filter		<1	<1	<1	<1	<1
ø **Nickel**	7440-02-0	1	µg/filter		<1	<1	<1	<1	<1
ø **Selenium**	7782-49-2	1	µg/filter		<1	<1	<1	<1	<1
ø **Silver**	7440-22-4	1	µg/filter		<1	<1	<1	<1	<1
ø **Tin**	7440-31-5	1	µg/filter		<1	<1	<1	<1	<1
ø **Mercury**	7439-97-6	1	µg/filter		<1	<1	<1	<1	<1
ø **Zinc**	7440-66-6	1	µg/filter		**10**	**19**	**16**	**16**	**16**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	003912 Triangle Flat	----	----	----	----
				Client sampling date / time	11-Sep-2020 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		CA2007418-021	--------	--------	--------	--------
					Result	----	----	----	----
EG005CA: Total Metals by ICP-OES									
ø **Iron**	7439-89-6	1	µg/filter		**528**	----	----	----	----
EG020CA: Total Metals by ICP-MS									
ø **Aluminium**	7429-90-5	1	µg/filter		**1440**	----	----	----	----
ø **Antimony**	7440-36-0	1	µg/filter		<1	----	----	----	----
ø **Arsenic**	7440-38-2	1	µg/filter		**1**	----	----	----	----
ø **Barium**	7440-39-3	1	µg/filter		**13**	----	----	----	----
ø **Beryllium**	7440-41-7	1	µg/filter		<1	----	----	----	----
ø **Cadmium**	7440-43-9	1	µg/filter		<1	----	----	----	----
ø **Chromium**	7440-47-3	1	µg/filter		**3**	----	----	----	----
ø **Cobalt**	7440-48-4	1	µg/filter		<1	----	----	----	----
ø **Copper**	7440-50-8	1	µg/filter		**9**	----	----	----	----
ø **Lead**	7439-92-1	1	µg/filter		**1**	----	----	----	----
ø **Manganese**	7439-96-5	1	µg/filter		**12**	----	----	----	----
ø **Molybdenum**	7439-98-7	1	µg/filter		<1	----	----	----	----
ø **Nickel**	7440-02-0	1	µg/filter		<1	----	----	----	----
ø **Selenium**	7782-49-2	1	µg/filter		<1	----	----	----	----
ø **Silver**	7440-22-4	1	µg/filter		<1	----	----	----	----
ø **Tin**	7440-31-5	1	µg/filter		<1	----	----	----	----
ø **Mercury**	7439-97-6	1	µg/filter		<1	----	----	----	----
ø **Zinc**	7440-66-6	1	µg/filter		**19**	----	----	----	----

ALS Water

CERTIFICATE OF ANALYSIS

Work Order	: **CA2100246**	Page	: 1 of 8
Client	: **Newcrest Mining**	Laboratory	: ALS Water Resources Group
Contact	: Kendra Campbell	Contact	: Client Services
Address	: 1460 Cadia Road Orange NSW 2800	Address	: 16B Lithgow Street Fyshwick ACT Australia 2609
Telephone	: ----	Telephone	: +61 2 6202 5404
Project	: CVO Hi-Vol Sampling and Analysis	Date Samples Received	: 12-Jan-2021 16:45
Order number	: ----	Date Analysis Commenced	: 15-Jan-2021
C-O-C number	: ----	Issue Date	: 18-Jan-2021 12:26
Sampler	: Kendra Campbell, Martin Englert		
Site	: CADIA		
Quote number	: ----		
No. of samples received	: 26		
No. of samples analysed	: 26		

Accreditation No. 992
Accredited for compliance with
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Signatories	*Position*	*Accreditation Category*
Clare Kennedy	Analyst	Inorganics, Fyshwick, ACT

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LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- **For samples collected by ALS WRG, sampling was carried out in accordance with Procedure EN67**

Analytical Results

Sub-Matrix: **SOLID**
(Matrix: **SOLID**)

Compound	CAS Number	LOR	Unit	Sample ID	003906 Triangle Flat	003986 Triangle Flat	003987 Triangle Flat	003909 Triangle Flat	001814 Triangle Flat
				Sampling date / time	26-Oct-2020 00:00	01-Nov-2020 00:00	07-Nov-2020 00:00	13-Nov-2020 00:00	19-Nov-2020 00:00
					CA2100246-001	CA2100246-002	CA2100246-003	CA2100246-004	CA2100246-005
					Result	Result	Result	Result	Result
EA143CA: Total Suspended Particulates									
ø Paper Number	----	1	-		**3906**	**3986**	**3987**	**3909**	**1814**
ø Initial Weight	----	0.00001	g		**3.53**	**3.54**	**3.53**	**3.54**	**3.61**
ø Final Weight	----	0.00001	g		**3.54**	**3.55**	**3.56**	**3.56**	**3.65**
ø Sampling Period	----	1.00	hours		**24.1**	**24.1**	**24.1**	**24.8**	**23.4**
ø Volume	----	1.00	m^3		**1620**	**1640**	**1640**	**1690**	**1580**
ø PM10	----	1.0	$\mu g/m^3$		**7.5**	**10.0**	**13.6**	**13.8**	**26.4**

Analytical Results

Sub-Matrix: **SOLID**
(Matrix: **SOLID**)

Compound	CAS Number	LOR	Unit	Sample ID	001806 Triangle Flat	001808 Triangle Flat	001809 Triangle Flat	003871 Triangle Flat	003872 Triangle Flat
				Sampling date / time	25-Nov-2020 00:00	01-Dec-2020 00:00	07-Dec-2020 00:00	13-Dec-2020 00:00	19-Dec-2020 00:00
					CA2100246-006	CA2100246-007	CA2100246-008	CA2100246-009	CA2100246-010
					Result	Result	Result	Result	Result
EA143CA: Total Suspended Particulates									
ø **Paper Number**	----	1	-		**1806**	**1808**	**1809**	**3871**	**3872**
ø **Initial Weight**	----	0.00001	g		**3.62**	**3.63**	**3.63**	**3.56**	**3.56**
ø **Final Weight**	----	0.00001	g		**3.64**	**3.67**	**3.65**	**3.58**	**3.57**
ø **Sampling Period**	----	1.00	hours		**24.1**	**24.1**	**24.2**	**24.0**	**24.0**
ø **Volume**	----	1.00	m^3		**1630**	**1630**	**1640**	**1620**	**1620**
ø **PM10**	----	1.0	$\mu g/m^3$		**13.2**	**26.4**	**13.2**	**8.5**	**7.9**

Analytical Results

Sub-Matrix: **SOLID**
(Matrix: **SOLID**)

Compound	CAS Number	LOR	Unit	Sample ID	001812 Triangle Flat	003873 Triangle Flat	003874 Triangle Flat	003989 Meribah	003907 Meribah
				Sampling date / time	25-Dec-2020 00:00	31-Dec-2020 00:00	06-Jan-2021 00:00	22-Oct-2020 00:00	01-Nov-2020 00:00
					CA2100246-011	CA2100246-012	CA2100246-013	CA2100246-014	CA2100246-015
					Result	Result	Result	Result	Result
EA143CA: Total Suspended Particulates									
ø Paper Number	----	1	-		**1812**	**3873**	**3874**	**3989**	**3907**
ø Initial Weight	----	0.00001	g		**3.61**	**3.56**	**3.56**	**3.54**	**3.53**
ø Final Weight	----	0.00001	g		**3.63**	**3.57**	**3.57**	**3.55**	**3.55**
ø Sampling Period	----	1.00	hours		**24.0**	**24.1**	**24.1**	**24.1**	**24.0**
ø Volume	----	1.00	m^3		**1620**	**1640**	**1640**	**1620**	**1630**
ø PM10	----	1.0	$\mu g/m^3$		**11.2**	**6.0**	**7.2**	**9.1**	**10.4**

Analytical Results

Sub-Matrix: **SOLID**
(Matrix: **SOLID**)

Compound	CAS Number	LOR	Unit	Sample ID	003908 Meribah	001805 Meribah	001813 Meribah	001807 Meribah	001810 Meribah
				Sampling date / time	07-Nov-2020 00:00	13-Nov-2020 00:00	19-Nov-2020 00:00	25-Nov-2020 00:00	01-Dec-2020 00:00
					CA2100246-016	CA2100246-017	CA2100246-018	CA2100246-019	CA2100246-020
					Result	Result	Result	Result	Result
EA143CA: Total Suspended Particulates									
ø **Paper Number**	----	1	-		**3908**	**1805**	**1813**	**1807**	**1810**
ø **Initial Weight**	----	0.00001	g		**3.54**	**3.62**	**3.62**	**3.63**	**3.61**
ø **Final Weight**	----	0.00001	g		**3.57**	**3.65**	**3.66**	**3.65**	**3.67**
ø **Sampling Period**	----	1.00	hours		**30.6**	**17.7**	**24.1**	**24.1**	**24.0**
ø **Volume**	----	1.00	m^3		**2060**	**1200**	**1640**	**1630**	**1610**
ø **PM10**	----	1.0	$\mu g/m^3$		**12.8**	**21.4**	**26.5**	**15.9**	**32.8**

Analytical Results

Sub-Matrix: **SOLID**
(Matrix: **SOLID**)

Compound	CAS Number	LOR	Unit	Sample ID	001811 Meribah	003900 Meribah	003899 Meribah	003898 Meribah	003897 Meribah
				Sampling date / time	07-Dec-2020 00:00	13-Dec-2020 00:00	19-Dec-2020 00:00	25-Dec-2020 00:00	31-Dec-2020 00:00
					CA2100246-021	CA2100246-022	CA2100246-023	CA2100246-024	CA2100246-025
					Result	Result	Result	Result	Result
EA143CA: Total Suspended Particulates									
ø **Paper Number**	----	1	-		**1811**	**3900**	**3899**	**3898**	**3897**
ø **Initial Weight**	----	0.00001	g		**3.62**	**3.60**	**3.59**	**3.59**	**3.56**
ø **Final Weight**	----	0.00001	g		**3.64**	**3.62**	**3.61**	**3.61**	**3.58**
ø **Sampling Period**	----	1.00	hours		**24.1**	**24.1**	**24.1**	**24.0**	**24.1**
ø **Volume**	----	1.00	m^3		**1620**	**1630**	**1620**	**1630**	**1630**
ø **PM10**	----	1.0	$\mu g/m^3$		**14.4**	**12.5**	**10.2**	**12.5**	**10.9**

Analytical Results

Sub-Matrix: **SOLID** (Matrix: **SOLID**)			Sample ID	**003893 Meribah**	**----**	**----**	**----**	**----**
			Sampling date / time	06-Jan-2021 00:00	----	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**CA2100246-026**	**--------**	**--------**	**--------**	**--------**
				Result	----	----	----	----
EA143CA: Total Suspended Particulates								
ø Paper Number	----	1	-	**3893**	**----**	**----**	**----**	**----**
ø Initial Weight	----	0.00001	g	**3.56**	**----**	**----**	**----**	**----**
ø Final Weight	----	0.00001	g	**3.58**	**----**	**----**	**----**	**----**
ø Sampling Period	----	1.00	hours	**24.1**	**----**	**----**	**----**	**----**
ø Volume	----	1.00	m^3	**1620**	**----**	**----**	**----**	**----**
ø PM10	----	1.0	$\mu g/m^3$	**10.1**	**----**	**----**	**----**	**----**

ALS Water

CERTIFICATE OF ANALYSIS

Work Order	: **CA2100247**	Page	: 1 of 8
Client	: **Newcrest Mining**	Laboratory	: ALS Water Resources Group
Contact	: Kendra Campbell	Contact	: Client Services
Address	: 1460 Cadia Road Orange NSW 2800	Address	: 16B Lithgow Street Fyshwick ACT Australia 2609
Telephone	: ----	Telephone	: +61 2 6202 5404
Project	: CVO Hi-Vol Sampling and Analysis	Date Samples Received	: 12-Jan-2021 16:45
Order number	: 4501057533	Date Analysis Commenced	: 18-Jan-2021
C-O-C number	: ----	Issue Date	: 22-Jan-2021 17:33
Sampler	: Kendra Campbell, Martin Englert		
Site	: CADIA		
Quote number	: ----		
No. of samples received	: 26		
No. of samples analysed	: 26		

Accreditation No. 992
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Titus Vimalasiri	Metals Teamleader	Inorganics, Fyshwick, ACT

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- **For samples collected by ALS WRG, sampling was carried out in accordance with Procedure EN67**

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Sample ID	003906 Triangle Flat	003986 Triangle Flat	003987 Triangle Flat	003909 Triangle Flat	001814 Triangle Flat
				Sampling date / time	26-Oct-2020 00:00	01-Nov-2020 00:00	07-Nov-2020 00:00	13-Nov-2020 00:00	19-Nov-2020 00:00
					CA2100247-001	CA2100247-002	CA2100247-003	CA2100247-004	CA2100247-005
					Result	Result	Result	Result	Result
EG005CA: Total Metals by ICP-OES									
ø **Iron**	7439-89-6	1	µg/filter		**74**	**111**	**142**	**218**	**460**
EG020CA: Total Metals by ICP-MS									
ø **Aluminium**	7429-90-5	1	µg/filter		**780**	**931**	**996**	**890**	**1280**
ø **Antimony**	7440-36-0	1	µg/filter		<1	<1	<1	<1	<1
ø **Arsenic**	7440-38-2	1	µg/filter		<1	<1	<1	<1	<1
ø **Barium**	7440-39-3	1	µg/filter		**17**	**19**	**20**	**17**	**52**
ø **Beryllium**	7440-41-7	1	µg/filter		<1	<1	<1	<1	<1
ø **Cadmium**	7440-43-9	1	µg/filter		<1	<1	<1	<1	<1
ø **Chromium**	7440-47-3	1	µg/filter		**3**	**3**	**4**	**3**	**4**
ø **Cobalt**	7440-48-4	1	µg/filter		<1	<1	<1	<1	<1
ø **Copper**	7440-50-8	1	µg/filter		**6**	**6**	**7**	**12**	**9**
ø **Lead**	7439-92-1	1	µg/filter		<1	<1	<1	<1	**2**
ø **Manganese**	7439-96-5	1	µg/filter		**3**	**4**	**4**	**7**	**18**
ø **Molybdenum**	7439-98-7	1	µg/filter		<1	<1	<1	<1	<1
ø **Nickel**	7440-02-0	1	µg/filter		<1	<1	<1	<1	<1
ø **Selenium**	7782-49-2	1	µg/filter		<1	<1	<1	<1	<1
ø **Silver**	7440-22-4	1	µg/filter		<1	<1	<1	<1	<1
ø **Tin**	7440-31-5	1	µg/filter		<1	<1	<1	<1	<1
ø **Mercury**	7439-97-6	1	µg/filter		<1	<1	<1	<1	<1
ø **Zinc**	7440-66-6	1	µg/filter		**18**	**17**	**23**	**16**	**39**

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Sample ID	001806 Triangle Flat	001808 Triangle Flat	001809 Triangle Flat	003871 Triangle Flat	003872 Triangle Flat
				Sampling date / time	25-Nov-2020 00:00	01-Dec-2020 00:00	07-Dec-2020 00:00	13-Dec-2020 00:00	19-Dec-2020 00:00
					CA2100247-006	CA2100247-007	CA2100247-008	CA2100247-009	CA2100247-010
					Result	Result	Result	Result	Result
EG005CA: Total Metals by ICP-OES									
ø **Iron**	7439-89-6	1	µg/filter		**243**	**407**	**260**	**142**	**178**
EG020CA: Total Metals by ICP-MS									
ø **Aluminium**	7429-90-5	1	µg/filter		**1220**	**1260**	**1200**	**1010**	**1140**
ø **Antimony**	7440-36-0	1	µg/filter		<1	<1	<1	<1	<1
ø **Arsenic**	7440-38-2	1	µg/filter		<1	<1	<1	<1	<1
ø **Barium**	7440-39-3	1	µg/filter		**50**	**48**	**50**	**21**	**21**
ø **Beryllium**	7440-41-7	1	µg/filter		<1	<1	<1	<1	<1
ø **Cadmium**	7440-43-9	1	µg/filter		<1	<1	<1	<1	<1
ø **Chromium**	7440-47-3	1	µg/filter		**4**	**4**	**4**	**4**	**4**
ø **Cobalt**	7440-48-4	1	µg/filter		<1	<1	<1	<1	<1
ø **Copper**	7440-50-8	1	µg/filter		**15**	**7**	**10**	**6**	**6**
ø **Lead**	7439-92-1	1	µg/filter		**1**	**1**	**1**	<1	<1
ø **Manganese**	7439-96-5	1	µg/filter		**6**	**13**	**8**	**6**	**8**
ø **Molybdenum**	7439-98-7	1	µg/filter		<1	<1	<1	<1	<1
ø **Nickel**	7440-02-0	1	µg/filter		<1	<1	<1	<1	<1
ø **Selenium**	7782-49-2	1	µg/filter		<1	<1	<1	<1	<1
ø **Silver**	7440-22-4	1	µg/filter		<1	<1	<1	<1	<1
ø **Tin**	7440-31-5	1	µg/filter		<1	<1	<1	<1	<1
ø **Mercury**	7439-97-6	1	µg/filter		<1	<1	<1	<1	<1
ø **Zinc**	7440-66-6	1	µg/filter		**39**	**37**	**38**	**17**	**17**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	001812 Triangle Flat	003873 Triangle Flat	003874 Triangle Flat	003989 Meribah	003907 Meribah
			Sampling date / time	25-Dec-2020 00:00	31-Dec-2020 00:00	06-Jan-2021 00:00	26-Oct-2020 00:00	01-Nov-2020 00:00
Compound	CAS Number	LOR	Unit	CA2100247-011	CA2100247-012	CA2100247-013	CA2100247-014	CA2100247-015
				Result	Result	Result	Result	Result
EG005CA: Total Metals by ICP-OES								
ø Iron	7439-89-6	1	µg/filter	167	117	200	69	94
EG020CA: Total Metals by ICP-MS								
ø Aluminium	7429-90-5	1	µg/filter	1170	1130	1080	803	788
ø Antimony	7440-36-0	1	µg/filter	<1	<1	<1	1	<1
ø Arsenic	7440-38-2	1	µg/filter	<1	<1	<1	<1	<1
ø Barium	7440-39-3	1	µg/filter	48	19	18	16	16
ø Beryllium	7440-41-7	1	µg/filter	<1	<1	<1	<1	<1
ø Cadmium	7440-43-9	1	µg/filter	<1	<1	<1	<1	<1
ø Chromium	7440-47-3	1	µg/filter	4	4	4	3	3
ø Cobalt	7440-48-4	1	µg/filter	<1	<1	<1	<1	<1
ø Copper	7440-50-8	1	µg/filter	8	8	13	6	6
ø Lead	7439-92-1	1	µg/filter	1	<1	<1	<1	<1
ø Manganese	7439-96-5	1	µg/filter	6	4	5	3	3
ø Molybdenum	7439-98-7	1	µg/filter	<1	<1	<1	<1	<1
ø Nickel	7440-02-0	1	µg/filter	<1	<1	<1	<1	<1
ø Selenium	7782-49-2	1	µg/filter	<1	<1	<1	<1	<1
ø Silver	7440-22-4	1	µg/filter	<1	<1	<1	<1	<1
ø Tin	7440-31-5	1	µg/filter	<1	<1	<1	<1	<1
ø Mercury	7439-97-6	1	µg/filter	<1	<1	<1	<1	<1
ø Zinc	7440-66-6	1	µg/filter	37	16	19	29	16

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Sample ID	003908 Meribah	001805 Meribah	001813 Meribah	001807 Meribah	001810 Meribah
				Sampling date / time	07-Nov-2020 00:00	13-Nov-2020 00:00	19-Nov-2020 00:00	25-Nov-2020 00:00	01-Dec-2020 00:00
					CA2100247-016	CA2100247-017	CA2100247-018	CA2100247-019	CA2100247-020
					Result	Result	Result	Result	Result
EG005CA: Total Metals by ICP-OES									
ø **Iron**	7439-89-6	1	µg/filter		**216**	**293**	**624**	**244**	**789**
EG020CA: Total Metals by ICP-MS									
ø **Aluminium**	7429-90-5	1	µg/filter		**825**	**1180**	**1240**	**1160**	**1390**
ø **Antimony**	7440-36-0	1	µg/filter		<1	<1	<1	<1	<1
ø **Arsenic**	7440-38-2	1	µg/filter		<1	<1	<1	<1	<1
ø **Barium**	7440-39-3	1	µg/filter		**17**	**46**	**47**	**42**	**43**
ø **Beryllium**	7440-41-7	1	µg/filter		<1	<1	<1	<1	<1
ø **Cadmium**	7440-43-9	1	µg/filter		<1	<1	<1	<1	<1
ø **Chromium**	7440-47-3	1	µg/filter		**3**	**4**	**4**	**4**	**4**
ø **Cobalt**	7440-48-4	1	µg/filter		<1	<1	<1	<1	<1
ø **Copper**	7440-50-8	1	µg/filter		**10**	**13**	**8**	**10**	**11**
ø **Lead**	7439-92-1	1	µg/filter		<1	**1**	**1**	**1**	**2**
ø **Manganese**	7439-96-5	1	µg/filter		**5**	**9**	**14**	**6**	**22**
ø **Molybdenum**	7439-98-7	1	µg/filter		<1	<1	<1	<1	<1
ø **Nickel**	7440-02-0	1	µg/filter		<1	<1	<1	<1	**1**
ø **Selenium**	7782-49-2	1	µg/filter		<1	<1	<1	<1	<1
ø **Silver**	7440-22-4	1	µg/filter		<1	<1	<1	<1	<1
ø **Tin**	7440-31-5	1	µg/filter		<1	<1	<1	<1	<1
ø **Mercury**	7439-97-6	1	µg/filter		<1	<1	<1	<1	<1
ø **Zinc**	7440-66-6	1	µg/filter		**17**	**35**	**36**	**35**	**35**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	001811 Meribah	003900 Meribah	003899 Meribah	003898 Meribah	003897 Meribah
			Sampling date / time	07-Dec-2020 00:00	13-Dec-2020 00:00	19-Dec-2020 00:00	25-Dec-2020 00:00	31-Dec-2020 00:00
Compound	CAS Number	LOR	Unit	CA2100247-021	CA2100247-022	CA2100247-023	CA2100247-024	CA2100247-025
				Result	Result	Result	Result	Result
EG005CA: Total Metals by ICP-OES								
ø **Iron**	7439-89-6	1	µg/filter	**288**	**227**	**165**	**185**	**193**
EG020CA: Total Metals by ICP-MS								
ø **Aluminium**	7429-90-5	1	µg/filter	**1060**	**940**	**998**	**950**	**1160**
ø **Antimony**	7440-36-0	1	µg/filter	<1	<1	<1	<1	<1
ø **Arsenic**	7440-38-2	1	µg/filter	<1	<1	<1	<1	<1
ø **Barium**	7440-39-3	1	µg/filter	**38**	**16**	**16**	**16**	**18**
ø **Beryllium**	7440-41-7	1	µg/filter	<1	<1	<1	<1	<1
ø **Cadmium**	7440-43-9	1	µg/filter	<1	<1	<1	<1	<1
ø **Chromium**	7440-47-3	1	µg/filter	**4**	**3**	**3**	**3**	**4**
ø **Cobalt**	7440-48-4	1	µg/filter	<1	<1	<1	<1	<1
ø **Copper**	7440-50-8	1	µg/filter	**5**	**6**	**6**	**8**	**11**
ø **Lead**	7439-92-1	1	µg/filter	<1	<1	<1	<1	**1**
ø **Manganese**	7439-96-5	1	µg/filter	**9**	**6**	**6**	**5**	**6**
ø **Molybdenum**	7439-98-7	1	µg/filter	<1	<1	<1	<1	<1
ø **Nickel**	7440-02-0	1	µg/filter	<1	<1	<1	<1	<1
ø **Selenium**	7782-49-2	1	µg/filter	<1	<1	<1	<1	<1
ø **Silver**	7440-22-4	1	µg/filter	<1	<1	<1	<1	<1
ø **Tin**	7440-31-5	1	µg/filter	<1	<1	<1	<1	<1
ø **Mercury**	7439-97-6	1	µg/filter	<1	<1	<1	<1	<1
ø **Zinc**	7440-66-6	1	µg/filter	**31**	**14**	**19**	**15**	**19**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	003893 Meribah	----	----	----	----
				Sampling date / time	13-Oct-2020 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		CA2100247-026	--------	--------	--------	--------
					Result	----	----	----	----
EG005CA: Total Metals by ICP-OES									
ø **Iron**	7439-89-6	1	µg/filter		**222**	----	----	----	----
EG020CA: Total Metals by ICP-MS									
ø **Aluminium**	7429-90-5	1	µg/filter		**973**	----	----	----	----
ø **Antimony**	7440-36-0	1	µg/filter		<1	----	----	----	----
ø **Arsenic**	7440-38-2	1	µg/filter		<1	----	----	----	----
ø **Barium**	7440-39-3	1	µg/filter		**16**	----	----	----	----
ø **Beryllium**	7440-41-7	1	µg/filter		<1	----	----	----	----
ø **Cadmium**	7440-43-9	1	µg/filter		<1	----	----	----	----
ø **Chromium**	7440-47-3	1	µg/filter		**3**	----	----	----	----
ø **Cobalt**	7440-48-4	1	µg/filter		<1	----	----	----	----
ø **Copper**	7440-50-8	1	µg/filter		**12**	----	----	----	----
ø **Lead**	7439-92-1	1	µg/filter		<1	----	----	----	----
ø **Manganese**	7439-96-5	1	µg/filter		**5**	----	----	----	----
ø **Molybdenum**	7439-98-7	1	µg/filter		<1	----	----	----	----
ø **Nickel**	7440-02-0	1	µg/filter		<1	----	----	----	----
ø **Selenium**	7782-49-2	1	µg/filter		<1	----	----	----	----
ø **Silver**	7440-22-4	1	µg/filter		<1	----	----	----	----
ø **Tin**	7440-31-5	1	µg/filter		<1	----	----	----	----
ø **Mercury**	7439-97-6	1	µg/filter		<1	----	----	----	----
ø **Zinc**	7440-66-6	1	µg/filter		**18**	----	----	----	----

Appendix G. RCA Australia certificates of analysis

THIS DOCUMENT MAY NOT BE REPRODUCED EXCEPT IN FULL

Robert Carr & Associates Pty Ltd Trading as RCA Laboratories – Environmental
92 Hill Street PO Box 175, Carrington NSW 2294
ABN 53 063 515 711 Ph 02 4902 9200 – Fax 02 4902 9299
Email: administrator@rca.com.au Web www.rca.com.au

NATA Accredited Laboratory 9811
Corporate Site Number 18077
Accredited for compliance with ISO/IEC 17025-Testing

28/08/2020

Newcrest – Cadia Hill Gold Mine
C/- Post Office
South Orange NSW 2800

Attention : Tim Wigley

CERTIFICATE OF ANALYSIS – GRAVIMETRIC ANALYSIS OF DUST ON FILTERS

Report 15083-701/0

Client order number

Site location Woodville,
The Pines Bundarra

Type of samples Membrane filters

Date received 26/08/2020

ANALYSIS METHOD

Gravimetric analysis is undertaken in accordance with the Australian Standard AS/NZS 3650.9.9-2017 Determination of suspended particulate matter –PM10 low volume sampler gravimetric method, as per RCA Laboratories Method ENV-LAB120 All sampling and site work has been undertaken by the Client Analytical procedures and results reported in this report have been conducted by RCA Laboratories' staff.

RESULTS

Laboratory Sample No.	Date Sampled	Filter No.	Pre –Weight (mg)	Post-Weight (mg)	Airborne Concentration (mg / filter)
082015083001	16/07/2020 - 17/07/2020	PVC 07-20-01	14.887	14.887	0.000
082015083002	16/07/2020 – 17/07/2020	PVC 07-20-08	14.730	14.748	0.018
082015083003	16/07/2020 – 17/07/2020	PVC 07-20-05	16.423	16.427	0.004
082015083004	28/07/2020 – 29/07/2020	PVC 07-20-04	14.841	14.849	0.008
082015083005	28/07/2020 – 29/07/2020	PVC 07-20-12	14.829	14.850	0.021
082015083006	28/07/2020 – 29/07/2020	PVC 07-20-06	15.545	15.549	0.004
082015083007	9/08/2020 – 10/08/2020	PVC 07-20-10	15.269	15.269	0.000
082015083008	9/08/2020 – 10/08/2020	PVC 07-20-03	15.623	15.623	0.000
082015083009	9/08/2020 – 10/08/2020	PVC 07-20-02	15.520	15.452	0.032
082015083010	Blank	BLK 1	15.499	15.499	0.000
082015083011	Blank	BLK 2	15.104	15.103	0.001

Lab blanks withing ±20µg

Please contact the undersigned if you have any queries.

Yours sincerely

Laura Schofield
Environmental Laboratory Manager
Robert Carr & Associates Pty Ltd Trading as
RCA Laboratories – Environmental

Dr Neena Tewari
Senior Environmental Microbiologist
Robert Carr & Associates Pty Ltd Trading as
RCA Laboratories – Environmental

Robert Carr & Associates Pty Ltd Trading as RCA Laboratories – Environmental
92 Hill Street PO Box 175, Carrington NSW 2294
ABN 53 063 515 711 Ph 02 4902 9200 – Fax 02 4902 9299
Email: administrator@rca.com.au Web www.rca.com.au

NATA Accredited Laboratory 9811
Corporate Site Number 18077
Accredited for compliance with ISO/IEC 17025-Testing

22/09/2020

Newcrest – Cadia Hill Gold Mine
C/- Post Office
South Orange NSW 2800

Attention : Tim Wigley

CERTIFICATE OF ANALYSIS – GRAVIMETRIC ANALYSIS OF DUST ON FILTERS

Report 15083-702/0

Client order number		**Site location**	Woodville, The Pines Bundarra
Type of samples	Membrane filters	**Date received**	9/09/2020

ANALYSIS METHOD

Gravimetric analysis is undertaken in accordance with the Australian Standard AS/NZS 3650.9.9-2017 Determination of suspended particulate matter –PM10 low volume sampler gravimetric method, as per RCA Laboratories Method ENV-LAB120 All sampling and site work has been undertaken by the Client Analytical procedures and results reported in this report have been conducted by RCA Laboratories' staff.

RESULTS

Laboratory Sample No.	Date Sampled	Filter No.	Pre –Weight (mg)	Post-Weight (mg)	Airborne Concentration (mg / filter)
092015083001	18/08/2020 – 31/08/2020	PVC 07-20-15	15.811	16.600	0.789
092015083002	18/08/2020 – 31/08/2020	PVC 07-20-11	15.838	17.381	1.543
0982015083003	18/08/2020 – 31/08/2020	PVC 07-20-07	16.139	16.716	0.577

Please contact the undersigned if you have any queries.

Yours sincerely

Laura Schofield
Environmental Laboratory Manager
Robert Carr & Associates Pty Ltd Trading as
RCA Laboratories – Environmental

Dr Neena Tewari
Senior Environmental Microbiologist
Robert Carr & Associates Pty Ltd Trading as
RCA Laboratories – Environmental

Robert Carr & Associates Pty Ltd Trading as RCA Laboratories – Environmental
92 Hill Street PO Box 175, Carrington NSW 2294
ABN 53 063 515 711 Ph 02 4902 9200 – Fax 02 4902 9299
Email: administrator@rca.com.au Web www.rca.com.au

NATA Accredited Laboratory 9811
Corporate Site Number 18077
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21/01/2021

Newcrest – Cadia Hill Gold Mine
C/- Post Office
South Orange NSW 2800

Attention : Tim Wigley

CERTIFICATE OF ANALYSIS – GRAVIMETRIC ANALYSIS OF DUST ON FILTERS

Report 15083-703/0

Client order number

Site location Woodville,
The Pines Bundarra

Type of samples Membrane filters

Date received 17/12/2020

ANALYSIS METHOD

Gravimetric analysis is undertaken in accordance with the Australian Standard AS/NZS 3650.9.9-2017 Determination of suspended particulate matter –PM10 low volume sampler gravimetric method, as per RCA Laboratories Method ENV-LAB120 All sampling and site work has been undertaken by the Client Analytical procedures and results reported in this report have been conducted by RCA Laboratories' staff.

RESULTS

Laboratory Sample No.	Date Sampled	Filter No.	Pre –Weight (mg)	Post-Weight (mg)	Airborne Concentration (mg / filter)
122015083001	31/08/2020 13:29 – 11/09/2020 13:35	PVC 07-20-14	15.478	15.733	0.255
122015083002	31/08/2020 14:09 – 11/09/2020 12:17	PVC 07-20-13	16.103	16.815	0.712
122015083003	3/08/2020 15:21 – 14/09/2020 13:17	PVC 07-20-09	16.634	17.587	0.953
122015083004	11/09/2020 12:20 – 23/09/2020 10:17	PVC 07-20-25	15.225	15.933	0.708
122015083005	11/09/2020 13:35 – 23/09/2020 12:10	PVC 07-20-16	14.961	15.043	0.082
122015083006	14/09/2020 103:21 – 23/09/2020 11:26	PVC 07-20-19	15.345	16.162	0.817
122015083007	23/09/2020 10:19 – 6/10/2020 10:30	PVC 07-20-27	15.394	15.903	0.509
122015083008	23/09/2020 11:29 – 6/10/2020 11:43	PVC 07-20-29	15.086	16.018	0.932
122015083009	6/10/2020 10:33 – 3/11/2020 9:04	PVC 07-20-26	15.777	17.184	1.407
122015083010	6/10/2020 11:47 – 3/11/2020 10:09	PVC 07-20-17	15.809	17.535	1.726

Robert Carr & Associates Pty Ltd Trading as RCA Laboratories – Environmental
92 Hill Street PO Box 175, Carrington NSW 2294
ABN 53 063 515 711 Ph 02 4902 9200 – Fax 02 4902 9299
Email: administrator@rca.com.au Web www.rca.com.au

NATA Accredited Laboratory 9811
Corporate Site Number 18077
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Laboratory Sample No.	Date Sampled	Filter No.	Pre –Weight (mg)	Post-Weight (mg)	Airborne Concentration (mg / filter)
122015083011	3/11/2020 9:07 – 15/12/2020 10:19	PVC 07-20-30	15.592	18.710	3.118
122015083012	3/11/2020 10:12 – 15/12/2020 10:43	PVC 07-20-18	15.772	20.783	5.011
122015083013	15/11/2020 13:57 – 15/12/2020 11:01	PVC 10-20-11	15.021	16.569	1.548

Note PVC 07-20-16 Comments logger off no power

Please contact the undersigned if you have any queries.

Yours sincerely

Laura Schofield
Environmental Laboratory Manager
Robert Carr & Associates Pty Ltd Trading as
RCA Laboratories – Environmental

Dr Neena Tewari
Senior Environmental Microbiologist
Robert Carr & Associates Pty Ltd Trading as
RCA Laboratories – Environmental

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 250503

Client Details

Client	RCA Australia
Attention	Laura Schofield
Address	PO Box 175, Carrington, NSW, 2294

Sample Details

Your Reference	**15053**
Number of Samples	4 Filter
Date samples received	04/09/2020
Date completed instructions received	04/09/2020

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	11/09/2020
Date of Issue	24/09/2020
Reissue Details	This report replaces R01 created on 24/09/2020 due to: result entry error

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Results Approved By
Nick Sarlamis, Inorganics Supervisor

Authorised By

Nancy Zhang, Laboratory Manager

Quartz in dust					
Our Reference		250503-1	250503-2	250503-3	250503-4
Your Reference	UNITS	PVC 07-20-08	PVC 07-20-12	PVC 07-20-2	Blank included
Type of sample		Filter	Filter	Filter	Filter
Date Sampled		16/7/20	28/7/20	9/8/20	-
Date prepared	-	17/09/2020	17/09/2020	17/09/2020	17/09/2020
Date analysed	-	17/09/2020	17/09/2020	17/09/2020	17/09/2020
a-Quartz on Filter	µg	<5	10	<5	<5
Cristobalite on Filter	µg	<10	<10	<10	<10

Method ID	Methodology Summary
DUST-004	Respirable Quartz (and/or Cristabolite) determined after ashing, redeposition and FTIR determination. The Quartz exposure standard is 50µg/m3, therefore where sampling follows MDHS 101 guidelines and at least 500L of air is sampled, this is equivalent to a dust weight of 25µg/filter. The estimated measurement uncertainty for the laboratory analysis of Quartz is 40% at 25µg at 95% confidence limit (i.e. statistically the true value lies between 15-35µg / filter (30 –70 µg/m3) at 95% confidence). The estimated measurement uncertainty was determined during method validation.

QUALITY CONTROL: Quartz in dust						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			10/09/2020	[NT]	[NT]	[NT]	[NT]	10/09/2020	[NT]
Date analysed	-			10/09/2020	[NT]	[NT]	[NT]	[NT]	10/09/2020	[NT]
a-Quartz on Filter	µg	5	DUST-004	<5	[NT]	[NT]	[NT]	[NT]	103	[NT]
Cristobalite on Filter	µg	10	DUST-004	<10	[NT]	[NT]	[NT]	[NT]	99	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

Report Comments

MPL report no. 250284

Envirolab Services (WA) Pty Ltd trading as MPL Laboratories
ABN 53 140 099 207
16-18 Hayden Court Myaree WA 6154
ph 08 9317 2505 fax 08 9317 4163
lab@mpl.com.au
www.mpl.com.au

CERTIFICATE OF ANALYSIS 250764

Client Details

Client	RCA Australia
Attention	Laura Schofield
Address	PO Box 175, CARRINGTON, NSW, 2294

Sample Details

Your Reference	**15083 - Orange**
Number of Samples	3 Filters
Date samples received	25/09/2020
Date completed instructions received	25/09/2020
Sampler Name	Not applicable for this job

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	05/10/2020
Date of Issue	06/10/2020

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Results Approved By
Michael Kubiak, Laboratory Manager

Authorised By

Michael Kubiak, Laboratory Manager

Quartz in Dust					
Our Reference			250764-1	250764-2	250764-3
Your Reference	UNITS	PQL	PVC-07-20-15	PVC-07-20-07	PVC-07-20-11
a-Quartz on Filter	µg	5	25	10	34
Cristobalite on Filter	µg	10	<20	<20	<20

Method ID	Methodology Summary
DUST-004	Airborne samples analysed according to AS 2985 for Respirable Dust or AS 3640 for Inhalable Dust . Sample results based on volume data supplied by client. Samples tested as received, *accreditation does not cover sampling.
DUST-004	Respirable Quartz determined after ashing, redeposition and FTIR determination. The Quartz exposure standard is 50µg/m3, therefore where sampling follows MDHS 101 guidelines and at least 500L of air is sampled, this is equivalent to a dust weight of 25µg/filter. The estimated measurement uncertainty for the laboratory analysis of Quartz is 40% at 25µg at 95% confidence limit (i.e. statistically the true value lies between 15-35µg / filter (30 –70µg/m3) at 95% confidence). The estimated measurement uncertainty was determined during method validation.

QUALITY CONTROL: Quartz in Dust					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
a-Quartz on Filter	µg	5	DUST-004	<5	[NT]	[NT]	[NT]	[NT]	101	[NT]
Cristobalite on Filter	µg	10	DUST-004	<10	[NT]	[NT]	[NT]	[NT]	115	[NT]

Result Definitions

DOL	Samples rejected due to particulate overload
RPF	Sample rejected due to pump failure
RFD	Sample rejected due to filter damage
RUD	Sample rejected due to uneven deposition
PQL	Practical quantitation limit

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

Report Comments

Crystoballite pql raised due to spectrum interferences.

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 260401

Client Details

Client	RCA Australia
Attention	Laura Schofield
Address	PO Box 175, Carrington, NSW, 2294

Sample Details

Your Reference	**15083, Orange**
Number of Samples	13 Filter
Date samples received	28/01/2021
Date completed instructions received	28/01/2021

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	04/02/2021
Date of Issue	04/02/2021

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Results Approved By
Diego Bigolin, Team Leader, Inorganics

Authorised By

Nancy Zhang, Laboratory Manager

Quartz in dust						
Our Reference		260401-1	260401-2	260401-3	260401-4	260401-5
Your Reference	UNITS	PVC 07-20-14	PVC 07-20-13	PVC 07-20-09	PVC 07-20-25	PVC 07-20-16
Type of sample		Filter	Filter	Filter	Filter	Filter
Date Sampled		31/08/2020	31/08/2020	31/08/2020	11/09/2020	11/09/2020
Date prepared	-	01/02/2021	01/02/2021	01/02/2021	01/02/2021	01/02/2021
Date analysed	-	02/02/2021	02/02/2021	02/02/2021	02/02/2021	02/02/2021
a-Quartz on Filter	µg	10	30	30	40	<5
Cristobalite on Filter	µg	<10	<10	<10	<10	<10

Quartz in dust						
Our Reference		260401-6	260401-7	260401-8	260401-9	260401-10
Your Reference	UNITS	PVC 07-20-19	PVC 07-20-27	PVC 07-20-29	PVC 07-20-26	PVC 07-20-17
Type of sample		Filter	Filter	Filter	Filter	Filter
Date Sampled		14/09/2020	23/09/2020	23/09/2020	6/10/2020	6/10/2020
Date prepared	-	01/02/2021	01/02/2021	01/02/2021	01/02/2021	01/02/2021
Date analysed	-	02/02/2021	02/02/2021	02/02/2021	02/02/2021	02/02/2021
a-Quartz on Filter	µg	40	20	40	30	80
Cristobalite on Filter	µg	<10	<10	<10	<10	<10

Quartz in dust				
Our Reference		260401-11	260401-12	260401-13
Your Reference	UNITS	PVC 07-20-30	PVC 07-20-18	PVC 10-20-11
Type of sample		Filter	Filter	Filter
Date Sampled		3/11/2020	3/11/2020	15/11/2020
Date prepared	-	01/02/2021	01/02/2021	01/02/2021
Date analysed	-	02/02/2021	02/02/2021	02/02/2021
a-Quartz on Filter	µg	160	280	130
Cristobalite on Filter	µg	<10	<10	<10

Method ID	Methodology Summary
DUST-004	Respirable Quartz (and/or Cristabolite) determined after ashing, redeposition and FTIR determination. The Quartz exposure standard is 50µg/m3, therefore where sampling follows MDHS 101 guidelines and at least 500L of air is sampled, this is equivalent to a dust weight of 25µg/filter. The estimated measurement uncertainty for the laboratory analysis of Quartz is 40% at 25µg at 95% confidence limit (i.e. statistically the true value lies between 15-35µg / filter (30 –70 µg/m3) at 95% confidence). The estimated measurement uncertainty was determined during method validation.

QUALITY CONTROL: Quartz in dust						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			01/02/2021	[NT]	[NT]	[NT]	[NT]	01/02/2021	[NT]
Date analysed	-			02/02/2021	[NT]	[NT]	[NT]	[NT]	02/02/2021	[NT]
a-Quartz on Filter	µg	5	DUST-004	<5	[NT]	[NT]	[NT]	[NT]	103	[NT]
Cristobalite on Filter	µg	10	DUST-004	<10	[NT]	[NT]	[NT]	[NT]	110	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

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Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
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The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

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Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

Glossary of terms and abbreviations

aerodynamic diameter	the diameter of a hypothetical sphere of density 1 g/cm^3 having the same terminal settling velocity in calm air as the particle in question, regardless of its geometric size, shape and true density
aesthetic guideline	a value, which is the concentration or measure of a water quality characteristic that is associated with acceptability of water to the consumer; for example, appearance, taste and odour
ALS	Australian Laboratory Services
ambient air	the air in the general outdoors atmosphere
ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ASLP	Australian Standard Leachate Procedure
Australian Drinking Water Guidelines	NHMRC, NRMMC (2011) *Australian Drinking Water Guidelines Paper 6 National Water Quality Management Strategy*, version 3.6, updated March 2021, National Health and Medical Research Council, National Resource Management Ministerial Council, Commonwealth of Australia, Canberra.
CLP	Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006.
coarse particulate matter	see $PM_{10-2.5}$
crustal dust	dust generated from materials derived from the earth's crust
CVO	Cadia Valley Operations
DDG	dust deposition gauge
deposited dust	airborne particulate matter that settles out of the air under the influence of gravity
dust deposition	the process of airborne particulate matter settling out of the air under the influence of gravity
EC	European Commission
EPA Victoria	Environmental Protection Authority Victoria
EU	European Union
fine particulate matter	see $PM_{2.5}$, but may also sometimes mean PM_{10}
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
health-based guideline	a value, which is the concentration or measure of a water quality characteristic that, based on present knowledge, does not result in any significant risk to the health of the consumer over a lifetime of consumption
HSE	health, safety and environment
HVAS	high volume air sampler or sampling
IARC	International Agency for Research on Cancer
IMA - Europe	Industrial Minerals Association – Europe
Livestock Drinking Water Guidelines	*Australian and New Zealand guidelines for fresh and marine water quality. Volume 1: The guidelines*, ANZECC and ARMCANZ, October 2000, Canberra.

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LOD	limit of detection
LOR	limit of reporting
LVAS	low volume air sampler or sampling
MeClas	A web-based tool used to generate toxicity hazard categories and corresponding classification and labelling information of inorganic metal-containing complex materials such as ores, concentrates, intermediates or alloys using the GHS/CLP rules.
MOE	Ontario Ministry of Environment
NAG	net acid generation
NEPM	National Environment Protection (Ambient Air Quality) Measure
NHMRC	National Health and Medical Research Council
NRMMC	National Resource Management Ministerial Council
NSW EPA	New South Wales Environment Protection Authority
NTSF	Northern Tailings Storage Facility
Ontario MOE	Ontario Ministry of Environment
p.	page
$PM_{0.1}$	particulate matter less than 0.1 micrometres in aerodynamic diameter (often referred to as the ultrafine fraction or ultrafine particulate matter)
PM_{10}	particulate matter less than 10 micrometres in aerodynamic diameter
$PM_{10-2.5}$	particulate matter between 2.5 and 10 micrometres in aerodynamic diameter (often referred to as the coarse fraction or coarse particulate matter)
$PM_{2.5}$	particulate matter less than 2.5 micrometres in aerodynamic diameter (often referred to as the fine fraction or fine particulate matter)
pp.	pages
PTSF	Open Pit Tailings Storage Facility
QUT	Queensland University of Technology
RCS	respirable crystalline silica
STOT-RE	Specific Target Organ Toxicity - Repeated Exposure
STSF	Southern Tailings Storage Facility
Study	Cadia Tailings Dust Monitoring and Assessment Project
TEOM	Tapered Element Oscillating Microbalance
TSP	total suspended particulate
ultrafine particulate matter	see $PM_{0.1}$
USEPA	United States Environmental Protection Agency
WHO	World Health Organization
XRD	X-ray diffraction analysis

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Units of measure

g/cm^3	grams per cubic centimetre
g/m^2/month	grams per square metre per month
L/min	litres per minute
m^3	cubic metre
mg/kg	milligrams per kilogram (same as ppm for solids)
mg/L	milligrams per litre (same as ppm for liquids)
micrometre	one thousandth of a metre
micron	see micrometre
pH	A figure expressing the acidity or alkalinity of a solution on a logarithmic scale on which 7 is neutral, lower values are more acid and higher values more alkaline. pH can range from 0 to 14.
ppm	parts per million (by volume for liquids – mg/L – and by weight for solids – mg/kg)
wt%	weight percent – the weight of the thing being measured present in every 100 grams of total material
µg	microgram
µg/m^3	micrograms per cubic metre
µS/cm	microsiemens per centimetre

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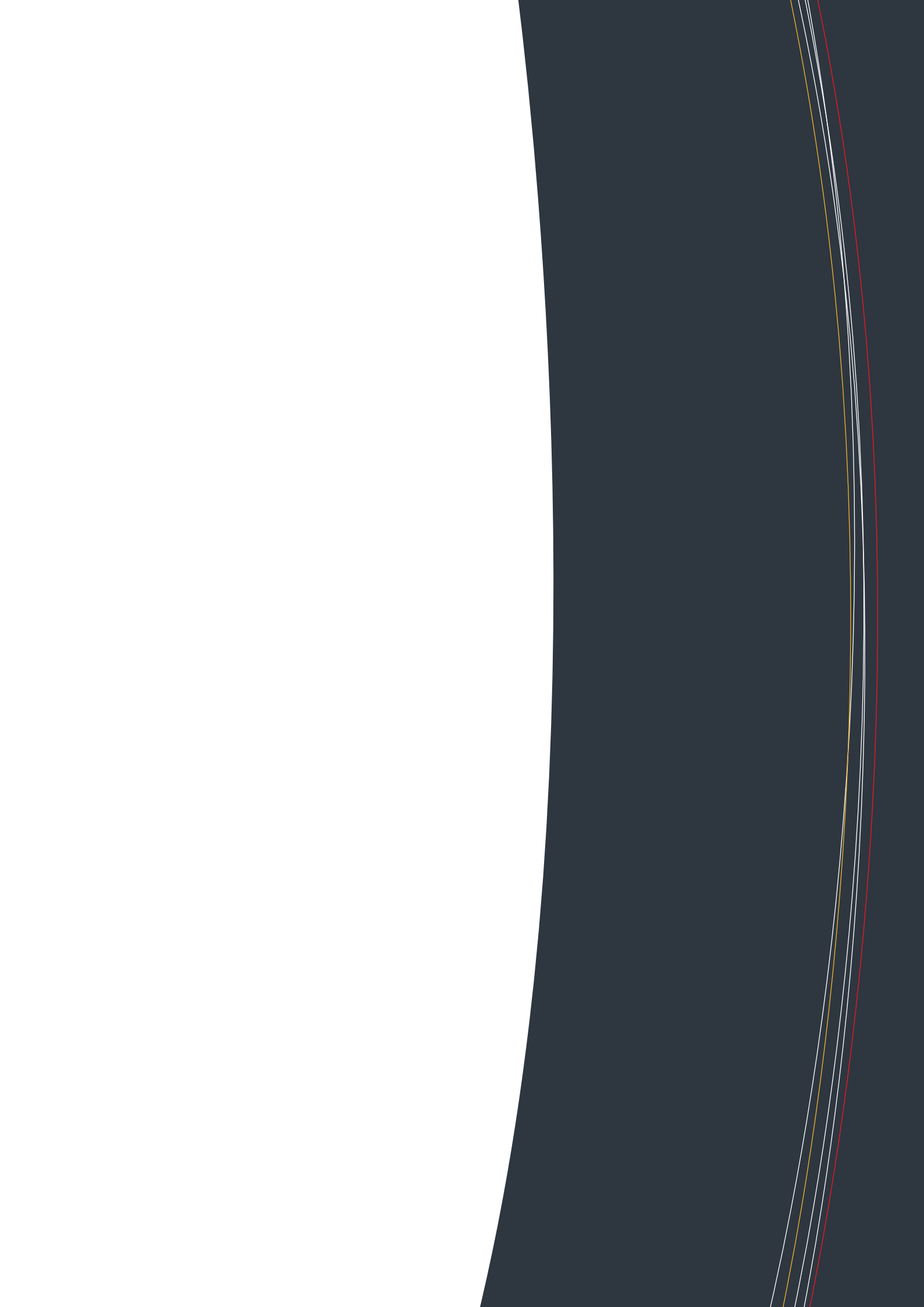

SERINUS
HEALTH SAFETY AND ENVIRONMENT

Serinus Pty Ltd
PO Box 2152
Brookside Centre Qld 4053
Australia

+61 439 892 893
+61 422 954 046

enquiries@serinushse.com.au

www.serinushse.com.au

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Newcrest Mining Ltd (Cadia)

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Prepared For

Newcrest Mining Ltd (Cadia)

Martin Englert, Environmental Specialist

Email: martin.englert@newcrest.com.au, Telephone: 02 6366 6326

Private Mail Bag South Orange NSW 2800

Prepared By

Advitech Pty Limited t/a **Advitech Environmental**

ABN: 29 003 433 458

Natasha Pegler, Acoustic Scientist

Email: natasha.pegler@advitech.com.au, Telephone: 02 4924 5400,

Facsimile: 02 4967 3772, Web: www.advitech.com.au, General Email: mail@advitech.com.au

7 Riverside Drive Mayfield West NSW 2304 PO Box 207 Mayfield NSW 2304

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Function	Signature	Name and Title	Date
Prepared by		Natasha Pegler Acoustic Scientist	2 Nov 2020
Checked by		Clayton Sparke (M.A.A.S) Environment Specialist (Acoustics)	2 Nov 2020
Authorised for Release by		Clayton Sparke (M.A.A.S) Environment Specialist (Acoustics)	2 Nov 2020

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EXECUTIVE SUMMARY

Advitech Pty Limited was engaged by Newcrest Mining to undertake attended noise monitoring at sensitive receivers adjacent to its Cadia Valley Operations (CVO). The objective of the monitoring was to evaluate compliance with the conditions of the CVO Project Approval (PA 06_0295) and Environment Protection Licence (EPL) No. 5590.

Operator attended noise monitoring was undertaken between 15 and 17 September, 2020, at fourteen locations adjacent to the Cadia Valley Operations (CVO), former Blayney Dewatering Facility (BDF) and the Cadia Dewatering Facility (CDF). Results indicate that measured noise levels associated with Newcrest activities were below the relevant criteria levels at all monitoring locations.

While noise generated by demolition, mining, and concentrate handling activities was observed to influence noise levels in several receiving environments, prevailing noise levels were controlled by extraneous (non-mining) noise sources in most cases. Analysis of operator attended monitoring results indicates that:

- mining and processing activities were audible at the Bonnie Glen, Northwest, and South Log monitoring locations adjacent to Cadia Valley mining operations;
  - CVO contributions were measured or evaluated at levels below the relevant noise criteria in all cases;
- the Blayney Dewatering Facility was demolished earlier in the year, and no noise sources were present on site;
- activities at the Cadia Dewatering Facility were audible at 247 Newbridge Rd and were largely inaudible at other nearby monitoring locations. Contributions were below all relevant noise criteria at all CDF monitoring locations.

Observed noise levels did not exceed the cumulative criteria at any monitoring location. Noise impacts were assessed to be compliant with both Project Specific and Cumulative noise impact criteria established in the CVO Project Approval (PA 06_0295) and Environment Protection Licence (EPL) No. 5590 at all monitoring locations.

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APPENDICES

Appendix I Calibration Certificates
Appendix II Detailed Monitoring Results

1. INTRODUCTION

Advitech Pty Limited (trading as Advitech Environmental) was engaged by Newcrest Mining to undertake operator attended noise monitoring at sensitive receivers adjacent to Cadia Valley Operations (Cadia). The objective of the monitoring was to evaluate compliance with the conditions of the CVO Project Approval (PA 06_0295 Mod13) and Environment Protection Licence (EPL) No. 5590.

It should be noted that this report was prepared by Advitech Pty Limited for Newcrest Mining Ltd (Cadia) ('the customer') in accordance with the scope of work and specific requirements agreed between Advitech and the customer. This report was prepared with background information, terms of reference and assumptions agreed with the customer. The report is not intended for use by any other individual or organisation and as such, Advitech will not accept liability for use of the information contained in this report, other than that which was intended at the time of writing.

1.1 Environmental Monitoring Programme

Attended noise monitoring is undertaken at fourteen locations adjacent to the Cadia Valley mining, Blayney Dewatering Facility and Cadia Dewatering Facility operations in accordance with provisions of the CVO Noise Monitoring Program (NMP). The Cadia Valley monitoring locations (shown in **Figure 1**) include:

- Rosebank;
- Chesterfield;
- Willow Creek;
- South Log;
- Bonnie Glen;
- Warrengong;
- Northwest.

The Blayney dewatering facility monitoring locations (shown in **Figure 2**) include:

- Blayney L1;
- Blayney L2;
- Blayney L3;
- Blayney L5.

The CVO dewatering facility monitoring locations (shown in **Figure 2**) include:

- Athol;
- Hollwood;
- 247 Newbridge Road (Ewens).

1.2 Mining Operations

During the monitoring period, CVO mining operations were comprised of the following activities:

- underground mining;
- surface movement of stockpiled material;
- operation of an ore treatment facility;
- operation of tailings dams;
- progressive rehabilitation of the South Waste Rock Dump;
- operation and maintenance of ancillary plant and infrastructure; and
- dewatering and loading of concentrate for rail transportation at the CVO Dewatering Facility.

The general arrangement of CVO workings and infrastructure are provided in **Figure 1** and **Figure 2.**

Figure 1: Cadia Valley Monitoring Locations

Figure 2: Blayney and Cadia Dewatering Facility monitoring locations

1.3 Statutory Requirements

1.3.1 Noise Assessment Criteria

Table 1 and **Table 2** detail the noise criteria for each of the monitoring locations adjacent to CVO. These criteria are established in a Noise Monitoring Program (NMP), and address the conditions of:

- Project Approval (PA) 06_0295 (Mod13) issued by the NSW Department of Planning and Infrastructure (DoPI); and
- Environment Protection License (EPL) 5590 (dated 11 June, 2020) issued by the NSW Environment Protection Authority (EPA).

Table 1: Environmental noise limits for all privately owned land (dB(A)) (Cadia Valley)

Environment	Location	$L_{Aeq,15minute}$			$L_{Aeq,period}$			$L_{A1,1minute}$ (night)
		Day	Evening	Night	Day	Evening	Night	
Cadia Valley Operations	Chesterfield	43	38	35	50	45	40	45
	Willow Creek	43	38	35	50	45	40	45
	South Log	43	38	38	50	45	40	45
	Bonnie Glen	43	38	36	50	45	40	45
	Rosebank	43	38	36	50	45	40	45
	Northwest	43	38	38	50	45	40	45
	Warrengong	43	38	35	50	45	40	45

Table 2: Environmental noise limits for all privately owned land (dB(A)) (dewatering operations)

Environment	Location	$L_{Aeq,15minute}$			$L_{Aeq,period}$			$L_{A1,1minute}$ (night)
		Day	Evening	Night	Day	Evening	Night	
Blayney Dewatering Facility	Blayney L1	50	50	39	-	-	-	49
	Blayney L2	50	50	36	-	-	-	46
	Blayney L3	46	46	37	-	-	-	47
	Blayney L5	58	58	45	-	-	-	55
Cadia Dewatering Facility	Athol	38	38	35	-	-	-	45
	247 Newbridge Road	50	42	42	-	-	-	45
	Hollwood	43	35	35	50	45	40	45

1.3.2 Assessment Periods

Current approvals and management plans state that noise generated by the project is to be measured and evaluated in accordance with the relevant requirements and exemptions of the NSW Industrial Noise Policy (INP). The INP states:

- a day is defined as the period from 7am to 6pm Monday to Saturday, and 8am to 6pm Sundays and public holidays;
- an evening is defined as the period from 6pm to 10pm; and
- a night is defined as the period from 10pm to 7am Monday to Saturday, and 10pm to 8am Sundays and public holidays.

1.3.3 Monitoring Locations

The INP establishes that noise from the mine is to be measured at:

- the most affected point on, or within the residential boundary; or,
- at the most affected point within 30 metres of the dwelling where the dwelling is more than 30m from the boundary.

1.3.4 Meteorological Conditions

Condition 2 of the Project Approval notes that *"noise generated by the project is to be measured in accordance with the relevant procedures and exemptions (including meteorological conditions) of the NSW Industrial Noise Policy".* The INP identifies the following meteorological exemptions:

- wind speeds exceeding 3m/s (measured at 10m);
- temperature inversions greater than 3˚C / 100m; and
- rainfall.

On this basis, monitoring data observed when these conditions prevail would lead to their exclusion from any assessment of compliance.

1.4 Monitoring Objectives

This assessment relates to operational noise monitoring undertaken between 15 and 17 September 2020. The objective of the monitoring is to evaluate compliance with the conditions of the CVO Project Approval (PA 06_0295) and Environment Protection Licence (EPL) No. 5590.

2. METHODOLOGY

2.1 Operational Noise Monitoring

Operator attended noise monitoring was undertaken as a means of assessing the character of, and to identify the noise sources contributing to, measured noise levels at each of the monitoring locations. Attended noise monitoring was undertaken at each location for a period of 30 minutes (2 x 15 minute measurements):

- in accordance with the methodology established in *AS1055-2018: Acoustics - Description and measurement of environmental noise*;
- following guidance in the NSW Industrial Noise Policy (INP) and Noise Policy for Industry (NPfI);
- in accordance with *AS2659 - 1998: Guide to the use of sound measuring equipment - portable sound level meters*; and
- using equipment that satisfied the requirements of *AS1259 - 1990. Acoustics - Sound Level Meters*.

Details of operator attended monitoring equipment are provided in **Table 3.** A copy of calibration certificates are provided in **Appendix I**.

Table 3: Operator attended noise monitoring

Parameter	SLM
Sound Level Meter (SLM)	Svantek 971 / Svantek 958
SLM Serial Number	60686 / 20777
SLM Calibration Date	23/4/2020 / 24/7/2020
Field Calibrator	Svantek SV30A / Svantek SV35A
Field Calibrator Serial Number	7906 / 90218
Field Calibrator Calibration Date	24/7/2020 / 23/4/2020
Frequency Weighting(s),(Response), Units	A, C, Lin (Fast), dB SPL

Review of prevailing regional meteorology from the Ridgeway and Spring Hill (Orange Airport) monitoring stations was undertaken for the Cadia Valley and Blayney monitoring locations respectively. These monitoring data were reviewed to validate results in the context of INP and NPfI provisions.

2.2 Evaluating Operational Source Contributions

The noise criteria established in **Section 1.3.1** are assessable only in terms of the contribution from CVO noise sources, not total measured environmental noise. For the purposes of this assessment, extraneous noise is defined as noise contributed from any source that is not associated with CVO activities. In typical rural receiving environments, this may include:

- transportation noise (except that associated with train loading at the Blayney Dewatering Facility (BDF), CVO Dewatering Facility, or road traffic generated by Cadia Valley Operations);
- environmental noise, such as gusting wind, rustling leaves, birds, insects, frogs and livestock;
- domestic noise, such as barking dogs or loud music.

Several methods are available to exclude extraneous noise contributions or evaluate contributions from specific noise sources.

2.2.1 Exclusions Based on Operator Observation

Where contributions from extraneous noise sources are considered to influence measured noise levels, operator observations may be used to exclude discrete events, or identify alternate descriptors representative of noise contributions from the assessable noise source. These may include:

- exclusion of a portion of the measurement influenced by short term extraneous events (for example, the passage of a vehicle), allowing recalculation of results from remaining data; or
- use of the L_{A90} descriptor, where the character of the noise source under assessment is typically continuous, with little variation in level.

Alternative methods are available where extraneous sources cannot be reasonably excluded based on measurement descriptors or discrete events.

2.2.2 Band Pass Filters

Previous assessment of mining and quarrying developments indicates that noise emissions from these operations typically manifest in the low frequency end of the noise spectrum (<1000Hz). Application of band pass filtering is further supported by recent industry research (Parnell, 2015). Review of the CVO receiving environments indicates environmental noise measurements may be subject to significant (continuous) influence from extraneous sources across the full noise spectrum, including frogs (approximately 2000 to 3150Hz) and insect noise (approximately 3150 to 6300Hz).

Where multiple sources cannot be excluded on the basis of operator observations, and are found to contribute in different parts of the spectrum, a frequency band filter may be applied to isolate contributions from specific sources. The extent of band pass filtering is determined based on operator observations at the time of monitoring. Following application of a band pass filter, the $L_{Aeq\ (band\ pass)}$ noise level may be recalculated as a means of evaluating the contribution from mining operations.

3. RESULTS

3.1 Operational Noise Monitoring

Operator attended noise monitoring was undertaken at fourteen locations between 15 and 17 September, 2020. The objective was to measure noise levels at each of the monitoring locations, evaluate the contribution from Cadia noise sources and assess these contributions against the noise criteria relevant to each receiver location. Preliminary findings of the assessment indicate:

- mining and concentrate processing activities were audible at the Bonnie Glen, Northwest, and South Log receiver locations. Audible contributions were not observed at other locations in the monitoring network;
- no audible contributions were observed from the Blayney Dewatering Facility;
- operation of the Cadia Dewatering Facility (CDF) was audible at 247 Newbridge Rd and was largely inaudible at other nearby monitoring locations.

Monitoring data indicates that total environmental noise levels (from all sources) did exceed the CVO criteria levels at several monitoring locations. Extraneous noise contributions were observed from a variety of sources, including:

- insects;
- bird noise;
- aircraft;
- livestock;
- windblown vegetation;
- trains;
- barking dogs;
- road traffic;
- domestic noise.

The characteristics of these sources (often continuous or affecting large portions of the measurement data) made it difficult to evaluate monitoring results based on discrete event contributions (for example, single car pass-by). Where feasible, application of alternative descriptors and band pass filters were used to evaluate CVO contributions.

3.2 Operator Attended Monitoring: Noise Impact Assessment Results

A summary of the results from attended noise monitoring in the receiving environments adjacent to mining and dewatering operations is provided in **Table 4** to **Table 6**. Results are provided for comparison against the relevant $L_{Aeq,15minute}$ noise criteria. Potential sleep disturbance impacts are evaluated against the highest observed $L_{A1,\ 1minute}$ noise level during each night period measurement, with relevant sources identified when this level is above the criteria.

Detailed assessment of monitoring results, including measured noise levels, and description of the ambient noise environment is provided in **Appendix II**. These results indicate that:

- mining activities were audible (but below the relevant noise criteria) at the Bonnie Glen, Northwest, and South Log receiver locations. Audible contributions were not observed at the Chesterfield, Rosebank, Warrengong, or Willow Creek monitoring locations;
  - measurements representative of Northwest were undertaken at a location approximately 500m from the dwelling, at the nearest publicly accessible boundary of the property, closest to the CVO. Levels at this location are likely to be marginally higher than equivalent levels at the dwelling (due to distance and topographical effects). Thus, where compliance can be demonstrated at the measurement location, it may be assumed at the dwelling location;
  - measurements representative of Chesterfield were undertaken at a location approximately 160 metres east of the residence at the nearest publicly accessible

boundary of the property. Noise immissions from the CVO may be lower at this position than at an appropriate location within 30 metres of the residence, as the residence is positioned on a hill. While it is possible that results at the monitoring location may be lower than at the residence (as the residence is located on a rise, and closer to the CVO), the inaudibility of any mining contribution at this location indicates compliance. Should mining noise have been observed at the monitoring location, the residence would have been subject to further assessment (within 30m of the dwelling) once access arrangements with the landowner were made.

  - measurements representative of Rosebank were undertaken at a location approximately 300 metres northwest of the property. While the monitoring location is slightly further away from the CVO than the residence, it is also positioned at a higher altitude, and would receive less shielding from the hill to the southeast of the residence. Levels at this location are likely to be marginally higher than equivalent levels at the dwelling. Thus, where compliance can be demonstrated at the measurement location, it may be assumed at the dwelling location;
  - emissions from the CVO were observed at Bonnie Glen, Northwest, and South Log at levels below 35dB(A). Noise from CVO was noted to potentially contain dominant low frequency characteristics. However, quantitative tests (Fact Sheet C of the NPfI) indicate a modifying factor was not warranted at any of the locations with CVO contributions;
  - tests for annoying noise characters (Fact Sheet C of the NPfI) indicated no tonal characters in measurements where CVO operations were audible;

- no activities were occurring at the Blayney Dewatering Facility, and no audible contributions were observed at L1, L2, L3, or L5.
- operations at the CDF were audible at the Athol, Hollwood, and 247 Newbridge Rd monitoring locations but were assessed to be below the relevant NIAC;
  - a train idling at the CDF was audible throughout the daytime measurements at 247 Newbridge Rd and Hollwood. Noise from the train was the main contributor to the L_{A90} sound descriptors;
  - emissions from the CDF were observed at the Athol and Hollwood monitoring locations as noise events with impulse-like characteristics, likely from impact noise caused by container handling. Contributions were determined to be below the $L_{Aeq,15min}$ criteria in all cases. Events observed during the night (at the Athol location) did not exceed the $L_{A1,1min}$ criterion.

Observed noise levels did not exceed the cumulative criteria at any monitoring location. Noise impacts were assessed to be compliant with both Project Specific and Cumulative noise impact criteria established in the CVO Project Approval (PA 06_0295) and Environment Protection Licence (EPL) No. 5590 at all monitoring locations.

Table 4 : Cadia Valley Operations summary of monitoring results, dB(A)

Location	Period	CVO Contribution (L_{Aeq}) Mes1	CVO Contribution (L_{Aeq}) Mes2	$L_{A1, 1min}$ Source	Criteria	Compliance Assessment
Bonnie Glen	Day $L_{Aeq, 15min}$	Inaudible	Inaudible		43	Compliant
	Evening $L_{Aeq, 15min}$	Inaudible	Inaudible		38	
	Night $L_{Aeq, 15min}$	Inaudible	31[3]		36	
	$L_{A1, 1min}$	45	51	Livestock	45	
Rosebank[2]	Day $L_{Aeq, 15min}$	Inaudible	Inaudible		43	Compliant
	Evening $L_{Aeq, 15min}$	Inaudible	Inaudible		38	
	Night $L_{Aeq, 15min}$	Inaudible	Inaudible		36	
	$L_{A1, 1min}$	53	47	Aircraft	45	
Warrengong	Day $L_{Aeq, 15min}$	Inaudible	Inaudible		43	Compliant
	Evening $L_{Aeq, 15min}$	Inaudible	Inaudible		38	
	Night $L_{Aeq, 15min}$	Inaudible	Inaudible		35	
	$L_{A1, 1min}$	38	44	Wind	45	
South Log	Day $L_{Aeq, 15min}$	Inaudible	Inaudible		43	Compliant
	Evening $L_{Aeq, 15min}$	32	36		38	
	Night $L_{Aeq, 15min}$	Inaudible	Inaudible		38	
	$L_{A1, 1min}$	58	62	Wind	45	
Northwest[2]	Day $L_{Aeq, 15min}$	Inaudible	Inaudible		43	Compliant
	Evening $L_{Aeq, 15min}$	33	34		38	
	Night $L_{Aeq, 15min}$	Inaudible	Inaudible		38	
	$L_{A1, 1min}$	51	60	Wind, Operator	45	
Willow Creek	Day $L_{Aeq, 15min}$	Inaudible	Inaudible		43	Compliant
	Evening $L_{Aeq, 15min}$	Inaudible	Inaudible		38	
	Night $L_{Aeq, 15min}$	Inaudible	Inaudible		35	
	$L_{A1, 1min}$	56	59	Wind	45	
Chesterfield[2]	Day $L_{Aeq, 15min}$	Inaudible	Inaudible		43	Compliant
	Evening $L_{Aeq, 15min}$	Inaudible	Inaudible		38	
	Night $L_{Aeq, 15min}$	Inaudible	Inaudible		35	
	$L_{A1, 1min}$	49	53	Livestock, Aircraft	45	

Note 1: L_{A1} level equivalent to or less than the criteria, no further assessment undertaken.

Note 2: Monitoring was undertaken at a position not representative of the property in accordance with the INP. See **Section 3.2** for more information.

Note 3: The effect of ambient noise could not be fully isolated from site noise. The value presented is an absolute upper limit of the CVO contribution.

Table 5 : Blayney Dewatering Facility summary of monitoring results, dB(A)

Location	Period	CVO Contribution Mes1	CVO Contribution Mes2	$L_{A1, 1min}$ Source	Criteria	Compliance Assessment
L1	Day $L_{Aeq, 15min}$	Inaudible	Inaudible		50	Compliant
	Evening $L_{Aeq, 15min}$	Inaudible	Inaudible		50	
	Night $L_{Aeq, 15min}$	Inaudible	Inaudible		39	
	$L_{A1, 1min}$	49	50	Road traffic	49	
L2	Day $L_{Aeq, 15min}$	Inaudible	Inaudible		50	Compliant
	Evening $L_{Aeq, 15min}$	Inaudible	Inaudible		50	
	Night $L_{Aeq, 15min}$	Inaudible	Inaudible		36	
	$L_{A1, 1min}$	49	48	Road traffic	46	
L3	Day $L_{Aeq, 15min}$	Inaudible	Inaudible		46	Compliant
	Evening $L_{Aeq, 15min}$	Inaudible	Inaudible		46	
	Night $L_{Aeq, 15min}$	Inaudible	Inaudible		37	
	$L_{A1, 1min}$	47	57	Train/Road traffic	47	
L5	Day $L_{Aeq, 15min}$	Inaudible	Inaudible		58	Compliant
	Evening $L_{Aeq, 15min}$	Inaudible	Inaudible		58	
	Night $L_{Aeq, 15min}$	Inaudible	Inaudible		45	
	$L_{A1, 1min}$	52	48	Road traffic	55	

Note 1: $L_{A1, 1minute}$ level equivalent to or less than the criteria, no further assessment undertaken.

Table 6 : Cadia Dewatering Facility summary of monitoring results, dB(A)

Location	Period	CVO Contribution Mes1	CVO Contribution Mes2	$L_{A1, 1min}$ Source	Criteria	Compliance Assessment
247 Newbridge Road	Day $L_{Aeq, 15min}$	36	34		50	Compliant
	Evening $L_{Aeq, 15min}$	34	34		42	
	Night $L_{Aeq, 15min}$	21	Inaudible		42	
	$L_{A1, 1min}$	48	43	Road traffic/Livestock	45	
Hollwood	Day $L_{Aeq, 15min}$	33	34		43	Compliant
	Evening $L_{Aeq, 15min}$	Inaudible	Inaudible		35	
	Night $L_{Aeq, 15min}$	Inaudible	Inaudible		35	
	$L_{A1, 1min}$	55	53	Train/Road traffic	45	
Athol	Day $L_{Aeq, 15min}$	Inaudible	Inaudible		38	Compliant
	Evening $L_{Aeq, 15min}$	33	Inaudible		38	
	Night $L_{Aeq, 15min}$	Inaudible	32		35	
	$L_{A1, 1min}$	63	51	Train	45	

4. RECOMMENDATIONS AND CONCLUSIONS

Advitech Pty Limited was engaged by Newcrest Mining to undertake attended noise monitoring at sensitive receivers adjacent to its Cadia Valley Operations (CVO). The objective of the monitoring was to evaluate compliance with the conditions of the CVO Project Approval (PA 06_0295) and Environment Protection Licence (EPL) No. 5590.

Operator attended noise monitoring was undertaken between 15 and 17 September, 2020, at fourteen locations adjacent to the Cadia Valley Operations (CVO), Blayney Dewatering Facility (BDF) and the Cadia Dewatering Facility (CDF). Results indicate that measured noise levels (from all sources) were below the relevant criteria levels at all monitoring locations.

While noise generated by mining and concentrate handling activities was observed to influence noise levels in several receiving environments, prevailing noise levels were controlled by extraneous (non-mining) noise sources in most cases. Analysis of operator attended monitoring results indicates that:

- mining and processing activities were audible at the Bonnie Glen, Northwest, and South Log monitoring location adjacent to Cadia Valley mining operations;
  - CVO contributions were measured or evaluated at levels below the relevant noise criteria in all cases;
- noise associated with operation of the Blayney Dewatering Facility was inaudible at all monitoring locations;
- emissions from the Cadia Dewatering Facility were audible at 247 Newbridge Rd, Athol, and Hollwood. Contributions were below all relevant noise criteria at all CDF monitoring locations.

Observed noise levels did not exceed the cumulative criteria at any monitoring location. Noise impacts were assessed to be compliant with both Project Specific and Cumulative noise impact criteria established in the CVO Project Approval (PA 06_0295) and Environment Protection Licence (EPL) No. 5590 at all monitoring locations.

5. REFERENCES

The following information was used in the preparation of this report:

1. AS1055-2018: Acoustics – Description and measurement of environmental noise;
2. AS1259 – 1990. Acoustics – Sound Level Meters.
3. AS2659 – 1998: Guide to the use of sound measuring equipment – portable sound level meters.
4. AS 2706-1984: Numerical Values: Rounding and interpretation of limiting values.
5. Cadia Environmental Protection Licence (EPL) (5590)(dated 11 June, 2020).
6. Cadia Valley Operations Noise Monitoring Program (Version 4, dated June 2018).
7. Cadia Valley Operations Project Approval (06_0295) (Mod13).
8. EPA, 2000. NSW Industrial Noise Policy, NSW Environment Protection Agency, Sydney.
9. EPA, 2017. NSW Noise Policy for Industry, NSW Environment Protection Agency, Sydney.
10. Parnell, J (2015). Acoustic Signature of Open Cut Coal Mines, Acoustics 2015. Hunter Valley: Australian Acoustical Society.
11. Wilkinson Murray Pty Ltd (2009). Cadia East Project Noise and Blast Impact Assessment.

Appendix I Calibration Certificates

CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: SLM 26771 & FILT 5755

Equipment Description:	Sound & Vibration Analyser		
Manufacturer:	Svantek		
Model No:	Svan-971	**Serial No:**	60686
Microphone Type:	7052E	**Serial No:**	66701
Preamplifier Type:	SV18	**Serial No:**	62787
Filter Type:	1/3 Octave	**Serial No:**	60686
Comments:	All tests passed for class 1. (See over for details)		
Owner:	Advitech Pty Ltd 7 Riverside Drive Mayfield West NSW 2304		
Ambient Pressure:	1003 hPa ±1.5 hPa		
Temperature:	24 °C ±2° C	**Relative Humidity:**	39% ±5%
Date of Calibration:	23/04/2020	**Issue Date:**	23/04/2020

Acu-Vib Test Procedure: AVP10 (SLM) & AVP06 (Filters)

CHECKED BY: MB **AUTHORISED SIGNATURE:** Bruce Meldrum

Accredited for compliance with ISO/IEC 17025 - Calibration
The results of the tests, calibration and/or measurements included in this document are traceable to Australian/national standards.

NATA ACCREDITATION

Accredited Lab. No. 9262
Acoustic and Vibration Measurements

ACU-VIB ELECTRONICS
HEAD OFFICE
Unit 14, 22 Hudson Ave. Castle Hill NSW 2154
Tel: (02) 96808133 Fax: (02)96808233
Mobile: 0413 809606
web site: www.acu-vib.com.au

CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: SLM 27400 & FILT 5922

Equipment Description:	Sound & Vibration Analyser		
Manufacturer:	Svantek		
Model No:	Svan-958	**Serial No:**	20777
Microphone Type:	40AE	**Serial No:**	151134
Preamplifier Type:	SV12L	**Serial No:**	25683
Filter Type:	1/3 Octave	**Serial No:**	20777
Comments:	All tests passed for class 1. (See over for details)		
Owner:	Advitech Pty Ltd 7 Riverside Drive Mayfield West NSW 2304		
Ambient Pressure:	1014hPa ±1.5 hPa		
Temperature:	22 °C ±2° C	**Relative Humidity:**	42% ±5%
Date of Calibration:	24/07/2020	**Issue Date:**	24/07/2020
Acu-Vib Test Procedure:	AVP10 (SLM) & AVP06 (Filters)		

CHECKED BY: ..... **AUTHORISED SIGNATURE:** .....

Jack Rietz

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Measurements

ACU-VIB
ELECTRONICS

HEAD OFFICE
Unit 14, 22 Hudson Ave. Castle Hill NSW 2154
Tel: (02) 96836133 Fax: (02)96808233
Mobile: 0413 809805
web site: www.acu-vib.com.au

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CERTIFICATE OF CALIBRATION

CERTIFICATE NO: 26763

EQUIPMENT TESTED: Sound Level Calibrator

Manufacturer: Svantek
Type No: SV35A **Serial No:** 90218
Owner: Advitech Pty Ltd
7 Riverside Drive
Mayfield West NSW 2304

Tests Performed: Measured output pressure level was found to be:

Parameter	Pre-Adj	Adj Y/N	Output: (db re 20 µPa)	Frequency: (Hz)	THD&N (%)
Level 1:	NA	N	94.15	999.99	1.78
Level 2:	NA	N	114.16	999.99	0.40
Uncertainty:			±0.11 dB	±0.05%	±0.20 %
Uncertainty (at 95% c.l.) k=2					

CONDITION OF TEST:
Ambient Pressure: 1001 hPa ±1.5 hPa **Relative Humidity:** 45% ±5%
Temperature: 23 °C ±2° C
Date of Calibration: 22/04/2020 **Issue Date:** 23/04/2020
Acu-Vib Test Procedure: AVP02 (Calibrators)
Test Method: AS IEC 60942 - 2017
CHECKED BY: JKB **AUTHORISED SIGNATURE:** .....
Jack Kidd

Accredited for compliance with ISO/IEC 17025 - Calibration
The results of the tests, calibration and/or measurements included in this document are traceable to Australian/national standards.
The uncertainties quoted are calculated in accordance with the methods of the ISO Guide to the Uncertainty of Measurement and quoted at a coverage factor of 2 with a confidence interval of approximately 95%.

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Acoustic and Vibration Measurements

ACU-VIB
ELECTRONICS
HEAD OFFICE
Unit 14, 22 Hudson Ave. Castle Hill NSW 2154
Tel: (02) 98608133 Fax: (02)98836233
Mobile: 0413 809806
Web site: www.acu-vib.com.au

CERTIFICATE OF CALIBRATION

CERTIFICATE NO: 27404

EQUIPMENT TESTED: Sound Level Calibrator

Manufacturer: Svantek
Type No: SV-30A **Serial No:** 7906
Owner: Advitech Pty Ltd
7 Riverside Drive
Mayfield West NSW 2304

Tests Performed: Measured output pressure level was found to be:

Parameter	Pre-Adj	Adj Y/N	Output: (db re 20 µPa)	Frequency: (Hz)	THD&N (%)
Level 1:	NA	N	93.86	1000.00	2.51
Level 2:	NA	N	113.83	1000.04	0.45
Uncertainty:			±0.11 dB	±0.05%	±0.20 %
Uncertainty (at 95% c.l.) k=2					

CONDITION OF TEST:
Ambient Pressure: 1009 hPa ±1.5 hPa **Relative Humidity:** 39% ±5%
Temperature: 23°C ±2° C
Date of Calibration: 24/07/2020 **Issue Date:** 24/07/2020
Acu-Vib Test Procedure: AVP02 (Calibrators)
Test Method: AS IEC 60942 - 2017
CHECKED BY: JKJ **AUTHORISED SIGNATURE:** .....
Jack Kielt

Accredited for compliance with ISO/IEC 17025 - Calibration
The results of the tests, calibration and/or measurements included in this document are traceable to Australian/national standards.
The uncertainties quoted are calculated in accordance with the methods of the ISO Guide to the Uncertainty of Measurement and quoted at a coverage factor of 2 with a confidence interval of approximately 95%.

NATA ACCREDITATION

Accredited Lab. 9262
Acoustic and Vibration Measurements

ACU-VIB
ELECTRONICS
HEAD OFFICE
Unit 14, 22 Hudson Ave. Castle Hill NSW 2154
Tel: (02) 98808133 Fax: (02)96806233
Mobile: 0413 809806
Web site: www.acu-vib.com.au

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Appendix II Detailed Monitoring Results

AII.1 Assessment of Results – Blayney L1 (Blayney)

The L1 monitoring location noise environment was dominated by local traffic, bird calls and insect/frog noise. No BDF contributions were observed during all periods.

Table 7: L1 noise monitoring results, dB(A)

Period	Criteria	Date	Time	L_{Aeq}	L_{A90}	CVO Contribution	Description of Noise Environment	Local Weather	Regional Weather[2]
Day	50	15/9/20	12:18	44	30	n/a[1]	Birds, road traffic, barking dogs, lawnmower	Calm	4.4 m/s
		15/9/20	12:33	52	32	n/a[1]			
Evening	50	15/9/20	19:00	52	38	n/a[1]	Road traffic, barking dogs	Calm	2.5 m/s
		15/9/20	19:16	51	38	n/a[1]			
Night	39	15/9/20	22:00	44	34	n/a[1]	Distant road traffic, frogs	Calm	Calm
		15/9/20	22:16	41	36	n/a[1]			

Note 1: Site operations not audible during assessment.

Note 2: Prevailing meteorology assessed on basis of regional conditions in accordance with provisions of INP and Project Approval, as outlined in **Section 1.3.4**.

AII.2 Assessment of Results – L2 (Blayney)

The L2 monitoring location noise environment was dominated by local traffic, bird calls and barking dogs. No BDF contributions were observed during all periods.

Table 8 : L2 (Railway Ln, Blayney) noise monitoring results

Period	Criteria	Date	Time	L_{Aeq}	L_{A90}	CVO Contribution	Description of Noise Environment	Local Weather	Regional Weather[2]
Day	50	15/9/20	12:25	44	35	n/a[1]	Road traffic, birds, car door slam, lawnmower	1 m/s	4.4 m/s
		15/9/20	12:42	45	34	n/a[1]			
Evening	50	15/9/20	18:56	46	39	n/a[1]	Road traffic, insects, occasional barking dog	1-2 m/s	2.5 m/s
		15/9/20	19:12	44	38	n/a[1]			
Night	36	15/9/20	23:14	40	34	n/a[1]	Distant road traffic, insects, frogs, livestock	Calm	Calm
		15/9/20	23:31	39	33	n/a[1]			

Note 1: Site operations not audible during assessment.

Note 2: Prevailing meteorology assessed on basis of regional conditions in accordance with provisions of INP and Project Approval, as outlined in **Section 1.3.4**.

AII.3 Assessment of Results – L3 (Blayney)

The noise environment at this location consisted of road traffic, local industrial noise, and barking dogs. No BDF contributions were observed during all periods.

Table 9 : L3 (Hill Street, Blayney) noise monitoring results

Period	Criteria	Date	Time	L_{Aeq}	L_{A90}	CVO Contribution	Description of Noise Environment	Local Weather	Regional Weather[2]
Day	46	15/9/20	13:06	52	36	n/a[1]	Road traffic, train, schoolkids, industrial noise	<1 m/s	4.7 m/s
		15/9/20	13:21	52	43	n/a[1]			
Evening	46	15/9/20	19:35	50	39	n/a[1]	Road traffic, domestic noise	1-2 m/s	1.8 m/s
		15/9/20	19:57	44	38	n/a[1]			
Night	37	15/9/20	23:53	41	35	n/a[1]	Train passby, road traffic, insects, frogs	Calm	Calm
		16/9/20	0:09	47	34	n/a[1]			

Note 1: Site operations not audible during assessment.

Note 2: Prevailing meteorology assessed on basis of regional conditions in accordance with provisions of INP and Project Approval, as outlined in **Section 1.3.4**.

AII.4 Assessment of Results – L5 (Railway Lane Pre School)

Road traffic, windblown vegetation and birds were audible and characteristic of the noise environment at this location. No BDF contributions were observed during all periods.

Table 10 : L5 (Railway Lane Pre School, Blayney) noise monitoring results

Period	Criteria	Date	Time	L_{Aeq}	L_{A90}	CVO Contribution	Description of Noise Environment	Local Weather	Regional Weather[2]
Day	58	15/9/20	12:59	51	38	n/a[1]	Kids playing, occasional road noise	Calm	4.7 m/s
		15/9/20	13:15	50	39	n/a[1]			
Evening	58	15/9/20	19:16	47	34	n/a[1]	Distant road traffic, vehicle passbys, frogs	Calm	2.2 m/s
		15/9/20	19:39	39	34	n/a[1]			
Night	45	15/9/20	22:00	43	37	n/a[1]	Distant road traffic, barking dogs, insects	Calm	Calm
		15/9/20	22:16	40	35	n/a[1]			

Note 1: Site operations not audible during assessment.

Note 2: Prevailing meteorology assessed on basis of regional conditions in accordance with provisions of INP and Project Approval, as outlined in **Section 1.3.4**.

AII.5 Assessment of Results – Bonnie Glen

This noise environment is dominated by local environmental sources, including barking dogs, birds, windblown vegetation, livestock, domestic noise, and occasional road traffic noise. Mining operations at CVO were rarely audible at this monitoring location and were considered compliant for all time periods.

Table 11 : Bonnie Glen noise monitoring results

Period	Criteria	Date	Time	L_{Aeq}	L_{A90}	CVO Contribution	Description of Noise Environment	Local Weather	Regional Weather[2]
Day	**43**	17/9/20	9:32	50	44	n/a[1]	Wind in trees, birds, occasional barking dogs	1-3 m/s	10.0 m/s
		17/9/20	9:48	49	43	n/a[1]			
Evening	**38**	16/9/20	20:05	35	27	n/a[1]	Frogs, insects, barking dogs, passing vehicle	Calm	4.6 m/s
		16/9/20	20:22	43	27	n/a[1]			
Night	**36**	17/9/20	22:56	34	28	n/a[1]	Frogs, insects, wind in foliage; CVO vehicles rarely audible	>3 m/s	1.9 m/s
		17/9/20	23:13	42	30	31[3]			

Note 1: Mining operations not audible during assessment.

Note 2: Prevailing meteorology assessed on basis of regional conditions in accordance with provisions of INP and Project Approval, as outlined in **Section 1.3.4**.

Note 3: The effect of ambient noise could not be fully isolated from site noise. The value presented is an absolute upper limit of the CVO contribution.

AII.7 Assessment of Results – Warrengong

This receiving environment is characterised by local environmental sources including insects, birds, livestock and windblown vegetation. Contributions from mining operations at CVO were not audible at this monitoring location and were considered compliant for all time periods.

Table 12 : 346 Carbine Rd noise monitoring results

Period	Criteria	Date	Time	L_{Aeq}	L_{A90}	CVO Contribution	Description of Noise Environment	Local Weather	Regional Weather[2]
Day	**43**	17/9/20	9:57	50	42	n/a[1]	Birds, wind in foliage	2-3 m/s	6.5 m/s
		17/9/20	10:14	50	41	n/a[1]			
Evening	**38**	16/9/20	20:39	49	34	n/a[1]	Domestic noise, cattle, distant traffic, frogs	Calm	2.7 m/s
		16/9/20	20:55	35	33	n/a[1]			
Night	**35**	17/9/20	22:49	33	32	n/a[1]	Frogs, wind, ambient environmental noise	Calm	1.9 m/s
		17/9/20	23:04	35	32	n/a[1]			

Note 1: Mining operations not audible during assessment.

Note 2: Prevailing meteorology assessed on basis of regional conditions in accordance with provisions of INP and Project Approval, as outlined in **Section 1.3.4**.

AII.8 Assessment of Results – South Log

Monitoring at this location indicates the noise environment consists mainly of environmental noise sources including insects, birds, livestock and windblown vegetation. Contributions from mining operations at CVO were rarely audible at this monitoring location and were considered compliant for all time periods.

Table 13 : South Log noise monitoring results

Period	Criteria	Date	Time	L_{Aeq}	L_{A90}	CVO Contribution	Description of Noise Environment	Local Weather	Regional Weather[2]
Day	**43**	17/9/20	11:54	50	43	n/a[1]	Wind in foliage	2-3 m/s	5.7 m/s
		17/9/20	12:10	49	44	n/a[1]			
Evening	**38**	16/9/20	19:04	47	45	32	Frogs, CVO vehicles occasionally audible	Calm	3.8 m/s
		16/9/20	19:21	47	45	36			
Night	**38**	17/9/20	23:54	52	47	n/a[1]	Wind in foliage	>3 m/s	2.2 m/s
		18/9/20	0:10	56	50	n/a[1]			

Note 1: Mining operations not audible during assessment.

Note 2: Prevailing meteorology assessed on basis of regional conditions in accordance with provisions of INP and Project Approval, as outlined in **Section 1.3.4**.

AII.9 Assessment of Results – North West

Monitoring was conducted at the boundary of the property closest to the CVO. This location is approximately 500m from the dwelling, closer to the CVO and at a more (topographically) exposed location that the dwelling. Where compliance is demonstrated at this location, it is assumed at the dwelling. Audible noise sources at this monitoring location included environmental noise (windblown vegetation, and birds) and intermittent road traffic. Noise from mining activities at CVO was audible below the criteria at this location, and was considered compliant.

Table 14 : Northwest noise monitoring results

Period	Criteria	Date	Time	L_{Aeq}	L_{A90}	CVO Contribution	Description of Noise Environment	Local Weather	Regional Weather[2]
Day	**43**	17/9/20	8:19	54	42	n/a[1]	Wind in foliage, birds, occasional road traffic	2-3 m/s	11.6 m/s
		17/9/20	8:36	58	43	n/a[1]			
Evening	**38**	16/9/20	18:57	56	32	33	Frogs, wind blown vegetation, occasional road traffic, cattle; constant CVO low frequency noise	Calm	2.5 m/s
		16/9/20	19:07	54	32	34			
Night	**38**	18/9/20	0:39	43	39	n/a[1]	Wind in vegetation, insects	1-2 m/s	2.4 m/s
		18/9/20	0:54	55	41	n/a[1]			

Note [1]: Mining operations not audible during assessment.

Note 2: Prevailing meteorology assessed on basis of regional conditions in accordance with provisions of INP and Project Approval, as outlined in **Section 1.3.4**.

AII.10 Assessment of Results – Willow Creek

The noise environment at this location was dominated by environmental sources including windblown vegetation and livestock. Noise from mining activities at CVO was inaudible at this location, and was therefore considered compliant.

Table 15 : Willow Creek noise monitoring results

Period	Criteria	Date	Time	L_{Aeq}	L_{A90}	CVO Contribution	Description of Noise Environment	Local Weather	Regional Weather[2]
Day	**43**	17/9/20	9:09	64	56	n/a[1]	Wind in foliage	>3 m/s	10.9 m/s
		17/9/20	9:26	64	56	n/a[1]			
Evening	**38**	16/9/20	21:25	39	36	n/a[1]	Wind in foliage, cattle, distant road traffic, frogs, insects	2-3 m/s	4.6 m/s
		16/9/20	21:44	39	37	n/a[1]			
Night	**35**	17/9/20	23:49	51	47	n/a[1]	Wind in foliage	>3 m/s	2.2 m/s
		18/9/20	0:05	55	52	n/a[1]			

Note 1: Mining operations not audible during assessment.

Note 2: Prevailing meteorology assessed on basis of regional conditions in accordance with provisions of INP and Project Approval, as outlined in **Section 1.3.4**.

AII.11 Assessment of Results – Chesterfield

Monitoring was conducted at the nearest publicly accessible location. The monitoring location is approximately 160 metres east of the residence, and is at a less (topographically) exposed position. Noise levels experienced at the residence may be higher than those observed at the monitoring position. The noise environment at this location was characterised by environmental sources including windblown vegetation, insects, and livestock noise. Noise from mining activities at CVO was inaudible at this location, and was therefore considered compliant at the measurement position.

Table 16 : Chesterfield noise monitoring results

Period	Criteria	Date	Time	L_{Aeq}	L_{A90}	CVO Contribution	Description of Noise Environment	Local Weather	Regional Weather[2]
Day	**43**	17/9/20	11:57	48	42	n/a[1]	Wind in foliage, birds, aircraft	2-3 m/s	5.7 m/s
		17/9/20	12:08	46	41	n/a[1]			
Evening	**38**	16/9/20	19:52	45	42	n/a[1]	Frogs, aircraft, road noise	Calm	3.1 m/s
		16/9/20	20:07	46	43	n/a[1]			
Night	**35**	17/9/20	21:59	47	45	n/a[1]	Frogs, insects, cattle, distant aircraft	Calm	3.1 m/s
		17/9/20	22:15	48	45	n/a[1]			

Note 1: Mining operations not audible during assessment.

Note 2: Prevailing meteorology assessed on basis of regional conditions in accordance with provisions of INP and Project Approval, as outlined in **Section 1.3.4**.

AII.12 Assessment of Results – Rosebank

Monitoring was conducted at a position approximately 300 metres northwest of the residence. While slightly further away from the CVO than the residence, the monitoring location is a more (topographically) exposed location and experiences less shielding from the surrounding terrain. Where compliance is demonstrated at this location, it is assumed at the dwelling. The noise environment at this location was characterised by environmental noise sources including windblown vegetation, birds, insects, and livestock noise. Noise from mining activities at CVO was inaudible at this location, and was therefore considered compliant at the measurement position.

Table 17 : Rosebank noise monitoring results

Period	Criteria	Date	Time	L_{Aeq}	L_{A90}	CVO Contribution	Description of Noise Environment	Local Weather	Regional Weather[2]
Day	**43**	17/9/20	8:32	54	48	n/a[1]	Wind in foliage, occasional road traffic	<2 m/s	11.6 m/s
		17/9/20	8:48	55	49	n/a[1]			
Evening	**38**	16/9/20	19:04	40	27	n/a[1]	Insects, frogs, crickets, road traffic	Calm	3.8 m/s
		16/9/20	19:21	32	28	n/a[1]			
Night	**36**	17/9/20	22:09	37	27	n/a[1]	Frogs, road traffic, aircraft, trail bikes	Calm	2.6 m/s
		17/9/20	22:24	41	27	n/a[1]			

Note 1: Mining operations not audible during assessment.

Note 2: Prevailing meteorology assessed on basis of regional conditions in accordance with provisions of INP and Project Approval, as outlined in **Section 1.3.4**.

AII.13 Assessment of Results – 247 Newbridge Road

Background contributions from road traffic, gusting wind, and bird noise dominate noise environment at this monitoring location. Noise sources within the Cadia Dewatering Facility (CDF) were audible at this location, and were found to comply with the criteria during all measurements.

Table 18 : 247 Newbridge Road noise monitoring results

Period	Criteria	Date	Time	L_{Aeq}	L_{A90}	CVO Contribution	Description of Noise Environment	Local Weather	Regional Weather[2]
Day	50	15/9/20	14:25	56	36	36	Road traffic, train passby, idling train at CDF	Calm	1.5 m/s
		15/9/20	14:41	56	33	34			
Evening	42	15/9/20	21:05	48	43	34	Frogs, CDF impact noise	<2 m/s	0.8 m/s
		15/9/20	21:22	46	44	34			
Night	42	16/9/20	1:14	40	36	21[3]	Frogs, distant road traffic	Calm	Calm
		16/9/20	1:31	38	36	n/a[1]			

Note 1: Mining operations not audible during assessment.

Note 2: Prevailing meteorology assessed on basis of regional conditions in accordance with provisions of INP and Project Approval, as outlined in **Section 1.3.4**

Note 3: The effect of ambient noise could not be fully isolated from site noise. The value presented is an absolute upper limit of the CVO contribution.

AII.14 Assessment of Results – Hollwood

Background contributions from windblown vegetation, livestock and road traffic noise define the noise environment at this monitoring location. Noise sources within the Cadia Dewatering Facility (CDF) were audible at this location, and were found to comply with the criteria during all measurements.

Table 19 : Hollwood noise monitoring results

Period	Criteria	Date	Time	L_{Aeq}	L_{A90}	CVO Contribution	Description of Noise Environment	Local Weather	Regional Weather[2]
Day	**43**	15/9/20	14:09	41	33	33	Road noise, train, industrial noise, birds, train idling at CDF	2 m/s	1.5 m/s
		15/9/20	14:27	44	34	34			
Evening	**35**	15/9/20	20:25	39	36	n/a[1]	Insects, frogs, road traffic, sheep	1-2 m/s	1.7 m/s
		15/9/20	20:41	40	36	n/a[1]			
Night	**35**	16/9/20	0:40	45	36	n/a[1]	Frogs, train passby, sheep, distant road traffic	1-2 m/s	Calm
		16/9/20	0:56	40	37	n/a[1]			

Note 1: Mining operations not audible during assessment.

Note 2: Prevailing meteorology assessed on basis of regional conditions in accordance with provisions of INP and Project Approval, as outlined in **Section 1.3.4**

AII.15 Assessment of Results – Athol

Contributions from rustling vegetation, intermittent road traffic and bird noise typically control noise levels at this monitoring location. Activities associated with activities from nearby facility not associated with the CDF were audible during the day and night period. CDF contributions were just audible in the evening and night, and were found to comply with the criteria during all measurements.

Table 20 : Athol noise monitoring results

Period	Criteria	Date	Time	L_{Aeq}	L_{A90}	CVO Contribution	Description of Noise Environment	Local Weather	Regional Weather[2]
Day	38	15/9/20	13:42	53	31	n/a[1]	Insects, frogs, birds, road traffic, distant industrial noise	Calm	1.9 m/s
		15/9/20	14:00	54	33	n/a[1]			
Evening	38	15/9/20	20:22	55	47	33[3]	Frogs, distant industrial noise, occasional impact noise from CDF	Calm	1.7 m/s
		15/9/20	20:38	53	48	n/a[1]			
Night	35	16/9/20	0:34	54	47	n/a[1]	Frogs, passing train, distant industrial noise, occasional impact noise from CDF	Calm	Calm
		16/9/20	0:50	48	45	32			

Note 1: Mining operations not audible during assessment.

Note 2: Prevailing meteorology assessed on basis of regional conditions in accordance with provisions of INP and Project Approval, as outlined in **Section 1.3.4**

Note 3: The effect of ambient noise could not be fully isolated from site noise. The value presented is an absolute upper limit of the CVO contribution.

Report

Compliance Noise Monitoring

April, 2021

Newcrest Mining Ltd (Cadia)

3 May, 2021
Rev 1 (Final)

advitech.com.au

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Prepared For

Newcrest Mining Ltd (Cadia)

Martin Englert, Environmental Specialist

Email: martin.englert@newcrest.com.au, Telephone: 02 6366 6326

Private Mail Bag South Orange NSW 2800

Prepared By

Advitech Pty Limited t/a **Advitech Environmental**

ABN: 29 003 433 458

Clayton Sparke, Environment Specialist (Acoustics)

Email: clayton.sparke@advitech.com.au, Telephone: 02 4924 5400,

Facsimile: 02 4967 3772, Web: www.advitech.com.au, General Email: mail@advitech.com.au

7 Riverside Drive Mayfield West NSW 2304 PO Box 207 Mayfield NSW 2304

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Function	Signature	Name and Title	Date
Prepared by		Clayton Sparke (M.A.A.S) Environment Specialist (Acoustics)	3 May, 2021
Checked by		Natasha Pegler Acoustic Scientist	3 May, 2021
Authorised for Release by		Clayton Sparke (M.A.A.S) Environment Specialist (Acoustics)	3 May, 2021

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EXECUTIVE SUMMARY

Advitech Pty Limited was engaged by Newcrest Mining to undertake attended noise monitoring at sensitive receivers adjacent to its Cadia Valley Operations (CVO). The objective of the monitoring was to evaluate compliance with the conditions of the CVO Project Approval (PA 06_0295) and Environment Protection Licence (EPL) No. 5590.

Operator attended noise monitoring was undertaken between 6 and 9 April, 2021, at fourteen locations adjacent to the Cadia Valley Operations (CVO), former Blayney Dewatering Facility (BDF) and the Cadia Dewatering Facility (CDF). Results indicate that measured noise levels associated with Newcrest activities were below the relevant criteria levels at all monitoring locations.

While noise generated by mining and concentrate handling activities was audible in several receiving environments, prevailing noise levels were controlled by extraneous (non-mining) noise sources in most cases. Analysis of operator attended monitoring results indicates that:

- mining and processing activities were audible at the Rosebank, Bonnie Glen, Northwest, and South Log monitoring locations adjacent to Cadia Valley mining operations;
  - CVO contributions were measured or evaluated at levels below the relevant noise criteria in all cases;
- demolition and site rehabilitation work at the Blayney Dewatering Facility have been completed, and no noise sources were present on site;
- activities at the Cadia Dewatering Facility were audible at the 247 Newbridge Rd, Athol and Hollwood monitoring locations. Contributions were below relevant noise criteria at all times.

Observed noise levels did not exceed the cumulative criteria at any monitoring location. Noise impacts were assessed to be compliant with both Project Specific and Cumulative noise impact criteria established in the CVO Project Approval (PA 06_0295) and Environment Protection Licence (EPL) No. 5590 at all monitoring locations.

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Appendix II Detailed Monitoring Results

1. INTRODUCTION

Advitech Pty Limited (trading as Advitech Environmental) was engaged by Newcrest Mining to undertake operator attended noise monitoring at sensitive receivers adjacent to Cadia Valley Operations (Cadia). The objective of the monitoring was to evaluate compliance with the conditions of the CVO Project Approval (PA 06_0295 Mod13) and Environment Protection Licence (EPL) No. 5590.

It should be noted that this report was prepared by Advitech Pty Limited for Newcrest Mining Ltd (Cadia) ('the customer') in accordance with the scope of work and specific requirements agreed between Advitech and the customer. This report was prepared with background information, terms of reference and assumptions agreed with the customer. The report is not intended for use by any other individual or organisation and as such, Advitech will not accept liability for use of the information contained in this report, other than that which was intended at the time of writing.

1.1 Environmental Monitoring Programme

Attended noise monitoring is undertaken at fourteen locations adjacent to the Cadia Valley mining, Blayney Dewatering Facility and Cadia Dewatering Facility operations in accordance with provisions of the CVO Noise Monitoring Program (NMP). The Cadia Valley monitoring locations (shown in **Figure 1**) include:

- Rosebank;
- Chesterfield;
- Willow Creek;
- South Log;
- Bonnie Glen;
- Warrengong;
- Northwest.

The Blayney dewatering facility monitoring locations (shown in **Figure 2**) include:

- Blayney L1;
- Blayney L2;
- Blayney L3;
- Blayney L5.

The CVO dewatering facility monitoring locations (shown in **Figure 2**) include:

- Athol;
- Hollwood;
- 247 Newbridge Road (Ewens).

1.2 Mining Operations

During the monitoring period, CVO mining operations were comprised of the following activities:

- underground mining;
- surface movement of stockpiled material;
- operation of an ore treatment facility;
- operation of tailings dams;
- progressive rehabilitation of the South Waste Rock Dump;
- operation and maintenance of ancillary plant and infrastructure; and
- dewatering and loading of concentrate for rail transportation at the CVO Dewatering Facility.

Demolition and rehabilitation of the operations old dewatering facility in Blayney has been completed, and no activity (or noise sources) were observed at the site. Notwithstanding, monitoring was undertaken in receiving environments adjacent to this site in accordance with commitments of the approved Noise Monitoring Plan (NMP). Monitoring at these locations will continue until such time as the NMP is formally amended and these commitments removed. The general arrangement of CVO workings and infrastructure are provided in **Figure 1** and **Figure 2.**

Figure 1: Cadia Valley Monitoring Locations

Figure 2: Blayney and Cadia Dewatering Facility monitoring locations

1.3 Statutory Requirements

1.3.1 Noise Assessment Criteria

Table 1 and **Table 2** detail the noise criteria for each of the monitoring locations adjacent to CVO. These criteria are established in a Noise Monitoring Program (NMP), and address the conditions of:

- Project Approval (PA) 06_0295 (Mod13) issued by the NSW Department of Planning and Infrastructure (DoPI); and
- Environment Protection License (EPL) 5590 (dated 11 June, 2020) issued by the NSW Environment Protection Authority (EPA).

Table 1: Environmental noise limits for all privately owned land (dB(A)) (Cadia Valley)

		$L_{Aeq,15minute}$			$L_{Aeq,period}$			$L_{A1,1minute}$
Environment	Location	Day	Evening	Night	Day	Evening	Night	(night)
Cadia Valley Operations	Chesterfield	43	38	35	50	45	40	45
	Willow Creek	43	38	35	50	45	40	45
	South Log	43	38	38	50	45	40	45
	Bonnie Glen	43	38	36	50	45	40	45
	Rosebank	43	38	36	50	45	40	45
	Northwest	43	38	38	50	45	40	45
	Warrengong	43	38	35	50	45	40	45

Table 2: Environmental noise limits for all privately owned land (dB(A)) (dewatering operations)

Environment	Location	$L_{Aeq,15minute}$			$L_{Aeq,period}$			$L_{A1.1minute}$ (night)
		Day	Evening	Night	Day	Evening	Night	
Blayney Dewatering Facility	Blayney L1	50	50	39	-	-	-	49
	Blayney L2	50	50	36	-	-	-	46
	Blayney L3	46	46	37	-	-	-	47
	Blayney L5	58	58	45	-	-	-	55
Cadia Dewatering Facility	Athol	38	38	35	-	-	-	45
	247 Newbridge Road	50	42	42	-	-	-	45
	Hollwood	43	35	35	50	45	40	45

1.3.2 Assessment Periods

Current approvals and management plans state that noise generated by the project is to be measured and evaluated in accordance with the relevant requirements and exemptions of the NSW Industrial Noise Policy (INP). The INP states:

- a day is defined as the period from 7am to 6pm Monday to Saturday, and 8am to 6pm Sundays and public holidays;
- an evening is defined as the period from 6pm to 10pm; and
- a night is defined as the period from 10pm to 7am Monday to Saturday, and 10pm to 8am Sundays and public holidays.

1.3.3 Monitoring Locations

The INP establishes that noise from the mine is to be measured at:

- the most affected point on, or within the residential boundary; or,
- at the most affected point within 30 metres of the dwelling where the dwelling is more than 30m from the boundary.

1.3.4 Meteorological Conditions

Condition 2 of the Project Approval notes that *"noise generated by the project is to be measured in accordance with the relevant procedures and exemptions (including meteorological conditions) of the NSW Industrial Noise Policy".* The INP identifies the following meteorological exemptions:

- wind speeds exceeding 3m/s (measured at 10m);
- temperature inversions greater than 3˚C / 100m; and
- rainfall.

On this basis, monitoring data observed when these conditions prevail would lead to their exclusion from any assessment of compliance.

1.4 Monitoring Objectives

This assessment relates to operational noise monitoring undertaken between 6 and 9 April, 2021. The objective of the monitoring is to evaluate compliance with the conditions of the CVO Project Approval (PA 06_0295) and Environment Protection Licence (EPL) No. 5590.

2. METHODOLOGY

2.1 Operational Noise Monitoring

Operator attended noise monitoring was undertaken as a means of assessing the character of, and to identify the noise sources contributing to measured noise levels at each of the monitoring locations. Attended noise monitoring was undertaken at each location for a period of 30 minutes (2 x 15 minute measurements):

- in accordance with the methodology established in AS1055-2018: *Acoustics - Description and measurement of environmental noise*;
- following guidance in the NSW Industrial Noise Policy (INP) and Noise Policy for Industry (NPfI);
- in accordance with AS2659 - 1998: Guide to the use of sound measuring equipment - portable sound level meters; and
- using equipment that satisfied the requirements of AS1259 - 1990. Acoustics - Sound Level Meters.

Details of operator attended monitoring equipment are provided in **Table 3.** A copy of calibration certificates is provided in **Appendix I**.

Table 3: Operator attended noise monitoring

Parameter	SLM
Sound Level Meter (SLM)	Svantek 971 / Svantek 971 / Svantek 958
SLM Serial Number	77606 / 60686 / 20777
SLM Calibration Date	23/4/2020 / 24/7/2020
Field Calibrator	Svantek SV30A / Svantek SV35A
Field Calibrator Serial Number	7906 / 90218
Field Calibrator Calibration Date	24/7/2020 / 23/4/2020
Frequency Weighting(s),(Response), Units	A, C, Lin (Fast), dB SPL

Review of prevailing regional meteorology from the Ridgeway and Spring Hill (Orange Airport) monitoring stations was undertaken for the Cadia Valley and Blayney monitoring locations respectively. These monitoring data were reviewed to validate results in the context of INP and NPfI provisions.

2.2 Evaluating Operational Source Contributions

The noise criteria established in **Section 1.3.1** are assessable only in terms of the contribution from CVO noise sources, not total measured environmental noise. For the purposes of this assessment, extraneous noise is defined as noise contributed from any source that is not associated with CVO activities. In typical rural receiving environments, this may include:

- transportation noise (except that associated with train loading at the Blayney Dewatering Facility (BDF), CVO Dewatering Facility, or road traffic generated by Cadia Valley Operations);
- environmental noise, such as gusting wind, rustling leaves, birds, insects, frogs and livestock;
- domestic noise, such as barking dogs or loud music.

Several methods are available to exclude extraneous noise contributions or evaluate contributions from specific noise sources.

2.2.1 Exclusions Based on Operator Observation

Where contributions from extraneous noise sources are considered to influence measured noise levels, operator observations may be used to exclude discrete events, or identify alternate descriptors representative of noise contributions from the assessable noise source. These may include:

- exclusion of a portion of the measurement influenced by short term extraneous events (for example, the passage of a vehicle), allowing recalculation of results from remaining data; or
- use of the L_{A90} descriptor, where the character of the noise source under assessment is typically continuous, with little variation in level.

Alternative methods are available where extraneous sources cannot be reasonably excluded based on measurement descriptors or discrete events.

2.2.2 Band Pass Filters

Previous assessment of mining and quarrying developments indicates that noise emissions from these operations typically manifest in the low frequency end of the noise spectrum (<1000Hz). Application of band pass filtering is further supported by recent industry research (Parnell, 2015). Review of the CVO receiving environments indicates environmental noise measurements may be subject to significant (continuous) influence from extraneous sources across the full noise spectrum, including frogs (approximately 2000 to 3150Hz) and insect noise (approximately 3150 to 6300Hz).

Where multiple sources cannot be excluded on the basis of operator observations, and are found to contribute in different parts of the spectrum, a frequency band filter may be applied to isolate contributions from specific sources. The extent of band pass filtering is determined based on operator observations at the time of monitoring. Following application of a band pass filter, the $L_{Aeq\ (band\ pass)}$ noise level may be recalculated as a means of evaluating the contribution from mining operations.

3. RESULTS

3.1 Operational Noise Monitoring

Operator attended noise monitoring was undertaken at fourteen locations between 6 and 9 April, 2021. The objective was to measure noise levels at each of the monitoring locations, evaluate the contribution from Cadia noise sources and assess these contributions against the noise criteria relevant to each receiver location. Preliminary findings of the assessment indicate:

- mining and concentrate processing activities were audible at the Rosebank, Bonnie Glen, Northwest, and South Log receiver locations. Audible contributions were not observed at other locations in the monitoring network;
- no audible contributions were observed from the Blayney Dewatering Facility;
- operation of the Cadia Dewatering Facility (CDF) was audible at all 3 monitoring locations adjacent to that site (247 Newbridge Rd, Athol and Hollwood).

Monitoring data indicates that total environmental noise levels (from all sources) did exceed the CVO criteria levels at several monitoring locations. Extraneous noise contributions were observed from a variety of sources, including:

- insects;
- bird noise;
- aircraft;
- livestock;
- windblown vegetation;
- trains;
- barking dogs;
- road traffic;
- domestic noise.

The characteristics of these sources (often continuous or affecting large portions of the measurement data) made it difficult to evaluate monitoring results based on discrete event contributions (for example, single car pass-by). Where feasible, application of alternative descriptors and band pass filters were used to evaluate CVO contributions.

3.2 Operator Attended Monitoring: Noise Impact Assessment Results

A summary of the results from attended noise monitoring in the receiving environments adjacent to mining and dewatering operations is provided in **Table 4** to **Table 6**. Results are provided for comparison against the relevant $L_{Aeq,15minute}$ noise criteria. Potential sleep disturbance impacts are evaluated against the highest observed $L_{A1,\ 1minute}$ noise level during each night period measurement, with relevant sources identified when this level is above the criteria.

Detailed assessment of monitoring results, including measured noise levels, and description of the ambient noise environment is provided in **Appendix II**. These results indicate that:

- mining activities were audible (but below the relevant noise criteria) at the Rosebank, Bonnie Glen, Northwest, and South Log receiver locations. Audible contributions were not observed at the Chesterfield, Warrengong, or Willow Creek monitoring locations;
  - measurements representative of Northwest were undertaken at a location approximately 500m from the dwelling, at the nearest publicly accessible boundary of the property, closest to the CVO. Levels at this location are likely to be marginally higher than equivalent levels at the dwelling (due to distance and topographical effects). Thus, where compliance can be demonstrated at the measurement location, it may be assumed at the dwelling location;
  - measurements representative of Chesterfield were undertaken at a location approximately 250 metres south-west of the residence at the Blast Vibration Monitoring

(BVM) compound within the property (and between the CVO and the dwelling). Should mining noise have been observed at the monitoring location, the residence would have been subject to further assessment (within 30m of the dwelling) once access arrangements with the landowner were made.

  - measurements representative of Rosebank were undertaken at a location approximately 50 metres north of the property. The exposure to noise from CVO at this location is similar to that at the residence.
  - where audible, emissions from the CVO were all evaluated at levels below 35dB(A). Noise from CVO was subjectively observed to contain low frequency characteristics. However, quantitative tests (Fact Sheet C of the NPfI) indicate a modifying factor was not warranted at any of the locations with CVO contributions;
  - tests for annoying noise characters (Fact Sheet C of the NPfI) indicated no tonal characters in measurements where CVO operations were audible;

- no activities were occurring at the Blayney Dewatering Facility, and no audible contributions were observed at L1, L2, L3, or L5;
  - while this facility is no longer operational (and has been demolished) monitoring will continue at these locations until such time as the NMP is formally amended and these monitoring commitments removed;
- operations at the CDF were audible at the Athol, Hollwood, and 247 Newbridge Rd monitoring locations but were assessed to be below the relevant NIAC;
  - emissions from the CDF were observed with peak-like characteristics at 247 Newbridge Road and Hollwood monitoring locations, likely from impact noise caused by container handling and operation of the filter press;
  - emissions at the Athol monitoring location were characterised by continuous emissions from the pump farm, compressor house and mobile plant operating on stockpiles within the facility;
  - contributions were determined to be below the $L_{Aeq,15min}$ criteria in all cases. Events observed during the night were also below the $L_{A1,1min}$ criterion.

Observed noise levels did not exceed the cumulative criteria at any monitoring location. Noise impacts were assessed to be compliant with both Project Specific and Cumulative noise impact criteria established in the CVO Project Approval (PA 06_0295) and Environment Protection Licence (EPL) No. 5590 at all monitoring locations.

Table 4 : Cadia Valley Operations summary of monitoring results, dB(A)

Location	Period	CVO Contribution (L_{Aeq}) Mes1	CVO Contribution (L_{Aeq}) Mes2	$L_{A1, 1min}$ Source	Criteria	Compliance Assessment
Bonnie Glen	Day $L_{Aeq, 15min}$	Inaudible	Inaudible		43	Compliant
	Evening $L_{Aeq, 15min}$	33	29		38	
	Night $L_{Aeq, 15min}$	31	30		36	
	$L_{A1, 1min}$	45	38	n/a[1]	45	
Rosebank[2]	Day $L_{Aeq, 15min}$	Inaudible	Inaudible		43	Compliant
	Evening $L_{Aeq, 15min}$	30	32		38	
	Night $L_{Aeq, 15min}$	32	31		36	
	$L_{A1, 1min}$	37	37	n/a[1]	45	
Warrengong	Day $L_{Aeq, 15min}$	Inaudible	Inaudible		43	Compliant
	Evening $L_{Aeq, 15min}$	Inaudible	Inaudible		38	
	Night $L_{Aeq, 15min}$	Inaudible	Inaudible		35	
	$L_{A1, 1min}$	46	46	Wind	45	
South Log	Day $L_{Aeq, 15min}$	Inaudible	Inaudible		43	Compliant
	Evening $L_{Aeq, 15min}$	Inaudible	Inaudible		38	
	Night $L_{Aeq, 15min}$	30	32		38	
	$L_{A1, 1min}$	50	48	Wind	45	
Northwest[2]	Day $L_{Aeq, 15min}$	26	25		43	Compliant
	Evening $L_{Aeq, 15min}$	Inaudible	Inaudible		38	
	Night $L_{Aeq, 15min}$	26	24		38	
	$L_{A1, 1min}$	60	41	Road traffic	45	
Willow Creek	Day $L_{Aeq, 15min}$	Inaudible	Inaudible		43	Compliant
	Evening $L_{Aeq, 15min}$	Inaudible	Inaudible		38	
	Night $L_{Aeq, 15min}$	Inaudible	Inaudible		35	
	$L_{A1, 1min}$	43	48	Wind	45	
Chesterfield[2]	Day $L_{Aeq, 15min}$	Inaudible	Inaudible		43	Compliant
	Evening $L_{Aeq, 15min}$	Inaudible	Inaudible		38	
	Night $L_{Aeq, 15min}$	Inaudible	Inaudible		35	
	$L_{A1, 1min}$	41	43	n/a[1]	45	

Note 1: L_{A1} level equivalent to or less than the criteria, no further assessment undertaken.

Note 2: Monitoring was undertaken at a position not representative of the property in accordance with the INP. See **Section 3.2** for more information.

Table 5 : Blayney Dewatering Facility summary of monitoring results, dB(A)

Location	Period	CVO Contribution Mes1	CVO Contribution Mes2	$L_{A1, 1min}$ Source	Criteria	Compliance Assessment
L1	Day $L_{Aeq, 15min}$	Inaudible	Inaudible		50	Compliant
	Evening $L_{Aeq, 15min}$	Inaudible	Inaudible		50	
	Night $L_{Aeq, 15min}$	Inaudible	Inaudible		39	
	$L_{A1, 1min}$	74	44	Road traffic	49	
L2	Day $L_{Aeq, 15min}$	Inaudible	Inaudible		50	Compliant
	Evening $L_{Aeq, 15min}$	Inaudible	Inaudible		50	
	Night $L_{Aeq, 15min}$	Inaudible	Inaudible		36	
	$L_{A1, 1min}$	46	46	Road traffic	46	
L3	Day $L_{Aeq, 15min}$	Inaudible	Inaudible		46	Compliant
	Evening $L_{Aeq, 15min}$	Inaudible	Inaudible		46	
	Night $L_{Aeq, 15min}$	Inaudible	Inaudible		37	
	$L_{A1, 1min}$	47	50	Road traffic	47	
L5	Day $L_{Aeq, 15min}$	Inaudible	Inaudible		58	Compliant
	Evening $L_{Aeq, 15min}$	Inaudible	Inaudible		58	
	Night $L_{Aeq, 15min}$	Inaudible	Inaudible		45	
	$L_{A1, 1min}$	45	46	Road traffic	55	

Note 1: $L_{A1, 1minute}$ level equivalent to or less than the criteria, no further assessment undertaken.

Table 6 : Cadia Dewatering Facility summary of monitoring results, dB(A)

Location	Period	CVO Contribution Mes1	CVO Contribution Mes2	$L_{A1, 1min}$ Source	Criteria	Compliance Assessment
247 Newbridge Road	Day $L_{Aeq, 15min}$	<20	Inaudible		50	Compliant
	Evening $L_{Aeq, 15min}$	Inaudible	Inaudible		42	
	Night $L_{Aeq, 15min}$	25	25		42	
	$L_{A1, 1min}$	37	40	n/a[1]	45	
Hollwood	Day $L_{Aeq, 15min}$	21	Inaudible		43	Compliant
	Evening $L_{Aeq, 15min}$	Inaudible	Inaudible		35	
	Night $L_{Aeq, 15min}$	Inaudible	Inaudible		35	
	$L_{A1, 1min}$	38	45	n/a[1]	45	
Athol	Day $L_{Aeq, 15min}$	32	Inaudible		38	Compliant
	Evening $L_{Aeq, 15min}$	33	33		38	
	Night $L_{Aeq, 15min}$	33	33		35	
	$L_{A1, 1min}$	51	37	Road traffic	45	

Note 1: $L_{A1, 1minute}$ level equivalent to or less than the criteria, no further assessment undertaken.

4. RECOMMENDATIONS AND CONCLUSIONS

Advitech Pty Limited was engaged by Newcrest Mining to undertake attended noise monitoring at sensitive receivers adjacent to its Cadia Valley Operations (CVO). The objective of the monitoring was to evaluate compliance with the conditions of the CVO Project Approval (PA 06_0295) and Environment Protection Licence (EPL) No. 5590.

Operator attended noise monitoring was undertaken between 6 and 9 April, 2021, at fourteen locations adjacent to the Cadia Valley Operations (CVO), Blayney Dewatering Facility (BDF) and the Cadia Dewatering Facility (CDF). Results indicate that measured noise levels (from all sources) were below the relevant criteria levels at all monitoring locations.

While noise generated by mining and concentrate handling activities was observed to influence noise levels in several receiving environments, prevailing noise levels were controlled by extraneous (non-mining) noise sources in most cases. Analysis of operator attended monitoring results indicates that:

- mining and processing activities were audible at the Rosebank, Bonnie Glen, Northwest, and South Log monitoring location adjacent to Cadia Valley mining operations;
  - CVO contributions were measured or evaluated at levels below the relevant noise criteria in all cases;
- noise associated with operation of the Blayney Dewatering Facility was inaudible at all monitoring locations;
- emissions from the Cadia Dewatering Facility were audible at 247 Newbridge Rd, Athol, and Hollwood. Contributions were below all relevant noise criteria at all CDF monitoring locations.

Observed noise levels did not exceed the cumulative criteria at any monitoring location. Noise impacts were assessed to be compliant with both Project Specific and Cumulative noise impact criteria established in the CVO Project Approval (PA 06_0295) and Environment Protection Licence (EPL) No. 5590 at all monitoring locations.

5. REFERENCES

The following information was used in the preparation of this report:

1. AS1055-2018: Acoustics – Description and measurement of environmental noise;
2. AS1259 – 1990. Acoustics – Sound Level Meters.
3. AS2659 – 1998: Guide to the use of sound measuring equipment – portable sound level meters.
4. AS 2706-1984: Numerical Values: Rounding and interpretation of limiting values.
5. Cadia Environmental Protection Licence (EPL) (5590)(dated 11 June, 2020).
6. Cadia Valley Operations Noise Monitoring Program (Version 4, dated June 2018).
7. Cadia Valley Operations Project Approval (06_0295) (Mod13).
8. EPA, 2000. NSW Industrial Noise Policy, NSW Environment Protection Agency, Sydney.
9. EPA, 2017. NSW Noise Policy for Industry, NSW Environment Protection Agency, Sydney.
10. Parnell, J (2015). Acoustic Signature of Open Cut Coal Mines, Acoustics 2015. Hunter Valley: Australian Acoustical Society.
11. Wilkinson Murray Pty Ltd (2009). Cadia East Project Noise and Blast Impact Assessment.

Appendix I Calibration Certificates

CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: SLM 26769 & FILT 26787

Equipment Description:	Sound & Vibration Analyser		
Manufacturer:	Svantek		
Model No:	Svan-971	**Serial No:**	77606
Microphone Type:	7052E	**Serial No:**	76567
Preamplifier Type:	SV18	**Serial No:**	78287
Filter Type:	1/3 Octave	**Serial No:**	77606
Comments:	All tests passed for class 1. (See over for details)		
Owner:	Advitech Pty Ltd 7 Riverside Drive Mayfield West NSW 2304		
Ambient Pressure:	1006 hPa ±1.5 hPa		
Temperature:	23 °C ±2° C	**Relative Humidity:**	46% ±5%
Date of Calibration:	24/04/2020	**Issue Date:**	28/04/2020
Acu-Vib Test Procedure:	AVP10 (SLM) & AVP06 (Filters)		

CHECKED BY: MKB **AUTHORISED SIGNATURE:** Bruce Meldrum

Accredited for compliance with ISO/IEC 17025 - Calibration
The results of the tests, calibration and/or measurements included in this document are traceable to Australian/national standards.

NATA
ACCREDITATION

Accredited Lab. No. 9262
Acoustic and Vibration Measurements

ACU-VIB
ELECTRONICS
HEAD OFFICE
Unit 14, 22 Hudson Ave. Castle Hill NSW 2154
Tel: (02) 98806133 Fax: (02)96838233
Mobile 0413 809806
web site: www.acu-vib.com.au

CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: SLM 26771 & FILT 5755

Equipment Description:	Sound & Vibration Analyser		
Manufacturer:	Svantek		
Model No:	Svan-971	**Serial No:**	60686
Microphone Type:	7052E	**Serial No:**	66701
Preamplifier Type:	SV18	**Serial No:**	62787
Filter Type:	1/3 Octave	**Serial No:**	60686
Comments:	All tests passed for class 1. (See over for details)		
Owner:	Advitech Pty Ltd 7 Riverside Drive Mayfield West NSW 2304		
Ambient Pressure:	1003 hPa ±1.5 hPa		
Temperature:	24 °C ±2° C	**Relative Humidity:**	39% ±5%
Date of Calibration:	23/04/2020	**Issue Date:**	23/04/2020
Acu-Vib Test Procedure:	AVP10 (SLM) & AVP06 (Filters)		

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Unit 14, 22 Hudson Ave. Castle Hill NSW 2154
Tel: (02) 96808133 Fax: (02)96808233
Mobile: 0413 808606
web site: www.acu-vib.com.au

CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: SLM 27400 & FILT 5922

Equipment Description:	Sound & Vibration Analyser		
Manufacturer:	Svantek		
Model No:	Svan-958	**Serial No:**	20777
Microphone Type:	40AE	**Serial No:**	151134
Preamplifier Type:	SV12L	**Serial No:**	25683
Filter Type:	1/3 Octave	**Serial No:**	20777
Comments:	All tests passed for class 1. (See over for details)		
Owner:	Advitech Pty Ltd 7 Riverside Drive Mayfield West NSW 2304		
Ambient Pressure:	1014hPa ±1.5 hPa		
Temperature:	22 °C ±2° C	**Relative Humidity:**	42% ±5%
Date of Calibration:	24/07/2020	**Issue Date:**	24/07/2020
Acu-Vib Test Procedure:	AVP10 (SLM) & AVP06 (Filters)		

CHECKED BY: JK **AUTHORISED SIGNATURE:** ..... Jack Riedl

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HEAD OFFICE
Unit 14, 22 Hudson Ave. Castle Hill NSW 2154
Tel: (02) 96836133 Fax: (02)96808233
Mobile: 0413 809805
web site: www.acu-vib.com.au

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CERTIFICATE OF CALIBRATION

CERTIFICATE NO: 26763

EQUIPMENT TESTED: Sound Level Calibrator

Manufacturer: Svantek
Type No: SV35A **Serial No:** 90218
Owner: Advitech Pty Ltd
7 Riverside Drive
Mayfield West NSW 2304

Tests Performed: Measured output pressure level was found to be:

Parameter	Pre-Adj	Adj Y/N	Output: (db re 20 µPa)	Frequency: (Hz)	THD&N (%)
Level 1:	NA	N	94.15	999.99	1.78
Level 2:	NA	N	114.16	999.99	0.40
Uncertainty:			±0.11 dB	±0.05%	±0.20 %
Uncertainty (at 95% c.l.) k=2					

CONDITION OF TEST:
Ambient Pressure: 1001 hPa ±1.5 hPa **Relative Humidity:** 45% ±5%
Temperature: 23 °C ±2° C
Date of Calibration: 22/04/2020 **Issue Date:** 23/04/2020
Acu-Vib Test Procedure: AVP02 (Calibrators)
Test Method: AS IEC 60942 - 2017
CHECKED BY: JKB **AUTHORISED SIGNATURE:** .....
Jack Kidd

Accredited for compliance with ISO/IEC 17025 - Calibration
The results of the tests, calibration and/or measurements included in this document are traceable to Australian/national standards.
The uncertainties quoted are calculated in accordance with the methods of the ISO Guide to the Uncertainty of Measurement and quoted at a coverage factor of 2 with a confidence interval of approximately 95%.

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Web site: www.acu-vib.com.au

CERTIFICATE OF CALIBRATION

CERTIFICATE NO: 27404

EQUIPMENT TESTED: Sound Level Calibrator

Manufacturer: Svantek
Type No: SV-30A **Serial No:** 7906
Owner: Advitech Pty Ltd
7 Riverside Drive
Mayfield West NSW 2304

Tests Performed: Measured output pressure level was found to be:

Parameter	Pre-Adj	Adj Y/N	Output: (db re 20 µPa)	Frequency: (Hz)	THD&N (%)
Level 1:	NA	N	93.86	1000.00	2.51
Level 2:	NA	N	113.83	1000.04	0.45
Uncertainty:			±0.11 dB	±0.05%	±0.20 %
Uncertainty (at 95% c.l.) k=2					

CONDITION OF TEST:
Ambient Pressure: 1009 hPa ±1.5 hPa **Relative Humidity:** 39% ±5%
Temperature: 23°C ±2° C
Date of Calibration: 24/07/2020 **Issue Date:** 24/07/2020
Acu-Vib Test Procedure: AVP02 (Calibrators)
Test Method: AS IEC 60942 - 2017
CHECKED BY: ..JK.. **AUTHORISED SIGNATURE:** .....
Jack Kielt

Accredited for compliance with ISO/IEC 17025 - Calibration
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The uncertainties quoted are calculated in accordance with the methods of the ISO Guide to the Uncertainty of Measurement and quoted at a coverage factor of 2 with a confidence interval of approximately 95%.

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Tel: (02) 96808133 Fax: (02)96806233
Mobile: 0413 809606
Web site: www.acu-vib.com.au

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Appendix II Detailed Monitoring Results

AII.1 Assessment of Results – Blayney L1 (Blayney)

The L1 monitoring location noise environment was dominated by local traffic, bird calls and insect/frog noise. No BDF contributions were observed.

Table 7: L1 noise monitoring results, dB(A)

Period	Criteria	Date	Time	L_{Aeq}	L_{A90}	CVO Contribution	Description of Noise Environment	Local Weather	Regional Weather[2]
Day	50	8/04/2021	17:28	46	42	n/a[1]	Insects, birds and distant traffic noise dominate measurement results at this location. No audible contribution from the Blayney Dewatering Facility site.	Calm	ENE at 1.9ms
		8/04/2021	17:43	47	44	n/a[1]			
Evening	50	6/04/2021	19:37	45	42	n/a[1]	Road traffic dominates, with occasional barking dogs. Insect noise controls background levels. No BDF contributions audible.	Calm	ESE at 1.9ms
		6/04/2021	19:52	47	40	n/a[1]			
Night	39	6/04/2021	22:16	59	38	n/a[1]	Road traffic dominates, with occasional barking dogs and noise from an approaching train. Insect noise controls background levels. No BDF contributions audible.	Calm	SSE at 1.9ms
		6/04/2021	22:31	40	38	n/a[1]			

Note 1: Site operations not audible during assessment.

Note 2: Prevailing meteorology assessed on basis of regional conditions in accordance with provisions of INP and Project Approval, as outlined in **Section 1.3.4**.

AII.2 Assessment of Results – L2 (Blayney)

The L2 monitoring location noise environment was dominated by local traffic, bird calls and barking dogs. No BDF contributions were observed.

Table 8 : L2 (Railway Ln, Blayney) noise monitoring results

Period	Criteria	Date	Time	L_{Aeq}	L_{A90}	CVO Contribution	Description of Noise Environment	Local Weather	Regional Weather[2]
Day	50	8/04/2021	16:55	51	40	n/a[1]	Environmental (birds) and road traffic noise are dominant at this location. No audible contribution from the Blayney Dewatering Facility site.	Calm	ENE at 1.9ms
		8/04/2021	17:11	54	40	n/a[1]			
Evening	50	6/04/2021	18:43	47	38	n/a[1]	Distant traffic through Blayney and background of insect noise, with occasional barking dog. No audible contribution from the Blayney Dewatering Facility site	Calm	E at 1.9ms
		6/04/2021	19:02	48	37	n/a[1]			
Night	36	6/04/2021	23:34	38	31	n/a[1]	Road traffic (distant through Blayney and vehicles on nearby road) is the only significant noise source. No BDF contributions audible.	Calm	E at 3.1ms
		6/04/2021	23:49	36	30	n/a[1]			

Note 1: Site operations not audible during assessment.

Note 2: Prevailing meteorology assessed on basis of regional conditions in accordance with provisions of INP and Project Approval, as outlined in **Section 1.3.4**.

AII.3 Assessment of Results – L3 (Blayney)

The noise environment at this location consisted of road traffic, local industrial noise, and barking dogs. No BDF contributions were observed.

Table 9 : L3 (Hill Street, Blayney) noise monitoring results

Period	Criteria	Date	Time	L_{Aeq}	L_{A90}	CVO Contribution	Description of Noise Environment	Local Weather	Regional Weather[2]
Day	46	8/04/2021	15:49	54	40	n/a[1]	Noise environment dominated by local traffic, and noise from local industrial sheds. No audible contribution from the Blayney Dewatering Facility site.	E at 1ms	ENE at 1.9ms
		8/04/2021	16:04	60	38	n/a[1]			
Evening	46	6/04/2021	19:24	43	36	n/a[1]	Noise levels controlled by through traffic on Mid-Western Highway, with background of insect noise. No audible contribution from the Blayney Dewatering Facility site.	Calm	E at 2.5ms
		6/04/2021	19:39	54	32	n/a[1]			
Night	37	6/04/2021	23:57	36	28	n/a[1]	Noise environment largely controlled by environmental noise sources (insects and barking dogs), with occasional higher levels associated with road traffic. No audible contribution from the Blayney Dewatering Facility site.	Calm	ESE at 3.1ms
		7/04/2021	0:12	38	27	n/a[1]			

Note 1: Site operations not audible during assessment.

Note 2: Prevailing meteorology assessed on basis of regional conditions in accordance with provisions of INP and Project Approval, as outlined in **Section 1.3.4**.

AII.4 Assessment of Results – L5 (Railway Lane Pre School)

Road traffic, windblown vegetation and birds were audible and characteristic of the noise environment at this location. No BDF contributions were observed.

Table 10 : L5 (Railway Lane Pre School, Blayney) noise monitoring results

Period	Criteria	Date	Time	L_{Aeq}	L_{A90}	CVO Contribution	Description of Noise Environment	Local Weather	Regional Weather[2]
Day	58	8/04/2021	16:23	49	36	n/a[1]	Environmental (birds and barking dogs) and transportation (local traffic) noise sources dominate the noise environment at this location. No audible contribution from the Blayney Dewatering Facility site.	Calm	ENE at 1.9ms
		8/04/2021	16:38	45	35	n/a[1]			
Evening	58	6/04/2021	18:57	50	35	n/a[1]	Road traffic dominates, with insect noise in the background. No BDF contributions audible.	Calm	E at 2.5ms
		6/04/2021	19:12	46	34	n/a[1]			
Night	45	6/04/2021	22:39	36	28	n/a[1]	Noise environment at this location controlled by distant traffic on Mid Western Highway and local environmental sources (birds, barking dogs). No audible contribution from the Blayney Dewatering Facility site.	Calm	E at 2.5ms
		6/04/2021	22:54	35	28	n/a[1]			

Note 1: Site operations not audible during assessment.

Note 2: Prevailing meteorology assessed on basis of regional conditions in accordance with provisions of INP and Project Approval, as outlined in **Section 1.3.4**.

AII.5 Assessment of Results – Bonnie Glen

This noise environment is dominated by local environmental sources, including barking dogs, birds, windblown vegetation, livestock, domestic noise, and occasional road traffic noise. Mining operations at CVO were continually audible at this monitoring location during evening and night periods, but were considered compliant.

Table 11 : Bonnie Glen noise monitoring results

Period	Criteria	Date	Time	L_{Aeq}	L_{A90}	CVO Contribution	Description of Noise Environment	Local Weather	Regional Weather[2]
Day	43	9/04/2021	9:41	44	36	n/a[1]	Noise from wind in foliage is dominant. Frequent interjections from dogs and birds, and occasional road traffic. No CVO contribution audible.	NW at 2 to 5 m/s	WNW at 7.6ms
		9/04/2021	9:57	46	35	n/a[1]			
Evening	38	7/04/2021	18:17	50	36	33	Occasional road traffic, but most noise contribution is from the background mix of crickets and CVO site hum. CVO contributions estimated as equivalent to frequency bands 1.6kHz and below	Calm	NE at 2ms
		7/04/2021	18:31	36	33	29			
Night	36	8/04/2021	0:16	35	29	31	Dominant noise sources are continuous noise from CVO and frogs. Occasional dogs or louder frogs are audible. CVO contribution determined using frequencies 1.25 kHz and lower.	E to 1 m/s	NNW at 4.5ms
		8/04/2021	0:32	32	29	30			

Note 1: Mining operations not audible during assessment.

Note 2: Prevailing meteorology assessed on basis of regional conditions in accordance with provisions of INP and Project Approval, as outlined in **Section 1.3.4**.

Note 3: The effect of ambient noise could not be fully isolated from site noise. The value presented is an absolute upper limit of the CVO contribution.

AII.7 Assessment of Results – Warrengong

This receiving environment is characterised by local environmental sources including insects, birds, livestock and windblown vegetation. Contributions from mining operations at CVO were not audible at this monitoring location.

Table 12 : 346 Carbine Rd noise monitoring results

Period	Criteria	Date	Time	L_{Aeq}	L_{A90}	CVO Contribution	Description of Noise Environment	Local Weather	Regional Weather[2]
Day	43	7/04/2021	15:26	42	34	n/a[1]	Major noise sources are birds and a tractor operating in the distance. Wind noise also present for part of measurement. No CVO contributions audible.	W at 1 to 3 m/s	S at 4.9ms
		7/04/2021	15:42	40	32	n/a[1]			
Evening	38	7/04/2021	21:43	38	34	n/a[1]	Dominant noise source is wind in foliage. Occasional road traffic also contributes. CVO contributions are inaudible.	E at 1 to 2 m/s	NE at 4.2ms
		7/04/2021	21:59	39	35	n/a[1]			
Night	35	7/04/2021	22:01	40	35	n/a[1]	Noise environment dominated by windblown vegetation. Insects and frogs are audible in background when wind level drops. No audible contribution from the CVO.	E at 3ms	NE at 5.4ms
		7/04/2021	22:17	41	38	n/a[1]			

Note 1: Mining operations not audible during assessment.

Note 2: Prevailing meteorology assessed on basis of regional conditions in accordance with provisions of INP and Project Approval, as outlined in **Section 1.3.4**.

AII.8 Assessment of Results – South Log

Monitoring at this location indicates the noise environment consists mainly of environmental noise sources including insects, birds, livestock and windblown vegetation. Contributions from mining operations at CVO were occasionally audible at this monitoring location during periods of lower environmental noise levels but were considered compliant for all time periods.

Table 13 : South Log noise monitoring results

Period	Criteria	Date	Time	L_{Aeq}	L_{A90}	CVO Contribution	Description of Noise Environment	Local Weather	Regional Weather[2]
Day	43	9/04/2021	10:58	50	44	n/a[1]	Windblown vegetation and gusting wind control noise levels at this location. Insect and bird noise also audible in background when wind speeds drop. Activities within the CVO are visible but not audible.	W to NW at 5ms	W at 5.8ms
		9/04/2021	11:14	50	44	n/a[1]			
Evening	38	7/04/2021	19:57	44	41	n/a[1]	Noise environment dominated by frogs, insects and windblown vegetation. CVO was visible but not audible.	E at 2 to 4ms	ENE at 4.1ms
		7/04/2021	20:12	45	42	n/a[1]			
Night	38	7/04/2021	23:30	44	41	30	Frogs and insects at nearby dam dominate noise environment, with occasional distant livestock noise also audible. Noise from mobile plant engine / exhaust noise very faintly audible (with occasional short term surge) in background of animal noise.	NE at 1ms	NNE at 5.2ms
		7/04/2021	23:45	43	40	32			

Note 1: Mining operations not audible during assessment.

Note 2: Prevailing meteorology assessed on basis of regional conditions in accordance with provisions of INP and Project Approval, as outlined in **Section 1.3.4**.

AII.9 Assessment of Results – North West

Monitoring was conducted at the boundary of the property closest to the CVO. This location is approximately 500m from the dwelling, closer to the CVO and at a more (topographically) exposed location that the dwelling. Where compliance is demonstrated at this location, it is assumed at the dwelling. Audible noise sources at this monitoring location included environmental noise (windblown vegetation, and birds) and intermittent road traffic. Noise from mining activities at CVO was occasionally audible but below the criteria at this location and was thus considered compliant.

Table 14 : Northwest noise monitoring results

Period	Criteria	Date	Time	L_{Aeq}	L_{A90}	CVO Contribution	Description of Noise Environment	Local Weather	Regional Weather[2]
Day	43	7/04/2021	17:18	59	22	26	Road traffic noise dominates, with birds contributing in between. CVO contributions audible when no other noise is present.	NE to 1 m/s	NE at 1.3ms
		7/04/2021	17:34	66	25	25			
Evening	38	7/04/2021	20:17	40	35	n/a[1]	Dominant noise source is wind in tree bank. Occasional road traffic also contributes. CVO contributions not audible.	E at 3 to 4 m/s	NE at 3.9ms
		7/04/2021	20:34	56	37	n/a[1]			
Night	38	7/04/2021	23:11	58	33	26	Constant noise of wind in tree bank is dominant. CVO operations occasionally audible as a low frequency hum, and contributions were calculated as frequencies 315 Hz and below	E at 1 to 3 m/s	NNE at 6.6ms
		7/04/2021	23:32	35	31	24			

Note 1: Mining operations not audible during assessment.

Note 2: Prevailing meteorology assessed on basis of regional conditions in accordance with provisions of INP and Project Approval, as outlined in **Section 1.3.4**.

AII.10 Assessment of Results – Willow Creek

The noise environment at this location was dominated by environmental sources including windblown vegetation and livestock. Noise from mining activities at CVO was inaudible at this location.

Table 15 : Willow Creek noise monitoring results

Period	Criteria	Date	Time	L_{Aeq}	L_{A90}	CVO Contribution	Description of Noise Environment	Local Weather	Regional Weather[2]
Day	43	7/04/2021	17:21	38	28	n/a[1]	Noise environment dominated by animal (insect and livestock) noise, aircraft and light wind. No audible contribution from the CVO.	NE at 1ms	NE at 1.3ms
		7/04/2021	17:37	32	28	n/a[1]			
Evening	38	7/04/2021	18:00	40	37	n/a[1]	Measured noise levels controlled by windblown vegetation (wind speeds noticeably increase after sunset). Activities within the CVO were visible but not audible.	NE at 3 to 4ms	NE at 3.7ms
		7/04/2021	18:15	44	40	n/a[1]			
Night	35	8/04/2021	0:18	39	37	n/a[1]	Windblown vegetation and frog noise dominate measurement data. No audible contribution from the CVO.	N at 2ms	NNW at 4.5ms
		8/04/2021	0:34	43	36	n/a[1]			

Note 1: Mining operations not audible during assessment.

Note 2: Prevailing meteorology assessed on basis of regional conditions in accordance with provisions of INP and Project Approval, as outlined in **Section 1.3.4**.

AII.11 Assessment of Results – Chesterfield

Noise monitoring was undertaken at the Blast Vibration Monitoring (BVM) compound, approximately 250m south-west of the residence (and closer to the CVO). The noise environment at this location was characterised by environmental sources including windblown vegetation, insects, livestock and occasional road traffic noise. Noise from mining activities at CVO was inaudible at this location.

Table 16 : Chesterfield noise monitoring results

Period	Criteria	Date	Time	L_{Aeq}	L_{A90}	CVO Contribution	Description of Noise Environment	Local Weather	Regional Weather[2]
Day	43	9/04/2021	9:47	51	47	n/a[1]	Noise levels controlled by windblown vegetation and background of insect noise. Transportation sources (road and aircraft) occasionally audible. No audible contribution from the CVO.	NW at 4ms	WNW at 8ms
		9/04/2021	10:02	51	46	n/a[1]			
Evening	38	7/04/2021	18:56	36	32	n/a[1]	Environmental noise sources dominated this location (livestock and insects). Road traffic from both Woodville and Cadia Roads occasionally audible. No audible contribution from CVO.	Calm	NE at 3.9ms
		7/04/2021	19:11	35	32	n/a[1]			
Night	35	8/04/2021	1:13	36	33	n/a[1]	Constant insect and frog noise, with occasional car on Cadia Road. No audible contribution from the CVO.	Calm	NNW at 2.9ms
		8/04/2021	1:29	37	33	n/a[1]			

Note 1: Mining operations not audible during assessment.

Note 2: Prevailing meteorology assessed on basis of regional conditions in accordance with provisions of INP and Project Approval, as outlined in **Section 1.3.4**.

AII.12 Assessment of Results – Rosebank

Monitoring was conducted at a position approximately 50 metres north of the residence. The noise environment at this location was characterised by residential noise sources, including local vehicle movements, tools, and a fan or air compressor, and environmental noise sources including windblown vegetation, birds, insects, and livestock noise. Noise from mining activities at CVO was continually audible at this location during the evening and night periods, but was assessed to be compliant.

Table 17 : Rosebank noise monitoring results

Period	Criteria	Date	Time	L_{Aeq}	L_{A90}	CVO Contribution	Description of Noise Environment	Local Weather	Regional Weather[2]
Day	43	9/04/2021	8:39	58	36	n/a[1]	Residential noise dominates (vehicles, tools, machines), with occasional noise from wind gusts or horses. No CVO contribution.	SE at 1 to 2 m/s	WNW at 6ms
		9/04/2021	8:53	54	37	n/a[1]			
Evening	38	7/04/2021	19:11	40	37	30	Occasional wind gusts, frequent noise from horses, and a fan operating nearby. CVO audible in background, mixed with crickets; CVO contribution was determined as noise 2kHz and below.	E at 1 to 3 m/s	NE at 2.3ms
		7/04/2021	19:16	37	35	32			
Night	36	8/04/2021	1:09	33	30	32	CVO continuous noise dominates the environment, with occasional interruptions from nearby horses and wind in foliage	Calm	NNW at 2.9ms
		8/04/2021	1:25	30	26	31			

Note 1: Mining operations not audible during assessment.

Note 2: Prevailing meteorology assessed on basis of regional conditions in accordance with provisions of INP and Project Approval, as outlined in **Section 1.3.4**.

AII.13 Assessment of Results – 247 Newbridge Road

Measurements were undertaken on driveway at gate entrance to property to avoid disturbance to resident, and exclude intermittently audible talking / music emanating from dwelling. This location was approximately 60m from the dwelling and equidistant to the CDF, and would be representative of any contribution from the site. Background contributions from road traffic, gusting wind, and bird noise dominate noise environment at this monitoring location. Noise sources within the Cadia Dewatering Facility (CDF) were audible at this location but were found to comply with the criteria during all measurements.

Table 18 : 247 Newbridge Road noise monitoring results

Period	Criteria	Date	Time	L_{Aeq}	L_{A90}	CVO Contribution	Description of Noise Environment	Local Weather	Regional Weather[2]
Day	50	8/04/2021	16:42	56	29	<20	Road traffic dominates measurement, with insect noise forming the background. CDF noise is occasionally audible in the form of impact noise from container handling, with peaks of ~31-34 dB(A).	NW to 1 m/s	ENE at 1.9ms
		8/04/2021	16:58	62	28	n/a[1]			
Evening	42	6/04/2021	20:10	38	35	n/a[1]	Noise environment dominated by windblown vegetation (poplar trees) at residence. No audible contribution from the CDF.	NE at 2 to 3ms	ESE at 3.1ms
		6/04/2021	20:27	44	38	n/a[1]			
Night	42	7/04/2021	0:36	32	28	25	Noise environment dominated by environmental noise (windblown vegetation and insects / frogs). Occasional heavy vehicle noise from Mid-Western Highway also audible. CDF was intermittently audible within background when wind speed / wind noise drops (filter press and engine noise from mobile plant within the building). Contribution from the CDF estimated to be in order of 25dB(A).	NE at 1 to 2ms	E at 1.9ms
		7/04/2021	0:51	34	30	25			

Note 1: Mining operations not audible during assessment.

Note 2: Prevailing meteorology assessed on basis of regional conditions in accordance with provisions of INP and Project Approval, as outlined in **Section 1.3.4**

AII.14 Assessment of Results – Hollwood

Background contributions from windblown vegetation, livestock and road traffic noise define the noise environment at this monitoring location. Noise sources within the Cadia Dewatering Facility (CDF) were briefly audible at this location during the day period but were found to comply with the criteria during all measurements.

Table 19 : Hollwood noise monitoring results

Period	Criteria	Date	Time	L_{Aeq}	L_{A90}	CVO Contribution	Description of Noise Environment	Local Weather	Regional Weather[2]
Day	43	8/04/2021	17:26	38	30	21	Windblown vegetation dominates noise environment, with occasional noise from traffic on Newbridge Rd. CDF container handling audible on occasion, with peaks up to 46 dB(A)	NW to 1 m/s	ENE at 1.9ms
		8/04/2021	17:43	41	32	n/a[1]			
Evening	35	6/04/2021	20:53	45	42	n/a[1]	Noise environment controlled by windblown vegetation. Heavy vehicles (compression braking) on Mid-Western Highway on northern approach to Blayney occasionally audible when wind calms. No audible contribution from the CDF.	NE at 3ms	E at 1.9ms
		6/04/2021	21:08	42	40	n/a[1]			
Night	35	7/04/2021	0:54	34	29	n/a[1]	Wind in foliage is dominant, with frog noise forming the background. No CDF contributions audible.	SE at 1 to 2 m/s	E at 1.9ms
		7/04/2021	1:11	38	34	n/a[1]			

Note 1: Mining operations not audible during assessment.

Note 2: Prevailing meteorology assessed on basis of regional conditions in accordance with provisions of INP and Project Approval, as outlined in **Section 1.3.4**

AII.15 Assessment of Results – Athol

Contributions from rustling vegetation, intermittent road traffic and bird noise typically control total noise levels at this monitoring location, but CDF was clearly audible during all assessment periods. Activities associated with activities from nearby facility not associated with the CDF were also audible. CDF contributions were found to comply with the criteria during all measurements.

Table 20 : Athol noise monitoring results

Period	Criteria	Date	Time	L_{Aeq}	L_{A90}	CVO Contribution	Description of Noise Environment	Local Weather	Regional Weather[2]
Day	38	8/04/2021	16:03	55	34	32	Frequent road traffic noise dominates, along with residential noise from lawnmower and whippersnapper. Noise from CDF (pump operation) is occasionally audible when other sources are quiet.	NW at 1 m/s	ENE at 1.9ms
		8/04/2021	16:19	53	40	n/a[1]			
Evening	38	6/04/2021	20:23	46	32	33[3]	Continuous CDF noise (pump & compressor) dominates, with occasional road traffic. Some CDF impacts also audible. Frogs & crickets contribute to background along with CDF noise. CDF contribution was taken as frequencies less than 3.15kHz	SE to 2 m/s	ESE at 3.1ms
		6/04/2021	20:31	49	33	33			
Night	35	7/04/2021	1:15	39	33	33	With exception of occasional road traffic, noise levels at this location were controlled by emissions from the CDF (pump farm, air compressors, filter press and engine noise from mobile plant inside building). Contribution evaluated as L_{Aeq}<3.15kHz to exclude any potential effects of insect noise. Short term noise level peaks from the CDF were less than 40dB(A)	NE at 1ms	ESE at 1.9ms
		7/04/2021	1:31	33	31	33			

Note 1: Mining operations not audible during assessment.

Note 2: Prevailing meteorology assessed on basis of regional conditions in accordance with provisions of INP and Project Approval, as outlined in **Section 1.3.4**

Cadia Valley Operations - AEMP

Annual Report 2020 - 2021

Newcrest Mining Limited

27 September 2021

The Power of Commitment

GHD Pty Ltd | ABN 39 008 488 373
180 Lonsdale Street, Level 9
Melbourne, Victoria 3000, Australia
T +61 3 8687 8000 | **F** +61 3 8732 7046 | **E** melmail@ghd.com | **ghd.com**

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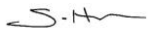
S4	0	P Lind	S Harrow		D Scott		27/09/2021

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Executive summary

The Newcrest Cadia Valley Operations (CVO) environmental monitoring program includes an Aquatic Ecosystem Monitoring Project (AEMP) implemented biannually since spring 2006. The AEMP focusses on the assessment of macroinvertebrates, fish, and aquatic habitat condition potentially impacted by mine operations, within and surrounding the CVO mine lease area (MLA). This report presents data collected during the spring 2020 and autumn 2021 monitoring periods and includes additional eDNA monitoring for platypus. Major findings in this report are:

- There were several high rainfall events between July 2020 and May 2021 that resulted in high flows upstream of Cadiangullong Dam. However, low flows persisted downstream of the dam at CC1 due to the capture and storage of water.
- Flows further downstream and in other waterways varied in response to rainfall and associated surface water and groundwater contributions.
- Disturbances to riparian zone vegetation and broader catchment scale land-use are likely to be impacting on aquatic ecosystem health regardless of mining activities.
- There was no evidence to suggest mining activities have impacted on water quality of Cadiangullong Creek or Rodd's Creek.
- Relatively higher concentrations of barium, cobalt, iron, manganese and selenium were detected at CC1 which had not previously been observed. This site is upstream of the CVO MLA and only water from Cadiangullong Dam passes through this site and the reasons for this are not known.
- As found in previous monitoring periods, there was evidence of increased copper in the sediments of Cadiangullong Creek downstream of the mine at CC2 and CC3 where concentrations exceeded the upper ANZG (2018) guideline. Due to the geomorphology of CC2, the pool at this site appears to act as a sink for copper.
    - Sediment transport from CC2 and CC3 with copper bound to it may occur during higher flow events and appears to be dependent on a) the connectivity between CC2 and downstream reaches, b) the frequency and size of the high flow events, and c) the size of the sediment particles
    - Despite elevated concentrations at CC2 and CC3, copper was found to dissipate further downstream at CC4
    - Although copper concentrations at CC4 were higher than upstream of the mine, the dissipation downstream reduces potential ecological risks with conditions no longer exceeding the upper ANZG (2018) guideline
- Macroinvertebrate communities of all waterways are potentially impacted by multiple disturbances irrespective of mine operations including high salinity or nutrient levels, agricultural pollution, or the downstream impacts of dams.
- There was some evidence that site CC2 was less healthy than other sites on Cadiangullong Creek or reference sites. It is likely habitat conditions are more influential on macroinvertebrate community health than water or sediment quality.
- Sediment analytes were not found to be a major contributor to macroinvertebrate health. This includes the relatively high copper concentrations at CC2.
- A relatively healthy fish community dominated by the native Mountain Galaxias (*Galaxias olidus*) remains distributed throughout Cadiangullong Creek, along with Flyers Creek and Swallow Creek. Spring recruitment of juveniles indicates a self-sustaining population with adequate recruitment.
- The most recent eDNA monitoring for platypus suggest they remain distributed throughout Cadiangullong Creek with the exception of the most downstream site CC4 at Oaky Station, where they have been regularly absent.

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Appendix A Site location details for the CVO AEMP
Appendix B Field sheets summarising habitat conditions
Appendix C Sediment quality analytes schedule and results (spring 2020 and autumn 2021)
Appendix D Long term patterns in macroinvertebrate indices

1. Introduction

1.1 Background

Cadia Valley Operations (CVO) is the largest gold and copper producer in New South Wales (NSW) and is one of Australia's largest gold mining operations. It is located approximately 25 km from the city of Orange in central west NSW and is 250 km west of Sydney. CVO is 100% owned by Newcrest Mining Ltd (Newcrest).

The CVO mine lease area (MLA) and associated land holdings cover over 9000 ha and current operations include the underground mining of copper and gold at 'Cadia East' and an ore processing facility. The Cadia Hill open pit mine ceased operation and has been in a state of care and maintenance since July 2012.

The key activities, both currently and historically, carried out at CVO include:

– Underground block and panel caving mining of copper and gold currently at Cadia East and historically at Ridgeway
– Open pit mining of copper and gold at Cadia Hill – ceased in 2012 now in care and maintenance phase
– Processing of ores
– Waste rock storage
– Tailing storage
– Water storage in Cadiangullong Dam and Rodd's Creek Dam

As part of the Newcrest CVO environmental monitoring program, an Aquatic Ecosystem Monitoring Project (AEMP) is implemented on a biannual basis (autumn and spring). Commencing in spring 2006, this AEMP has focused on the assessment of macroinvertebrate and fish populations, and aquatic habitat condition of streams potentially impacted by mine operations within and surrounding the CVO MLA. GHD Pty Ltd (GHD) was commissioned to conduct the most recent monitoring events for the AEMP from 5 to 11 December 2020 (spring) and 1 to 6 May 2021 (autumn).

1.2 Scope and limitations

This report details the AEMP and documents the field sampling conducted by GHD in spring 2020 and autumn 2021. It describes the methodology, results for the various components of the monitoring program, and discusses these in relation to various assessment criteria (where applicable) and in the context of the mining operation.

This report has been prepared by GHD for Newcrest Mining Ltd and may only be used and relied on by Newcrest Mining Ltd for the purpose agreed between GHD and Newcrest Mining Ltd. GHD otherwise disclaims responsibility to any person other than Newcrest Mining Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible. The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points, and on conditions encountered and information reviewed at the date of preparation of the report. Site conditions at other parts of the mine may be different from the site conditions found at the specific sample points. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

Investigations undertaken in respect of this report are constrained by the particular site conditions. As a result, not all relevant site features and conditions may have been identified in this report. Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

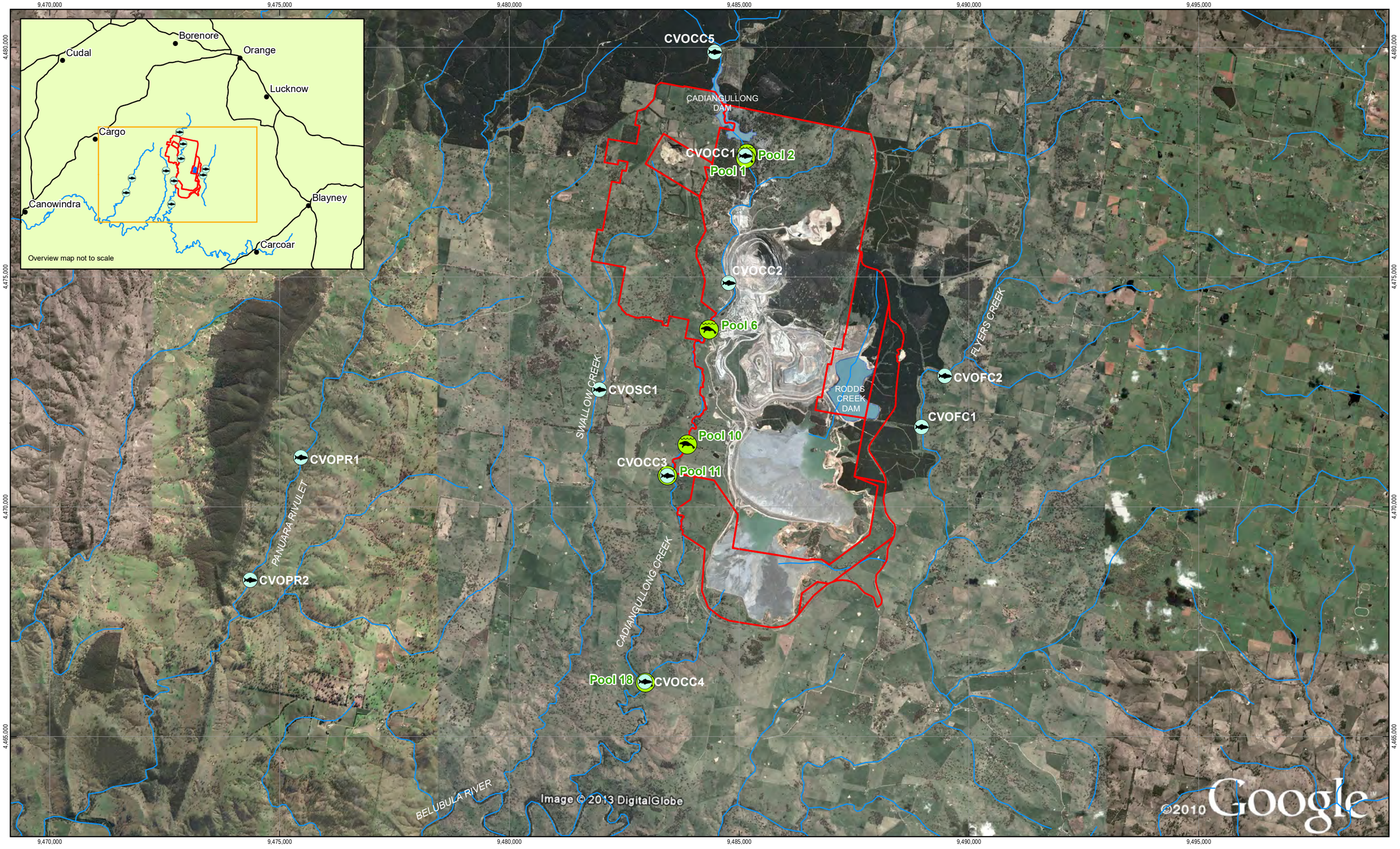
1.3 Rationale for using biological indicators

Aquatic macroinvertebrates are widely accepted and used for biological assessment of rivers and streams. The use of macroinvertebrates in ecosystem disturbance studies stems from their high abundance and diversity, sensitivity to changes in water quality, flow regime and habitat conditions, ease of sampling, a good understanding of their taxonomy and ecological requirements, and an ability to detect long-term impacts (DNR, 2001). The successful application of macroinvertebrates for biological assessment in the mining industry has been demonstrated both within Australia and overseas (Brycroft et al., 1982; Dudka & Adriano, 1997; Norris et al., 1982; Faith et al., 1995; Humphrey et al., 1995). Traditionally, biological indices such as diversity and pollution indices have been used to determine the level of impact (Garcia-Criado et al., 1999).

Fish have been widely used as indicators of water quality throughout the world and were the basis for the North American Index of Biological Integrity (IBI) that has been modified for use in temporary streams and Australian inland rivers. The quantitative monitoring of fish has been applied successfully to the assessment of water quality impacts in temporary waters in Australia. Previous studies of fish populations within streams in the CVO area (Bauer, 1995; Goldney, 2000; Ecowise Environmental, 2007, 2008; ALS, 2010, 2011; GHD, 2012 to 2020) have identified the occurrence of five species; only one of which, Mountain Galaxias (*Galaxias olidus*), is native to the region. The other four exotic species recorded in past studies include Redfin Perch (*Perca fluviatilis*), Eastern Gambusia (*Gambusia holbrooki*), Rainbow Trout (*Oncorhynchus mykiss*) and Brown Trout (*Salmo trutta*).

1.4 Study area

Cadiangullong Creek is the main focus of the AEMP as it runs in a southerly direction directly through the mine and is therefore susceptible to impacts from mining operations (Figure 1). Cadiangullong Dam, a key water supply for mining facilities and environmental flow releases (termed '*riparian releases*'), is located upstream of the main CVO mining facilities. A 2.4 km diversion, excavated from igneous rock, was created around open cut mining operations to allow for continuation of water supply to downstream reaches of Cadiangullong Creek. Cadiangullong Creek flows south into the Belubula River, approximately 14 km downstream of the CVO southern lease boundary. Flyers Creek, Swallow Creek, Diggers Creek, Panuara Rivulet and Rodd's Creek are monitored in the AEMP and also flow into the Belubula River.



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LEGEND

- Platypus Monitoring Sites
- Aquatic Monitoring Sites
- Cadia Valley Operations MLA
- Water Storage/Reservoir
- Roads
- River/Creek

Newcrest Pty Ltd
Cadia Valley Operations - Aquatic Ecosystem Monitoring Project

Job Number 23-12540968
Revision B
Date 12 Jul 2021

Aquatic Ecosystem Monitoring Sites Surface Water Features

Figure 1

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Level 6, 20 Smith Street Parramatta NSW 2150 Australia **T** 61 2 8898 8800 **F** 61 2 8898 8810 **E** sydmail@ghd.com **W** www.ghd.com

1.5 Monitoring locations

Twelve sites were monitored in the AEMP during spring 2020 and autumn 2021 with site locations enabling comparisons of different treatments (Table 1; Figure 1). Five sites were located on Cadiangullong Creek (CC1 to CC5), the main waterway flowing through the CVO MLA (Plate 1). One site was located on Swallow Creek (SC1) and two sites on Panuara Rivulet (PR1 and PR2) to the west of the MLA (Plate 2). One site was also located on Rodd's Creek (RC1) and Diggers Creek (DG1) (Plate 2). Two sites were located on Flyers Creek (FC1 and FC2) to the east of CVO (Plate 3).

Table 1 Monitoring site locations

Waterway	Site code	Site treatment
Cadiangullong Creek	CC5	Upstream
	CC1	Upstream
	CC2	On-site
	CC3	Downstream
	CC4	Downstream
Flyers Creek	FC2	Reference
	FC1	Reference
Panuara Rivulet	PR1	Reference
	PR2	Reference
Swallow Creek	SC1	Reference
Rodd's Creek	RC1	On-site (downstream tailings dam)
Diggers Creek	DG1	Upstream

In addition to the standard AEMP monitoring components, monitoring of platypus was also undertaken during the spring 2020 and autumn 2021 period (Figure 1). Under normal conditions, the CVO riparian releases are approximately 2.8 ML/day and are aimed at achieving 0.9 ML/day at Oaky Creek. However, due to a lack of water in Cadiangullong Dam during 2019 CVO applied to the NSW Department of Water and Energy (DWE) for a variation to the riparian release conditions and to temporarily cease the releases into Cadiangullong Creek. To support the DWE application and address specific questions related to ecological risks should the releases cease, GHD prepared a report that recommended a three-stage monitoring program (GHD, 2019a). The aims of the program were to determine the current distribution of platypus in Cadiangullong Creek, predict changes during the cease-to-flow period, and identifying potential management actions to mitigate against potential impacts.

Monitoring of platypus and associated water quality and habitat conditions (generally on a monthly basis) was carried out between March 2019 and July 2020 with environmental DNA (eDNA) sampling used to determine platypus presence (GHD 2020a). The overall findings from the monitoring were that platypus persisted in Cadiangullong Creek, even during the cessation of the riparian releases, and continued to persist once releases were reinstated. The monthly monitoring program ceased in July 2020 although CVO decided to include the eDNA component in the AEMP to continue tracking platypus distribution.

CC1 	**CC1**
CC2 	CC2
CC3 	CC3
CC4 	CC4
CC5 	CC5

Plate 1 ***Cadiangullong Creek site photographs in spring 2020 (left) and autumn 2021 (right)***

RC1 	**RC1**
SC1 	SC1
DG1 	DG1
PR1 	PR1
PR2 	PR2

Plate 2 ***Reference sites and off-site photographs spring 2020 (left) and autumn 2021 (right)***

FC1 	**FC1**
FC2 	FC2

Plate 3 Flyers Creek site photographs in spring 2020 (left) and autumn 2021 (right)

2. Methodology

2.1 Permits and licences

GHD has current NSW Fisheries permits and licenses to conduct macroinvertebrate and fish monitoring in NSW rivers and streams and staff operate under a NSW Department of Primary Industries (DPI) Fisheries permit, issued under section 37 of the *Fisheries Management Act 1994* (Permit No: P07/0142-4.0 & OUT13/22250).

2.2 Aquatic habitat

The aquatic habitat assessment was undertaken following methods described in the NSW AUSRIVAS Manual (Turak et al., 2004) that includes a range of physical habitat measurements and the Visual Assessment of Disturbance Related to Human Activities (VisAssess). This visual assessment method is an evidence-based approach of grading the degree of anthropogenic impacts at a monitoring site based on four assessment categories:

– Water Quality: odour, water clarity, disruption of the natural hydrology, presence of foam from detergents, oil
– Instream: change in substrate (e.g. rock piles or sedimentation from road construction or other development pipes), rubbish, filamentous algae, alien fish species, invasion by exotic aquatic plants
– Riparian Zone: de-vegetation, exotic plant invasion, bank degradation, point sources
– Catchment: mine, sewage treatment plant, landfill, dam, industry, logging, agriculture, clearing, salinity, grazing, urban development

A ranking of 0 to 4 and an associated description is assigned for each category with a higher score indicating a higher level of anthropogenic impact (Table 2). The Total Visual Assessment Score is the sum of these rankings for each site, which provides an overall assessment of anthropogenic impacts ranging from 0 to 16.

Table 2 ***NSW AUSRIVAS VisAssess ranking categories, descriptions and total scores***

Ranking	Description	Total Visual Assessment Score
0	No evidence of disturbance	0 -2
1	Little disturbance	3 – 5
2	Moderate disturbance	6 – 8
3	High disturbance	9 – 12
4	Extreme disturbance	13 - 16

2.3 Water quality

In situ water quality recordings were made from the surface at each site for the following physico-chemical parameters:

– Temperature (°C)
– pH (pH units)
– Electrical Conductivity (µS/cm)
– Dissolved Oxygen (% saturation and mg/L)
– Turbidity (NTU)
– Alkalinity (mg/L CaCO3)

Temperature, pH, electrical conductivity and dissolved oxygen were recorded at each site using a YSI 556 multi-parameter water quality meter. This meter was calibrated in accordance with QS/QA (Quality System/Quality Assurance) requirements and the manufacturer's specifications. Alkalinity was measured using a Hach Digital Alkalinity Titration kit. Turbidity was measured using a Hach 2100Q portable turbidimeter. The water quality results were compared to ANZG (2018) default guideline values for slightly disturbed upland rivers of south eastern Australia (previously known as ANZECC, 2000).

2.4 Sediment quality

2.4.1 Sampling

Sediment quality has been included in the monitoring program since autumn 2018 to fill a knowledge gap identified following a review of the water quality, environmental and biological data for CVO (GHD, 2018). One of the key recommendations from the review was to include sediment monitoring to assess its relationship with benthic macroinvertebrate communities. There was some evidence of a relationship between macroinvertebrate communities and sediment in autumn 2018, so monitoring continued to determine whether there was evidence of seasonal variation in sediment quality.

From a minimum of five locations at each site, sediment was collected and consolidated into a single composite sample. Sediment from multiple locations encapsulates variation associated with different habitats and hydrological units and allows for a more standardised procedure for comparing sediments amongst sites. The sediment samples were analysed for a suite of total metals (Table 3).

Table 3 Analytical schedule – sediment samples

Laboratory analyses	Analytes
Total metals	Aluminium (Al), Antimony (Sb), Arsenic (As), Barium (Ba), Beryllium (Be), Cadmium (Cd), Chromium (Cr), Cobalt (Co), Copper (Cu), Iron (Fe), Lead (Pb), Manganese (Mn), Mercury (Hg), Molybdenum (Mo), Nickel (Ni), Selenium (Se), Silver (Ag), Zinc (Zn)

2.4.2 Data analysis

In previous seasons, sediment concentrations were compared to ANZECC (2000) interim sediment quality guidelines (ISQG) for 95% level of protection for slightly to moderately disturbed ecosystems. These guidelines have now been reviewed and updated and in this report, sediments concentrations are compared to default guideline values (DGVs) published in ANZG (2018). The sediment DGVs indicate concentrations below which there is a low risk of unacceptable effects occurring in aquatic ecosystems (ANZG, 2018). Upper guideline values are also published to provide an indication of concentrations at which toxicity-related adverse effects may be expected (ANZG, 2018). The sediment concentrations in this report have compared to both the DGVs and upper DGVs.

Note that the major toxic effect of metals on the macroinvertebrate communities is due to the dissolved form of metals in an ecosystem (ANZG, 2018). As such, the total metal concentrations assessed in this monitoring program overestimate the fraction that is bioavailable.

Relationships in sediment quality amongst sites were examined using a Principal Components Analysis (PCA) that reduces a large set of variables into a small set that retains most information associated with the large set. In this case, the suite of metals listed in Table 3 were reduced to two principal components (PC1 and PC2). These principal components were used as axes in PCA ordinations to graphically represent sites in ordinal space. Principal component scores explain the percentage of variation in the sediment quality contributed by each axis and linear coefficients define the contribution of each analyte to each axis. Vectors plotted on the PCA ordination superimpose environmental gradients. Prior to performing the PCA, the data were normalised to ensure scale independence. PCA analyses were conducted using PRIMER Version 7 (Clarke & Warwick, 2001). Note that where sediment results were presented as below laboratory limits of resolution (LOR), these values were halved (i.e. <0.5 / 2 = 0.25 and <1 / 2 = 0.5 respectively) and retained in the analysis. Antimony, cadmium and silver were removed from analyses as all values were below laboratory detection limits and provided no information about variation.

2.5 Macroinvertebrates

2.5.1 Sampling

Macroinvertebrates were sampled in accordance with the NSW AUSRIVAS Sampling and Processing Manual (Turak et al., 2004). At each site, the littoral or edge habitat was sampled by sweeping the collecting net along the edge of the stream in areas of little or no current. Where present, riffles were sampled using a kick sampling method.

For each sample, the collected material was placed into a sorting tray and macroinvertebrates '*live picked*' for a minimum of 40 minutes. Live picked macroinvertebrates were preserved in 70% ethanol and labelled with information including site code, site location, habitat, sampling method, date, sampler and picker.

2.5.2 Laboratory processing

Macroinvertebrates samples were examined using Leica M80 or S6 series stereo-dissection microscopes with a minimum of 6.3:1 zoom and a standard magnification of 7.5-60x. Freshwater macroinvertebrates were identified using published taxonomic keys (Hawking, 2000), unpublished working keys and an extensive specimen reference collection maintained by GHD. Based on standard conventions for NSW AUSRIVAS models (Turak et al., 2004) macroinvertebrates were identified to family-level with the following exceptions:

– Chironomidae (Diptera) were identified to Sub-family (e.g. Orthocladiinae, Chironominae and Tanypodinae)
– Groups such as Nematoda, Oligochaeta and Acarina were identified to Class or Order
– Microcrustacea, Ostracoda, Copepoda and Cladocera were identified to the Order

Upon completion of identifications, all samples were returned to 100% ethanol for long-term archiving. This process allows samples to be re-examined at a later date if required. This may be important, particularly if taxonomy changes significantly in the future under a long-term monitoring program or for QA/QC purposes. GHD will ensure archived samples are retained for the life of the AEMP. Reference specimens will remain the property of GHD.

2.5.3 Data analysis

The data analyses in this AEMP is designed to achieve the key objective of developing an understanding of macroinvertebrate communities as an indicator of aquatic ecosystem health.

Univariate analyses - Biological indices

The biological indices calculated from the macroinvertebrate data include:

– Taxa Richness
– EPT Taxa Richness
– SIGNAL-2
– NSW AUSRIVAS models: spring, autumn, and combined season edge and riffle where applicable

Taxa Richness

Taxa Richness refers to the number of different taxa (identified to levels outlined in Section 2.5.2) contained in a sample. Taxa Richness can reasonably indicate ecological health with healthy waterways generally having more taxa.

EPT Taxa Richness

The EPT Raxa Richness index refers to the number of key macroinvertebrate taxa (identified to family level) belonging to the Orders **E**phemeroptera, **P**lecoptera and **T**richoptera. These Orders are generally considered to contain pollution–sensitive insects and a loss of families usually indicates some level of disturbance (Plafkin et al*.,* 1989).

SIGNAL-2

SIGNAL-2 (Stream Invertebrate Grade Number Average Level) is a simple scoring system for macroinvertebrates in Australian rivers (see Chessman, 2003). SIGNAL-2 is a biotic index based on pollution sensitivity values (grade numbers) assigned to aquatic macroinvertebrate taxa at the Order and Family levels. These grades have been derived from published and unpublished information on taxa tolerance to pollutants such as sewage and nitrification (Chessman, 1995). Each taxon is assigned a grade from 1 (tolerant) to 10 (sensitive) based on eco-toxicity assessment data.

Not all macroinvertebrate families have been assigned a SIGNAL-2 grade and those without are removed from SIGNAL-2 calculations which is the average of the grades within a sample. SIGNAL-2 scores only use the presence of taxa and are not weighted with regard to abundance. For easier interpretation, SIGNAL-2 scores and the number of macroinvertebrate taxa are graphed using a bi-plot. The resulting bi-plot is placed into context using a quadrant diagram that divides the results into four general realms, with each indicating various factors of site condition that may explain the macroinvertebrate community SIGNAL-2 score (Figure 2).

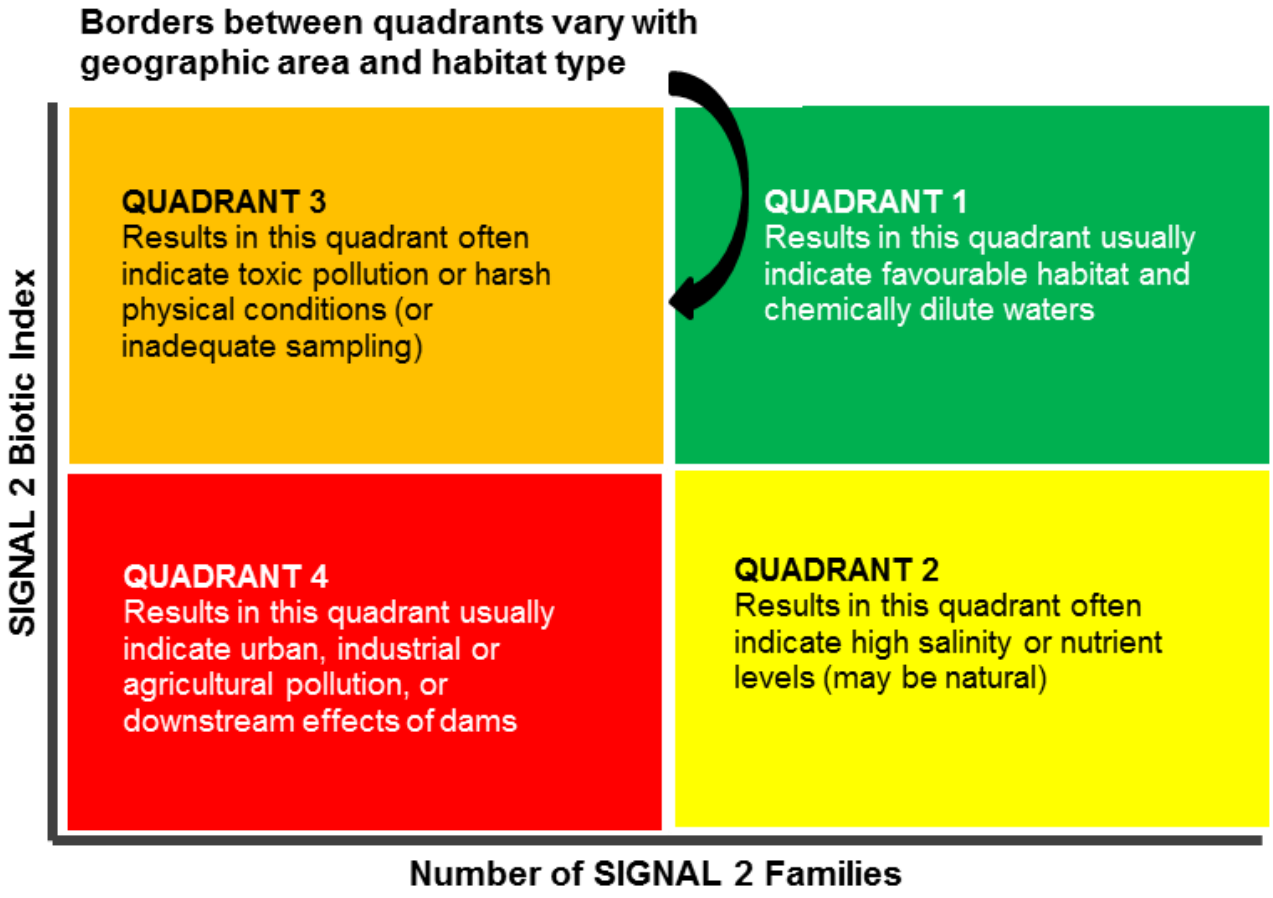

Figure 2 *SIGNAL-2 bi-plot displaying the four quadrants and explanations of what each indicates*

The SIGNAL-2 quadrant boundaries have been set according to the NSW interim boundaries suggested for sites within the Murray Darling basin above 400 m elevation (Chessman, 2001). These are a SIGNAL-2 score of 5 and 19 for number of families in edge habitats, and SIGNAL-2 score of 6 and 17 for number of families in riffle habitats.

NSW AUSRIVAS Model

All macroinvertebrate data, water quality parameters and habitat variables required by the AUSRIVAS models were collected according to the NSW AUSRIVAS manual (Turak et al., 2004) and ANZG (2018) Water Quality Guidelines for aquatic ecosystems in south eastern Australia. NSW AUSRIVAS models and accompanying scores and bandings have been used to detect changes in observed and expected macroinvertebrate communities for sites associated with the AEMP and include:

– NSW - Spring Riffle
– NSW - Spring Edge
– NSW - Autumn Riffle
– NSW - Autumn Edge
– NSW - Autumn + Spring (combined season) Riffle
– NSW - Autumn + Spring (combined season) Edge

AUSRIVAS generates site-specific predictions of the macroinvertebrate fauna expected to be present in the absence of environmental stress. The expected fauna from reference sites with a similar set of physical and chemical characteristics are compared to the observed fauna, and the ratio derived is used to indicate the extent of the impact. This ratio can range from zero (0), when none of the expected taxa are found at a site, to approximately one (1), when all the expected taxa are present. The value can also be greater than one (1) when more families are found at a site than predicted by the model. The ratio scores are placed in bands which indicate whether the site is richer than reference, reference quality, significantly impaired, severely impaired or extremely impaired. An example of outputs from the AUSRIVAS models (i.e. O/E 50 upper limits and band descriptions) are demonstrated for the combined season edge and riffle models in Table 4.

Table 4 AUSRIVAS bands, O/E 50 upper limits, and band names and descriptions for the NSW combined season models

Band Label	O/E 50 Upper Limit Edge	O/E 50 Upper Limit Riffle	Band Name	Band Description
Band X	>1.17	>1.14	More biologically diverse than reference sites.	More taxa found than expected. Potential biodiversity hot spot. Possible mild organic enrichment.
Band A	1.17	1.14	Reference condition	Most/all of the expected families found. Water quality and/or habitat condition roughly equivalent to reference sites. Impact on water quality and habitat condition does not result in a loss of macroinvertebrate diversity.
Band B	0.82	0.85	Significantly impaired	Fewer families than expected. Potential impact, either on water quality or habitat quality or both, resulting in loss of taxa.
Band C	0.48	0.57	Severely impaired	Many fewer families than expected. Loss of macroinvertebrate biodiversity due to substantial impacts on water and/or habitat quality.
Band D	0.14	0.29	Extremely impaired	Few of the expected families remain. Extremely poor water and/or habitat quality. Highly degraded.

Multivariate Analysis

Multivariate analyses were performed on the macroinvertebrate data for both spring and autumn separately as strong seasonal differences have previously been identified by the AEMP. Edge and riffle habitats were also analysed separately due to differences in the communities associated with these habitats. The multivariate analyses were utilised to determine if significant differences in the macroinvertebrate community existed spatially. That is, are there significant differences between sites associated with each treatment type (i.e. upstream, on-site, downstream and reference). All multivariate analyses were performed using the PRIMER V7 software package (Clarke and Gorley, 2015).

Initially, the macroinvertebrate data was transformed to presence/absence data as the RBA sampling protocol is a semi-quantitative technique. Furthermore, transformation of the macroinvertebrate data increases the influence of rare species and decreases potential sample variability based on the inherent variation associated with different sample collectors.

A similarity matrix was subsequently calculated between all samples based on the Bray-Curtis similarity measure. Non-metric multidimensional scaling (nMDS) was then used to produce an ordination plot as a graphical representation of key spatial and temporal trends in the macroinvertebrate assemblages. The stress value associated with the nMDS ordination was examined to identify the accuracy of the ordination. A stress value <0.2 indicates a potential useful 2-dimensional ordination (Clarke and Warwick 2001).

To test if there were statistically significant differences in the macroinvertebrate communities between each treatment type (see Table 1), permutation-based analyses of variance (ANOSIMs) were used using 999 permutations. If significant differences were detected, taxa analysis was conducted using the similarity percentages (SIMPER) routine to identify the taxa that best discriminate between the treatments. SIMPER quantifies the contribution of each taxon to the average dissimilarity between the two groups of samples, and to the average similarity within a group (Clarke and Warwick 2001).

Sediment / macroinvertebrate relationships

A key focus of the sediment monitoring was to assess if there was an association between sediment quality and macroinvertebrate communities. To investigate this, the RELATE, BEST and DISTLM procedures in the PRIMER V7 software package were used (see Clarke and Gorley, 2015). Initially, the RELATE procedure was used to test if there was a correlation between sediment quality and macroinvertebrate communities. That is, to explore if the patterns on the sediment PCA show some correlation to the macroinvertebrate nMDS. Using 999 permutations, RELATE calculates the rank correlation (q) and if the null hypothesis was accepted (significance level $P > 0.05$) no relationship between two data sets is assumed.

The sediment analytes that best explained relationships were identified using the BEST procedure. BEST identifies which analytes most strongly correlated with the macroinvertebrate communities and was carried out by generating a resemblance matrix (based on Euclidean distance) of normalised sediment analytes and matching it, using a Spearman rank correlation, to the macroinvertebrate data.

The limitation of the BEST procedure is it gives an indication of correlation between sediment analytes and macroinvertebrate communities but does not identify how much of the variation in macroinvertebrates communities is explained by each analyte. This was determined using the distanced based linear modelling (DISTLM) procedure to test if there was a significant correlation, using 999 permutations, between each sediment analyte and the macroinvertebrate communities. DISTLM then identifies the percentage variation in the macroinvertebrate community explained by the analytes.

Note that where sediment results were presented as below laboratory limits of resolution (LOR), these values were halved (i.e. <0.5/ 2 = 0.25 and <1 / 2 = 0.5 respectively) and retained in the analysis. However, antimony, cadmium and silver were removed from analyses as all values were below laboratory detection limits and provided no information about variation.

2.6 Fish

2.6.1 Sampling

Electrofishing was conducted in accordance with the Australian Code of Electrofishing Practice (SCFFA, 1997) and GHD's Fauna Survey Standard Operating Procedure to ensure all safety requirements were met prior to commencing work. At each site, the total reach surveyed was defined as 10 x bank full width. Electrofishing was undertaken using an E-fish 500 W Backpack System in areas where the depth, instream habitat, and water quality was suitable for safe operation.

Due to stream depth, elevated conductivity or turbidity electrofishing could not be conducted at CC5 and SC1. At these sites eight baitfish traps (250 mm x 250 mm x 450 mm; 5 mm mesh) were set using a stratified approach to cover all habitat types within the reach. Traps were baited with dry cat biscuits and left overnight for approximately 12 hours. Fish surveys are not conducted at Rodd's Creek (RC1) or Diggers Creek (DG1).

2.6.2 Identification and processing

At each site, fish collected were identified to species using published keys (e.g. Allen et al*.,* 2002; Lintermans, 2007; Kuiter, 2013) and their total length (TL) to the nearest millimetre (mm) recorded. Native species were returned unharmed to the stream. Non-native species were euthanized and disposed of in accordance with ethics permit requirements. All by-catch fauna (e.g. Cherax sp. (Yabbies)) were noted and immediately returned to the stream.

2.7 Platypus

2.7.1 Sampling

At each site, samples were collected in duplicate by passing 200-500 mL water through a 0.22 µm filter (Sterivex) on site. Filters were stored on ice for a maximum of 48 hrs before being transported to the laboratory (EnviroDNA) for processing.

2.7.2 Laboratory processing

DNA was extracted from the filters using a commercially available DNA extraction kit (Qiagen DNeasy Blood and Tissue Kit). Real-time quantitative Polymerase Chain Reaction (qPCR) assays were used to amplify the target DNA, using a species-specific marker targeting a small region of the mitochondrial DNA, previously developed and assessed for specificity and sensitivity by EnviroDNA (Weeks et al., 2015; Lugg et al., 2018). Assays were performed in triplicate on each sample. Negative controls were included for the DNA extraction and qPCR steps. At least two positive PCR's (out of six assays performed for each site) were required to classify the site as positive for the presence of platypus.

3. Results

3.1 Rainfall and hydrology

During the six months prior to the spring 2020 sampling in early December, rainfall in the surrounding catchments of the CVO was generally close to the long-term average (Table 5). There were two exceptions; rainfall was 47% higher than the long-term average in August and 49% higher than the long-term average in October. Rainfall remained higher than the long-term average from January to March prior to the autumn monitoring in April, particularly February and March when it was 85% and 206% higher respectively. However, rainfall during April was 88% lower than the long-term average. Overall, rainfall between June 2020 and May 2021 (1,080 mm) was much higher than for the period between June 2019 and May 2020 (688 mm).

The hydrograph for Cadiangullong Creek upstream of Cadiangullong Dam (CC5) reflected the pattern in rainfall with an increase in mean daily flow following increased rainfall. The peaks in the hydrograph correspond to intense rainstorms in July, August, October and March (Figure 3). Downstream of Cadiangullong Dam at CC1, flows were much lower and remained between 0-3 ML/day from July to mid-October before increasing to 2-7 ML/day from November to May. The peaks in the hydrograph observed at CC5 did not manifest at CC1, indicating the higher flows were captured by Cadiangullong Dam. Sites CC3 and CC4 downstream of the CVO MLA followed rainfall patterns more closely than CC1 as they receive additional runoff and water tributaries. Runoff peaks were observed in July, August and October.

There was little runoff in the Swallow Creek reference site (SC1) throughout the year and from October to May flow was generally below 1 ML/day. However, there were peaks associated with high rainfall in August, October and March. The Flyers Creek reference site (FC1) has more frequent high flow events and higher baseflow than both Swallow Creek and Cadiangullong Creek. High flow events were observed in July, August, October and March following high rainfall. There was a downward trend in baseflow in Flyers Creek from September to March.

Table 5 Monthly rainfall and temperature recorded at Orange Airport (63303) from June 2020 to May 2021

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Total rainfall (mm)	69.2	78.8	121.0	70.8	106.6	55.8	70.2	81.6	145.6	233.8	5.0	41.2
Long-term rainfall mean (mm)	77.0	72.2	82.3	78.0	71.7	78.3	86.3	64.3	78.5	76.5	42.0	49.8
Mean maximum temperature (°C)	10.9	10.5	10.1	15.2	18.5	23.0	23.9	25.5	24.2	20.9	17.7	

Source: BOM (2021)

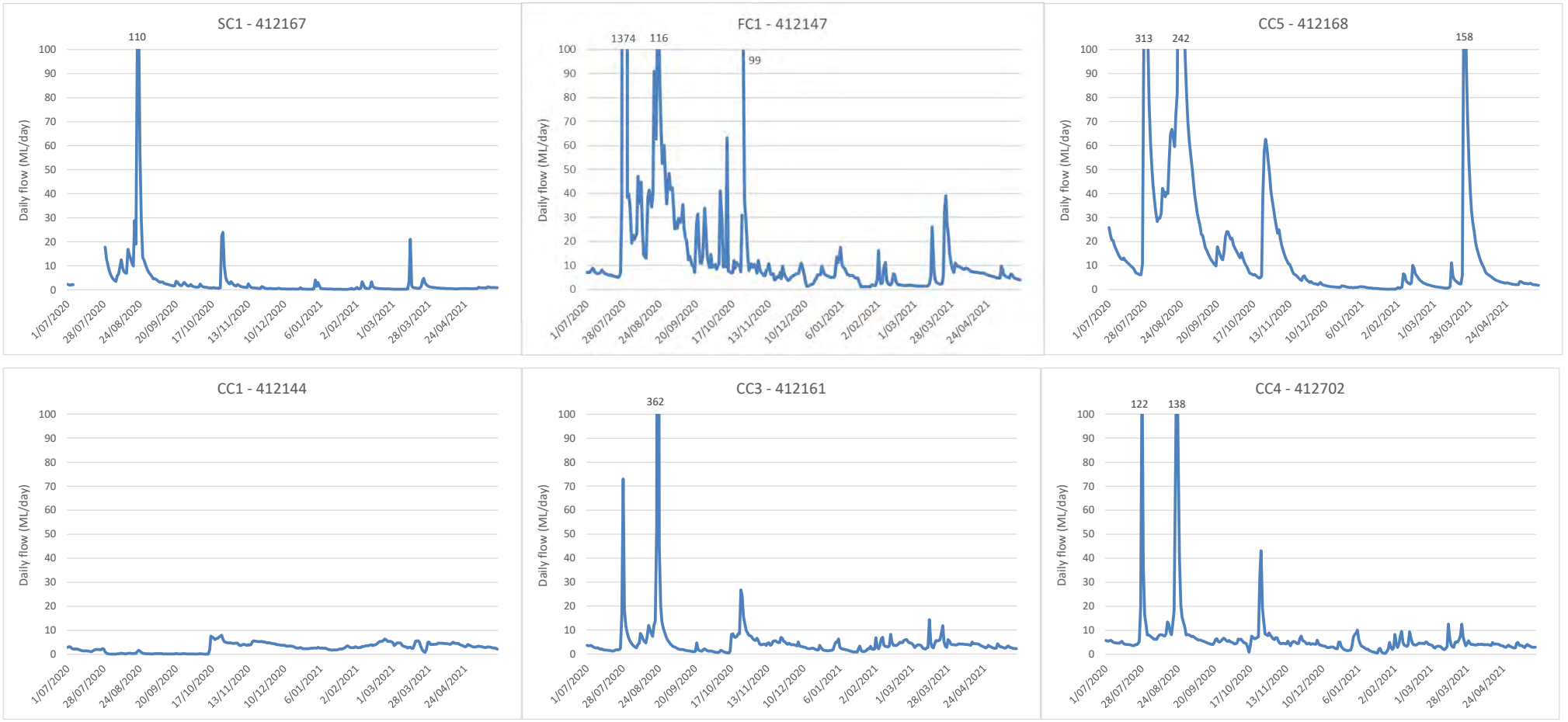

Figure 3 ***Hydrographs from Swallow Creek (SC), Flyers Creek (FC) and Cadiangullong Creek (CC) for the period 1 July 2020 to 18 May 2021***

3.2 Aquatic habitat

Following the NSW AUSRIVAS Visual Assessment of Disturbance Related to Human Activities, the majority of sites on the Cadiangullong Creek were assessed as ‘high disturbance’ (Table 6). Site CC2, which is located on-site at CVO, was categorised as ‘extreme disturbance’ during spring, with water quality being the only disturbance assessment criteria that did not score the maximum value.

The site PR1 on the Panuara Rivulet reference site also recorded levels of ‘extreme disturbance’ in both seasons. Rodd’s Creek reference site (RC1) recorded levels of ‘extreme disturbance’, though this was limited to just autumn. These results were primarily due to the conditions of the riparian zone although catchment conditions also impacted Rodd’s Creek.

In general, sites on the Cadiangullong Creek, Swallow Creek, Flyers Creek, Panuara Rivulet and Rodd’s Creek had ‘high disturbance’ ranks due to the impacts to riparian zone vegetation and broader catchment scale land-use which, aside from mining and associated operations, is heavily influenced by grazing in the mid to lower catchment areas as well as pine plantations in the upper catchment. Excessive algal growth in Panuara Rivulet due in part to agricultural land use and nutrients inputs are demonstrated in Plate 4.

Plate 4 *Filamentous algal growth in Panuara Rivulet spring 2020*

Table 6 *Results of the NSW AUSRIVAS visual assessment of disturbance*

Site	Season	Water Quality	Instream	Riparian Zone	Catchment	Total Score	Rank
CC5	Spring	2	2	3	2	9	High disturbance
	Autumn	2	2	3	2	9	High disturbance
CC1	Spring	2	1	2	2	7	Moderate disturbance
	Autumn	3	2	2	2	9	High disturbance
CC2	Spring	2	4	3	4	13	Extreme disturbance
	Autumn	2	3	4	4	13	Extreme disturbance
CC3	Spring	2	3	3	3	11	High disturbance
	Autumn	2	2	3	3	10	High disturbance
CC4	Spring	2	3	3	3	11	High disturbance
	Autumn	2	3	3	3	10	High disturbance
FC1	Spring	2	2	4	3	11	High disturbance
	Autumn	2	3	4	3	12	High disturbance
FC2	Spring	2	2	3	3	10	High disturbance
	Autumn	2	3	3	3	11	High disturbance
PR1	Spring	3	4	4	3	14	Extreme disturbance
	Autumn	3	3	4	3	13	Extreme disturbance
PR2	Spring	2	2	3	3	10	High disturbance
	Autumn	2	2	3	2	9	High disturbance
SC1	Spring	2	3	4	2	11	High disturbance
	Autumn	2	3	4	2	11	High disturbance
RC1	Spring	2	2	4	4	12	High disturbance
	Autumn	2	3	4	4	13	Extreme disturbance
DG1	Spring	2	2	4	3	11	High disturbance
	Autumn	2	2	4	3	11	High disturbance

3.3 Water quality

Results for the *in situ* water quality variables collected in spring 2020 and autumn 2021 are presented in Table 7 and are compared to the relevant ANZG (2018) DGVs.

Table 7 ***Results of in-situ water quality for the CVO aquatic ecosystems sites sampled in spring 2020 and autumn 2021. Red values exceed ANZG (2018) DGVs***

Site code	Season	Temp. (°C)	DO (mg/L)	DO (%Sat.)	EC (µS/cm)	pH (pH units)	Turbidity (NTU)	Alkalinity (mg/L)
ANZG (2018) DGVs[1]		NA	NA	90-110	350	6.8-8.0	25	NA
CC5	Spring	16.2	6.8	75.9	92	7.9	6	35
	Autumn	10.8	8.3	81.6	82	6.6	10	115
CC1	Spring	12.4	8.9	90.3	92	7.1	13	35
	Autumn	13.0	7.9	82.0	100	7.0	8	45
CC2	Spring	16.8	6.3	92.8	110	6.5	5	50
	Autumn	12.4	8.2	83.4	176	6.9	7	50
CC3	Spring	18.4	8.0	92.1	356	7.2	5	90
	Autumn	13.8	9.0	91.8	339	6.9	6	120
CC4	Spring	16.4	5.9	64.2	596	7.2	3	160
	Autumn	12.8	8.9	89.9	670	7.2	4	125
DG1	Spring	17.1	4.7	53.8	1071	6.9	6	200
	Autumn	12.4	5.9	60.0	1260	7.1	6	160
FC1	Spring	18.9	7.6	89.7	434	7.8	5	220
	Autumn	12.7	10.9	111.3	335	7.4	6	125
FC2	Spring	16.6	7.9	89.2	449	7.2	9	220
	Autumn	10.3	9.6	93.0	330	7.5	9	125
PR1	Spring	23.4	10.5	130.0	833	8.2	3	160
	Autumn	15.4	10.8	115.0	1174	7.8	4	190
PR2	Spring	28.0	11.2	147.9	739	8.8	2	160
	Autumn	16.8	10.6	117.0	1094	7.9	4	190
RC1	Spring	21.8	8.0	97.4	2028	7.7	8	400
	Autumn	15.3	7.6	80.8	1612	7.4	7	220
SC1	Spring	16.4	7.1	79.3	1803	7.4	5	280
	Autumn	12.1	7.6	76.0	1821	6.8	4	200

[1] ANZG (2018) default guideline values (DGVs) are for upland rivers in south-eastern Australia.

3.3.1 Electrical conductivity

Electrical conductivity (EC) was above the ANZG (2018) guideline value of 350 µS/cm at the majority of sites in both seasons (Table 7, Figure 4). The exceptions were the upstream sites CC5 and CC1, as well as the CVO MLA site CC2 in both seasons, and CC3 during autumn. Flyers Creek (FC1 and FC2) complied with the guideline in autumn only. There was also a degree of seasonal variation in EC along Cadiangullong Creek with slighter higher levels during autumn at most sites. In Cadiangullong Creek, there was a consistent salinity gradient with EC increasing moving downstream. This trend was not noted in Flyers Creek or Panuara Rivulet based on the two sites monitored on these waterways. Generally, higher EC occurs in Rodd's Creek and Swallow Creek compared to the other waterways.

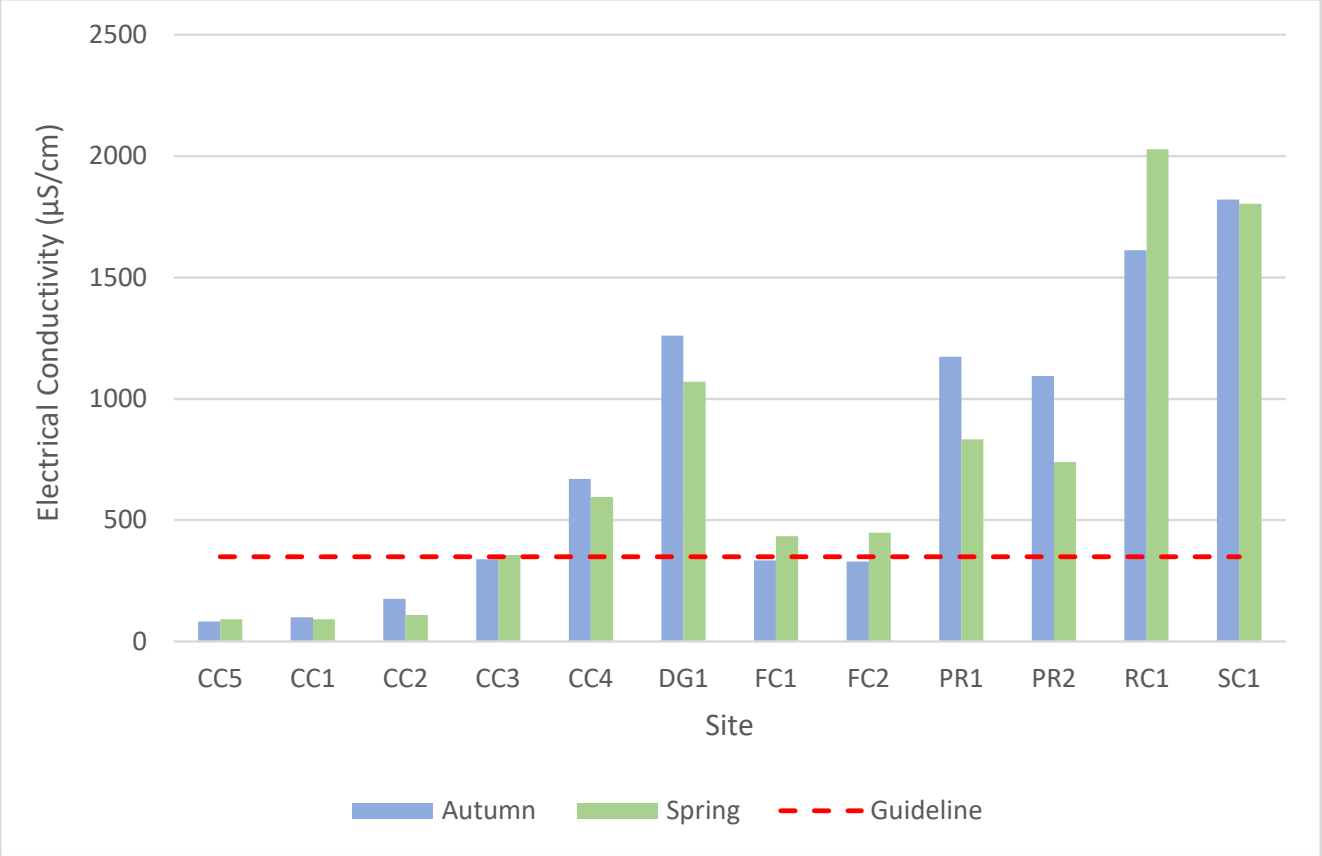

Figure 4 ***Electrical Conductivity for CVO sites monitored spring 2020 and autumn 2021. Red line is ANZG (2018) default guideline value***

3.3.2 pH

The pH at most sites was within the ANZG (2018) default guideline value range in both spring 2020 and autumn 2021 (Table 7, Figure 5). However, pH was slightly below the guideline value range at sites CC5 in autumn and CC2 in spring. pH exceeded the upper guideline value at the Panuara Rivulet reference sites in spring (PR1 & PR2).

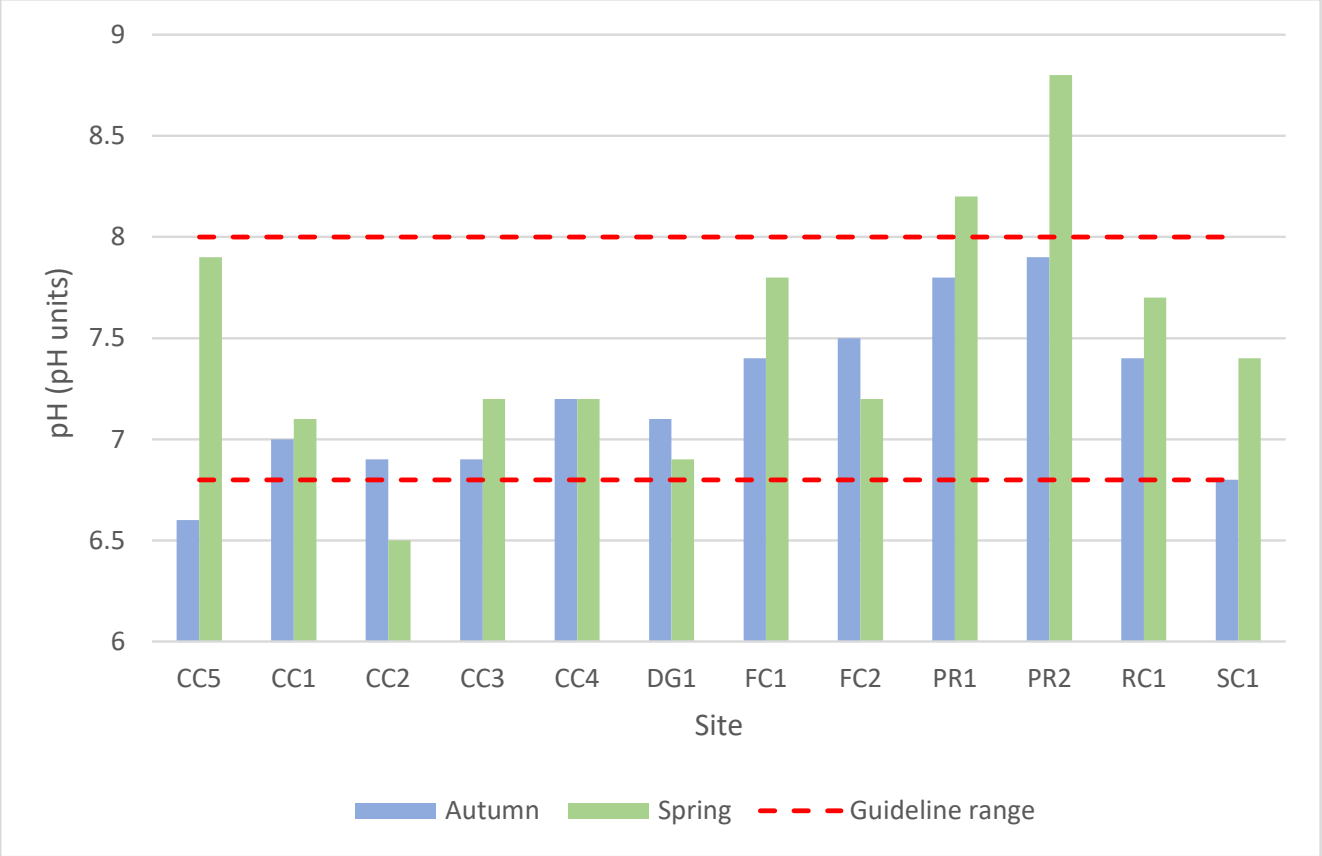

Figure 5 *pH for CVO sites monitored spring 2020 and autumn 2021. Red lines are ANZG (2018) default guideline value range*

3.3.3 Dissolved oxygen

Dissolved oxygen (DO) at most sites did not comply with the ANZG (2018) guideline value in both seasons with most sites below the guideline value range (Table 7, Figure 6). Exceptions to this include the Cadiangullong Creek sites CC1 and CC2 in spring as well as CC3 in both autumn and spring. The two sites on Panuara Rivulet (PR1 & PR2) exceeded the guideline values in both seasons and one site on Flyers Creek (FC1) exceeded the guideline value in autumn 2021. The high readings in Panuara Rivulet are likely due to photosynthesis by algae (see Plate 4).

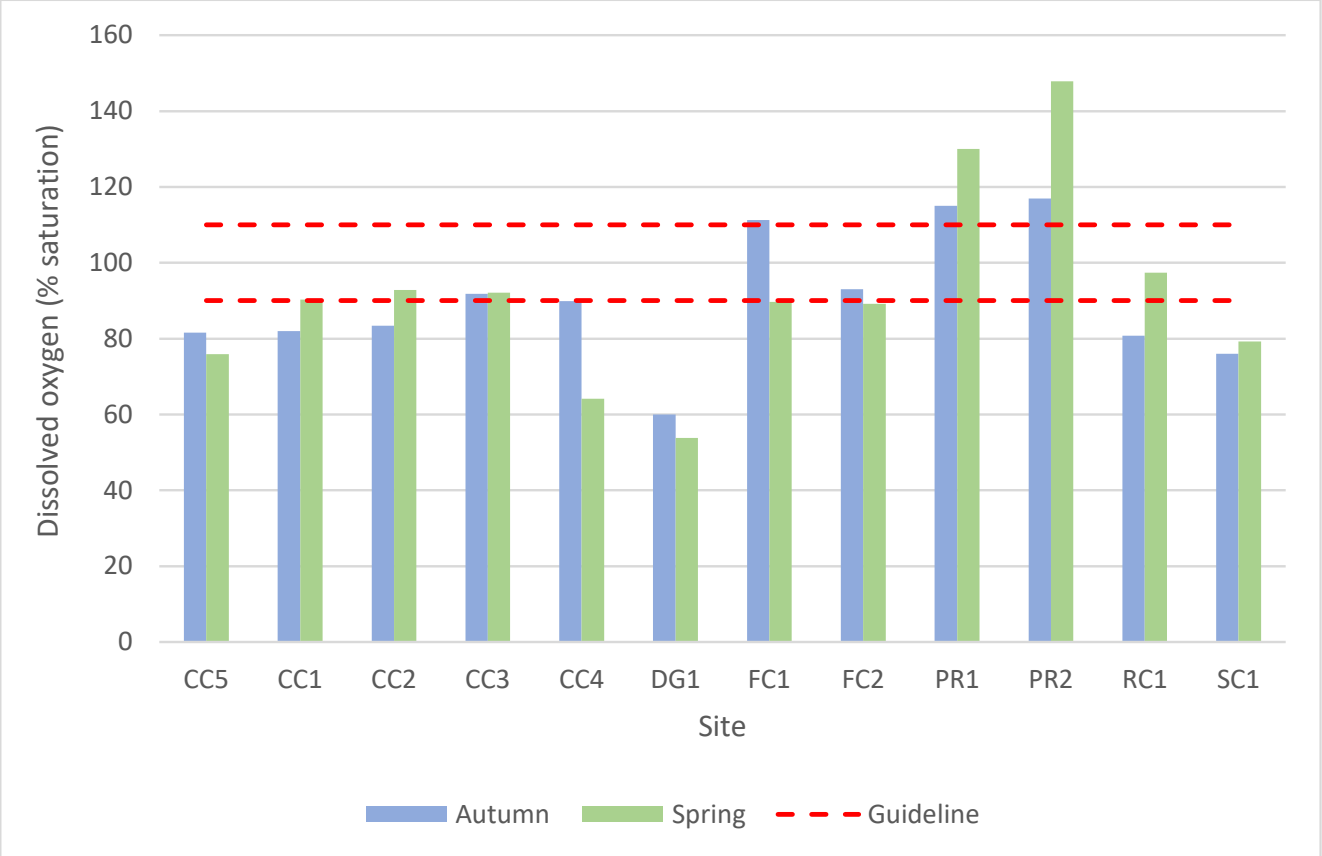

Figure 6 ***Dissolved Oxygen for CVO sites monitored spring 2020 and autumn 2021. Red lines are ANZG (2018) default guideline value range***

3.3.4 Turbidity

Turbidity remained below the ANZG (2018) guideline value of 25 NTU at all of sites in both seasons (Table 7, Figure 7). All values represent reasonably clear water.

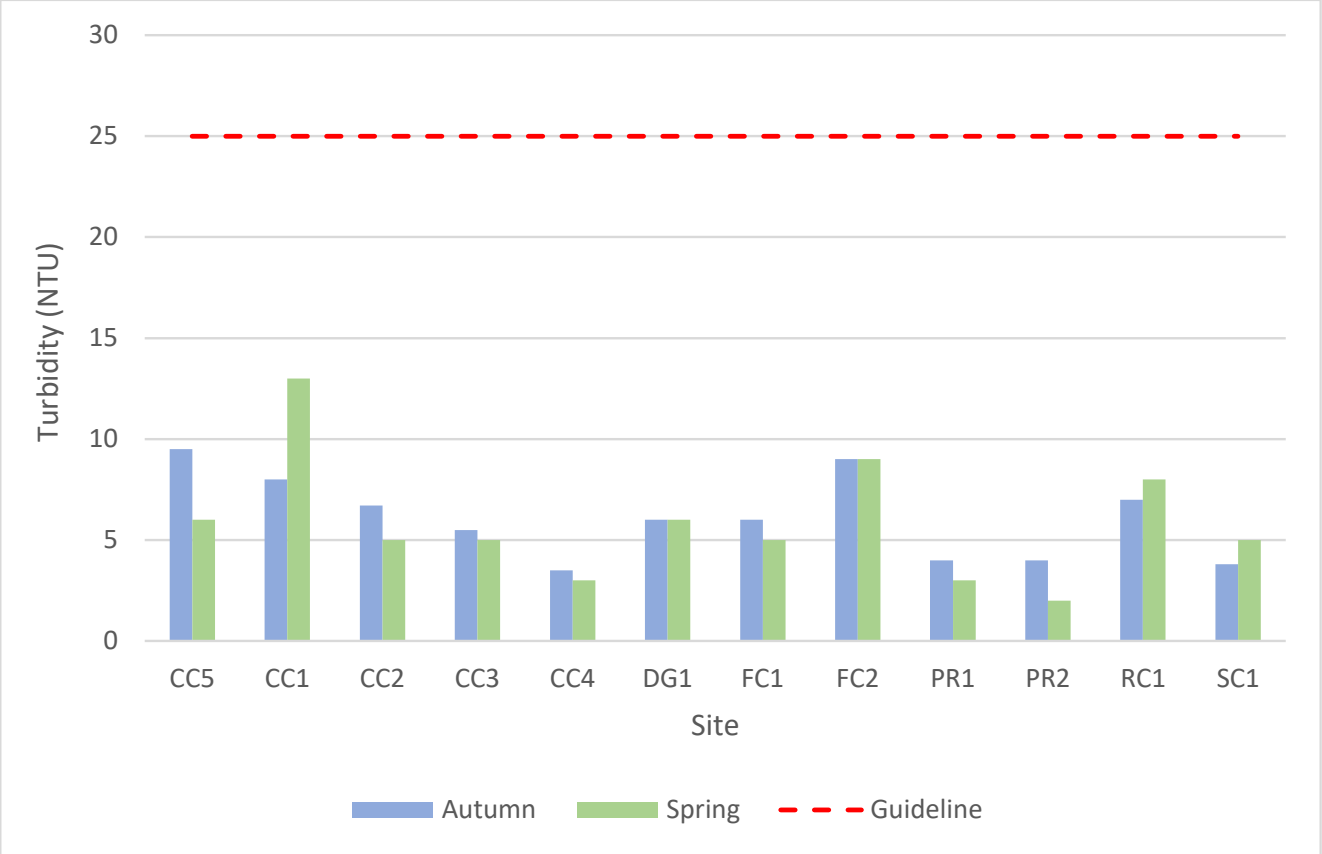

Figure 7 ***Turbidity for CVO sites monitored spring 2020 and autumn 2021. Red line is ANZG (2018) default guideline value***

3.3.5 Temperature

Generally, there was a consistent seasonal pattern in temperature with all sites having higher values during spring compared to autumn, with the exception of site CC1 downstream of Cadiangullong Dam (Table 7, Figure 8). The variation in temperature is related to differences in air temperature between the seasons with higher average maximums during the spring monitoring in 2020 (Table 5). There is no ANZG (2018) default guideline value for temperature.

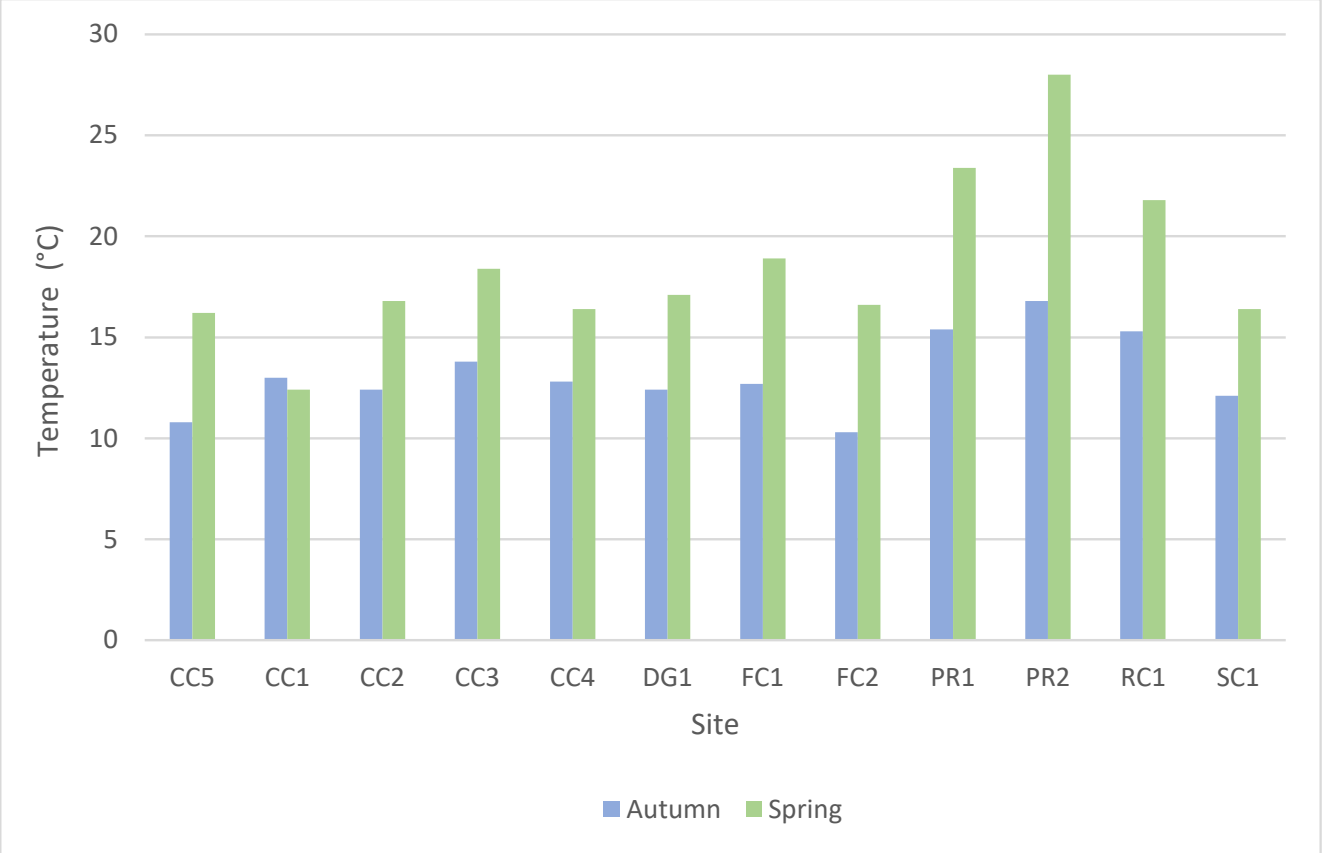

Figure 8 ***Temperature for CVO sites monitored spring 2020 and autumn 2021***

3.3.6 Alkalinity

Alkalinity is water's capacity to resist changes in pH and is influenced by the soil and bedrock through which it passes as well as by rainfall. Alkalinity can also be influenced by acids from mining runoff, which may decrease alkalinity. There was no clear seasonal pattern for alkalinity on Cadiangullong Creek (CC). However, alkalinity was higher in spring at Diggers Creek (DC), Flyers Creek (FC), Rodd's Creek (RC) and Swallow Creek (SC), whereas alkalinity was higher in autumn at Panuara Rivulet. The change in alkalinity might be caused by the different flow rates in spring compared to autumn. There is no ANZG (2018) default guideline value for alkalinity.

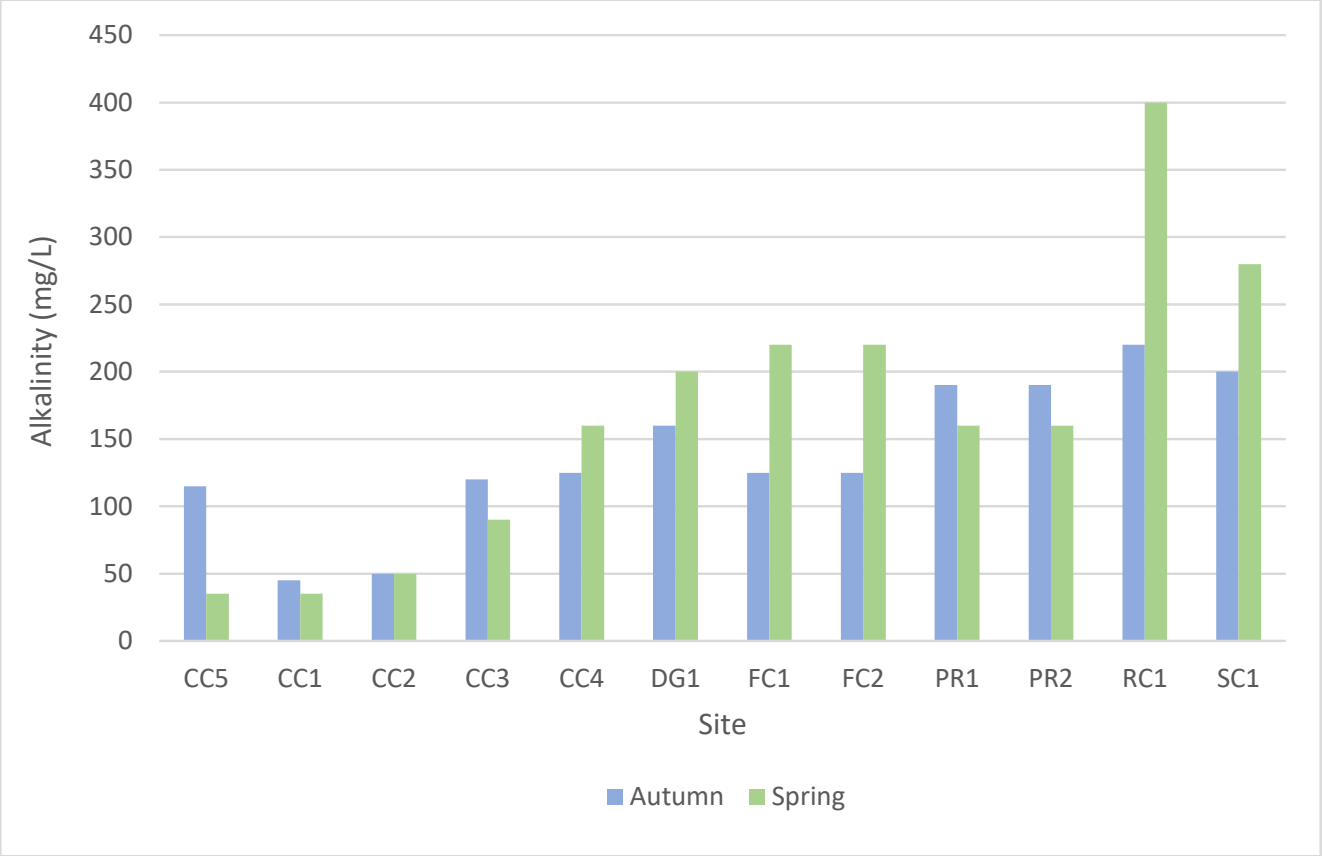

Figure 9 ***Alkalinity for CVO sites monitored spring 2020 and autumn 2021***

3.4 Sediment quality

Comparisons of total metals concentrations in sediments against the ANZG (2018) DGVs are shown in Table 8. Antimony, cadmium and silver were below laboratory limits of reporting (LOR) at all sites in both seasons. Of the metals that have DGVs published, only arsenic, copper and nickel exceeded guidelines. Of these, only arsenic and copper exceeded the upper DGV. Arsenic was exceeded the upper DGV in Diggers Creek (DG1) in autumn. Copper concentrations exceeded the upper DGV in the Cadiangullong Creek site CC2 during autumn, and in both seasons at site CC3. In Rodd's Creek the upper DGV was exceeded in spring.

PCA based on the sediment quality was carried out for two sets of sites:

1. All monitoring sites to identify major differences in sediment quality between the different waterways
2. Cadiangullong Creek sites only, to identify site differences within Cadiangullong Creek

For the PCA ordination of all monitoring sites, the two principal components accounted for almost 52% of the variation in sediment metal concentrations (Figure 10). The most noticeable pattern amongst sites was that the Cadiangullong Creek site CC1 was clearly separated from all other sites in both seasons to the right-hand side of PC1. The vectors on the PCA ordination and the metals with the highest loadings on PC1 (see Table 9) suggest this is due to a combination of relatively higher concentrations of cobalt, iron, barium, selenium, manganese and aluminium in Cadiangullong Creek immediately downstream of Cadiangullong Dam. For the other sites, there was some seasonal separation vertically along PC2 with spring samples generally towards the top of the PCA ordination. The vectors on the PCA ordination and the metals with the highest loadings on PC2 suggest this was predominately due to higher concentrations of chromium, zinc, nickel, mercury and lead during autumn.

For the PCA ordination of the Cadiangullong Creek sites, the two principal components accounted for over 75.8% of the variation in sediment metal concentrations (Figure 11). However, in both seasons site CC1 (Cadiangullong Creek immediately downstream of Cadiangullong Dam) was again separated from the other sites to the right-hand side of PC1. The vectors on the PCA ordination and the metals with the highest loadings on PC1 (see Table 9) suggests this is due to relatively higher concentrations of selenium, barium, manganese, cobalt and iron at CC1. There was separation along PC2, though there were no obvious seasonal patterns. Site CC2, located at the mine site, had relatively high concentrations of molybdenum, copper and cobalt in spring. Site CC5, located upstream of Cadiangullong Dam, had relatively higher concentrations of beryllium in both seasons.

Table 8 Comparisons of total metals (mg/kg) against the ANZG (2018) DGVs for sediment. Yellow values exceeded the DGV and red values exceeded both the DGV and Upper DGV

Site	Season	Aluminium	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Zinc
DGVs		NA	2	20	NA	NA	1.5	80	NA	65	NA	50	NA	0.15	NA	21	NA	1	200
Upper DGVs		NA	25	70	NA	NA	10	370	NA	270	NA	220	NA	1	NA	52	NA	4	410
CC5	Spring	15800	<5	6	140	3	<1	25	15	25	36500	9	696	<0.1	<2	13	<5	<2	120
	Autumn	24600	<5	12	130	5	<1	52	20	51	62100	13	700	<0.1	<2	19	<5	<2	137
CC1	Spring	19600	<5	13	680	<2	<1	16	55	64	55400	12	27300	<0.1	<2	14	27	<2	90
	Autumn	25700	<5	16	640	<2	<1	29	78	74	77100	12	22100	<0.1	<2	21	38	<2	80
CC2	Spring	16200	<5	8	70	<1	<1	22	14	253	29200	6	242	<0.1	<2	12	<5	<2	70
	Autumn	10900	<5	19	90	<1	<1	50	32	428	26400	12	1000	<0.1	4	23	<5	<2	71
CC3	Spring	12800	<5	10	90	<1	<1	25	21	461	37300	11	864	<0.1	2	13	<5	<2	76
	Autumn	19200	<5	9	100	<1	<1	31	14	273	30400	6	212	<0.1	<2	14	<5	<2	116
CC4	Spring	18700	<5	9	120	<1	<1	20	13	141	28400	7	390	<0.1	<2	12	<5	<2	70
	Autumn	22900	<5	12	140	<1	<1	33	23	202	43000	9	431	<0.1	<2	18	<5	<2	94
DG1	Spring	12300	<5	42	140	1	<1	21	16	41	45800	19	848	<0.1	<2	16	<5	<2	155
	Autumn	12900	<5	117	150	<1	<1	15	20	49	52000	35	382	<0.1	<2	16	<5	<2	128
FC2	Spring	11800	<5	8	90	<1	<1	32	13	47	23400	12	1050	<0.1	<2	12	<5	<2	70
	Autumn	21200	<5	20	170	<1	<1	68	26	81	46000	23	3110	0.1	<2	24	6	<2	120
FC1	Spring	11600	<5	22	130	<1	<1	44	19	48	41000	17	2050	<0.1	<2	15	<5	<2	82
	Autumn	14700	<5	22	130	<1	<1	50	20	59	37200	18	2280	<0.1	<2	16	<5	<2	101
PR1	Spring	9970	<5	8	90	<1	<1	15	9	18	22900	11	593	<0.1	<2	10	<5	<2	42
	Autumn	10300	<5	9	110	<1	<1	17	9	19	24100	12	673	<0.1	<2	11	<5	<2	44
PR2	Spring	11000	<5	8	120	<1	<1	15	10	21	21100	16	706	<0.1	<2	14	<5	<2	49
	Autumn	10400	<5	9	120	<1	<1	21	12	19	25900	15	535	<0.1	<2	15	<5	<2	51
RC1	Spring	25100	<5	10	120	<1	<1	36	20	322	46600	6	548	<0.1	<2	18	5	<2	64
	Autumn	25500	<5	9	160	<1	<1	37	20	133	43100	<5	2610	<0.1	<2	16	6	<2	83
SC1	Spring	14100	<5	23	180	<1	<1	19	19	63	28300	8	1750	<0.1	<2	15	<5	<2	60
	Autumn	15900	<5	58	350	<1	<1	32	35	82	53200	13	3400	<0.1	<2	21	6	<2	83

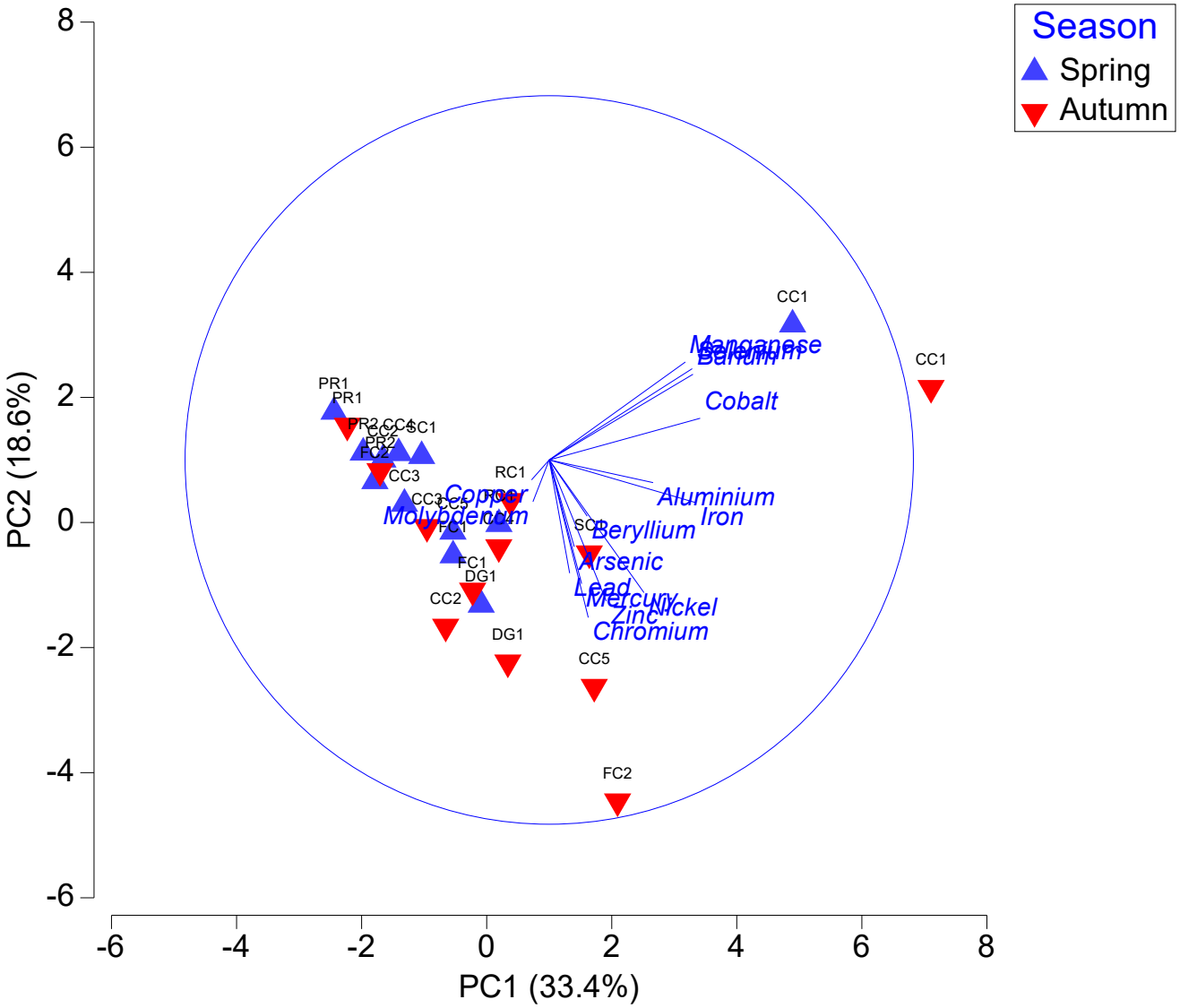

Figure 10 *PCA ordination showing relationship between sediment concentrations and monitoring sites for all sites*

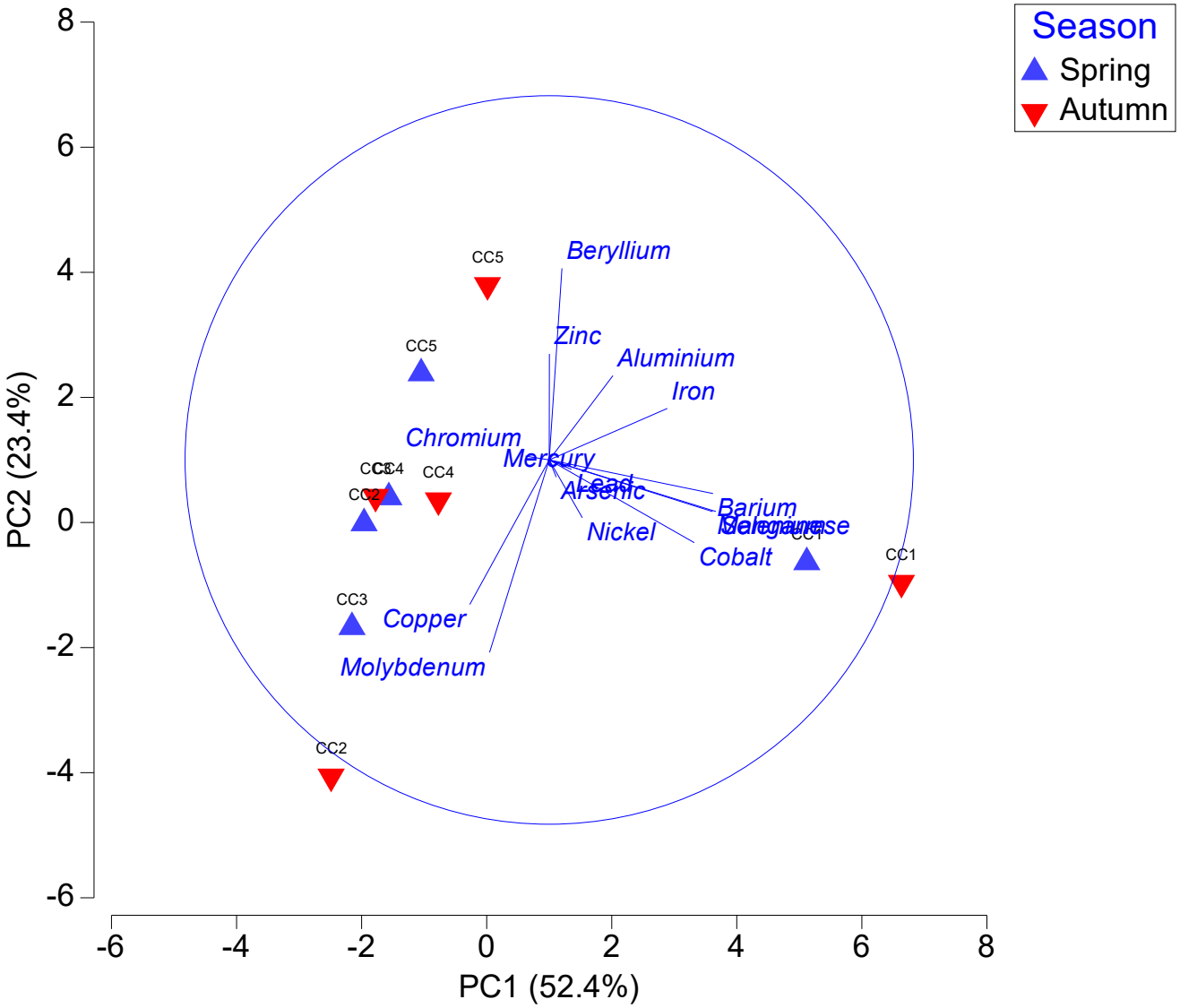

Figure 11 PCA ordination showing the relationship between sediment concentrations and monitoring sites for Cadiangullong Creek only

Table 9 Coefficients in the linear combinations of variables making up the principal components

Variable	PC1	PC2	PC1	PC2
	All sites		Cadiangullong Creek sites	
Aluminium	0.285	-0.062	0.175	0.231
Arsenic	0.069	-0.238	0.019	-0.047
Barium	0.395	0.235	0.450	-0.092
Beryllium	0.104	-0.154	0.035	0.526
Chromium	0.107	-0.433	-0.065	0.011
Cobalt	0.415	0.114	0.398	-0.227
Copper	-0.049	-0.055	-0.218	-0.397
Iron	0.403	-0.117	0.324	0.141
Lead	0.056	-0.311	0.061	-0.026
Manganese	0.374	0.269	0.449	-0.142
Mercury	0.089	-0.340	0.000	0.000
Molybdenum	-0.045	-0.115	-0.164	-0.528

Variable	PC1	PC2	PC1	PC2
	All sites		Cadiangullong Creek sites	
Nickel	0.260	-0.364	0.091	-0.159
Selenium	0.393	0.251	0.458	-0.141
Zinc	0.157	-0.387	0.001	0.291

3.5 Macroinvertebrates

A summary of the macroinvertebrate biological indices is presented in Table 10. AUSRIVAS results are coloured according to the Banding scheme presented in Table 4. Combined season AUSRIVAS model bands are included in the final column of Table 10.

3.5.1 Taxonomic richness and EPT

In Cadiangullong Creek there was no consistent pattern to suggest that sites downstream of CVO had lower taxonomic richness than sites upstream (Figure 12). For example, for edge habitats during spring there was a decrease at CC2, although richness increased further downstream at CC3 and CC4 and returned to similar levels observed at upstream sites. During autumn similar richness was found at the upstream CC1 and downstream at CC2 and CC4. In both seasons, the riffle habitat at CC1 was often lower than further downstream at CC3 and CC4. Taxonomic richness of Cadiangullong Creek, and downstream of the tailings dam on Rodd's Creek (RC1), was also similar to that observed at the reference sites in Flyers Creek, Panuara Rivulet and Swallow Creek.

There was also little difference in EPT richness between the upstream and downstream sites for edge habitat in Cadiangullong Creek (Figure 12). EPT was relatively lower in both the upstream site CC1 and the downstream site CC2 for edge samples in both spring and autumn. There was little difference in EPT richness for edge habitat for any of the other sites. For riffle habitat, EPT richness was lower at upstream site CC1 compared to downstream sites CC3 and CC4. There were no riffles present at sites CC5 and CC2.

3.5.2 AUSRIVAS

For single season edge habitats, site CC5 upstream of the dam was allocated to Band A in both seasons suggesting it was similar to reference conditions (Table 10). There was no clear difference in the AUSRIVAS bands for the upstream site CC1 and the downstream Cadiangullong Creek sites. The majority of these sites were allocated to Band B, indicating fewer families than expected due to potential impacts from water quality and/or habitat quality. Downstream site CC3 was allocated Band X in spring with more families found than expected which potentially represents a biodiversity 'hot spot' due mild organic enrichment. There was also no difference between the upstream site CC1 and downstream sites for riffle habitat. Most sites were allocated to Band B although CC3 and CC4 in autumn 2020 were allocated to Band C. This suggests a loss of families due to moderate to severe impacts on water and/or habitat quality.

There was substantial variation in the AUSRIVAS Bands for the reference sites on Flyers Creek, Panuara Rivulet and Swallow Creek. The edge habitat combined season results for Flyers Creek (FC1) and Panuara Rivulet (PR1) were allocated Band A, while the riffle habitat for Flyers Creek (FC1, FC2) and Panuara Rivulet (PR1, PR2) were classified as Band C. The results for the CVO and downstream sites on Cadiangullong Creek (CC2, CC3 and CC4) do not suggest impairment compared to other sites.

3.5.3 SIGNAL-2

For edge habitats, there was a large degree of variation in SIGNAL-2 results amongst sites (Table 10). CC2, located on-site, had a marginally lower score than the upstream sites (CC1 and CC5). The downstream sites (CC3 and CC4) were not substantially different to the upstream sites (CC5 and CC1) on Cadiangullong Creek. The SIGNAL-2 results were similar for both upstream and downstream sites for riffle habitat along the Cadiangullong Creek, although riffle habitat was not present at sites CC5 and CC2. The scores for both upstream and downstream sites along the Cadiangullong Creek were roughly equal with or higher than the reference sites and SIGNAL-2 scores were generally higher in autumn than in spring.

All sites were within either quadrant 2 or quadrant 4 of the SIGNAL-2 family bi-plot (Figure 13 and Figure 14). The spread of samples across the two quadrants is not season specific. The SIGNAL-2 scores for edge habitat were mostly within quadrant 2, while scores for riffle habitats were spread evenly across quadrant 2 and quadrant 4. Results in quadrant 2 may indicate high salinity or nutrient levels (which may be natural), while results in quadrant 4 may indicate industrial or agricultural pollution or the downstream impacts of dams (Chessman, 2001).

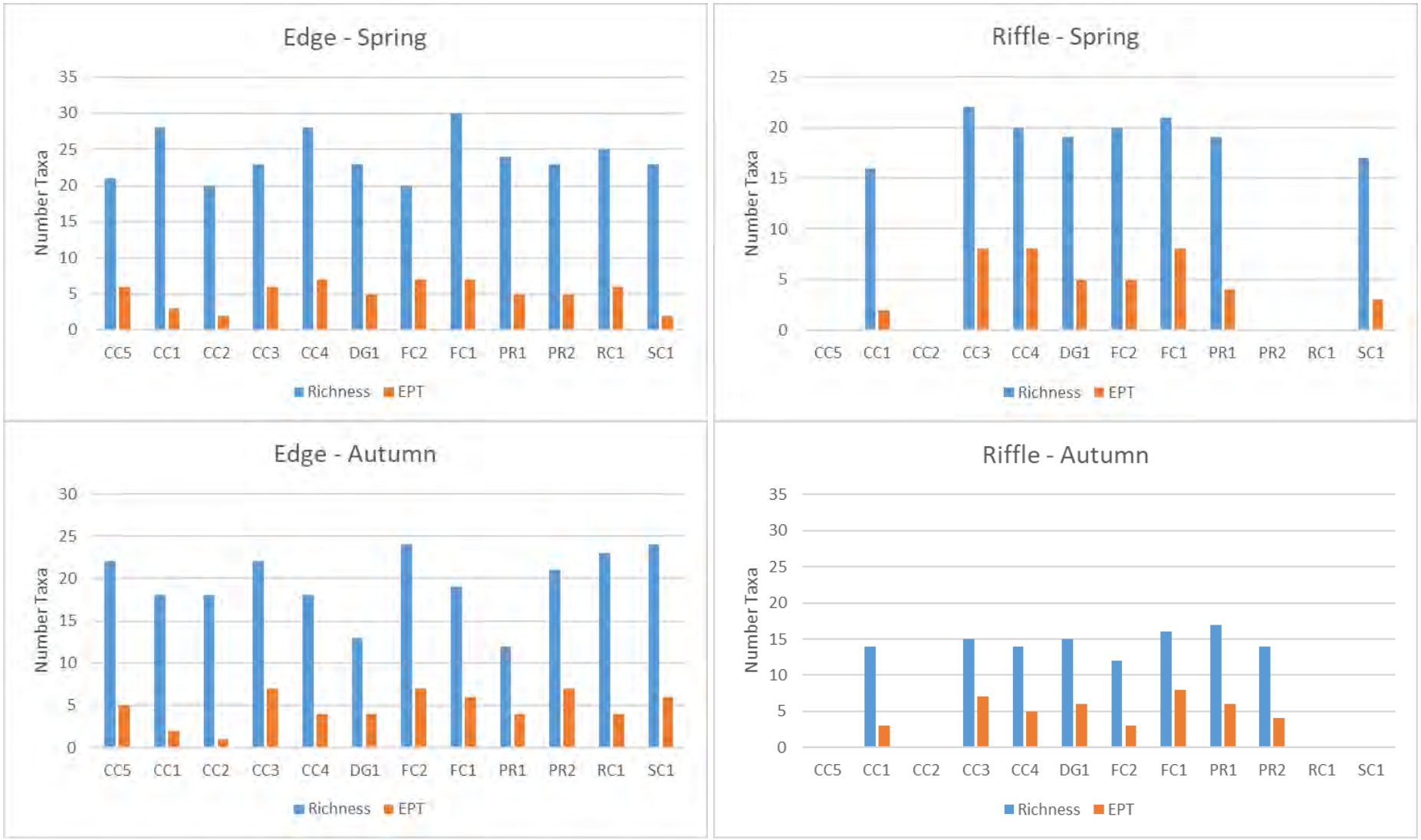

Figure 12 Taxa and EPT richness during spring 2020 and autumn 2021 for each site

Table 10 Summary of macroinvertebrate biological indices

Site	Habitat	Season	Taxa Richness	EPT richness	SIGNAL-2 score	AUSRIVAS		
						OE50	Band	Combined Season Band
CC5	Edge	Autumn	22	5	3.77	0.89	A	B
		Spring	21	6	3.82	0.84	A	
	Riffle	Autumn	No samples					NA
		Spring						
CC1	Edge	Autumn	18	2	4.39		OEX	B
		Spring	28	3	3.48	0.75	B	
	Riffle	Autumn	14	3	5.29	0.65	B	C
		Spring	16	2	4.19	0.54	B	
CC2	Edge	Autumn	18	1	3.61	0.81	B	B
		Spring	20	2	3.24	0.75	B	
	Riffle	Autumn	No samples					NA
		Spring						
CC3	Edge	Autumn	22	7	4.45	0.88	A	A
		Spring	23	6	3.83	1.24	X	
	Riffle	Autumn	15	7	5.40	0.6	C	B
		Spring	22	8	4.57	0.77	B	
CC4	Edge	Autumn	18	4	3.50	0.7	B	A
		Spring	28	7	3.90	0.82	B	
	Riffle	Autumn	14	5	5.07	0.6	C	C
		Spring	20	8	4.65	0.72	B	
DG1	Edge	Autumn	13	4	4.00	0.63	B	OEX
		Spring	23	5	3.72	1	A	
	Riffle	Autumn	15	6	5.33		OEX	OEX
		Spring	19	5	4.15		OEX	
FC1	Edge	Autumn	19	6	4.11	0.87	A	A
		Spring	30	7	3.84	1.27	X	
	Riffle	Autumn	16	8	4.88	0.75	B	C

Site	Habitat	Season	Taxa Richness	EPT richness	SIGNAL-2 score	AUSRIVAS		
						OE50	Band	Combined Season Band
		Spring	21	8	4.43	0.7	B	
FC2	Edge	Autumn	24	7	4.33	0.88	A	B
		Spring	20	7	4.10		OEX	
	Riffle	Autumn	12	3	4.75	0.45	C	C
		Spring	20	5	5.19	0.89	A	
PR1	Edge	Autumn	12	4	4.58	0.35	C	A
		Spring	24	5	3.46	1.09	A	
	Riffle	Autumn	17	6	4.00	0.45	C	C
		Spring	19	4	3.62	0.54	B	
PR2	Edge	Autumn	21	7	3.87	0.96	A	B
		Spring	23	5	3.64	1	A	
	Riffle	Autumn	14	4	4.36	0.6	C	C
		Spring	No samples					
RC1	Edge	Autumn	23	4	3.75		OEX	OEX
		Spring	25	6	4.04		OEX	
	Riffle	Autumn	No samples					NA
		Spring						
SC1	Edge	Autumn	24	6	4.08	0.69	B	B
		Spring	23	2	3.33	0.91	A	
	Riffle	Autumn	No samples					OEX
		Spring	17	3	3.50	0.54	B	

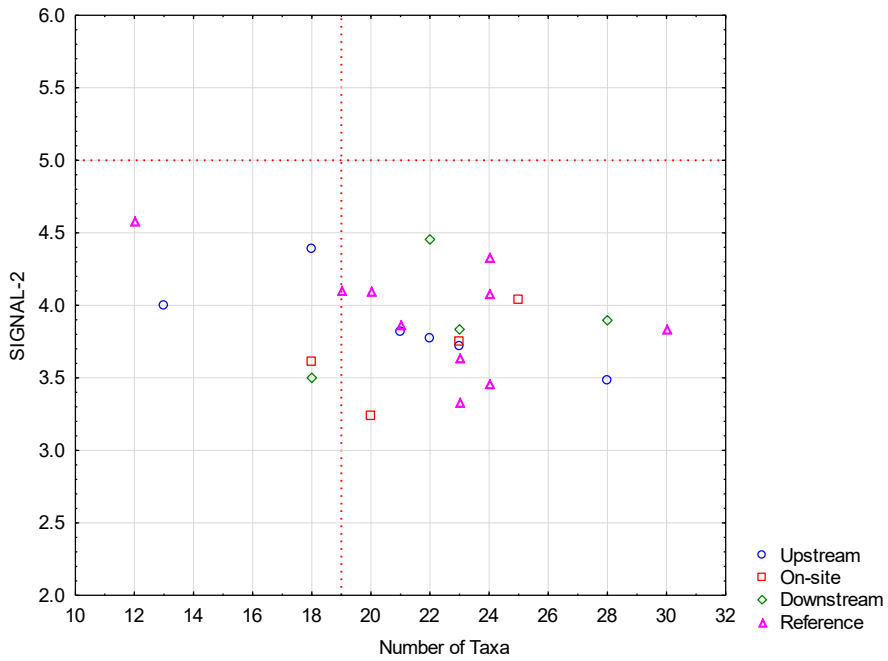

Figure 13 ***SIGNAL-2 bi-plot for the spring and autumn edge samples (red lines indicate the NSW interim SIGNAL-2 quadrant boundaries)***

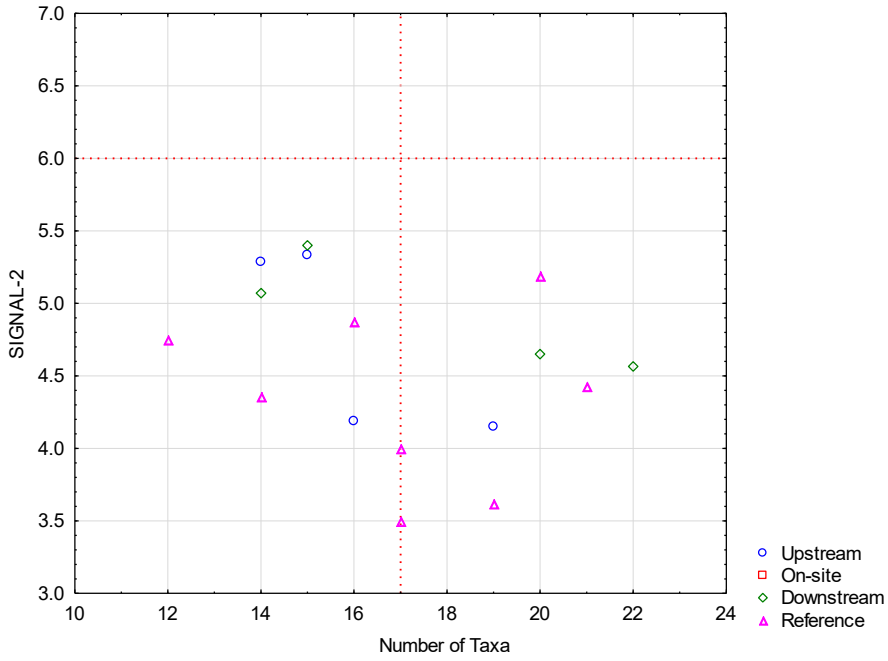

Figure 14 ***Combined season riffle SIGNAL-2 bi-plot (red lines indicate the NSW interim SIGNAL-2 quadrant boundaries)***

3.5.4 Multivariate analyses

Riffle habitats

The nMDS (non-metric multidimensional scaling) ordination of spring riffle habitats shows a high degree of separation amongst sites, and no grouping of sites from the same waterway (Figure 15). For example, Flyers Creek (FC2) and Cadiangullong Creek (CC3) were more similar to one another than they were to other sites on the same waterway. Furthermore, the Cadiangullong Creek upstream site (CC1) and the Diggers Creek site (DG1) had a distinct macroinvertebrate community and were not grouped with any other sites. The Analysis of Similarities (ANOSIM) detected the difference amongst treatments was close to the significant threshold (R = 0.388; *P* = 0.052) although pairwise comparison did not detect any differences amongst the site treatments (*P* < 0.05).

A different pattern was found for the autumn riffle habitats. The upstream site CC1 was separated from the downstream sites as it was in the spring analysis. However, downstream sites CC3 and CC4 were grouped with the upstream site DG1 as well as Flyers Creek site FC1 (Figure 16). Despite the patterns, there were no significant differences in the riffle macroinvertebrate communities associated with the different treatment types detected by the ANOSIM in autumn (R = -0.006; *P* = 0.481).

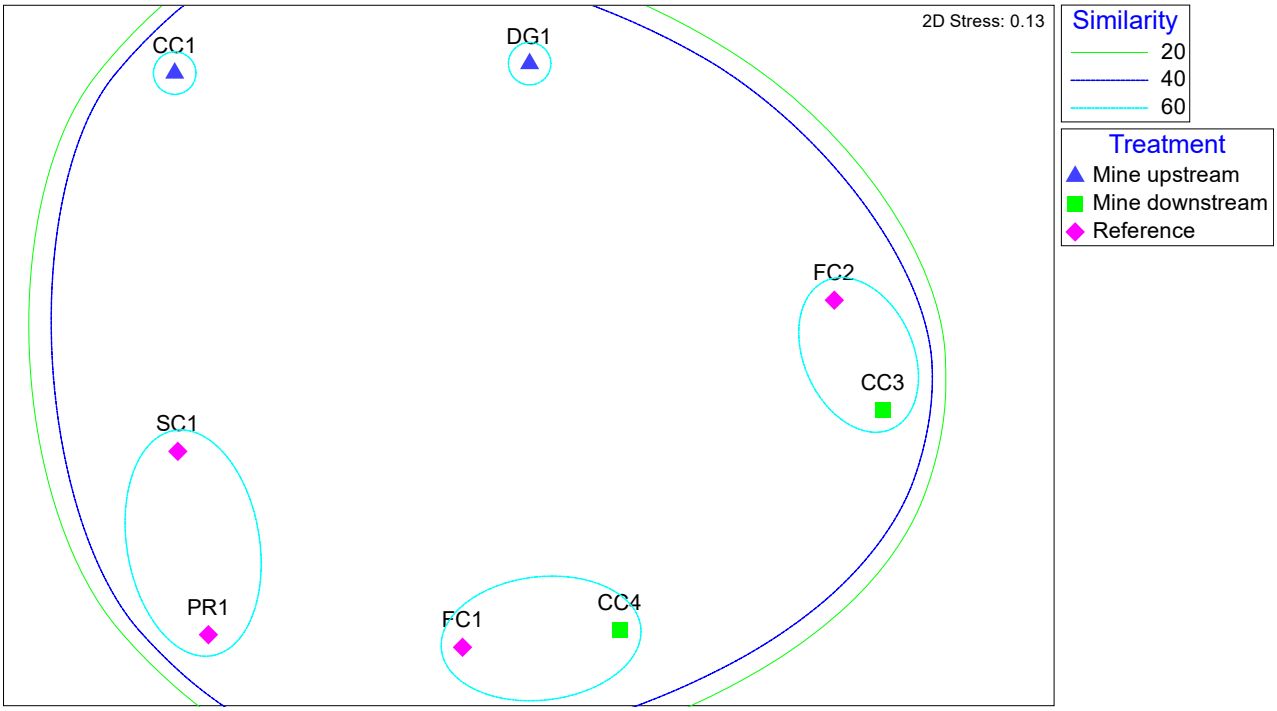

Figure 15 ***nMDS analysis of spring riffle data displaying influence of site treatment on the similarities of macroinvertebrate communities***

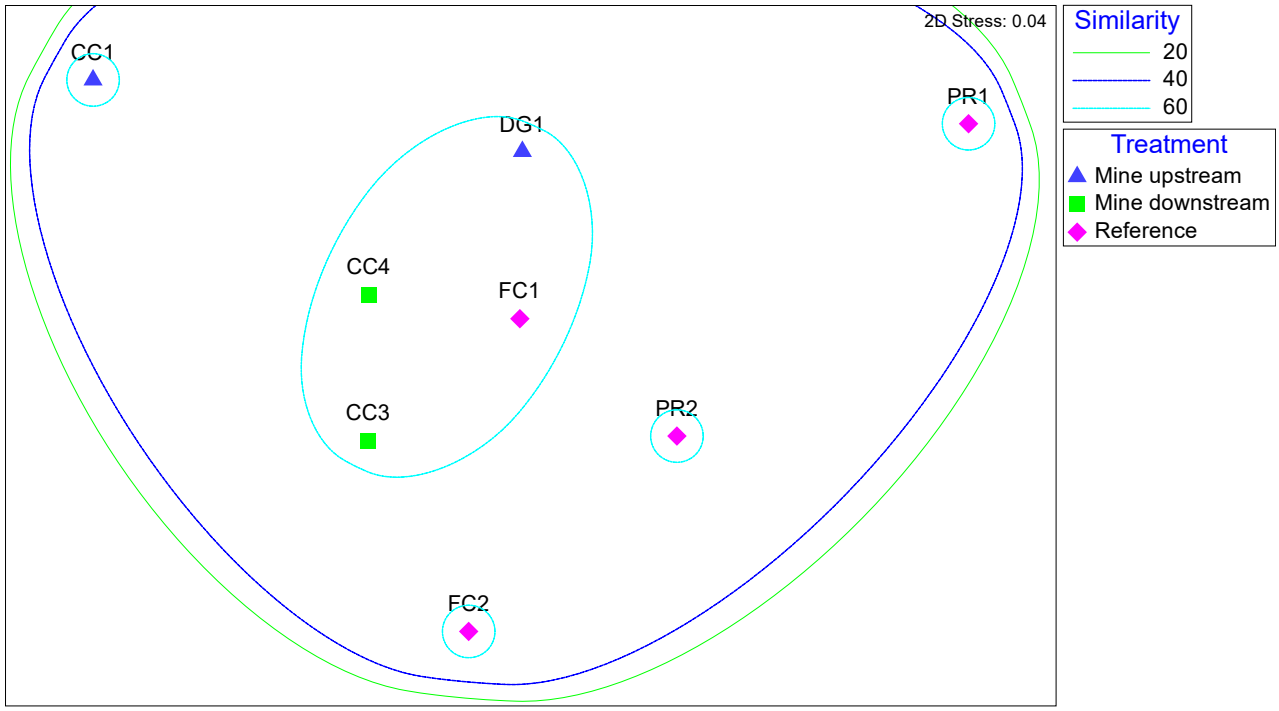

Figure 16 ***nMDS analysis of autumn riffle data displaying influence of site treatment on the similarities of macroinvertebrate communities***

Edge habitats

The nMDS ordination for spring edge habitats suggested the downstream sites on Cadiangullong Creek (CC3 and CC4) were more similar to the reference sites on Flyers Creek and the Panuara Rivulet, than the upstream sites (Figure 17). The upstream sites (CC5 and CC1) were more similar to the on-site locations (CC2 and RC1) and the Swallow Creek reference site (SC1).

The nMDS ordination showed a different pattern for autumn edge habitat Figure 18. Upstream site CC1 was separated from the other sites. Site CC5 was more similar to the Rodd's Creek and Swallow Creek reference sites. Sites CC2, CC3 and CC4 were found to be similar to the Diggers Creek site and CC3 was more similar to the Flyers Creek reference sites.

Overall, there were no significant differences in the macroinvertebrate communities associated with the different treatment types detected by the ANOSIMs for both spring (R = -0.016; *P* = 0.509) or autumn (R = 0.123; *P* = 0.228).

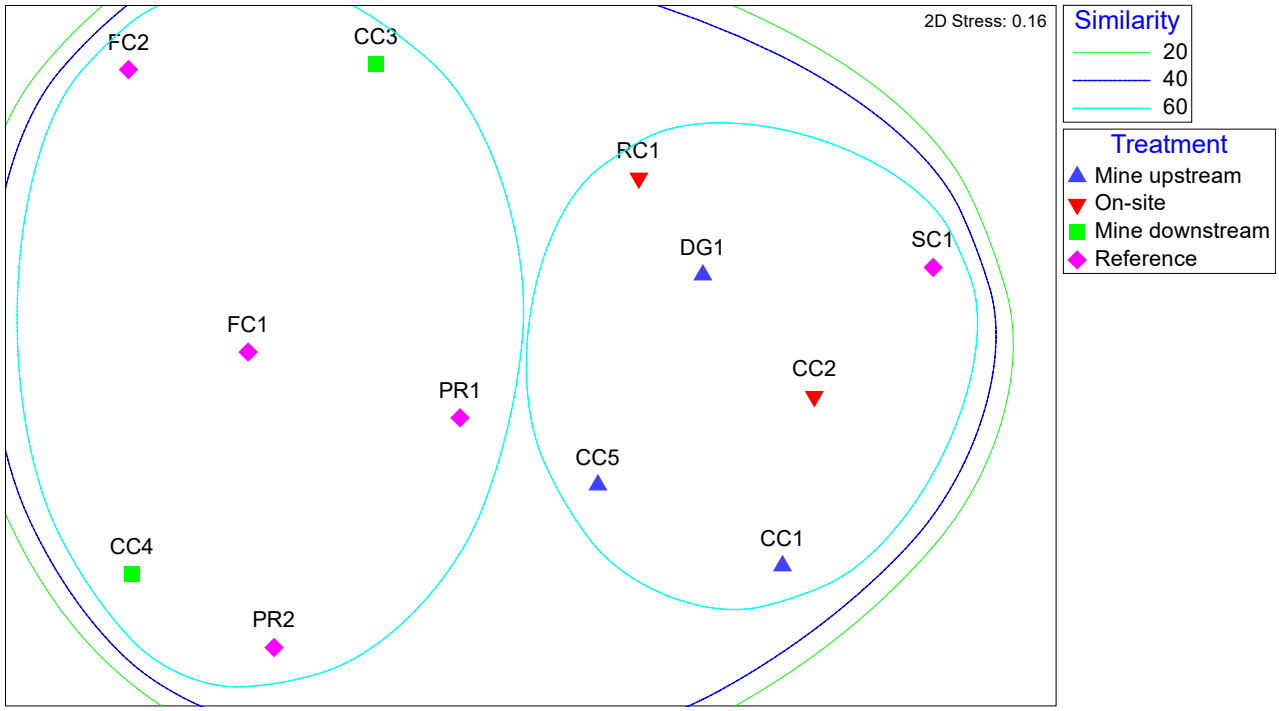

Figure 17 *nMDS analysis of spring edge data displaying influence of site treatment on the similarities of macroinvertebrate communities*

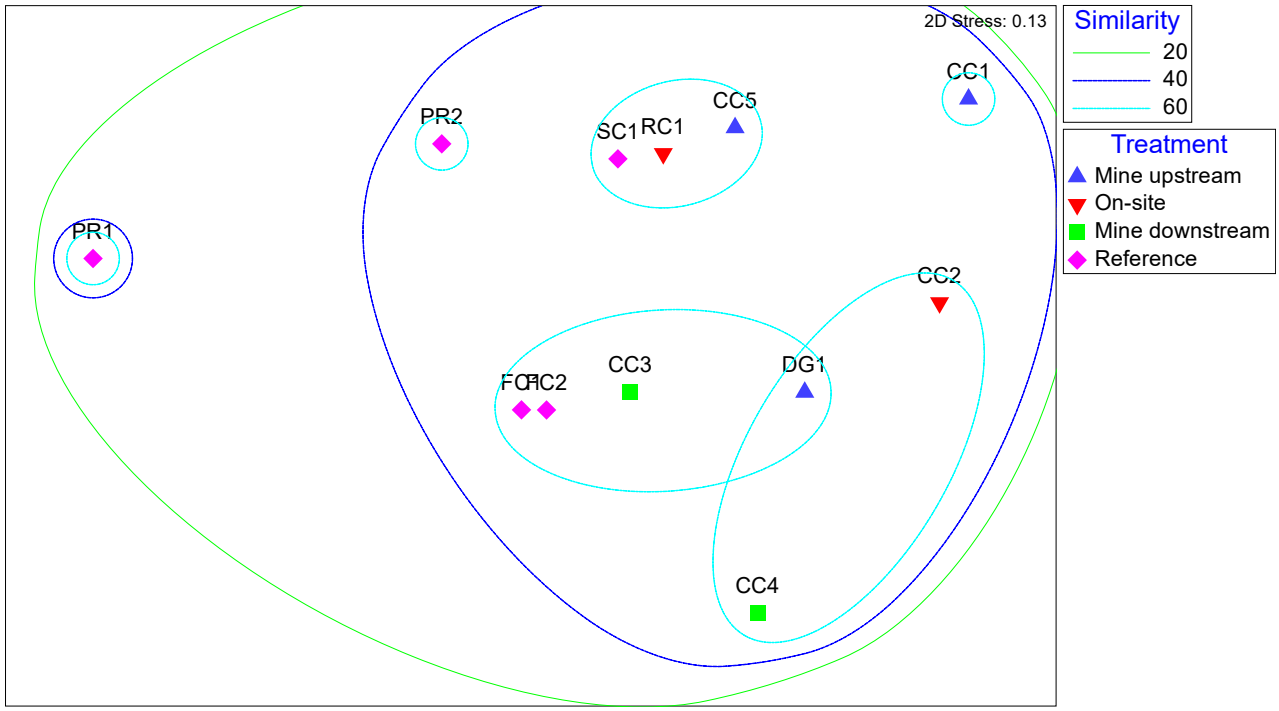

Figure 18 *nMDS analysis of autumn edge data displaying influence of site treatment on the similarities of macroinvertebrate communities*

3.6 Sediment/macroinvertebrate relationship

The RELATE procedure determined that there was no significant correlation between patterns in the sediment quality and macroinvertebrate communities for edge samples in either spring (Rho -0.103, *P* = 0.729) or autumn (Rho 0.201, *P* = 0.173). For riffle samples, a significant correlation was found for spring (Rho 0.387, *P* = 0.044) and the autumn riffle sample correlation was almost significant (Rho 0.201, *P* = 0.055). Overall, the RELATE analyses suggests that sediment quality is not a driver of macroinvertebrate community composition in edge habitats, but it may influence riffle habitats.

Based on the RELATE analyses, the BEST analyses were undertaken for riffle habitats only. While the BEST analyses determined there was some degree of correlation between several sediment metal concentrations and the macroinvertebrate community composition, this correlation was not significant Table 11.

The previous analyses demonstrated there was some degree of seasonal variation for both sediment quality (Section 3.4) and macroinvertebrate communities (Section 3.4). Consequently, the analyses were repeated based on combined season data. The RELATE analyses again detected no significant correlation for edge habitats (Rho 0.161, *P* = 0.112) but a significant correlation for riffle habitats (Rho 0.500, *P* = 0.001). For riffle habitats, the BEST did detect a significant correlation with several sediment quality analytes for the combined season data (Table 11).

Table 11 BEST results of associations between macroinvertebrate communities and sediment quality for riffle habitats. Bold text indicates a significant correlation

Model	BEST Variables	Correlation	BEST *P*
Spring riffle	Barium, Beryllium, Molybdenum, Selenium, Zinc	0.542	0.260
Autumn riffle	Aluminium, Beryllium, Chromium, Cobalt, Molybdenum, Nickel, Zinc	0.731	0.240
Combined seasons riffle	Barium, Beryllium, Manganese, Zinc, Mercury	0.572	**0.002**

Results of the DISTLM procedure are included in Table 12 and indicate that of the sediment analyte combinations that best correlated to the macroinvertebrate communities from riffle habitats across both seasons, Barium, Beryllium and Manganese significantly correlated and explained 20% of the variation in the communities. The nMDS ordination plot incorporating the DISTLM results suggest the high concentrations of these analytes may have contributed to the more distinct macroinvertebrate community at the upstream site on Cadiangullong Creek (CC1) and Diggers Creek (DG1) (Figure 19).

Table 12 DISTLM results of associations between macroinvertebrate communities and sediment quality. Significant results at the P = 0.050 level in red

Model	Variables	DISTLM *P*	Variation explained (%)
Combined seasons riffle	Barium	0.002	20
	Beryllium	0.002	20
	Manganese	0.002	20
	Zinc	0.086	10
	Mercury	0.248	9

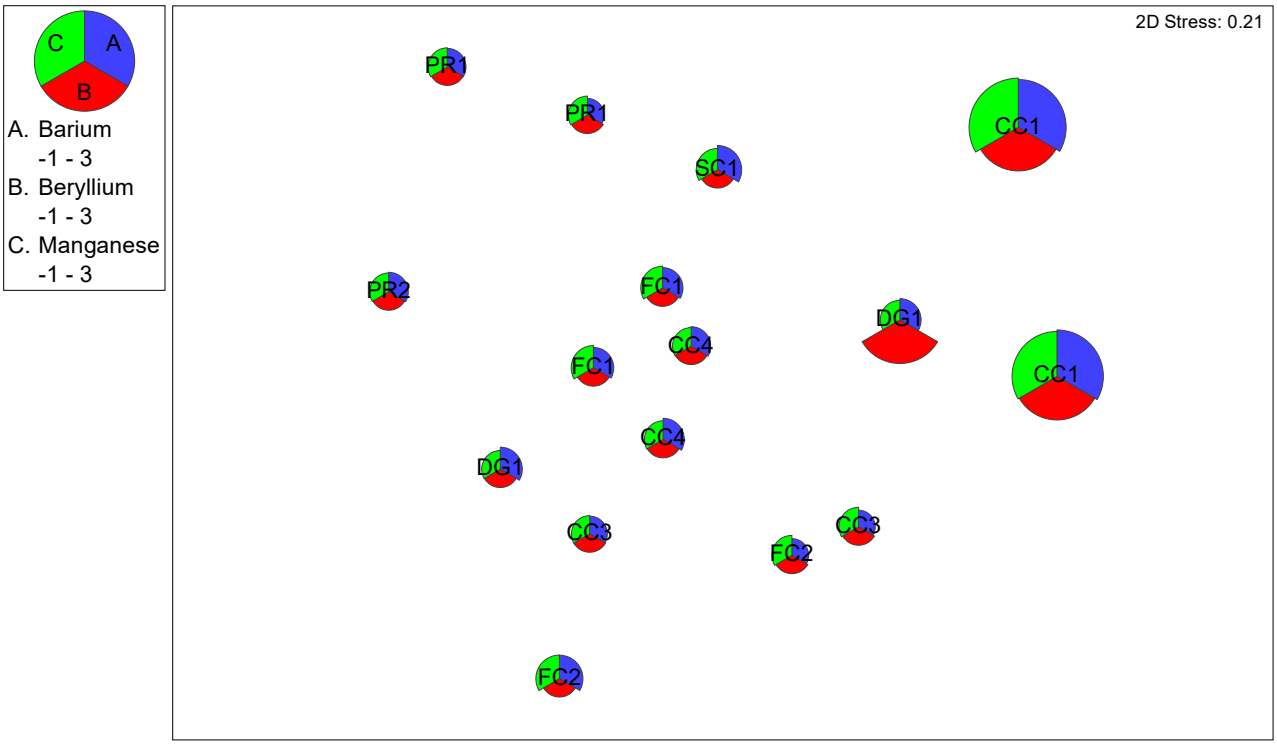

Figure 19 ***nMDS ordination indicating association between sediment analytes and macroinvertebrates from riffle habitats across all sites. Bubble plots showing relative concentration of sediment analytes***

3.7 Fish

Mountain Galaxias (*Galaxias olidus*) were collected from all sites on Cadiangullong Creek except for CC2, where a lack of surface water prevented electrofishing. However, they were observed during autumn 2021. No fish were observed or collected from Panuara Rivulet in both seasons. Summary statistics of Mountain Galaxias collected in spring and autumn are presented in Table 13.

Table 13 Total catch and summary statistics of total tenth (mm) of Mountain Galaxias (G. olidus) caught at each site per season

Site	Season	Count	Mean	Median	Min	Max	10th Percentile	90th Percentile	StdDev
CC5	Spring	8	25	30	9	40	10	39	13
CC5	Autumn	5	59	62	52	64	54	63	5
CC1	Spring	16	40	52	8	78	10	74	28
CC1	Autumn	86	64	60	43	104	48	84	15
CC2	Spring	No fish collected							
CC2	Autumn								
CC3	Spring	99	39	38	14	93	22	54	15
CC3	Autumn	112	65	62	39	107	48	87	16
CC4	Spring	58	44	40	21	84	31	69	15
CC4	Autumn	134	69	65	48	110	55	89	13
FC2	Spring	45	52	40	28	103	32	88	23
FC2	Autumn	97	65	58	49	113	52	98	17
FC1	Spring	76	37	35	12	82	26	47	13
FC1	Autumn	106	59	55	45	92	50	75	11
PR1	Spring	No fish collected							
PR1	Autumn								
PR2	Spring	No fish collected							
PR2	Autumn								
SC1	Spring	75	35	36	21	46	27	43	6
SC1	Autumn	5	64	62	61	72	61	68	5

Fewer Mountain Galaxias were collected from the upstream sites (CC5 and CC1) compared to the downstream sites (CC3, CC4) and the Flyers Creek reference site. It should be noted that no fish surveys are undertaken at Diggers Creek (DG1), the other upstream treatment site, or Rodd's Creek downstream of the tailings dam.

Histograms of total length of Mountain Galaxias indicates all site treatments have a wide distribution of lengths, indicating a combination of recent recruits and older fish (Figure 20). This suggests that sites across all treatments are maintaining self-sustaining populations with adequate recruitment levels.

The Gaussian kernel curves indicate that during spring, smaller Mountain Galaxias were collected. There was also some variation in size amongst the site treatments. During spring, most individuals were in the 0 – 50 mm range upstream of the mine, while downstream of the mine as well as at the Flyers Creek and Swallow Creek reference sites most fish were in the 30 to 40 mm range. During autumn, the size distribution of Mountain Galaxias was similar for upstream, downstream and reference sites, with most fish being with the 50 – 70 mm range.

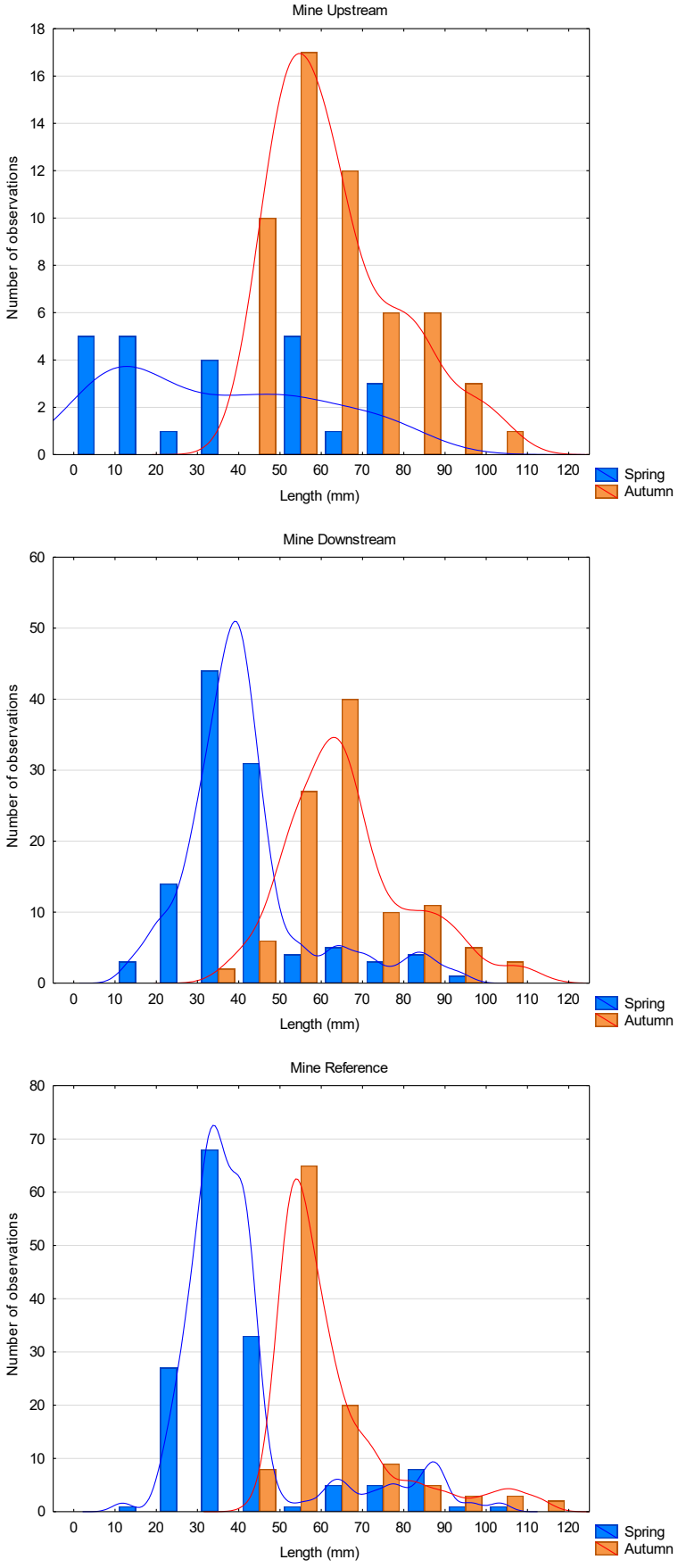

Figure 20 *Histograms of total length (mm) of Mountain Galaxias categorised by site treatment with Gaussian kernel density curves*

3.8 Platypus

The eDNA monitoring for platypus determined that they have been regularly present in upper reaches of Cadiangullong Creek in Pools 1 and 2 since March 2019, and in Pool 7 approximately 1 km downstream of site CC2 (Table 14). Following the trial environmental flow release, which concluded on 29 July 2019, platypus were detected in Pool 10 but were not recorded again until April 2020. It is possible that improved flows in April 2020 have allowed platypus to recolonise these pools from upstream locations. The presence of platypus in Pools 17 and 18 has been rare although they were detected in March 2019 and as an equivocal result in June 2020. Importantly, the autumn 2021 eDNA results demonstrate platypus are present throughout Cadiangullong Creek although they still appear absent at the most downstream site at Oaky Station (Pools 17/18).

Table 14 ***Summary of platypus results; green cells indicate presence based on eDNA; green cells with Sighted or Video indicate presence confirmed by chance visual observations or capture on field deployed cameras; orange cells indicate equivocal eDNA results; red cells indicate absence based on eDNA***

	Pool 1	Pool 2	Pool 6/7	Pool 9/10/11	Pool 17/18
14/03/2019					
1/05/2019					
6/06/2019	Sighted				
2/07/2019					
23/07/2019	Not sampled	Photography	Not sampled	Not sampled	Not sampled
31/07/2019		Sighted		Photography	
27/08/2019	Photography	Photography	Photography		
23/09/2019					
4/11/2019	Photography				
17/12/2019	Not sampled	Photography	Not sampled	Not sampled	Not sampled
15/01/2020					
11/02/2020					
7/04/2020					
19/05/2020					
20/06/2020					
8/12/2020					
3/05/2021					

Note Table 14 refers to Pools 9 and 11. These sites were used in previous surveys, but were replaced by Pool 10.

4. Discussion

4.1 Rainfall and hydrology

This report presents the results from the spring 2020 and autumn 2021 monitoring for the CVO AEMP. Prior to the spring and autumn monitoring rainfall was higher than for the same period in the previous 12 months. This included substantial rainfall events prior to the spring monitoring in August and October and prior to the Autumn monitoring in February and March.

Flow in Cadiangullong Creek upstream of Cadiangullong Dam (CC5) reflected the pattern in rainfall with an increase in mean daily flow following increased rainfall. Downstream of Cadiangullong Dam at CC1, flows were lower and remained between 0-3 ML/day from July to mid-October before increasing to 2-7 ML/day from November to May. The increased flow following rainfall observed at CC5 did not manifest at CC1, indicating the higher flows were captured by Cadiangullong Dam. Sites CC3 and CC4 downstream of the CVO MLA followed the rainfall pattern and flow at these sites is due to a combination of surface water and groundwater inputs, and releases from Cadiangullong Dam.

Riparian releases from Cadiangullong Dam are made in accordance with Condition 27 of the Project Approval PA06_0295 to meet the criteria listed in Table 15. Under normal conditions, the CVO riparian releases are approximately 2.8 ML/day and are aimed at achieving 0.9 ML/day at Oaky Creek although this varies depending on storage levels in the dam and inflows upstream of the dam at gauge 412168 (site CC5). Overall, from 1 July 2020 to 18 May 2021 average flow at gauge 412702 (site CC4) was 6.8 ML/day with a minimum of 0.4 ML/day and a maximum of 138.1 ML/day. It can therefore be considered the riparian releases contributed to maintaining connectivity throughout Cadiangullong Creek. Although there were some short-term high flow events prior to monitoring in both seasons, these are not expected to influence the results of the AEMP.

Table 15 Cadiangullong flow criteria

Cadiangullong Dam			Inflow	Downstream minimum	Other conditions
RL (masl)	Volume (ML)	Capacity (%)	ML/day @ GS412168	ML/day @ GS412702	
>778.8	420 to 4200	10 to 100	0 to 0.4	0.4	
			0.4 to 3.47	Inflow	
			>3.4	3.4	
773 – 778.8	170 to 420	4 to 10	0 to 0.4	0.4	No water to be extracted
			0.4 to 3.4	Inflow	
			>3.4	3.4	
762.8 – 773	5 to 170	0.1 to 4	0 to 0.4	Inflow*	
			>0.4	0.4*	
<762.8	5	0.1		No release required	

*Measured at the Dam GS412144

There was little runoff in the Swallow Creek reference site (SC1) throughout the year and from October to May flow was generally below 1 ML/day. However, there were peaks associated with high rainfall in August, October and March. The Flyers Creek reference site (FC1) has more frequent high flow events and higher baseflow than both Swallow Creek and Cadiangullong Creek. High flow events were observed in July, August, October and March following high rainfall. There was a downward trend in baseflow in Flyers Creek from September to March.

4.2 Aquatic habitat

All waterways assessed as part of the AEMP are subject to disturbance from different land use activities. This includes changes to Cadiangullong Creek due to activities within the CVO MLA, and agricultural uses further downstream. The upstream reference site (CC5) is also located in a modified landscape surrounded by pine plantations.

Habitat conditions during spring 2020 and autumn 2021 were generally consistent with those found in previous years (e.g. GHD 2020; 2019). However, excessive algal growth was observed in Panuara Rivulet that reflects impacts due to agricultural land use.

4.3 Water quality

In Cadiangullong Creek, the longitudinal increase in EC was consistent with previous monitoring periods (e.g. GHD 2020; 2019). In some cases EC was elevated in autumn compared to spring, likely due to the reduced flow and an increase in groundwater contribution. Sites CC5, CC1, CC2 and CC3 remained relatively fresh in both seasons while the higher EC further downstream at CC4 regularly exceeded the ANZG (2018) DGV. High EC in Diggers Creek, Panuara Rivulet, Rodd's Creek and Swallow Creek have also been observed in previous years

The high pH in most waterways was within the ANZG (2018) DGV range although higher levels were observed in Panuara Rivulet during spring. The low DO levels are also consistent with monitoring from previous years although high levels were observed at Panuara Rivulet in both seasons, particularly spring. As noted above there was excessive algal growth observed in Panuara Rivulet that is likely to have contributed to the high pH and DO. That is, during daytime hours photosynthesis by algae can lead to increased DO in the water. However, during the night this reduces DO and increases the proportion of carbon dioxide. Carbon dioxide (CO_2) is acidic and the sequestration of CO_2 photosynthesis increases the pH of water which is carried over to daytime. However, the increased pH may also be related to changing land use between sites, or a combination of this and photosynthesis.

Overall, the results do not suggest that CVO had a detectable influence on the surface water quality during the spring 2020 and autumn 2021 monitoring. Increases in EC were not beyond expected levels for the region based on the other waterways monitored. The high pH and low DO observed in Cadiangullong Creek also occurred in other waterways. The tailing dam appears to have negligible impact on water quality in Rodd's Creek (RC1) based on comparisons with the previous monitoring periods and other waterways.

4.4 Sediment quality

Of the metals that have DGVs published, only arsenic, copper, and nickel were exceeded. Of these, only arsenic and copper exceeded the ANZG (2018) upper DGV. Arsenic was exceeded in Diggers Creek (DG1) in autumn and copper in Cadiangullong Creek at CC2 in autumn, and CC3 in both seasons. Compared with other sites, Diggers Creek was found to have higher concentrations of arsenic, lead and zinc.

As found in other monitoring periods, there was evidence of increased copper concentrations levels in Cadiangullong Creek downstream of the mine at CC2 and CC3 that dissipates further downstream. Due to the geomorphology of CC2, the pool at this site appears to act as sink for copper and other contaminants. The pool acts as a settlement pond due to dense stands of *Typha* sp. that limits downstream sediment movement during low flows. Sediment transport may occur during higher flow events and the risk of contamination downstream appears to be dependent on a) the connectivity between CC2 and downstream reaches, b) the frequency and size of the high flow events, and c) the size of the sediment particles.

Other than copper, there was no evidence to suggest the CVO MLA is contributing to elevated metals in Cadiangullong Creek when compared to the reference waterways. However, at CC1 there were higher concentrations of barium, cobalt, iron, manganese and selenium compared to other sites. CC1 is upstream of the CVO MLA and only water from Cadiangullong Dam passes through this site. Given it was observed in both spring 2020 and autumn 2021 it is unlikely to be due to laboratory errors or cross-contamination during sampling. Comparisons of the current sediment results to those from the 2019-2020 monitoring, along with CVO water quality data, are included in Table 16. The CVO water quality data does not suggest there have been consistently high concentrations of these parameters in the water at CC1 that may have contributed to the elevated metals in the sediment. Although high concentrations of manganese were recorded in the water on 13 March 2019 (3.18 mg/L) and 23 March 2020 (9.1 mg/L) all other recordings were below the ANZG (2018) DGV. Ultimately, it is not considered mining operations contributed to these concentrations in the sediments although the reasons for the high concentrations are unknown.

Table 16 Selected total metals concentrations in sediment (mg/kg) at CC1 upstream of the CVO MLA during the 2019-20 and 2020-21 monitoring periods; CVO water quality monitoring results included for comparisons

Season	Barium	Cobalt	Iron	Manganese	Selenium
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Spring 2019	131	21	38200	1040	<1
Autumn 2020	88	25	46000	1500	<3
Spring 2020	680	55	55400	27300	27
Autumn 2021	640	78	77100	22100	38
CVO water quality monitoring March 2018 to June 2021 (mg/L)					
Average Std. Dev. Min. Max.		0.001 0.001 0.000 0.004	0.296 0.189 0.050 0.780	0.721 1.940 0.022 9.100	0.009 0.003 0.001 0.010
ANZG (2018)		0.0014 mg/L		1.9 mg/L	0.011 mg/L

All metal concentrations in Rodd's Creek, with the exception of copper, were also below the ANZG (2018) DGV and there was no evidence to suggest an impact due to seepage from the tailings dam.

4.5 Macroinvertebrates

In Cadiangullong Creek, there was some evidence of reduced diversity, including EPT taxa, at CC2 compared to other sites. However, the SIGNAL-2 scores at CC2 were generally comparable to those observed at reference sites on Flyers Creek and Panuara Rivulet. The SIGNAL-2 results also suggest that all waterways monitored may be subject to multiple disturbances irrespective of mine operations including high salinity or nutrient levels, agricultural pollution, or the downstream impacts of dams.

The AUSRIVAS results also suggest that all waterways monitored regularly have fewer taxa than expected and potential impacts due to water quality and/or habitat quality. Rarely did any site have most/all of the expected taxa found and water quality and/or habitat condition roughly equivalent to reference sites. Although this was observed at site CC2 for combined seasons edge habitats, downstream at CC3 and CC4 conditions had improved to be similar to reference conditions. In general, the EPA consider SIGNAL to be more sensitive to impacts of pollution while AUSRIVAS is relatively more sensitive to impacts on habitat (EPA, 2000). Consequently, it is likely that habitat conditions are more influential on the macroinvertebrate community health at CC2 than water or sediment quality. Although all sites are subject to disturbance from different land use activities, extensive willows at CC2 has reduced habitat diversity at this site. This is also reflected by the multivariate analyses that did not detect any differences amongst treatments.

4.6 Sediment/macroinvertebrate relationship

Within each season, there was no evidence to suggest the sediment quality and macroinvertebrate communities correlated for both edge and riffle habitats. When seasons were combined, it did suggest barium, beryllium, manganese, zinc and mercury may have contributed to the more distinct macroinvertebrate community at the upstream site on Cadiangullong Creek (CC1) and Diggers Creek (DG1). However, as outlined in Section 4.5, the health of the riffle habitat at CC1 was comparable to sites further downstream and other references sites. This again suggests that habitat quality is likely to be the main driver of macroinvertebrate and waterway health.

4.7 Fish

Overall, the results from the 2021-21 fish monitoring indicate a relatively healthy community dominated by the native Mountain Galaxias (*Galaxias olidus*). Low water levels during both spring and autumn prevented the captured of fish at CC2. However, the species remains distributed throughout Cadiangullong Creek, along with Flyers Creek and Swallow Creek. The absence of fish in Panuara Rivulet, which is consistent with previous seasons, is potentially due to the uncharacteristically low flows that have occurred over the past three years.

The low numbers of fish collected at CC5 and SC1 in autumn is consistent with previous seasons and may be due to predatory Trout upstream of Cadiangullong Dam and the small size of Swallow Creek. It is reported that the presence of trout has reduced the abundance of Mountain Galaxias in lowland streams and completely eliminated them in some upland streams (Lintermans, 2007). The barrier effect of Cadiangullong Dam may also prevent recruitment and recolonisation of upstream reaches. However, it should be noted electrofishing was not possible at CC5 and SC1 and this may have biased the results.

For all treatments (i.e. upstream, on-site, downstream and reference) there was a range of size classes in the fish community. Furthermore, there was an increase in length during autumn compared to spring. This may indicate the recruitment of juveniles during spring that had matured by the following autumn, indicating reasonably healthy self-sustaining with adequate recruitment. On current evidence, the mine does not appear to be negatively impacting populations of Mountain Galaxias.

4.8 Platypus

The eDNA monitoring for platypus determined that they have been regularly present in upper reaches of Cadiangullong Creek in Pools 1 and 2 since March 2019, and in Pool 7 approximately 1 km downstream of site CC2. The lack of detection of platypus during spring 2020 was surprising given they had been detected at multiple sites in previous monitoring. These results may represent ‘false negatives’ in that they were present but eDNA had deteriorated by the time samples and reached the laboratory (pers. comm. Josh Griffiths EnviroDNA). Importantly, the autumn 2021 eDNA results demonstrate platypus are present throughout Cadiangullong Creek although they still appear absent at the most downstream site at Oaky Station (Pools 17/18).

5. Conclusion

- High flow events occurred throughout the 12-month period between July 2020 and May 2021 in response to rainfall events.
- Discharge in Cadiangullong Creek upstream of the dam (CC5) reflected the pattern in rainfall with an increase in mean daily flow following increased rainfall. Downstream of Cadiangullong Dam at CC1, flow generally remained low due to the capture and storage of water. Sites CC3 and CC4 downstream of the CVO MLA followed rainfall patterns more closely than CC1 as they receive additional runoff and water from tributaries.
- Disturbances to riparian zone vegetation and broader catchment scale land-use which, aside from mining and associated operations, is heavily influenced by grazing in the mid to lower catchment areas, and pine plantations in the upper catchments, are likely to be impacting on aquatic ecosystem health.
- Low flows are reflected by an increase in electrical conductivity in Cadiangullong Creek, likely due to a concentration effect, increased groundwater contributions, changing land use, or a combination of these factors.
- Variation in DO and pH are likely influenced by photosynthetic activity and land use between sites, or a combination of the two. Overall, the results do not suggest that CVO had a detectable influence on the surface water quality during the spring 2020 and autumn 2021 monitoring. Seepage from the tailing dam also appears to have negligible impact on water quality or sediment quality in Rodd's Creek (RC1).
- Relatively higher concentrations of selenium, barium, manganese, cobalt and iron were detected at CC1 which had not previously been observed. This site is upstream of the CVO MLA so the reasons for this are not known. Additional monitoring in the future is required to determine if these values are outliers or there is another potential source of contamination.
- There was evidence of increased copper in the sediments of Cadiangullong Creek downstream of the mine and the pool at CC2 appears to act as a sink for copper and other contaminants. Sediment transport may occur during high flow events thereby increasing the risk of contamination downstream of CC2. This risk is dependent on a) the connectivity between CC2 and the reaches downstream, b) the frequency and size of the high flow events, and c) the size of the sediment particles. As found in previous years, copper is dissipated further downstream.
- Overall, all waterways monitored regularly have fewer macroinvertebrate taxa than expected and potential impacts due to water quality and/or habitat quality. Results suggest that all waterways monitored may be subject to multiple disturbances irrespective of mine operations including high salinity or nutrient levels, agricultural pollution, or the downstream impacts of dams.
- There was some evidence that site CC2 was less healthy than other sites on Cadiangullong Creek or the reference sites. It is likely that habitat conditions are more influential on the macroinvertebrate community health at CC2 than water or sediment quality.
- There was some evidence to suggest barium, beryllium, manganese, zinc and mercury may have contributed to the macroinvertebrate community composition at CC1. However, this is upstream of the CVO MLA and overall, sediment analytes were not found to be a major contributor the macroinvertebrate health that is likely driven more by habitat conditions. This includes the relatively high copper concentrations at CC2 and CC3.
- A relatively healthy fish community dominated by the native Mountain Galaxias remains distributed throughout Cadiangullong Creek, along with Flyers Creek and Swallow Creek. There was a range of size classes in the fish community and an increase in length during autumn compared to spring. This may indicate the recruitment of juveniles during spring that had matured by the following autumn, indicating a reasonably healthy self-sustaining community with adequate recruitment.
- A lack of detection for platypus during spring 2020 was surprising and may have been an artifact of eDNA decomposition. Importantly, platypus remain distributed throughout Cadiangullong Creek although they still appear absent at the most downstream site at Oaky Station (Pools 17/18).

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Appendices

Appendix A

Site location details for the CVO AEMP

Site Code	Site Name	Position Relative to Potential Impacts and CVO	Latitude	Longitude	Catchment Area (km^2)
CC5	Cadiangullong Creek at Forestry gauging station	Downstream of Canobolas State Forest (pine plantation); upstream of CVO	-33.41563	148.98528	33.44
CC1	Cadiangullong Creek 200 m downstream of Cadiangullong Dam	Downstream of Cadiangullong Dam; upstream of CVO mining facilities	-33.43592	148.99287	40.28
CC2	Cadiangullong Creek at South Portal Road (lower cutting)	Downstream of Cadiangullong Dam; downstream of Cadiangullong Creek diversion; adjacent to Cadia pit (now in care and maintenance phase)	-33.46092	148.98957	58.16
CC3	Cadiangullong Creek at Southern Lease Boundary	Downstream of CVO facilities; upstream of tailings dams; grazing in surrounding lands	-33.49894	148.97604	72.71
CC4	Cadiangullong Creek at Oaky Creek Gauging Station	Downstream of CVO facilities; downstream of tailings dams; grazing in surrounding lands	-33.53951	148.97173	107.36
FC2	Flyers Creek at Extraction Weir	Catchment east and adjacent to Cadiangullong Creek catchment; grazing and pine plantation in surrounding lands; upstream of Flyers Creek Extraction Weir	-33.47829	149.04060	52.36
FC1	Flyers Creek at Martin Road Gauging Station	Catchment east and adjacent to Cadiangullong Creek catchment; grazing and pine plantation in surrounding lands; downstream of Flyers Creek Extraction Weir	-33.48849	149.03539	56.16
SC1	Swallow Creek at Gauging Station No. 412167	Catchment west and adjacent to Cadiangullong Creek catchment; grazing in surrounding lands; downstream of Ridgeway underground mine sinkhole	-33.48234	148.95974	17.97
PR1	Panuara Rivulet upstream of Revegetation Area	Catchment west of CVO; located on leased sheep grazing property; upstream of proposed revegetation area	-33.49671	148.89010	54.04
PR2	Panuara Rivulet downstream of Revegetation Area	Catchment west of CVO; located on leased sheep grazing property; downstream of proposed revegetation area	-33.52097	148.87873	58.72
RC1	Rodd's Creek upstream of Cadiangullong Creek	Downstream of tailing dams on Rodd's Creek; upstream of CVOCC4 confluence with Cadiangullong Creek	-33.53107	148.98513	21.14
DG1	Diggers Creek at Diggers Weir Station No. 412166	Upstream of Panuara Rivulet, catchment adjacent to, but not influenced by mining operations.	-33.43434	148.93373	5.29

Appendix B

Field sheets summarising habitat conditions

	Site	CC5	CC1	CC2	CC3	CC4	FC1	FC2	PR1	PR2	SC1	RC1	DG1
Site Attributes	Topography	Broad Valley	Steep Valley	Steep Valley	Broad Valley	Steep Valley	Steep Valley	Broad Valley	Broad Valley	Broad Valley	Broad Valley	Steep Valley	Broad Valley
	Water Level	Low	Moderate	Low	Low	Low	Low	Moderate	NF	NF	Low	Low	Low
	Shading of River	Moderate	High	Low	Moderate	Moderate	None	Low	Low	Low	None	None	Low
	Trees >10 m	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present
	Trees <10 m	60	10	15	15	45	5	5	1	5	15	2	5
	Shrubs / Vines / Rushes	30	30	5	5	10	5	3	0	30	5	5	0
	Grasses / Herbs / Ferns	40	90	40	80	3	80	95	30	15	90	90	90
	Stream Width - Min	1	1	1	0.5	3	0.5	2	0	0	51	1	1
	Stream Width - Max	5	6	5	2	7	2	12	4	3	2	2	1
	Stream Width - Mode	3	3	1.5	1	4	1.5	5	0.5	1.5	1	1	1
Land Use	Left Bank	Forestry	Exotic Grassland (no grazing)	Mining (Open Cut)	Grazing	Grazing	Grazing	Grazing	Grazing	Grazing	Grazing	Grazing	Grazing
	Right Bank	Forestry	Exotic Grassland (no grazing)	Exotic Grassland (no grazing)	Grazing	Grazing	Grazing	Grazing	Grazing	Grazing	Grazing	Grazing	Grazing
Riffle	Bedrock	/	10	/	5	0	5	15	30	/	/	/	/
	Boulder	/	20	/	20	2	10	10	40	0	/	/	/
	Cobble	/	40	/	40	30	45	20	20	/	/	/	/
	Pebble	/	5	/	10	35	15	20	5	/	/	/	/
	Gravel	/	5	/	10	20	10	10	1	/	/	/	/
	Sand	/	10	/	5	5	10	10	0	/	/	/	/
	Silt	/	10	/	10	4	5	10	2	/	/	/	/

	Site	CC5	CC1	CC2	CC3	CC4	FC1	FC2	PR1	PR2	SC1	RC1	DG1
	Clay	/	0	/	0	4	0	5	2	/	/	/	/
	Depth - Mode	/	4	12	10	15	9	14	0	/	/	/	/
Edge	Bedrock	15	0	10	0	0	0	0	40	15	0	0	20
	Boulder	10	0	30	0	5	0	0	5	0	0	0	10
	Cobble	10	0	20	30	30	0	0	30	10	15	20	5
	Pebble	20	15	2	0	30	15	5	15	2	10	10	5
	Gravel	15	10	2	0	15	15	5	5	3	10	10	10
	Sand	15	20	1	10	5	40	5	0	5	15	40	20
	Silt	20	50	30	50	8	20	70	3	60	35	10	25
	Clay	5	5	5	10	7	10	15	2	5	15	10	5
	Detritus Cover	30	60	30	60	15	25	65	20	30	40	30	15
	Bank Overhang	20	30	5	40	25	15	5	5	10	20	10	40
	Total Macrophytes	60	80	80	70	20	70	20	0	60	90	80	70
Site Assessment	Water Quality	2	2	2	2	2	2	3	3	2	2	2	2
	Instream	2	2	4	3	3	2	3	4	2	3	2	2
	Riparian Zone	3	1	3	2	3	4	3	4	3	4	4	3
	Catchment Assessment	2	2	3	3	3	3	3	3	3	4	3	3
	Total	9	7	12	10	11	11	12	14	10	13	11	10

Appendix C

Sediment quality analytes schedule and results (spring 2020 and autumn 2021)

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES2044363**	Page	: 1 of 5
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MS DEMELZA SCOTT	Contact	: Angus Harding
Address	: 270 SUMMER STREET ORANGE NSW, AUSTRALIA 2800	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: +61 02 6393 6400	Telephone	: +61 2 8784 8555
Project	: 12540968	Date Samples Received	: 14-Dec-2020 15:00
Order number	: ----	Date Analysis Commenced	: 15-Dec-2020
C-O-C number	: ----	Issue Date	: 18-Dec-2020 14:50
Sampler	: Grace Rogers		
Site	:		
Quote number	: EN/005		
No. of samples received	: 12		
No. of samples analysed	: 12		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	CC3	CC1	RC1	CC5	SC1
			Sampling date / time	09-Dec-2020 00:00	09-Dec-2020 00:00	09-Dec-2020 00:00	09-Dec-2020 00:00	09-Dec-2020 00:00
Compound	CAS Number	LOR	Unit	ES2044363-001	ES2044363-002	ES2044363-003	ES2044363-004	ES2044363-005
				Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	69.1	81.9	45.5	72.5	48.9
EG005(ED093)T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	12800	19600	25100	15800	14100
Antimony	7440-36-0	5	mg/kg	<5	<5	<5	<5	<5
Barium	7440-39-3	10	mg/kg	90	680	120	140	180
Beryllium	7440-41-7	1	mg/kg	<1	<2	<1	3	<1
Cobalt	7440-48-4	2	mg/kg	21	55	20	15	19
Iron	7439-89-6	50	mg/kg	37300	55400	46600	36500	28300
Manganese	7439-96-5	5	mg/kg	864	27300	548	696	1750
Molybdenum	7439-98-7	2	mg/kg	2	<2	<2	<2	<2
Selenium	7782-49-2	5	mg/kg	<5	27	5	<5	<5
Silver	7440-22-4	2	mg/kg	<2	<2	<2	<2	<2
Arsenic	7440-38-2	5	mg/kg	10	13	10	6	23
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	25	16	36	25	19
Copper	7440-50-8	5	mg/kg	461	64	322	25	63
Lead	7439-92-1	5	mg/kg	11	12	6	9	8
Nickel	7440-02-0	2	mg/kg	13	14	18	13	15
Zinc	7440-66-6	5	mg/kg	76	90	64	120	60
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	FC1	CC2	PR1	CC4	FC2
			Sampling date / time	09-Dec-2020 00:00	09-Dec-2020 00:00	09-Dec-2020 00:00	09-Dec-2020 00:00	09-Dec-2020 00:00
Compound	CAS Number	LOR	Unit	ES2044363-006	ES2044363-007	ES2044363-008	ES2044363-009	ES2044363-010
				Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	54.1	44.6	29.8	70.6	62.7
EG005(ED093)T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	11600	16200	9970	18700	11800
Antimony	7440-36-0	5	mg/kg	<5	<5	<5	<5	<5
Barium	7440-39-3	10	mg/kg	130	70	90	120	90
Beryllium	7440-41-7	1	mg/kg	<1	<1	<1	<1	<1
Cobalt	7440-48-4	2	mg/kg	19	14	9	13	13
Iron	7439-89-6	50	mg/kg	41000	29200	22900	28400	23400
Manganese	7439-96-5	5	mg/kg	2050	242	593	390	1050
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	<2	<2
Selenium	7782-49-2	5	mg/kg	<5	<5	<5	<5	<5
Silver	7440-22-4	2	mg/kg	<2	<2	<2	<2	<2
Arsenic	7440-38-2	5	mg/kg	22	8	8	9	8
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	44	22	15	20	32
Copper	7440-50-8	5	mg/kg	48	253	18	141	47
Lead	7439-92-1	5	mg/kg	17	6	11	7	12
Nickel	7440-02-0	2	mg/kg	15	12	10	12	12
Zinc	7440-66-6	5	mg/kg	82	70	42	70	70
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	DG1	PR2	----	----	----
			Sampling date / time	09-Dec-2020 00:00	09-Dec-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit	ES2044363-011	ES2044363-012	--------	--------	--------
				Result	Result	----	----	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	**55.0**	**52.0**	----	----	----
EG005(ED093)T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	**12300**	**11000**	----	----	----
Antimony	7440-36-0	5	mg/kg	<5	<5	----	----	----
Barium	7440-39-3	10	mg/kg	**140**	**120**	----	----	----
Beryllium	7440-41-7	1	mg/kg	**1**	<1	----	----	----
Cobalt	7440-48-4	2	mg/kg	**16**	**10**	----	----	----
Iron	7439-89-6	50	mg/kg	**45800**	**21100**	----	----	----
Manganese	7439-96-5	5	mg/kg	**848**	**706**	----	----	----
Molybdenum	7439-98-7	2	mg/kg	<2	<2	----	----	----
Selenium	7782-49-2	5	mg/kg	<5	<5	----	----	----
Silver	7440-22-4	2	mg/kg	<2	<2	----	----	----
Arsenic	7440-38-2	5	mg/kg	**42**	**8**	----	----	----
Cadmium	7440-43-9	1	mg/kg	<1	<1	----	----	----
Chromium	7440-47-3	2	mg/kg	**21**	**15**	----	----	----
Copper	7440-50-8	5	mg/kg	**41**	**21**	----	----	----
Lead	7439-92-1	5	mg/kg	**19**	**16**	----	----	----
Nickel	7440-02-0	2	mg/kg	**16**	**14**	----	----	----
Zinc	7440-66-6	5	mg/kg	**155**	**49**	----	----	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	----	----	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES2117592**	Page	: 1 of 5
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR PETER LIND	Contact	: Angus Harding
Address	: 270 SUMMER STREET ORANGE NSW, AUSTRALIA 2800	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: +61 03 8687 8000	Telephone	: +61 2 8784 8555
Project	: 12540968	Date Samples Received	: 11-May-2021 15:06
Order number	: ----	Date Analysis Commenced	: 14-May-2021
C-O-C number	: ----	Issue Date	: 19-May-2021 19:35
Sampler	: PETER LIND		
Site	: Cadia AEMP 12540968		
Quote number	: EN/005		
No. of samples received	: 12		
No. of samples analysed	: 12		

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This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

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Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EG005: Poor precision was obtained for Iron on sample ES2117525-7 Results have been confirmed by re-extraction and reanalysis.

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)				Sample ID	FC2	FC1	CC5	SC1	CC4
				Sampling date / time	01-May-2021 00:00	01-May-2021 00:00	02-May-2021 00:00	02-May-2021 00:00	02-May-2021 00:00
Compound	CAS Number	LOR	Unit		ES2117592-001	ES2117592-002	ES2117592-003	ES2117592-004	ES2117592-005
					Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	1.0	%		75.5	64.7	62.8	60.3	74.5
EG005(ED093)T: Total Metals by ICP-AES									
Aluminium	7429-90-5	50	mg/kg		21200	14700	24600	15900	22900
Antimony	7440-36-0	5	mg/kg		<5	<5	<5	<5	<5
Barium	7440-39-3	10	mg/kg		170	130	130	350	140
Beryllium	7440-41-7	1	mg/kg		<1	<1	5	<1	<1
Cobalt	7440-48-4	2	mg/kg		26	20	20	35	23
Iron	7439-89-6	50	mg/kg		46000	37200	62100	53200	43000
Manganese	7439-96-5	5	mg/kg		3110	2280	700	3400	431
Molybdenum	7439-98-7	2	mg/kg		<2	<2	<2	<2	<2
Selenium	7782-49-2	5	mg/kg		6	<5	<5	6	<5
Silver	7440-22-4	2	mg/kg		<2	<2	<2	<2	<2
Arsenic	7440-38-2	5	mg/kg		20	22	12	58	12
Cadmium	7440-43-9	1	mg/kg		<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg		68	50	52	32	33
Copper	7440-50-8	5	mg/kg		81	59	51	82	202
Lead	7439-92-1	5	mg/kg		23	18	13	13	9
Nickel	7440-02-0	2	mg/kg		24	16	19	21	18
Zinc	7440-66-6	5	mg/kg		120	101	137	83	94
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		0.1	<0.1	<0.1	<0.1	<0.1

Analytical Results

Sub-Matrix: **SEDIMENT** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Sample ID	RC1	CC4	CC3	CC2	DG1
				Sampling date / time	02-May-2021 00:00	05-May-2021 00:00	05-May-2021 00:00	05-May-2021 00:00	06-May-2021 00:00
					ES2117592-006	ES2117592-007	ES2117592-008	ES2117592-009	ES2117592-010
					Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	1.0	%		**75.1**	**45.6**	**75.0**	**88.8**	**62.7**
EG005(ED093)T: Total Metals by ICP-AES									
Aluminium	7429-90-5	50	mg/kg		**25500**	**19200**	**10900**	**25700**	**12900**
Antimony	7440-36-0	5	mg/kg		<5	<5	<5	<5	<5
Barium	7440-39-3	10	mg/kg		**160**	**100**	**90**	**640**	**150**
Beryllium	7440-41-7	1	mg/kg		<1	<1	<1	<2	<1
Cobalt	7440-48-4	2	mg/kg		**20**	**14**	**32**	**78**	**20**
Iron	7439-89-6	50	mg/kg		**43100**	**30400**	**26400**	**77100**	**52000**
Manganese	7439-96-5	5	mg/kg		**2610**	**212**	**1000**	**22100**	**382**
Molybdenum	7439-98-7	2	mg/kg		<2	<2	**4**	<2	<2
Selenium	7782-49-2	5	mg/kg		**6**	<5	<5	**38**	<5
Silver	7440-22-4	2	mg/kg		<2	<2	<2	<2	<2
Arsenic	7440-38-2	5	mg/kg		**9**	**9**	**19**	**16**	**117**
Cadmium	7440-43-9	1	mg/kg		<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg		**37**	**31**	**50**	**29**	**15**
Copper	7440-50-8	5	mg/kg		**133**	**273**	**428**	**74**	**49**
Lead	7439-92-1	5	mg/kg		<5	**6**	**12**	**12**	**35**
Nickel	7440-02-0	2	mg/kg		**16**	**14**	**23**	**21**	**16**
Zinc	7440-66-6	5	mg/kg		**83**	**116**	**71**	**80**	**128**
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1

Analytical Results

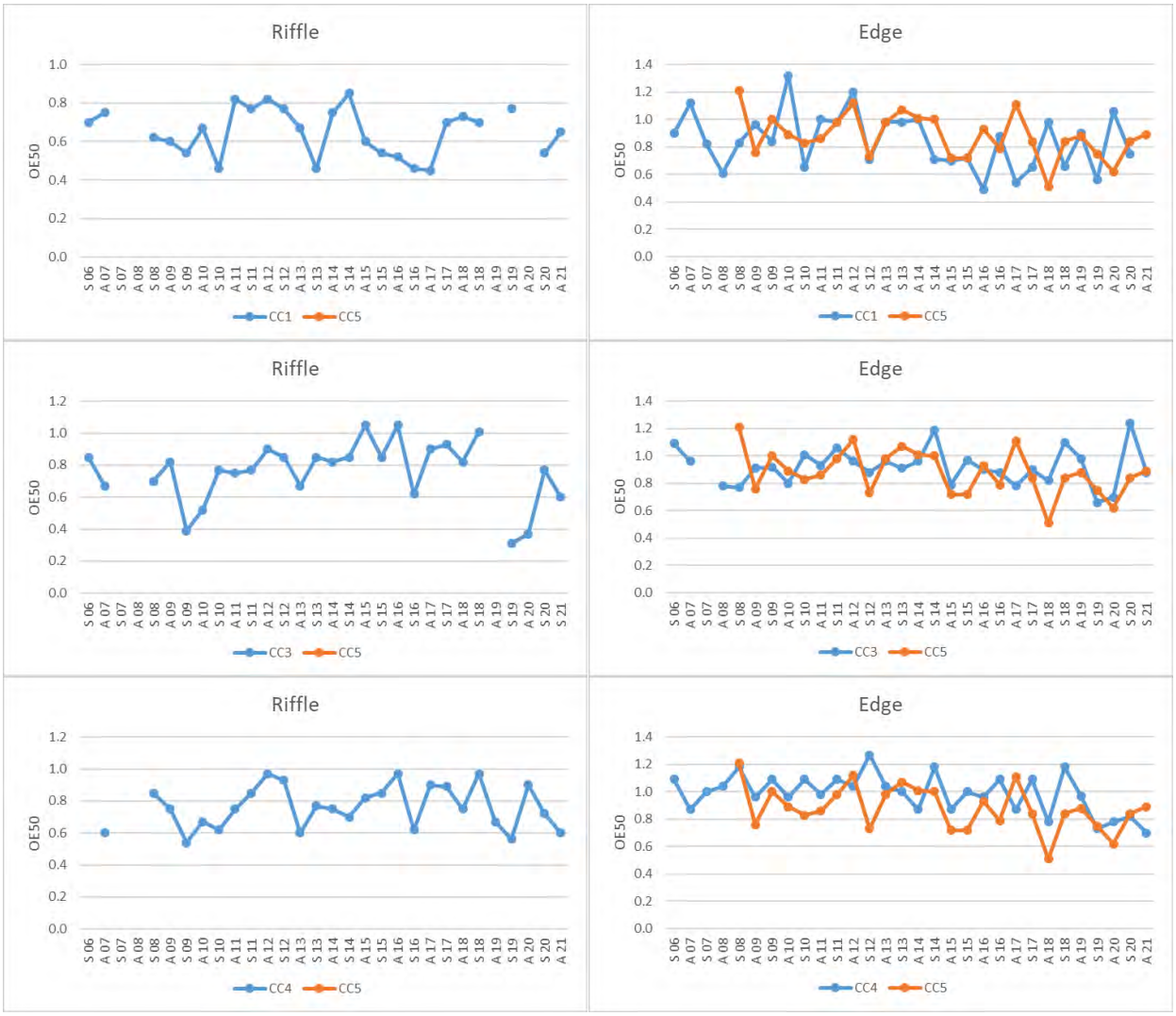
Sub-Matrix: SEDIMENT (Matrix: SOIL)			Sample ID	PR1	PR2	----	----	----
			Sampling date / time	06-May-2021 00:00	06-May-2021 00:00	----	----	----
Compound	CAS Number	LOR	Unit	ES2117592-011	ES2117592-012	--------	--------	--------
				Result	Result	----	----	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	**32.7**	**32.0**	----	----	----
EG005(ED093)T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	**10300**	**10400**	----	----	----
Antimony	7440-36-0	5	mg/kg	<5	<5	----	----	----
Barium	7440-39-3	10	mg/kg	**110**	**120**	----	----	----
Beryllium	7440-41-7	1	mg/kg	<1	<1	----	----	----
Cobalt	7440-48-4	2	mg/kg	**9**	**12**	----	----	----
Iron	7439-89-6	50	mg/kg	**24100**	**25900**	----	----	----
Manganese	7439-96-5	5	mg/kg	**673**	**535**	----	----	----
Molybdenum	7439-98-7	2	mg/kg	<2	<2	----	----	----
Selenium	7782-49-2	5	mg/kg	<5	<5	----	----	----
Silver	7440-22-4	2	mg/kg	<2	<2	----	----	----
Arsenic	7440-38-2	5	mg/kg	**9**	**9**	----	----	----
Cadmium	7440-43-9	1	mg/kg	<1	<1	----	----	----
Chromium	7440-47-3	2	mg/kg	**17**	**21**	----	----	----
Copper	7440-50-8	5	mg/kg	**19**	**19**	----	----	----
Lead	7439-92-1	5	mg/kg	**12**	**15**	----	----	----
Nickel	7440-02-0	2	mg/kg	**11**	**15**	----	----	----
Zinc	7440-66-6	5	mg/kg	**44**	**51**	----	----	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	----	----	----

Appendix D

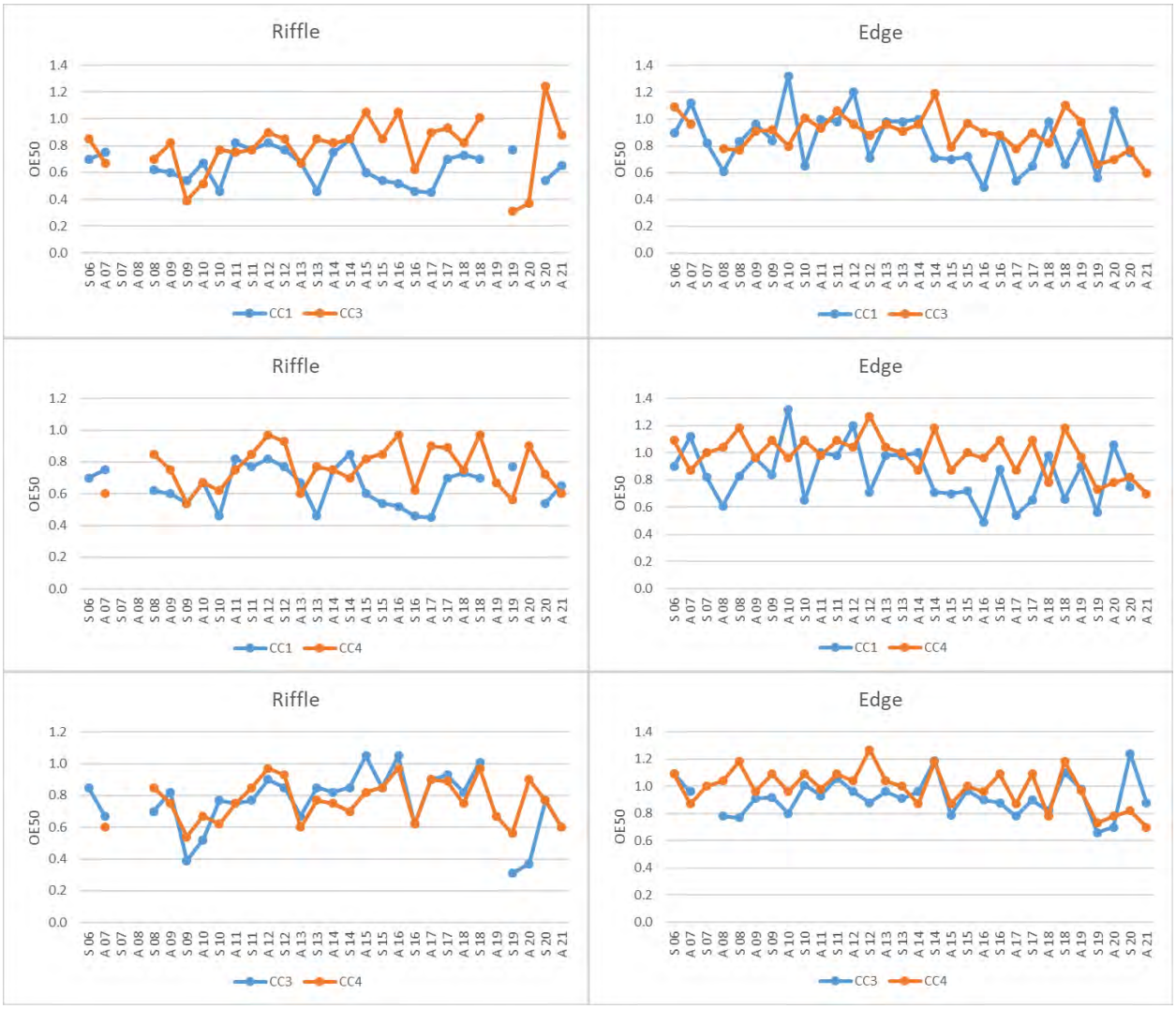
Long term patterns in macroinvertebrate indices

This appendix includes long term plots for the macroinvertebrate indices measured as part of the Cadia Valley Operations AEMP. These graphs include all monitoring sites for the period, spring 2006 – autumn 2020, and are grouped into the sites pairings that were described in the recent 10 year data review. Pairwise comparisons of water quality monitoring sites were investigated to determine the key factors that may influence the water quality and streamflow of Cadiangullong Creek. The site comparisons and rationale are as follows:

- CC5 vs CC1 - Cadiangullong Creek upstream of Cadiangullong Dam vs downstream of Cadiangullong Dam; investigating the influence of Cadiangullong dam on the water quality and streamflow of the waterway
- CC5 vs CC3 - Cadiangullong Creek upstream of Cadiangullong Dam vs Cadiangullong Creek at Southern Lease Boundary, downstream of the main areas of mining operations; investigating the influence of Cadiangullong Dam and mining operations on the water quality of Cadiangullong Creek
- CC5 vs CC4 - Cadiangullong Creek upstream of Cadiangullong Dam vs Cadiangullong Creek at Oaky Creek gauging station: investigating the influence of all CVO operations including Cadiangullong Dam, CVO facilities and tailing dams on the water quality and stream flow of Cadiangullong Creek
- CC1 vs CC3 – Cadiangullong Creek downstream of Cadiangullong Dam vs Cadiangullong Creek at Southern Lease Boundary; investigating the influence of CVO main area of operations on the water quality of Cadiangullong Creek, separated from the influence of Cadiangullong Dam
- CC1 vs CC4- Cadiangullong Creek downstream of Cadiangullong Dam vs Cadiangullong Creek at Oaky Creek gauging station; investigating the influence of CVO main area of operations and tailing dams on the water quality and stream flow of Cadiangullong Creek without separated from the influence of Cadiangullong Dam
- CC3 vs CC4 - Cadiangullong Creek at Southern Lease Boundary vs Cadiangullong Creek at Oaky Creek gauging station; investigating the influence of land use and tailings dams in the Rodds Creek catchment on Cadiangullong Creek, separated from the influence of CVO main operations, and Cadiangullong Dam upstream
- All of the other sites are grouped by their catchments



Macroinvertebrate OE50 scores in Cadiangullong Creek between spring 2006 and autumn 2021



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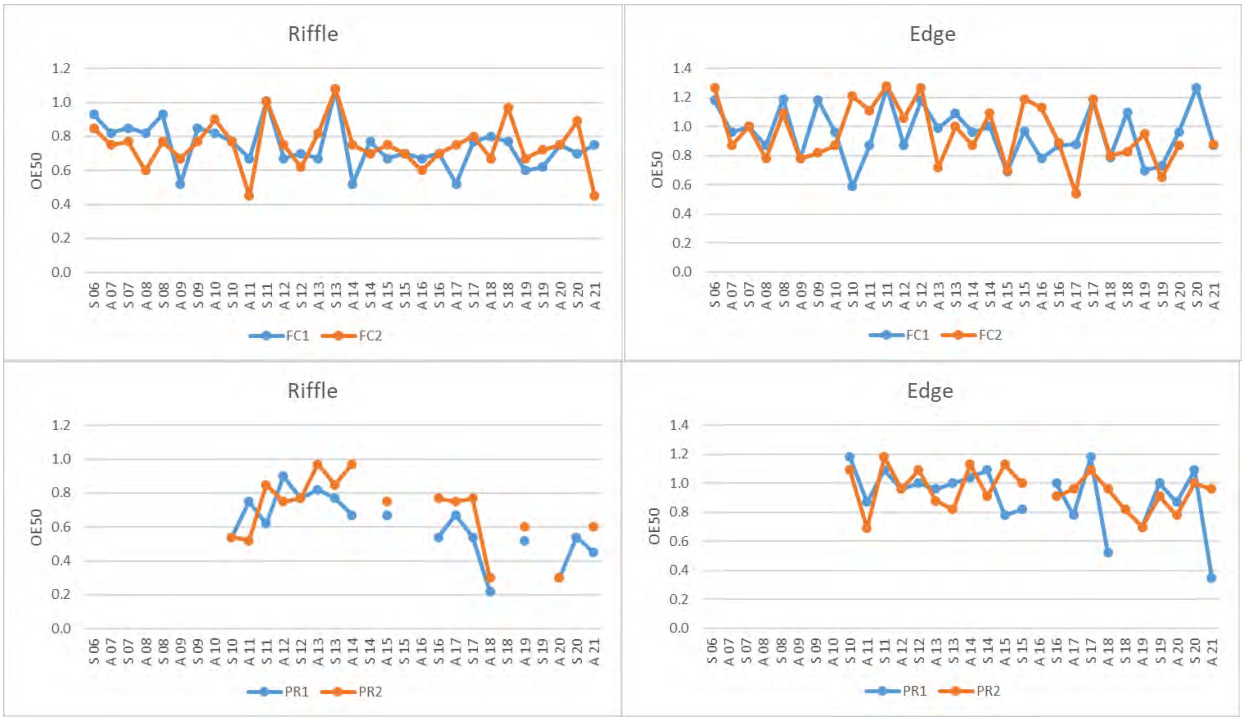
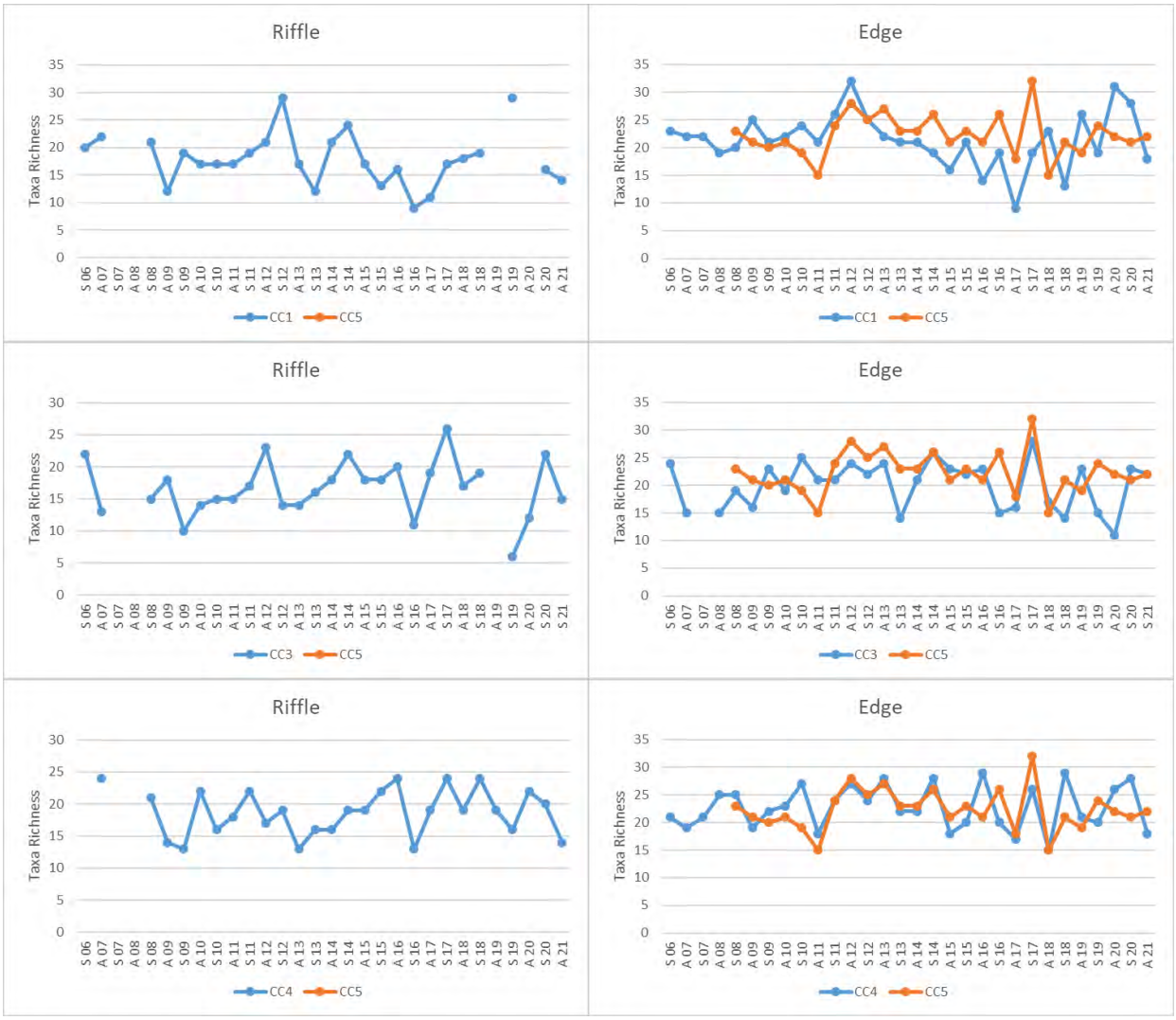


Macroinvertebrate OE50 scores in Flyers Creek (top) and Panuara Rivulet (bottom) between spring 2006 and autumn 2021

Macroinvertebrate OE50 scores in Diggers Creek (top), Swallow Creek (middle) and Rodd's Creek (bottom) between spring 2006 and autumn 2021



Macroinvertebrate taxa richness in Cadiangullong Creek between spring 2006 and autumn 2021

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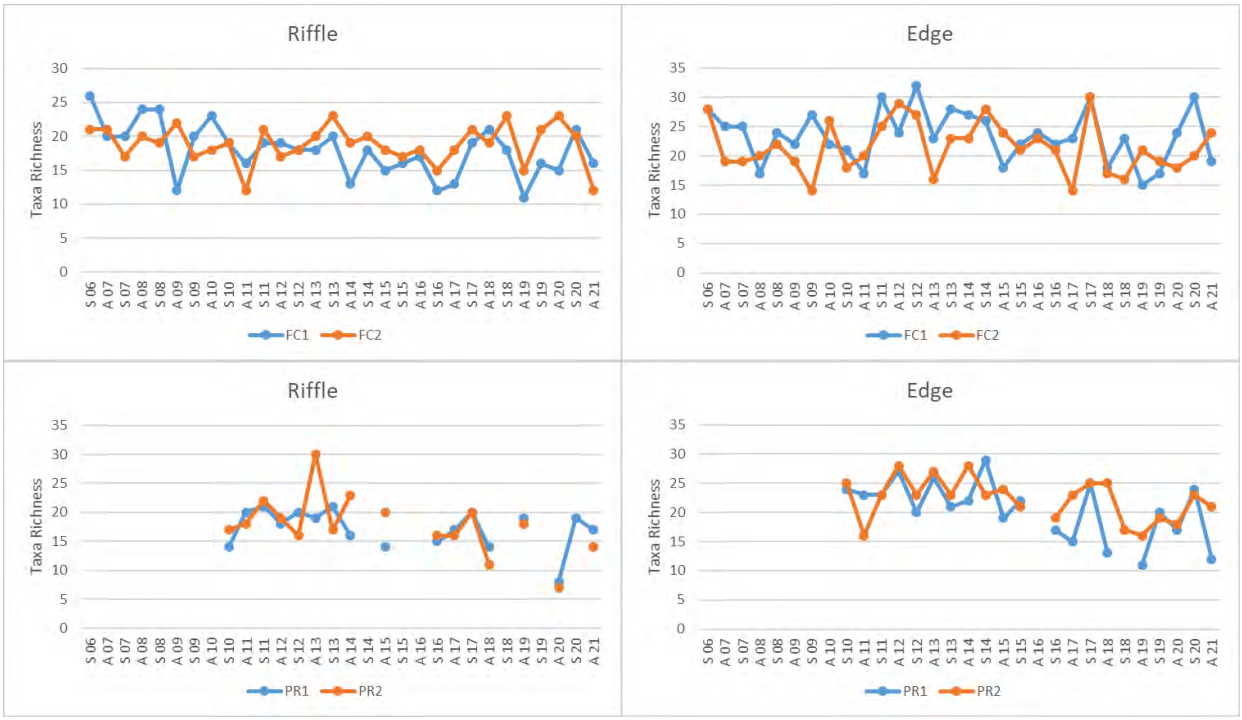

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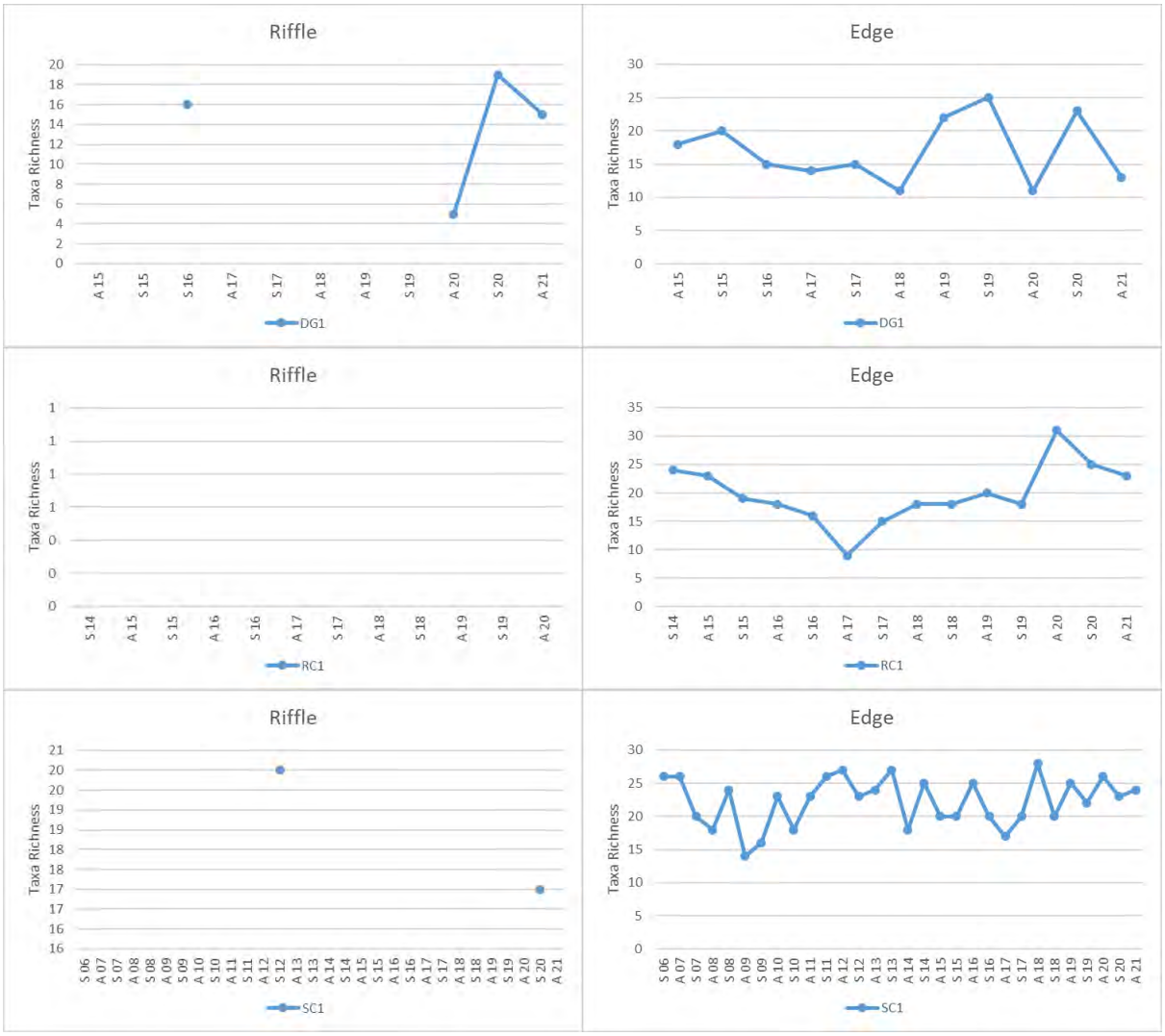

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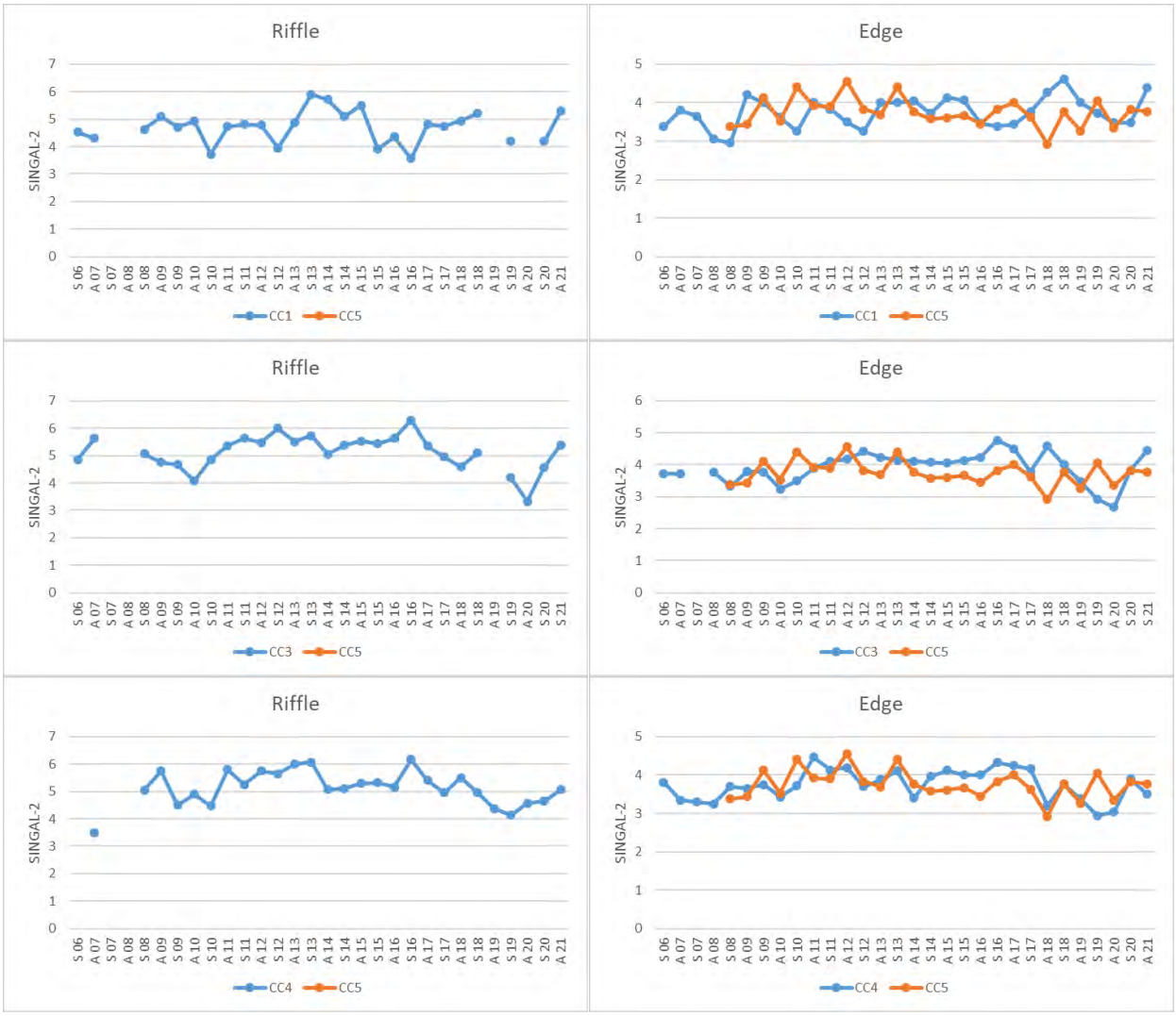
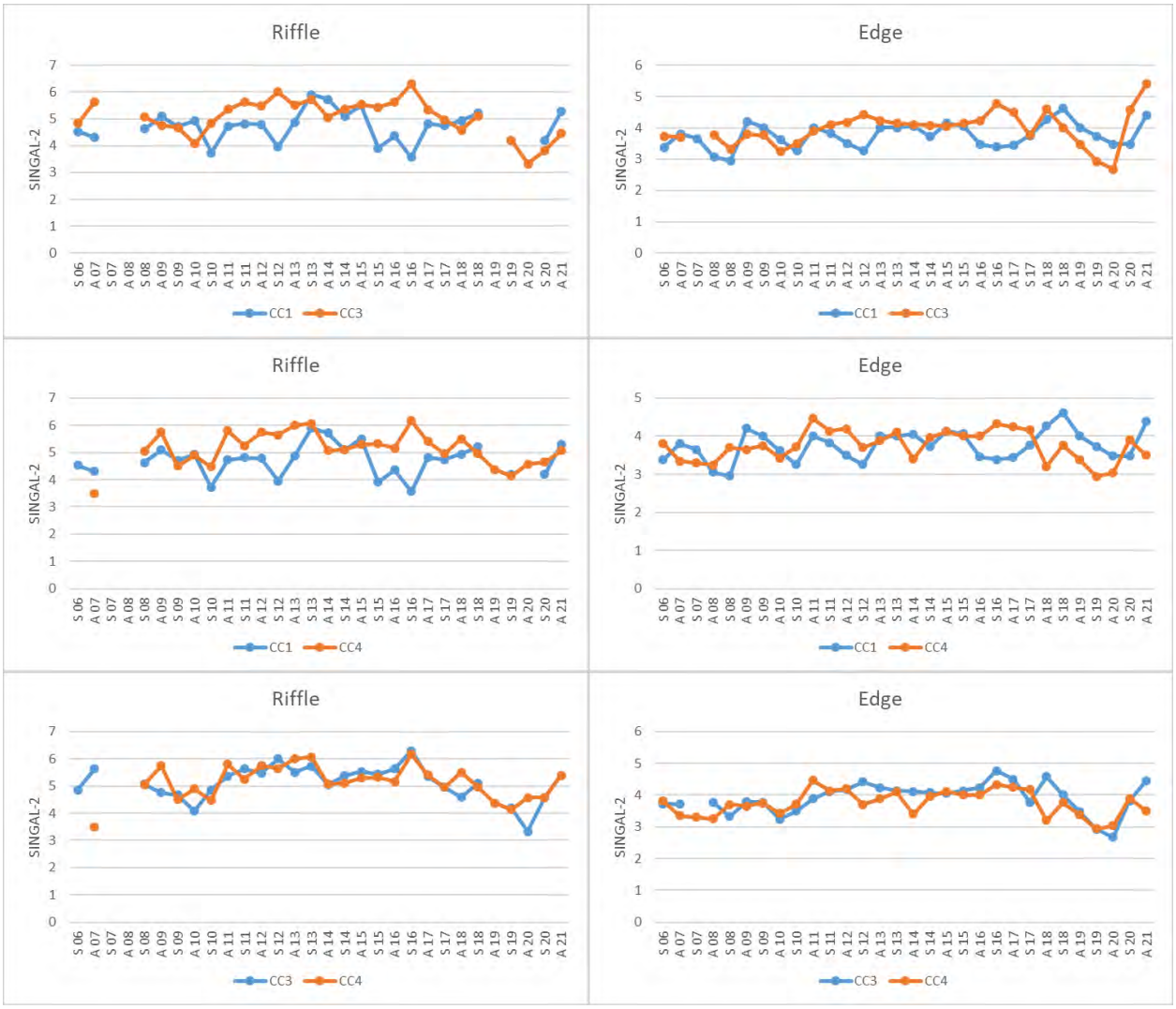


Macroinvertebrate SIGNAL-2 Scores in Cadiangullong Creek between spring 2006 and autumn 2021



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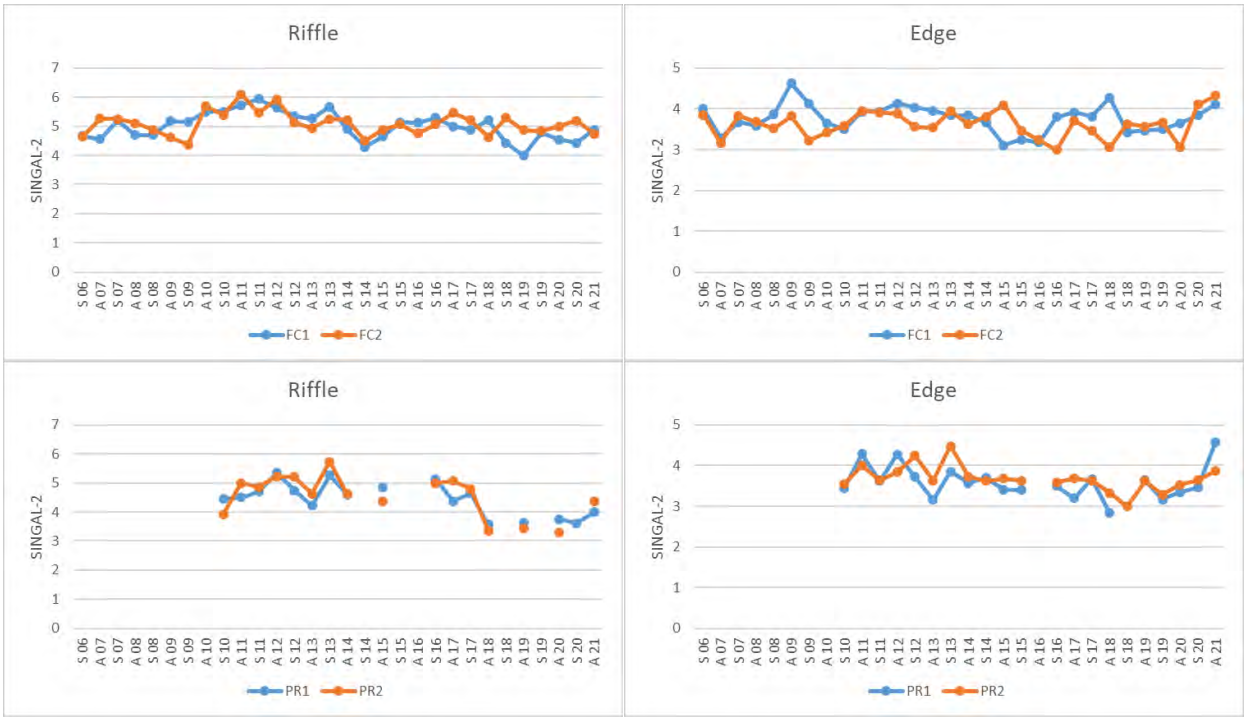

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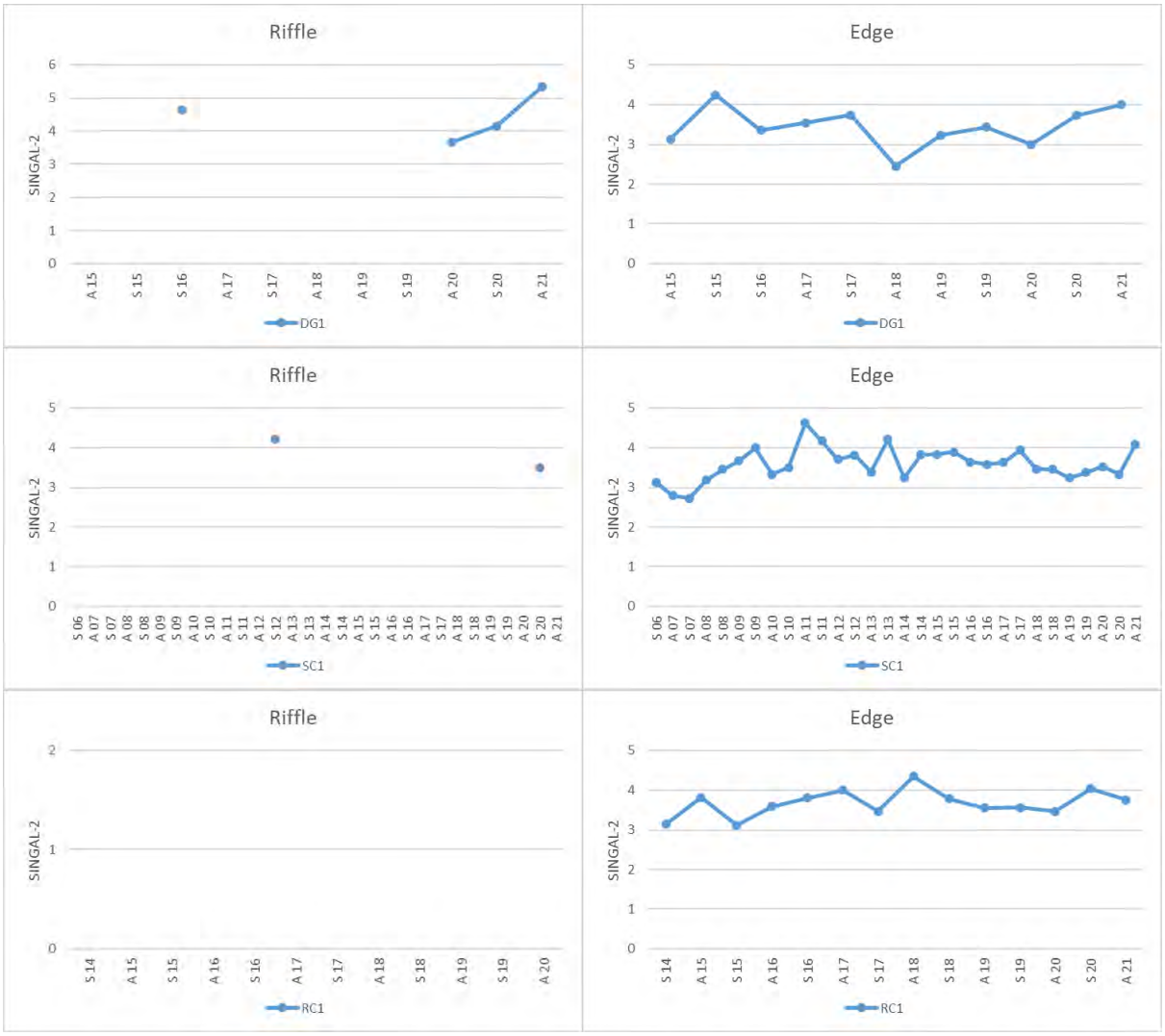

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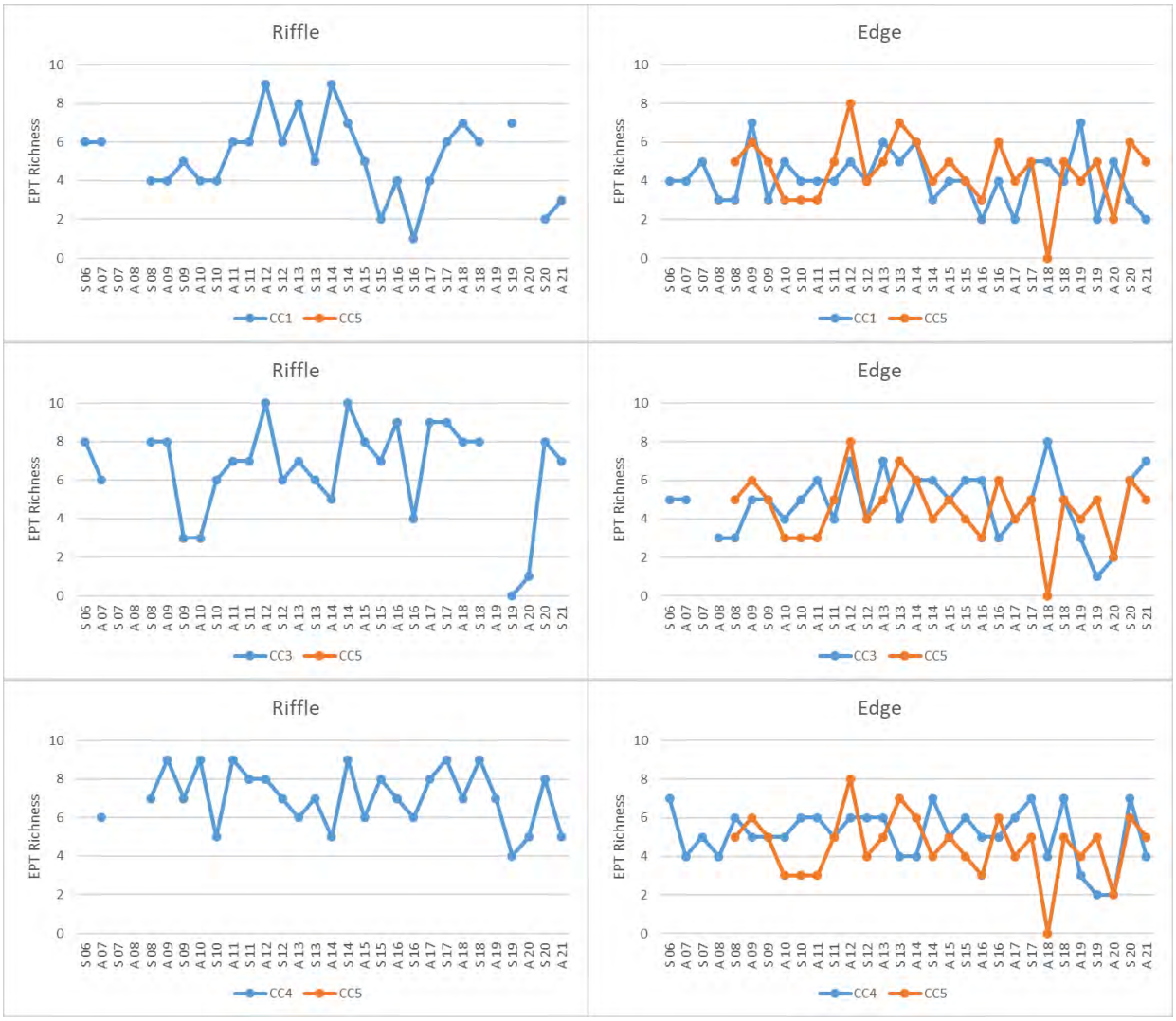
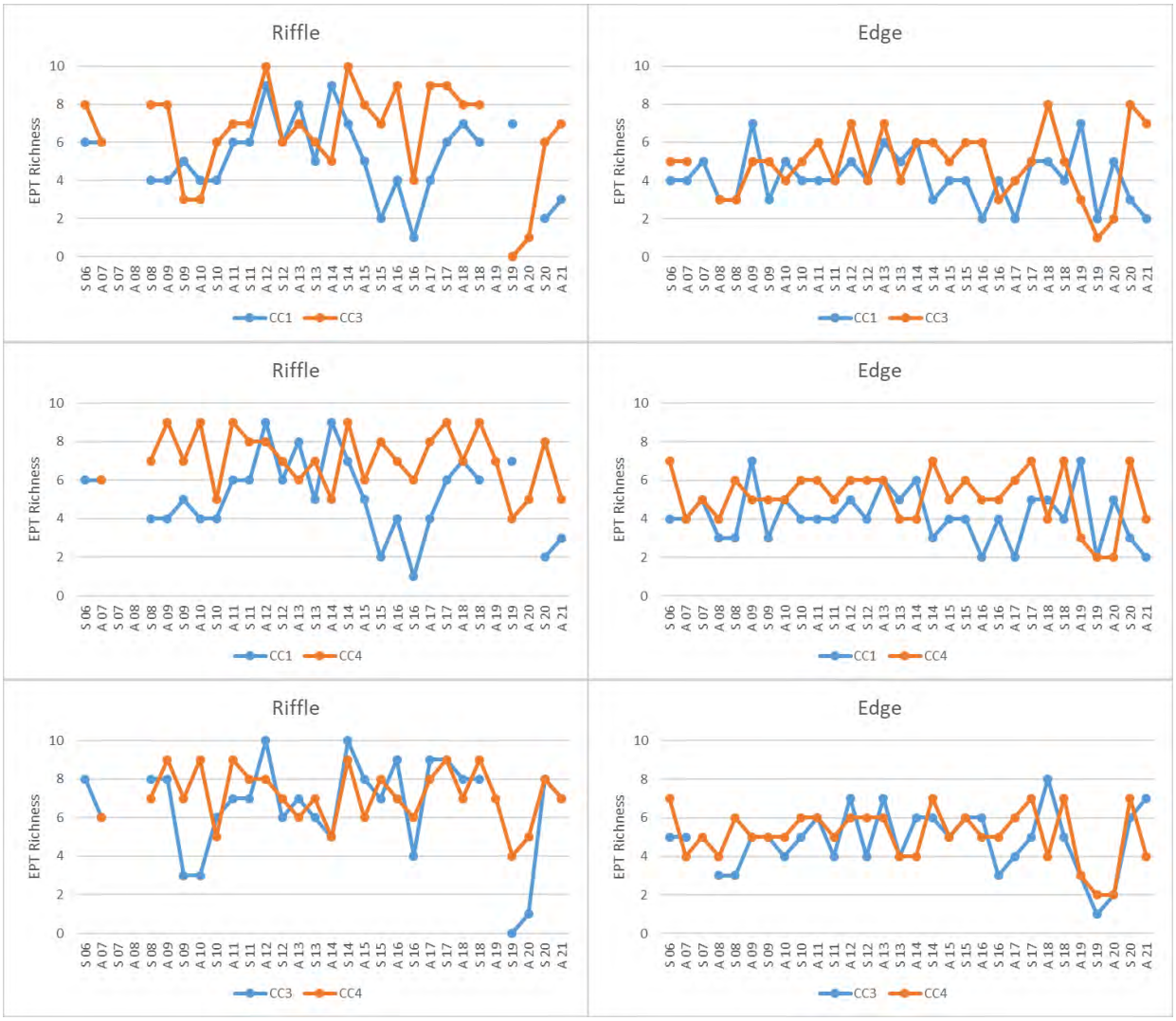


Macroinvertebrate EPT Richness in Cadiangullong Creek between spring 2006 and autumn 2021



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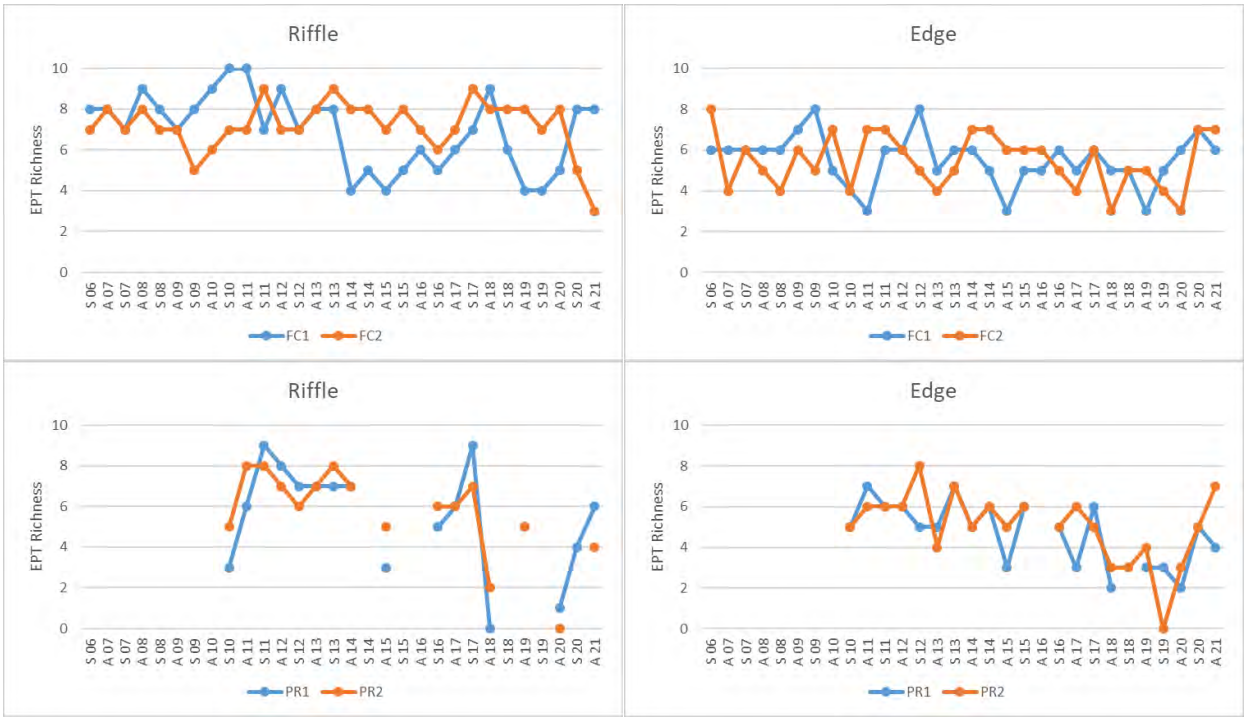

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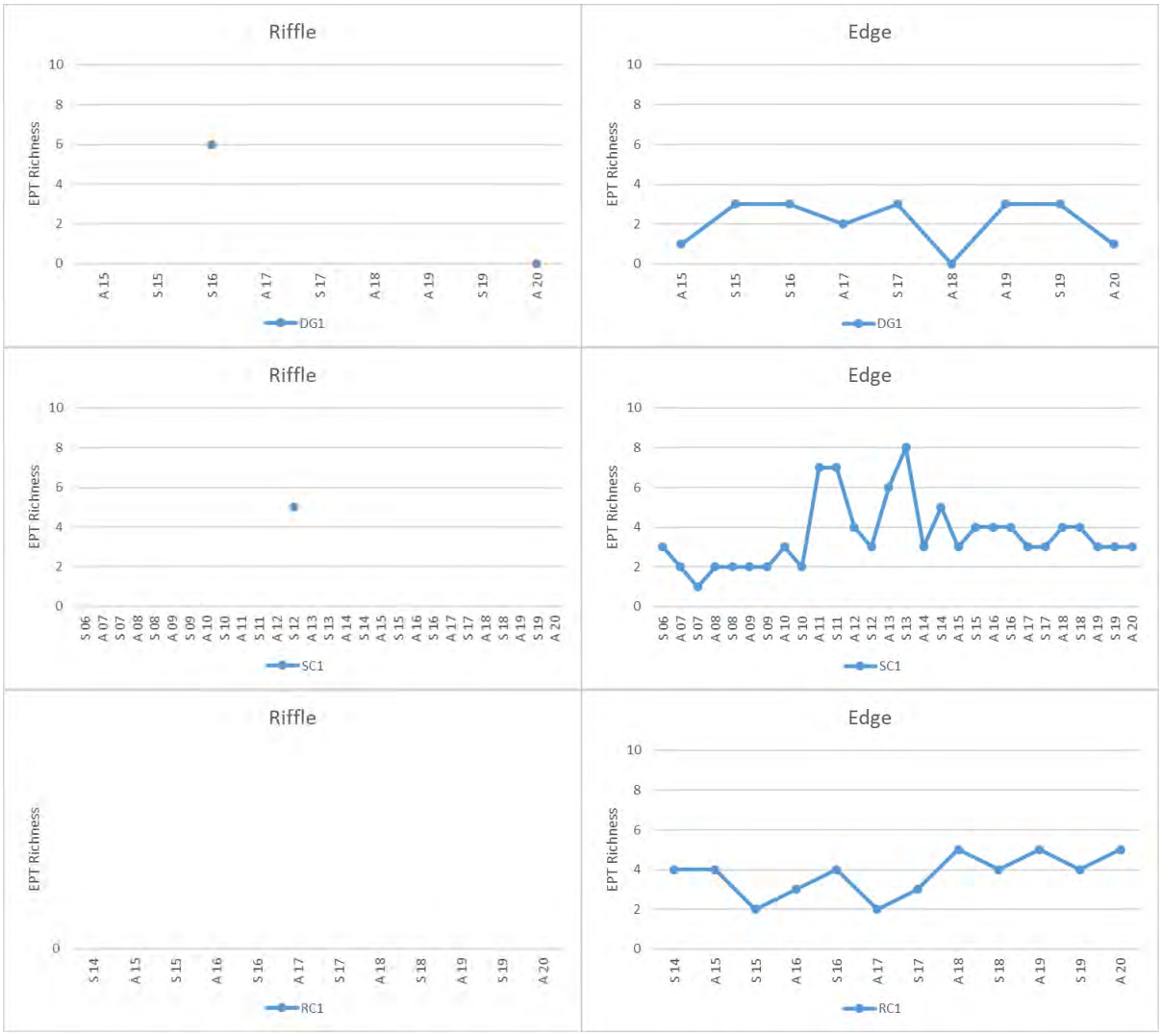

Macroinvertebrate EPT Richness in Diggers Creek (top), Swallow Creek (middle) and Rodd's Creek (bottom) between spring 2006 and autumn 2021

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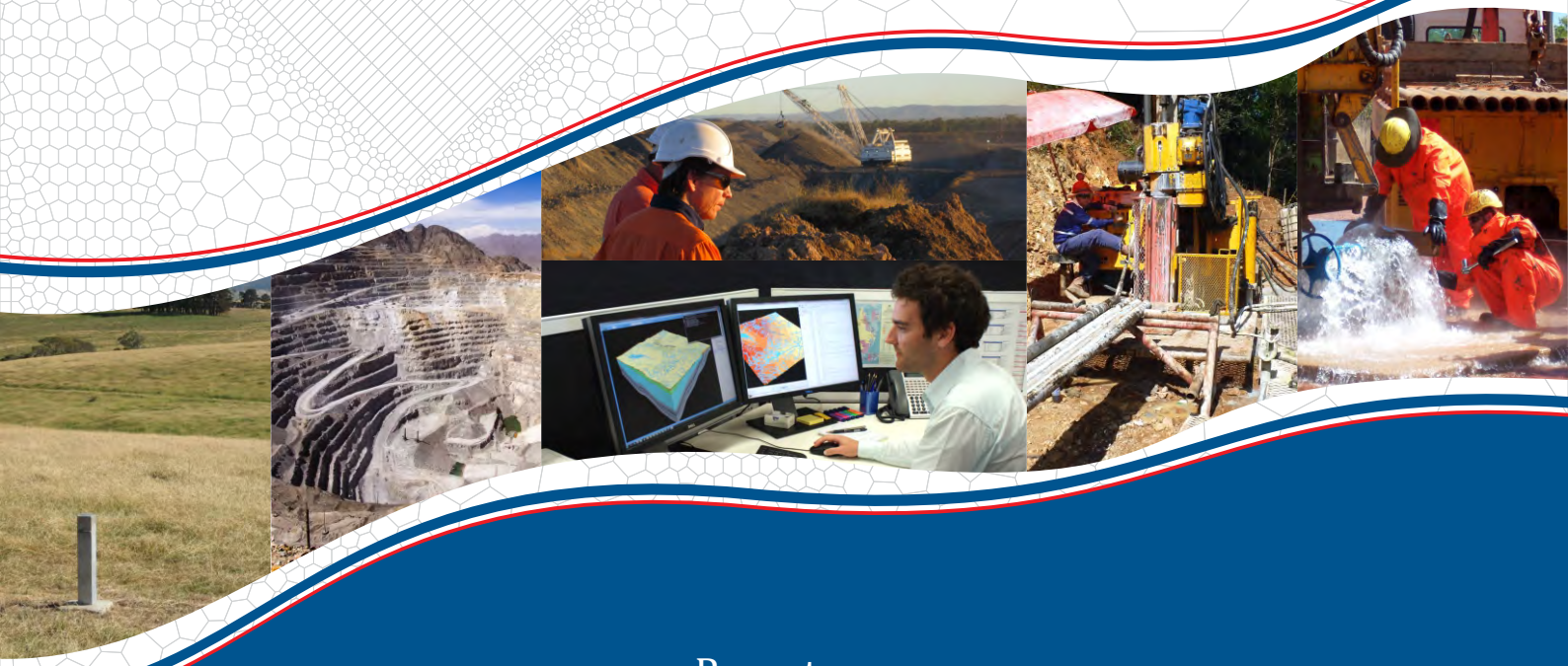

Report on

Cadia Groundwater Model Update 2021

Prepared for
Newcrest Mining

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Australasian Groundwater and Environmental Consultants Pty Ltd

AGE Head Office
Level 2 / 15 Mallon Street,
Bowen Hills, QLD 4006, Australia
T. +61 7 3257 2055
F. +61 7 3257 2088
brisbane@ageconsultants.com.au

AGE Newcastle Office
4 Hudson Street
Hamilton, NSW 2303, Australia
T. +61 2 4962 2091
F. +61 2 4962 2096
newcastle@ageconsultants.com.au

AGE Townsville Office
Unit 3, Building A, 10 Cummins Street
Hyde Park, QLD 4812, Australia
T. +61 7 4413 2020
F. +61 7 3257 2088
townsville@ageconsultants.com.au

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Report on

Cadia Groundwater Model Update 2021

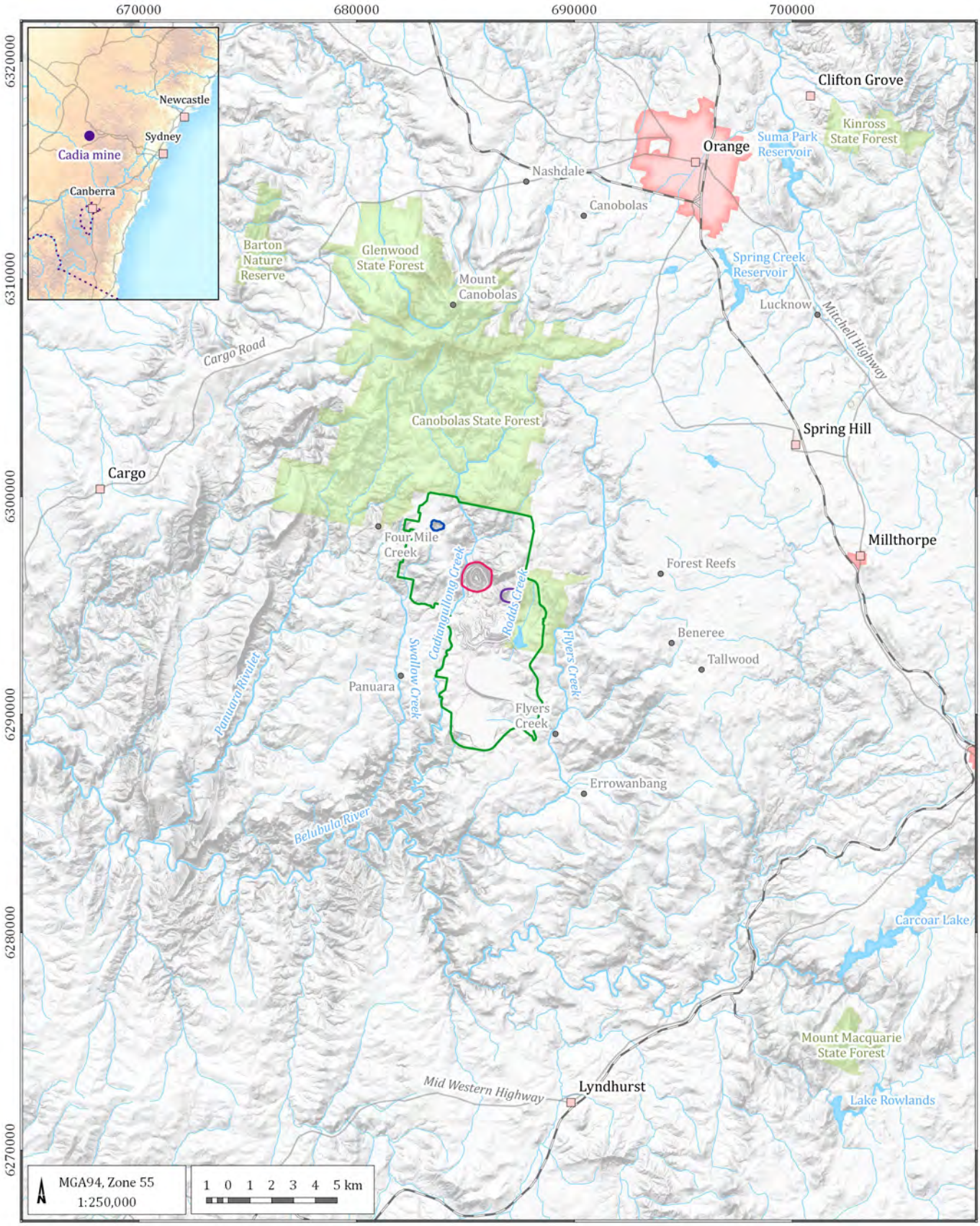
1 Introduction

Cadia Holdings Pty Limited (CHPL) own and operate a gold/copper mine located in the Cadia Valley in central west New South Wales. The Cadia Valley Operations (CVO) are located approximately 25 km southwest of the city of Orange and about 250 km west of Sydney as shown in Figure 1.1.

The conditions of approval for the Cadia East underground mine require that Newcrest Mining have a program for ongoing verification and improvement of the groundwater model. The approved Water Management Plan (WMP) suggests that this review be undertaken every three to four years. The original Cadia East modelling (for approval) was undertaken in 2009, with model performance reviews completed in 2013, 2016, and 2019. Groundwater model sophistication has increased through time, from a series of steady state models in 2009, to the current approach which consists of transient numerical models that include mine development through time. The model software selection reflects these changes, which keeps the assessment contemporary, and takes advantage of the latest available tools (i.e. migration from MODFLOW SURFACT to MODFLOW USG).

Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) developed the original steady state models for the Cadia East approval and have since undertaken the various model performance reviews and model updates. In 2019, AGE reviewed the performance of the 2016 model against new data and identified some departures between the observed and predicted water levels. The performance review concluded that aspects of the conceptual and numerical models could be improved to better replicate changes occurring in the groundwater regime.

This report documents the updates of the conceptual and numerical models, to better replicate the dynamics of the groundwater regime.



LEGEND

- Cadia Hill Pit
- Block cave mine subsidence zone
- Ridgeway cave mine subsidence zone
- Mining lease
- Populated place
- Place name
- Major road
- Rail
- Major drainage
- Minor drainage
- Built up area
- Water area
- Reserve

Cadia Model Update (G1383Y)

Regional project location

DATE 18/03/2021

FIGURE No: **1.1**

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G:\Projects\G1383Y.Cadia Mine Model Update\3_GIS\Workspaces\001_Deliverable1\01.01_G1383Y_Regional project location.qgs

2 Objectives and scope of work

The objective of the project is to update the conceptual and numerical models for CVO, with the intention of improving confidence in the predictive capability of the numerical model. Tasks required to meet these objectives are as follows:

- review new data for conceptualisation;
- identify model updates and data requirements;
- update site environmental setting and hydrogeological conceptualisation;
- rebuild and calibrate numerical groundwater model;
- conduct predictive simulations that incorporates mining to 2038;
- conduct sensitivity analysis;
- reporting;
- conduct presentations of modelling progress to CVO during and at completion of modelling; and
- conduct numerical model handover including training to CVO.

This report provides the updated hydrogeological conceptualisation, details the numerical model development and calibration process, and also presents groundwater predictions for approved mining with associated uncertainty analysis.

3 Environmental setting

3.1 Climate

The Orange district is located within the Central West Tablelands on an elevated plateau that ranges from approximately 800 mAHD to 1,000 mAHD. The climate is temperate, with warm to hot summers and cold winters. There are occasional snowfalls, particularly at Mount Canobolas that rises to around 1,400 mAHD.

Rainfall is distributed fairly evenly throughout the year averaging approximately 860 mm/year at the Orange Agricultural Institute (Station No. 063254). The Institute is located about 14 km to the northeast of the Cadia Hill open pit mine, at an elevation of 922 mAHD. Rainfall is controlled by topography and generally reduces as the land elevation decreases to the south towards the Belubula River. The average annual evaporation rate is 1,394 mm/year, and this exceeds rainfall for eight months of the year from September through to April (Figure 3.1).

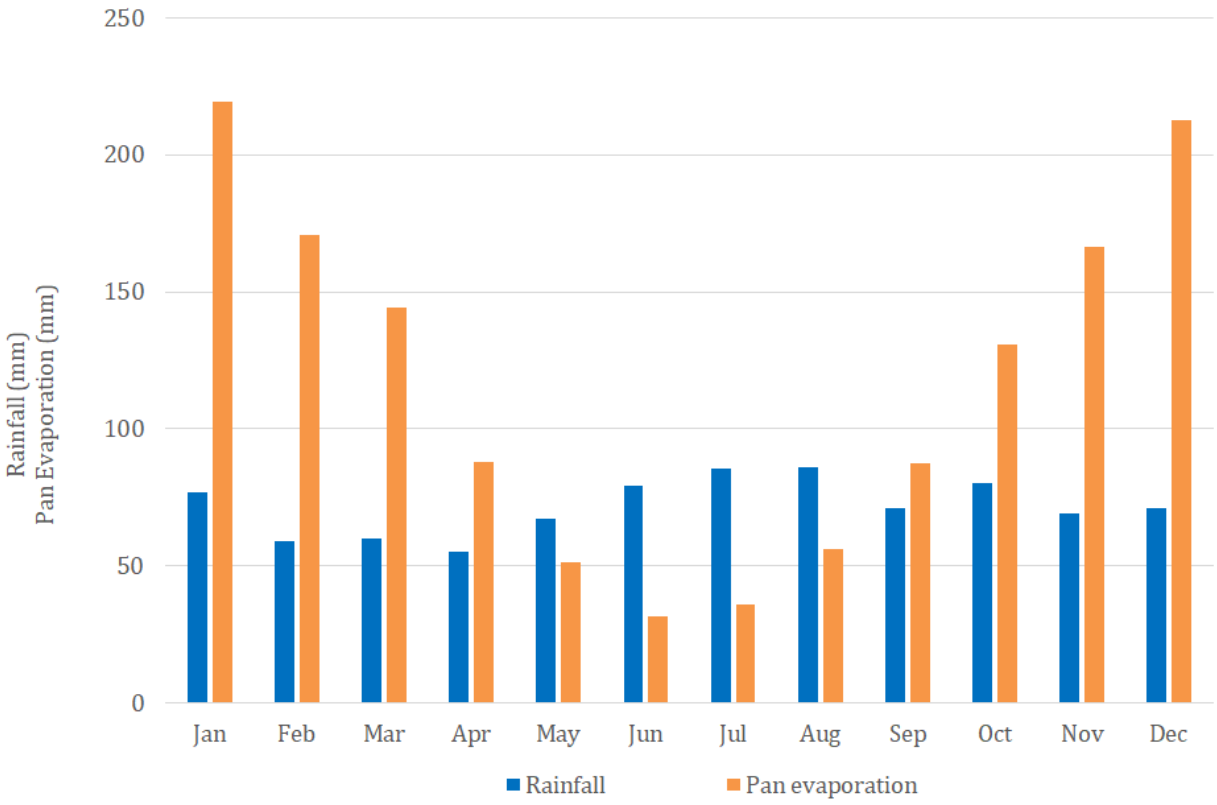


Figure 3.1 Average monthly rainfall and pan evaporation

Figure 3.2 presents the Cumulative Rainfall Departure (CRD) plot for rainfall data collected at the Orange Agricultural Institute. The CRD graphically presents long-term trends in rainfall, with a rising slope indicating above average rainfall, and a falling slope indicating below average rainfall. CRD trends indicate prolonged below average conditions between 2002 to 2010, 2012 to 2016, and more recently 2017 into early 2020. Above average conditions have occurred between 1998 to 2002, 2010 to 2012, and recently during 2020.

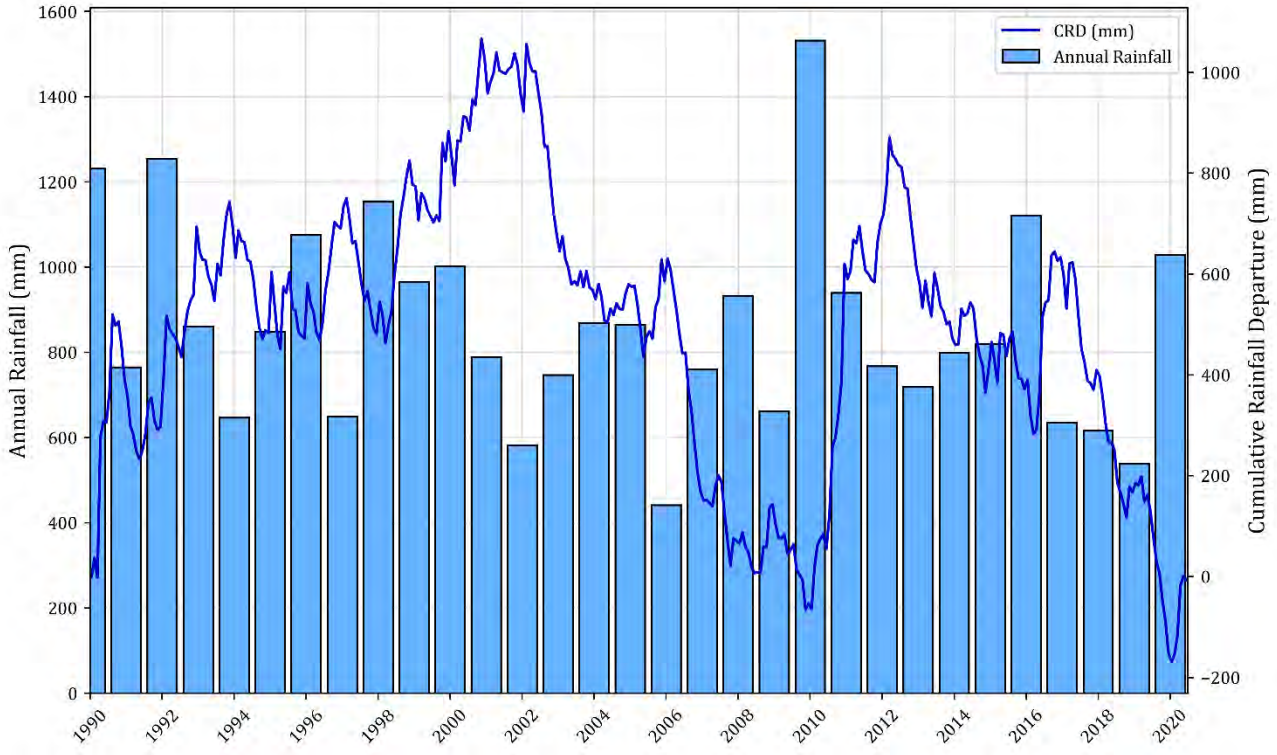


Figure 3.2 Cumulative rainfall departure – Orange Agricultural Institute

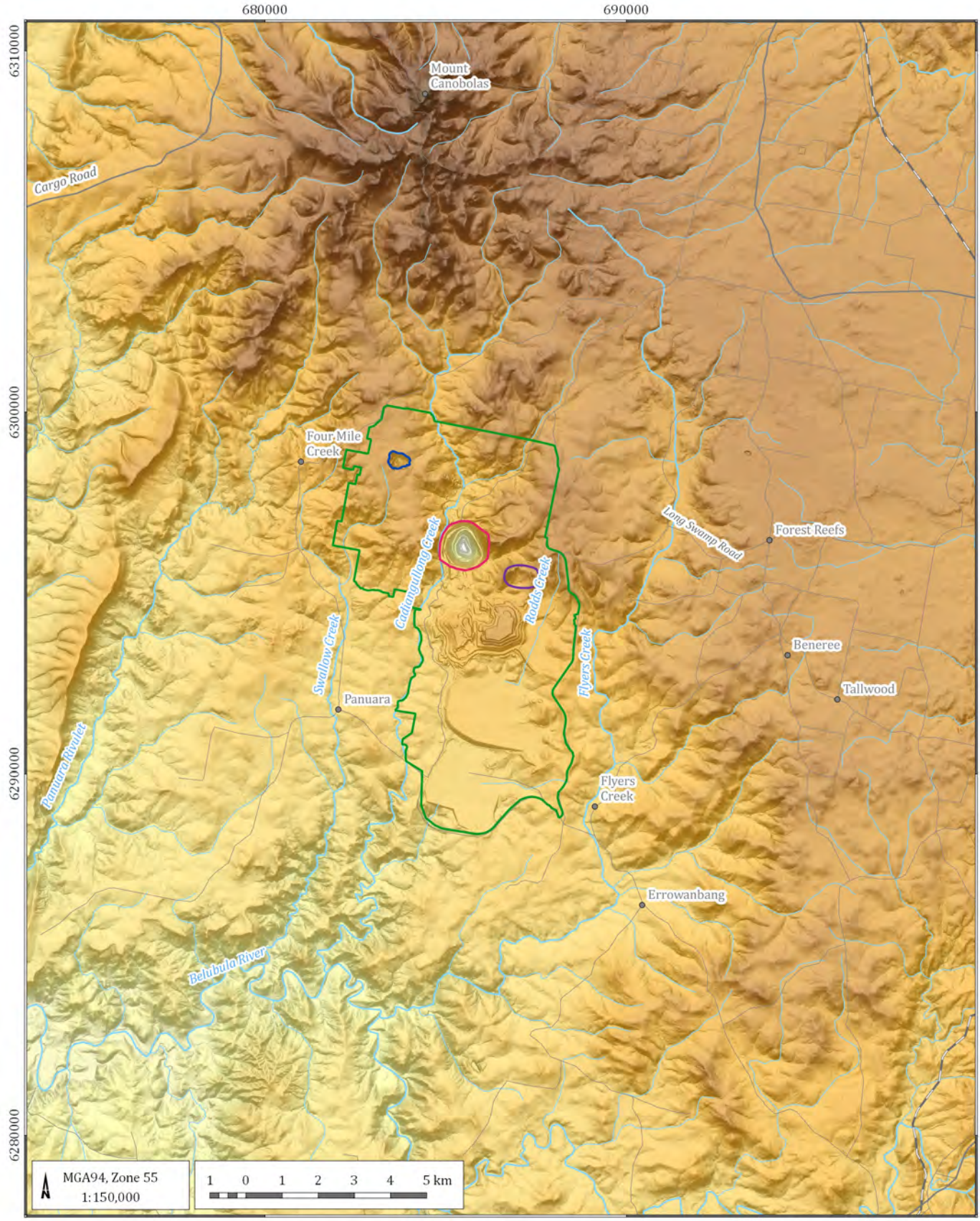
3.2 Terrain and drainage

The most significant natural topographic feature of the Project area is the Cadia Valley, which runs in a north-south orientation, between a series of rolling hills that form ridgelines to the east and west of Cadiangullong Creek (Figure 3.3). The local terrain within the CVO mining leases falls from approximately 1,000 mAHD at the northern boundary, down to approximately 600 mAHD on the southern boundary. Further to the south, the Cadia Valley opens out to gently undulating land (Figure 3.3).

Cadiangullong Creek is the major watercourse in the Cadia Valley. Local tributaries of Cadiangullong Creek include Cadia Creek, Hoares Creek, Copper Gully Creek, and Rodds Creek. Other watercourses near CVO include Swallow Creek and Flyers Creek, which are respectively located to the west and east of mining operations. Both Swallow Creek and Flyers Creek generally run north to south, before joining the Belubula River.

Many of these creeks and their tributaries are naturally ephemeral and show no measurable flow during extended dry periods. The exception is Flyers Creek, which is likely perennial downstream of Long Swamp Road due to baseflow contributions from groundwater fed springs. Riparian flows in Cadiangullong Creek are maintained by CHPL via a low-flow release protocol from the Cadiangullong Dam. Flow gauge data from Flyers Creek (gauge no. 412147), Cadiangullong Creek (gauge no. 412161), and Swallow Creek (412167), is shown in Figure 3.4, and are consistent with rainfall data (Figure 3.2).

Man-made water storages associated with CVO include Cadiangullong Dam, the Rodds Creek Water Holding Dam, Cadia Weir and Flyers Creek Weir.



LEGEND

- Populated place
- Place name
- Major road
- Rail
- Major drainage
- Minor drainage
- Cadia Hill Pit
- Block cave mine subsidence zone
- Ridgeway cave mine subsidence zone
- Mining lease

Elevation (mAHD)

- 200
- 500
- 800
- 1000
- 1200
- 1400

Cadia Model Update (G1383Y)

Terrain and drainage

DATE 29/03/2021

FIGURE No: **3.3**

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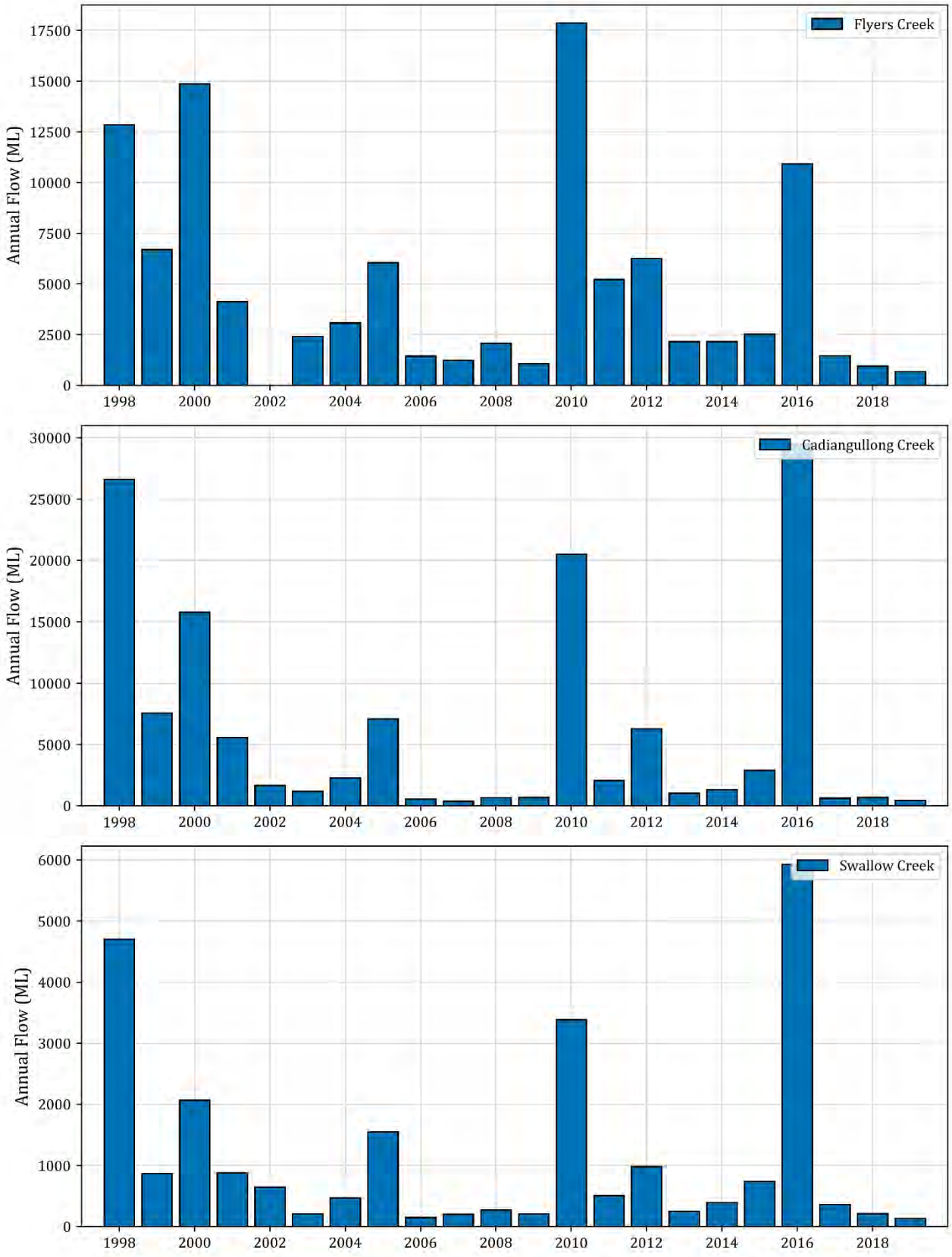


Figure 3.4 Annual flow data

3.3 Land use

The Cadia Valley is characterised by cleared open grassland, scattered native vegetation remnants and State Forest Monterey Pine (Pinus radiata) plantations. Land use in the vicinity of the Cadia Valley is dominated by sheep and cattle grazing in flat areas, and private and state forestry operations on poorer soil and steeper slopes. The Canobolas State Forest is located to the east and north of the mine. Within the mining leases, the main land use is mining and associated activities (e.g. ore processing, waste rock management, and tailings deposition).

3.3.1 Mining and tailings deposition

CVO comprises one open cut mine (Cadia Hill) and two underground mines (Ridgeway and Cadia East). Mining commenced at the Cadia Hill open pit mine in 1998 with the pit closing in mid-2012. The Ridgeway underground mine opened in 2001 using the sub-level caving (SLC) mining method and operated until 2010. The Ridgeway Deeps mine commenced in 2009 using cave mining and involved the continuous dewatering of the underground workings until 2016. Mining at the Cadia East underground mine commenced in late 2012 using panel cave mining methods. Construction of the Northern Tailings Storage Facility (NTSF) and the Southern Tailings Storage Facility (STSF) were completed in May 1998 and November 2001 respectively, and tailings emplacement within the Cadia Hill Pit commenced in May 2018. All three of the tailing storage facilities are still active, with both the NTSF and STSF having seen a number of raises since their initial construction. A summary of mining and tailings deposition dates are presented in Table 3.1.

Table 3.1 Mining and tailings deposition summary – CVO

Mine/TSF	Start date	End date	Mining method
Cadia Hill	1998	2012	Open cut
Cadia Hill Extended	2003	2004	Open cut
Ridgeway	2001	2010	Sub-level caving
Ridgeway Deeps	2009	2016	Cave mining (with continuous dewatering)
Cadia East	2012	Ongoing	Cave mining
NTSF	1998	Ongoing	-
STSF	2002	Ongoing	-
Cadia Hill tailings	2018	Ongoing	-

3.3.2 Forestry

The Forestry Corporation of NSW conducts forestry operations at the Canobolas State Forest located to the east and north of CVO, with periodic harvesting/thinning campaigns likely to continue over the life of mining activities. Pine plantations are typical within the Canobolas State Forest and are predominately comprised of Radiata Pine trees. At the onset of mining, these plantations were limited to the area north of CVO. Plantations to the east of CVO were well established in the southern and northern sections of the forest, by 2000 and 2009 respectively. Satellite imagery shows that large scale harvesting has occurred historically, with a large area of forest to the north of CVO cleared between 1990 to 1995, and then reinstated by 2002.

4 Geology

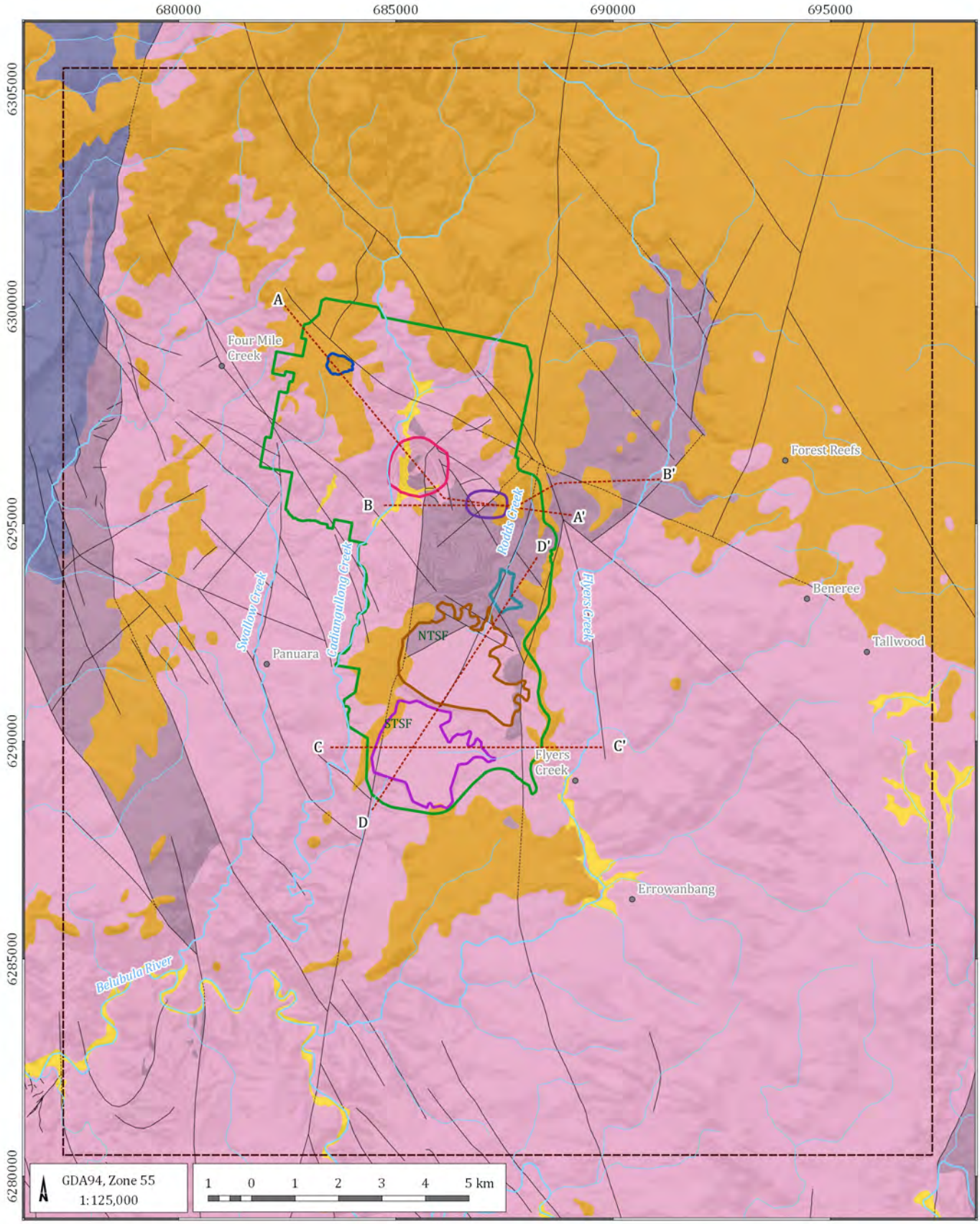
4.1 Regional setting

CVO is located within the eastern Lachlan Fold Belt, where northerly trending volcanic and sedimentary belts have experienced several episodes of intrusive volcanism. Regional mapping by Colquhou et al. (2018) shows that surface geology of the local area is primarily comprised of sedimentary turbidites and volcanic/volcaniclastic units, which are Ordovician, Silurian or Devonian in age. These geological units are overlain by younger Tertiary aged basalt flows, largely to the north of CVO, and more recent Quaternary alluvium which generally occurs along drainage lines. The gold/copper porphyry deposit at Cadia is associated with monzonite intrusives, accompanied by low grade alteration within Ordovician host rocks.

Within the Lachlan Fold Belt, the dominant regional structure consists of a series of roughly north striking faults and splays. These faults were caused by several tectonic events that occurred between the Ordovician and the Carboniferous Periods, with deformation generally driven by east-west crustal shortening (Washburn, 2008).

4.2 Stratigraphic units

Stratigraphic units within the Cadia region are described below, with Figure 4.1 showing the simplified regional geology (i.e. Ordovician, Silurian, and Tertiary aged units) between the Belubula River and the southern outskirts of Orange. A detailed local geological plan within the Cadia mining area and surrounds is provided on Figure 4.2.



LEGEND

- Place name
- Drainage
- Fault lineaments
- Fault lineaments beneath Tertiary cover
- Hydrogeology section lines (refer to report Section 5.2)
- Mining lease
- Cadia Hill Pit
- Block cave mine subsidence zone
- Ridgeway cave mine subsidence zone
- Numerical model extent
- NTSF
- STSF
- Rodds Creek dam

Surface geological age

- Quaternary
- Tertiary
- Devonian
- Silurian
- Ordovician

Cadia Mine Model Update (G1383Y)

Regional geology plan

DATE 19/03/2021

FIGURE No: **4.1**

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Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
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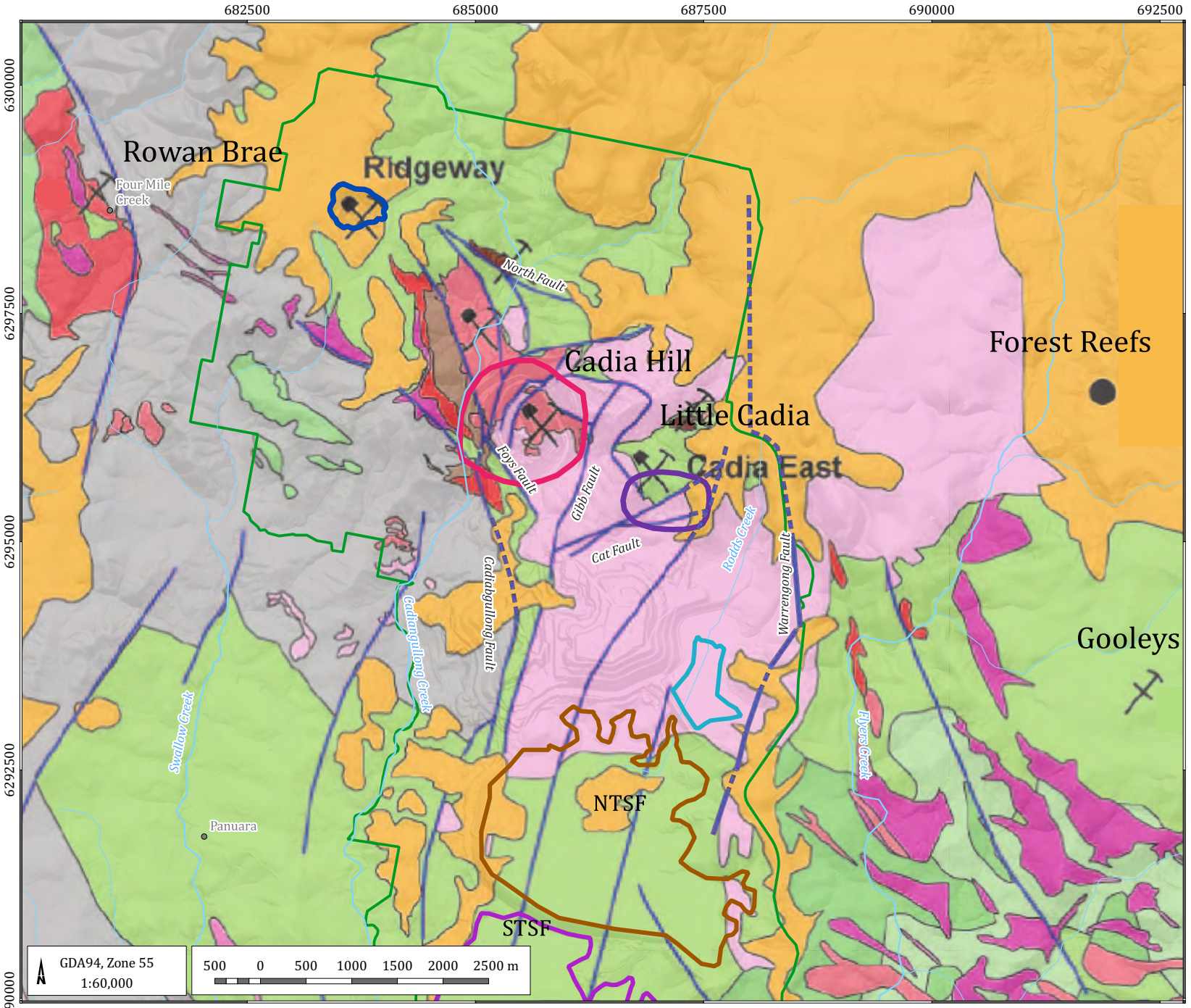

LEGEND

- Place name
- Drainage
- Faults
- Faults in rocks concealed beneath Tertiary basalt
- Cadia Hill Pit
- Block cave mine subsidence zone
- Ridgeway cave mine subsidence zone
- Rodds Creek dam
- NTSF
- STSF
- Mining lease

Geology

- Tertiary Basalt-Tertiary Basalt

Silurian

- Waugoola Group sandstone, siltstpone and minor conglomerate

Ordovician - Silurian

Intrusives

- Diorite
- Granodiorite
- Monzonite
- Syenite

Forest Reefs and Volcanics

- Volcanic and volcaniclastic rocks, rare limestone
- Undifferentiated volcanic rocks (Angullong Fm)
- Feldpathic sandstone, siltstone

Weemalla Formation

- Feldspathic sandstone, siltstone and siliceous siltstone

Geology Source: Harris et. al (2012)

Cadia Mine Model Update (G1383Y)

Detailed surface geology – mining areas and surrounds

DATE
19/03/2021

FIGURE No:
4.2

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4.2.1 Alluvium

The alluvium generally comprises clays, sands and some gravels deposited by meandering fluvial systems that are generally well incised with poorly developed backplains (Pogson and Watkins, 1998). Alluvial deposits are generally less than 5 m thick along the creeks in the Cadia region. Creeks are commonly incised into the bedrock with alluvium largely absent. The thickness of alluvium is known to be greater along the Belubula River south of Cadia.

4.2.2 Tertiary basalt

The Tertiary basalt originated from numerous extrusive episodes from Mount Canobolas and surrounding volcanic vents, covering an area of about 530 square kilometres (km^2). The nature of the basalt varies from relatively massive and low yielding to vesicular (scoriaceous). Ash or clay layers may be present between successive basalt flows, which reflect periods of dormancy between flows. The Tertiary basalt thickness is dependent on the topography of the underlying land surface, with the basalt being thickest along paleochannels. Pogson and Watkins (1998) indicate that the thickness of the Tertiary basalt varies from a few metres to over 150 m. In the Cadia area, the Tertiary basalt cover is predominantly to the north/northeast of the Cadia mine, but also outcrops along elevated ridgelines adjacent to both the NTSF and STSF. The basalts in the Cadia East area are up to 80m thick and comprise at least six separate flows (Wilson, 2003). Potassium-Argon dating of the Canobolas Basalt (Gibson, 2007) provides a Middle Miocene age of 12.7 to 11.2 Ma (KCB, 2019).

4.2.3 Silurian sediments

The Silurian sediments proximal to CVO are low energy shallow to deep water sediments that were deposited in the Cowra Trough in the early Silurian period (430 to 400 million years ago). The Silurian rocks that occur at Cadia Hill (and to the east) are overlain by Tertiary basalt flows in areas. The Silurian sediments are subdivided into the Ashburnia Group and the overlying Waugoola Group. Only scattered remnants of a much larger Silurian basin remain in the region. Washburn (2008) noted that:

> *"Basement rocks are distinguished from Silurian sedimentary rocks due to differences in alteration. The Silurian cover rocks are unaltered, whereas Ordovician to early Silurian basement rocks are variably altered by chlorite-hematite and feldspathic alteration*."

In the Cadia Valley area, the Silurian aged Waugoola Group is present, which is predominantly comprised of siltstones and sandstones, with minor conglomerate and calcirudite layers at the base. The unit represents fluctuating transgressive/regressive marine depositional conditions. The Waugoola Group unconformably overlies the Ordovician rocks. The Silurian sediment sequence is divided into the following lithologies (Washburn, 2008):

- an upper massive sandstone unit;
- interbedded siltstone and sandstone units;
- a lower siltstone unit; and
- a basal unit comprising boulder conglomerate, calcirudite (limestone) or red beds (oxidised siltstone).

The basal units vary across the district and the calcirudite, redbeds and conglomerate do not occur together. The generalised stratigraphic sequence discussed above is shown graphically in Figure 4.3 (Washburn, 2008).

The southern and western extent of the Silurian sediments is marked by a faulted contact with Ordovician volcanics and has been well defined by exploration drilling. To the north and east, the Silurian sediments are overlain by the Tertiary basalt and the extent of the formation in this area is not well known as limited exploration drilling has been undertaken in this area.

Pogson and Watkins (1998) report the combined thickness of the Ashburnia and Waugoola Groups to be up to approximately 250 m thick to the southwest of Orange. Exploration drilling above the Cadia East orebody has typically intersected between 100 m and 300 m of Silurian sediments, with an average thickness of approximately 100 m. The exception is a single exploration drill hole (NC599) that intersected about 1,000 m of Silurian sediments overlying Ordovician volcaniclastics. Drill hole NC599 indicates the presence of a substantial Silurian basin northeast of the Cadia East mine. This basin is interpreted by the Newcrest exploration unit to have formed in a complex graben zone, of which the western margin is a fault zone. This fault zone, referred to as the Warrengong Fault, is located to the east of the proposed Cadia East underground mine (including the subsidence zone) and is considered to be extensive along a north-south axis. The approximate location of the Warrengong Fault zone is shown in Figure 4.2.

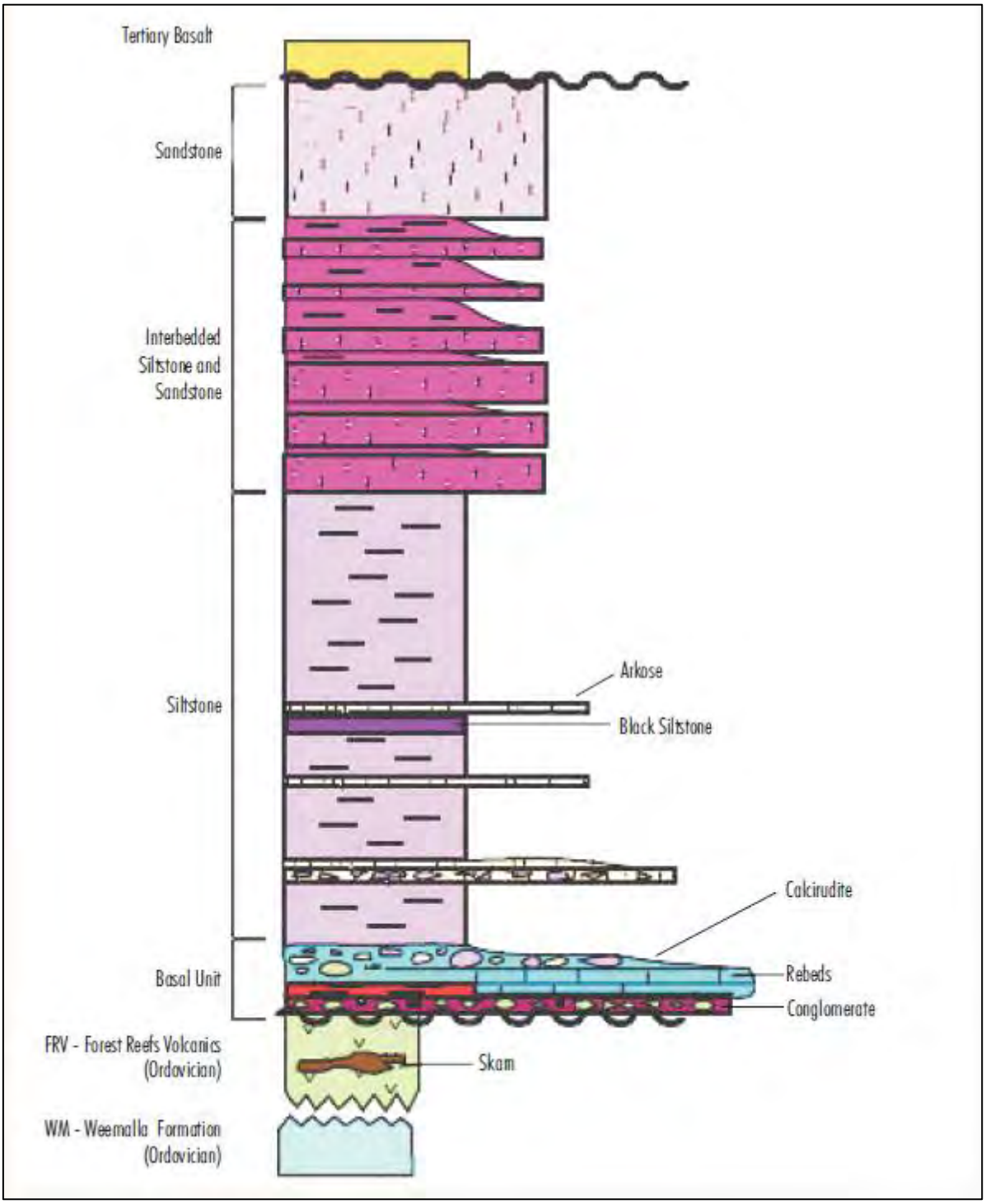


Figure 4.3 Silurian stratigraphic sequence (Washburn, 2008)

4.2.4 *Ordovician units*

The Ordovician units in the region comprise the Forest Reef Volcanics that conformably overly the Weemalla Formation. A simplified summary of the Ordovician geology of the study area is provided in Figure 4.4 (Wilson, 2003). The Ordovician rocks are generally exposed at surface around CVO, except where there are overlying Silurian sediments and/or Tertiary basalt.

The Forest Reefs Volcanics are prevalent in the area and host the Cadia orebodies. The Forest Reef Volcanics are dominated by volcaniclastic lithologies, which comprise lithic conglomerates, breccias, sandstones, and lesser siliceous siltstone. The volcanic and volcaniclastic components of the unit are formed by effusive and explosive processes (Harris, 2014). Exploration drilling works have investigated the Forest Reefs Volcanics to a vertical depth of approximately 1,800 m, although the total thickness of the sequence is not known.

Pogson and Watkins (1998) describe the Forest Reefs Volcanics as:

> "*representing the products of a major volcanic centre. Rock types range from basaltic lava and breccia, matrix supported volcanic conglomerate, volcaniclastic sand and ash, and more fractionated volcanic products including latite possibly deposited as sub-aerial ignimbrite to masses and veins of hydrothermally altered rock including sericite-pyrite-quartz rock, tourmaline-quartz-muscovite greisen and epidote rich rock. The whole complex is intimately intruded by irregularly shaped high level bodies of mostly monzonite and syenite, which when fine grained and altered are difficult to distinguish from extrusive and clastic rocks.*"

The Weemalla Formation comprises turbidite sediments that consist of fine grained and thinly laminated, carbonaceous to volcanic siltstones, with minor arenaceous volcanic beds, including pillow basalts.

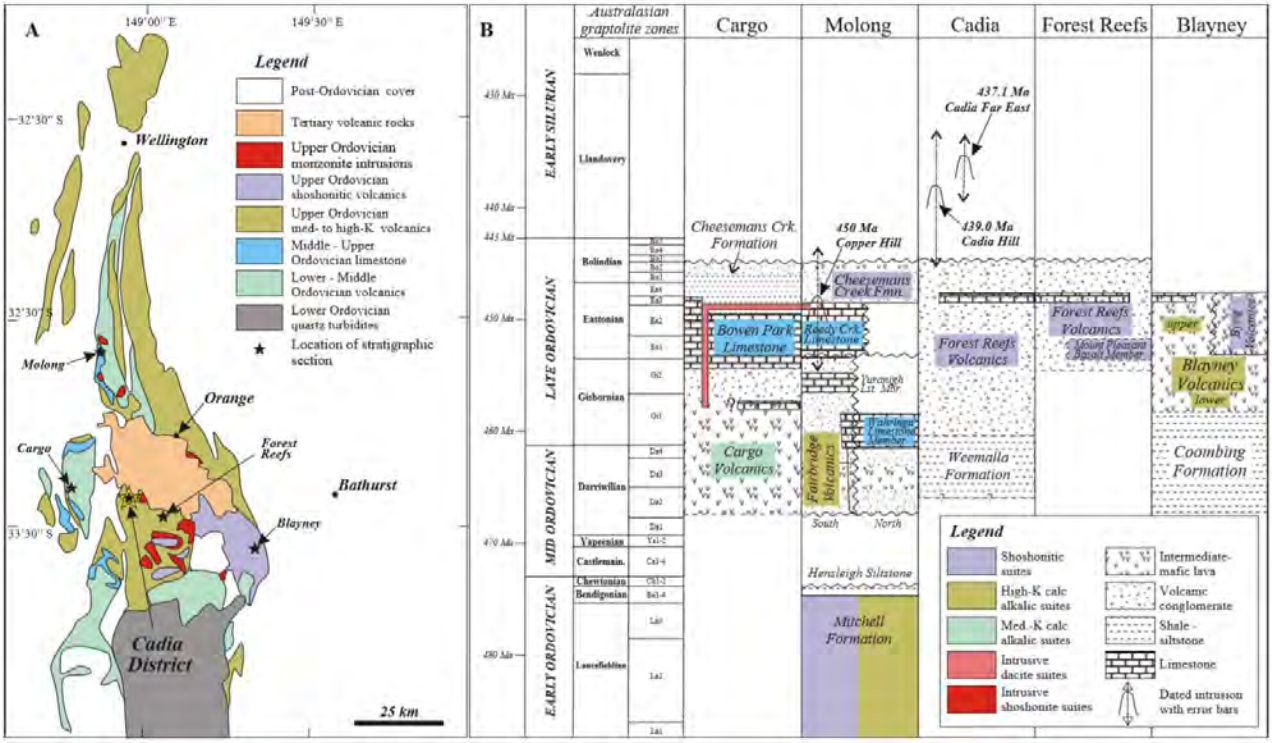


Figure 4.4 Simplified Ordovician Geology of the region (Wilson, 2003)

4.3 Mineralisation

The Cadia Valley deposits occur as part of a Late Ordovician-Early Silurian porphyry system, hosted within rocks of the Forest Reefs Volcanics and the Weemalla Formation. The gold/copper mineralisation is spatially and genetically associated with an alkalic intrusive complex of monzonitic composition named the Cadia Intrusive Complex (CIC). Narrow pipe-like stocks and dykes cutting both the volcaniclastic rocks and the central intrusive complex are associated with gold and copper mineralisation.

The Cadia Valley is host to three known gold-copper porphyry deposits including Ridgeway, Cadia Hill (including Cadia Quarry), and Cadia East. Two iron-rich skarn deposits named Big Cadia and Little Cadia have also been identified. These occurrences strike along a 6 km long by 2 km wide 'highly prospective' mineralised corridor. Emplacement of these mineralised systems is thought to have been facilitated by a structural zone trending northwest to southeast (MESH, 2009). Porter et al. (2005) report that the intrusive complex is represented as a stock at the Cadia Hill and Cadia Extended mines, as a narrow, restricted pipe at the Ridgeway mine, and as a series of dykes at the Cadia East mine (MESH, 2009).

4.4 Geological Structure

Within the Lachlan Fold Belt, the dominant regional structures are a series of roughly north striking reverse faults and related splays. These reverse faults are moderately to steeply dipping to the west, curviplanar, and commonly have a strike slip component. These faults were caused by several tectonic events that occurred between the Ordovician and the Carboniferous Periods, with deformation generally driven by east-west crustal shortening (Washburn, 2008).

Washburn (2008) subdivides faults in the Cadia District into three major sets based on orientation as follows:

- north striking, west dipping reverse faults and associated folds and fault splays;
- northeast striking, northwest-dipping faults and associated folds that are locally developed at the district scale; and
- west-northwest striking, steeply north dipping oblique-reverse faults.

Major regional faults include the north striking Werribee Fault (known as the Cadiangullong Fault in the Cadia area) and the Warrengong Fault, which is located approximately 1 km east of the Cadia East mine (Figure 4.2). The north to north-northeast trending Cadiangullong Fault is inferred to underly the western margin of the STSF and slightly to the west of the NTSF (Hatch, 2018) within the Ordovician aged Forest Reef volcanoclastic rocks. The Cadiangullong Fault extends north between the waste rock dump and Cadiangullong Creek within the Ordovician Weemalla Formation (shale, siltstone, and sandstone), before skirting the western side of the Cadia Hill pit. The fault has a westerly dipping thrust with a strike-slip component, and truncates several north-northwest trending faults. It can be inferred from these truncations that the fault is a late-stage feature. The structure has a damage zone noted up to 200 to 400 m wide, with a vertical offset of about 300 m (KCB, 2019).

Mapping of faults to the north of the Cadia East workings shows a series of carbonate faults which appear to be of late Devonian age, and related to the Gibb Fault. The faults are dipping to the southwest and intersect the Cadia East workings. These faults are discussed further in Sections 5.13.4 and 5.17.

The displacement of faulted rocks is quite significant in the Cadia area with offsets ranging up to several hundred metres. The orientation and displacement of faults within the Cadia mining area is provided in Table 4.1 (Washburn, 2008). The location of major faults is shown in plan view on Figure 4.1 and Figure 4.2, and on hydrogeological sections presented in Section 5.2.

Table 4.1 Orientation and displacement of faults in the Cadia area (Washburn, 2008)

Fault	Strike	Dip	Minimum vertical displacement	Location
Powerline Fault	NE	steep to N	600 m	N of Sharps Ridge
Cadiangullong Fault	N	steep to W	300 m	W of Cadia Hill
Gibb Fault	N	moderate to W	300 m	E of Cadia Hill
Cat Fault	NE	moderate to N	200 m	Cadia East
Copper Gully Fault	NE	steep to N	20 m	S of Sharps Ridge

5 Hydrogeology

5.1 Previous groundwater investigations and results

Prior to the discovery of the Cadia Hill deposit in 1992, groundwater investigations of the area included studies by Chestnut and Corkery (1976) and Coffey and Partners (1981). These studies were primarily focused on the occurrence of groundwater in the Orange-Bathurst area, the hydrogeology of the Cadia Hill area, and the hydrogeology of the Forest Reefs Gold Prospect (located approximately 8 km east-southeast of Cadia East) (CHPL, 2000).

Detailed groundwater studies commenced in the vicinity of the Cadia Hill deposit in 1993. These investigations included the drilling of a number of exploratory groundwater bores and the collection of a range of hydrogeological data from mineral exploration and resource identification drilling programs. A groundwater resource evaluation study was completed in 1995 (Woodward – Clyde, 1995) and comprised the installation and test pumping of a number of bores in the Cadia Valley area. The assessment identified potential geological units for developing a groundwater supply borefield. Groundwater samples were collected for chemical analysis.

The 1995 investigation identified a number of predominantly low yielding aquifer units within the main CVO Mining Lease (ML) 1405. The most promising aquifer zone was within intensive brittle fracturing along Cadiangullong Creek, which is associated with the Cadiangullong Fault Zone. Other aquifer resources included localised limestone units, fractured volcaniclastic and sedimentary units, stratigraphic unconformities, and fractured intrusive units. The investigation identified groundwater within Tertiary basalts located to the north and northeast of ML 1405. An assessment of the hydrogeology in the NTSF area was based on borehole airlift yield data, which indicated that groundwater flow was primarily restricted to fractures and faults within the underlying Ordovician units.

Investigations have been conducted by Kalf & Associates (2000, 2004) at the Ridgeway mine and within the Rodds Creek catchment (where the NTSF, STSF and Rodds Creek Water Holding Dam are located). The groundwater drilling investigation results at the Ridgeway mine indicated that some groundwater is contained within the weathered soil profile, although groundwater predominantly occurred within lower sections of the Tertiary basalt and within the fractured zones of the underlying Ordovician volcaniclastic rocks. Test pumping of three bores screened in fractured Ordovician volcanic rocks at the Ridgeway mine provided moderate to low hydraulic conductivity estimates. However, results are not considered to be representative of the regional Ordovician rock mass, which is likely typified by lower hydraulic conductivities.

Investigations were carried out by Aquaterra (2005) at the Cadia East mine for a proposed open pit. These investigations comprised the drilling of five deep boreholes targeting Silurian metasediments, Ordovician volcaniclastics, and a series of hanging wall faults (F111 series). The bores were airlifted, with yields used to determine coarse estimates of permeability. The results indicated that boreholes targeting the faults had variable yields (up to 2.1 L/s), although the permeability of the saturated rock mass was shown to be relatively low, with the yields chiefly originating from specific localised fracturing of higher permeability. Water samples from airlifted holes were analysed against relevant guidelines for mine use or discharge suitability. Boreholes were completed as piezometers. Estimates of pit inflows were carried out using a simple analytical model and ranged from 9 to 18 L/s.

In 2009 groundwater investigations were conducted for the Cadia East mine Environmental Impact Statement (EIS) (AGE, 2009). Investigations included the installation of bores in Silurian sediments to obtain yield, permeability, groundwater levels, and groundwater quality data. All bores were relatively low yielding (< 2 L/s), except for one bore that was screened within fractured Silurian limestone (MB47A). Bore MB47A provided a significant airlift yield of approximately 12 L/s. Hydraulic testing completed during the 2009 investigations included test pumping of a 200 m deep bore in Silurian sediments (MB43) and falling head (slug) tests in bores screened within either the Silurian sediments or Tertiary basalts. The hydraulic test results indicated the Silurian sediments were in most cases of low permeability. Investigations indicated relatively high baseflow discharge into Flyers Creek.

In 2019, groundwater supply investigations were undertaken in eight bores located mainly within Ordovician rocks, which were located on the perimeter of the NTSF/STSF, at the waste rock dump, or near Cadiangullong Creek (AGE, 2020). Initial airlift yields for most of the bores were high, although bores were low yielding (< 0.5 L/s) over the long-term when pumped. This indicated a limited fracture connectivity and low storage capacity. The bore with the most water supply potential was located in intensely fractured Ordovician rock, which is associated with the Cadiangullong fault zone. This bore was located near Cadiangullong Creek and was pumped at approximately 7 L/s over seven days and was estimated to have a long-term yield of 2.4 L/s.

In 2020 investigations were undertaken for a proposed new TSF located south of the STSF (AGE, 2021). Investigation bores were installed within Ordovician rocks (volcaniclastics, sedimentary, and intrusives) and the Tertiary basalt. Permeability testing was completed via rising/falling head tests within completed monitoring bores, as well as by constant head injection tests, with hydraulic packers used to isolate test intervals (packer tests). These packer tests generally focused on the observed or inferred fractured zones and weathered residual rock zones. The majority of hydraulic test results indicated the Ordovician rocks were of low permeability, although there were some tests completed within fractured zones that indicated low to moderate permeability. A few hydraulic tests were completed within the Tertiary basalts, and permeability results were generally low. A hydraulic test was also conducted within an inferred fault zone (BH40/MB109/BM110), which comprised deep residual bedrock clays of low permeability, overlying weathered sheared fractured Ordovician rock of low to moderate permeability. The permeability in the fractured rock was found to decrease at depth, due to re-healing of fractures by carbonate precipitation.

5.2 Conceptual groundwater model

The geological units described previously can be grouped into the following hydrostratigraphic units based on their ability to store and transmit groundwater:

- **Quaternary alluvium** - forms minor saturated porous systems that are limited to major drainage lines, although of limited extent, thin, and of variable permeability;
- **Tertiary basalt flows** - variable permeability unit that forms fractured aquifer systems or aquitards;
- **Silurian sediments** - generally fine grained and forms low permeability aquitards, except in zones of fracturing where permeability (and storage) is enhanced; and
- **Ordovician volcanics** - rock matrix has inherently low permeability and forms competent aquitards, except in zones of fracturing where permeability is enhanced.

The main aquifers in the Cadia region are within fractured systems within the Tertiary basalt and structural zones (fault zones) in the underlying Silurian and Ordovician rocks. The extent of the fractured aquifer system is highly uncertain and is dependent on the connectivity of fracture networks, as well as the occurrence of chemical precipitates or clay infill restricting groundwater flow. The transmission of groundwater within these fractured systems may be enhanced in the weathered zone and subsequently restricted at depth due to a combination of rock mass loading (which reduces fracture apertures) and an absence of weathering.

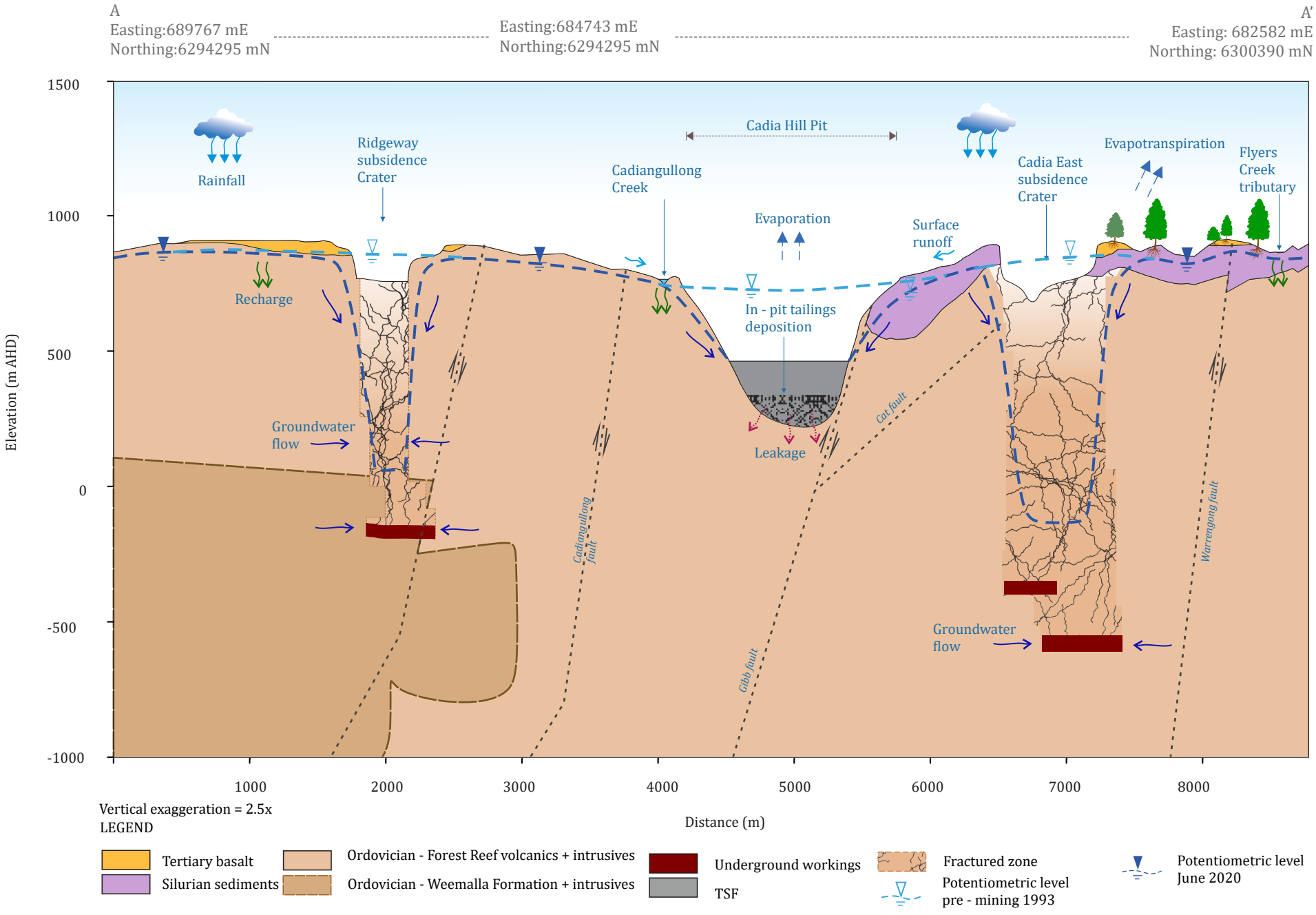
Perched groundwater systems may form at the interface between weathered and fractured units (including Silurian/Ordovician rocks and Tertiary basalt), which overly fresh massive rock that forms an aquitard and restricts downward flow. These systems will drain downslope and emanate as surface seepage typically within creek lines or topographic breaks in slope.

The hydrostratigraphic units detailed above are adopted in both the conceptual and numerical models described in this report.

The hydrogeological conceptualisation is discussed in detail in the following sections. The conceptualisation adopted by AGE is supported by four hydrogeological cross-sections, as illustrated in Figure 5.1 to Figure 5.4, with the section alignments shown on Figure 4.1:

- **A – A'** (Figure 5.1): extends west of Ridgeway mine and to the southeast/east through Cadia Hill pit, Cadia East mine, and to Flyers Creek. Cross section includes block cave development and faults;
- **B – B'** (Figure 5.2): east – west section extending from Cadiangullong Creek through Cadia East mine to Flyers Creek and crossing through the strike of north orientated faults.
- **C – C'** (Figure 5.3): east – west section from Cadiangullong Creek, beneath STSF and extending under Flyers Creek and crossing through the strike of north orientated faults.
- **D – D'** (Figure 5.4): southwest – northeast section from Rodds Creek to the south of the STSF and extending beneath STSF and NTSF to northeast of Rodds Creek Dam.

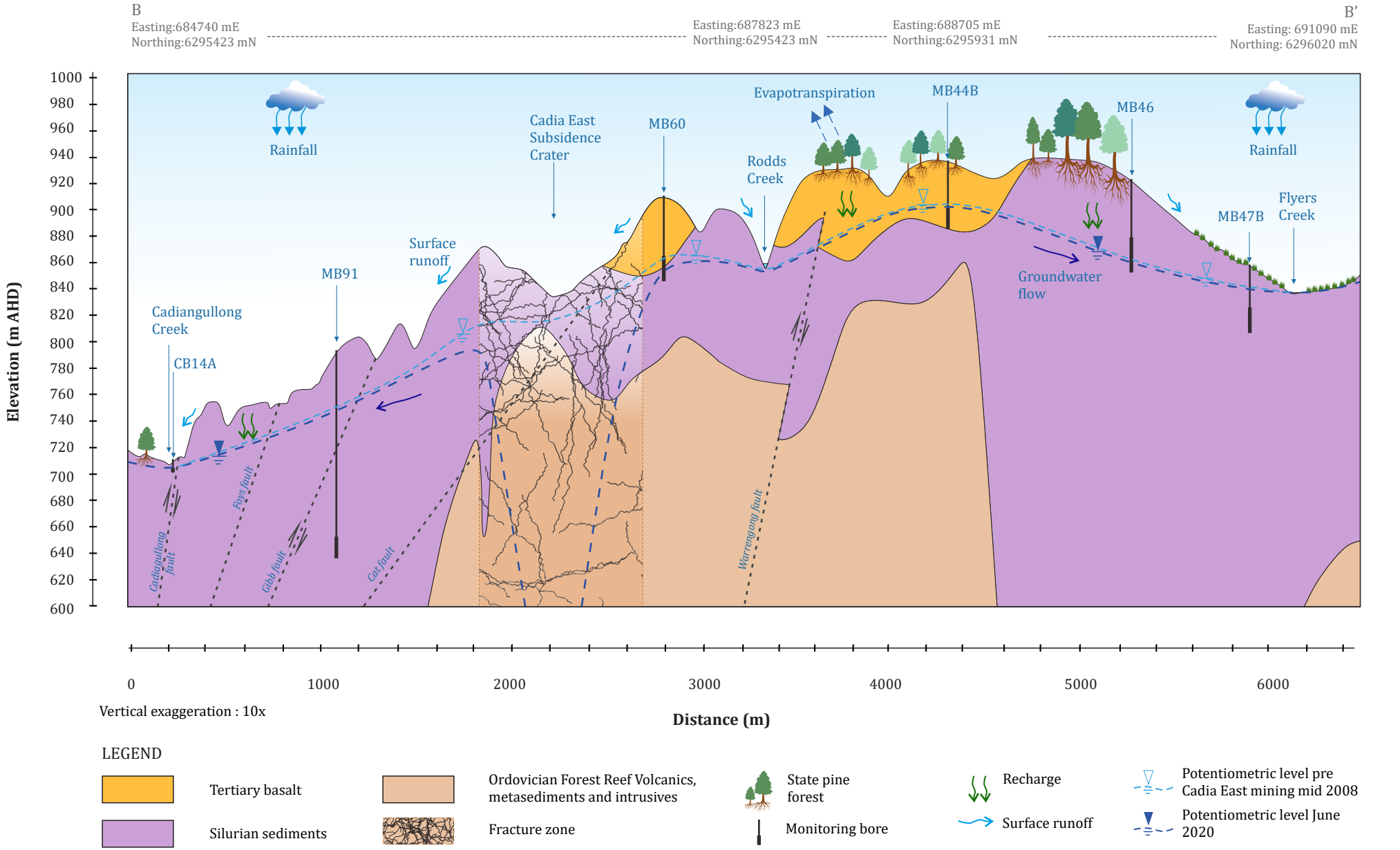
These conceptual sections have been developed from interpretation of geological datasets, historic groundwater level data/borelogs, 2020 predicted groundwater levels and surface water–groundwater interaction at creeks. The hydrostratigraphic units and attributes are discussed in detail below.



Hydrogeological conceptual section 1 (A – A')

Figure - 5.1

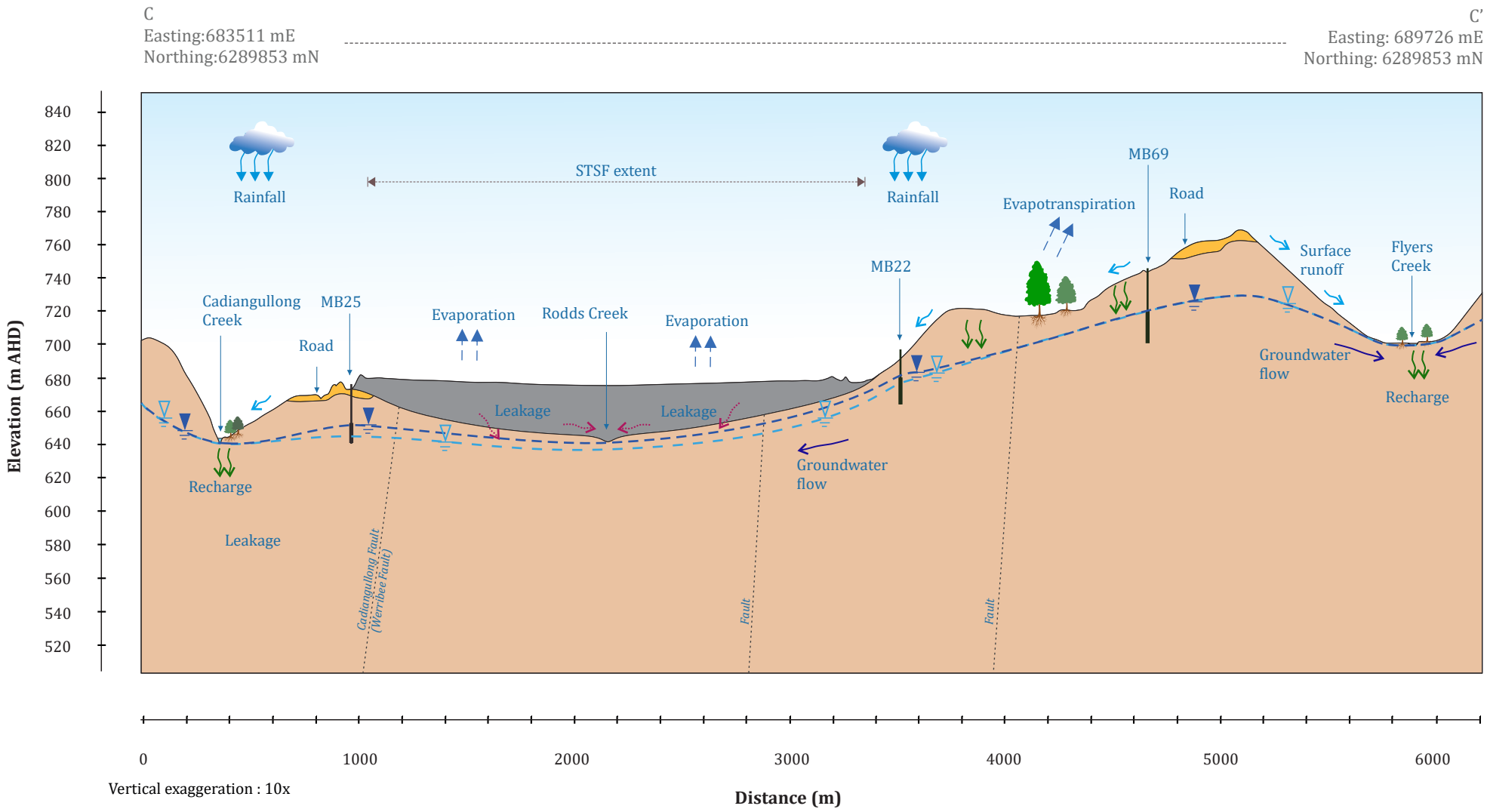
Cadia Mine Model Update (G1383Y)



Hydrogeological conceptual section 2 (B - B')

Figure - 5.2

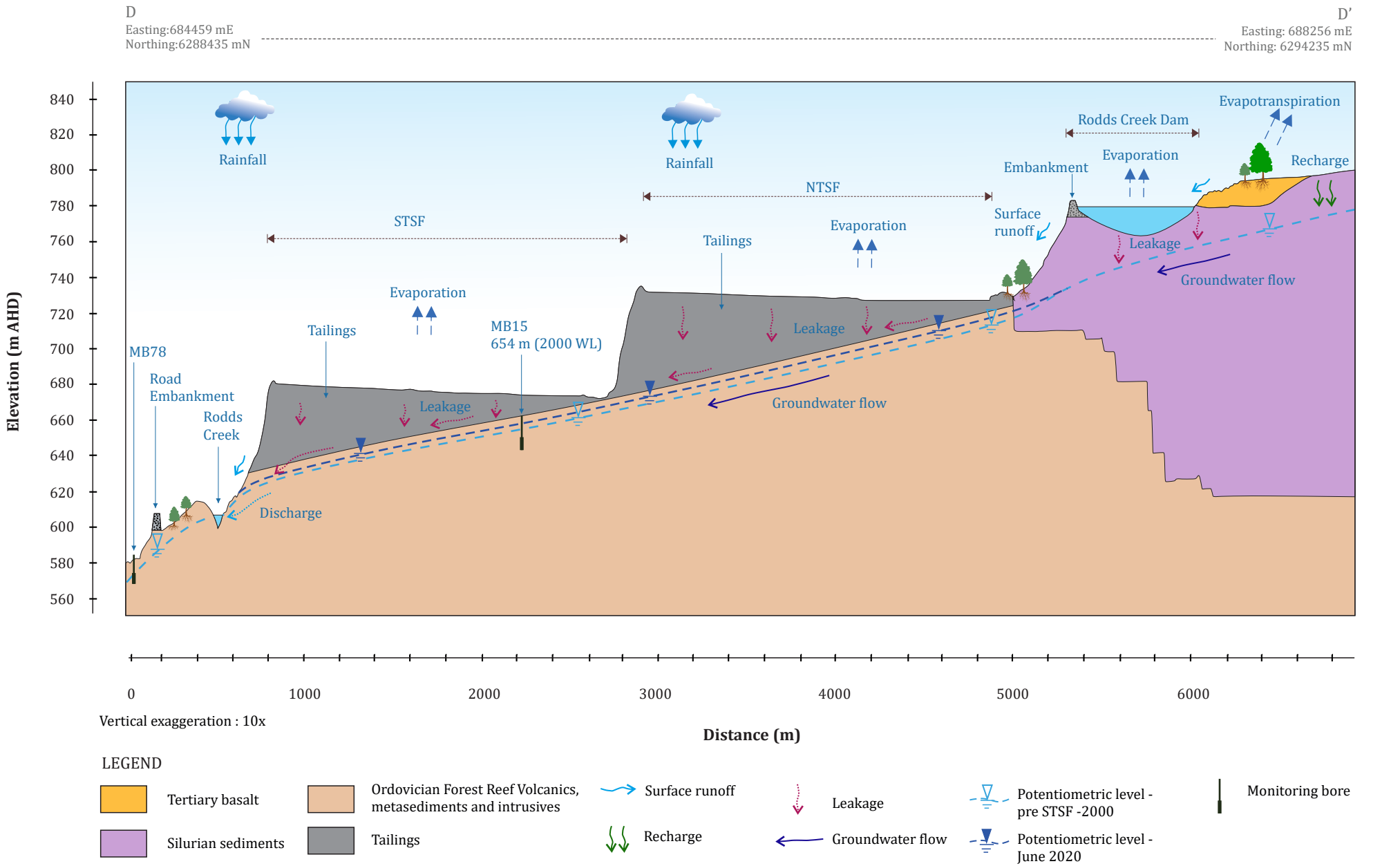
Cadia Mine Model Update (G1383Y)



Hydrogeological conceptual section 3 (C – C')

Figure - 5.3

Cadia Mine Model Update (G1383Y)



Hydrogeological conceptual section 4 (D - D')

Figure - 5.4

Cadia Mine Model Update (G1383Y)

5.3 Hydrostratigraphic units

The hydrostratigraphic units are described in further detail in this section and include the Quaternary alluvium, the Tertiary basalts, the Silurian sediments and the Ordovician units. The distribution of the hydrostratigraphic units varies naturally across the site. Thin sequences of Quaternary alluvium are generally constrained along drainage lines and are largely unsaturated. Similarly, the Tertiary basalts and Silurian sediments are absent in large areas of the Cadia Valley. Only the Ordovician volcanics occur throughout the site, where it is found outcropping at the surface or underlying other hydrostratigraphic units.

The Tertiary basalts, Silurian sediments, and Ordovician units have a low permeability rock mass, but more permeable aquifers are present where fracturing occurs. In the case of the Tertiary basalts, higher permeability aquifers are also present within fractured/weathered vesicular (scoriaceous) layers and where weathered contacts exist between sequential lava flows.

The Silurian and Ordovician rocks have similar hydraulic characteristics, that is the rock mass is of low permeability and generally form an aquitard, while fracturing associated with jointing, shearing, or faulting provides enhanced permeability along these lineaments. Not all structural features will have enhanced permeability due to the presence of clay gouge infill, cement precipitate, or carbonate/quartz veining within the fault zone, which may lead to compartmentalisation of groundwater. Weathering at shallow depths may enhance permeability by increasing fracture aperture from dissolution/rock breakdown or reduced permeability by clogging fractures with clay.

5.3.1 Quaternary alluvium

The Quaternary alluvium in the Cadia area generally occurs above the water table due to its shallow thickness (typically less than 5 m along creeks). Alluvium occurrence along creeks (i.e. Cadiangullong Creek) may be temporarily saturated in places where there is baseflow from weathered rock (basalt, Silurian, or Ordovician rocks), especially during wetter periods. There are some locations along drainage lines where permanent baseflow contributions from adjacent units reports to the alluvial sediments. Permanent baseflow expression is known to occur at Flyers Creek for example. Seepage may also occur from perched systems within fractured and/or weathered bedrock overlying low permeability fresh rock (e.g. Rodds Creek). The saturated thickness of these alluvial systems is very thin, and typically they are not very laterally extensive. Anecdotal evidence suggests most of the Quaternary alluvium consists of silty/clayey sediments of low permeability. Therefore, the alluvium along creeks forms only minor aquifers. The nearest alluvial system of significance, is most likely the Belubula River, which is located to the south of CVO. Given the Quaternary alluvium is not known to form a significant groundwater resource locally, coupled with the fact that it is either dry (or has very limited saturated thickness or spatial distribution), its inclusion in the numerical model cannot be justified at this point in time.

5.3.2 Tertiary basalt

The Tertiary basalt hosts the Orange Basalt fractured rock aquifer. The nature of the basalt varies spatially from relatively massive and low yielding, to vesicular (scoriaceous) and highly transmissive. Fracturing that is associated with magma cooling and loading provides variable aquifer connectivity but is spatially highly variable. The contacts between lava flows may form preferential groundwater flow paths, due to weathering and the presence of porous paleo-sediment layers. The basalt aquifers are generally unconfined at shallow depths but may be semi-confined at deeper depths because of poor vertical connectivity between layers of low permeability (e.g. massive basalt, clay, or ash).

The Australian Natural Resources Atlas (NWLRA, 2011) indicates that groundwater within the Orange basalt fractured rock aquifer occurs at a depth of approximately 20 m and is found in:

> "*weathered zones (old land surfaces) between successive flows, or as jointed and/or scoriaceous zones within the flows. The fractured nature of the permeability in this formation is highly variable. In some areas, fractures are open and relatively wide, with considerable capacity for storage and transmission of water. In other parts, fractures are rare, and the aquifer is consequently a poor source of water. A major problem with this aquifer is its variable nature, and the lack of continuity of fracture zones. A bore sunk into a well fractured and consequently highly permeable zone may appear to have a good supply, especially if not tested rigorously. On long term pumping, however, the yield might not be sustainable because the radius of influence extends beyond the fractured zone into the surrounding non-fractured area. This characteristic is presumably at least part of the reason for the relatively small use of groundwater compared to estimated sustainable yield in this Groundwater Management Unit*".

A review of registered Tertiary basalt bore data, which was completed as part of the Cadia East EIS (AGE, 2009), indicates that supplies from individual bores vary widely. Average yields are low to moderate with a median value of 1.25 L/s, with 96% of bores having yields less than 10 L/s.

5.3.3 Silurian sediments

The Silurian sediments are largely fine grained rocks that were formed in a low energy environment. The rock mass is inherently of low permeability and of very low primary porosity, which generally forms an effective aquitard. Although sandstone is intersected within the Silurian sequence, it is very fine grained and has a low porosity. Groundwater flow within the Silurian sediments is primarily due to secondary porosity induced by fracturing and weathering.

In zones of fracturing along geological structures and within karstic zones of the basal limestone unit, the permeability and effective porosity of the Silurian sediments can be enhanced locally. Karstic conditions may be associated with geological structures such as faults, although these features are not pervasive throughout the limestone. In areas of massive limestone, the permeability is generally low. Where karstic conditions have been intercepted during mine development, high initial inflows have been recorded. Groundwater inflows have typically waned shortly afterwards, as the storage is depleted from the fractures or karstic voids. This situation occurred during the drilling of raised bore VR71 in early 2011 (AGE, 2011). A breccia structure at the contact of the basal limestone within the Forest Reef Volcanics was intersected and an initial high inrush of water entered the mine. The inflow declined rapidly as groundwater was depleted from the breccia structure, indicating the structure was not well connected on a regional scale. A replacement raised bore VR81 was drilled 300 m from VR71 and intersected massive limestone with minimal groundwater yield.

There is little historical information on the hydraulic properties of this formation at Cadia Valley because the surface exposure of Silurian sediments mostly occurs to the east of the Cadia Hill pit, and it is not intersected at Ridgeway.

Data collected through site investigations suggests that the bulk hydraulic conductivity of the Silurian sediments is relatively low, although in areas of faulting, and areas where fractures are closely spaced hydraulic conductivities can be higher. Airlift yields are typically less than 1 L/s but may range up to 12 L/s in fractured rock (refer to Section 5.6).

5.3.4 Ordovician units

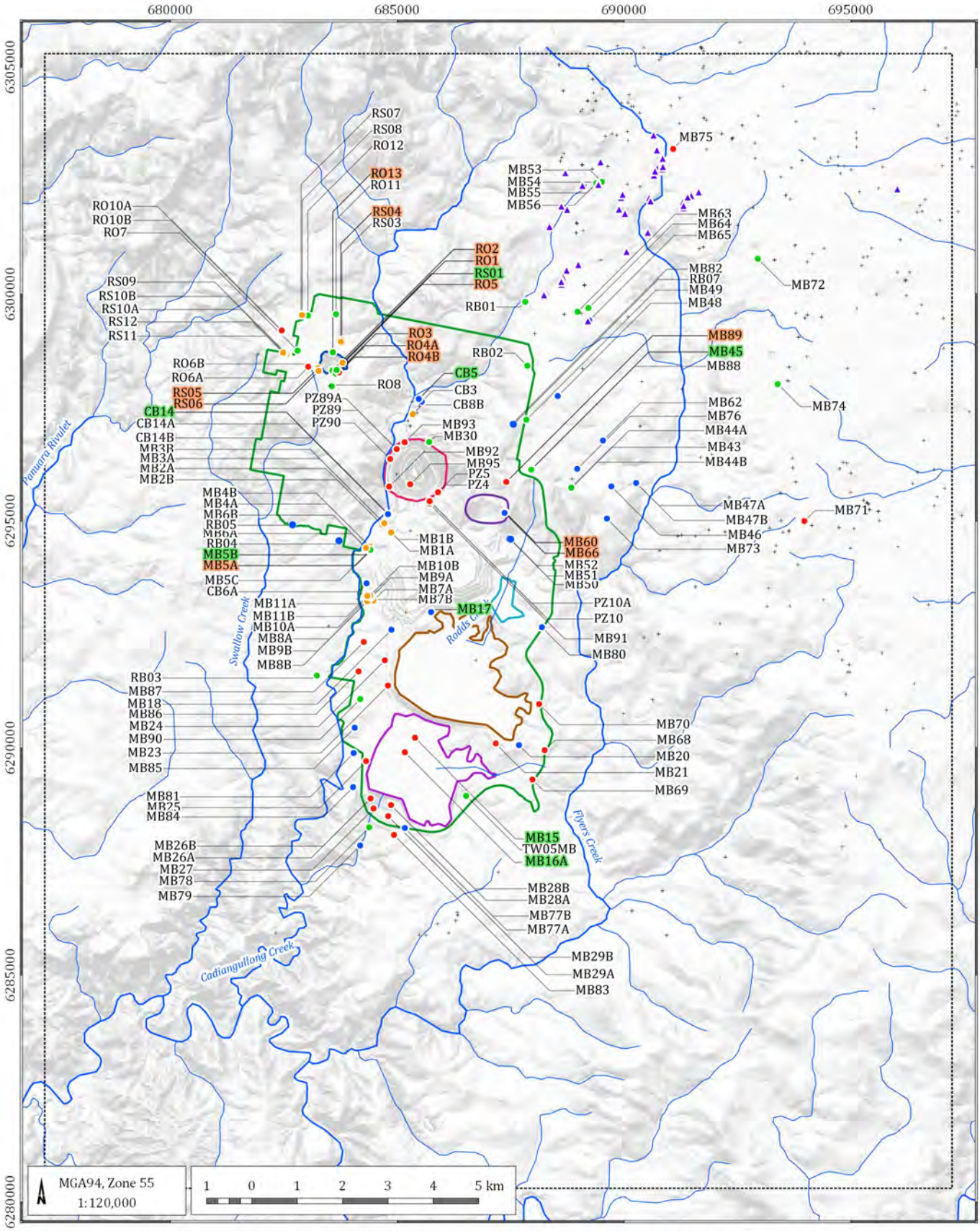
Like the Silurian sediments, the Ordovician rock mass is inherently of low permeability and of very low primary porosity. The unit thereby generally forms a competent aquitard. Groundwater flow is primarily due to secondary porosity that is induced by fracturing and weathering. In zones of fracturing along geological structures the permeability and effective porosity is enhanced.

Data collected through site investigations suggests that the hydraulic conductivity of the Ordovician volcanics is relatively low. In areas of faulting, and areas where fractures are closely spaced, hydraulic conductivities can be higher. Airlift yields are typically less than 1 L/s but may range much higher in fractured rock.

The available storage within fractured zones is generally poor as was indicated by the drilling and test pumping of bores on the perimeter of the STSF/NTSF and waste rock dump (AGE, 2020). These bores were up to 75 m deep and installed within the Forest Reef Volcanics (4 bores) and within the mapped Weemalla Formation, between the waste rock dump and Cadiangullong Creek in the Cadiangullong Fault zone (bore TP03). Initial airlift yields ranged between 2 L/s to 6 L/s, except for Cadiangullong fault zone bore TW03 where the recorded airlift yield was 20 L/s. Test pumping results indicated that only two bores (TW02 and TW03) provided short term (one week) sustainable yields greater than 1 L/s, with Cadiangullong fault zone bore TW03 affording a long-term extraction rate of more than 2.4 L/s. Analysis of test pumping from the remaining bores suggest long term extraction rates ranging from 0.1 to 0.5 L/s.

5.4 Groundwater monitoring network

Groundwater level monitoring is generally undertaken on a monthly or quarterly basis. The CVO monitoring bore network has increased over time and currently there are 124 groundwater bores active within and surrounding CVO. There are several bores that have become inoperable due to mine site disturbance or blockages overtime. Figure 5.5 shows the location of active and decommissioned bores and the screened geological units for each of the bores. This data was obtained from the CVO Environmental database, and it is acknowledged there are some errors with the interpretation of screened geological units.



LEGEND

- Drainage
- Cadia Hill Pit
- Block cave mine subsidence zone
- Ridgeway cave mine subsidence zone
- Rodds Creek dam
- NTSF
- STSF
- Mining lease
- Model boundary

NOTE:
Cadia geological units assigned to monitoring bores is from the CVO Environmental database

- Private landholder bores
- Springs

Cadia monitoring bores

- Tertiary Basalt
- Soil/Alluvium/Clay
- Silurian Sediments
- Ordovician Volcanics

NOTE:
"BM83" - Active bore
"MB16A" - Decomissioned
"MB60" - Abandoned

Cadia Model Update (G1383Y)

Monitoring bore network

DATE 07/04/2021

FIGURE No: 5.5

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5.5 Groundwater level and flow

5.5.1 Pre-mining

The pre-mining characteristics of the groundwater system in the Cadia Valley were described in the Cadia Hill EIS (Newcrest, 1995) as follows:

- the water table generally mimics the topography of the valley;
- groundwater flows are generally toward the southwest (Cadiangullong Creek flow direction);
- a significant groundwater table high (> 915 mAHD) occurs under the Cadia Hill and Canobolas State Forest areas;
- steep hydraulic gradients exist in the north and east, becoming gentler towards the south and west (reflecting topographic contrast); and
- the groundwater flow patterns are strongly controlled by the major catchments in the Cadia Valley area, particularly Cadiangullong Creek and to a lesser extent Rodds Creek and Cadia Creek.

The 1997 potentiometric surface (groundwater level contours) prior to mining at Cadia Hill in 1998 is provided on Figure 5.6.

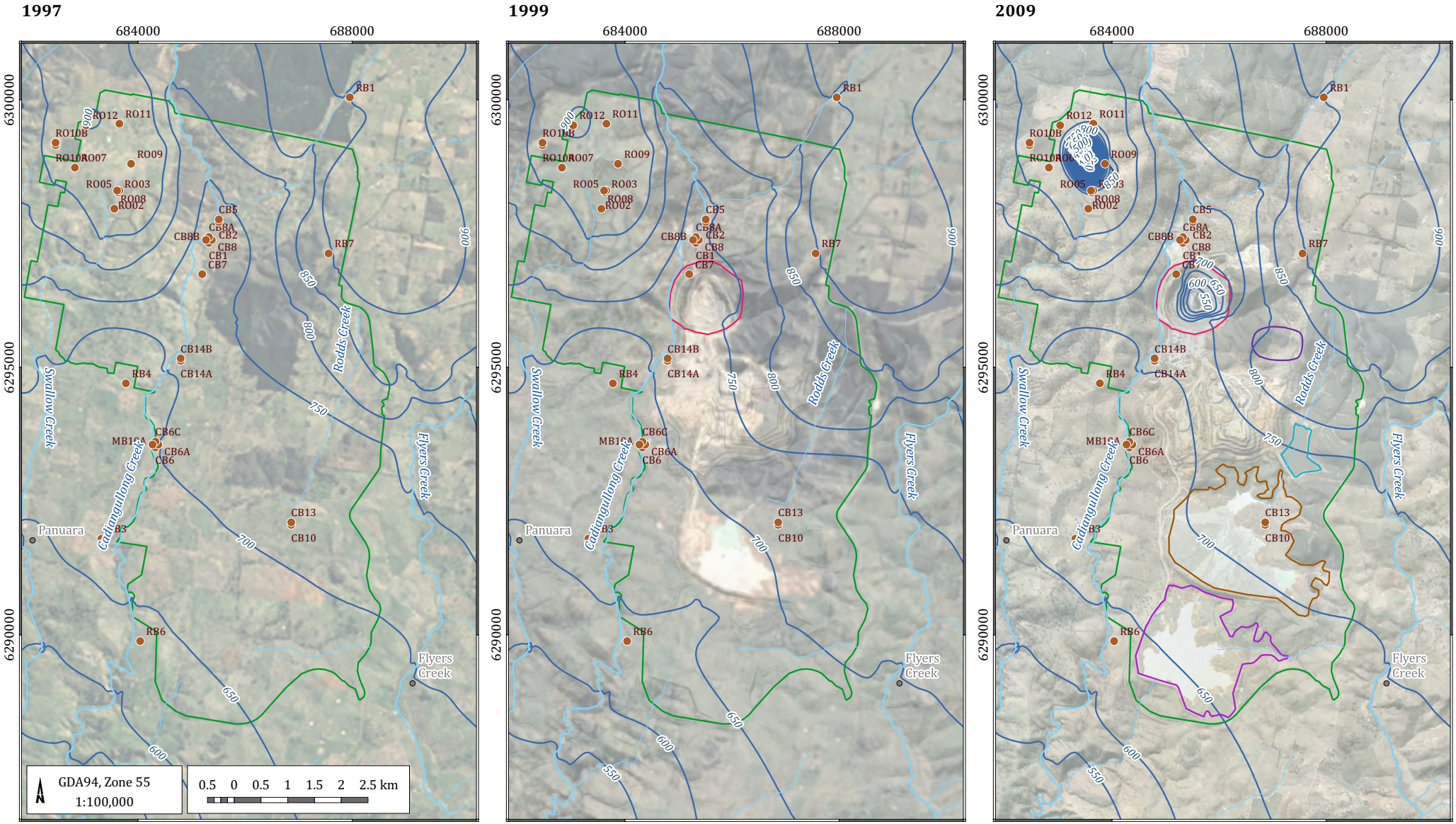
5.5.2 During mining

Groundwater levels and contours generated from observation data are presented for the following times:

- September 1999 – approximately one year after commencement of mining at Cadia Hill, but prior to the commencement of mining at Ridgeway (Figure 5.6);
- September 2009 –approximately eight years after mining commenced at Cadia Hill and six years after Ridgeway commenced (Figure 5.6); and
- June 2020 – approximately eight and a half years after panel cave mining commenced in Cadia East, and two years after tailings deposition commenced in Cadia Pit (Figure 5.7).

The contours were generated using the available CHPL groundwater level data and where appropriate water levels of major creek lines, floor or tailings levels of the Cadia Hill open pit, and floor levels of the Ridgeway/Cadia East underground mines. As illustrated on the groundwater contour plans, the piezometric surface on a regional scale has been relatively stable over time, with the exception of the steep zone of depressurisation that has developed locally around the Cadia Hill pit and the Ridgeway/Cadia East underground mines. Note that the groundwater contours beneath TSF infrastructure and within mine subsidence zones are approximations as there is limited groundwater monitoring conducted in these areas.

The recorded groundwater levels in 2020 vary from 0 meters below ground level (mbgl) (Flyers Creek baseflow discharge) to greater than 70 mbgl for bores located near Cadia East subsidence crater and on the perimeter of Cadia Hill Pit. The majority of the measurements are shallow (between 5 to 20 mbgl) and occur in topographically depressed areas including drainage lines. The June 2020 values ranged from 568 mAHD at MB79 located along Rodds Creek to the south of the STSF, to over 980 mAHD at MB53, MB55 and MB56, which are located at higher elevations approximately 6 km north of Cadia East. One bore in the vicinity of Cadia Hill pit (MB95) recorded a standing water level of 477 mAHD.



LEGEND

- Place name
- Groundwater monitoring bore
- Dainage
- Groundwater level contours (mAHD)
- Mining lease
- Cadia Hill Pit
- Block cave mine subsidence zone
- Ridgeway cave mine subsidence zone
- NTSF
- STSF
- Rodds creek dam

Cadia Mine Model Update (G1383Y)

Historic Groundwater levels and contours

DATE
29/03/2021

FIGURE No:
5.6

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Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
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LEGEND

- Drainage
- Cadia Hill Pit
- Block cave mine subsidence zone
- Ridgeway cave mine subsidence zone
- Rodds Creek dam
- NTSF
- STSF
- Mining lease
- Cadia monitoring bores
- Groundwater level contours (mAHD)

Cadia Model Update (G1383Y)

June 2020 Groundwater levels and contours

AGE

DATE 26/03/2021

FIGURE No: **5.7**

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5.6 Hydraulic parameters

Hydraulic parameters obtained from site investigations are presented in Table 5.1. Pumping test results from water supply bore investigations including Woodward and Clyde (1995) and test pumping around the margins of the TSFs/waste rock dump (AGE, 2020) have not been provided in this table. The reason being is that they provide elevated hydraulic properties of localised and relatively conductive fractured strata, which are not representative of the regional rock mass.

Hydraulic estimates from the Silurian and Ordovician units were obtained largely from bores within 200 m of the ground surface Some deeper testing using inflatable packers was completed by Kalf and Associates (2000) for the Ridgeway mine EIS, with tests up to 384 mbgl completed in the Ordovician rocks. The permeability of the rock mass is expected to decrease as depth increases due to fracture closure through overburden pressure and a lack of weathering.

5.6.1 Tertiary Basalt

Site investigation results from the Tertiary basalts indicate that the hydraulic conductivity is moderately variable, with known measurements ranging from 0.009 m/d (< 1×10^{-7} m/s), up to 1 m/d (1×10^{-5} m/s) (Kalf and Associates, 2000). This variability is characteristic of fractured systems, where the same geological unit can present a wide range of hydraulic properties that depend on the occurrence of secondary porosity features such as fractures and defects. Regional bore yields suggest that the basalt can be highly permeable through further secondary porosity features (i.e. permeabilities greater than 1 m/d).

5.6.2 Silurian sediments

Site investigations of the Silurian sediments indicate the hydraulic conductivity is relatively low, with estimates ranging between approximately 0.0001 m/d (1×10^{-9} m/s) to 0.01 m/d (1×10^{-7} m/s).

Aquaterra (2005) drilled four test holes in the area of the previously proposed Cadia East open pit, targeting the Silurian sediments and geological structure. The boreholes were drilled to depths of between 93 m and 180 m, and yielded up to 2.1 L/s. The airlift testing data was used to estimate the hydraulic conductivity of the rock mass and indicated a range of 2×10^{-4} m/d (2×10^{-9} m/s) to 0.03 m/d (4×10^{-7} m/s), with a relatively low average of 0.004 m/d (4×10^{-8} m/s).

As part of the Cadia East EIS assessment (AGE, 2009) six holes were drilled in the Silurian sediments to the east of the proposed Cadia East underground mine (i.e. MB43, MB44A, MB46, MB47A, MB47B, and MB48). All bores produced relatively modest yields (between 1 L/s and 2 L/s), except for MB47A which yielded approximately 12 L/s. Bore MB47A was drilled to a depth of 182 m and intersected water in several zones of fractured sandstone, siltstone, and limestone.

A short-term constant rate pumping test was undertaken in bore MB43 within the Silurian sediments, which is located to the east of the proposed Cadia East underground mine. Analysis of the pumping test data using the Cooper-Jacob method for confined aquifers indicated a transmissivity of 1.1 m^2/d. Assuming an aquifer thickness of 164 m, this is equivalent to a hydraulic conductivity of 0.007 m/d (8×10^{-8} m/s), which is comparable to the Aquaterra (2005) average for the Silurian sediments (0.004 m/d).

5.6.3 Ordovician units

On a regional scale, the hydraulic conductivity and transmissivity of the Ordovician volcanics is relatively low. The low volumes of groundwater inflows that are recorded in the Cadia Hill open pit, Cadia East and Ridgeway underground mine also demonstrate this low transmissivity.

The Ordovician volcanics have similar hydraulic properties to the Silurian sediments. Investigations by Kalf and Associates (2000) and AGE (2021) have indicated typical hydraulic conductivity estimates ranging between 0.001 m/d (1 x 10^{-8} m/s) to 0.01 m/d (1 x 10^{-7} m/s), with localised fracturing/faulting increasing the conductivity to approximately 0.2 m/d (2 x 10^{-6} m/s) (AGE, 2020). Test pumping from the intensely fractured Ordovician sediments of the Weemalla Formation (siltstones/shales) adjacent to the Cadiangullong Fault produced hydraulic conductivity estimates of 0.5 m/d (5 x 10^{-6} m/s) (AGE, 2020). The bulk storativity in the Ordovician rocks is low, with estimates ranging between 1 x 10^{-5} to 1 x 10^{-4}, which reflects the overall low porosity of the rock. However, along the Cadiangullong Fault where there is greater secondary porosity, the storativity is assumed to be higher (Woodward and Clyde, 1995; AGE, 2020).

Kalf and Associates (2000) undertook pumping tests on three bores constructed in the Ordovician volcanics at the Ridgeway mine. Based on these tests, the hydraulic conductivity was estimated to be in the range 0.01 m/d to 0.3 m/d. Kalf and Associates (2004) adopted a much lower uniform hydraulic conductivity of 10^{-3} m/d for the Ordovician aquifer during numerical modelling for the Ridgeway Deeps, with storativity set at 4 x 10^{-3}. On a regional scale, the hydraulic conductivity and transmissivity of the Ordovician volcanics is relatively low.

CVO conducted laboratory testing of horizontal hydraulic conductivity on 195 core samples (AGE, 2019) within the Cadia Hill pit in 2018. Tested samples primarily comprised monzonite and lesser volcanics, dacite, and sedimentary units. The majority of the results indicated very low permeability (virtually impermeable at the lower range), ranging from 10^{-8} to 10^{-1} m/d. Only ten of the samples yielded an estimated hydraulic conductivity greater than 10^{-4} m/d, however these samples were observed to be fractured, which indicates groundwater movement through secondary porosity features.

AGE (2020) conducted test pumping on six bores constructed in the Forest Reef Volcanics (5 bores) and the Weemalla Formation (1 bore) targeting the inferred geological structure on the perimeter of the NTSF/STSF and the waste rock dump. The test pumping results provided hydraulic conductivity estimates in the range of 0.004 m/d (transmissivity of 0.2 m^2/d), up 0.4 m/d (transmissivity of 13 m^2/d). The highest conductivity was estimated for bore TW03, which is mapped in the Weemalla Formation in the Cadiangullong Fault zone. Two aquifer storativity estimates were obtained from the test pumping; 1.1 x 10^{-5} at test bore TW05 (within the Forest Reef Volcanics), and 1.2 x 10^{-3} at test bore TW03, which is located within intensely fractured siltstone/shale.

Table 5.1 Hydraulic properties of geology units from site investigations

Investigation	Geological unit	Bore ID	K (m/d)	K (m/s)	Storativity	Investigation test method
Kalf and Associates (2000) - Ridgeway EIS	Tertiary basalt	RO4A, R07, RO9, R010A, RO11, RO13	0.2 to 1	2×10^{-6} to 1×10^{-5}	-	Ridgeway site. Six hour single rate pumping tests.
Kalf and Associates (2000) - Ridgeway EIS	Fractured Ordovician rocks (in proximity of fault zone)	RP1, R04B, RO10B	#0.01 to 0.16 ^0.02 to 0.3	#1×10^{-7} to 1×10^{-6} ^3.5×10^{-7} to 2.3×10^{-6}	2×10^{-5} to 9×10^{-5}	24 hour pumping test and six hour recovery on RP1/R04A and six hour pumping test and 2 hour recovery on RO10B
Kalf and Associates (2000) - Ridgeway EIS	Ordovician volcaniclastics	NC518, NC528 and GT7	0.001	1.2×10^{-8}	-	Injection test results at Ridgeway provided geometric mean for 88 test intervals to a depth of 384 m
Kalf and Associates (2000) - Ridgeway STSF EIS	Ordovician volcaniclastics 2.5 to 20 m in depth	LRC-BH1 to LRC-BH3 and LRC-BH5 to LRC-BH8	0.012	4×10^{-7}	-	Mean results from injection tests of seven boreholes in lower Rodds Creek area (proximity southern embankment of STSF).
Kalf & Associates (2000) Ridgeway STSF EIS	Ordovician volcaniclastics greater than 20 m in depth	LRC-BH1 to LRC-BH3 and LRC-BH5 to LRC-BH8	0.012	1×10^{-7}	-	Mean results from injection tests of seven boreholes in lower Rodds Creek area (proximity southern embankment of STSF)
Aquaterra (2005) - proposed Cadia East Pit	Silurian metasediments (fractured) in proximity of faults	CE058, CE059, CE060 and CE061	0.0002 to 0.03	2×10^{-9} to 3.5×10^{-7}	-	Coarse airlifting assessment from four boreholes at Cadia Pit ranging from 93 to 180 m deep, targeting hanging wall F111 faults. Airlift yields from boreholes ranged from negligible to 2.1 L/s
Aquaterra (2005) – proposed Cadia East Pit	Ordovician volcaniclastics	CE062	0.0008	$9x 10^{-9}$	-	Coarse airlifting assessment at Cadia Pit for 100m deep hole. Airlift yield of 0.04L/s.
AGE (2009)- Cadia East EIS	Tertiary basalt	MB49	0.08	9.5×10^{-7}	-	Falling head test - one bore

Investigation	Geological unit	Bore ID	K (m/d)	K (m/s)	Storativity	Investigation test method
AGE (2009) - Cadia East EIS	Silurian metasediments	MB43 / MB44A	0.007	8×10^{-8}	2.4×10^{-4}	Pumping test of MB43; K estimated from transmissivity of 1.1 m^2/d and unit saturated thickness of 164 m in bore
AGE (2019) – Cadia Hill. *CVO conducted the investigation.*	8 geological domains tested predominantly comprising Ordovician monzonite, with lesser Ordovician volcanics, diorite and Silurian sedimentary units	195 drill core samples	Primary matrix K typically 10^{-8} to 10^{-4}	Primary matrix permeability typically 10^{-13} to 10^{-9}	-	Laboratory core samples tested for horizontal K. Test results noted that ten samples were greater than 10^{-4} m/d but were fractured. Nine of these samples ranged between 0.0001 to 0.01 m/d and one sample was between 0.01 and 0.1 m/d.
AGE (2020) – TSF and waste rock dump perimeter water supply	Ordovician sediments (Forest Reef Volcanics and Weemalla Formation) in proximity of inferred geological structure	TW02, TW03, TW05, TW06, TW07 and TW08	0.005 (TW06) to 0.45 (TW03)	5×10^{-8} (TW06) to $5x\ 10^{-6}$ (TW03)	1×10^{-5} (TW05) & 1×10^{-3} (TW03)	Pumping tests; K estimates from transmissivity values ranging from 0.2 m^2/d to 13 m^2/d with bore saturation thickness ranging from 26 to 66 m. TW03 located in Cadiangullong fault zone in intensely fractured siltstone/shale of mapped Weemalla Formation
AGE (2021) – Life of Mine TSF study	Ordovician metasediments, volcaniclastics and intrusives	BH2,BH9B, BH11,BH17C and BH40S	0.017	2×10^{-7}	-	Injection test results provided a geometric mean for 12 test intervals to a depth of 57 m
AGE (2021) – Life of Mine TSF study	Ordovician metasediments, volcaniclastics and intrusives	MB102, MB103, MB104, MB105, MB108, MB109 and MB111	0.017	2×10^{-7}	-	Slug tests results provided a geometric mean for seven bores completed to a max depth of 55 m
AGE (2021) – Life of Mine TSF study	Fractured Ordovician volcanoclastic rocks (fault zone)	MB109	0.17	2×10^{-6}	-	Slug test result from one bore completed to a depth of 55 m depth
AGE (2021) – Life of Mine TSF study	Tertiary basalt	MB106, MB112	0.009	1×10^{-7}	-	Slug test average from two bores completed to depths of 29 and 48 m.

Notes: *K = hydraulic conductivity; Kalf and Associates investigation Ridgeway EIS (2000); - # = confined system analysis; ^ = leaky semi confined analysis.*

5.7 Recharge

The Australian Natural Resources Atlas (NLWRA, 2001) estimated the sustainable yield of the Orange basalt fractured rock aquifer to be 17,000 megalitres per year (ML/year). Recharge of the Tertiary Basalt is from rainfall and surface runoff/ponding.

Recharge to the Silurian sediments is expected to occur via direct rainfall infiltration at the surface and leakage from the overlying Tertiary basalt where the basalt overlies the Silurian sediments. The leakage rate from the Tertiary basalt aquifer into the underling Silurian sediments is expected to be controlled by the nature of the contact between the two formations. In the paleochannel to the northeast of the mine, the base of the channel was typically filled with up to about 10 m of clay sediments. These sediments would limit the rate of groundwater leakage between the two formations. Beyond the paleochannel limits, where the Tertiary basalt is deposited directly upon the Silurian sediments, the hydraulic connection is expected to be less restricted. Groundwater level monitoring at nested bore sites in the vicinity of Cadia East suggest leakage rates are low, with much higher groundwater levels in the basalt than in underlying Silurian sediments.

Recharge to the Ordovician aquifer is expected to occur via direct rainfall infiltration at the surface and leakage from overlying Tertiary basalt and Silurian aquifers. Pumping tests undertaken by Kalf & Associates (2000) for the Ridgeway underground mine observed leakage between the Tertiary basalt and the underlying Ordovician aquifer during testing. Subsequent numerical modelling for Ridgeway Deeps, Kalf & Associates (2004) applied a recharge rate of 5.5% of the annual rainfall to the surface layer including the Ordovician surface exposures.

Pine plantations, which are found to the north and east of CVO (see Section 3.3.2), likely affect recharge to underlying groundwater systems. Previous research (Holmes and Colville, 1970; Allison and Hughes, 1972; Benyon and Doody, 2009) demonstrates that there is typically no groundwater recharge under similar pine plantations. While recharge through direct infiltration is likely to be significantly diminished by water uptake in the pine tree roots, it should be noted that the local pine plantations are typically underlain by Tertiary Basalt, which predominately outcrops to the north of CVO. Groundwater within the Tertiary basalt (that underlies these plantations) is therefore down gradient of the recharge zone and a reduction in recharge may not significantly impact groundwater levels.

5.8 Discharge

Groundwater discharge occurs naturally through baseflow to creeks and springs. It also occurs as discharge to mine areas and uptake from regional water supply bores. In the Cadia area, there is discharge into the mine areas where the workings are intersected beneath the water table. Discharge may be directly from the Ordovician volcanics and Silurian sediments, or indirectly from the basalt through geological structures extending through the basement rocks.

Discharge from the Tertiary basalt aquifer occurs through abstraction from bores, discharge into creeks that are incised into the land surface, and through seepage into the underlying fractured rock formations. Seepage areas and springs occur in the upper headwaters of Cadia and Flyers Creeks that dissect the basalts. At these locations, groundwater discharge is likely from permeable zones in the basalt (such as weathered zones, jointed, and/or scoriaceous zones) overlying low permeability massive basalt or clay layers (aquitards) that restrict downward flow.

Groundwater discharge from the Silurian sediments occurs predominantly along creeks incised into the Silurian sediments, which include Copper Gully and the upper (northern) section of Flyers Creek/Rodds Creek. Groundwater discharge from the Ordovician volcanics is expected to occur in the creeks incised into the Ordovician volcanics (i.e. Swallow Creek, Cadiangullong Creek, and lower (southern) sections of Rodds Creek/Flyers Creek).

The flow in Cadiangullong Creek is controlled by releases from the Cadiangullong Dam and is therefore not representative of groundwater baseflow. Swallow Creek baseflow is generally less than 5 L/s. Flyers Creek has a relatively high baseflow component of 35 to 60 L/s, although much of this flow is from the Tertiary basalt and Silurian aquifers in the upper area of the catchment.

5.9 Vertical gradients

The CVO groundwater monitoring network includes 17 nested pairs of monitoring bores, which are installed at different depths and are suitable for assessing vertical gradients. Summary details of these bore pairs and the average difference between observations at each of the bores are provided in Table 5.2, with bore location shown on Figure 5.5.

Groundwater level differences indicate that vertical flow is generally downwards from higher groundwater systems to lower groundwater systems, with this trend strongly evident within 13 of the 17 bore pairs. Within the remaining four pairs, there are no strong vertical gradients apparent, which is likely indicative of groundwater systems being hydraulically connected through fracture networks. A general absence of upwards gradients indicates that local discharges of groundwater (see Section 5.8) are likely to be relatively minor compared to the volume of groundwater flowing to the southwest away from CVO.

Table 5.2 Summary of monitoring at nested sites

Upper bore			Lower bore			Average difference		
ID	Unit	Screened interval (mbgl)	ID	Unit	Screened interval (mbgl)	Total observations	(m)	Direction
CB14A	Silurian sediments	6.3-12.3	CB14B	Silurian sediments	31.5-37.5	74	1.3	downwards
MB19B	unknown	1.64-7.64	MB19A	Unknown	15.7-39.7	74	10.6	downwards
MB1B	soil/clay	0.3-6.3	MB1A	Silurian sediments	28.5-34.5	78	12.5	downwards
MB26A	Ordovician volcanics	4.5-10.5	MB26B	Ordovician volcanics	19.0-30.0	85	4.1	downwards
MB28A	Ordovician volcanics	4.5-10.6	MB28B	Ordovician volcanics	14.0-20.5	84	7.7	downwards
MB29A	Ordovician volcanics	3.5-10.5	MB29B	Ordovician volcanics	11.2-24.0	84	12.3	downwards
MB44B	Tertiary basalt	26-47	MB44A	Silurian sediments	82-142	130	6.2	downwards
MB47B	Silurian sediments	40-72	MB47A	Silurian sediments	152-182	127	0.1	~ equal
MB4B	soil/clay	0.3-6.3	MB4A	Ordovician volcanics	17.1-23.1	91	-0.3	~ equal
MB5B	soil/clay	2.2-8.2	MB5A	Ordovician volcanics	24-30	58	-0.8	~ equal
MB77A	Silurian sediments	6-12	MB77B	Silurian sediments	23-29	46	0.3	~ equal
PZ10A	Ordovician volcanics	30-54	PZ10	Ordovician volcanics	75-85	25	28.5	downwards
PZ4	Ordovician volcanics	36-45	PZ5	Ordovician volcanics	83-95	56	14.2	downwards
PZ89A	Ordovician volcanics	52-60	PZ89	Ordovician volcanics	138-150	17	11.0	downwards
RO10A	Tertiary basalt	39-44	RO10B	Ordovician volcanics	89-136	128	12.7	downwards
RO4A	Tertiary basalt	29.5-41.5	RO4B	Ordovician volcanics	99.7-129.7	42	42.1	downwards
RO6A	Tertiary basalt	31-37	RO6B	Ordovician volcanics	52-136	128	15.3	downwards

Note: *mbgl – meters below ground level.*

5.10 Cave mining

Caving technology is a method for mining minerals from underground mines safely and economically. Cave mining may be carried out either by:

- sub-level caving (SLC);
- block caving (BC); and
- panel caving (PC).

These methods are highly productive and proving low-cost underground mass mining methods. They take advantage of gravity by undercutting the base of the ore column to induce natural breakage and caving of the ore column.

CVO uses cave mining methods in Ridgeway Deeps and Cadia East mines, reducing their operating costs (Logan, 2017). Various deformation zones form during cave mining and can impact the groundwater flow regime by displacement of the rock mass and generation of fractured zones (Figure 5.8). The fracturing typically enhances permeability allowing groundwater movement to flow into the cave zone, to be removed via dewatering. Piezometric levels will be drawn down in the fractured zone due to dewatering. In the massive, low permeability "tight", fresh rock that is present outside of the impacted zone, the piezometric levels will gradually decrease over time. This decrease will be more pronounced along geological structure (e.g. faults), where secondary porosity leads to higher permeability and greater groundwater drainage. Figure 5.8 shows the zones of influence occurring during cave mining.

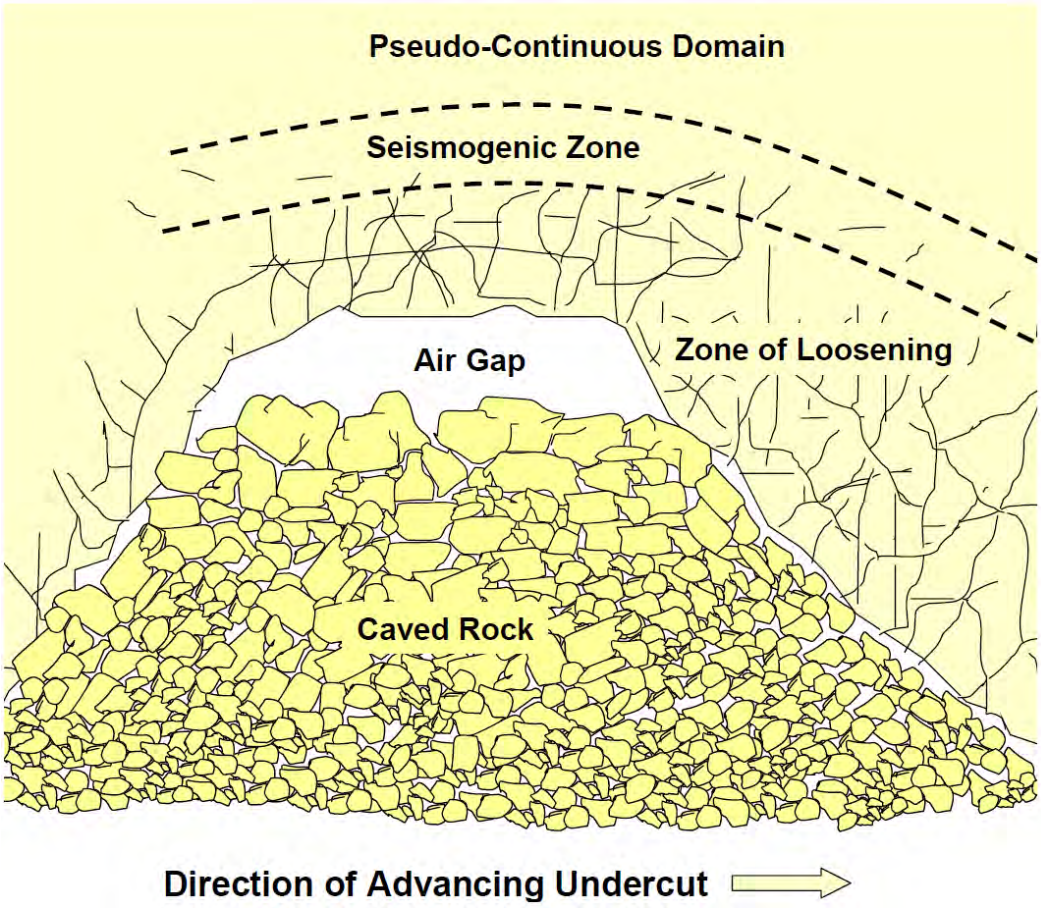


Figure 5.8 Cave mining zones (Logan, A. 2017)

Cave zones for the Ridgeway Deeps and Cadia East mines were closely investigated and processed to simplify (where possible) the simulation of these complex 3D cave geometries in the groundwater model. The cave mining implementation method is detailed in section 6.8.

5.11 Groundwater inflows

Figure 5.9 shows the estimated net groundwater inflows to the mining areas from CVO provided mine water balance spreadsheets.

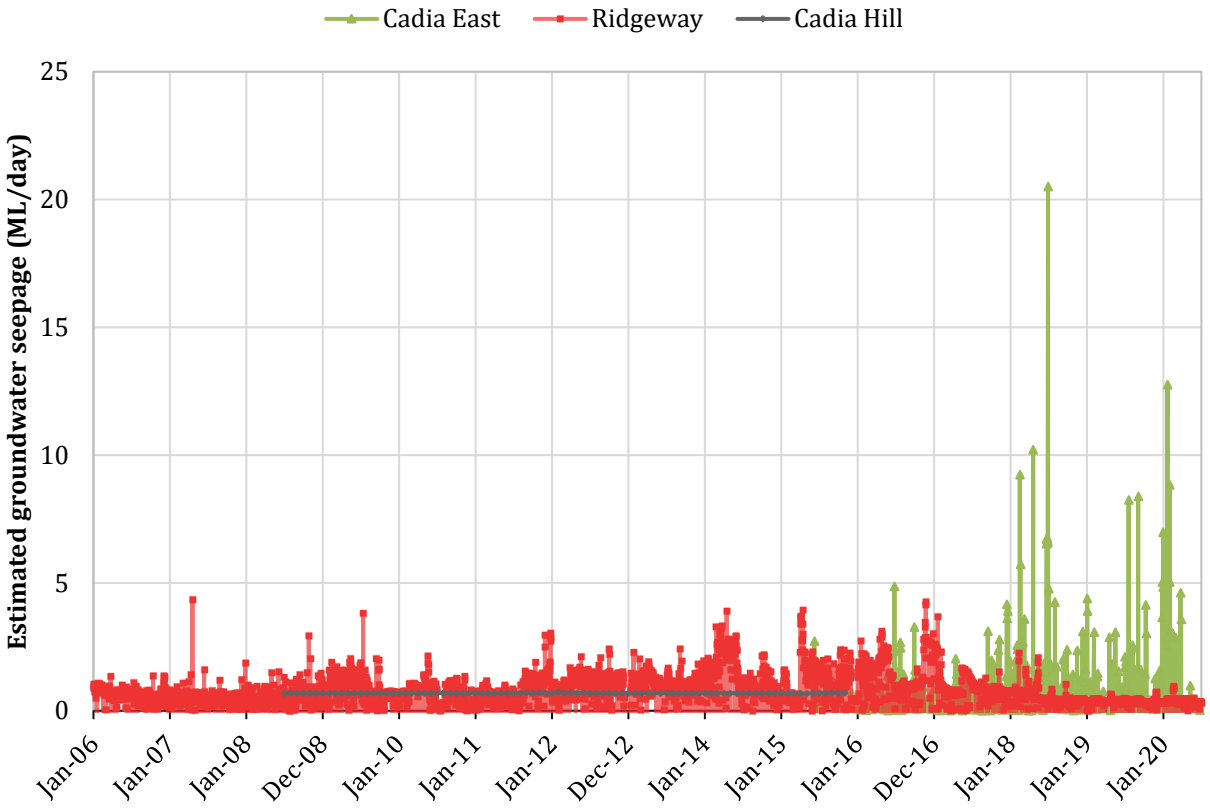


Figure 5.9 Estimated groundwater seepage to CVO mines

Table 5.3 shows the calculated annual average groundwater inflow rate to the Cadia Hill, Ridgeway, and Cadia East mines. A rising trend in the inflow to the Cadia East mine is observed between 2015 (0.06 ML/day) and 2018 (0.67 ML/day), with inflows since stabilising around 0.31 ML/day.

Table 5.3 Groundwater inflow – annual average

Year	Groundwater inflow (ML/day)		
	Cadia Hill	Ridgeway	Cadia East
2006	-	0.56	-
2007	-	0.29	-
2008	0.69	0.23	-
2009	0.69	0.59	-
2010	0.69	0.09	-
2011	0.69	0.32	-
2012	0.70	0.54	-
2013	0.69	0.66	-
2014	0.69	0.84	-
2015	0.69	0.51	0.06
2016	-	0.57	0.23
2017	-	0.65	0.30
2018	-	0.36	0.67
2019	-	0.15	0.31
2020	-	-	0.31

5.12 Cadia Valley Operation water supply bores

Groundwater supply bores are used to augment water supply to the Cadia operations. Bores CB3, CB6, CB8, CB9, RH641, and "Te Anu" are located along Cadiangullong Creek and intersect fractured basement. The Te Anu bore is believed to source water from fractured basalt. Four bores, CX1 to CX4, are located within the backfilled Extended Pit. Supply bores are used periodically when shortfalls occur, to provide makeup water. The locations of these bores are shown on Figure 5.10 below.

Observed groundwater level data is collected from the production bores and nearby monitoring bores infrequently (minimum monthly) during pumping operations and recovery periods. There is infrequent monitoring of yield data during pumping from the bores. These non-continuous datasets do not allow effective calibration of pumping induced drawdown within the groundwater numerical model, and therefore have been excluded from the model update.

Figure 5.10 CVO supply bores

5.13 Groundwater level responses

This section presents time series hydrographs of groundwater levels from monitoring bores within the operational areas of CVO. The groundwater levels have been grouped within each of the operational areas based on responses to either climatic conditions or from operational activities. An explanation for these trends has been provided where there is sufficient information. These operational areas have been subdivided into Cadia Hill Pit, Extended Pit, Ridgeway Mine, Cadia East Mine, NTSF, STSF, and water supply bore areas. The influence of the pine tree plantations on groundwater levels has been considered near the Cadia East Mine in Section 5.13.4 and also in Section 5.13.8. No groundwater level response data is available for the Waste Rock Dump (WRD) area due to an absence of bores. The closest monitoring bores to the WRD are located between Cadiangullong Creek and the western side of the WRD.

Observed groundwater levels, CRD trends, details on the screened aquifer (and depth), and the distance to the nearest operational area for each bore are provided in Appendix A.

5.13.1 Cadia Hill Pit

Mining at Cadia Hill commenced in 1998 and ceased in June 2012. There are twelve monitoring bores located either in the Cadia Hill Pit or on the periphery of the pit as shown on Figure 5.11. Groundwater levels for these bores are presented as time series hydrographs on Figure 5.12. Groundwater level responses for different periods are discussed below:

- gradual declines during mining of Cadia Hill up to 2012 are evident in bores MB30 and PZ90, which are located on northern side of the pit, and PZ5 located on the southern side of the pit;
- relatively stable water levels post Cadia Hill mining from 2012 to 2017 are evident in bores PZ4, PZ5, PZ10, and PZ89, although water level data is sparse;
- post 2017, declines in groundwater levels corresponding to Cadia East block cave mining are evident in bores PZ4, PZ5, MB9, PZ10, and PZ10A, which are located on southeast side of pit (this is discussed further in Section 5.13.4);
- 2019 declines observed in PZ89A, PZ89, and MB93 (which are located on northern margin of the pit) are likely to be a response from the extraction of stored water in the Cadia extended pit located immediately to the north; and
- a rise in groundwater level in bore MB95 (which is located in the pit) between 2018 to 2020, corresponds to tailings deposition.

Monitoring bore MB95 is the only bore screened at a similar elevation to the level of tailings deposition, i.e. between 330.76 to 398.55 mAHD. MB95 is consequently the only bore showing a rising trend in water levels, and presents a strong correlation to the rise in the PTSF. Bore MB95 was decommissioned in May 2020 due to inundation from tailings deposition, and a replacement bore has been installed (MB94) between the pit tailings and MB30 in August 2020.

The groundwater rise of 7.75 m in bore MB30 from January 2019 onwards is not considered to be attributed to tailings deposition. Bore MB30 is screened at least 200 m above the tailings deposition, at an elevation of 682.43 – 754.43 mAHD. The cause of groundwater level rise at MB30 during this period warrants further investigation. The high variability of groundwater levels in bore PZ89 prior to 2013 may suggest that PZ89 has been influenced by water storage (and subsequent pumping) in the Extended Pit.

Table 5.4 provides Cadia Hill bore details and groundwater level variation from May 2018 (start of in-pit tailings deposition) through to June 2020.

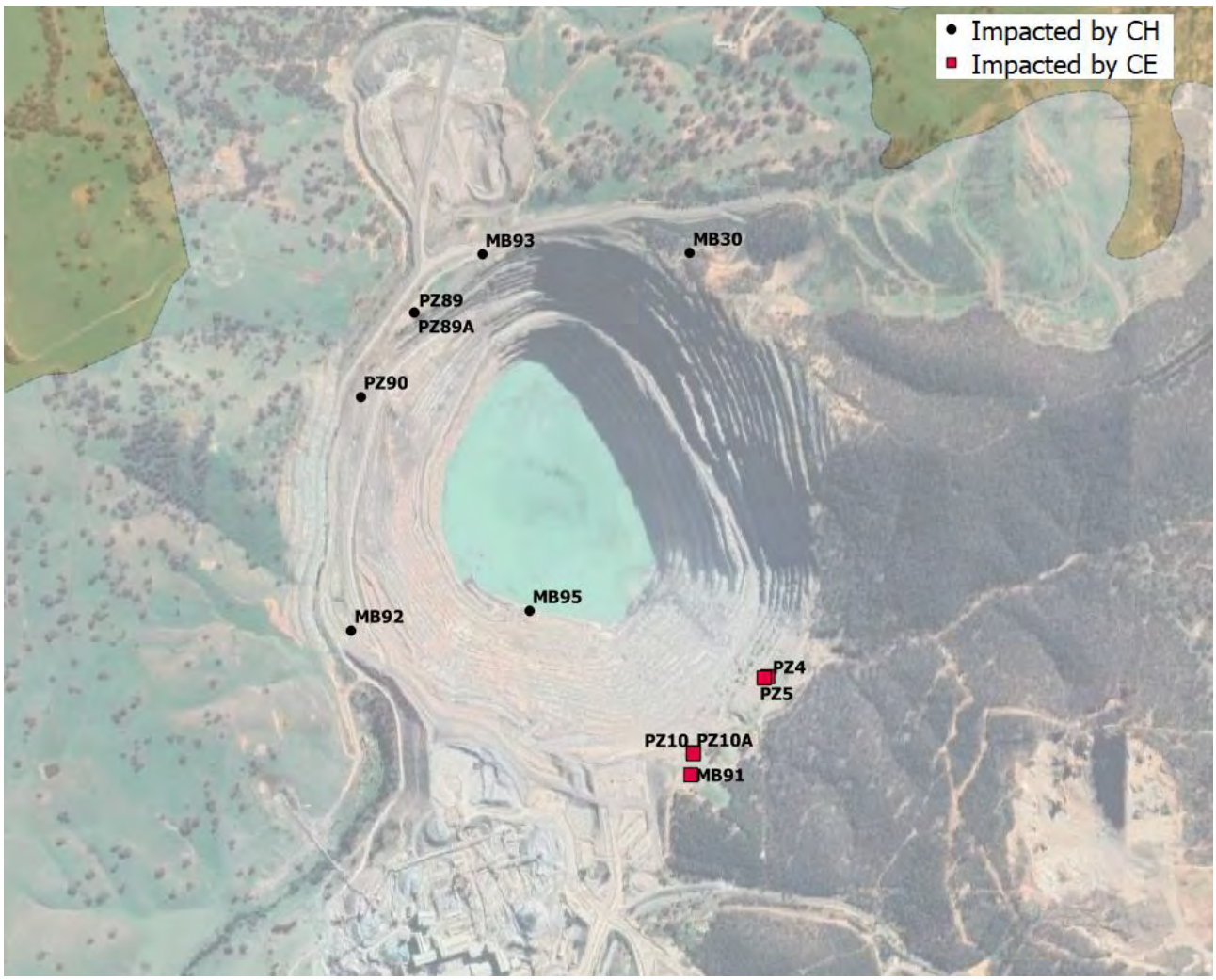
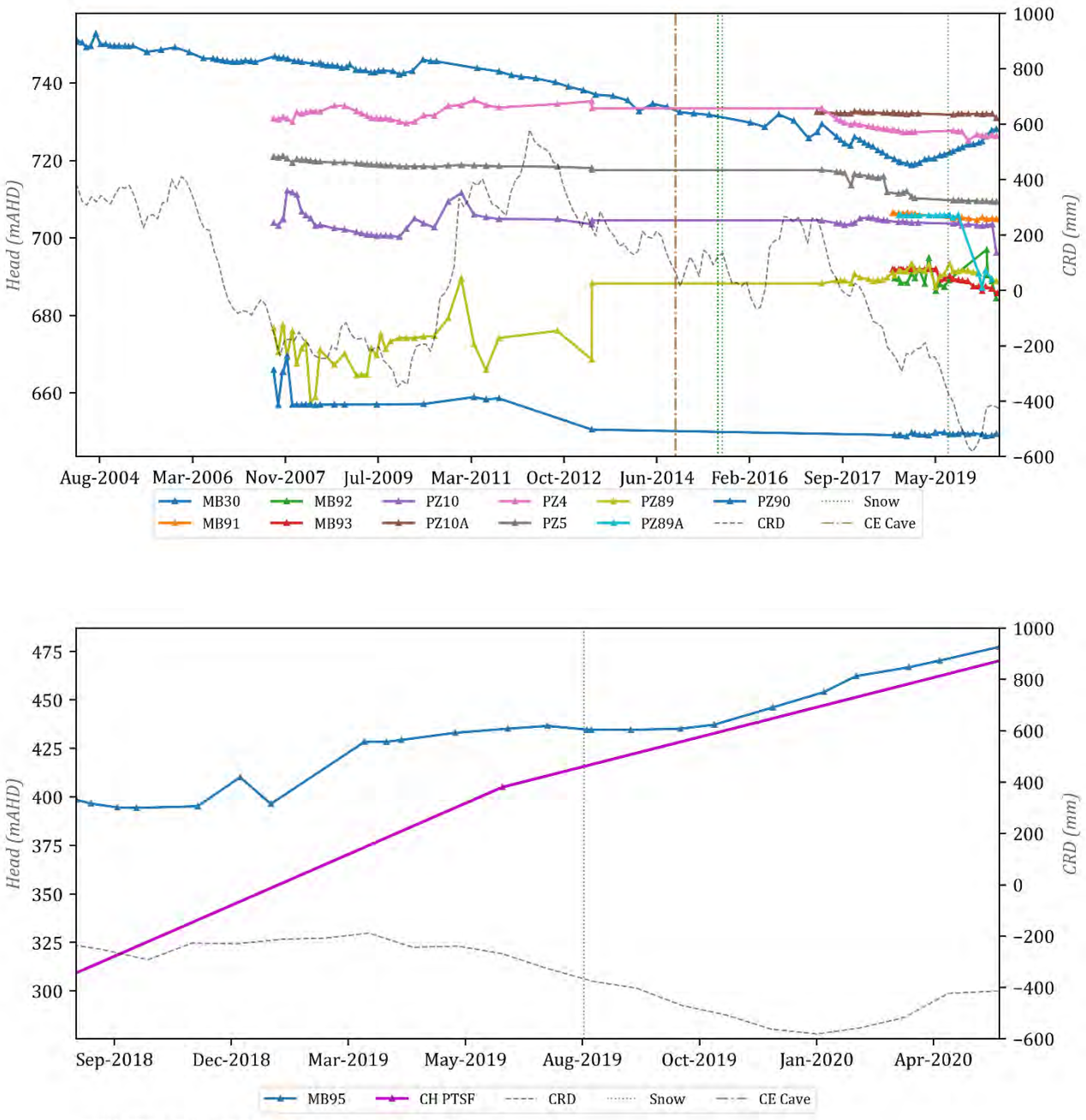


Figure 5.11 The location of bores around Cadia Hill pit (satellite image in April 2020)



** CH PTSF: Cadia Hill Pit Tailings Storage Facility*

Figure 5.12 Groundwater level response in Cadia Hill Pit bores

Table 5.4 Cadia Hill bore details and groundwater levels in 2018 and 2020

Bore	Screen base (mAHD)	Screen top (mAHD)	Aug-Sep 2018 WL (mAHD)	May-June 2020 WL (mAHD)	Difference in WL (m)
MB30	682.43	754.43	720.42	728.17	+ 7.74
MB91	786.88	636.88	706.50	704.81	-1.69
MB92	601.74	619.74	691.81	684.41	-7.40
MB93	612.74	660.74	691.83	685.75	-6.08
MB95	290.76	330.76	398.55	477.31	+ 78.76
PZ4	712.97	703.97	727.80	726.49	-1.32
PZ5	664.65	652.65	711.42	709.39	-2.03
PZ10	697.56	687.56	704.09	703.59	-0.50
PZ10A	742.56	718.56	732.18	732.01	-0.17
PZ89	582.66	594.66	691.07	688.88	-2.19
PZ89A	672.66	680.66	705.87	689.37	-16.51
PZ90	561.95	576.95	649.09	649.43	+ 0.34

5.13.2 Extended Pit

The extended pit located north of Cadia Hill has been backfilled with rubble and is used as an onsite water storage. The water storage was pumped in February to July 2020 and possibly June 2019. Monitoring bores located near the extended pit (MB93, PZ89, and PZ89A) show 2019 groundwater level responses from pumping, which can be seen on time series hydrographs on Figure 5.12.

5.13.3 Ridgeway Mine

The mining of the Ridgeway single level caving mine commenced in 2001 and stopped in about 2010, with fracture breakthrough occurring at the surface in 2002. The Ridgeway Deeps block cave extension occurred from 2009 to 2016 and the mine continues to be dewatered for future mining access. All the bores within 1 km of Ridgeway were examined for groundwater level responses. The locations of these bores are shown on Figure 5.13 and have been allocated into the following three groups based on the nature of the groundwater level response:

- "No impacts" – bores which show distinctive response to climatic events, without material departures;
- "Steady" - bores which show relatively stable groundwater levels after some declines, that are attributed to mine surface breakthrough in 2002; and
- "Declining" - bores which exhibit drawdown from the development of the subsidence zone and fracturing above the Ridgeway Deeps.

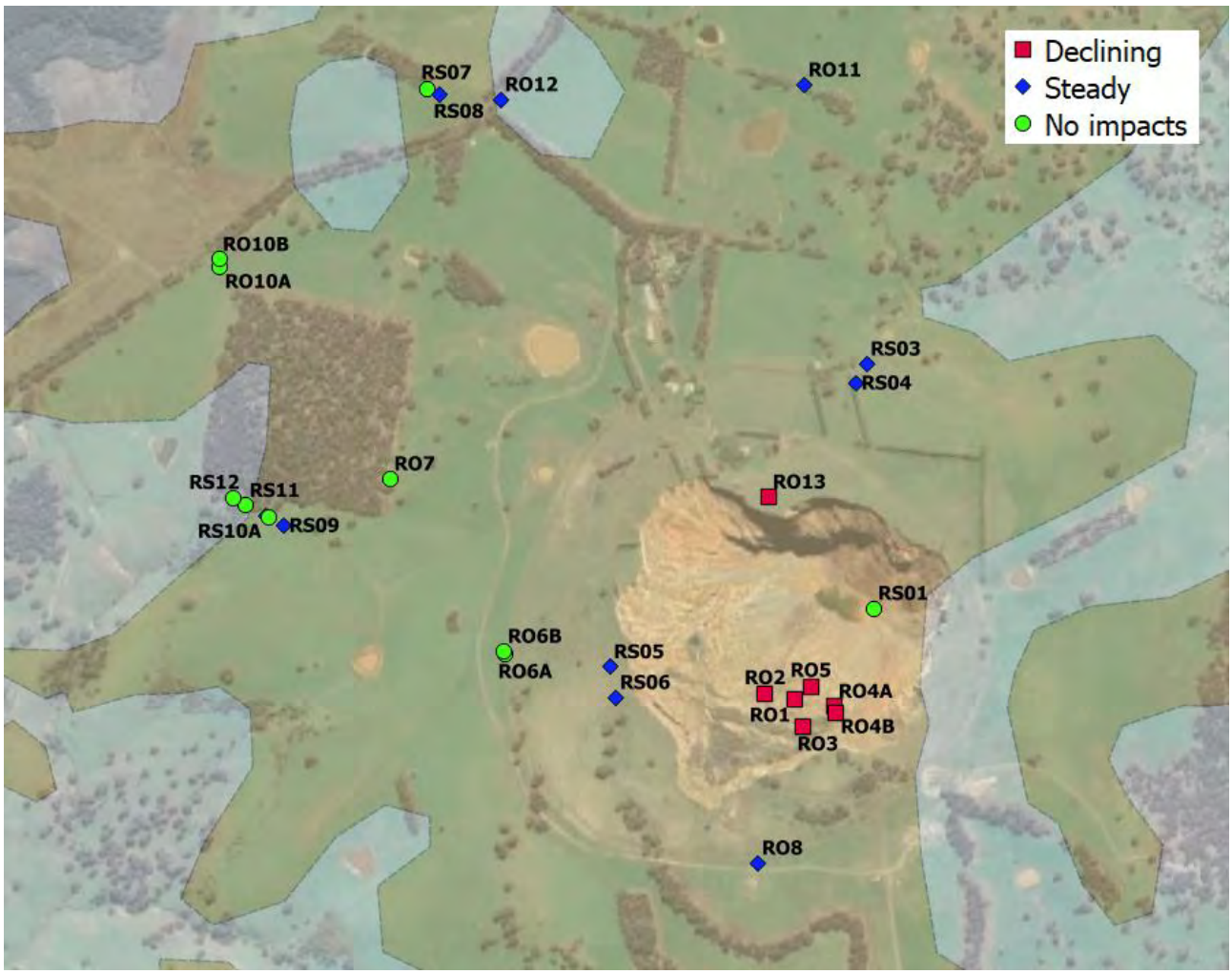


Figure 5.13 The location of Ridgeway bore groups (satellite image in April 2020)

Groundwater levels of ten bores that have distinctive responses to climatic events are shown on time series hydrographs in Figure 5.14. The nearest bores to the subsidence crater that show these responses are MB6A (which is screened in the Ordovician Volcanics to a depth of 18 m), and MB6B (which is screened in the soil and underlying clay to a depth of 7 mbgl). These bores are located 240 m from the edge of the subsidence crater. Bore RS01 is located within the crater and was decommissioned prior to crater development in August 2002.

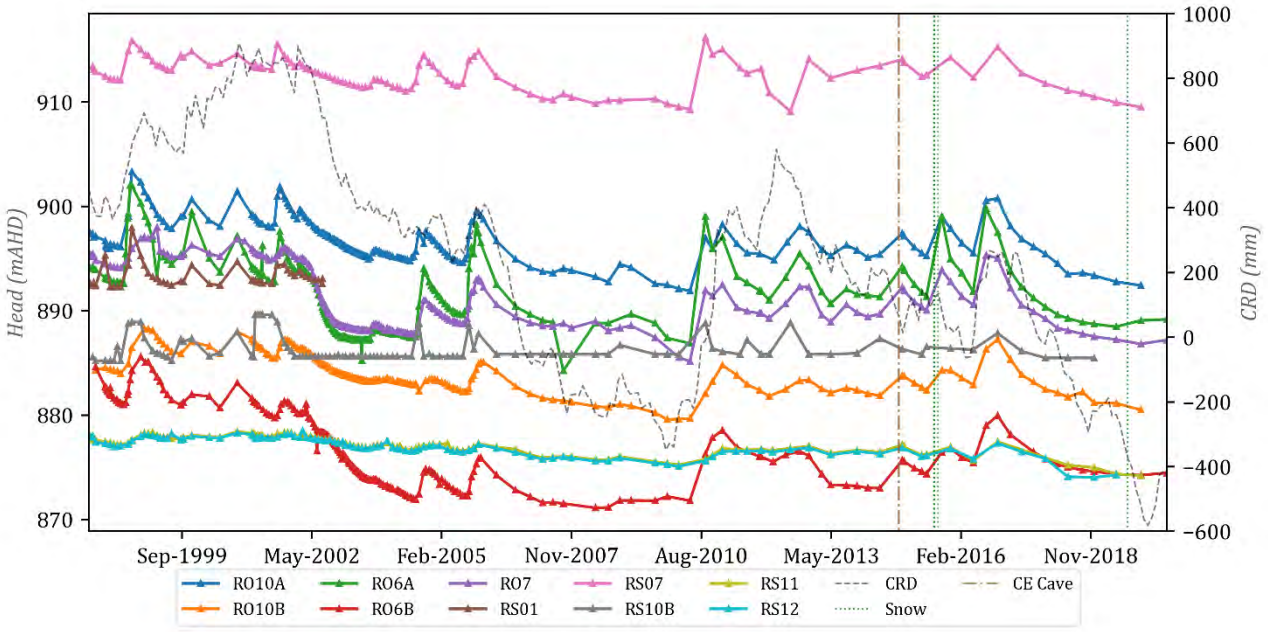


Figure 5.14 Ridgeway bores with characteristic climate responses

A large number of bores show a declining groundwater level trend due to underground mining in the Ridgeway mine before 2003 and are presented as time series hydrographs on Figure 5.15 and Figure 5.16. The declining trend observed from these abandoned bores is apparent in the majority of the bores adjacent to the Ridgeway mine.

Groundwater levels in bores that have shown generally steady levels since surface mining breakthrough in 2002 are presented as time series hydrographs on Figure 5.16. These stabilised levels are lower than pre-Ridgeway mining groundwater levels. Climatic responses are also significantly dampened post Ridgeway mining. This is likely due to an increase in aquifer storage.

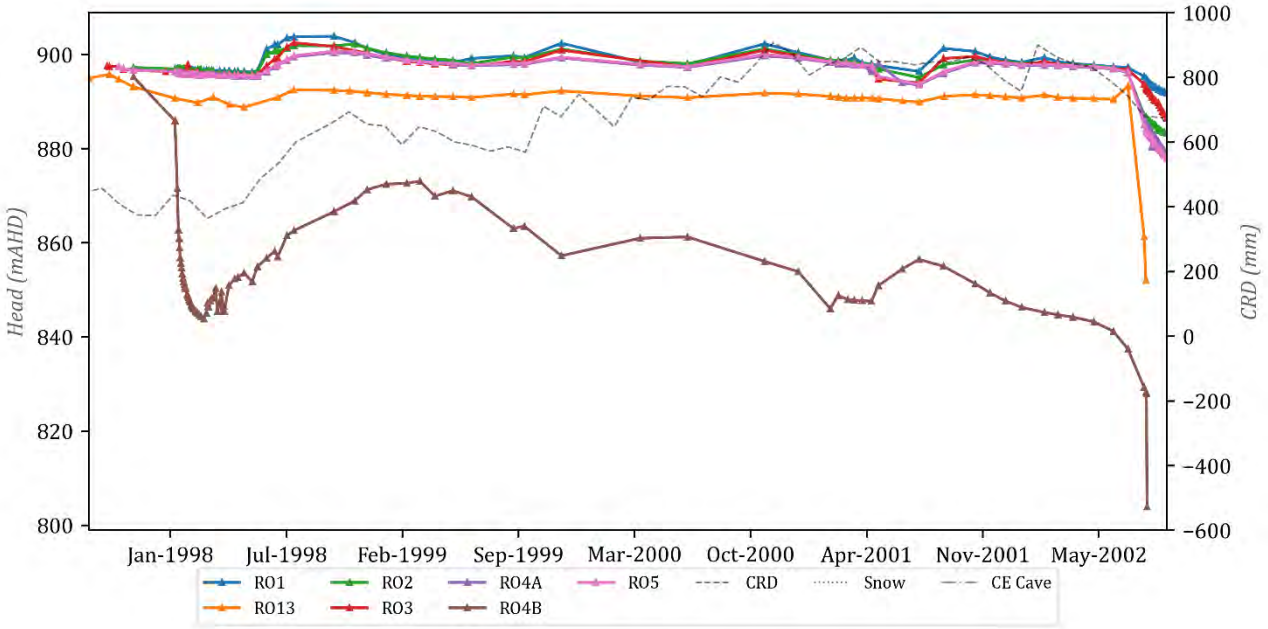


Figure 5.15 Ridgeway bores with declining groundwater levels

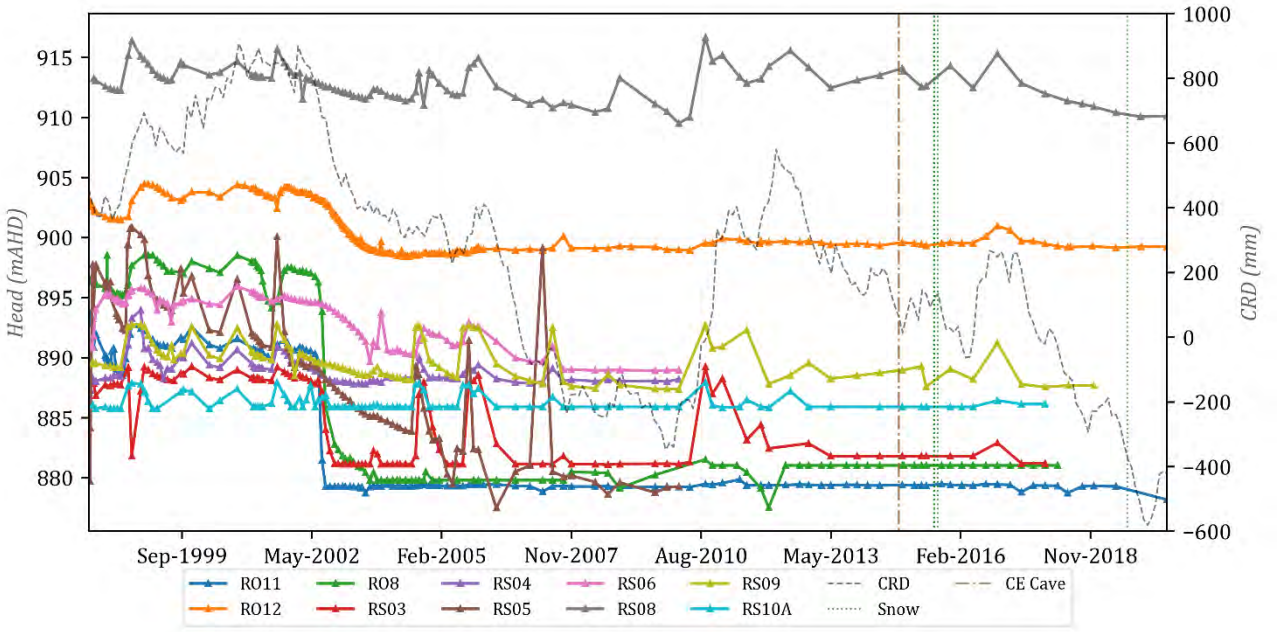
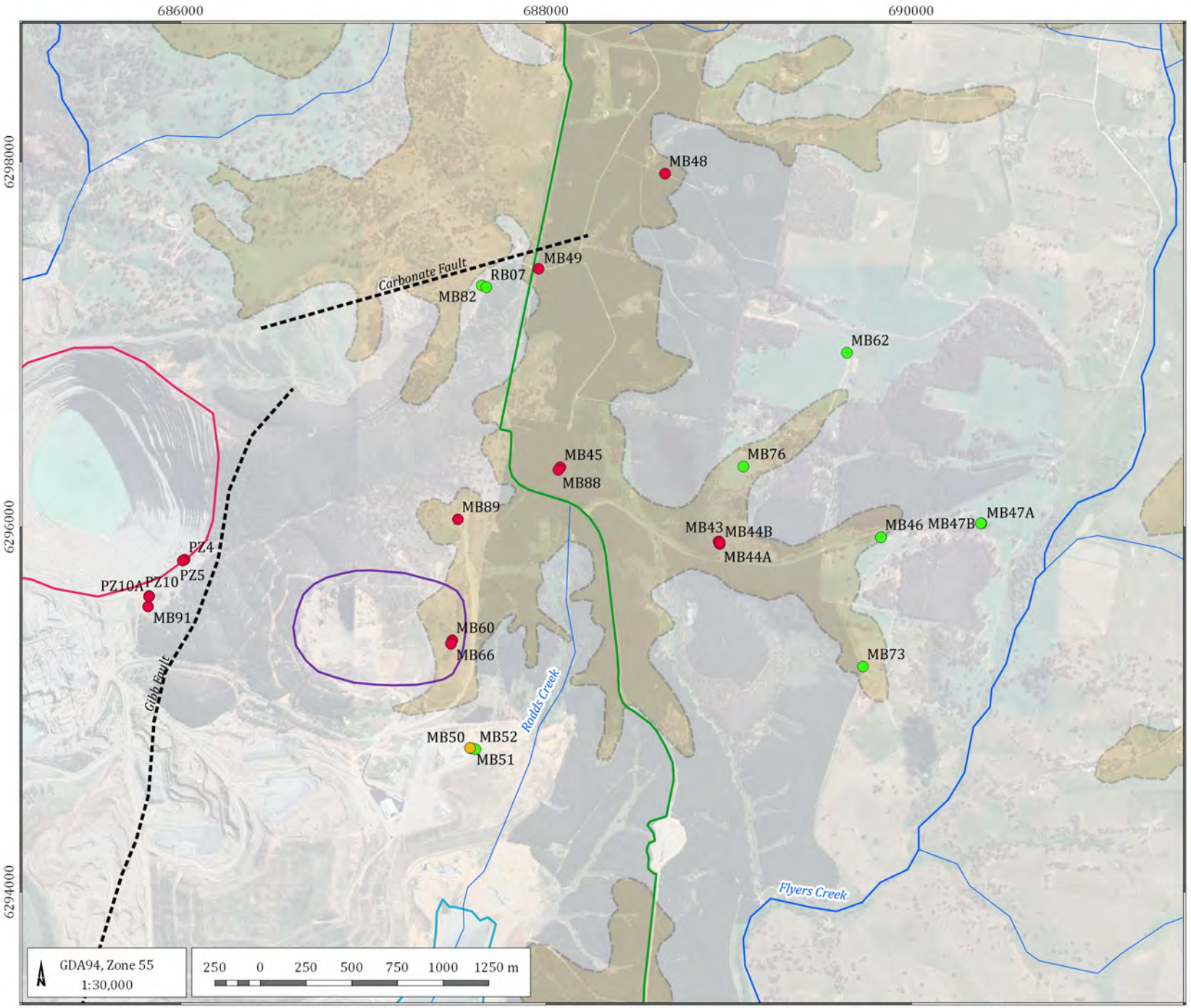


Figure 5.16 Ridgeway bores with declining groundwater levels and post 2003 plateau response

5.13.4 Cadia East Mine

Twenty six bores within 3 km to the north and east of the Cadia East mine were examined for possible impacts from underground mining (Figure 5.17) and have been characterised based on their water level responses:

- "No impact" – bores with no discernible impacts from mining;
- "Declining" – bores with observable impacts from mining; and
- "Rising" – bores with recovering levels, potentially from activities associated with raised bore VR71.



LEGEND

- Mining lease
- Cadia Hill Pit
- Block cave mine subsidence zone
- Rodds Creek dam
- Basalt extent
- Major drainage
- Minor drainage
- Fault

Bore details

- No impacts
- Rising
- Declining

Cadia Model Update (G1383Y)

Location of Cadia East bore groups

DATE
08/04/2021

FIGURE No:
5.17

©2021 Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) - www.ageconsultants.com.au; Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006
G:\Projects\G1383Y.Cadia Mine Model Update\3_GIS\Workspaces\001_Deliverable1\05.17_G1383Y_Location of Cadia East bore groups.qgs

Ten of these bores, which are screened in the Silurian sediments, have trends that show a strong relationship with climatic conditions. Time series hydrographs for these bores are shown on Figure 5.18. All of these bores show a decline in water level for the dry period from early 2017 through to early 2020, although some responses are subdued. It is possible that bores RB07, MB062, and MB82 have been impacted by mining, as evidenced from declining levels.

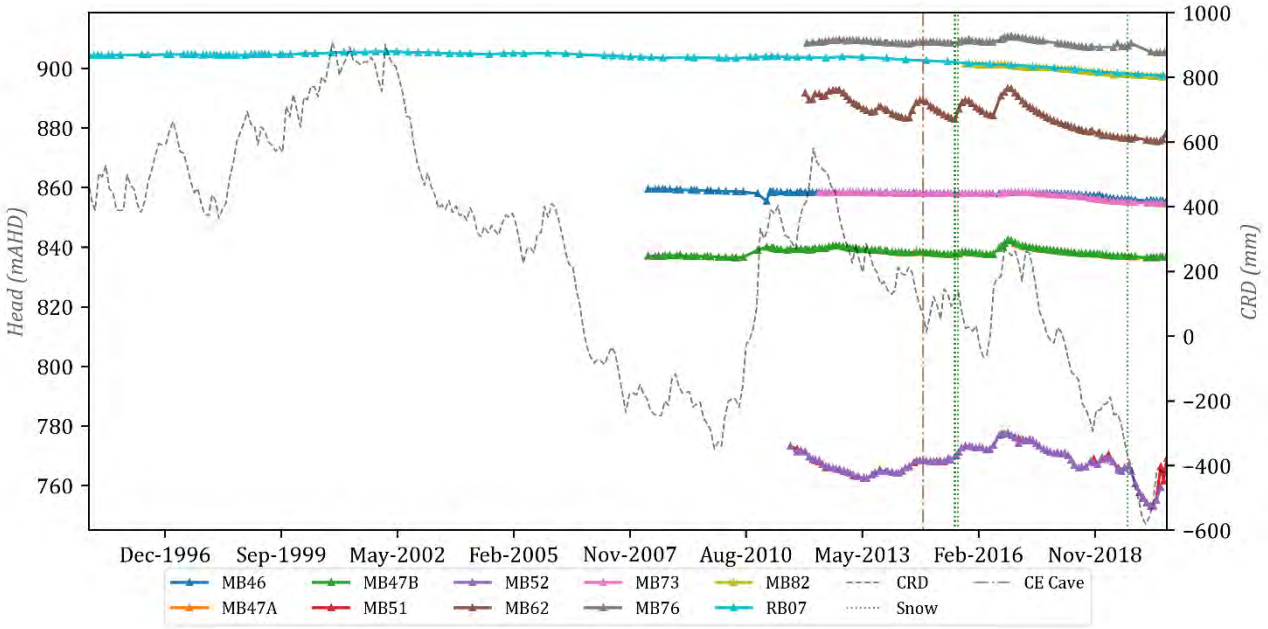


Figure 5.18 Cadia East bores with characteristic climate responses

Bores with long-term groundwater level declines in the Cadia East region have been identified as:

- basalt bores MB43, MB44A, MB44B, MB45, MB49, and MB88, which are located to the north and east of the subsidence crater;
- Silurian sediment bores MB60 (southeast of the subsidence crater) and MB48 (north of the subsidence crater), and potentially bores RB07, MB62, and MB82 (to the north/northeast of the subsidence crater); and
- Ordovician bores MB89 (east of the subsidence crater) and bores PZ4, PZ5, PZ10, P10A, and MB91 (on the edge of Cadia Hill Pit to the west of the subsidence crater).

AGE understands there are four primary factors that may contribute to declining groundwater levels at these bores. These factors may be cumulative and include:

- climatic changes that influence recharge, such as long periods of below average rainfall and potentially increasing evaporation associated with warmer and drier conditions;
- drawdown and depressurisation from the Cadia East mine;
- a reduction in recharge from the establishment of pine plantations in the 1990s and 2009, in the east and northeast (respectively) of Cadia East; and
- groundwater abstraction from bores in the region (particularly through drier periods).

The factors likely contributing to the decline in water levels at these bores is detailed below. The potential influence of groundwater take from regional bores is not well documented and hence not included in Table 5.5.

Table 5.5 Factors contributing to groundwater level decline near Cadia East

Bore	Screened Formation	Factors contributing to groundwater level decline		
		Climate reduced recharge	Cadia East Mine drawdown	Pine Plantation - reduced recharge
MB43	Basalt	Yes	Possibly	-
MB44A	Basalt	Yes	Possibly	-
MB44B	Basalt	Yes	Possibly	-
MB45	Basalt	Yes	Yes	Possibly (minimal)
MB46	Silurian	Yes	Unlikely	-
MB48	Silurian	Yes	-	Possibly (minor)
MB49	Basalt	Yes	-	Possibly (minor)
MB60	Silurian	Yes	Likely	-
MB62	Silurian	Yes	Unlikely	-
MB73	Silurian	Yes	Unlikely	-
MB82	Silurian	Yes	Possibly	-
MB88	Basalt	Yes	Yes	Possibly (minimal)
MB89	Ordovician	-	Yes	-
MB91	Ordovician	Possibly (minor)	Yes	-
PZ4	Ordovician	Possibly (minor)	Yes	-
PZ5	Ordovician	Possibly (minor)	Yes	-
PZ10	Ordovician	Possibly (minor)	Yes	-
PZ10A	Ordovician	Possibly (minor)	Yes	-
RB07	Silurian	Yes	Possibly	-

Based on the responses described above, the extent of the observed drawdown from mining extends approximately 1.3 km to the northeast of the subsidence crater (MB45/MB88) and potentially 2.5 to 3 km to the north of the subsidence crater (RB07/MB82). These declines either propagate through mine induced fracturing, or through faults within the underlying Ordovician/Silurian rocks.

Mapping of faults to the north of the Cadia East workings shows a series of carbonate faults (Cb2 – Cb5), which appear to be of late Devonian Age and related to the Gibb Fault (refer to Figure 5.19). The carbonate faults are dipping to the southwest and intersect the Cadia East workings. These faults strike in a northwest-southeast orientation within the Silurian and Ordovician rocks below the basalt. The deepest of these faults (Cb5) intersects the lower PC2 workings and outcrops in proximity to MB45, extending towards MB43, MB44A, and MB44B (beneath the basalt). All these bores are screened at relatively shallow depths (less than 150 m) in the Ordovician Volcanics. The lower workings commenced in late 2015/early 2016, and clearly corresponds with the groundwater response at bore MB45 (Figure 5.20).

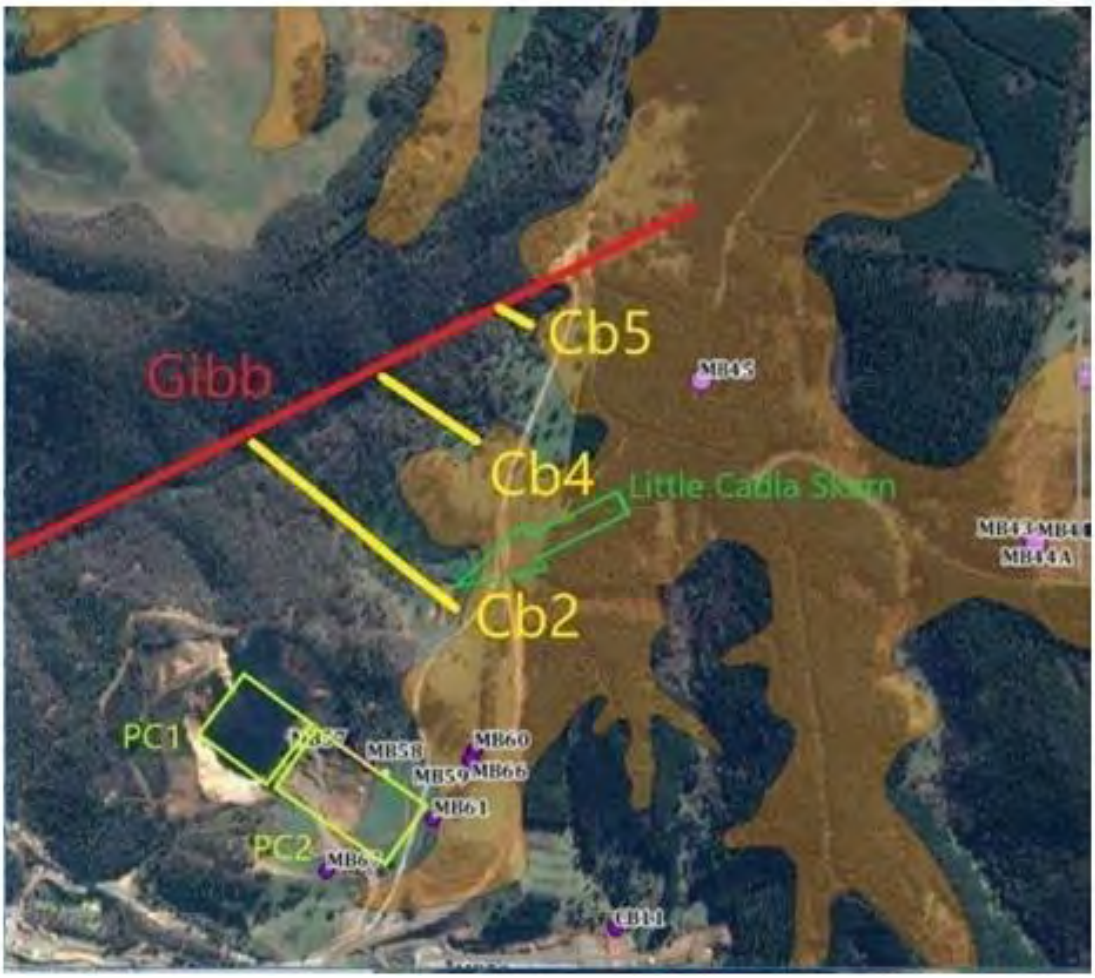


Figure 5.19 Surface outcropping of carbonate faults

Bore MB88 is a replacement bore for MB45, which shows a stabilisation of groundwater levels since January 2019. Stabilisation in groundwater levels in 2020 are also noted in some bores (such as MB48, MB91, and PZ10), which is likely due to the above average rainfall.

Four bores (MB43, MB44A, MB44B and MB60) exhibit a steady groundwater level response, followed by a short rise and subsequent decline (Figure 5.20). The rise in groundwater level occurs during the above average rainfall period in 2016. This is followed by a prominent decline, which is likely to be a cumulative response from mine induced drawdown and below average rainfall from early 2017 through to early 2020. The subdued influence of rainfall recharge is inferred for MB43, MB44A and MB44B, with a slight rise occurring between early 2010 through to early 2012, reflecting above average rainfall conditions.

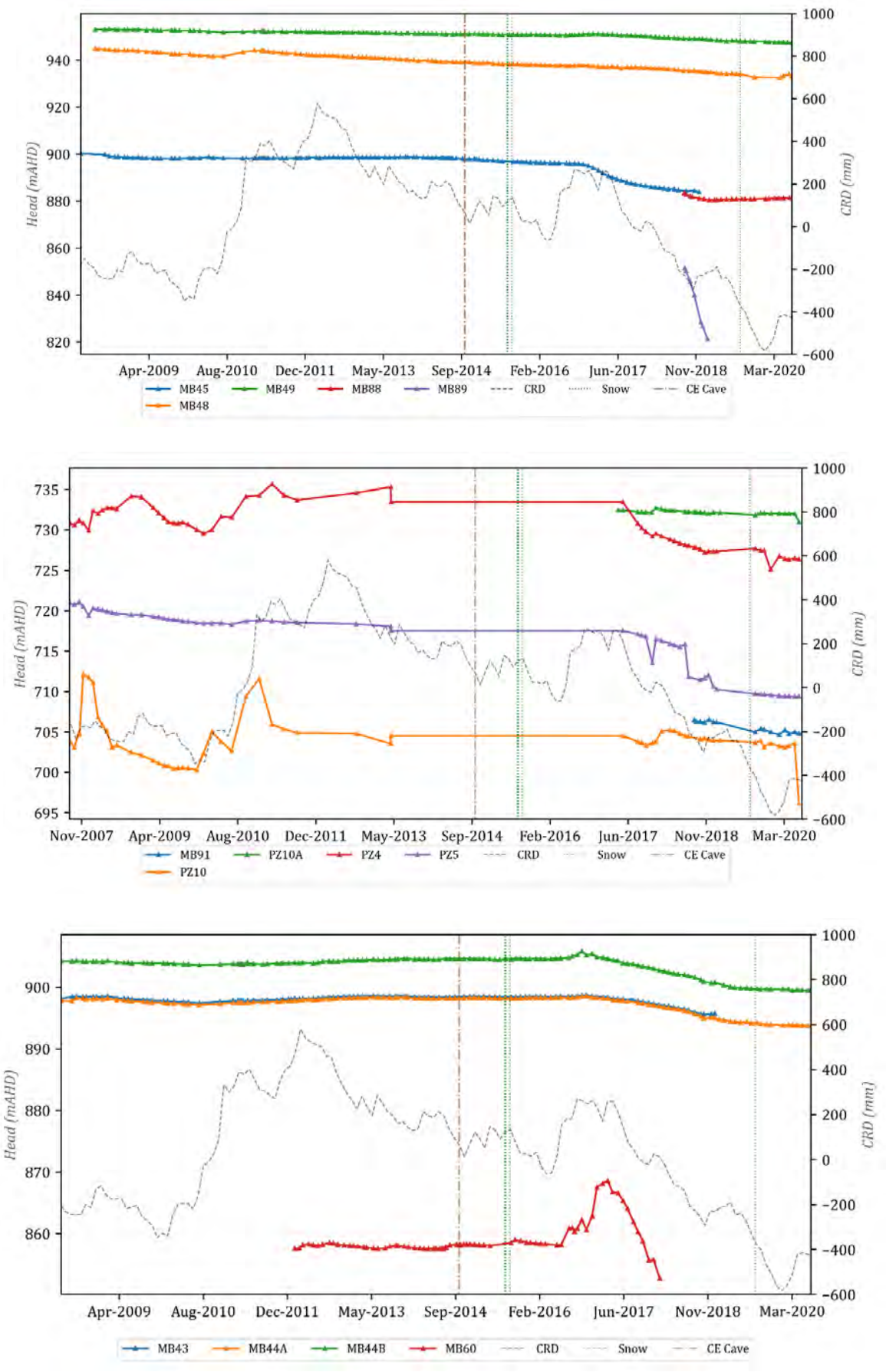


Figure 5.20 Groundwater levels for bores with declining trends near Cadia East

Three bores (MB50, MB51, and MB52) are located in close proximity to each other in Silurian sediments near the raised bore VR81, which is located southeast of the Cadia East subsidence crater. The deepest bore MB50 was drilled to a depth of 217 m and is screened in a basal low permeability limestone unit and the underlying Ordovician Forest Reef Volcanics. The bores MB51 and MB52 are both 56 m in depth and screened in fractured siltstone. The difference in piezometric levels between MB50 and MB51/MB52 is very high, ranging from 120 to 150 m (refer to Figure 5.21). This implies there is no vertical connectivity between the shallow water table and the deeper rock mass. The lower piezometric level in MB50 may be due to the draining of groundwater from a water bearing breccia structure at the contact between the Silurian limestone and the underlying Forest Reef Volcanics during the drilling of raised bore VR71 in early 2011. The subsequent rise that has been observed is likely to be associated with recovery of the groundwater system. The abandoned VR71 raised bore is located 300 m to the west of MB50. There is no long-term decline in groundwater levels, which implies both the deeper bore MB50 and the shallow bores MB51/MB52 have not been impacted by mining.

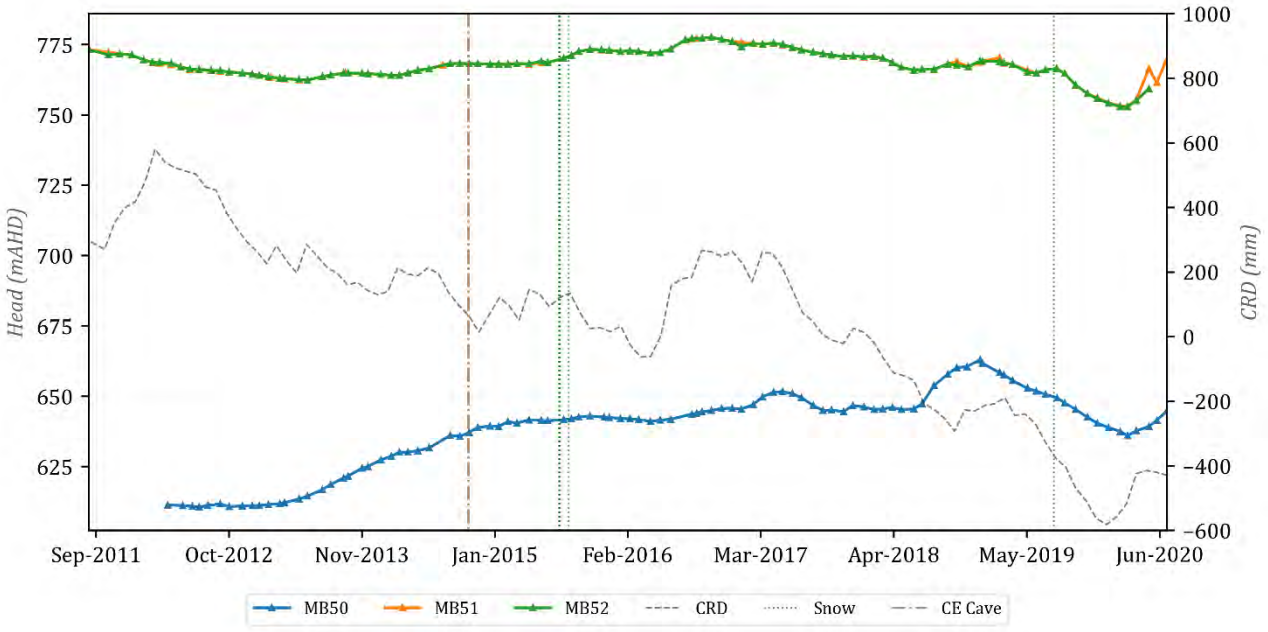


Figure 5.21 Groundwater level for bores near raised bore VR81

5.13.5 Northern Tailings Storage Facility

Tailings deposition in the NTSF commenced in 1998. According to URS (2008), seepage from the NTSF reports to the STSF storage and decant pond; and according to GHD (2018), no seepage has been observed to the west of the NTSF. Twelve bores around the NTSF were examined for possible impacts from TSF operations and have been characterised based on water level response as follows (Figure 5.22):

- "No impact" - bores show no impacts from the NTSF;
- "Rising" - bores suggest impacts from the NTSF; and
- "Steady" - bores shows no changes to groundwater levels from climate or NTSF operations.

Three bores located to the west of the NTSF (MB18, MB23, and MB24) show a gradual rise in groundwater levels over time, which is considered to be influenced by NTSF operations. The rise in groundwater level ranges from about 7 m at MB18 to 11 m at MB23 for the period from 2000 through to late 2016/early 2017 (Figure 5.23). This rise in groundwater levels is likely associated with compression of the groundwater system by the stored tailings in the TSFs (GHD, 2018; KCB, 2019). Groundwater levels in bores located south of NTSF within the STSF footprint (MB15, MB16A, and MB16B) show similar rising trends as MB18, MB23 and MB24. This may be associated with compression of the groundwater system from stored NTSF tailings. These bores were decommissioned due to STSF construction between 2002 and 2004.

Groundwater levels in bores located on the eastern side of the NTSF (MB20, MB21, MB68, MB70, and MB80) suggest climatic influences only. Groundwater levels in bore MB17, which is located north of the NTSF, shows no changes during the monitored period and no significant response to rainfall. The groundwater levels of these bores are presented as time-series hydrograph on Figure 5.24.

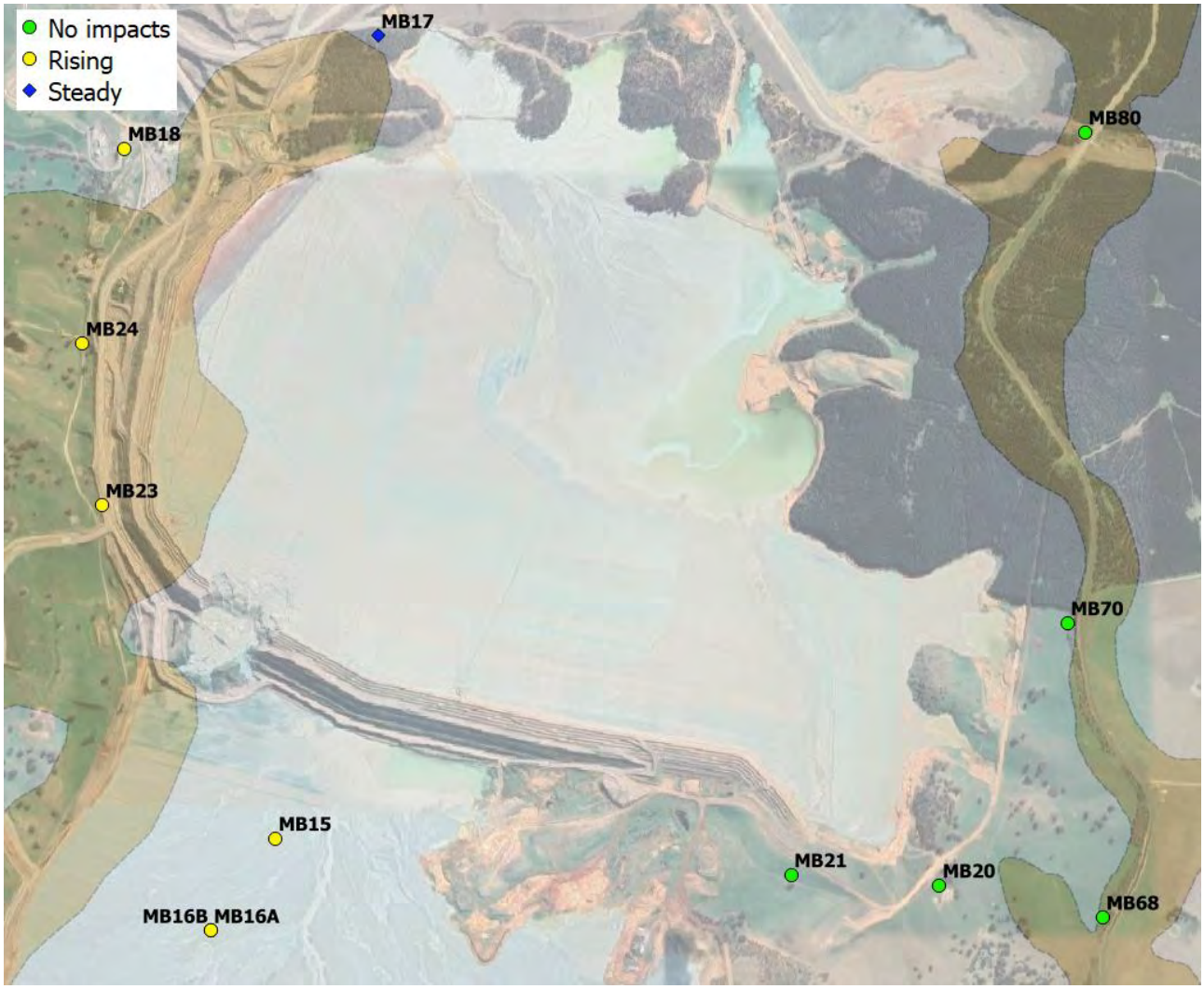


Figure 5.22 Location of NTSF bore groups

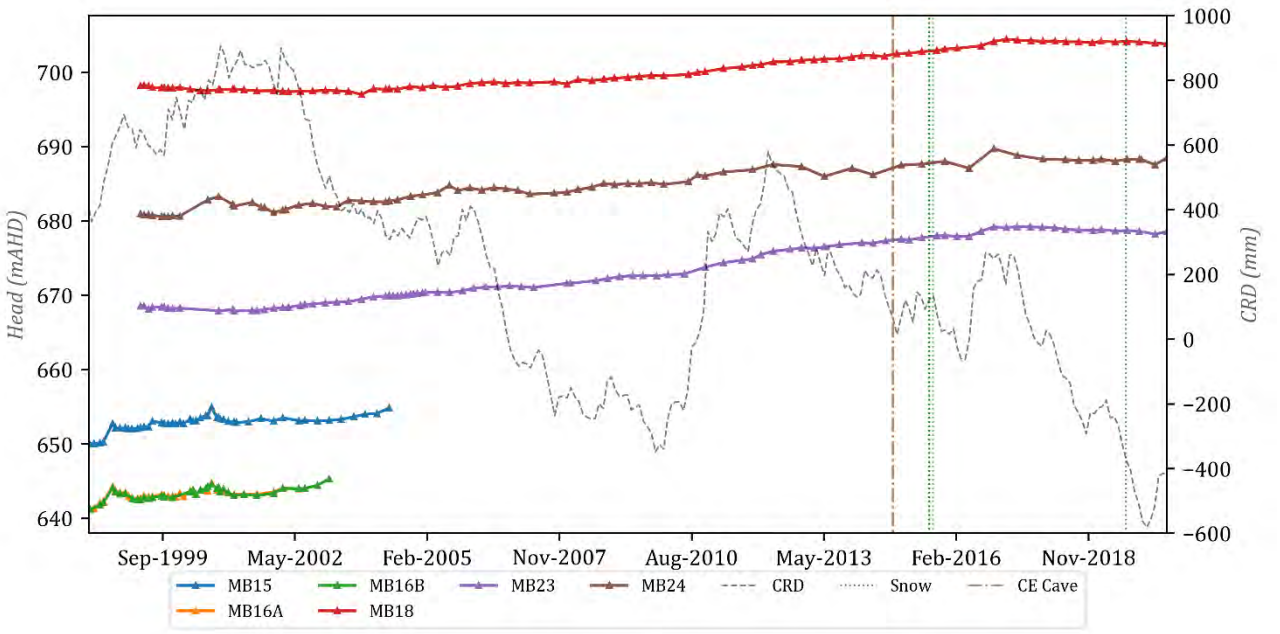


Figure 5.23 Groundwater level for bores with rising trend west and south of NTSF

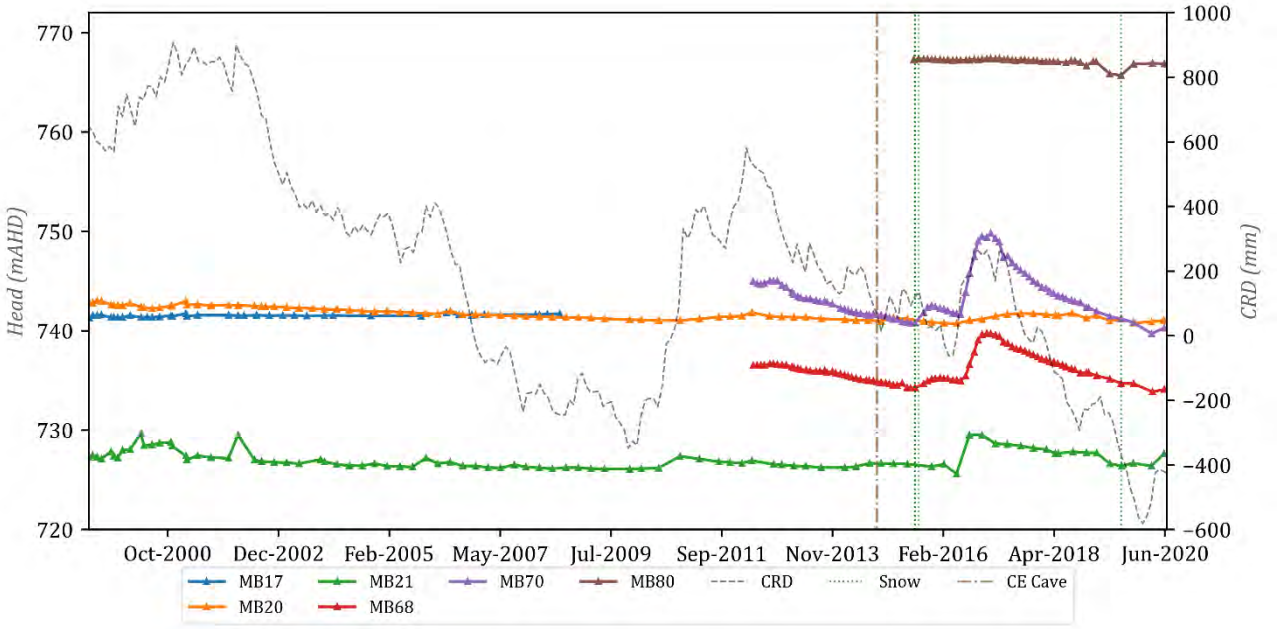


Figure 5.24 Groundwater levels showing climatic changes or steady groundwater levels in vicinity of NTSF

5.13.6 Southern Tailings Storage Facility

Tailings deposition in the STSF commenced in 2002. Monitoring bores around the STSF were examined for possible impacts from TSF operations and have been grouped by an assessment of their water level responses as follows (Figure 5.25):

- "No impact" – bores which shows no impacts from the STSF;
- "Rising" – bores which suggest impacts from the STSF;
- "Fluctuating" – bores which exhibit rising and declining trends; and
- "Steady" – bores with no significant changes to groundwater level.

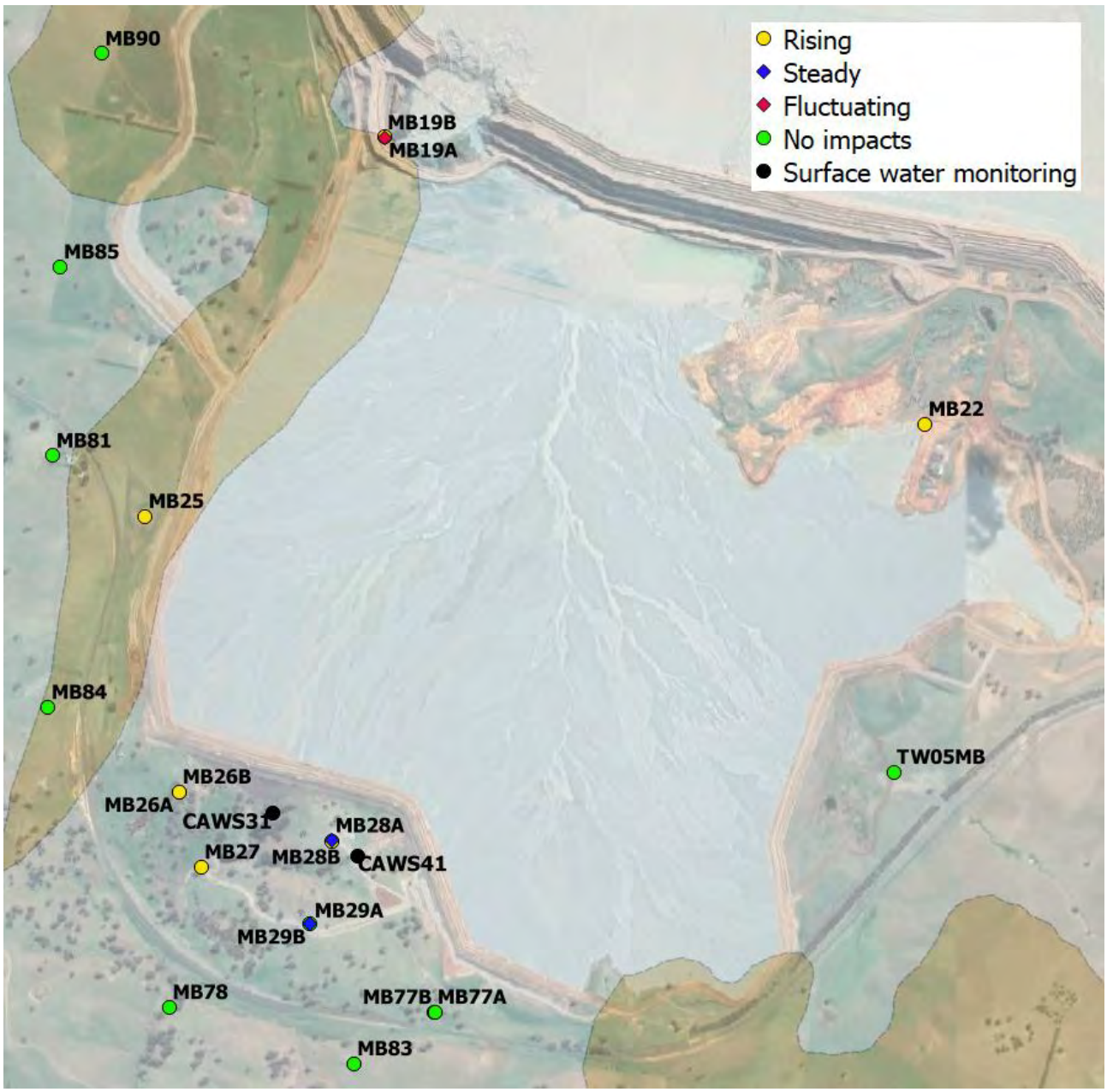


Figure 5.25 Location of STSF bore groups

Groundwater levels in bores showing rising trends (MB19A, MB22, MB25, MB26A, MB26B, MB27, and MB28B) are assumed to have been influenced by the STSF and are shown as time series hydrographs on Figure 5.26. There is no correlation of these long-term rising trends with the CRD, although over shorter timeframes, there are responses (rises) at some bores, associated with above average rainfall. Monitoring data from bore MB19A shows a significant increase in water level (approximately 16 m) between mid 1999 to early 2000, which may have occurred due to seepage of ponded water in the area. This rise occurred prior to the STSF being used for the deposition of tailings. With the exception of MB19A, the long-term rise in groundwater levels in the other bores ranged from 1.7 m in MB28B to 15 m in MB26B. Groundwater levels in these bores (with the exception of MB26A) have declined slightly from early 2017 to mid 2020. This may be associated with the below average rainfall during this period. Groundwater levels measured in bore MB27 have continued to rise during this same period.

Previous studies by GHD (2018) have identified only a single monitoring bore (MB27) that shows an increasing dominance of sulphate over time, which may be attributed to seepage from the TSF. Bore MB27 is screened in residual soil and andesite (Ordovician Forest Reef Volcanics) and is located approximately 270 m south of the STSF embankment toe, downgradient from the seepage collection pond along Rodds Creek. The long-term rising trends in groundwater level in the other bores are likely attributable to the compression of the groundwater system beneath the TSFs due to the bulk mass of tailings.

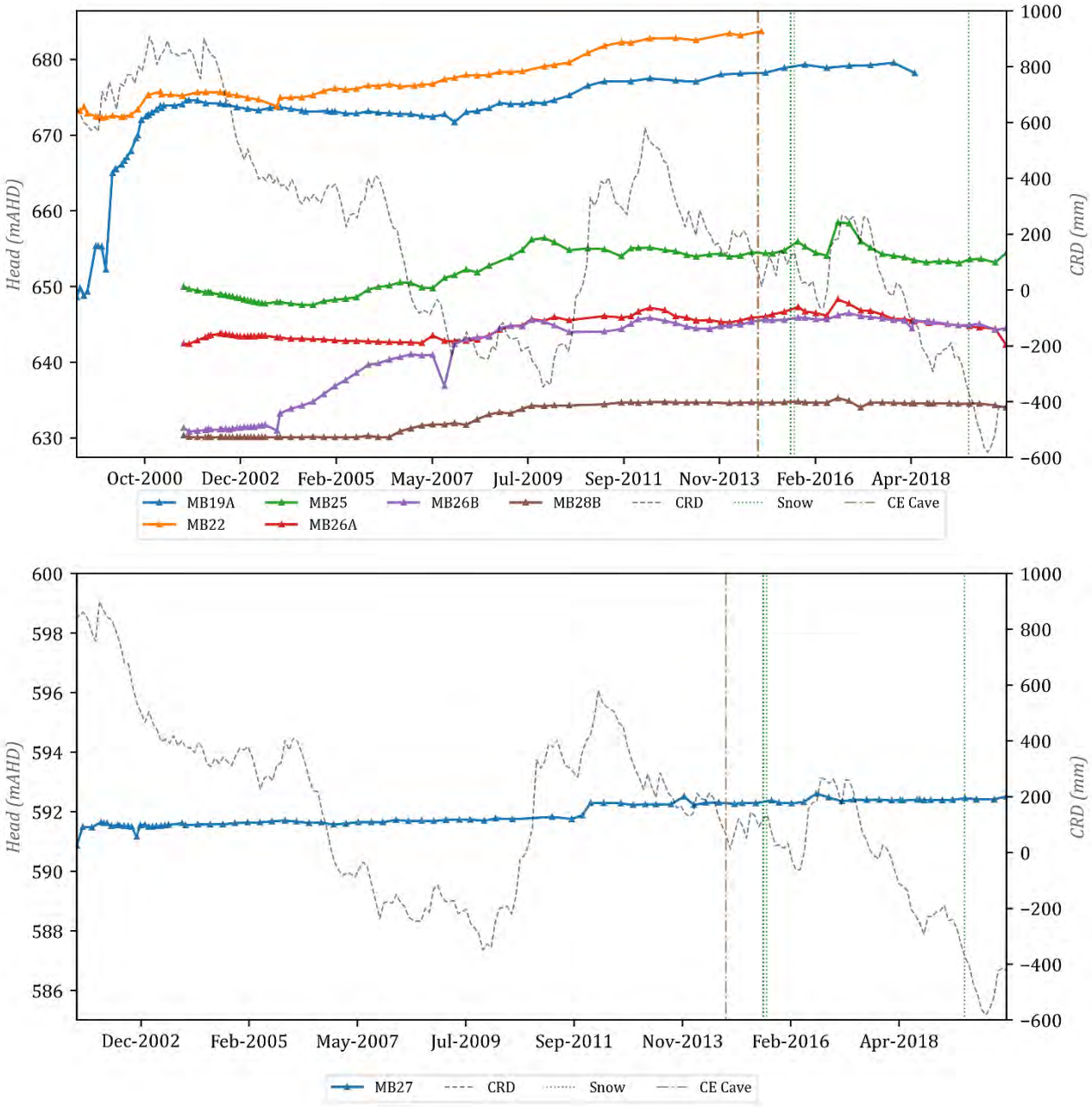


Figure 5.26 Groundwater level for bores with rising trend near STSF

Monitoring bores MB28A and MB29A have recorded a generally steady groundwater level, with no clear influence from the STSF or response to climate conditions (Figure 5.27). Data collected from bore MB29A exhibits 2 m amplitude fluctuations between 2001 to November 2003, possibly from early construction works. These bores are located to the south of the STSF in relatively shallow Ordovician Volcanic bores and have been drilled to approximately 11 m depth.

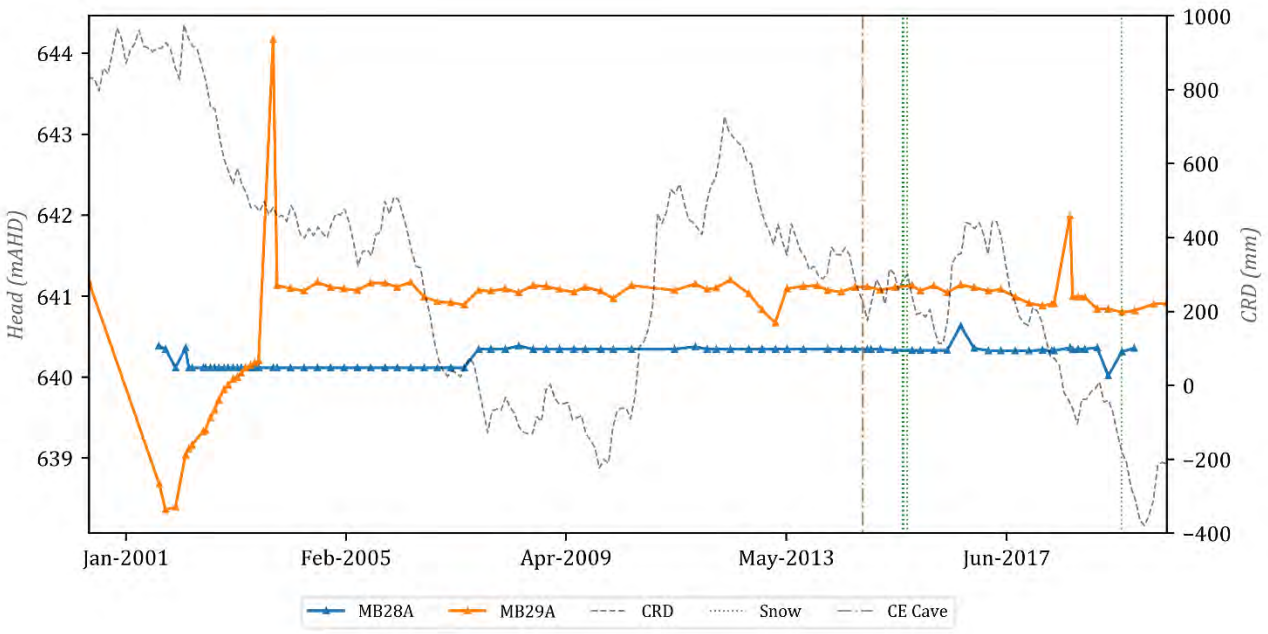


Figure 5.27 Steady groundwater levels at MB28A & MB29A (located south of STSF)

The groundwater level in bore MB19B, which is located to the south of NTSF (Figure 5.28) shows continuous fluctuations from 1999 to the last record in May 2018 before the bore was abandoned. This bore is relatively shallow (7.6 m in depth) and was installed within soil and weathered profile. The groundwater level at this location is likely to be influenced by surface water ponding nearby.

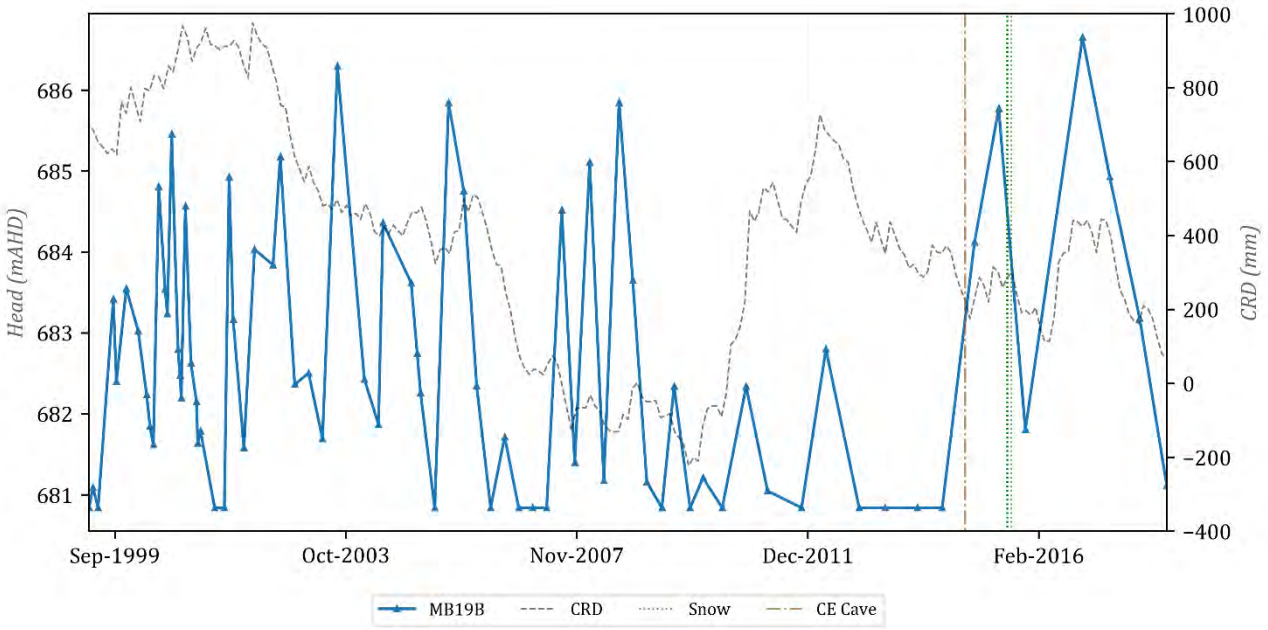


Figure 5.28 Groundwater level for MB19B located north of STSF

5.13.7 Water supply bores

Groundwater is intermittently pumped from water supply bores along Cadiangullong Creek. Groundwater levels in eight bores along Cadiangullong Creek (CB1, CB3, CB5, CB6A, CBA, CB8B, CB14A, and CB14B) have been impacted from abstraction, showing periods of significant decline during pumping, and significant recovery when the pumps are not in operation. The location of these bores are shown on Figure 5.29 and the groundwater levels from these bores are presented as time series hydrographs on Figure 5.30.

Four bores installed in the backfilled void of the extended pit were pumped during two campaigns (lasting for some months) in 2019 and 2020. Impacts on monitoring bore groundwater levels near the extended pit are discussed in Section 5.13.2.

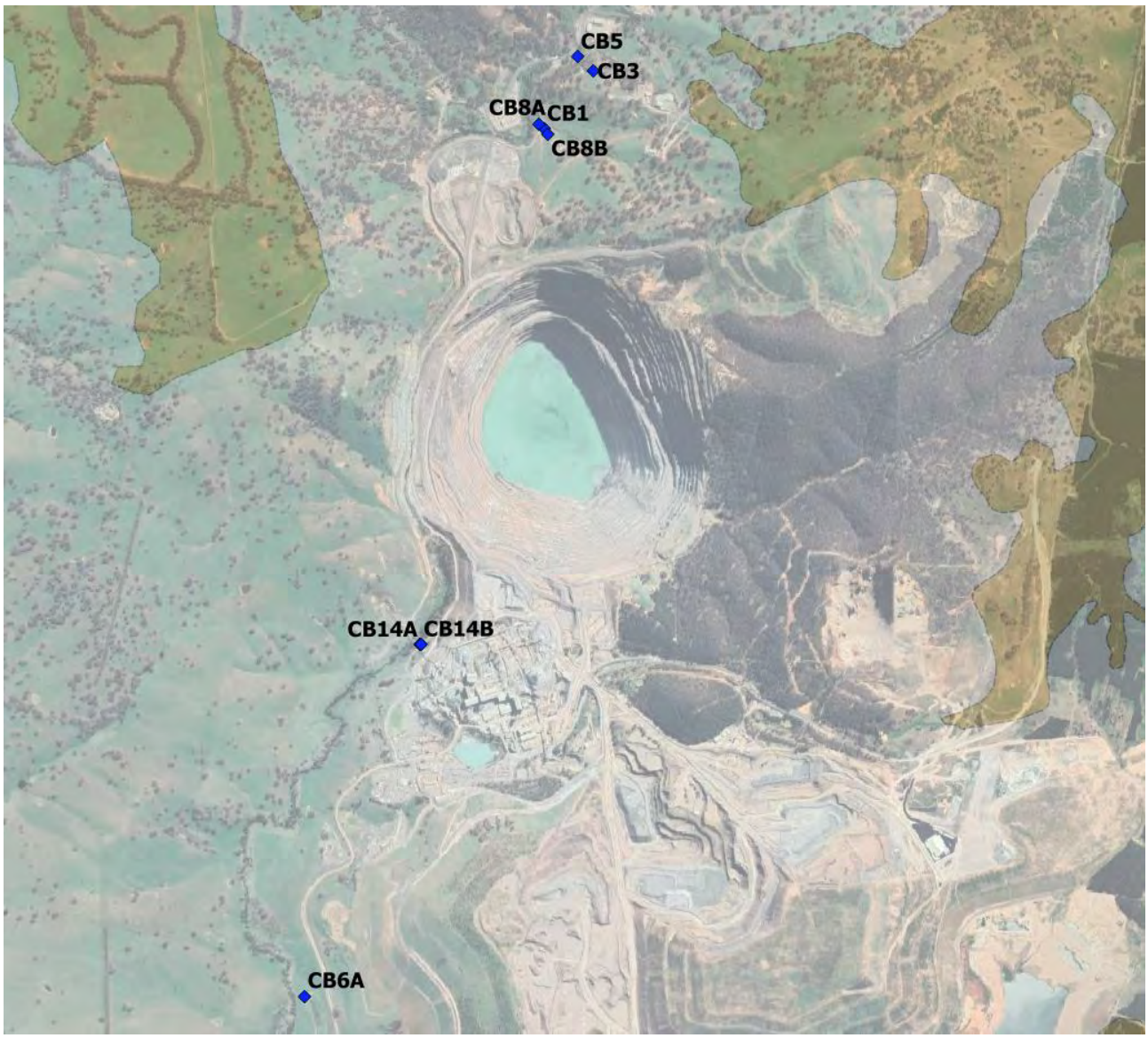


Figure 5.29 The location of bores affected by water supply bores

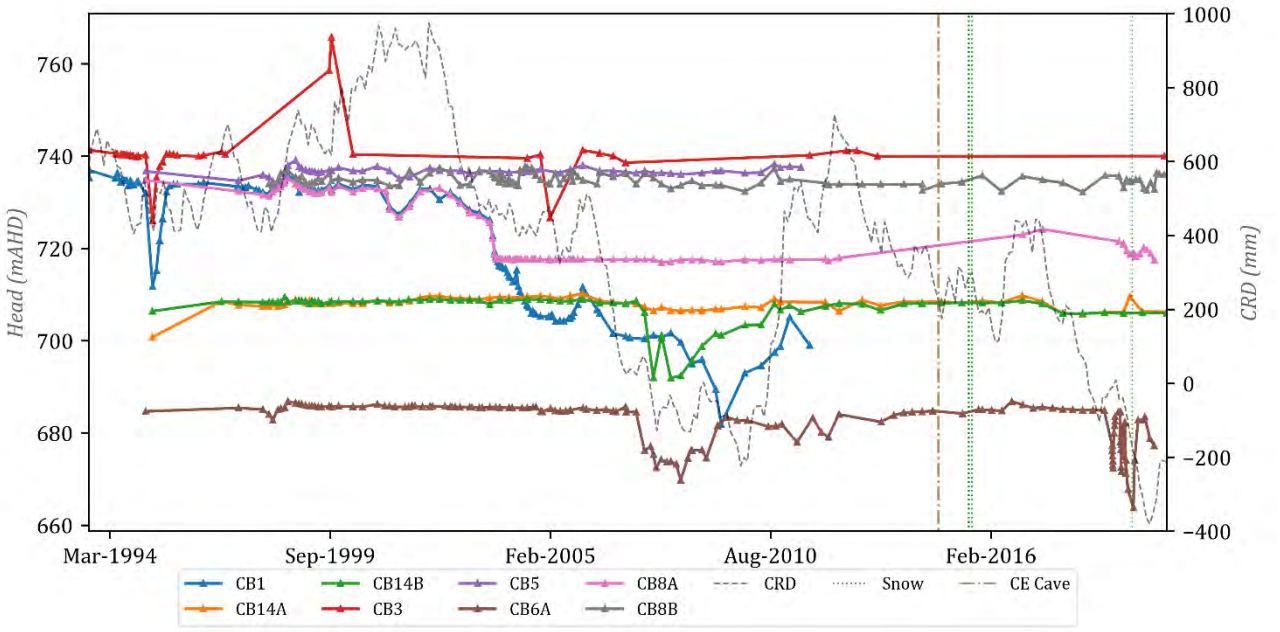


Figure 5.30 Groundwater level for bores near water supply bores

5.13.8 Pine plantation impacts

To assess if a likely reduction in recharge beneath pine plantations (see Section 5.7) has a noticeable impact on declining groundwater levels, trends in selected bores were compared to the plantation sequencing. As discussed in Section 3.3.2, historical aerial imagery shows that pine plantations to the east of CVO became well established by 2000 in the southern area and 2009 in the northern area. The trends of groundwater levels in monitoring bores in the pine plantations located north and east of the Cadia East mine are discussed in Section 5.13.4. The trends indicate that other factors (below average rainfall periods or drawdown from mining) influence declining levels to a greater degree than from an altered recharge regime from the pine tree cover. The groundwater level trends are largely overprinted by these other factors and the impact from the pine plantations on recharge is considered to be minimal. Furthermore, a large proportion of the groundwater recharge to the aquifers will occur from outside the pine plantations, particularly hydraulically upgradient (to the north) where there is direct recharge into the outcropping rock.

Groundwater levels for the northern Tertiary basalt bore MB48 and Silurian sediment bore MB49 are first observed in April 2008, which appears to correspond with the timing of pine trees first being planted in this area. Although levels in these bores respectively decline by approximately 6 m and 2 m between April 2008 and October 2014 (when the Cadia East cave zone broke through at the land surface), there is no clear evidence linking these declines to pine plantations as opposed to declines representing typical climatic variations. Groundwater level observations from bores in the southern pine plantation area were not collected as far back as 2000, and therefore it is not possible to infer any impacts from the southern pine plantations.

5.14 Previous seepage investigations of the NSTSF and STSF

The deposition of tailings in the NTSF and STSF commenced in 1998 and 2002 respectively. Groundwater seepage was noted in the NTSF footprint prior to construction (Woodward & Clyde, 1995) and in the STSF footprint prior to construction (Ridgeway EIS, 2000). Seepage occurred during sustained wet periods at locations where shallow fractured rock was exposed, and also within cover soils.

Kalf & Associates (2000) hydraulic testing of the Rodds Creek catchment (including within the STSF footprint) identified that the bulk of the underlying basement rock has low permeability, which decreases with depth. The low permeability characteristics of the rock restricts vertical infiltration, which leads to the occurrence of surface seepage (Ridgeway EIS, 2000).

Various modelled assessments for seepage from the STSF and the NTSF have been completed, with their results summarised in Table 5.6.

Table 5.6 NTSF & STSF Seepage assessment results

Facility	Investigation	Seepage rate	Comments
NTSF	Cadia Hill EIS (1997)	0.5 ML/d	Flux through starter embankment. Considered low for a large tailings dam
STSF	Kalf and Associates (2000)	0.36 ML/d * (short term) and 0.46 ML/d (long term)	Flux under core of the embankment assumed 4550 m length using 2D SeepW
STSF/NTSF	AGE (2009) Cadia East EIS	NTSF = 1.24ML/d STSF = 0.68 ML/d	Extrapolation of Kalf and Associates results based on approved crest elevation of 779 m RL for NTSF and 702 m RL for STSF and embankment lengths of 4550 (NTSF) and 4100 m (STSF)
STSF/NTSF	AGE (2009) Cadia East EIS	NTSF = 1.01 ML/d STSF = 0.36 ML/d	MODFLOW SURFACT 3D groundwater model using approved crest elevation of 779 m RL for NTSF and 702 m RL for STSF and embankment lengths of 4550 (NTSF) and 4100 m (STSF)
STSF/NTSF	AGE (2016) Model update	NTSF = 1.1 ML/d STSF = 0.25 ML/d	MODFLOW USG 3D model. Main difference from 2009 model is climate variability
NTSF	KCB (2019) ITRB report	0.098 ML/d	3D FEFLOW groundwater model simulated seepage conditions in 2018 under steady state conditions. Transient conditions provided seepage rates from drainage collection varying between 0.058 to 0.14 ML/d. Steady state model calibrated to VWP pore pressure data, CPT_U pressure gradients and drain flow. Transient conditions over 3 month period from January to March 2018 using recharge and pond level data. These results are for the drainage collection system and not overall seepage from the TSF footprint.

Notes: ** - Short term – 12 m tails thickness; long term – 71 m tails thickness.*

GHD (2018) conducted an assessment of leakage through the base of the TSF under the decant pond using the SeepW software. GHD adopted similar hydraulic parameters to Kalf and Associates (2000) in their leakage assessment. The GHD (2018) results indicated leakage typically between 0.02 – 0.03 ML/d. This is approximately 10% of the seepage rate predicted by AGE (2016), which estimated a seepage rate of 0.25 ML/d. GHD included an increase in tailings thickness of up to 20 m below the decant pond, which provided a conservative increase in seepage, but not exceeding 0.05 ML/d.

5.15 Groundwater quality and influences of tailings surface storages

5.15.1 In-pit tailings deposition

The open cut pit will remain a groundwater sink, with groundwater flow occurring towards the void until tailings slurry deposition reaches an approved elevation of 713 mAHD (Mod13 approval). This level occurs above the invert of Cadiangullong Creek, which is approximately 10 m below the Cadiangullong Creek diversion inlet (707 mAHD) on the southern side of the pit. It is lower than the invert on the northern side of the pit, which occurs at 725 mAHD. There is a risk that groundwater flow originating from the deposition of tailings may move through transmissive fractures and geological structure into Cadiangullong Creek. There are several monitoring bores that have been recently installed, that will be used to provide early warning of potential seepage towards Cadiangullong Creek.

August and November 2018 monitoring results (AGE, 2019) from water quality sampling in the pit lake which has formed over the deposited tailings, indicates the pit water is slightly brackish. Electrical conductivity (EC) measurements ranged between 2,100 to 2,600 uS/cm and were weakly alkaline (pH of 7.3 to 7.6). Results also indicate elevated concentrations of sulphate (908 to 966 mg/L) and molybdenum (0.3 to 0.4 mg/L), relative to groundwater sampled from adjacent pit bores prior to tailings deposition (PZ4/PZ5). Groundwater quality sampled from these bores can be characterised as low salinity, neutral to slightly acidic, with sulphate concentrations of 5 to 19 mg/L and a molybdenum concentration of less than 0.01 mg/L.

Geotechnical investigations (Mod13) have indicated the Cadia East subsidence zone will not extend to the Cadia Hill open pit. Golder (2018) conducted an assessment of tailings consolidation and concluded it will slowly settle to 563 mAHD in the middle of the Cadia Hill pit after approximately 100 years post closure. This means that after about six to seven years the level of the tailings will fall below 700 mAHD and a lake will form over the settled tailings. HEC (2019) completed a water balance model which indicated that the water level will stabilise and fluctuate between 687 mAHD and 699 mAHD, averaging about 694 mAHD. This suggests that post tailings deposition, the potential for groundwater flow or seepage towards Cadiangullong Creek will be reduced, as the surface level of the lake will become lower than the Cadiangullong Creek invert to the south of the pit. The final pit lake is expected to become a groundwater sink, as surrounding groundwater levels will be higher than the pit floor, based on existing monitoring data to the east of the pit, and modelled groundwater levels in the vicinity of Cadiangullong Creek.

5.15.2 North and south tailings storage facilities

The NTSF and STSF are located within the Rodds Creek catchment. According to GHD (2018) a greater proportion of seepage is likely to occur through the foundation of the STSF, rather than through the foundation of the NTSF. One reason for greater seepage occurring at the STSF is due to the clay seal blanket foundation only partially covering the Rodds Creek channel, approximately 160 m upstream of the STSF embankment. Conversely, the clay blanket constructed a the NTSF covers the entire Rodds Creek channel beneath the NTSF.

The TSFs have the following design elements to control seepage into foundations and through embankments:

- clay blanket seal of Rodds Creek beneath the TSFs, although only partially sealed beneath the STSF;
- underdrainage system beneath the TSFs that assist the control of seepage into the underlying foundation soil/rock and for consolidation of the tailings; and
- a low permeability clay core zone within the embankment to retard seepage through the embankment wall.

The underdrains consist of a gravel-filled drainage trench, constructed perpendicularly to the dam alignment. A submersible pump is used at each location to transfer drainage flows to the storage area.

Seepage rates are monitored in the vicinity of surface monitoring site CAWS31, which is located at the toe of the main STSF embankment. Seepage rates are also monitored in the vicinity of surface monitoring site CAWS41, which is located at a saddle dam, some 400 m to the east of the main seepage collection dam (refer to Figure 5.25). The combined seepage rates reported for these sites (2012 to 2016) have ranged being 167 L/min to 200 L/min.

GHD (2018) characterise the TSF decant water as sodium/potassium – sulphate type, while background groundwater is generally more calcium-magnesium and bicarbonate dominant. The main correlation indicator used by GHD (2018) for determining seepage from tailings decant water is an increasing trend in sulphate concentration in groundwater.

GHD (2018) have identified only one monitoring bore (MB27) that shows an increasing dominance of sulphate over time, which may be attributed to seepage from the TSF. This bore is located approximately 270 m south of the STSF embankment toe and is located downgradient from the seepage collection pond along Rodds Creek. GHD estimated that the groundwater chemistry at bore MB27 has a composition of approximately 20% TSF water and 80% groundwater, based on geochemical modelling. GHD also provided some evidence of tailings decant water influencing water quality results in monitoring bores MB77A and MB77B, which are located near the boundary road south of the STSF. GHD also reported an increase in sulphate dominance at MB24 and MB25 to the west of the TSFs over time, although sulphate in groundwater is naturally elevated throughout this area and it is difficult to pinpoint if the source is from seepage.

Other bores with identified groundwater level rises to the west (MB18, MB19A and MB23) and to the south (MB26A, MB26B and MB28B) of the TSFs do not show comparable increasing concentrations of sulphate. As previously discussed in Sections 5.13.5 and 5.13.6, these rising groundwater levels are likely attributed to compression of the groundwater system beneath the TSFs due to the loading of tailings bulk mass.

GHD (2018) have examined a number of groundwater seepage sites (CAWS30, CAWS31, CAWS41, CAWS55 and 14111004JB) located to the south of the STSF where the topography decreases sharply along the gullies of Rodds Creek and its tributaries. Results do not clearly determine the provenance of this seepage.

According to GHD (2018), conceptually the seepage from the TSFs is most likely to remain within the Quaternary alluvial soils and shallow weathered rock. In this scenario water would move laterally within the shallow strata rather than infiltrate vertically into the low permeability basement rock. Therefore, any seepage to the surface is likely to be localised and occur at shallow depths within the Rodds Creek catchment, rather than migrate within the deeper groundwater system at large distances from the TSFs.

5.16 Groundwater dependant assets

5.16.1 Private groundwater bore users

There are 258 private bores within the groundwater model domain (Figure 5.31), with the locations of these bores determined through findings of the 2007 bore census, in addition to publicly available data held by WaterNSW. NSW government datasets were used for constraining bore locations where installations post-dated the bore census, or for bores outside of the census investigation area. The licenced purpose for identified groundwater bores fell into the following categories: water supply, stock and domestic, irrigation, or commercial and industrial. The majority of the identified bores have been installed into the Tertiary basalt, which is known to be productive in part.

As part of the 2007 bore census, detailed information for 93 bores were reported, with collected information including measured water level, bore age, construction details, bore yields, and water usage. The inspected bores ranged in construction, from hand dug shallow wells, up to 120 m deep cased boreholes. Reported bore yields ranged from a very low supply of 0.08 L/s to high yields of up to approximately 33 L/s. A median yield of approximately 0.9 L/s has been calculated for all bores visited in the census, with a recorded bore yield. The dominant use of bores with low to moderate yields was for stock watering and domestic purposes. On smaller parcels of land, the bores were typically used for irrigation of gardens.

Large-scale irrigation of crops in the area (of the bore census) is restricted to a small number of properties that have bores with relatively high yields. The variability in bore yields is commensurate with the AGE conceptual hydrogeological model, which acknowledges the range in measured permeability of the Tertiary basalts.

5.16.2 Springs

Springs are flows of groundwater that emerge at the land surface. There are a broad range of different types of springs that occur, however to date there is no consistent system for the classification of springs. Based on the groundwater regime it is considered that the following key types of springs are present around CVO:

- Perched Springs – Occur where infiltrating rainfall recharge encounters a low permeability unit that restricts downward flow, resulting in the water moving laterally and discharging at the land surface where the low permeability unit outcrops. These perched springs are not connected to deeper regional aquifers; and
- Regional Springs – May occur where the topography of the land surface is lower in elevation than the hydraulic head in the underlying aquifer, and pathways exist (typically fractures, faults or defects that provide preferential flow pathways) for groundwater to discharge to the surface.

Seepage areas and springs occur in the upper headwaters of Cadia and Flyers Creeks as discharge from the Tertiary basalt, and its contacts with underlying bedrock, Tertiary paleochannel sediments, or fractured Silurian sediments.

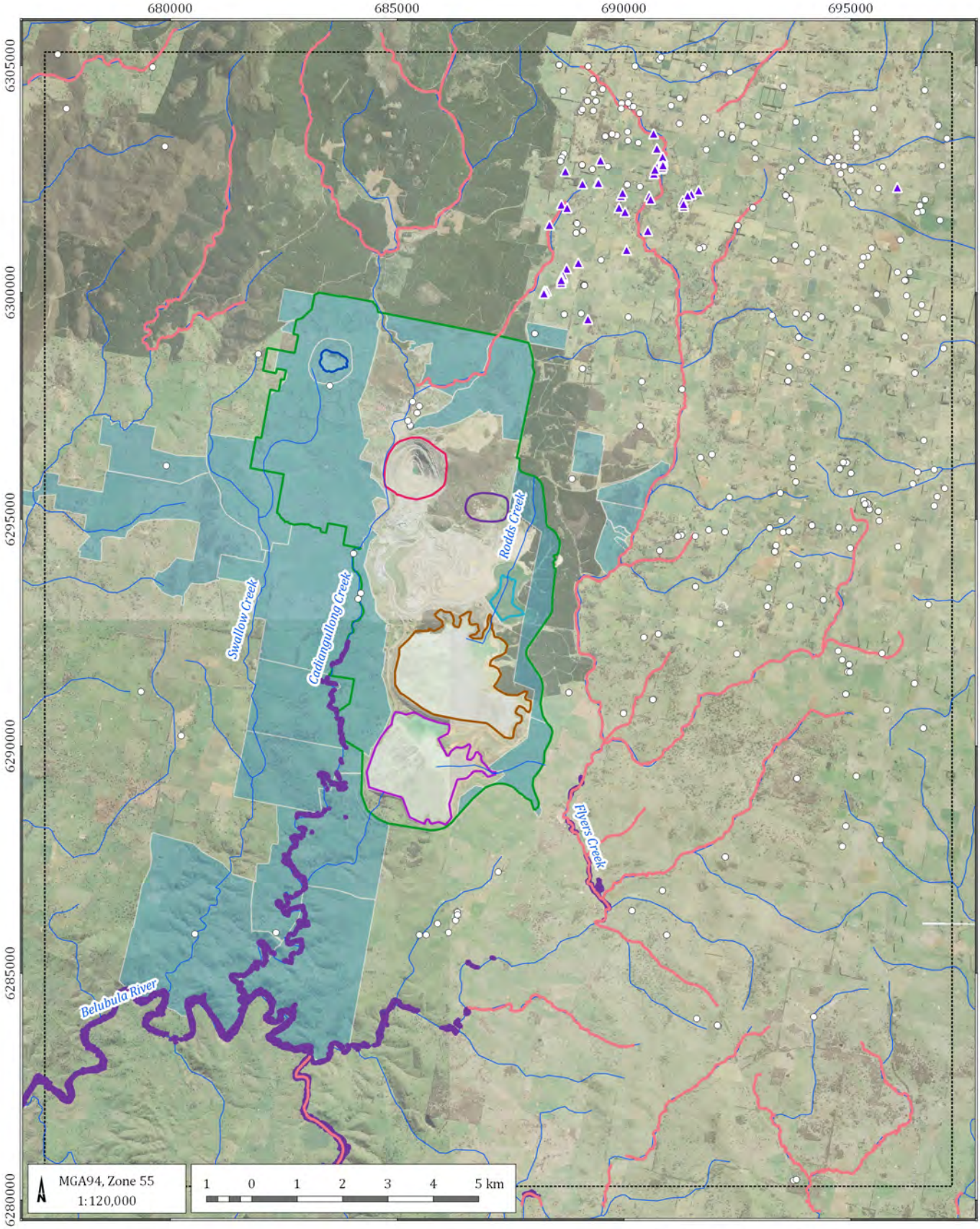
A review and inspection of groundwater seepage areas, seepage fed dams and springs was conducted in the upper headwaters of Cadia and Flyers Creeks in March and April 2009 as part of the Cadia East EIS (Figure 5.31). The inspections focused on the area to the northeast of Cadia East, based on the preliminary findings of the groundwater modelling. At the time, small farm dams had been constructed downstream of some of the identified groundwater seepage areas and springs. Based on discussions with the landowners, the water storages were used for a combination of direct livestock watering, supplementary livestock watering, and in some cases small-scale irrigation and domestic supply. Flow rates recorded during the field inspections ranged from flow being visible or measurable, up to approximately 4.6 L/s. The recorded EC was typically in the range of 50 to 100 µS/cm.

Baseflow in Flyers Creek, which is likely perennial, is partially maintained by an area of springs approximately 1.2 km downstream of Long Swamp Road, adjacent to the CVO owned Woodville property. An individual spring in this area had a visually estimated flow of about 20 L/s in autumn 2007 (Gilbert and Associates, 2009). Monitoring bores MB47A and MB47B are located approximately 300 m to the north-west of the spring zone and are within fractured Silurian limestone and siltstone. Discharge from these Silurian sediments is conceptualised to occur in this spring zone and is likely influenced by local fracture networks. An assessment of water quality data for the Cadia East EIS (AGE, 2009) found that groundwater in the Silurian limestone unit has a similar hydrogeochemical signature, to groundwater sampled from the Flyers Creek spring zone. This observation is consistent with the AGE's current hydrogeological conceptualisation.

5.16.3 Groundwater dependent ecosystems

High potential aquatic groundwater dependent ecosystems (GDEs), as defined by the BoM (2019) GDE Atlas, are mapped in the upper reaches of Cadiangullong Creek and the Panuara Rivulet, in Flyers Creek and its tributaries to the east of CVO, and in some tributaries of the Belubula River to the south of mining operations (Figure 5.30). Groundwater-surface water interactions for Flyers Creek are relatively well understood, with discharge through springs likely representing a significant component of baseflow (see Section 5.16.2).

The GDE Atlas (BoM, 2019) maps high potential terrestrial GDEs that comprise River Oak and River Red Gum trees in small areas adjacent to Flyers Creek (to the east and southeast of the STSF), adjacent to Cadiangullong Creek (downstream of the NTSF), and along the Belubula River (Figure 5.31). Note that these high potential terrestrial GDE's are consistent with the High Ecological Value Aquatic Ecosystems (HEVAE) framework (CSIRO, 2019), which in turn constitute high priority GDEs under 2020 updates to the Water Sharing Plan (WSP) for the NSW Murray Darling Basin Fractured Rock Groundwater Sources.



LEGEND

- Drainage
- Cadia Hill Pit
- Block cave mine subsidence zone
- Ridgeway cave mine subsidence zone
- Rodds Creek dam
- NTSF
- STSF
- Mining lease
- Model boundary
- CVO owned property
- Private landholder bores
- Springs

Aquatic GDEs

- High potential GDE - from national assessment

Terrestrial GDE

- High potential GDE - from regional studies

Satellite image : NSW Aerial

Cadia Model Update (G1383Y)

Groundwater dependent assets

DATE 25/03/2021

FIGURE No: **5.31**

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5.17 Role of geological structures

Faults can form barriers to groundwater flow or can act as more transmissive conduits for flow. Local faulting and fracturing may cause localised areas of higher permeability in the Ordovician/Silurian basement rocks. Washburn (2008) examined the major faults in the Cadia Hill open pit/Cadia East area and made the following observations:

- the Cadiangullong Fault is a 1 to 10 m wide zone of black cataclasite gouge and intensely fractured wall rocks;
- the Foys Fault is a 20 m wide zone of intensely fractured siltstone;
- the Gibb Fault is a 0.5 to 2 m wide zone of milled rock-matrix breccia and clay gouge; and
- the Copper Gully Fault is planar and narrow and has a reddish clay gouge.

The north-south orientated Cadiangullong Fault appears to have a more extensive damage zone between the waste rock dump and Cadiangullong Creek, with an east to west damage zone extending for approximately a couple of hundred metres. The fault zone is within intensely fractured Ordovician siliceous siltstone (shale) of the Weemalla Formation. The fracturing has produced a tabular to fissile geometry and the faulted zone has an elevated porosity and water storage capacity compared to the surrounding unfractured rock mass. Pumping bores are known to have been installed in this formation. Long term yields from these bores have generally been between 2 to 10 L/s (Woodward and Clyde, 1995; AGE, 2020).

The drilling of an exploration borehole (BH40) for the Life of Mine TSF Project, which is located south of the existing STSF (AGE, 2021), intersected a fault zone within the Ordovician volcaniclastics. The fault was characterised by deeper weathering than the surrounding rocks. It comprised a thick clay layer of residual bedrock approximately 20 m thick and was of low permeability (0.003 m/d). The layer was found to overlie a moderately to highly weathered fractured rock, with enhanced permeability 0.09 m/d). Carbonate veining in the identified weathered zone may have been dissolved, allowing for potential movement of groundwater. Below about 47 m depth, the fractures in the fault zone were observed to be largely re-healed by carbonate vein precipitation and the permeability was estimated as 0.002 m/d.

Observations relating to faulting indicate that the faults filled with clay gouge, residual bedrock clay, or carbonate infill will act as barriers to fluid flow and may lead to the compartmentalisation of groundwater systems. Faults with open fracturing would naturally act as conduits for groundwater flow.

The permeability of faults on a local scale will be influenced by the fabric of the host rocks, for example the siliceous fabric of the Weemalla siltstone will have a brittle nature from deformation, and therefore is conducive to enhanced permeability. Conversely, this may not be the case for other Ordovician volcaniclastics. The period of faulting may also influence the hydrothermal fluid activity, which in turn may lead to fault sealing with clays and precipitates. The permeability of the fault zones is expected to reduce at depth due to closing up of fractures from overloading rock mass pressure and an absence of weathering at depth.

The carbonate faults (Cb2 – Cb5) that intersect the PC1 and PC2 working levels in the Cadia East mine are known to extend to the surface of the Silurian/Ordovician rocks to the northeast of the subsidence crater. These faults may provide conduits for groundwater flow into the underground workings from the Tertiary basalt aquifer system. The notable decline in groundwater levels at MB45/BH88 (basalt), and possibly MB43, MB44A, and MB44B (basalt), which are all located approximately 1.9 km from the subsidence crater, may be due to drainage occurring through these carbonate faults.

6 Numerical model rebuild

6.1 Model updates

AGE (2009) developed the original groundwater flow model which was used to assess the impact of the then proposed Cadia East underground mine on the groundwater regime. This model was a 3D numerical groundwater flow model using the MODFLOW-SURFACT software. The model simulated the three key hydrostratigraphic units, being the Tertiary basalts, Silurian sediments and Ordovician volcaniclastics. The model was calibrated to steady state (average) water level measurements and used to estimate the zone of drawdown, which was also undertaken assuming steady state conditions. This early work provided estimates of the cumulative impacts of the various mining areas on groundwater levels and stream baseflow.

The MODFLOW SURFACT model was updated in 2013, about three years after the commencement of mining. Changes to the model included modifying the model layers and Cadia East subsidence zone, redefining the extent of the Tertiary basalt, adjusting the aquifer parameters, modifying the representation of the TSFs, and adding transient mining and recharge data.

AGE (2016) updated the previous version of the model to represent the key processes that occur in the mining area in a simple manner within the model, and to provide estimates of the uncertainty in the model predictions. The major updates included:

- changing the model code to MODFLOW USG allowing the use of an unstructured grid;
- modifying the model layers to represent the updated mine plan;
- removing the fixed heads boundary condition;
- simplifying hydraulic conductivity to be represented by uniform values for each geological unit;
- recalibrating the model and adjusting aquifer parameters in all the layers;
- removing the seepage face package;
- adding the evapotranspiration package; and
- updating the method used to represent rainfall recharge.

AGE (2019) updated the 2016 model with a new mine plan and climate data, to better align the model to what had occurred at the site since 2016. The model performance review showed that while the model was still calibrated to statistical measures, there were some critical mismatches that were needed to be addressed.

According to the latest developments at Cadia Valley sites, and the previous modelling experiences mentioned above, the conceptual hydrogeological model was reassessed, and the numerical model has been updated in 2021. The principal objective behind the numerical model update was to improve the confidence in mining impacts on groundwater levels, based on the recent data captured. A rebuild of the model packages, and a thorough update of the model has occurred through this scope of work. Full details of the updates are summarised in Table 6.1.

Table 6.1 2021 Model updates

Model feature	Model updates
Model extent	Expanded the model extent further to south and west to include future TSF sites and Belubula river.
Model layering	Refined model layers vertically where Cadia East and Ridgeway mines are located to provide a detailed simulation of complex 3D cave shapes.
Geological units	Updated Basalt bottom surface in the west and south where the model extent is expanded; and Updated Silurian bottom surface within approximately 1.5km around Cadia East.
Hydraulic properties	Adjusted conductivity, specific yield, and specific storage ranges within acceptable ranges according to previous field tests and values reported in published literature.
Coupled surface water – groundwater	Coupled SWAT+ and MODFLOW USG together to simulate interactions between surface water and groundwater.
Recharge/ Evapotranspiration	Included the impact of surface topography and land use in the groundwater model by coupling the interactions between surface water and groundwater.
River/Creeks	Used Streamflow-Routing (SFR2) package instead of river (RIV) package for simulation of surface drainage to include the run-off flow and unsaturated flow beneath streams.
Water storage and TSFs	Added Rodds Creek dam, and Cadia Hill PTSF to the model using RIV package; Updated NTSF and STSF levels with most recent data; and Added Horizontal Flow Barrier (HFB) package to the south of STSF to control leakage from STSF to Rodds Creek.
Ridgeway underground mines	Improved simulation details at Ridgeway mines using 16 vertically refined model layers; and Updated Ridgeway underground mine with sub-level cave shape and Ridgeway Deeps mine with mine progression plan.
Cadia Hill open pit mine	Updated Cadia Hill and Cadia Hill extended pit with pit shell shapes; and Updated Cadia Hill extended pit timing and pit shell shape in the model.
Cadia East underground mine	Improved simulation details at Cadia East mines using 36 vertically refined model layers; Updated crater and cave shapes in the model up to FY37; and Added Connected Linear Network (CLN) package to simulate the enhanced connection between carbonate fault, “Cb 5”, and fractured rocks above PC2 mine.
Hydraulic property changes	Added Time-Variant Materials (TVM) package to adjust hydraulic properties at fractured rock and crater zones above Ridgeway and Cadia East mines, mine working zones and Cadia Hill pit post-mining.
Boundary condition	Added General Head Boundary (GHB) condition at south and west of the model boundary using long-term averaged depth to water table from the SWAT model.
Particle tracking	Addition of particle tracking feature to the groundwater model.

6.2 Model code

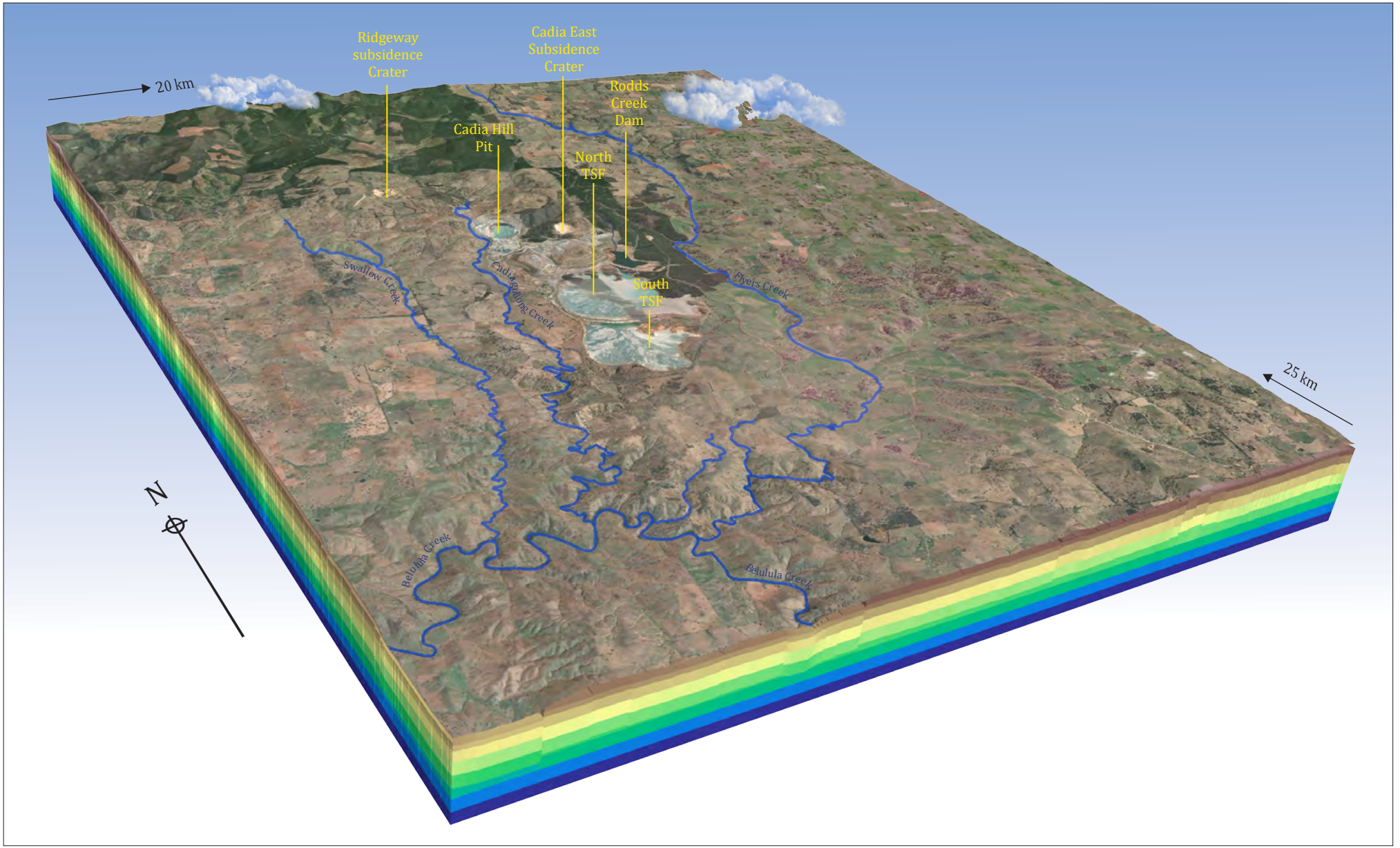
The model has been designed and built to run with the MODFLOW-USG code, which provided distinct advantages to simulate regional groundwater flow in the CVO area. This model code allows use of an unstructured mesh (compared to the more traditional and restrictive rectangular grids) and allows for model layers to be removed locally where geological units pinch out. It also allows extra vertical refinement of regional layers at Cadia East and Ridgeway underground mines, while minimising the total number of model cells. Therefore, the model size can be reduced allowing a faster model run time, more efficient calibration process, and further flexibility with the analyses of model outputs and uncertainty. A new model grid was created with refined voronoi shape cells around the mining areas and surface water features, with larger cells outside these areas where high resolution detail was not required.

The input files for the MODFLOW-USG model were created using a combination of Fortran and Python codes and run with a MODFLOW-USG edition of the Groundwater Data Utilities by Watermark Numerical Computing. This process was adopted, to take advantage of additional capabilities offered through using MODFLOW-USG. The mesh was generated using a combination of Python scripting and ALGOMESH (Hydroalgorithmics, 2014).

6.3 Model design

6.3.1 Model extent

Considering the importance of Cadia East mining in the project, the model extent was chosen so that the Cadia East mine is in the centre of the model domain. The model boundaries were then extended to approximately 10km to east, west, and north of the Cadia East mine, allowing enough distance to investigate possible impacts from the mining on regional groundwater flow in the Cadia Valley. The model extent was expanded 15km to the south, which will mean the current model will cover proposed areas for tailing storage facilities (south of STSF) in the future, and the inclusion of the Belubula river as a major surface drainage outlet from the model. The extent of the new model is larger compared to the 2016 model, and is 20 km 'wide' (west to east direction) and 25 km 'long' (north to south direction). The updated regional model has an approximate depth of 2km from the ground surface with the model scale shown in Figure 6.1.



Regional model scale

Figure - 6.1

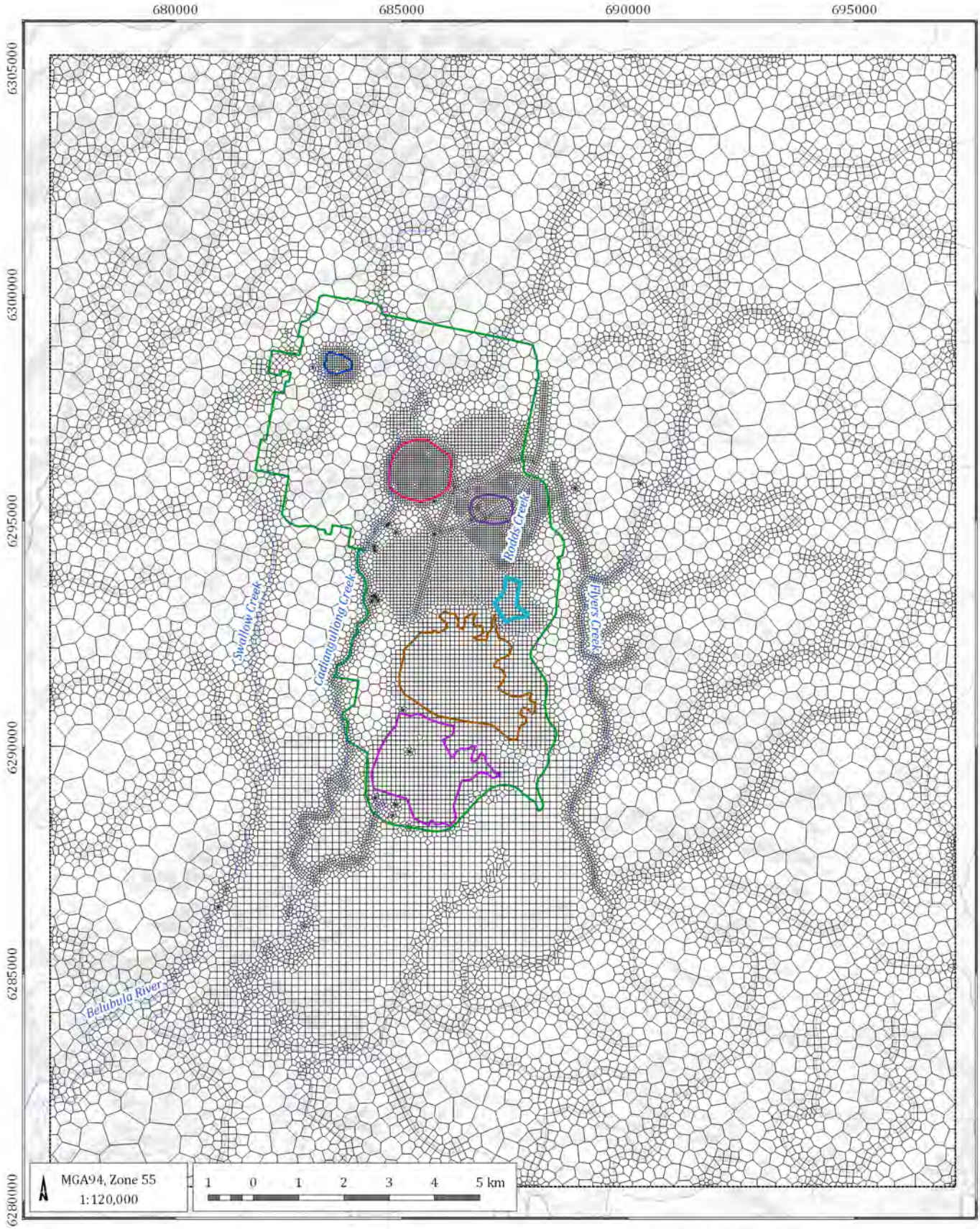
Cadia Mine Model Update (G1383Y)

6.3.2 Model grid and layers

The model domain was discretised and arranged into 70 layers comprising up to 19,737 cells in each layer, with the dimensions of the cells varying depending on proximity to the features that required representation in each part of the domain. The previous version of the model represented the major hydrostratigraphic units with 16 separate layers. An additional two layers were added to regional layers, while Cadia East and Ridgeway mining extent were further refined vertically to 36 and 16 layers, respectively. These refinements allow for a detailed simulation of complex 3D cave geometries compared to thicker regional model layers. Assessment of impacts from the fractured zone and/or subsidence on groundwater flow regimes is also possible through the extra vertical discretization. The following cell dimensions were targeted during mesh generation:

- mining areas – approximately 50 m x 50 m;
- creek line – depending on proximity to the mining area, three notional cell sizes were targeted; 100 m, 200 m, and 300 m;
- faults – approximately 50 m x 50 m;
- North and south waste rock dump areas – approximately 75 m x 75 m;
- NTSF and STSF – approximately 100 m x 100 m;
- future water storage and tailing facility sites south of STSF – approximately 150 m x 150 m; and
- overall, the model comprises 248,048 model cells across 70 layers.

Figure 6.2 shows the model extent and numerical model mesh. Table 6.2 summarises the salient details for the model layers, whilst Figure 6.3 presents the model layers graphically. For simplicity, this figure shows all Basalt and Silurian layers as a single unit, due to the amount of discretisation within the model.



LEGEND

- Drainage
- Cadia Hill Pit
- Block cave mine subsidence zone
- Ridgeway cave mine subsidence zone
- Rodds Creek dam
- NTSF
- STSF
- Mining lease
- Model grid
- Model boundary

Cadia Model Update (G1383Y)

Model grid

AGE

DATE: 18/03/2021

FIGURE No: **6.2**

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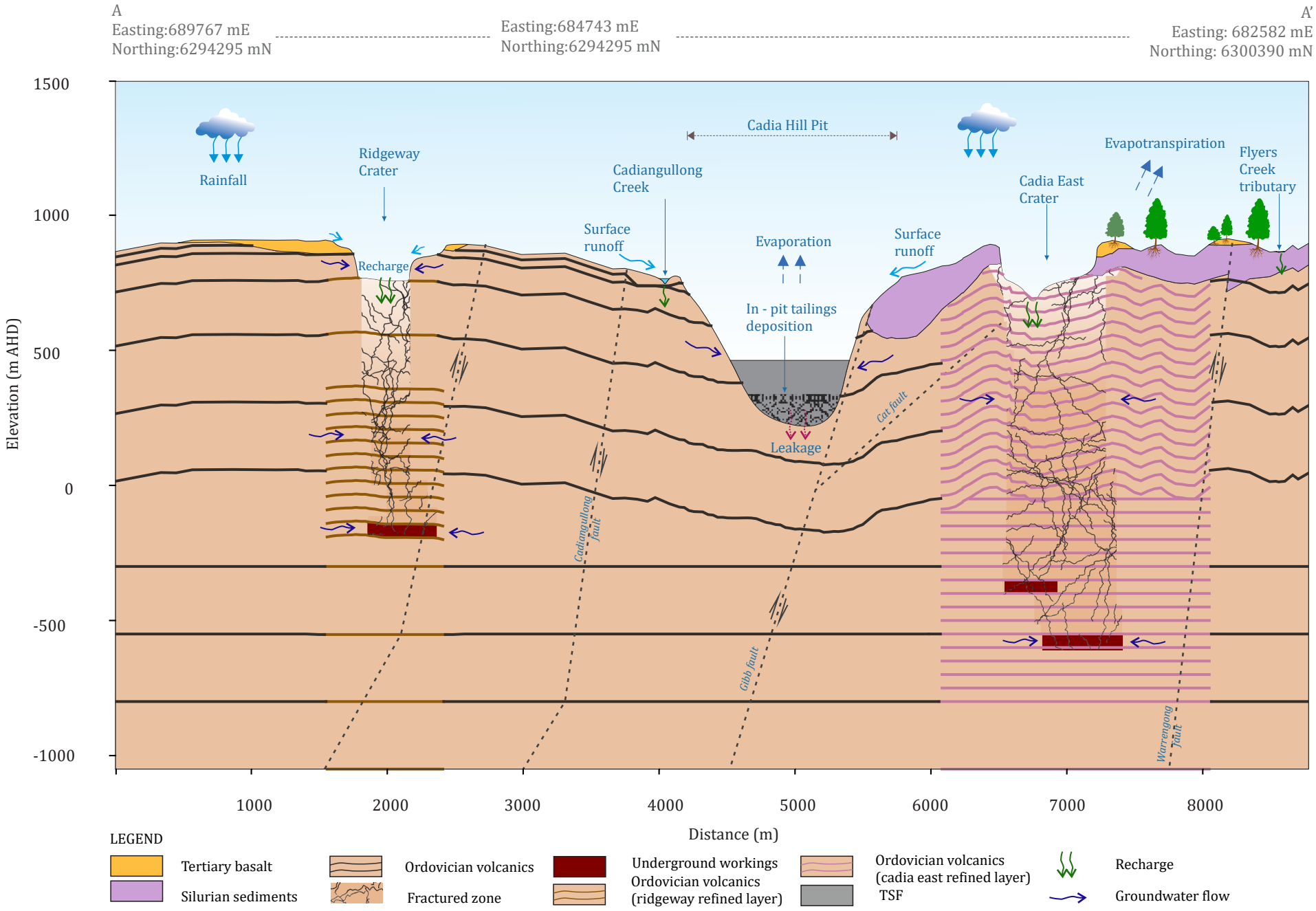
G:\Projects\G1383Y.Cadia Mine Model Update\3_GIS\Workspaces\001_Deliverable 1\06.02_G1383Y_Model grid.qgs

Table 6.2 Model layers

Hydrostratigraphic unit	Model thickness/elevation	Model layer
Tertiary Basalt	Layer 1: 25% of unit thickness Layer 2: 35% of unit thickness Layer 3: 40% of unit thickness	1 to 3
Silurian	Layer 4: 5% of unit thickness Layer 5: 10% of unit thickness Layer 6: 25% of unit thickness Layer 7: 30% of unit thickness Layer 8: 30% of unit thickness	4 to 8
Ordovician	Layer 9: layer base 20 m below land surface Layer 10: layer base 50 m below land surface Layer 11: layer base 150 m below land surface Layer 12: layer base 350 m below land surface Layer 13: layer base 600 m below land surface Layer 14: layer base 850 m below land surface Layer 15: constant layer base at -300 mAHD Layer 16: constant layer base at -550 mAHD Layer 17: constant layer base at -800 mAHD Layer 18: constant layer base at -1050 mAHD	8 to 18
Ordovician – Cadia East	Layers 19 to 36: 50 m thick layers with base 50 to 900 m below land surface Layers 37 to 53: 50 m thick layers with constant base at 0 to -800 mAHD Layer 54: constant layer base at -1050 mAHD	19 to 54
Ordovician – Ridgeway	Layer 55: layer base 550 m below land surface Layers 56 to 66: 50 m thick layers with base 600 to 1100 m below land surface Layers 67 to 70: 50 m thick layers with constant base at -300 to -1050 mAHD	55 to 70



Regional and reined model la yers

Figure - 6.3

Cadia Mine Model Update (G1383Y)

Vertical exaggeration = 2.5x

6.4 SWAT model development

SWAT+ (Soil and Water Assessment Tool) is a watershed to river basin-scale model originally developed by Texas A&M University to simulate the quality and quantity of surface water and groundwater (Beiger et al. 2017). The software is widely used to predict the environmental impact of land use, management practices and climate change. It is a hydrology model that includes functionality to simulate a range of processes including rainfall, surface runoff, return flow, percolation, evapotranspiration transmission losses, groundwater flow, reach routing, and water transfer. SWAT+ was chosen as the input/output model files are ascii based (similar to MODFLOW), meaning integration with PEST_HP and in-house Fortran/Python scripts is relatively amenable.

A SWAT+ model of the entire surface water catchment surrounding Flyers Creek, Cadiangullong Creek, and Swallow Creek discharging to Belubula river has been developed. SWAT+ requires specific input data relating to climate, soil properties, topography, land management practices, and vegetation within the model domain. The watershed is initially partitioned into a number of sub-basins according to user specified area thresholds. This allows the user to spatially separate like sub-catchments across the domain, improving the models ability to calibrate to measured data. These sub-basins are further split into Hydrologic Response Units (HRUs), aquifers (based on sub-basins), and channel reaches. In this instance, HRUs were defined by grouping land areas with common land cover, soil and management combinations.

Surface water is routed through the modelled channel network using a variable storage routing method, and Manning's equation to define the rate and velocity of flow.

The following sections define the specific inputs and settings used in the SWAT+ model.

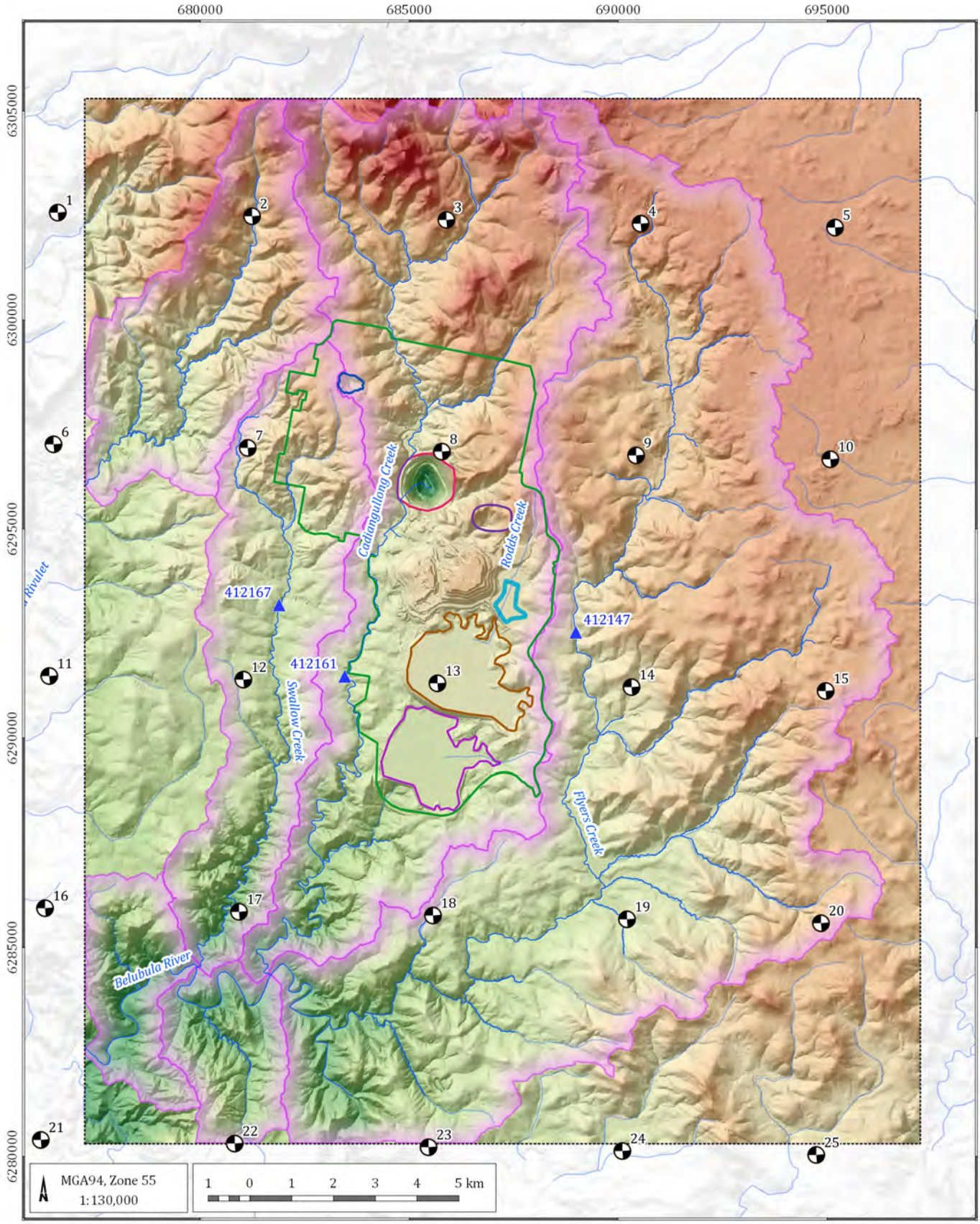
6.4.1 Sub-basins/aquifer

Topography used in the SWAT+ model was adopted from laser imaging, detection, and ranging (LIDAR) data. The boundary of the SWAT+ model was then derived from this digital elevation model (DEM) by calculating the watershed. Figure 6.4 shows the extent and segregation of the SWAT+ sub-basins and the DEM used to construct the watershed.

Each SWAT+ sub-basin simulates a shallow aquifer system which communicates with the HRUs, channel reaches, and the deep aquifer system.

6.4.2 Climate input data and flow targets

Daily SILO climate data (Queensland Government, 2020) from 25 grid cell locations across the model domain was imported directly into the SWAT+ model. Figure 3.1 shows the location of the SILO climate stations, as well as the location of surface water flow gauges used to calibrate the SWAT+ parameters.



LEGEND

- Drainage
- Channel network (from SWAT)
- Cadia Hill Pit
- Block cave mine subsidence zone
- Ridgeway cave mine subsidence zone
- Rodds Creek dam
- NTSF
- STSF
- Mining lease
- Model grid
- Model boundary
- SWAT subbasin/watershed

Elevation (mAHD)

- 400
- 500
- 600
- 700
- 800
- 900
- 1000
- 1100
- Weather grid cell
- Gauging station

Cadia Model Update (G1383Y)

SWAT+ watershed constructed from DEM

DATE 26/03/2021

FIGURE No: **6.4**

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G:\Projects\G1383Y.Cadia Mine Model Update\3_GIS\Workspaces\001_Deliverable1\06.04_G1383Y_SWAT+ watershed constructed from DEM.qgs

6.4.3 Land use and soil

The extent of tree based land cover across the model was considered to be a key component of the project area water balance, as well as representing a key control on water levels in these areas. Rather than use the default SWAT+ land use mapping and database sourced from USGS Global landuse data (USGS, 2018), a revised input land use data set was generated as shown in Figure 6.5. Satellite images showing three main land covers were used to generate land use:

- pine forestry to the east and north of project area (PINE);
- mixed dryland/irrigated cropland within the project area (MIXC); and
- generic agriculture land covering the remainder of the model extent (AGRL).

Soil input data used in the surface water model were based on the default SWAT+ soils mapping and database, which is sourced from FAO-UNESCO digital soil mapping data (FAO, 2003).

6.4.4 Hydraulic response units

Hydraulic response units were generated by grouping dominant landuse, topography, and soil groups. The resulting SWAT+ representation comprised some 400 HRUs, as shown in Figure 6.6.

6.4.5 Stream network and watershed outlets

The alignment of the streams were fine-tuned based on satellite imagery around key locations within the model extent. These refined stream polylines were used to 'burn in' the stream network using the QSWAT 3 plugin in QGIS 3 (Texas A&M university, 2019).

Figure 6.7 shows the locations of the 76 channels simulated in the SWAT+ model, as well as the two watershed outlets defined on the western boundary of the model.

6.4.6 Assumptions and limitations – SWAT+ model

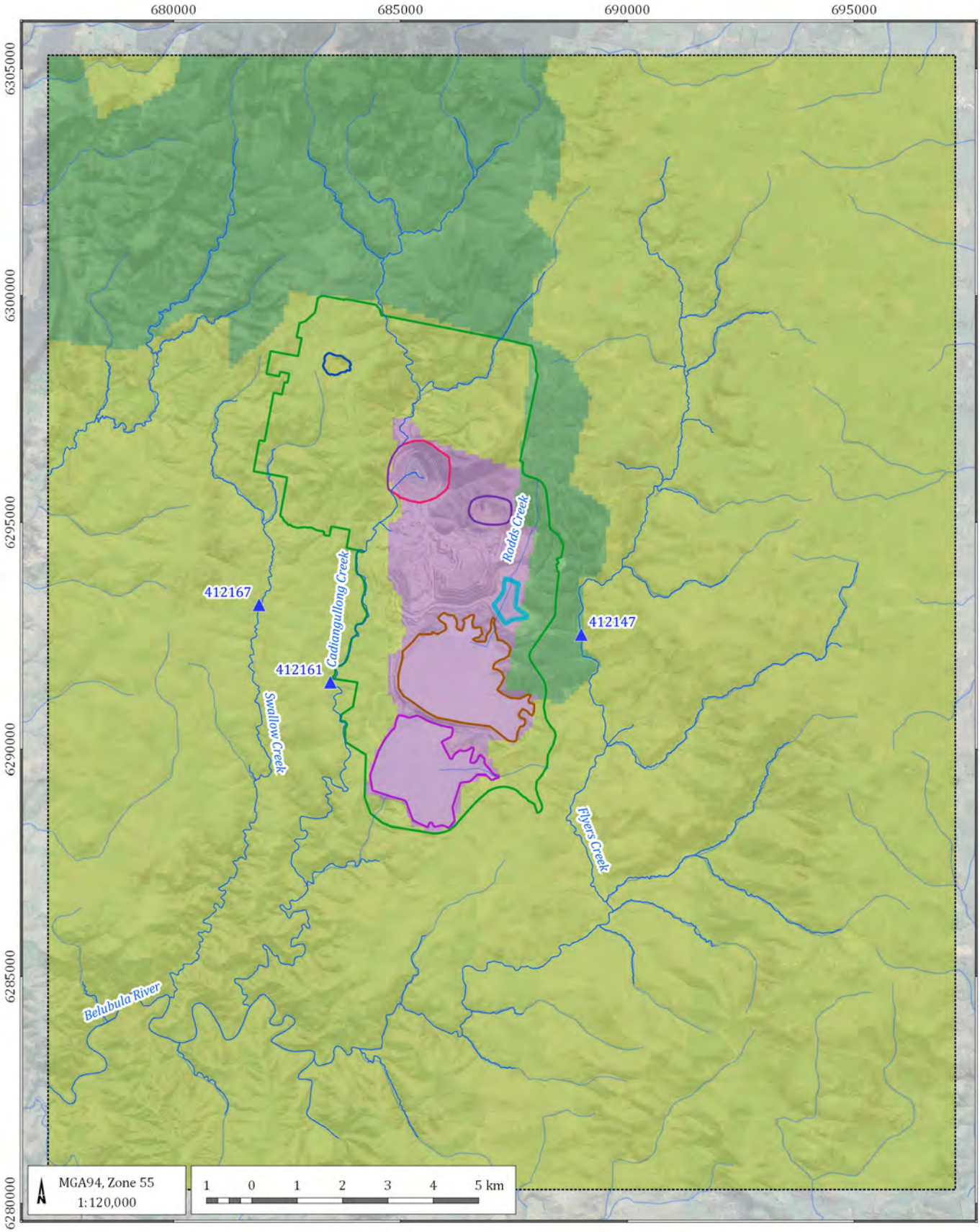
Key assumptions and limitations relating to the SWAT+ model are described below.

Model formulae are empirical and do not simulate 2D hydrodynamic flow, however for the purposes of this study, numerous external studies (including Jha, K. 2020; and Otieno, 2014) show SWAT+ channel flow simulations compare well with alternate lumped hydrological models and 2D flow simulation software.

The representation of the groundwater system in the SWAT+ model is simplistic, and accordingly, SWAT+ outputs have been used to quantify surface water budget components including runoff, evapotranspiration, and recharge at the base of the unsaturated soil zone. Groundwater budget components are then calculated using MODFLOW based on a fully distributed, 3D representation of the underlying strata.

The resolution of the global soils database raster is relatively coarse, meaning certain HRUs likely misrepresent actual soil properties. This will result in generation of further HRUs within zones with similar hydraulic properties (as seen in top left corner of Figure 6.6). It could also have implications on the soil-moisture deficit calculations in areas of the model where soil is highly variable. However, given the relatively close match to observed flow data achieved (Section 7.4 and Section 7.8) this does not appear to represent a significant limitation at this point in time.

Due to the overall size and complexity of the MODFLOW-USG model it was not possible to undertake the groundwater calculations using the same daily stress periods used for the SWAT+ calculations. Therefore SWAT+ daily outputs were averaged over the MODFLOW-USG stress periods and then imported into the groundwater model.



LEGEND

- Gauging station
- Drainage
- Channel network (from SWAT)
- Cadia Hill Pit
- Block cave mine subsidence zone
- Ridgeway cave mine subsidence zone
- Rodds Creek dam
- NTSF
- STSF
- Mining lease
- Model boundary

Landuse

- Generic agriculture land
- Mixed dryland/irrigated cropland
- Pine forestry

Cadia Model Update (G1383Y)

SWAT model – input land use

DATE 08/04/2021

FIGURE No: **6.5**

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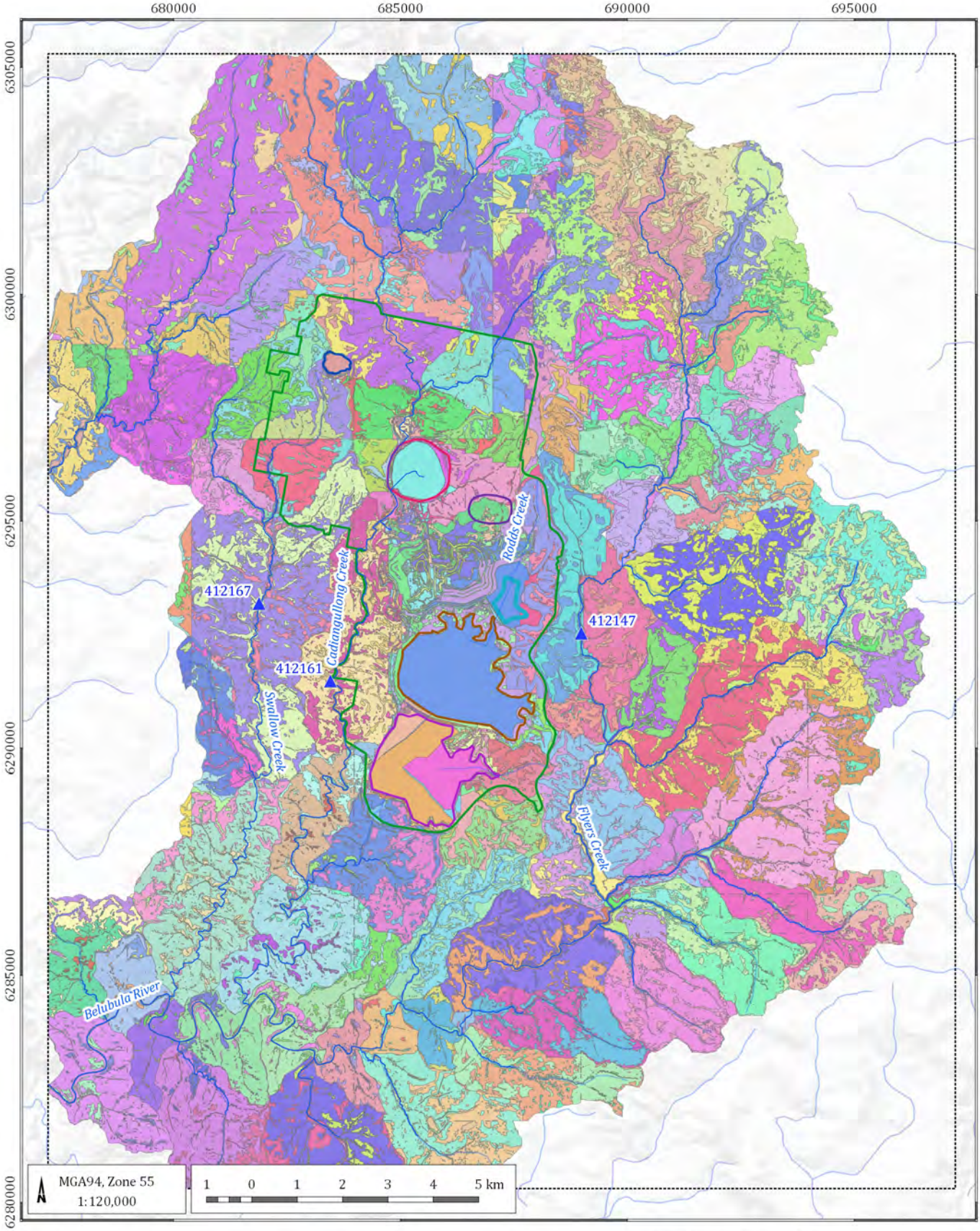
G:\Projects\G1383Y.Cadia Mine Model Update\3_GIS\Workspaces\001_Deliverable1\06.05_G1383Y_SWAT model – input land use.qgs



LEGEND

- Gauging station
- Drainage
- Channel network (from SWAT)
- Cadia Hill Pit
- Block cave mine subsidence zone
- Ridgeway cave mine subsidence zone
- Rodds Creek dam
- NTSF
- STSF
- Mining lease
- Model boundary

Hydraulic Response Units (HRUs)

- 1
- 10
- 20
- 50
- 100
- 200
- 300
- 400

Cadia Model Update (G1383Y)

SWAT Hydraulic Response Units (HRUs)

DATE 25/03/2021

FIGURE No: 6.6

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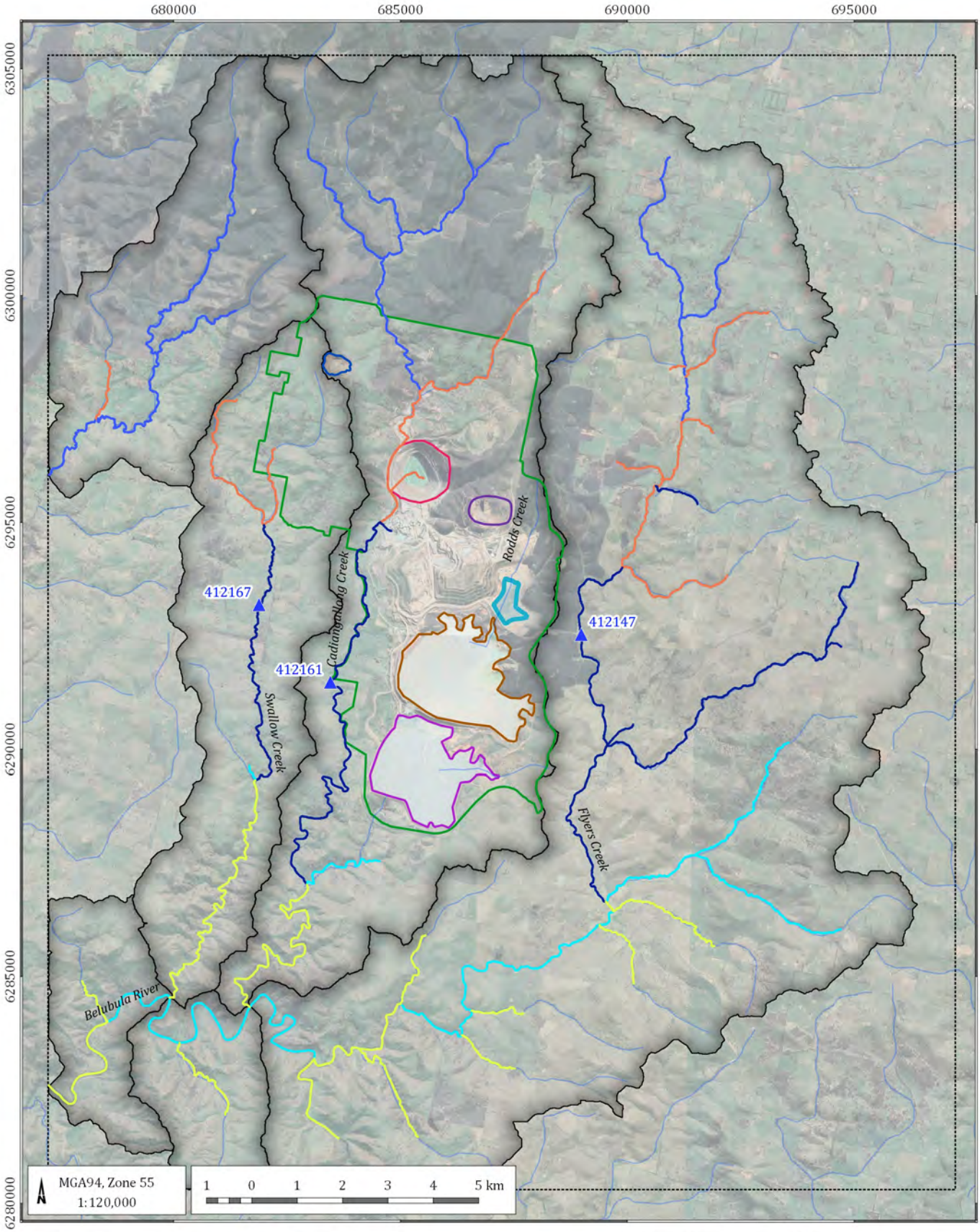
G:\Projects\G1383Y.Cadia Mine Model Update\3_GIS\Workspaces\001_Deliverable1\06.06_G1383Y_SWAT Hydraulic Response Units (HRUs).qgs



LEGEND

- Gauging station
- Drainage
- Cadia Hill Pit
- Block cave mine subsidence zone
- Ridgeway cave mine subsidence zone
- Rodds Creek dam
- NTSF
- STSF
- Mining lease
- Model boundary
- SWAT subbasin/watershed

Channel reaches (rivs1)

- 1 - 16
- 16 - 31
- 31 - 46
- 46 - 61
- 61 - 76

Cadia Model Update (G1383Y)

SWAT channels

DATE 24/03/2021

FIGURE No: **6.7**

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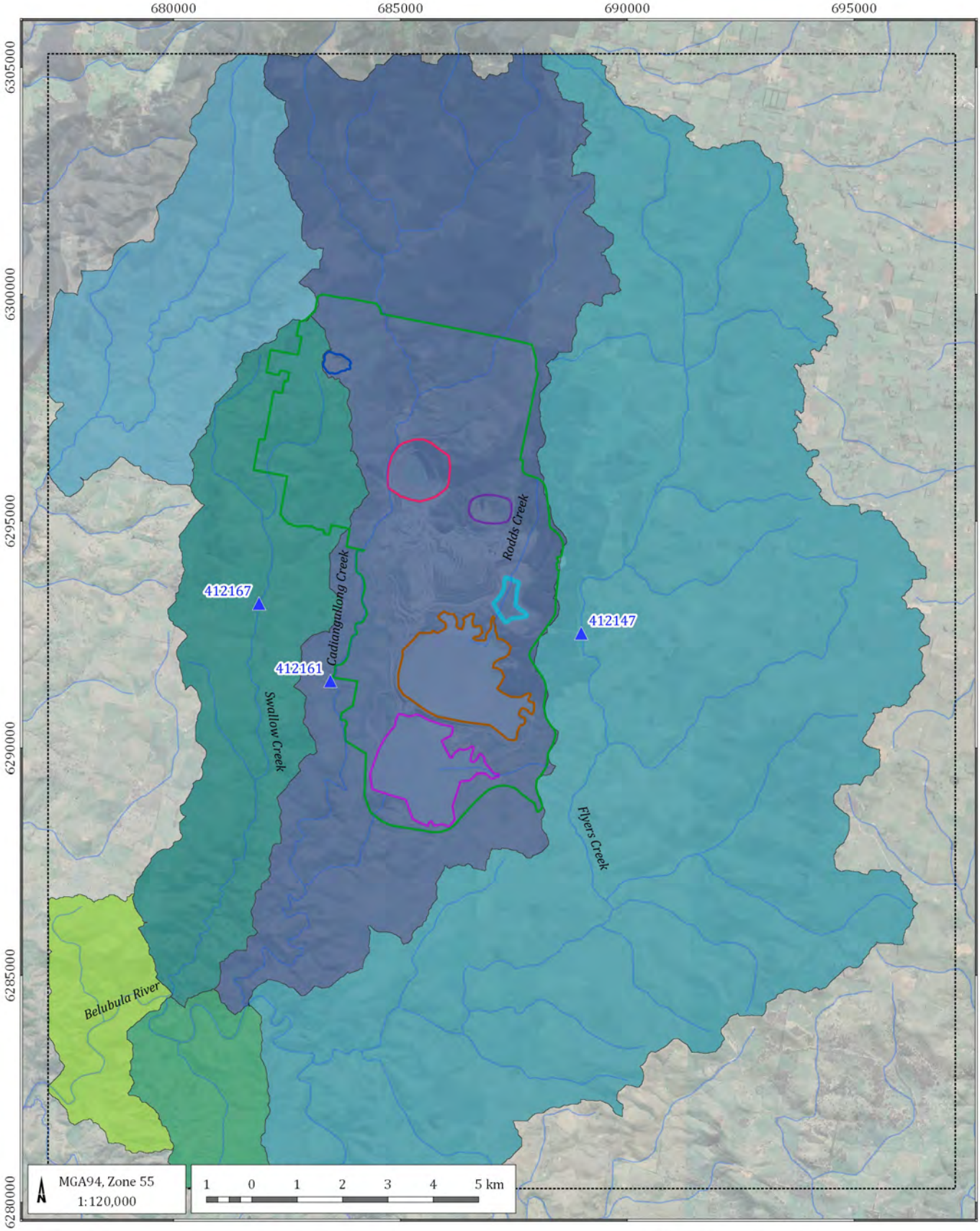
G:\Projects\G1383Y.Cadia Mine Model Update\3_GIS\Workspaces\001_Deliverable1\06.07_G1383Y_SWAT channels.qgs

6.5 Recharge

Groundwater recharge from infiltration is calculated at a daily frequency in the SWAT+ model. Recharge occurs in the SWAT+ model when water that moves beyond the soil profile by percolation or preferential pathway flow reaches the groundwater table. Recharge lag is simulated based on the depth of the water table and the hydraulic properties of the vadose and groundwater zones. SWAT+ utilises an exponential decay weighting function (Sangrey et al, 1984) to account for this lag. The water table is then estimated at a daily frequency using a simple groundwater flow equation.

Calculated SWAT+ seepage rates to each sub-basin shallow aquifer were aggregated and transferred to the MODFLOW recharge package using an in-house FORTRAN script.

The MODFLOW-USG model was set up using the 'upstream weighting' option, which essentially deactivates dry model cells from the groundwater flow equation and allows recharge to bypass the unsaturated zone directly to the water table if the overlying layers dry out. Recognising that the simulation of the water table in the SWAT+ model is relatively simple and that the SWAT+ and MODFLOW models are linked rather than fully integrated, initial recharge values calculated using SWAT (Figure 6.8) are varied during calibration as necessary to improve the fit to calibration targets (observed groundwater levels, total surface water flows, and mine inflows). Neighbouring values were used in the edges of the groundwater model and outside the SWAT model extent where water catchments extend beyond the groundwater model extent. Calibration is achieved by factoring the SWAT+ recharge output values at each geological unit, and within each sub-basin (23 zones) as shown in Figure 6.9.



LEGEND

- Gauging station
- Drainage
- Cadia Hill Pit
- Block cave mine subsidence zone
- Ridgeway cave mine subsidence zone
- Rodds Creek dam
- NTSF
- STSF
- Mining lease
- Model boundary

Recharge (mm/year)

- 0.885
- 0.953
- 2.951
- 5.251
- 7.283
- 8.827

Cadia Model Update (G1383Y)

SWAT modelled recharge distribution – Annual average

DATE 24/03/2021

FIGURE No: **6.8**

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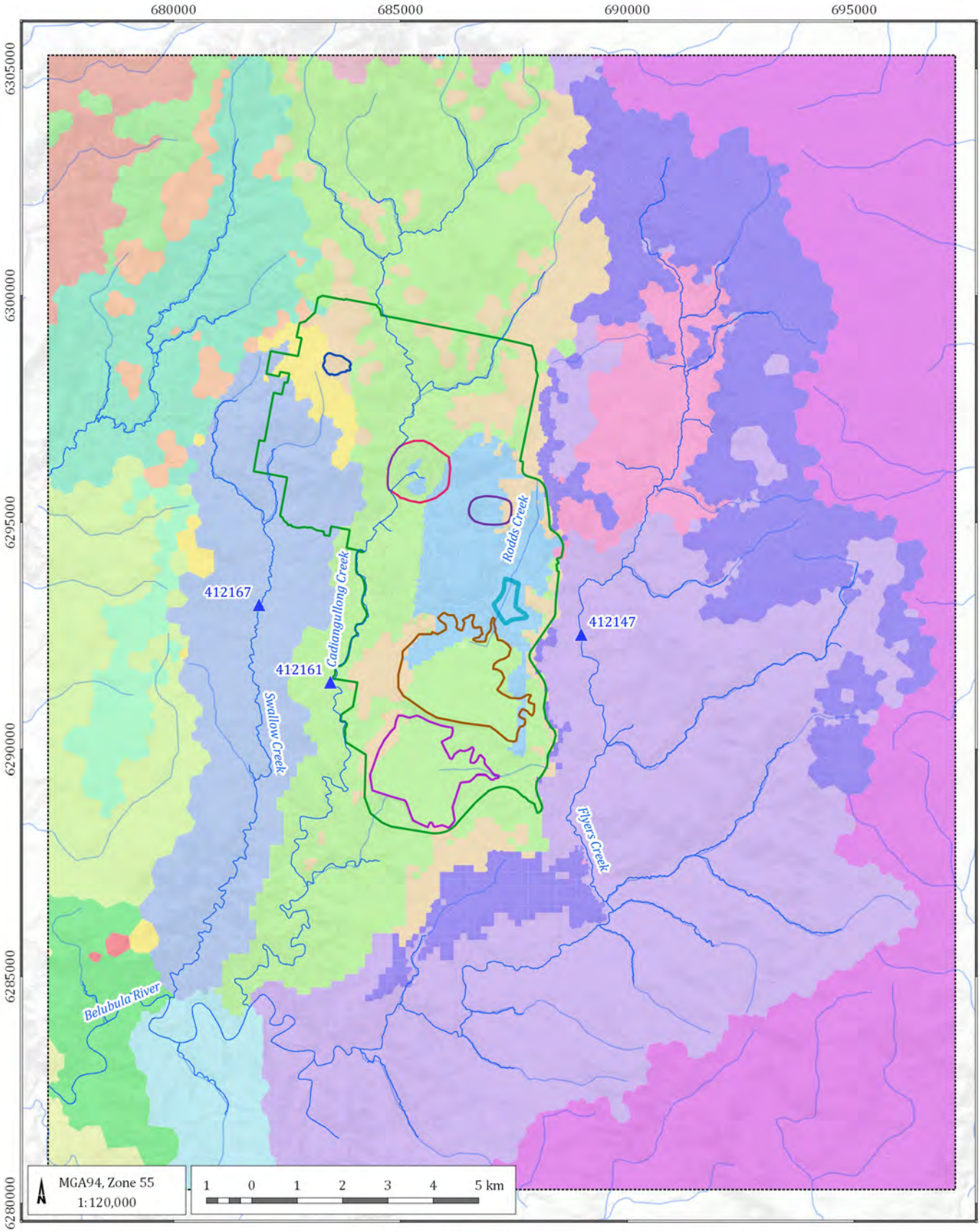
G:\Projects\G1383Y.Cadia Mine Model Update\3_GIS\Workspaces\001_Deliverable1\06.08_G1383Y_SWAT modelled recharge distribution – Annual average.qgs



LEGEND

- Gauging station
- Drainage
- Channel network (from SWAT)
- Cadia Hill Pit
- Block cave mine subsidence zone
- Ridgeway cave mine subsidence zone
- Rodds Creek dam
- NTSF
- STSF
- Mining lease
- Model boundary

Recharge zones

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23

Cadia Model Update (G1383Y)

MODFLOW factorised zone of recharge

DATE 25/03/2021

FIGURE No: **6.9**

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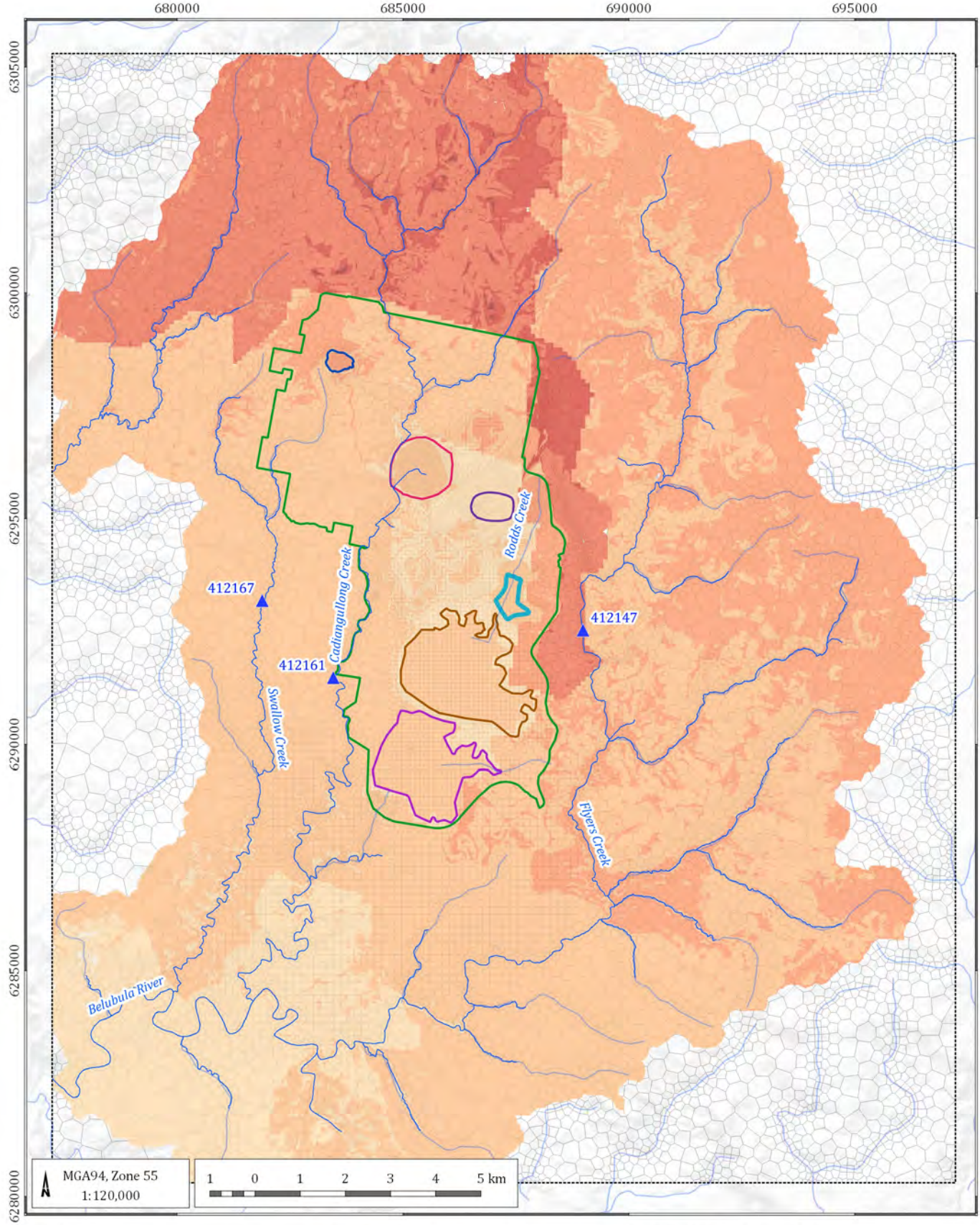
G:\Projects\G1383Y.Cadia Mine Model Update\3_GIS\Workspaces\001_Deliverable1\06.09_G1383Y_MODFLOW factorised zone of recharge.qgs

6.6 Evapotranspiration

Similar to the application of recharge to the MODFLOW model, daily evapotranspiration from SWAT+ is aggregated as necessary before being passed to the EVT package using in-house FORTRAN code.

SWAT+ annual averaged evapotranspiration rates are shown in Figure 6.10. Neighbouring values were used at the edges of the groundwater model and outside the SWAT model extent where surface water catchments extend beyond the groundwater model extent. The transient outputs of SWAT evapotranspiration values were transferred to 223 zones in MODFLOW (shown in Figure 6.11) by matching the larger HRU areas with the groundwater model cells. Adopted rooting depths are consistent between the SWAT+ and MODFLOW models, allowing the groundwater model to be calibrated with various rooting depths assigned to pine forestry, the project area, and general agricultural lands within the model extent.

It should be stressed these values would only occur in the groundwater model where the simulated water table reaches the modelled EVT surface, which is defined as the modelled ground surface in this case.



LEGEND

- Gauging station
- Drainage
- Channel network (from SWAT)
- Cadia Hill Pit
- Block cave mine subsidence zone
- Ridgeway cave mine subsidence zone
- Rodds Creek dam
- NTSF
- STSF
- Mining lease
- Model grid
- Model boundary

Evapotranspiration (mm/year)

- 450 - 500
- 500 - 550
- 550 - 600
- 600 - 650
- 650 - 700
- 700 - 750
- 750 - 800

Cadia Model Update (G1383Y)

SWAT modelled evapotranspiration distribution – Annual average

DATE 26/03/2021

FIGURE No: **6.10**

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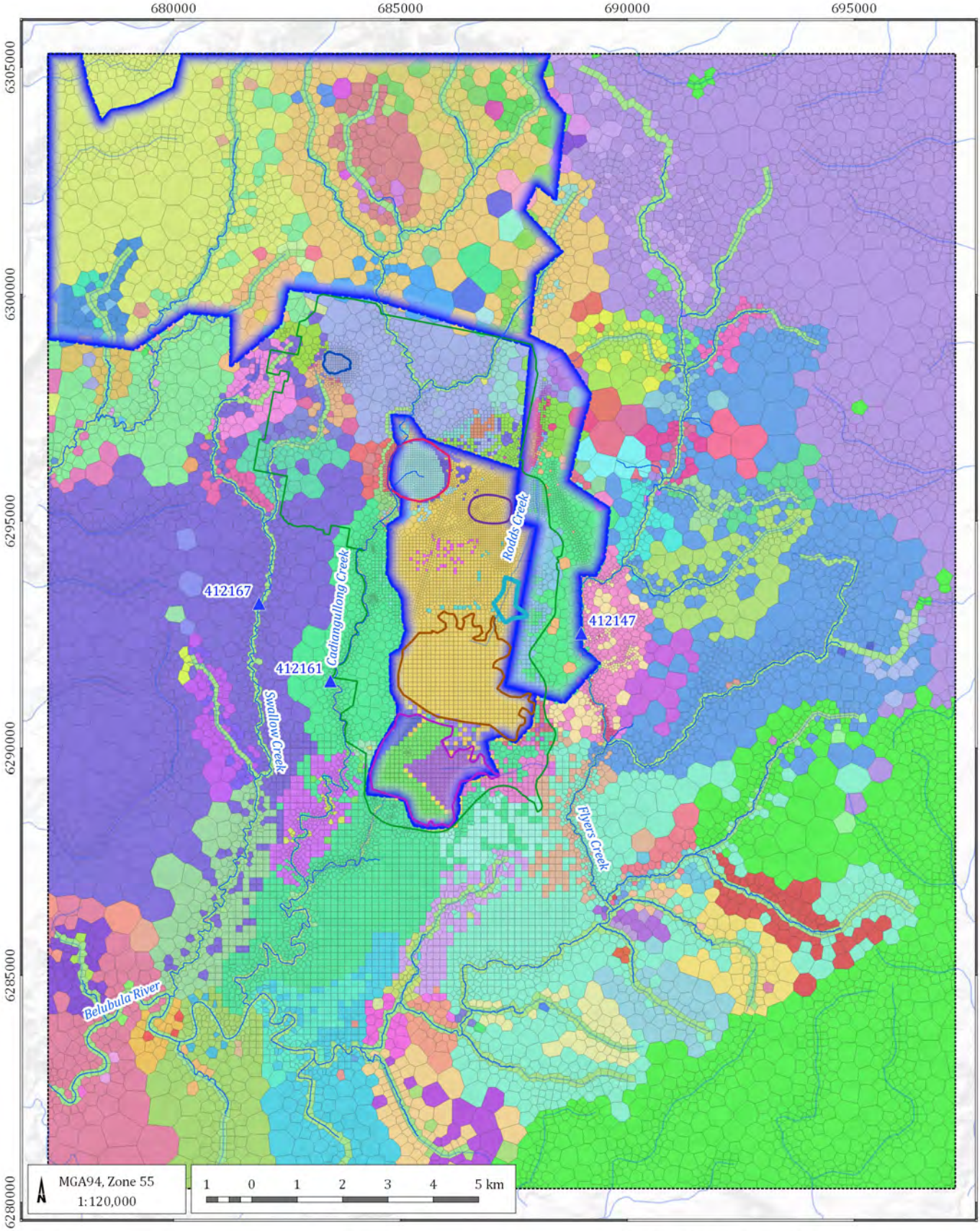
G:\Projects\G1383Y.Cadia Mine Model Update\3_GIS\Workspaces\001_Deliverable1\06.10_G1383Y_SWAT modelled evapotranspiration distribution – Annual average.qgs



LEGEND

- Gauging station
- Drainage
- Land use
- Cadia Hill Pit
- Block cave mine subsidence zone
- Ridgeway cave mine subsidence zone
- Rodds Creek dam
- NTSF
- STSF
- Mining lease
- Model grid
- Model boundary

Evapotranspiration zones

- 2
- 5
- 10
- 20
- 50
- 100
- 150
- 200
- 223

Cadia Model Update (G1383Y)

MODFLOW evapotranspiration zones and land uses

DATE 29/03/2021

FIGURE No: **6.11**

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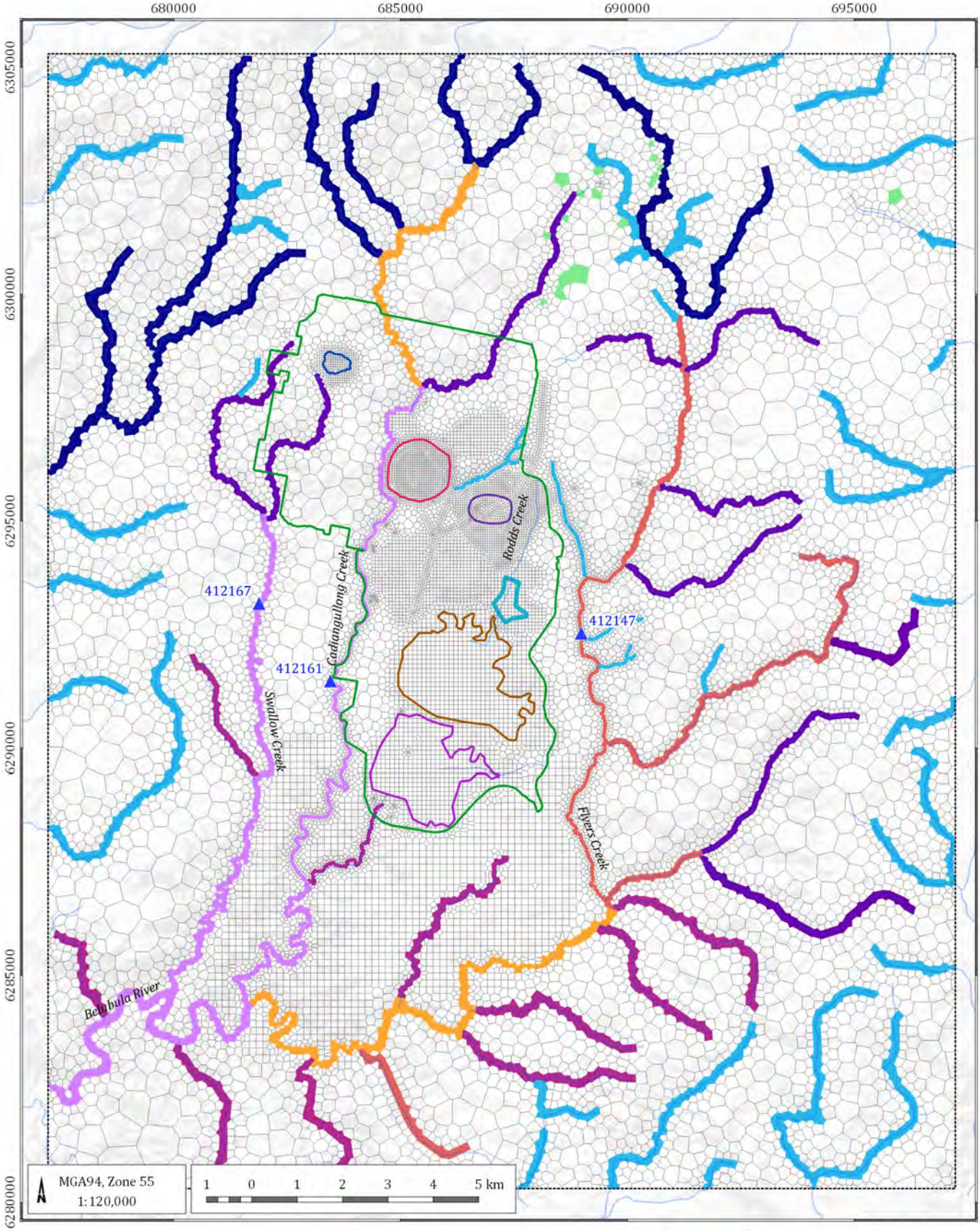
G:\Projects\G1383Y.Cadia Mine Model Update\3_GIS\Workspaces\001_Deliverable1\06.11_G1383Y_MODFLOW evapotranspiration zones and land uses.qgs

6.7 Surface drainage

The MODFLOW Streamflow-Routing (SFR2) package (Niswonger and Prudic, 2005) was used to simulate surface water routing from the SWAT+ channel flows. The package is setup to simulate prescribed transient runoff from SWAT+, whilst calculating the river stage using Manning's equation. Interactions between the groundwater systems and ephemeral watercourses (such as Cooper Gully Creek) and springs within model extent is repressed with the river (RIV) package. The network of modelled streams in the MODFLOW-USG model is shown in Figure 6.12.

Input surface water flows as calculated using the SWAT+ surface water model is processed to separate the runoff and baseflow components using an in-house script. The calculated daily runoff is averaged according to MODFLOW-USG stress periods and then imported to SFR2 package. The other drainage lines and springs simulated with the RIV package were set with a stage head of 0 m meaning baseflow into the stream could occur, but surface water recharge to the aquifer was not represented.



LEGEND

- Gauging station
- Drainage
- Cadia Hill Pit
- Block cave mine subsidence zone
- Ridgeway cave mine subsidence zone
- Rodds Creek dam
- NTSF
- STSF
- Mining lease
- Model grid
- Model boundary

RIV zones

- River cells
- Spring cells

SFR2 zones

- 1 - 11
- 11 - 21
- 21 - 31
- 31 - 41
- 41 - 51
- 51 - 60

Cadia Model Update (G1383Y)

MODFLOW-USG modelled stream network

DATE 08/04/2021

FIGURE No: **6.12**

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6.8 Mining

As discussed in the previous sections, accurately simulating the process of cave mining was one of the high priority objectives of the 2021 model updates, and a critical component in allowing the model to be used as a predictive tool to assess the regional impacts of cave mining on groundwater flow regimes.

The cave shape surfaces provided by CVO were intercepted with the 2016 regional model layers (prior to the 2021 model updates) using an in-house python script developed for cave mining. The intersected model cells were then visualised in 3D and compared with the input cave surface as shown in Figure 6.13 (front and side views).

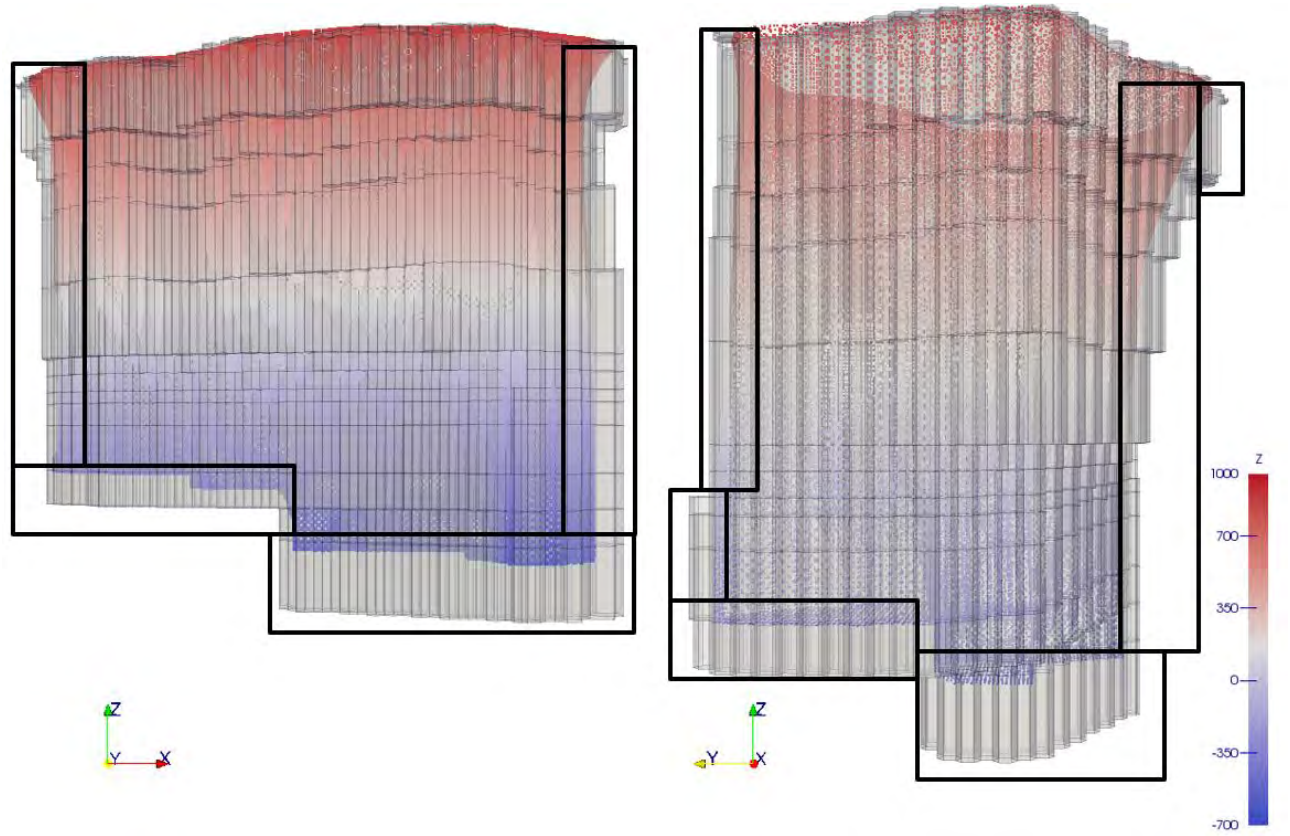


Figure 6.13 Comparison of a CE input cave shape (contoured point data) with an intercepted cave shape in 2016 model (grey cells)

The initial assessment showed that while it is possible to simulate estimated cave shapes within the groundwater model, further vertical discretisation was required to obtain a closer match, particularly with the surface of the cave shapes. Given the cave shapes have vertical variations that are smaller than the model layer thicknesses (marked with boxes in above figure), the simulation would be limited by two factors:

- The modelled cave shapes will have either a smaller (if extra cells are ignored) or larger volume than the input cave shape; and
- Vertical variations with a model cell cannot be simulated.

Considering the outcomes of this investigation, a model with sub-layering at Cadia East and Ridgeway mines was designed, as explained in section 6.3.2, and the above procedure was repeated with the updated model to reassess the quality of the modelled cave shape. A good match was achieved between the input and modelled cave shape as shown in Figure 6.14 (front and side views).

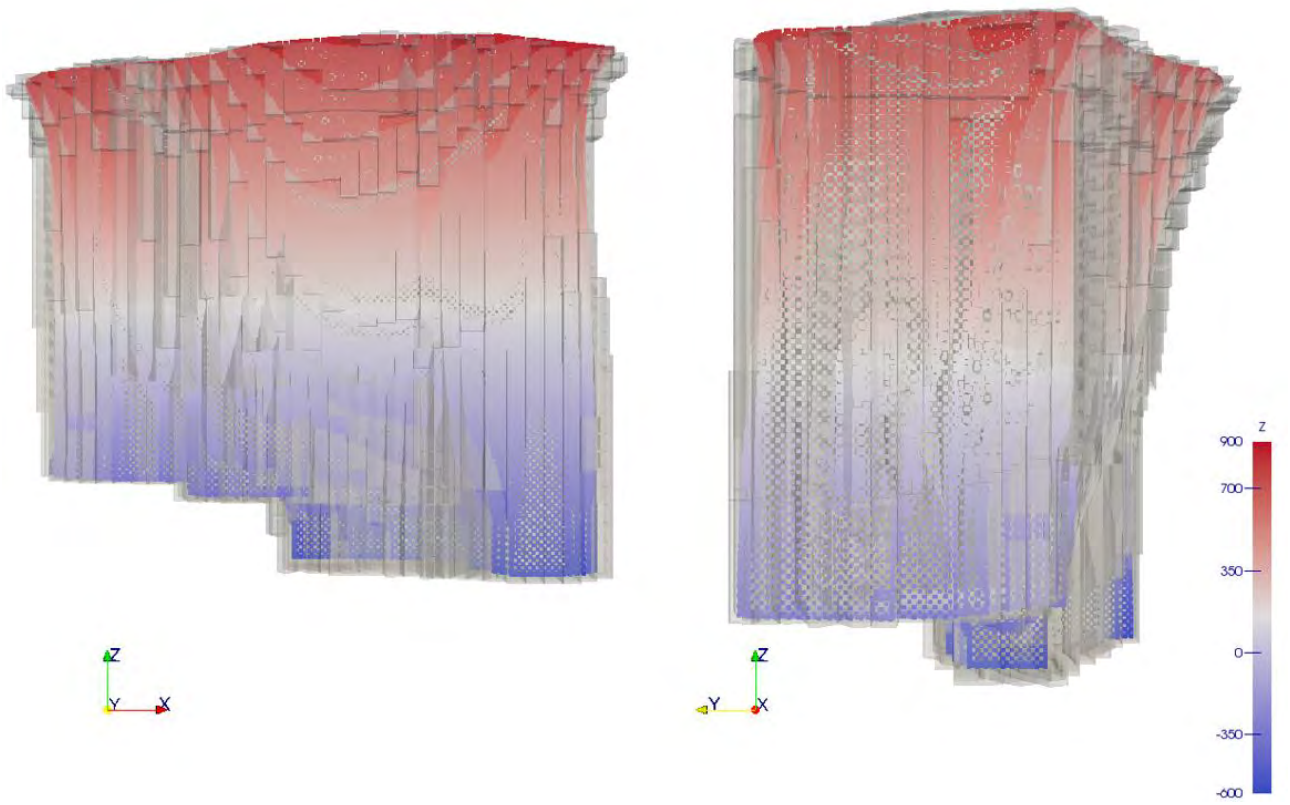


Figure 6.14 Comparison of a CE input cave shape (contoured point data) with an intercepted cave shape in the updated model (grey cells)

Mine dewatering in the model was simulated using drain (DRN) package, while cave mining fractured and crater zones and post-mining changes in the hydraulic properties were simulated using TVM package.

Dewatering from Cadia Hill and extended open pit mines was simulated using drain (DRN) package until mid-2012. After mining is ceased in Cadia Hill, the hydraulic properties were changed in the pit for PTSF simulation (discussed in the next section) and RIV package was used to keep the groundwater elevation to the bottom of pit elevation until 2018.

Three zones were defined for the simulation of cave mining in Ridgeway and Cadia East mines:

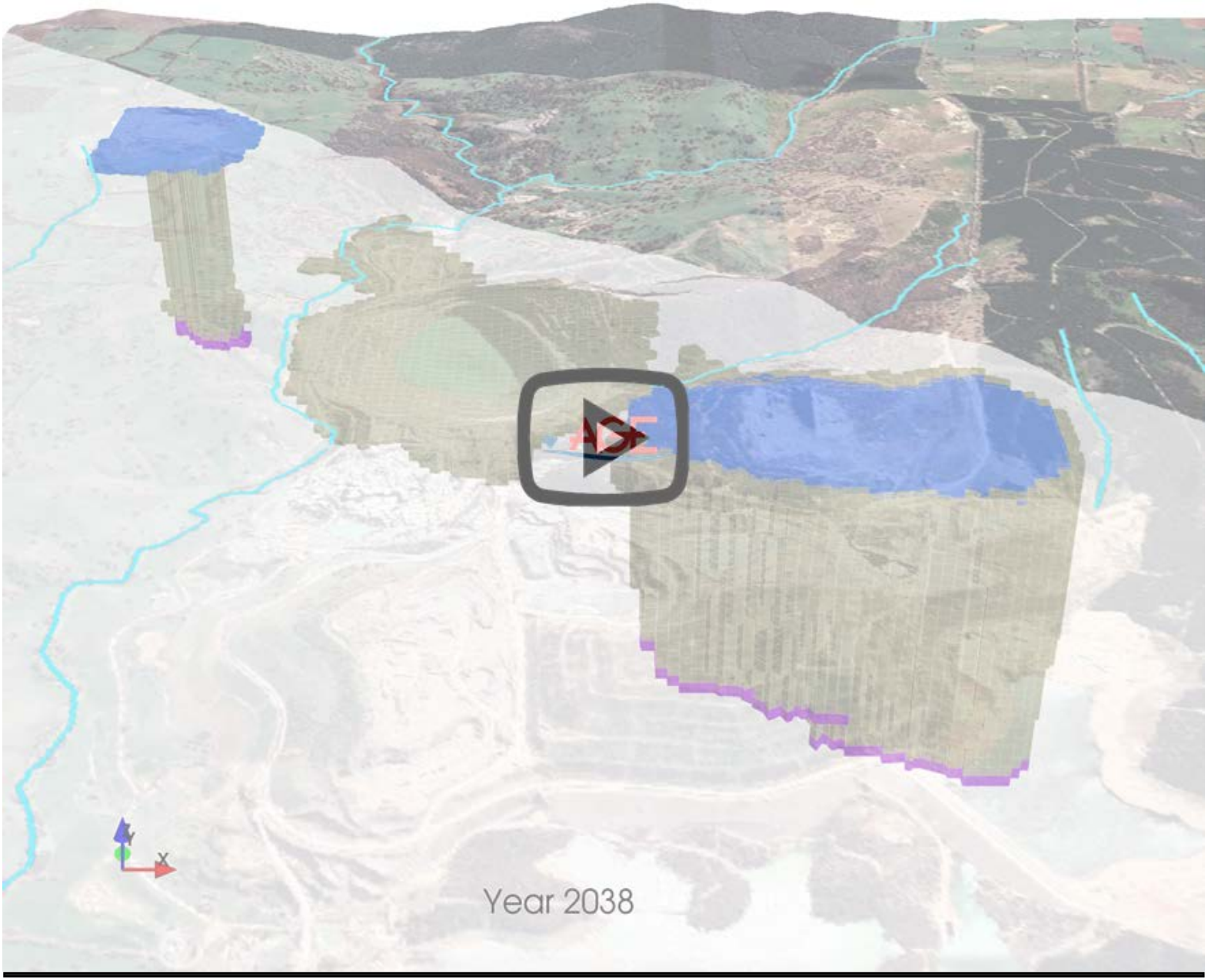
- mine workings – simulated at the bottom layer of the cave zone using active DRN cells;
- fractured cave zones – simulated above mine workings (using TVM package) matching with input cave shapes discussed previously. The cave shapes were adjusted by removing crater zones from them where cave zone and crater zone under the ground surface overlapped with each other; and
- Crater zones – simulated using TVM package to change the hydraulic properties to void.

The hydraulic properties in the cave zones and crater zones were allowed to be adjusted by the model calibration.

A series of cave and crater shapes with various dates were used to simulate the mine progression at Cadia East mine. To ensure that the cave shape dates are matched with the model timing, dewatering for each cave shape was started one stress period before so that the stress period end date and cave shape date match together. As such, the mining in Cadia East started in December 2013 to match the first cave shape (PC1) in January 2014 and the model was updated with cave shapes until financial year 2037.

Ridgeway mine sub-layer caving was simulated with three stages progressing from top to bottom (from 2001 to 2010) covering an input SLC volume. Each stage was simulated using the DRN cells at the bottom layer with TVM cells above that. After the completion of each stage the DRN cells were converted to TVM cells and the next stage was started similarly below the previous stage volume. Ridgeway Deeps mine was simulated from 2009 with the cave shapes remaining almost the same after 2014. The DRN cells were kept active since the end of mining in 2016 to continue dewatering from the mine workings. Similar to Cadia East mine simulation, a series of crater shapes were used to model the crater growth since the surface breakthrough of the mining caving in August 2002.

The complex mine progression discussed above, was visualised using time series of all mining related model cells at CVO and was converted to an animation for quality assurance as shown in Figure 6.15.



Mine progression - Cadia Valley Operations

Figure - 6.15

Cadia Mine Model Update (G1383Y)

LEGEND

Crater zone | Mine workings | Fracture cave zone/PTSF

* To play the video in Adobe, uncheck the following box, restart Adobe, and select "Trust document" when prompted: "Edit>Preferences>Security (Enhanced)>Enable Protected Mode at startup"

6.9 Other model features

6.9.1 Rodds Creek dam

Rodds Creek dam was simulated using river package becoming active in 2002, as seen in satellite images. Observed dam water elevation was averaged over the model stress periods and used as the stage elevation of the river cells with the cell bottom elevation defined as river bed elevation. The first and lass tress period elevation values (from the available dam elevation data) were extended back to 2002 and forward to 2038 as an estimation of water elevation in the dam when no data was available.

6.9.2 Tailing storage facilities

Similar approach discussed above was used for modelling NTSF and STSF using the updated TSF water elevation data. TSF levels from the previous model (AGE, 2016) was used outside the available data with constant water level growth rates in NTSF and STSF after the calibration period.

PTSF in Cadia Hill was simulated using the river package in all the model cells above the pit surface after the mining ceased in mid-2012. Water elevation was kept to the bottom of the pit surface until 2018, and after that, the water elevation in the pit was increased using the PTSF deposition schedule.

6.9.3 Carbonate fault 5

As discussed in section 5.13.4, declining groundwater levels in MB45 is likely to be due to its proximity to carbonate fault (Cb5) and enhanced connection with Cadia East mining areas. This fault outcrops next to (and under) the basalt near MB45 dipping to the southwest which intersects with zones lower than PC1 workings as shown in Figure 6.16.

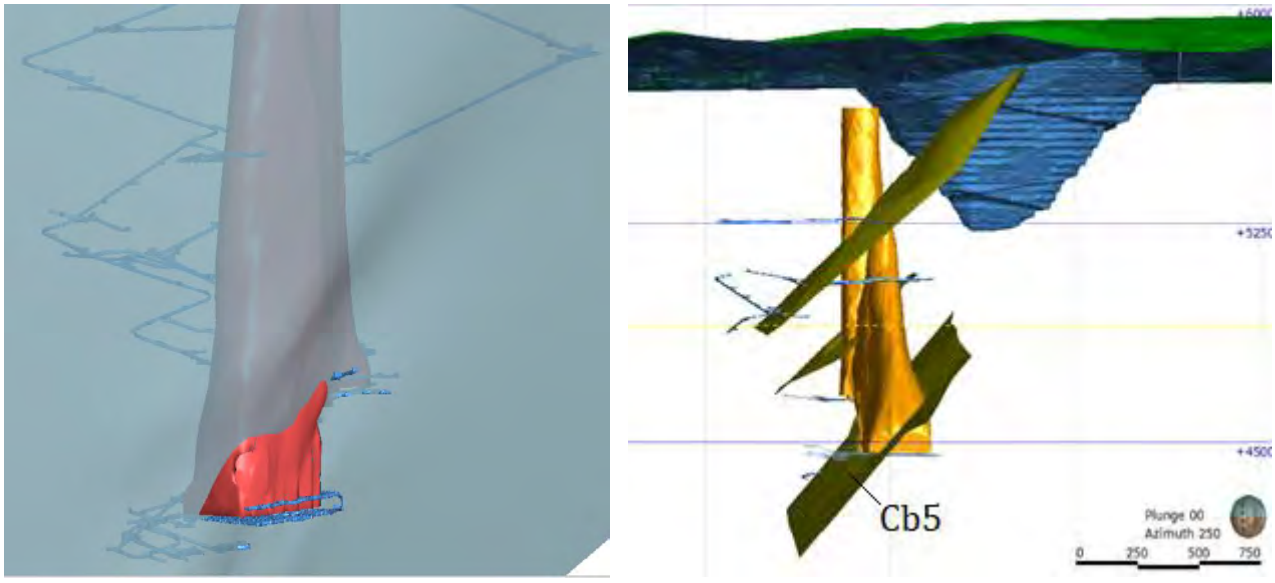


Figure 6.16 Carbonate faults intercepting Cadia East mining areas (figures from CVO presentation documents)

To allow for this increased hydraulic connection between the mining area and the basalt (aquifer) near MB45, Connected Linear Network (CLN) package was used to simulate the enhanced connection between Mb45, and fractured rocks above PC2 mine.

6.9.4 Horizontal flow barrier south of STSF

Groundwater level in bores to the south of STSF showed steady to slight rise while some of them showed no impacts from STSF (see section 5.13.6). This highlights the importance of a controlled leakage from the STSF created by the tailing's embankment. Considering the use of river package in STSF with rising groundwater elevations as well as southwest dipping ground surface, STSF embankment needs to be simulated in the model to prevent excessive leakage from the tailings to these bores. As such, horizontal flow barrier (HFB) package was used to simulate the tailing embankment south of STSF to control direct horizontal flow to the areas near Rodds Creek.

6.10 Model boundary conditions

To allow fluxes into and out of the model domain, general head boundary (GHB) condition was applied to the cells along the south and west edges of the model where they intersect with sub-basins shown in Figure 6.4. Long-term averaged depth to water table from each sub-basin in SWAT+ model was imported to GHB package in MODFLOW-USG model. No flow boundary conditions were adopted for all the other cells on the edges of model domain due to distance from the project site (over 6 km).

6.11 Model timing

The model starts with the generation of a pre-mining steady state condition, before progressing to transient model. The transient model simulates groundwater changes from 1998 to mid-2038, which is divided into 192 stress periods for historical and prediction periods.

The historical period is divided into 61 quarterly stress periods till 2012 (before mining simulation at Cadia East), followed by 96 monthly stress periods making a total of 157 historical stress periods. The predictive model represented mining activities from 2020 to mid-2038 that was divided into 35 biannual stress periods.

7 Model Calibration

The model was constructed to allow for the simulation of both historical and future approved mining at the Cadia Valley Operations, with the historical period allowing for comparison between observed and model predicted groundwater level and flow behaviour.

The combined steady state and historical transient model was calibrated by adjusting aquifer parameters and recharge rates to produce the best match between the observed and simulated water levels, while also aligning to observed mine inflow and flow at three surface water gauges. Manual parameter adjustments and automated parameterisation software (PEST, Doherty 2018) were used to determine optimal hydraulic parameters and recharge rates to achieve the best statistical calibration of the groundwater model to the observed data.

7.1 Calibration objectives and method

The objective of the model calibration exercise was to recalibrate the AGE (2016) groundwater model using transient groundwater levels, mine inflows, and surface water flow available between 1998 and 2020 after the model was rebuilt.

The recalibration varied the following parameters to match the available water levels and fluxes:

- horizontal hydraulic conductivity;
- vertical hydraulic conductivity;
- cave zone;
- creeks/river bed conductivity;
- recharge; and
- storage parameters.

7.2 Calibration targets

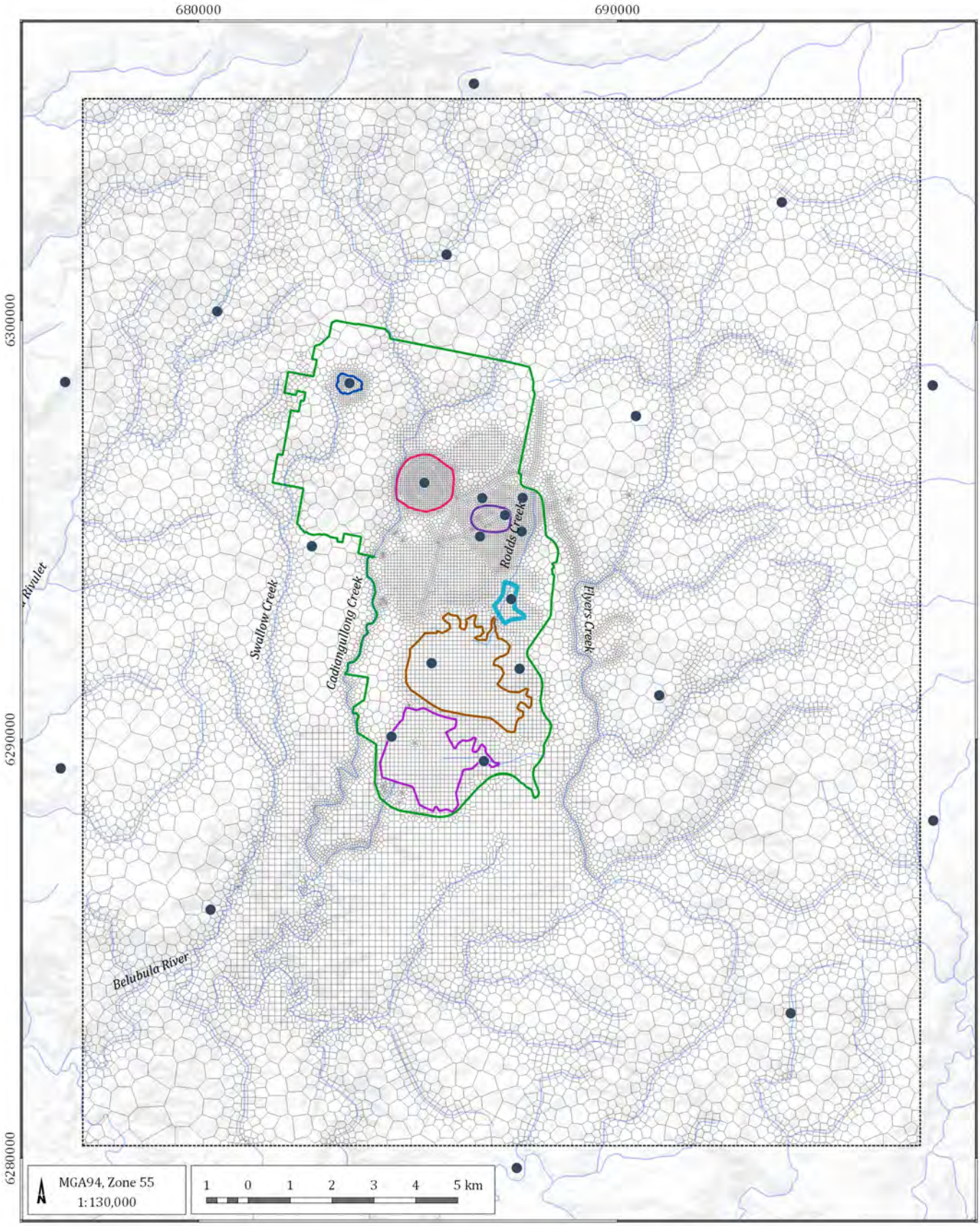
The model used water levels measured in the site monitoring bore network as shown in Figure 5.5. The steady state model used a starting water level from 136 individual bores to calibrate. The transient simulation used a wide range of data comprising:

- over 10,000 monthly-averaged groundwater level data points in 136 bores;
- over 1,300 monthly-averaged vertical gradient data points in 17 nested bores;
- annual average of mine inflows at Cadia Hill, Ridgeway and Cadia East mines; and
- 438 surface water flow data points (averaged over model stress periods) from three gauging sites at Flyers Creek (412147), Cadiangullong Creek (412161), and Swallow Creek (412167).

Considering smaller uncertainty in the accuracy of groundwater level data, higher weight was given to these data points compared to the rest of the collected data.

7.3 Pilot points

The water level responses recorded in the monitoring bores vary depending on a range of factors including bore construction, geology, location, climatic conditions, and operational activities as discussed in Section 5.13. Water levels recorded in the monitoring bores indicate heterogeneous hydraulic properties and recharge rates. To represent heterogeneity within the model domain and provide a degree of flexibility during the calibration, a series of pilot points were added to each model layer. The locations of the pilot points in each model layer are shown in Figure 7.1, and hydraulic parameter values at each pilot shown were adjusted during the steady state calibration.



LEGEND

- Pilot points
- Drainage
- Cadia Hill Pit
- Block cave mine subsidence zone
- Ridgeway cave mine subsidence zone
- Rodds Creek dam
- NTSF
- STSF
- Mining lease
- Model grid
- Model boundary

Cadia Model Update (G1383Y)

Pilot point locations

DATE 08/04/2021

FIGURE No: **7.1**

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7.4 Calibration measures

Figure 7.2 shows a scattergram of the observed and modelled groundwater levels plotted for the calibrated model. A high level of agreement between observed and modelled levels as evidenced by a root mean square (RMS) residual error of 9.5 m and a scaled RMS (SRMS) error of 1.6%. Barnett et al (2012) suggests models should aim to reduce SRMS error to less than 10%, and therefore the value of 1.6 % is considered an adequate calibration.

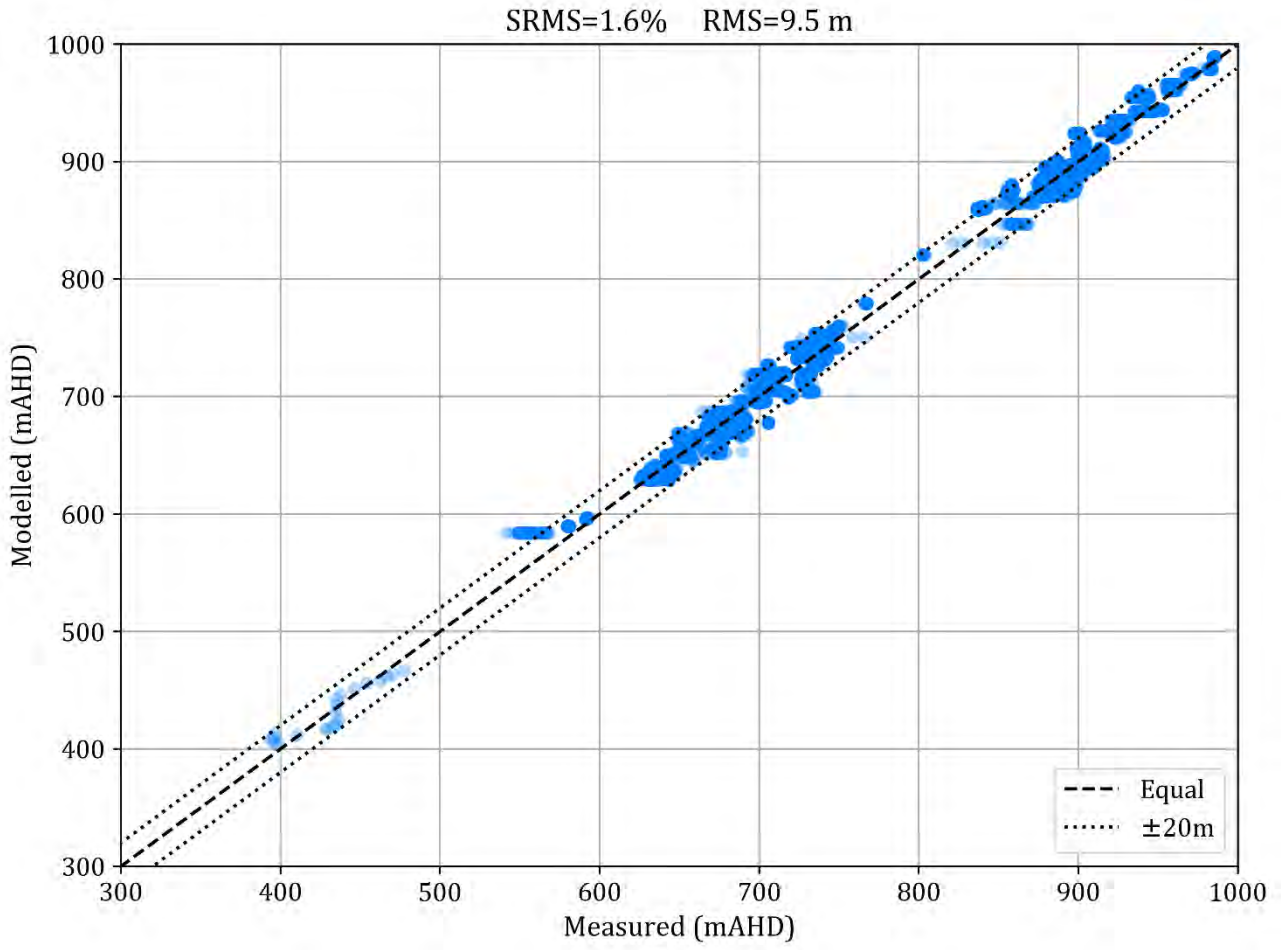
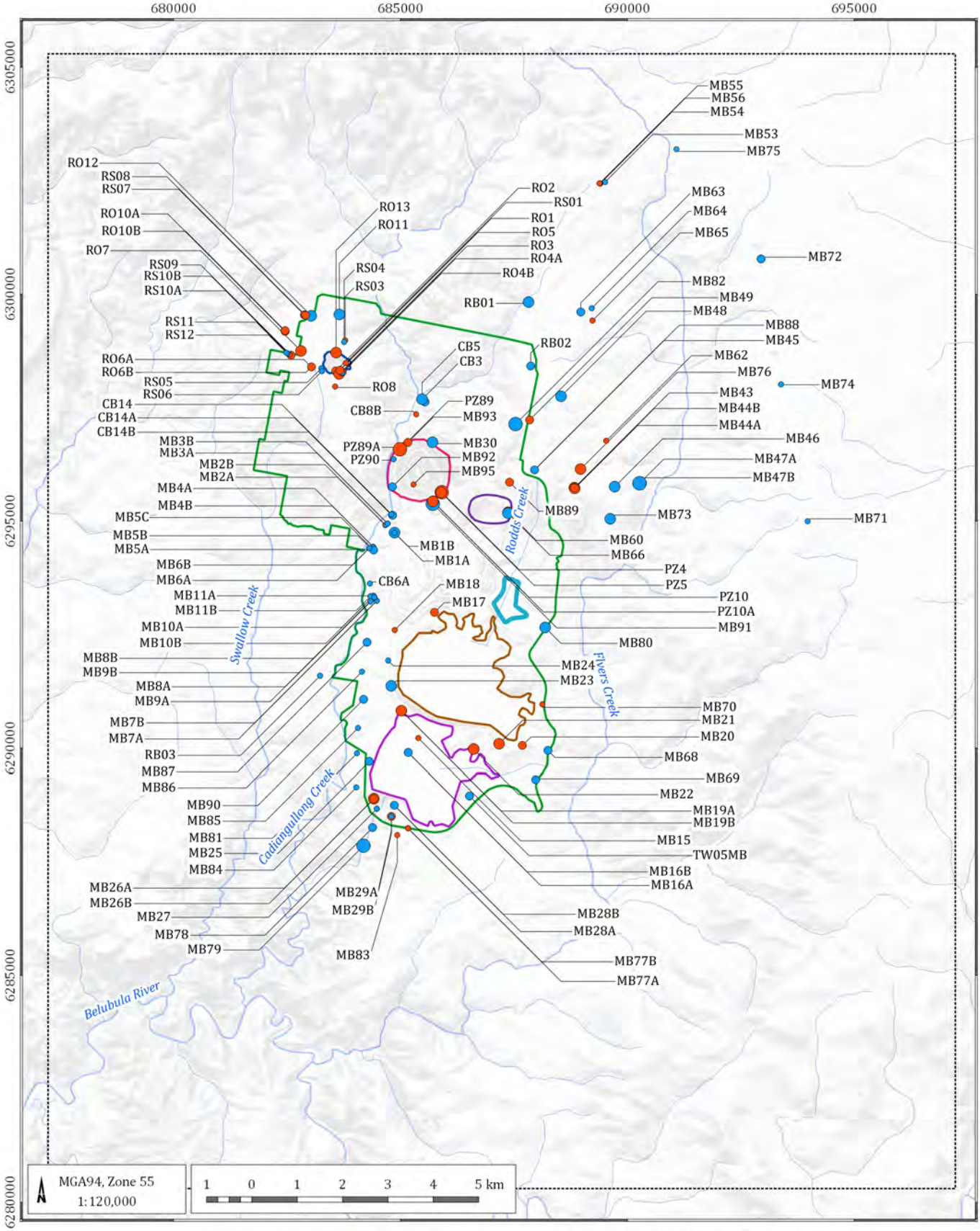


Figure 7.2 Transient calibration – modelled vs observed groundwater levels

Appendix B includes a table of average groundwater levels (observed and simulated) and residuals, which is the raw data upon which Figure 7.3 was developed. The residual is the difference between the measured and the modelled water level at each bore. A negative residual represents an over estimation of water levels, while a positive residual represents an under estimation. Figure 7.3 shows the residual value graphically with the size of bore symbol being proportional to the average residual at each site. In general, a uniform over estimation and under estimation of the groundwater level is seen within the site suggesting an appropriate amount of recharge is applied to the calibrated model. The only exception to this was seen in 33 bores along the Cadiangullong Creek, from south of Cadia Hill pit to the west of STSF, showing a minor over estimation of groundwater levels with a maximum average residual of -7.5 m and median average residual of -1.7 m. No monitoring bores were found to have a residual with the magnitude of 30 to 50 m and this range of residual was kept for comparison with the previous model calibration (AGE, 2016).

Appendix C includes all the hydrographs that show the measured groundwater levels and the model predicted water levels for 136 bores used for the transient. The hydrographs show the model has replicated many macro impacts such as rising water levels around the tailings dams, Cadia Hill PTSF (MB95) and drawdown around Ridgeway, Cadia Hill and Cadia East (MB45) mines. In most cases the groundwater levels in bores respond to the climate events however, there remain some bores that are not fully responding to the environmental process. The influence of parameter variability was explored further with a sensitivity analysis that is described in Section 8.9.



LEGEND

- Drainage
- Contour line
- Cadia Hill Pit
- Block cave mine subsidence zone
- Ridgeway cave mine subsidence zone
- Rodds Creek dam
- NTSF
- STSF
- Mining lease
- Model mesh

Residuals; observed - modelled (m)

- -50 to -30
- -30 to -20
- -20 to -10
- -10 to -5
- -5 to 0
- 0 to 5
- 5 to 10
- 10 to 20
- 20 to 30
- 30 - 50

Cadia Model Update (G1383Y)

Average transient residuals

DATE 08/04/2021

FIGURE No: **7.3**

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7.5 Calibrated aquifer parameters

Figure 7.4 and Figure 7.5 show the minimum, maximum, and average calibrated hydraulic conductivity for each layer in the horizontal and vertical directions, respectively.

As with all models, the resulting calibration is non-unique, and an alternative set of parameters could produce an equally valid calibration. Calibrated values of horizontal hydraulic conductivity for Ordovician and Silurian units are within the range of site investigations presented in Table 5.1. The adopted Kh values for basalt were lower than the ranges in the previous model (AGE, 2016). Known measurements of Tertiary basalts show variabilities and the calibrated Kh values in the updated model better match with the observed mine inflow, groundwater responses and predicted zone of drawdown (discussed in Section 8). Calibrated Kh for Ordovician unit generally shows a lower hydraulic conductivity range except for the weathered layer nine with values near the high bounds for this unit.

The calibrated range for vertical hydraulic conductivity in each model layer was approximately an order of magnitude smaller than the equivalent horizontal hydraulic conductivity. A comparison of Kv to Kh ratio (Kv/Kh) for all model cells showed a minimum, average, median, and maximum of 0.004, 0.32, 0.12, and 1, respectively.

Calibrated storage parameters for each model layer are presented in Table 7.1 and Table 7.2. One of the recommendations from the previous model performance review (AGE, 2020), was to update the specific storage values with plausible bounds suggested by Rau et el. ($2.3x10^{-7}$ m^{-1} < Ss < $1.3x10^{-5}$ m^{-1}). These bounds were later revisited by Timms et al. suggesting specific storage values ranging from $1.3x10^{-7}$ to $3.7x10^{-5}$ m^{-1}. The specific storage values in the previous model had a wide range from $1.0E^{-7}$ to $5x10^{-4}$ m^{-1}, which is now narrowed down to a more reasonable range in the calibrated model suggested by Timms et al.

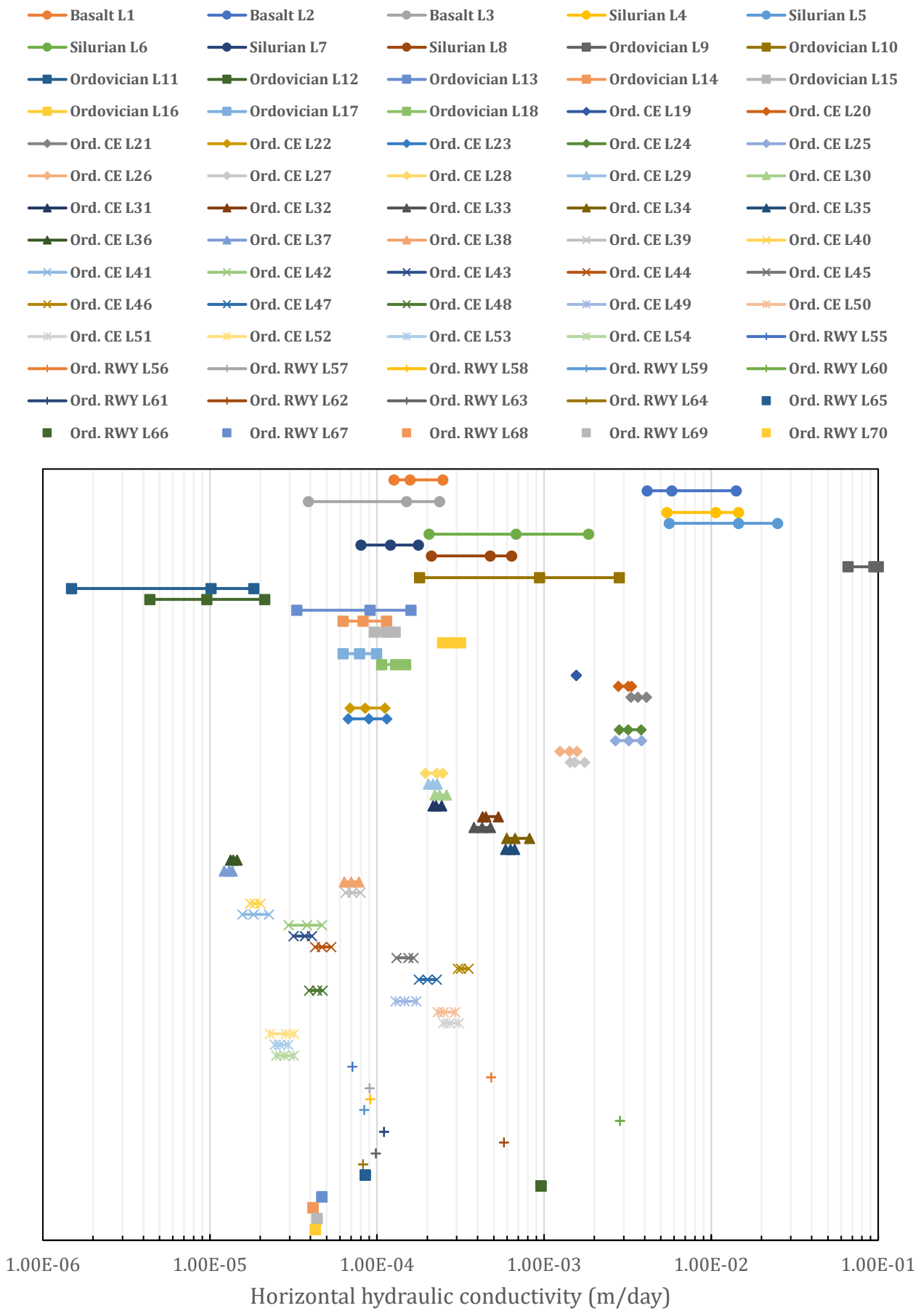


Figure 7.4 Calibrated values for horizontal hydraulic conductivity (Kh)

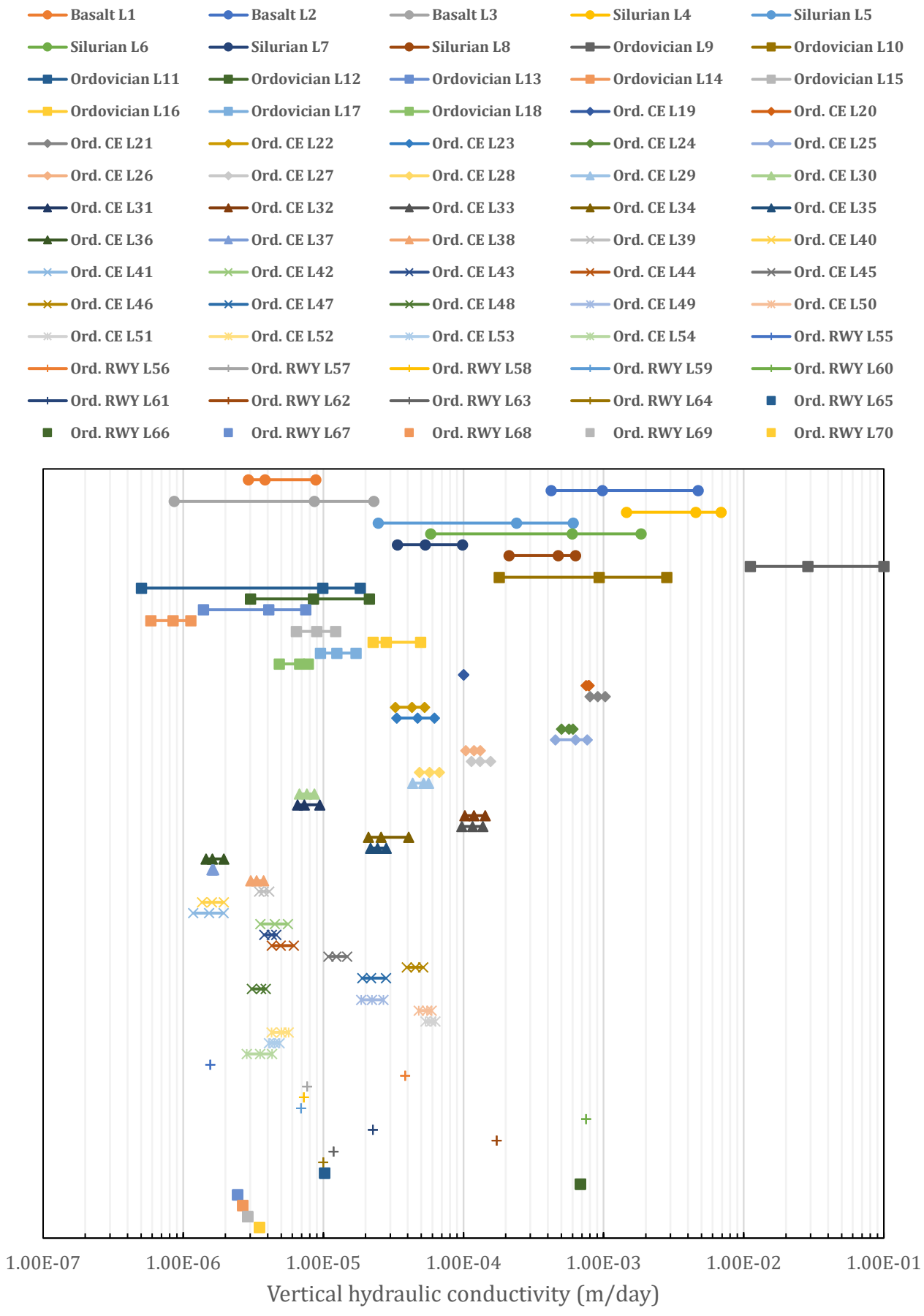


Figure 7.5 Calibrated values for vertical hydraulic conductivity (Kv)

Table 7.1 Calibrated values for specific storage

Model layer	Specific storage, Ss (m^{-1})	Model layer	Specific storage, Ss (m^{-1})
Basalt L1	$3.70X10^{-5}$	Ord. CE L36	$1.12X10^{-5}$
Basalt L2	$3.70X10^{-5}$	Ord. CE L37	$1.12X10^{-5}$
Basalt L3	$3.70X10^{-5}$	Ord. CE L38	$6.15X10^{-6}$
Silurian L4	$3.70X10^{-5}$	Ord. CE L39	$6.15X10^{-6}$
Silurian L5	$3.70X10^{-5}$	Ord. CE L40	$3.77X10^{-6}$
Silurian L6	$3.70X10^{-5}$	Ord. CE L41	$3.77X10^{-6}$
Silurian L7	$3.70X10^{-5}$	Ord. CE L42	$8.55X10^{-6}$
Silurian L8	$3.70X10^{-5}$	Ord. CE L43	$8.55X10^{-6}$
Ordovician L9	$3.70X10^{-5}$	Ord. CE L44	$8.52X10^{-6}$
Ordovician L10	$3.70X10^{-5}$	Ord. CE L45	$4.77X10^{-6}$
Ordovician L11	$3.70X10^{-5}$	Ord. CE L46	$7.34X10^{-6}$
Ordovician L12	$1.41X10^{-7}$	Ord. CE L47	$6.06X10^{-6}$
Ordovician L13	$3.70X10^{-5}$	Ord. CE L48	$6.66X10^{-6}$
Ordovician L14	$2.79X10^{-6}$	Ord. CE L49	$1.56X10^{-6}$
Ordovician L15	$3.59X10^{-6}$	Ord. CE L50	$1.09X10^{-5}$
Ordovician L16	$8.35X10^{-7}$	Ord. CE L51	$1.09X10^{-5}$
Ordovician L17	$8.06X10^{-7}$	Ord. CE L52	$5.01X10^{-6}$
Ordovician L18	$6.36X10^{-7}$	Ord. CE L53	$5.01X10^{-6}$
Ord. CE L19	$3.70X10^{-5}$	Ord. CE L54	$5.01X10^{-6}$
Ord. CE L20	$3.70X10^{-5}$	Ord. RWY L55	$9.88X10^{-6}$
Ord. CE L21	$3.70X10^{-5}$	Ord. RWY L56	$3.70X10^{-5}$
Ord. CE L22	$3.70X10^{-5}$	Ord. RWY L57	$3.70X10^{-5}$
Ord. CE L23	$3.70X10^{-5}$	Ord. RWY L58	$3.70X10^{-5}$
Ord. CE L24	$1.30X10^{-7}$	Ord. RWY L59	$3.70X10^{-5}$
Ord. CE L25	$1.30X10^{-7}$	Ord. RWY L60	$2.05X10^{-6}$
Ord. CE L26	$1.57X10^{-6}$	Ord. RWY L61	$1.37X10^{-6}$
Ord. CE L27	$1.57X10^{-6}$	Ord. RWY L62	$4.04X10^{-7}$
Ord. CE L28	$3.70X10^{-5}$	Ord. RWY L63	$8.21X10^{-7}$
Ord. CE L29	$3.70X10^{-5}$	Ord. RWY L64	$8.21X10^{-7}$
Ord. CE L30	$3.70X10^{-5}$	Ord. RWY L65	$8.21X10^{-7}$
Ord. CE L31	$3.70X10^{-5}$	Ord. RWY L66	$7.60X10^{-7}$
Ord. CE L32	$6.62X10^{-6}$	Ord. RWY L67	$1.15X10^{-6}$
Ord. CE L33	$6.62X10^{-6}$	Ord. RWY L68	$1.15X10^{-6}$
Ord. CE L34	$5.68X10^{-6}$	Ord. RWY L69	$1.15X10^{-6}$
Ord. CE L35	$5.68X10^{-6}$	Ord. RWY L70	$1.15X10^{-6}$

Table 7.2 Calibrated values for specific yield

Model layer	Specific yield, Sy (%)	Model layer	Specific yield, Sy (%)
Basalt L1	0.31	Ord. CE L36	0.10
Basalt L2	0.15	Ord. CE L37	0.10
Basalt L3	10.00	Ord. CE L38	0.10
Silurian L4	1.00	Ord. CE L39	0.10
Silurian L5	0.09	Ord. CE L40	0.17
Silurian L6	1.00	Ord. CE L41	0.17
Silurian L7	1.00	Ord. CE L42	0.47
Silurian L8	1.00	Ord. CE L43	0.47
Ordovician L9	0.50	Ord. CE L44	0.86
Ordovician L10	0.50	Ord. CE L45	0.58
Ordovician L11	0.50	Ord. CE L46	0.86
Ordovician L12	0.04	Ord. CE L47	1.95
Ordovician L13	0.01	Ord. CE L48	0.97
Ordovician L14	0.34	Ord. CE L49	0.10
Ordovician L15	0.36	Ord. CE L50	1.04
Ordovician L16	0.50	Ord. CE L51	1.04
Ordovician L17	0.50	Ord. CE L52	0.60
Ordovician L18	0.50	Ord. CE L53	0.60
Ord. CE L19	0.48	Ord. CE L54	1.18
Ord. CE L20	0.50	Ord. RWY L55	0.10
Ord. CE L21	0.50	Ord. RWY L56	0.10
Ord. CE L22	0.50	Ord. RWY L57	0.10
Ord. CE L23	0.50	Ord. RWY L58	0.10
Ord. CE L24	0.10	Ord. RWY L59	0.10
Ord. CE L25	0.10	Ord. RWY L60	0.10
Ord. CE L26	0.10	Ord. RWY L61	0.10
Ord. CE L27	0.10	Ord. RWY L62	0.10
Ord. CE L28	0.10	Ord. RWY L63	0.10
Ord. CE L29	0.10	Ord. RWY L64	0.10
Ord. CE L30	0.10	Ord. RWY L65	0.10
Ord. CE L31	0.10	Ord. RWY L66	0.50
Ord. CE L32	0.10	Ord. RWY L67	0.50
Ord. CE L33	0.10	Ord. RWY L68	0.50
Ord. CE L34	0.10	Ord. RWY L69	0.50
Ord. CE L35	0.10	Ord. RWY L70	0.50

7.6 Calibrated water budget

Table 7.3 shows individual water budget components for the transient simulation. Transient results represent long term averages for the full historic transient modelling period, January 1998 to December 2020 inclusive.

Table 7.3 Steady state and calibrated water budget – average (ML/day)

Water budget component	Transient model average (ML/day)		
	in	out	in - out
Rainfall recharge	24.69	0	24.69
Stream	0.19	-1.14	-0.95
River	0.55	-1.06	-0.51
Drain	0	-0.90	-0.90
Evapotranspiration	0	-22.82	-22.82
General head boundary	0.46	-0.07	0.39
Total	**25.89**	**-25.99**	**-0.1**

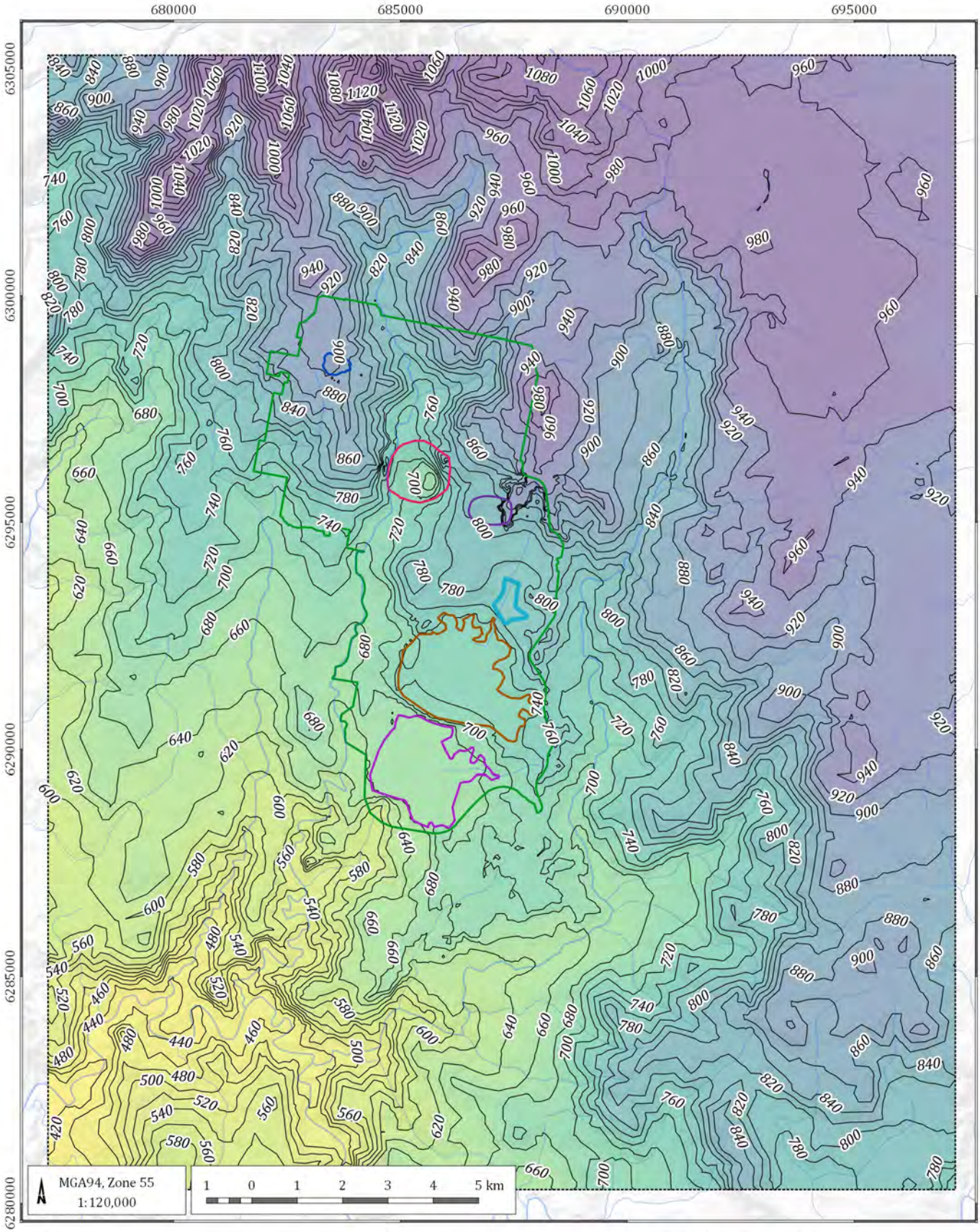
The average water budget of the entire model domain during the transient runs is dominated by inflows and outflows to/from shallow groundwater systems. Recharge is the main mechanism for groundwater input into the model with 95% of total groundwater input in the transient model. The groundwater discharge from the model is dominated by evapotranspiration with 88% of the total groundwater discharged during the transient model run. Surface drainage from stream and river cells as well as mine dewatering from the drain cells are other mechanisms for discharge from the model with smaller impacts on the overall water budget.

The mass balance error is a parameter used to quantify the quality of the internal numerical solution of the simulation, defined as the difference between the model inflows and outflows at the completion of model run. The maximum percent discrepancy at any one time step in the transient simulation was 0.28% which confirms that an accurate numerical solution was achieved and is well below the 2% criteria outlined in the Australian groundwater modelling guidelines.

7.7 Calibrated groundwater levels

Figure 7.6 and Figure 7.7 show the simulated steady state groundwater levels in top layers and model layers between Ridgeway Deeps and Cadia East, respectively. The figures show shallow groundwater levels and flow directions in top layers reflect the topography and are influenced by the main creeks that act as the discharge zones for the groundwater systems. The groundwater levels within the deeper layers which represents the deeper Forest Reef Volcanics, are more subdued and show little influence from topographic features with a gentle hydraulic gradient towards the south-west.

Figure 7.7 and Figure 7.8 show simulated groundwater levels at the end of the transient calibration model in 2020. The figures show the drawdown zones within the potentiometric surface caused by the mining activities in Cadia Hill open pit and Ridgeway.



LEGEND

- Drainage
- Contour line
- Cadia Hill Pit
- Block cave mine subsidence zone
- Ridgeway cave mine subsidence zone
- Rodds Creek dam
- NTSF
- STSF
- Mining lease

Groundwater level (mAHD)

- 400
- 500
- 600
- 700
- 800
- 900
- 1000
- 1100
- 1200

Cadia Model Update (G1383Y)

Simulated groundwater levels in top layers – steady state

DATE 08/04/2021

FIGURE No: **7.6**

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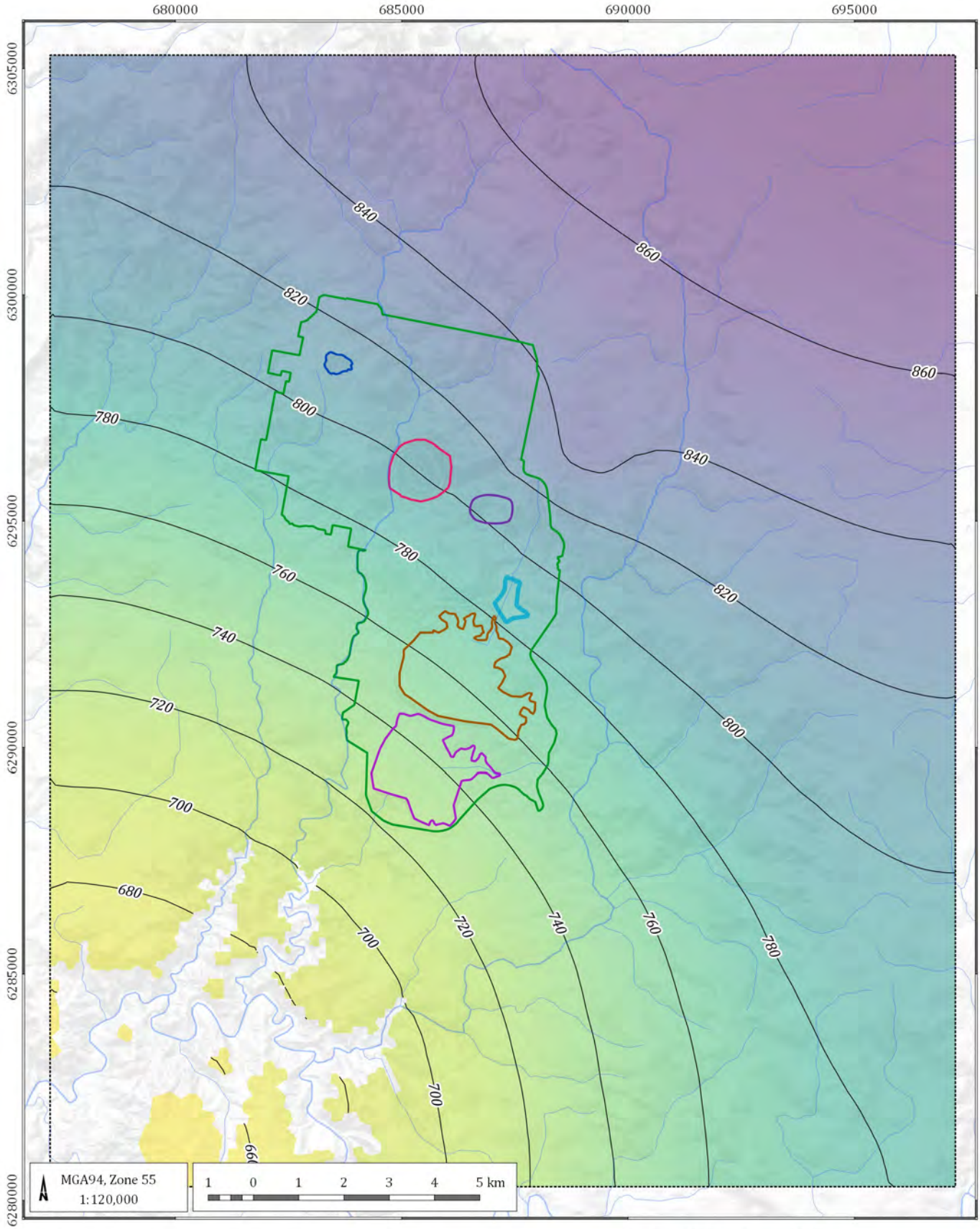
G:\Projects\G1383Y.Cadia Mine Model Update\3_GIS\Workspaces\001_Deliverable1\07.06_G1383Y_Simulated groundwater levels in top layers – steady state.qgs



LEGEND

- Drainage
- Contour line
- Cadia Hill Pit
- Block cave mine subsidence zone
- Ridgeway cave mine subsidence zone
- Rodds Creek dam
- NTSF
- STSF
- Mining lease
- Model mesh

Groundwater level (mAHD)

- 650
- 700
- 750
- 800
- 850
- 900

Cadia Model Update (G1383Y)

Simulated groundwater levels in zone between Ridgeway Deeps and Cadia East (layers 15, 42, and 67)– steady state

DATE 08/04/2021

FIGURE No: **7.7**

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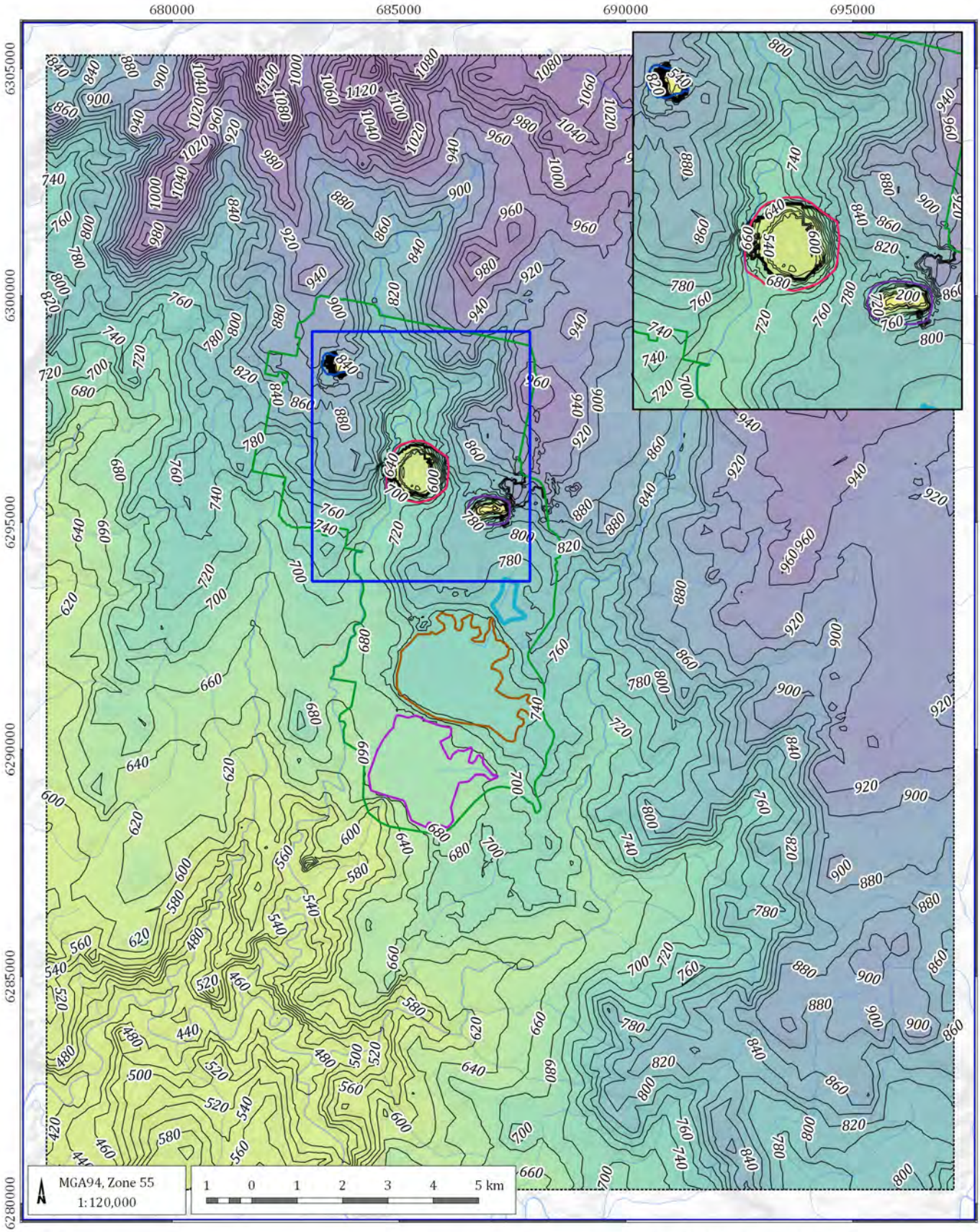
G:\Projects\G1383Y.Cadia Mine Model Update\3_GIS\Workspaces\001_Deliverable1\07.07_G1383Y_Simulated groundwater levels in zone between Ridgeway Deeps and Cadia East (layers 15, 42, and 67)– steady state_v01.qgs



LEGEND

- Drainage
- Contour line
- Cadia Hill Pit
- Block cave mine subsidence zone
- Ridgeway cave mine subsidence zone
- Rodds Creek dam
- NTSF
- STSF
- Mining lease
- Model mesh

Groundwater level (mAHD)

- -300
- -200
- 200
- 400
- 600
- 800
- 1000
- 1200

Cadia Model Update (G1383Y)

Simulated groundwater levels in top layers – end of transient calibration (December 2020)

DATE 08/04/2021

FIGURE No: **7.8**

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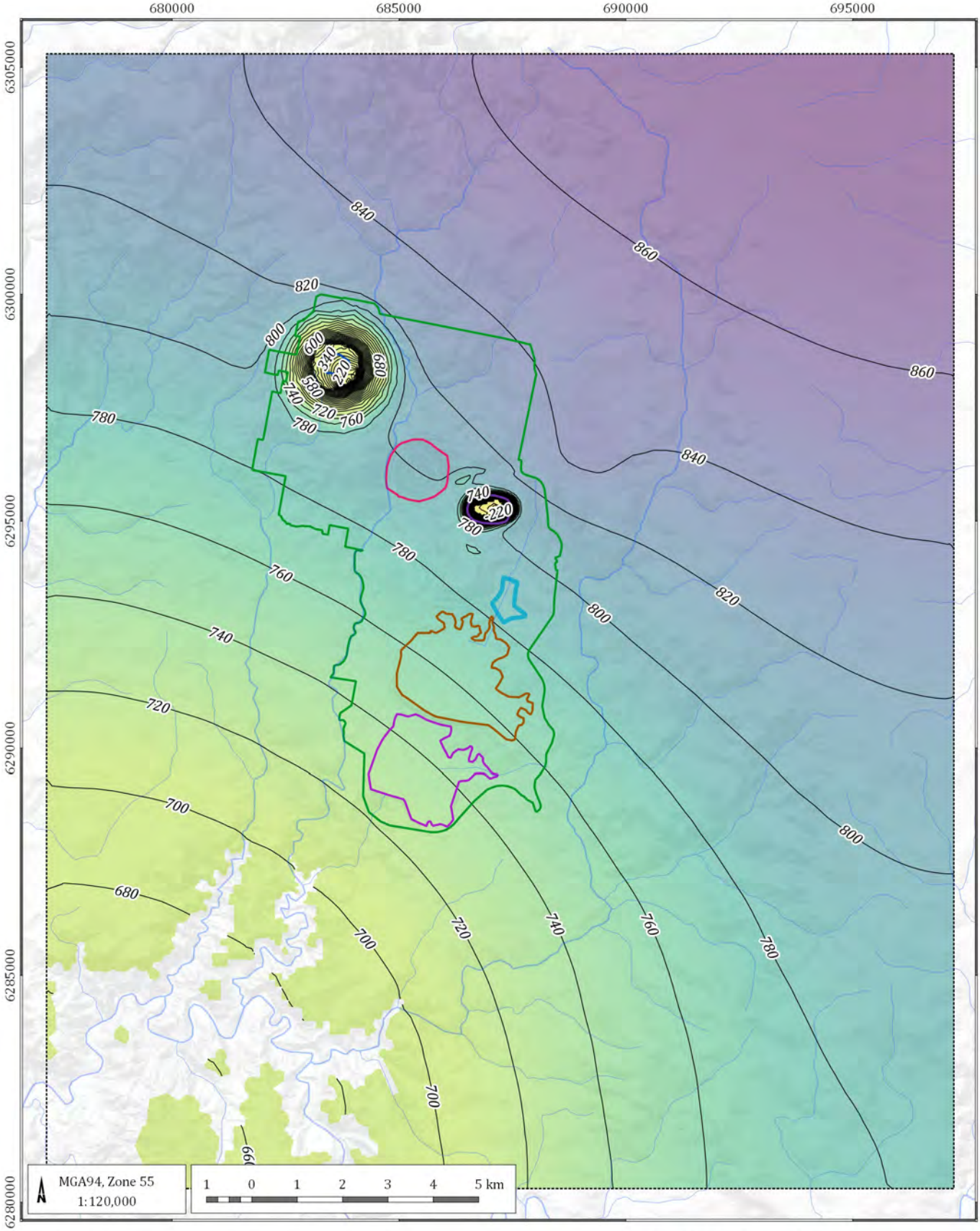
G:\Projects\G1383Y.Cadia Mine Model Update\3_GIS\Workspaces\001_Deliverable1\07_08_G1383Y_Simulated groundwater levels in top layers – end of transient calibration (December 2020).qgs



LEGEND

- Drainage
- Contour line
- Cadia Hill Pit
- Block cave mine subsidence zone
- Ridgeway cave mine subsidence zone
- Rodds Creek dam
- NTSF
- STSF
- Mining lease
- Model mesh

Groundwater level (mAHD)

- -400
- -200
- 200
- 400
- 800
- 900

Cadia Model Update (G1383Y)

Simulated groundwater levels in zone between Ridgeway Deeps and Cadia East (layers 15, 42, and 67)– end of transient calibration (December 2020)

DATE 08/04/2021

FIGURE No: **7.9**

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G:\Projects\G1383Y.Cadia Mine Model Update\3_GIS\Workspaces\001_Deliverable1\07.09_G1383Y_Simulated groundwater levels in zone between Ridgeway Deeps and Cadia East (layers 15, 42, and 67)– end of transient calibration (December 2020)_v01.qgs

7.8 Calibrated surface water flows

Observations of surface water flow were used indirectly to confirm the groundwater model was sufficiently calibrated.

Figure 7.10 shows the measured flow duration curves from available gauges and corresponding predicted flow duration from the groundwater model for the Flyers, Cadiangullong, and Swallow creeks. These figures show that generally the groundwater model is predicting surface water flow within less than an order of magnitude, which is acceptable for a groundwater model. As shown in the flow duration curves, high flows and low flows at each gauge are generally well matched, suggesting that the surface water runoff calculations undertaken by SWAT+ are reliable.

Figure 7.11 provides a comparison of these observed and modelled flows on a transient basis. The groundwater model shows a very good level of agreement with the climatic trends during periods of high or low rainfall with varying flow rates along the drainage lines.

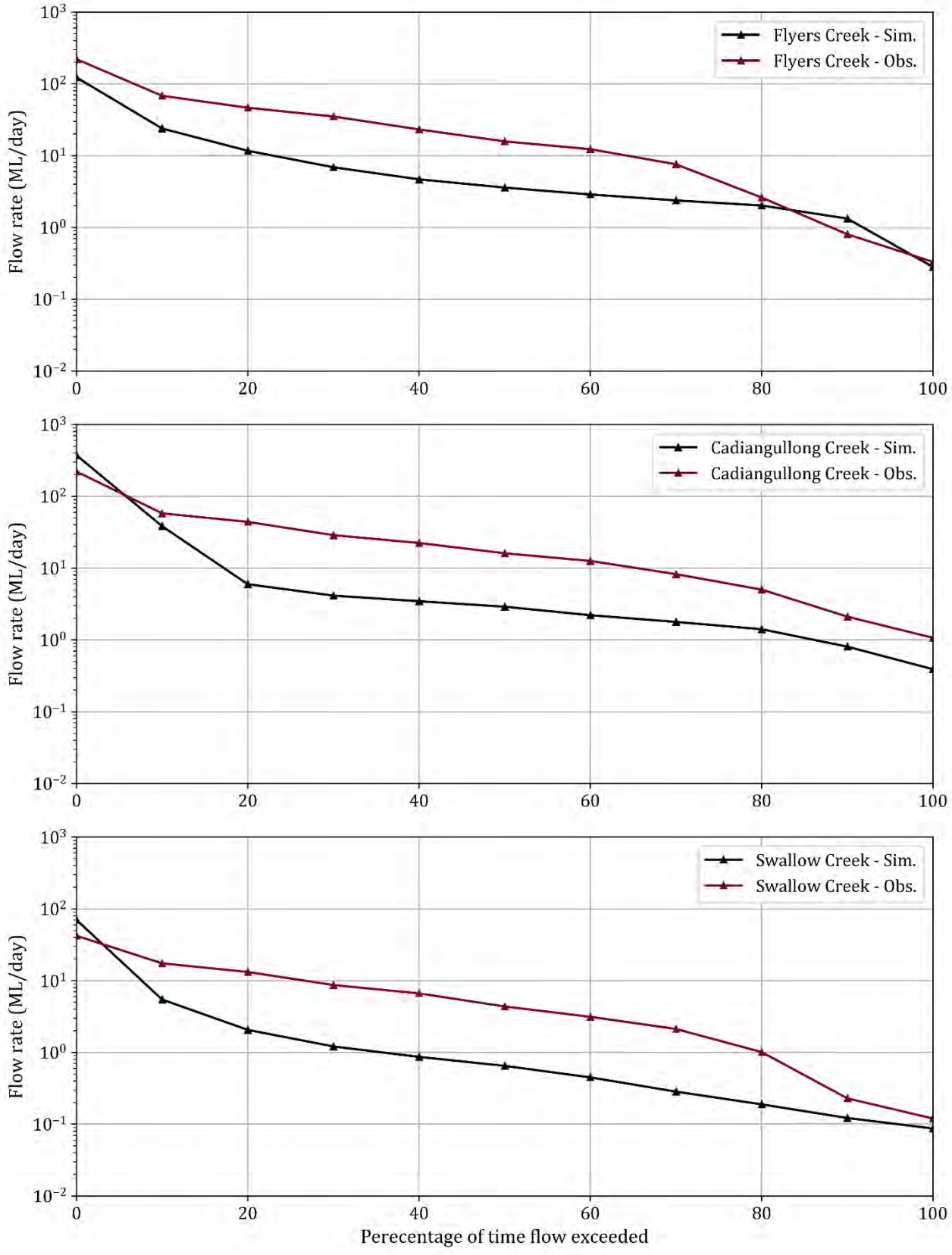


Figure 7.10 Measured and simulated flow duration curves at Flyers Creek (412147), Cadiangullong Creek (412161), and Swallow Creek (412167)

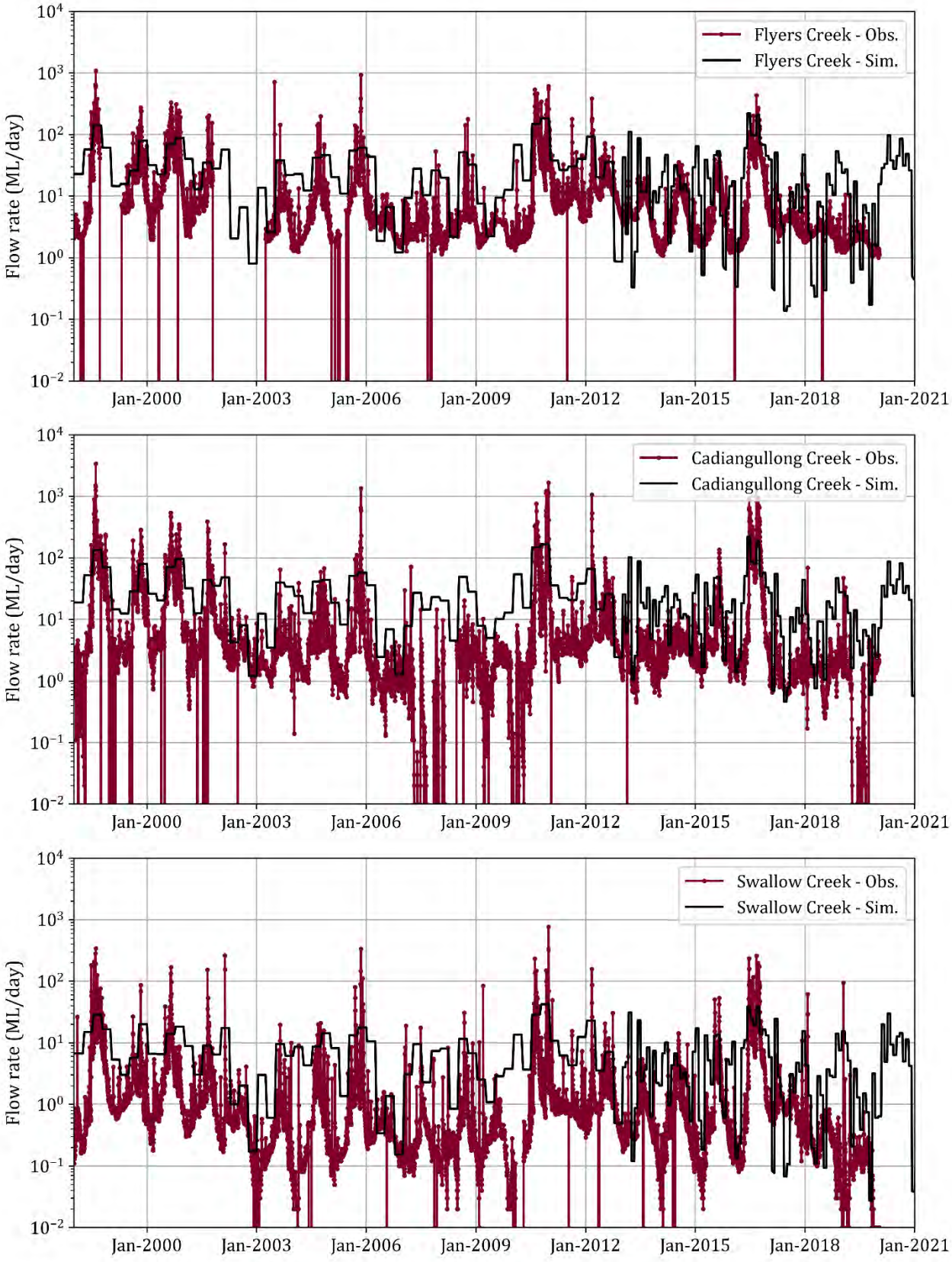


Figure 7.11 Measured and simulated flow rates at Flyers Creek (412147), Cadiangullong Creek (412161), and Swallow Creek (412167)

8 Predictions and sensitivity analysis

8.1 Predictive model setup

The predictive model continues on from the calibration model and simulates proposed approved mining until June 2038 with a model run that extend over this period. The Cadia East footprint is expected to expand from present day as shown in Figure 6.15. Ridgeway Mine continues to be simulated in care and maintenance. Cadia Hill pit continues to be used for the storage of tailings, with the level of tailings continue to increase until the end of the predictive simulation in 2038.

Recharge and streamflow are setup to match long term average monitoring, as the most appropriate way to represent these unknown rates.

8.2 Predicted changes in mine inflows

Figure 8.1 presents the predicted mine inflows through the calibration period and into the future until the approved end of mining. The predicted inflow for Cadia East is only shown to 2017, where the mining was dewatered after the end of mining and the pit void started to receive tailings. The inflow for Ridgeway remains fairly statis through to the end of mining which is to be expected given its 'care and maintenance' status.

Inflow to Cadia East is predicted to increase as mining progresses into the future, reaching a peak inflow of approximately 0.75 ML/day. This is a reasonable estimate of an averaged inflow and aligns well with current observations. Actual inflows are expected to be more variable as finer detail in the fracture network is intercepted by the cave zone, and may result in short lived high inflows (i.e. inrushes) which are beyond the ability of this regional scale impact model to predict.

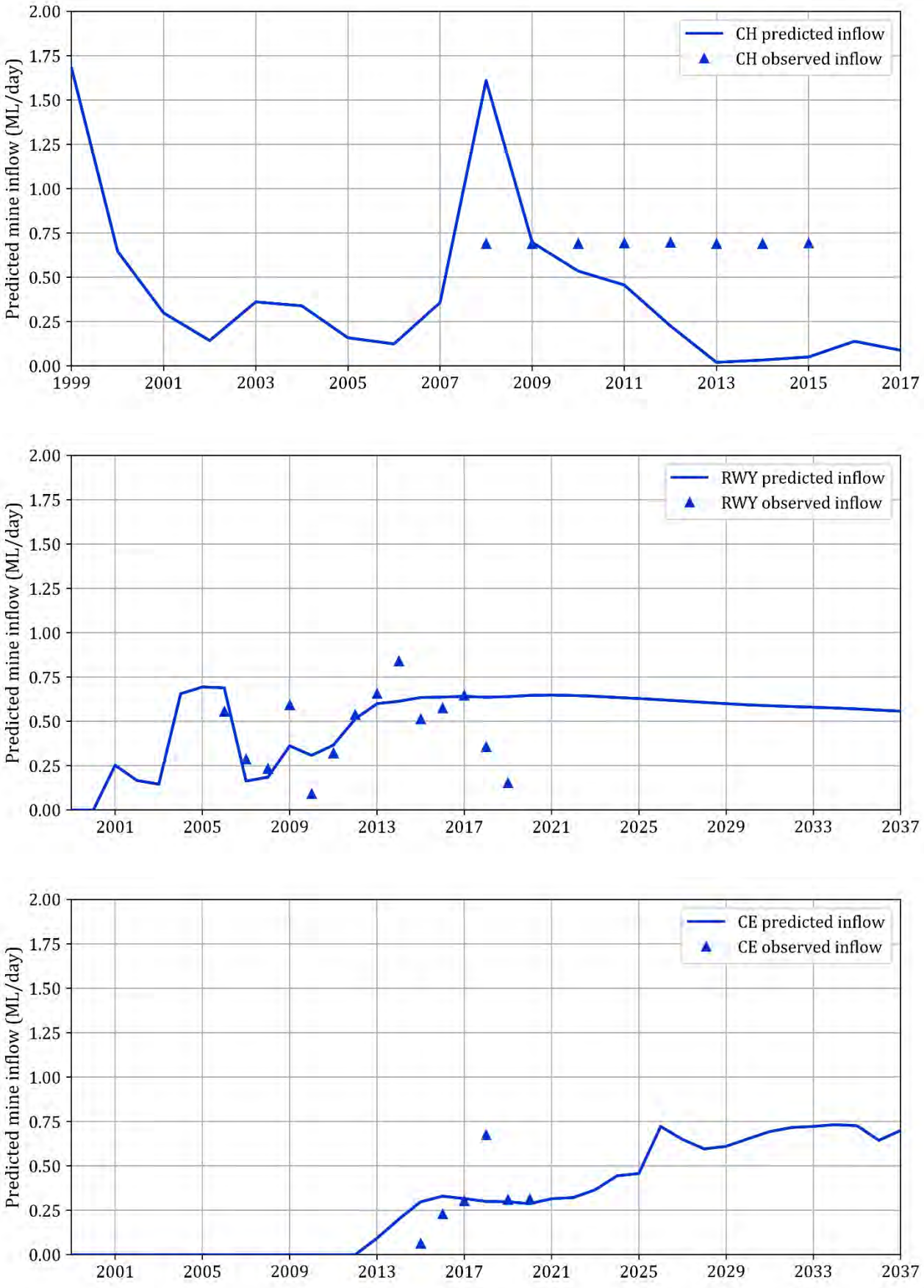
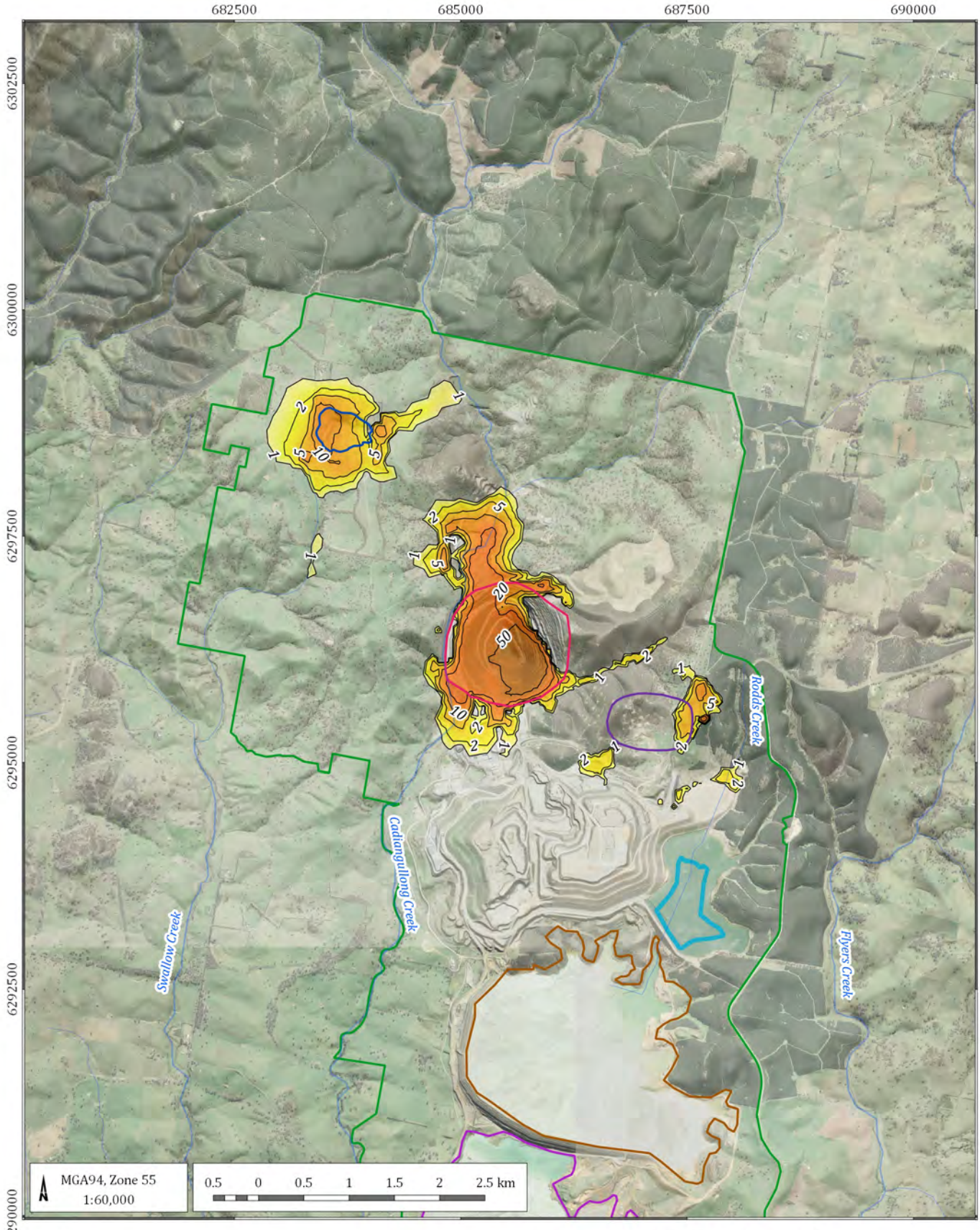


Figure 8.1 Predicted mine inflows

8.3 Predicted changes in water levels

Mine dewatering and tailings emplacement will modify groundwater levels across the Cadia Valley Operations into the future. Groundwater drawdown in the shallow formations is largely contained within the mining lease, as demonstrated in the predicted drawdown for top layers at the end of mining and the maximum water table drawdown (see Figure 8.2 and Figure 8.3). Deeper strata shows the depressurisation extending further than the shallower drawdown due to the low storage values. Depressurisation in the Ordovician at the base of the Cadia Hill Pit extends marginally outside of the mining lease extent (see Figure 8.4) which is of little consequence given its depth. Further depressurisation extent is predicted below the Ridgeway mine and towards the deeper parts of the Cadia East mine, as shown in Figure 8.5 for the end of mining.



LEGEND

- Drainage
- Contour line
- Cadia Hill Pit
- Block cave mine subsidence zone
- Ridgeway cave mine subsidence zone
- Rodds Creek dam
- NTSF
- STSF
- Mining lease

Drawdown (m)

- 0
- 1
- 2
- 5
- 10
- 20
- 50
- 100
- 200
- 500

Cadia Model Update (G1383Y)

Top layers – Maximum zone of drawdown in saturated areas

DATE 17/03/2021

FIGURE No: **8.2**

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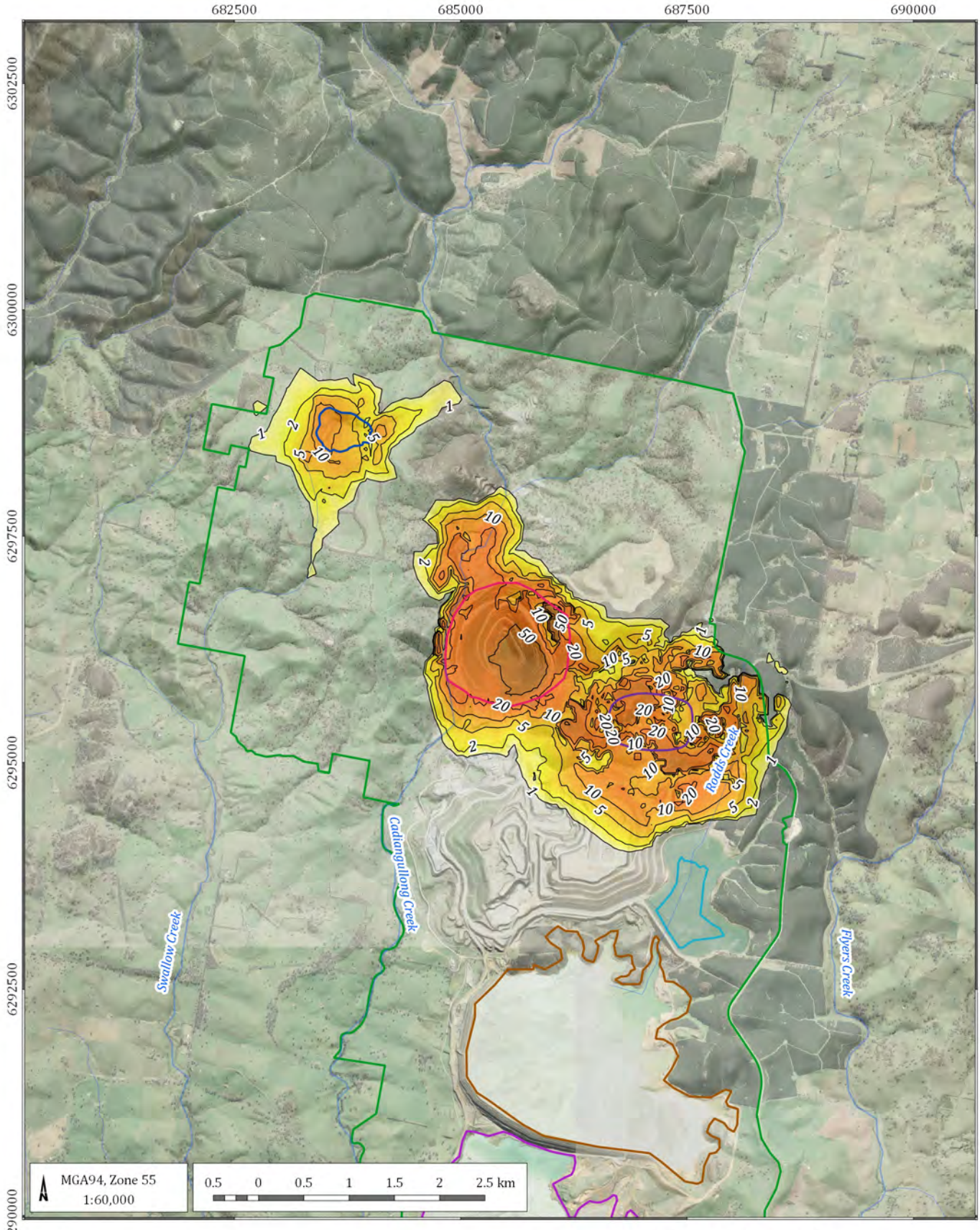
G:\Projects\G1383Y.Cadia Mine Model Update\3_GIS\Workspaces\001_Deliverable1\08.02_G1383Y_Top layers – Maximum zone of drawdown in saturated areas.qgs



LEGEND

- Drainage
- Contour line
- Cadia Hill Pit
- Block cave mine subsidence zone
- Ridgeway cave mine subsidence zone
- Rodds Creek dam
- NTSF
- STSF
- Mining lease

Drawdown (m)

- 0
- 1
- 2
- 5
- 10
- 20
- 50
- 100
- 200
- 500

Cadia Model Update (G1383Y)

Water table – Maximum zone of drawdown

DATE 29/03/2021

FIGURE No: **8.3**

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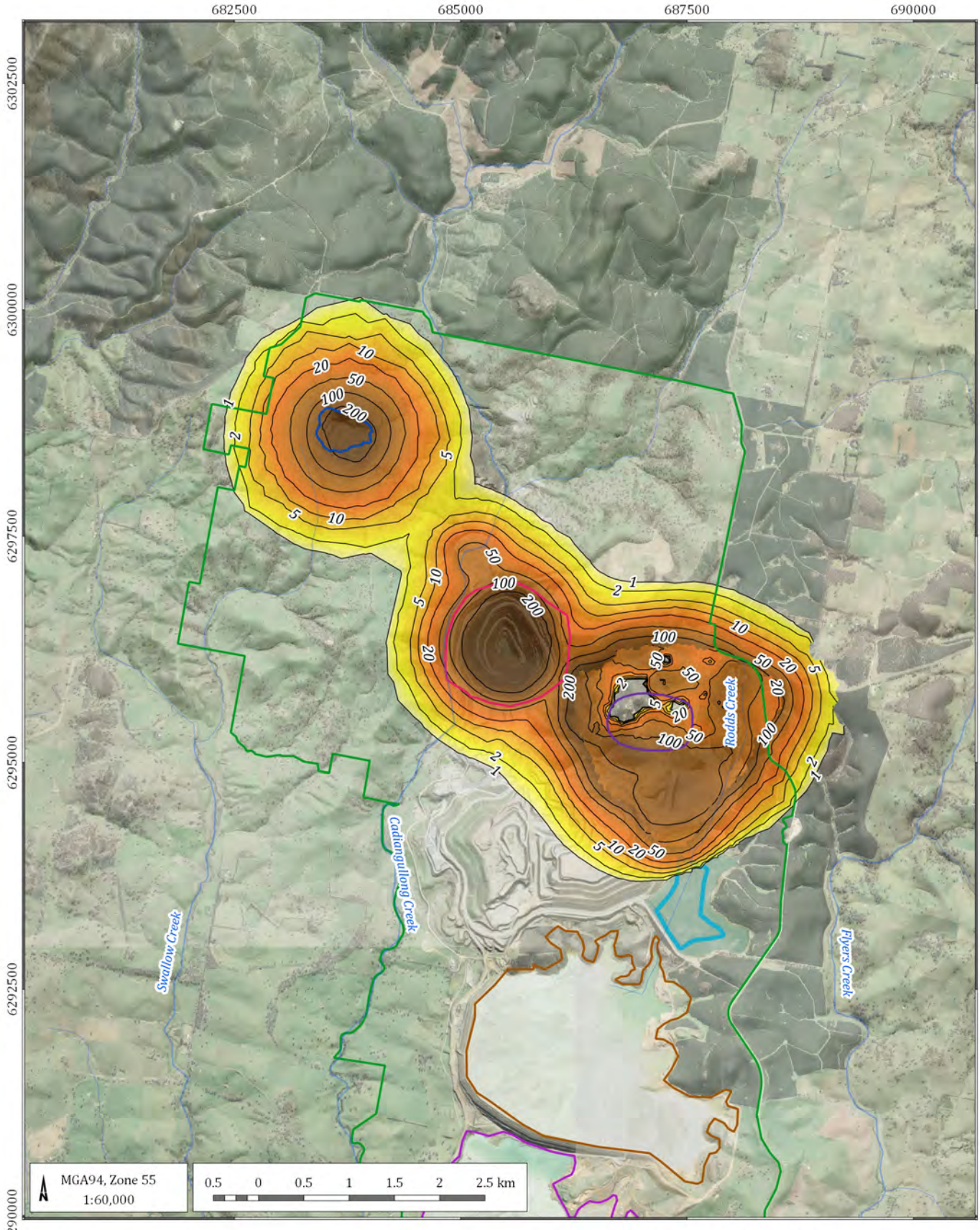
G:\Projects\G1383Y.Cadia Mine Model Update\3_GIS\Workspaces\001_Deliverable1\08.03_G1383Y_Water table – Maximum zone of drawdown.qgs



LEGEND

- Drainage
- Contour line
- Cadia Hill Pit
- Block cave mine subsidence zone
- Ridgeway cave mine subsidence zone
- Rodds Creek dam
- NTSF
- STSF
- Mining lease

Drawdown (m)

- 0
- 1
- 2
- 5
- 10
- 20
- 50
- 100
- 200
- 500

Cadia Model Update (G1383Y)

Ordovician (Cadia Hill bottom pit) and Silurian – Maximum zone of drawdown in layers 8 and 12

DATE 29/03/2021

FIGURE No: **8.4**

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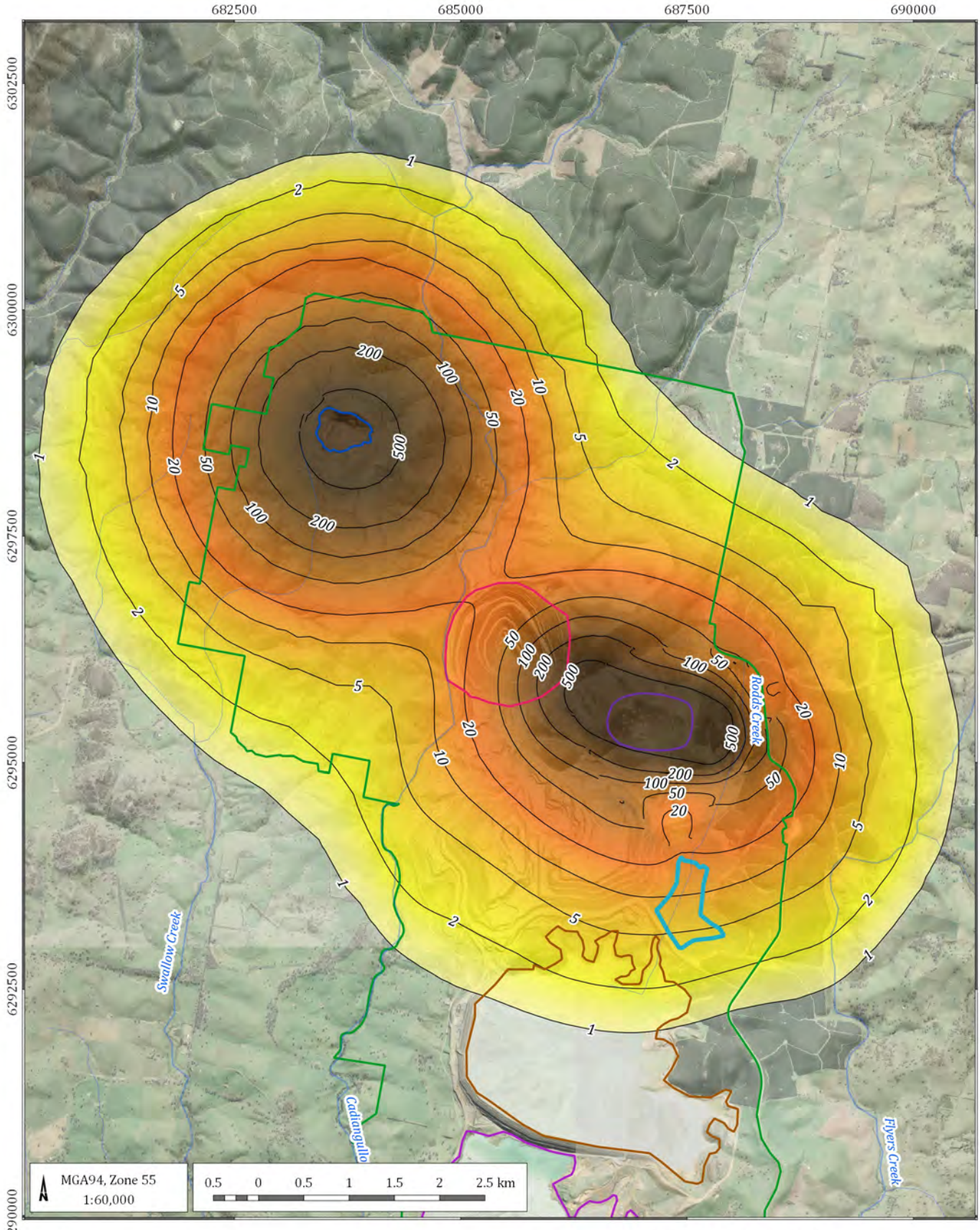
G:\Projects\G1383Y.Cadia Mine Model Update\3_GIS\Workspaces\001_Deliverable1\08.04_G1383Y_Ordovician (Cadia Hill bottom pit) and Silurian – Maximum zone of drawdown in layers 8 and 12.qgs



LEGEND

- Drainage
- Contour line
- Cadia Hill Pit
- Block cave mine subsidence zone
- Ridgeway cave mine subsidence zone
- Rodds Creek dam
- NTSF
- STSF
- Mining lease

Drawdown (m)

- 0
- 1
- 2
- 5
- 10
- 20
- 50
- 100
- 200
- 500

Cadia Model Update (G1383Y)

Ordovician zone between Ridgeway Deeps and Cadia East (PC1) – Maximum zone of drawdown in layers 15, 42, and 67

DATE 08/04/2021

FIGURE No: **8.5**

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G:\Projects\G1383Y.Cadia Mine Model Update\3_GIS\Workspaces\001_Deliverable1\08.05_G1383Y_Ordovician zone between Ridgeway Deeps and Cadia East (PC1) – Maximum zone of drawdown in layers 15, 42, and 67 (1).qgs

8.4 Predicted water budget

Table 8.1 shows individual water budget components for the predicted simulation. Predicted results represent long term averages for the full prediction modelling period, January 2021 to June 2038 inclusive.

Table 8.1 Predicted water budget – average (ML/day)

Water balance component	in	out	in - out
Rainfall recharge	39.98	0	39.98
Stream	0.17	-1.53	-1.36
River	1.38	-2.46	-1.08
Drains	0	-1.20	-1.20
Evapotranspiration	0	-37.83	-37.83
General head boundary	0.44	-0.08	0.36
Total	**41.97**	**-43.1**	**-1.13**

Similar to the calibrated water budget, recharge and evapotranspiration are the main mechanisms for the groundwater input and discharge to/from the model with 95% and 88% of total values, respectively.

The recharge rate is higher here in the predictive period than the corresponding calibration period as it is a truer reflection of the long term recharge rate. The drier climate during the calibration period meant that value reflected a lower average daily rate.

8.5 Predicted take from WSP and licencing

The Aquifer Interference Policy (AIP) states that a water licence is required for the aquifer interference activity regardless of whether water is taken directly for consumptive use or incidentally. Dewatering for mining to occur is considered an incidental take. This incidental take of groundwater can induce flow from adjacent groundwater sources or connected surface water, which constitutes take of water under the AIP. In all cases, separate access licences are required to account for the take from all individual water sources. The mining activities at Cadia Valley Operations will access water from the NSW Murray Darling Basin Fractured Rock Groundwater Sources water sharing plan. Under this water sharing plan CVO will directly take water from the Lachlan Fold Belt (MDB) Groundwater Source, and indirectly through induced flow from the Orange Basalt Groundwater Source.

Figure 8.6 presents the predicted water take from the Orange basalt and Lachlan Fold Belt Murray-Darling Basin (MDB) water sources due to dewatering generated by the mining operations from 1998 to the approved end of mining. Table 8.2 provides the predicted annual groundwater take since the WSPs came into effect and identifies that the peak take for the Orange Basalt is 152 ML/year (2018-2019) which is within the 286 units (ML) that CVO are licenced to take (WAL 31062). Likewise, the peak take from the Lachlan Fold Belt MDB Groundwater Source is predicted to be 481 ML/year (2024-2025) which is also within the 931 units (ML) that CVO are licenced (WAL 36229) to take.

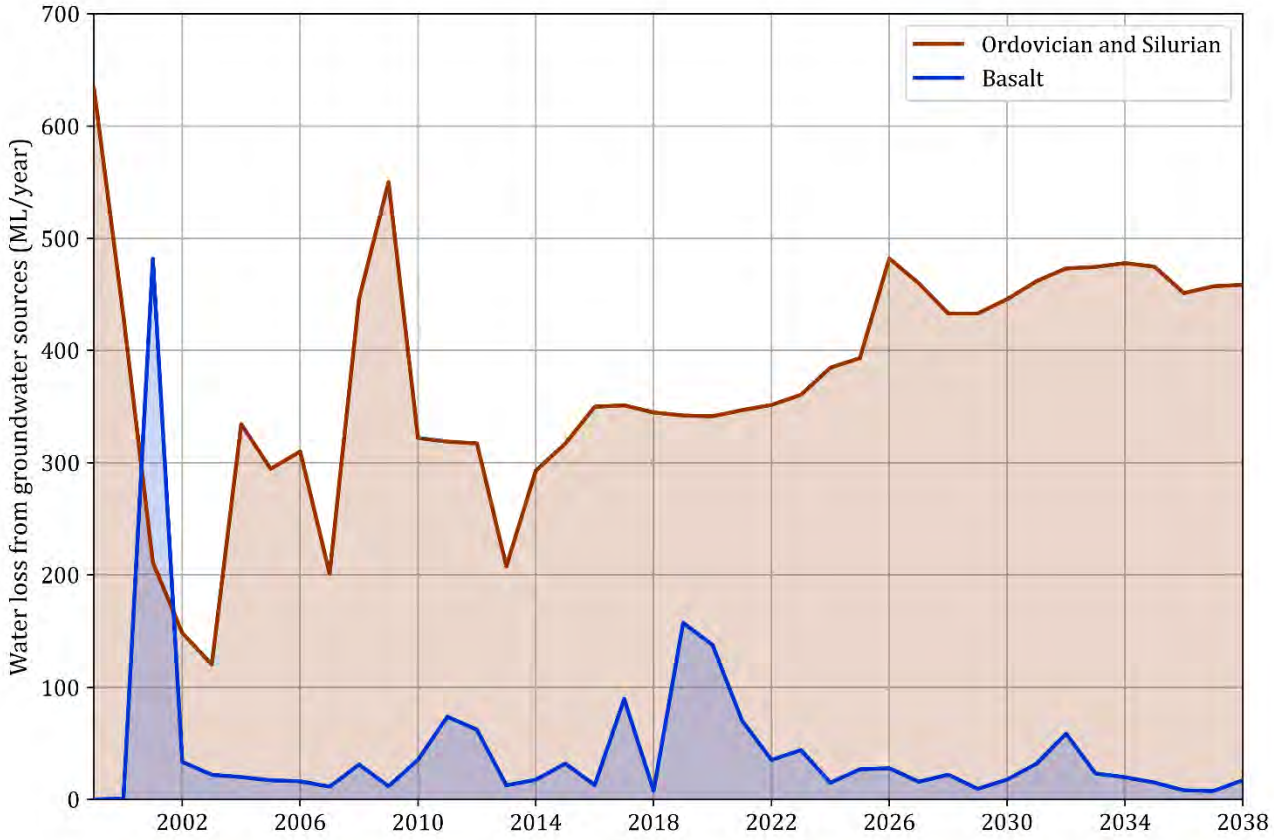


Figure 8.6 Water take from groundwater sources

Table 8.2 Water take prediction summary since 2012 (ML/year)

Financial year	From	To	Orange Basalt Groundwater Source	Lachlan Fold Belt MBD Groundwater Source
2012	July 2011	June 2012	62.11	317.21
2013	July 2012	June 2013	12.52	207.70
2014	July 2013	June 2014	17.51	292.97
2015	July 2014	June 2015	31.87	317.08
2016	July 2015	June 2016	12.77	349.84
2017	July 2016	June 2017	89.43	351.14
2018	July 2017	June 2018	7.73	344.78
2019	July 2018	June 2019	157.24	342.07
2020	July 2019	June 2020	137.53	341.35
2021	July 2020	June 2021	70.27	346.87
2022	July 2021	June 2022	35.18	351.50
2023	July 2022	June 2023	43.90	360.50
2024	July 2023	June 2024	14.85	384.68
2025	July 2024	June 2025	26.80	393.24
2026	July 2025	June 2026	27.76	481.95
2027	July 2026	June 2027	15.72	459.90

Financial year	From	To	Orange Basalt Groundwater Source	Lachlan Fold Belt MBD Groundwater Source
2028	July 2027	June 2028	22.01	432.99
2029	July 2028	June 2029	9.37	432.98
2030	July 2029	June 2030	17.69	445.73
2031	July 2030	June 2031	31.85	461.78
2032	July 2031	June 2032	58.60	473.15
2033	July 2032	June 2033	23.08	474.45
2034	July 2033	June 2034	19.76	477.83
2035	July 2034	June 2035	14.97	474.68
2036	July 2035	June 2036	8.05	451.11
2037	July 2036	June 2037	7.50	457.21
2038	July 2037	June 2038	17.03	458.53

8.6 Predicted leakage from TSFs

The model used the MODFLOW-USG river package to represent the water level within the northern and southern TSFs. A zone budget program was used to process the model output files and calculate the volumes of water moving from the TSFs into the groundwater regime. Figure 8.7 shows the predicted volume of water entering the groundwater systems through the base of the TSFs. The figure shows the simulated leakages from NTSF and STSF average around 0.43 ML/day and 0.2 ML/day, respectively. These values are generally within the same order of magnitude compared to the previous studies summarised in Section 5.14. The variation in simulated leakage from the TSFs is due to the climatic variability and updated tailing elevations in the model.

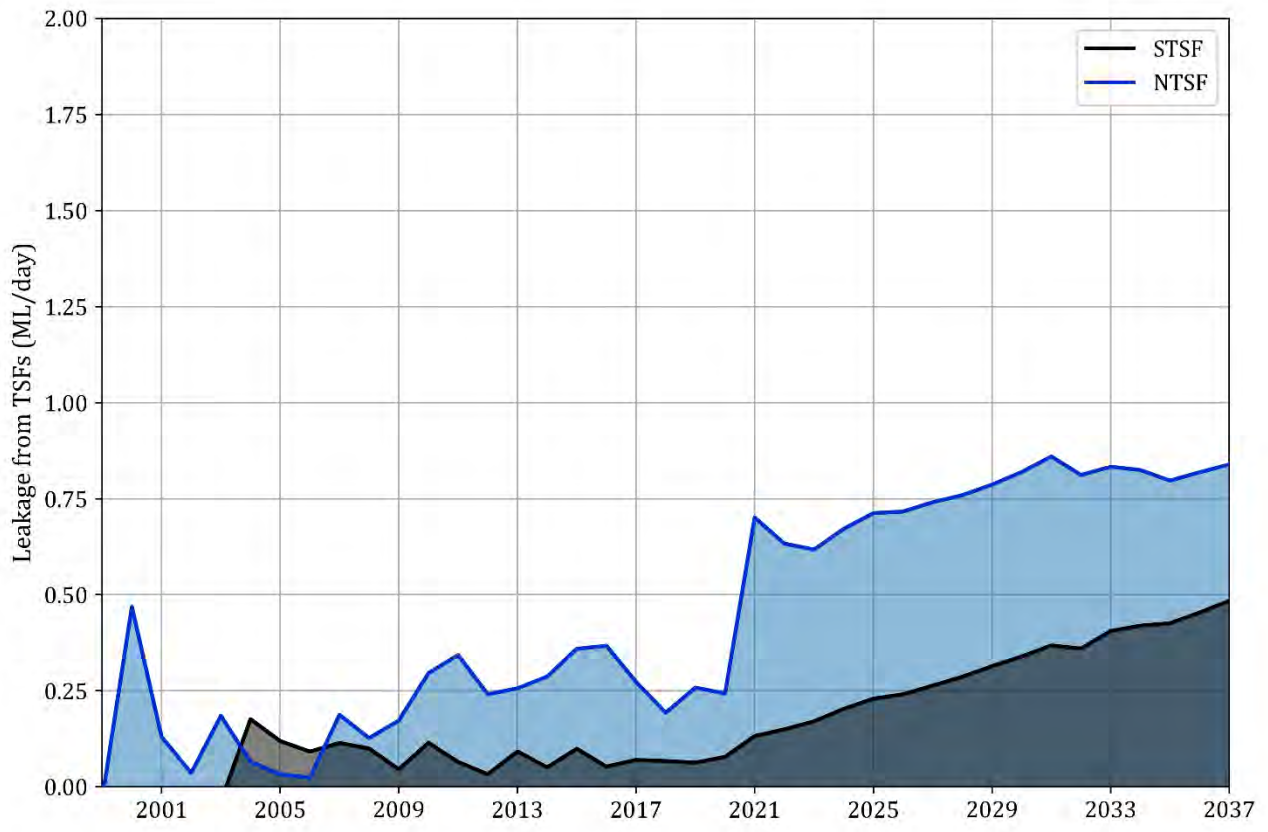


Figure 8.7 Predicted leakage from TSFs

8.7 Predicted baseflow changes in creeks

Figure 8.8 shows the net change in baseflow to Flyers Creek, Cadiangullong Creek, and Swallow Creek resulting from mining. Cadiangullong Creek has the highest loss of baseflow which agrees with results shown in Figure 8.3 where zone of maximum drawdown in water table intersects with this drainage line. The impact on both Flyers Creek and Swallows Creeks averages less than 0.01 ML/day which is insignificant as the creeks fall outside the zone of depressurisation predicted by the updated model, while Cadiangullong Creek shows a very small average baseflow reduction of 0.014 ML/day.

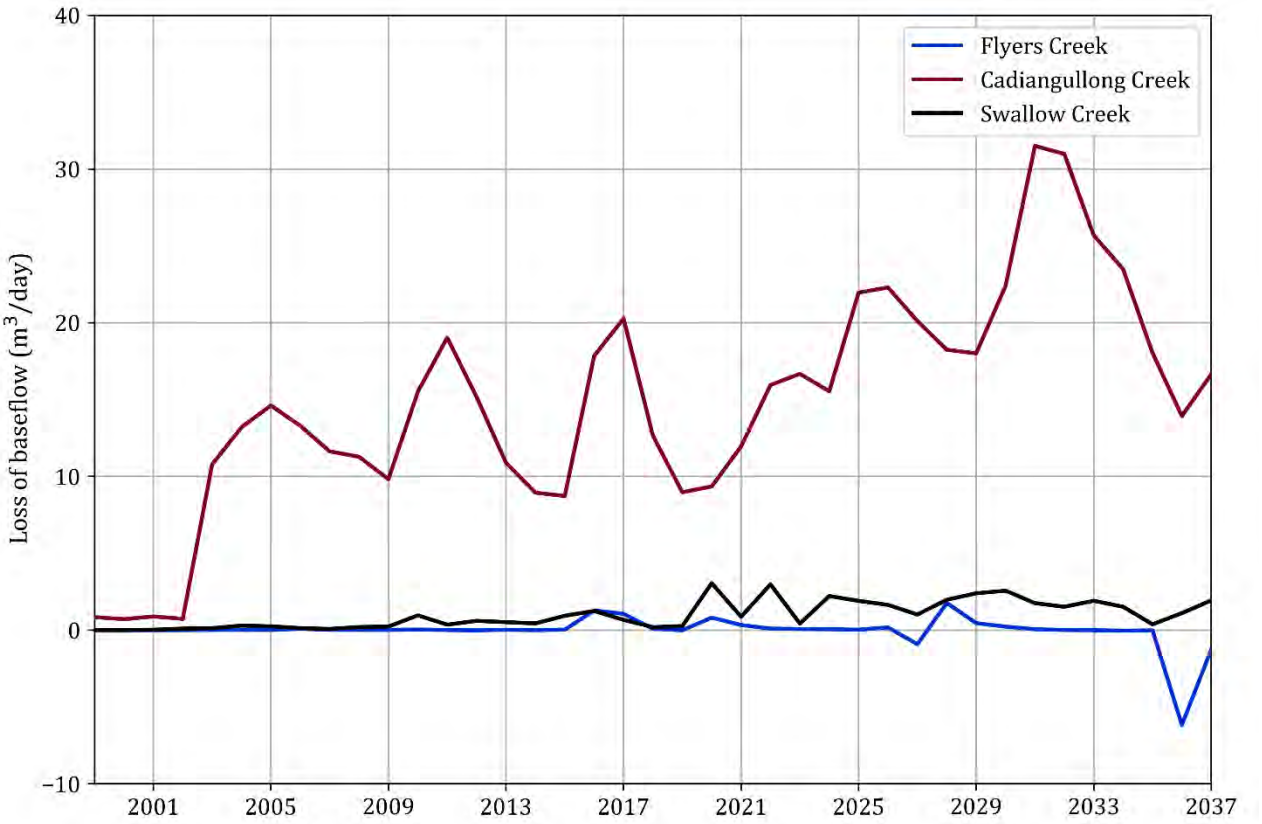


Figure 8.8 Baseflow rate reduction predicted for Flyers, Cadiangullong, and Swallow Creeks

Measured flow data at Cooper Gully Creek up to 2012 were processed through a baseflow filter to compare with the model predicted baseflow from cells used to simulate the creek (shown in Figure 8.9). The model predicts no baseflow before Cadia Hill mine closure in 2012, and low baseflow of less than 0.01 ML/day after 2012. Given the ephemeral nature of Cooper Gully Creek, there is a possibility that the observed baseflow calculations are to some extent inaccurate and most of the flow gauging data are from event based run-off flow into the creek, and thus not as representative of flows containing baseflow. Furthermore, the proximity of this creek to Cadia Hill mine and zone of depressurisation (as shown in Figure 8.2 and Figure 8.3) strengthens the possibility of negligible baseflow to Cooper Gully Creek before Cadia Hill mine closure.

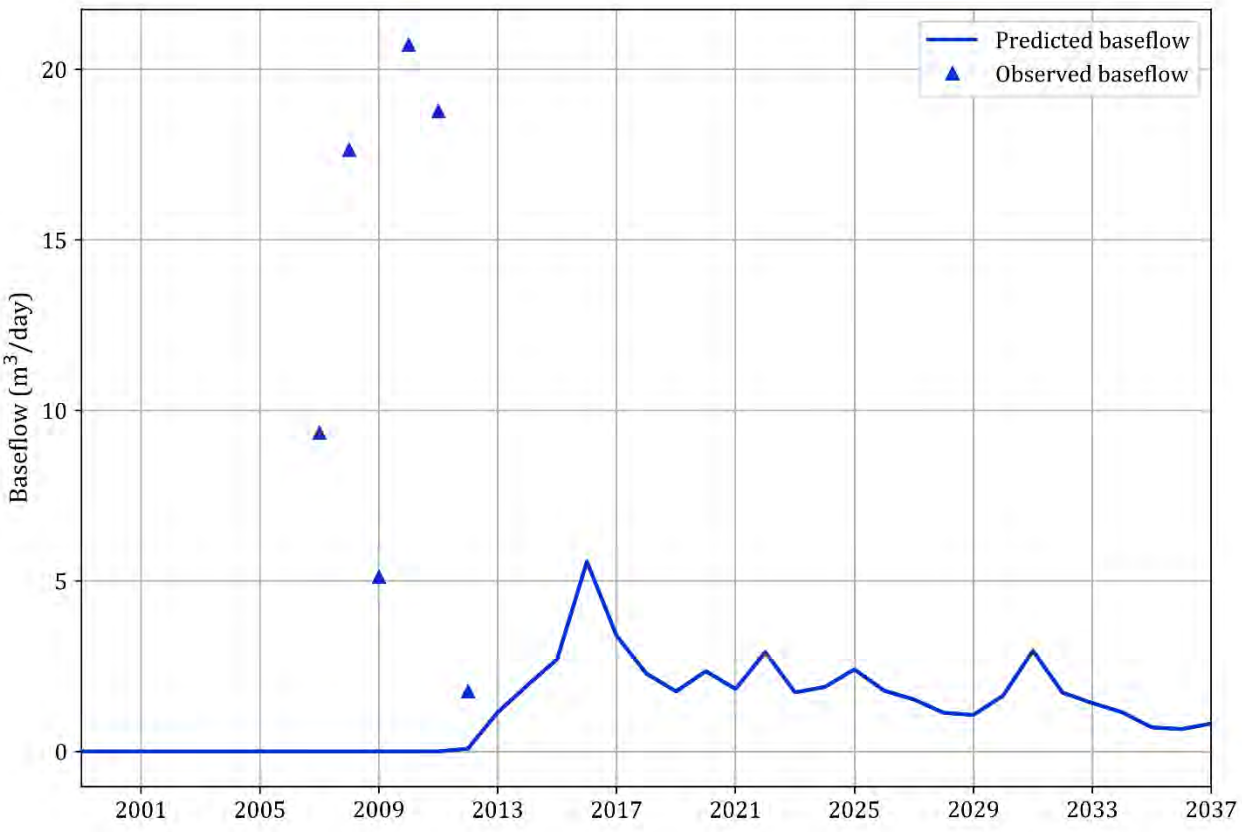


Figure 8.9 Baseflow in Cooper gully Creek

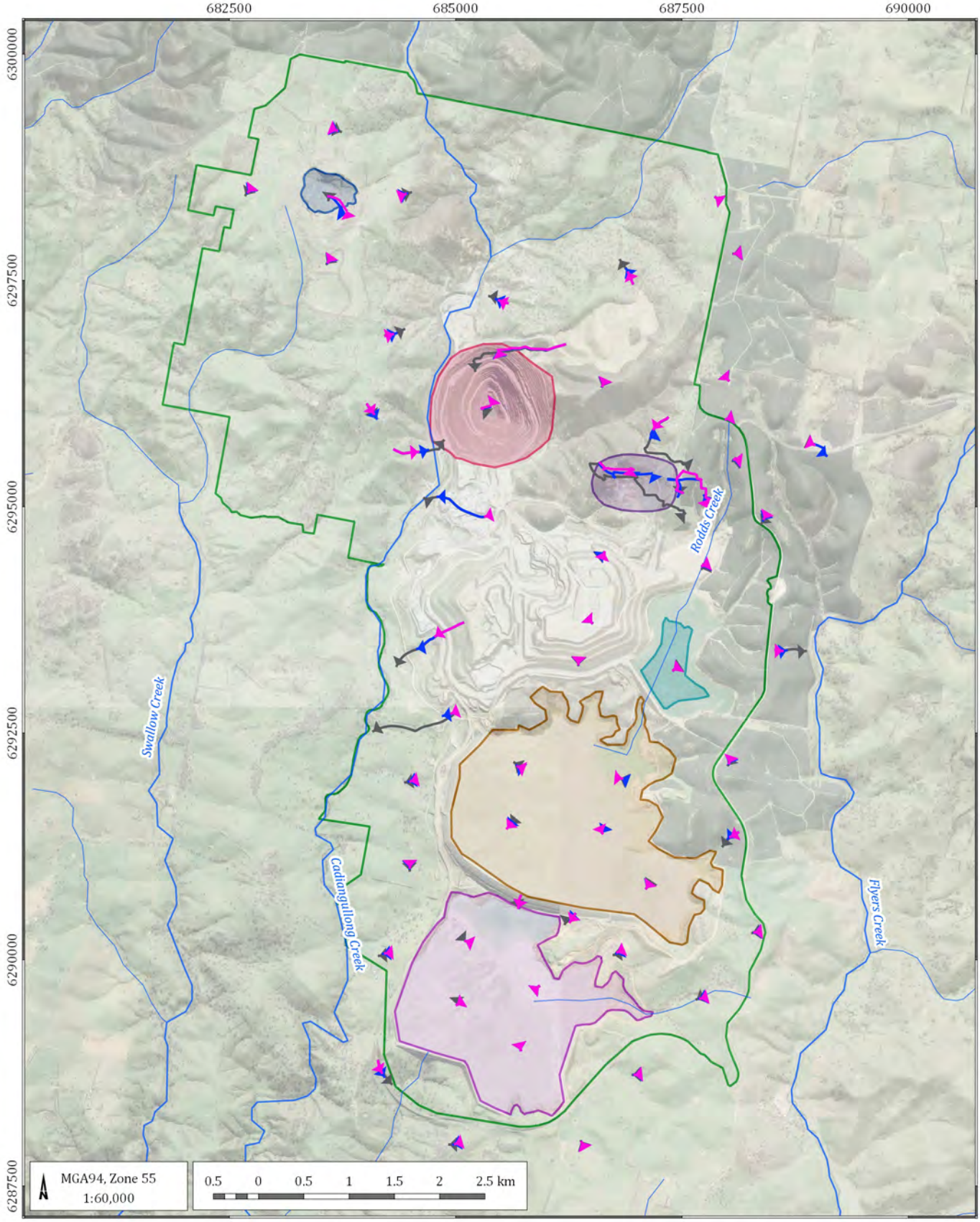
8.8 Particle tracking

Particle tracking was used to identify the likely travel paths of water particles surrounding Cadia Valley Operations sites in the predictive model. Points were placed around the mining lease and simulated up to June 2038 (future mining) to simulate the path line a water particle would travel based on the gradients surrounding the mining zones.

Figure 8.10shows particles within model layers 50 m below ground surface released at three different times:

- beginning of the mining in January 1998;
- before the start of mining in Cadia East in December 2013;
- at the end of the calibration period in December 2020.

This analysis shows the particles positioned surrounding Cadia Hill pit, Ridgway crater and Cadia East crater essentially track forwards radially towards the depressurised zones regardless of the length of the particle tracking timeframe. That is, the mine voids remain groundwater sinks, with seepage draining from with the surrounding aquifers towards the voids. The particles surrounding Cadia East flow first towards PC1 and then gradually change direction towards PC2. It is also shown that particles closer to creeks will generally flow towards the drainage lines while no particles of water within the TSFs migrate away from them.



LEGEND

- Drainage
- Cadia Hill Pit
- Block cave mine subsidence zone
- Ridgeway cave mine subsidence zone
- Rodds Creek dam
- NTSF
- STSF
- Mining lease

Particles released in:

- January 1998
- December 2013
- December 2020

Cadia Model Update (G1383Y)

Particle tracking in layers 50 m below ground surface

DATE 29/03/2021

FIGURE No: **8.10**

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G:\Projects\G1383Y.Cadia Mine Model Update\3_GIS\Workspaces\001_Deliverable1\08.10_G1383Y_Particle tracking in layers 50 m below ground surface.qgs

8.9 Sensitivity analysis

Sensitivity analysis evaluates the effects of model parameters on model results. Parameters selected for sensitivity analysis were based on the impact observed during the model calibration process. The parameter value was factored up or down and re-run through the steady state, transient and predictive models. Table 8.3 presents the upper and lower bound for the parameters selected for sensitivity analysis.

Table 8.3 Sensitivity analysis scenarios

Scenarios	Parameter(s) *Zone*	Description
Baseline	-	Calibrated model
Hydraulic conductivity up	Kh and Kv *in all model cells*	Horizontal and vertical hydraulic conductivities increase (10x)
Hydraulic conductivity down	Kh and Kv *in all model cells*	Horizontal and vertical hydraulic conductivities decrease (÷10)
Fractured K up	Kh and Kv *in caved zone cells*	Horizontal and vertical hydraulic conductivities increase (10x)
Fractured K down	Kh and Kv *in caved zone cells*	Horizontal and vertical hydraulic conductivities decrease (÷10)
Recharge up	RCH *in top layers*	Rainfall recharge increase (50%)
Recharge down	RCH *in top layers*	Rainfall recharge decrease (50%)

The model parameters were varied from the calibrated baseline scenario in separate model runs as described in the table above.

8.9.1 Prediction sensitivity of mine inflow

Figure 8.11 shows the sensitivity of the mine inflow to varying model parameters. The model was most sensitive to an increase in hydraulic conductivities as this was also seen during the calibration process. Decreasing hydraulic conductivities in the fractured caved zone had no impacts on Cadia Hill mine inflow as expected, while it slightly reduced the mine inflow in Ridgeway and Cadia East mines. Increasing the hydraulic conductivities of the caved zone (Fractured K) and changing recharge resulted in negligible change in the mine inflow rates.

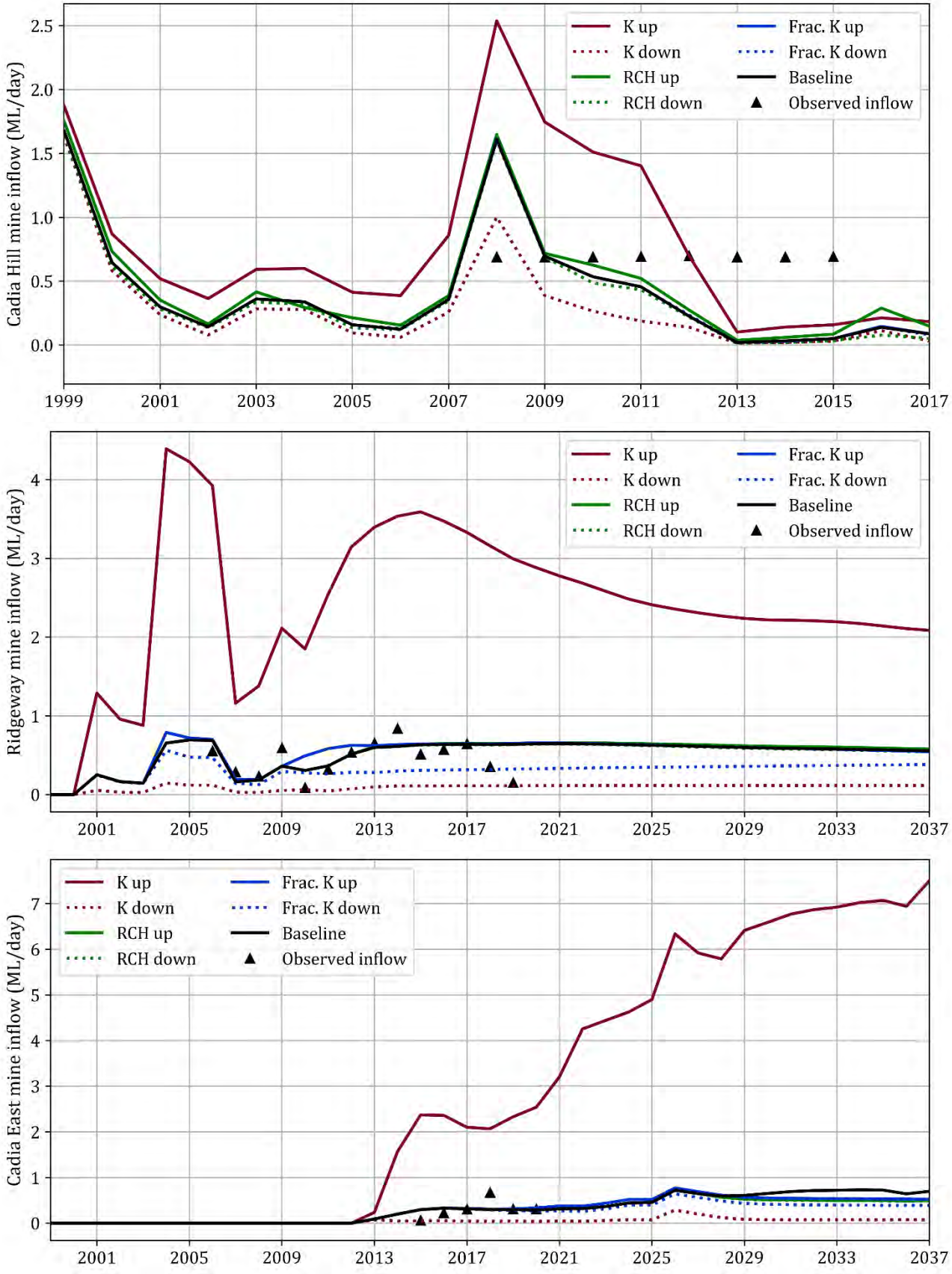
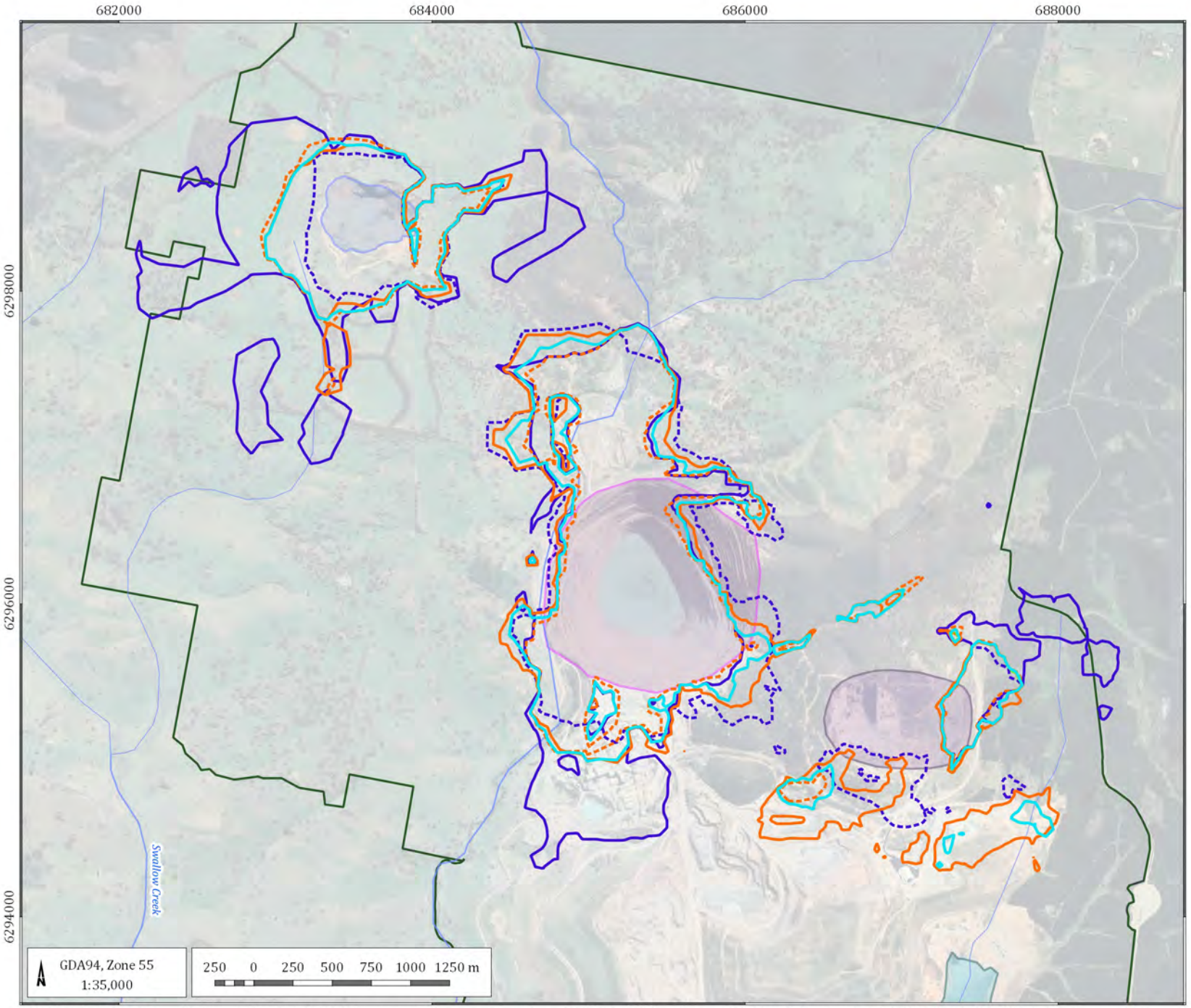


Figure 8.11 Predicted mine inflow sensitivity

8.9.2 Prediction sensitivity of groundwater drawdown

Figure 8.12 shows the impact of parameters changes to the maximum zone of depressurisation during mining. The horizontal hydraulic conductivity was the most sensitive parameter in the model. Changing recharge slightly influenced the zone of drawdown in the top layers due to variability in the top layer saturated area and consequent depressurisation near the mine sites. Hydraulic conductivities of the caved zone showed to have negligible impact on the maximum 2 m drawdown extent in top layers.



LEGEND

- Drainage
- Cadia Hill Pit
- Block cave mine subsidence zone
- Ridgeway cave mine subsidence zone
- Rodds Creek dam
- Mining lease
- Model boundary
- Baseline
- K up
- K down
- Fractured K up
- Fractured K down
- Recharge up
- Recharge down

Cadia Model Update (G1383Y)

Sensitivity of 2 m contours of maximum drawdown in top layers

DATE
08/04/2021

FIGURE No:
8.11

©2021 Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) - www.ageconsultants.com.au; Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006
G:\Projects\G1383Y.Cadia Mine Model Update\3_GIS\Workspaces\001_Deliverable1\08.11_G1383Y_Sensitivity of 2 m contours of maximum drawdown in top layers.qgs

9 Model confidence level assessment

A high level of confidence in model predictions is required for the Project. Barnett et al., (2012) developed a system to classify the confidence-level for groundwater models. Models are classified as either Class 1, Class 2 or Class 3 in order of increasing confidence. Several factors are considered in determining the model confidence-level:

- available data;
- calibration procedures;
- consistency between calibration and predictive analysis; and
- level of stresses.

A Class 3 model is often referred to as an aquifer simulator, in that it encapsulates a very detailed and well understood conceptualisation. Out of 22 Class 3 descriptors, the model has obtained 18 descriptors with the remaining four descriptors partially obtained. Despite the use of all available data for the model inputs, it is difficult to obtain all of the Class 3 descriptors, and the updated model has achieved a level closer to an aquifer simulator than an impact model. Barnett et al., (2012) consistently suggest "it is not expected that any individual model will have all the defining characteristics of Class 1, 2 or 3 models".

Comparison against the performance indicators for individual model classes are presented in Table 9.1.

Table 9.1 Model classification – model performance indicators

Class	Data	Calibration	Prediction	Quantitative Indicators
1 (Simple)	× Not much	× Not possible	× Timeframe >> Calibration	× Timeframe > 10x
	× Sparse coverage	× Large error statistic	× Long stress periods	✓ Stresses < 5x
	× No metered usage	× Inadequate data spread	× Poor/no validation	× Mass balance > 1% (or one-off 5%)
	× Low resolution	× Targets incompatible with model purpose.	× Transient prediction but steady-state calibration	× Properties < > field values
	× Poor aquifer geometry			× No review by Hydro/Modeller
2 (Impact Assessment)	× Some	× Partial performance	× Timeframe > Calibration	× Time frame = 3-10x
	✓ Ok coverage	× Some long term trends wrong.	× Long stress periods	✓ Stresses = 2-5x
	~ Some usage data/ low volumes	× Short term record.	✓ Ok validation	✓ Mass balance <1%
	~ Baseflow estimates. Some K & S measurements	× Weak seasonal match.	✓ Transient calibration and prediction	✓ Some properties < > field values. Review by Hydrogeologist
	✓ Some high resolution topographic DEM &/or some aquifer geometry	× No use of targets compatible with model purpose (heads & fluxes)	✓ New stresses not in calibration	× Some coarse discretisation in key areas of grid or at key times
3 (Complex Simulator)	~ Lots, with good coverage.	✓ Good performance stats	✓ Timeframe ~ calibration	✓ Timeframe < 3x
	~ Good metered usage info.	✓ Most long term trends matched	✓ Similar stress periods	✓ Stresses < 2x
	✓ Local climate data	✓ Most seasonal matches ok.	✓ Good validation	✓ Mass balance < 0.5%
	~ Kh, Kv & Sy measurements from range of tests	✓ Present day data targets	✓ Calibration & prediction consistent (transient or steady state).	~ Properties ~field measurements
	✓ High resolution DEM all areas.	✓ Head & Flux targets used to constrain calibration	✓ Similar stresses to those in calibration.	✓ No coarse discretisation in key areas (grid or time)
	✓ Good aquifer geometry.			✓ Review by experienced Modeller

10 Compliance with the Aquifer Interference Policy (AIP)

Proponents of aquifer interference activities are required to provide predictions of the volume of water to be taken from a water source(s) as a result of the activity. These usually occur prior to Project approval, however Cadia East's approval has predated this legislation. After approval and during operations, these volumes need to be measured and reported in an annual returns or environmental management reports. The water user must hold sufficient share component and water allocation to account for the take of water from the relevant water source when the take occurs.

Table 10.1 identifies the AIP requirements aligned to the scope of work for this model update and provides guidance in directing the reader to the relevant sections of the report.

Table 10.1 Accounting for or preventing the take of water

AIP requirement		Proponent response
1	Described the water source (s) the activity will take water from?	Section 8.5 describes the water sharing plan that the CVO have and will take water from, namely – the NSW Murray-Darling Fractured Rock Groundwater Sources. Under this water sharing plan CVO will take water from the Orange Basalts Groundwater Source and the Lachlan Fold Belt Groundwater Source.
2	Predict the total amount of water that will be taken from each connected groundwater or surface water source on an annual basis as a result of the activity?	Section 8.5 summarise the peak take of groundwater from each water source due to the approved mining.
3	Made these predictions in accordance with Section 3.2.3 of the AIP? (page 27)	Based on 3D numerical modelling.
4	Described how and in what proportions this take will be assigned to the affected aquifers and connected surface water sources?	Section 8.5 summarises the peak take of surface water and groundwater from each water source due to approved mining at CVO.
5	Determined if there are sufficient water entitlements and water allocations that are able to be obtained for the activity?	Section 8.5 describes the entitlements held by the proponent and indicates these are sufficient to account for water taken from the potentially affected water sources.
6	Determined how it will obtain the required water?	Via seepage to the mine (refer to Section 8.5).
7	Considered the effect that activation of existing entitlement may have on future available water determinations?	Not applicable.

Table 10.2 Determining water predictions

	AIP requirement	Proponent response
1	Establishment of baseline groundwater conditions?	Refer to Sections 5.4 and 5.5. Water quality and level data has been collected at CVO since 1997 for some of the key groundwater units and tested for a selection of water quality analytes. The monitoring network has been adapted over time to ensure that good spatial coverage is maintained.
2	Potential water level, quality or pressure drawdown impacts on nearby basic landholder rights water users?	See Section 8.3
3	Potential water level, quality or pressure drawdown impacts on nearby licensed water users in connected groundwater and surface water sources?	Refer to Section 8.3.
4	Potential water level, quality or pressure drawdown impacts on groundwater dependent ecosystems?	There are no high priority GDEs, as defined within WSPs, within the predicted area of drawdown.
5	Potential to cause or enhance hydraulic connection between aquifers?	The subsidence from the block cave mining technique and associated fracturing will enhance the connection between the Ordovician basement with the Silurian sediments and some of the local fracture networks in the basalt.

11 Summary

CVO numerical model was rebuilt after revisiting the conceptual model thoroughly and reviewing all the available data with the intention of improving confidence in the predictive capacity of the numerical model. An integrated surface water – groundwater model of CVO area was developed and calibrated with groundwater levels, mine inflows, and surface water flows.

The principal objective behind the numerical model update was to improve the confidence in mining impacts on groundwater levels, based on the recent data captured. A rebuild of the model packages, and a thorough update of the model has occurred through this scope of work. As such the following key features were updated or added to the CVO numerical model:

- expansion the model extent further to south and west to include future TSF sites and Belubula River;
- refinement of model layers vertically where Cadia East and Ridgeway mines are located to provide a detailed simulation of complex 3D cave shapes;
- adjustment of hydraulic property ranges within acceptable ranges according to previous filed investigations and values reported in the literature;
- development of a SWAT+ model of surface water flow components including runoff, soil evapotranspiration and recharge used as input to the MODFLOW-USG groundwater flow model;
- use of Streamflow-Routing (SFR2) package instead of river (RIV) package for simulation of surface drainage to include the runoff flow and unsaturated flow beneath streams;
- addition of Rodds Creek dam, and Cadia Hill PTSF to the model using RIV package;
- addition of Horizontal Flow Barrier (HFB) package to the south of STSF to control horizontal flow (leakage) through the STSF wall to Rodds Creek;
- ability to simulate more detail at Ridgeway mines through using 16 vertically refined model layers (sublayering);
- updated Ridgeway underground mine with sub-level cave shape and Ridgeway Deeps mine progression plan;
- updated Cadia Hill extended pit timing and pit shell shape in the model;
- ability to simulate more details at Cadia East mines through using 36 vertically refined model layers (sublayering);
- updated crater and cave shapes for Cadia East mine in the model up to FY37;
- addition of Connected Linear Network (CLN) package to simulate the enhanced connection between carbonate fault, “Cb 5”, and fractured rocks above PC2 mine;
- addition of Time-Variant Materials (TVM) package to adjust hydraulic properties at fractured rock and crater zones above Ridgeway and Cadia East mines, mine working zones and Cadia Hill pit post-mining;
- addition of General Head Boundary (GHB) condition at south and west of the model boundary to replicate continued flow beyond the model domain using long-term averaged depth to water table from the surface water model; and
- undertaking particle tracking to provide more insight into model predictions.

Having achieved a satisfactory match to the available head and flow observations, the model was then used to predict the impacts of Cadia Hill, Ridgeway, and Cadia East mines in the project area. A sensitivity analysis was then also undertaken providing a range of possible outcomes.

Best estimate predictions based on the fully calibrated or baseline model suggest inflow to Cadia East is predicted to increase as mining progresses into the future, reaching a peak inflow of approximately 0.75 ML/day. Groundwater drawdown in the shallow formations is largely contained within the mining lease, as demonstrated in the predicted drawdown for top layers at the end of mining and the maximum water table drawdown. Depressurisation in the Ordovician at the base of the Cadia Hill Pit extends marginally outside of the mining lease extent which is of little consequence given its depth.

Predicted annual groundwater take, since the WSPs came into effect, identifies that the peak take for the Orange Basalt and the Lachlan Fold Belt MDB Groundwater Sources are within the capacity of the existing CVO Water Access Licenses WAL 31062 and WAL 36229, respectively. The particle tracking analysis showed the particles positioned surrounding Cadia Hill pit, Ridgeway subsidence crater and Cadia East subsidence crater essentially track radially towards the depressurised zones. It also showed that particles closer to creeks will generally flow towards the drainage lines, while no particles of water within the TSFs migrate away from them.

12 Recommendations

The following recommendations are made to enhance and add value to model updates into the future:

- Require additional deep monitoring multilevel piezometers installed in the Ordovician Volcanics and overlying units to the north, east and south of Cadia East to assess the propagation of mine induced drawdown, which will assist in the calibration of the groundwater model.
- New bores have been drilled at the Cadia Hill Pit to investigate tailings water movement through the groundwater system as tailings deposition continues in the pit to approved height of 713 mAHD. This includes one bore in the pit (MB94) and several bores between Cadiangullong Creek and the western margin of the pit (MB96 – MB101) which were installed in December 2020 and March 2021. The groundwater levels in the bores can be used in future model iterations to predict if there is potential groundwater movement towards Cadiangullong Creek.
- Conduct underground permeability tests within boreholes intersecting the Carbonate fault structures; and obtain inflow yield from the fault zones; hydrochemistry or isotope analysis to determine source of water inflow and if it is coming from Tertiary basaltic rock. Use this information to update hydraulic conductance properties of these faults in the model.
- Identify other bores near Cadia East that might be influenced by mining and add them to CLN package to capture all the mining-induced falling trends in the groundwater levels.
- Update most recent mining, surface water, and groundwater level data in the model to review the model calibration performance (if influenced by operational variations) and update the model predictions.

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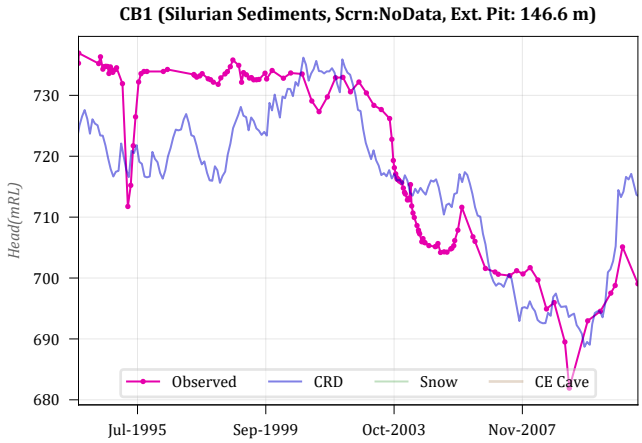
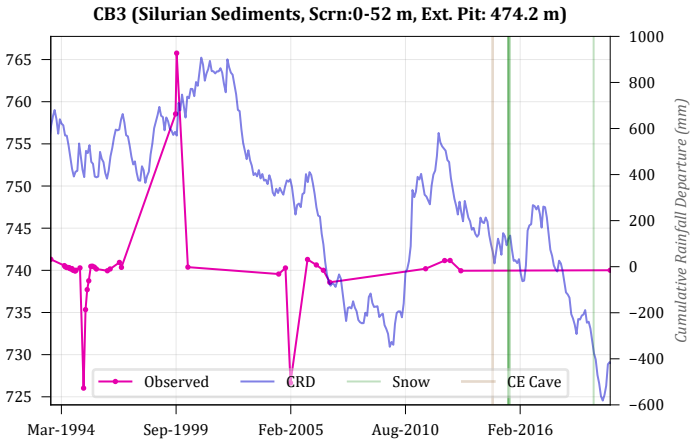
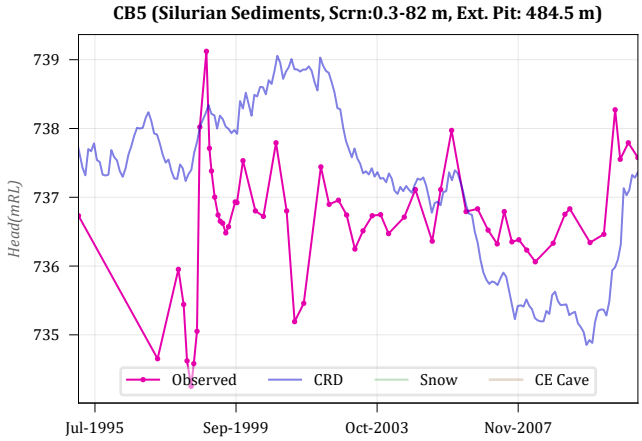
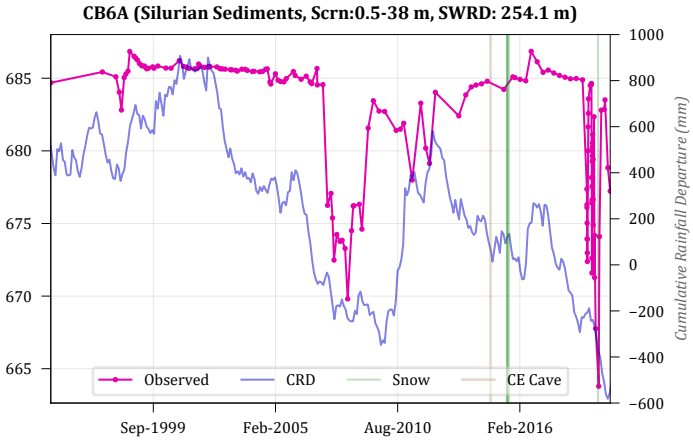
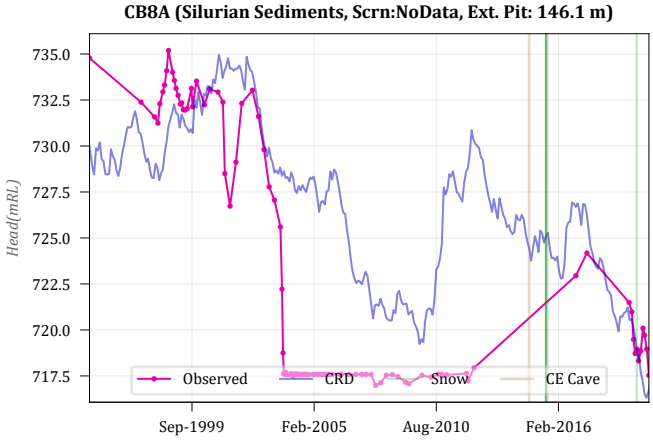
Appendix A Observed groundwater levels and bore details

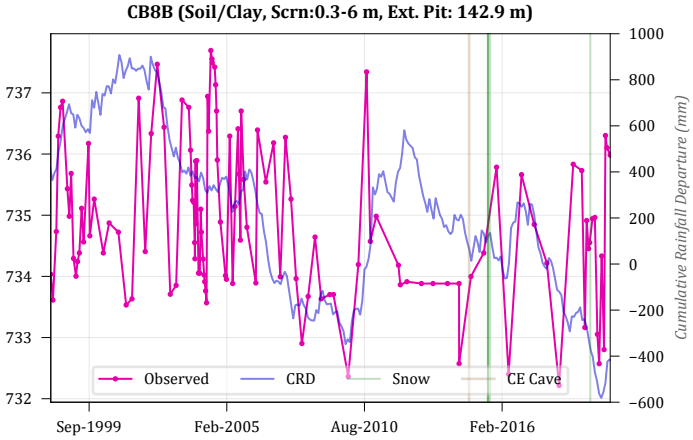

CB1 (Silurian Sediments, Scrn:NoData, Ext. Pit: 146.6 m)
Head(mRL)
730
720
710
700
690
680
Observed
CRD
Snow
CE Cave
Jul-1995
Sep-1999
Oct-2003
Nov-2007

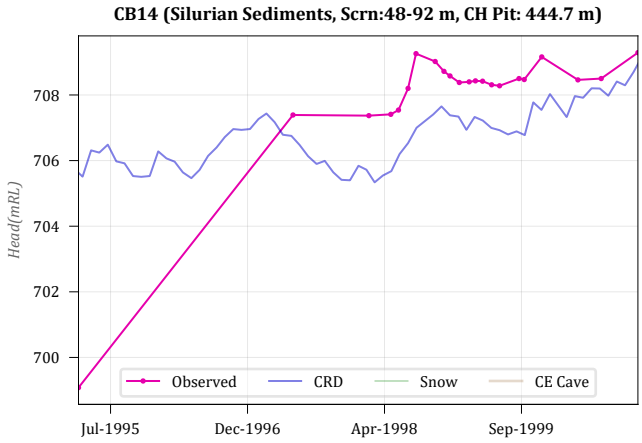

CB3 (Silurian Sediments, Scrn:0-52 m, Ext. Pit: 474.2 m)
765
760
755
750
745
740
735
730
725
1000
800
600
400
200
0
−200
−400
−600
Cumulative Rainfall Departure (mm)
Observed
CRD
Snow
CE Cave
Mar-1994
Sep-1999
Feb-2005
Aug-2010
Feb-2016

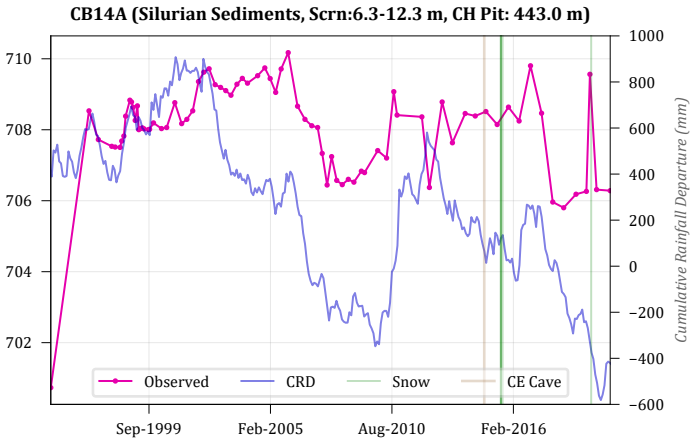

CB5 (Silurian Sediments, Scrn:0.3-82 m, Ext. Pit: 484.5 m)
Head(mRL)
739
738
737
736
735
Observed
CRD
Snow
CE Cave
Jul-1995
Sep-1999
Oct-2003
Nov-2007

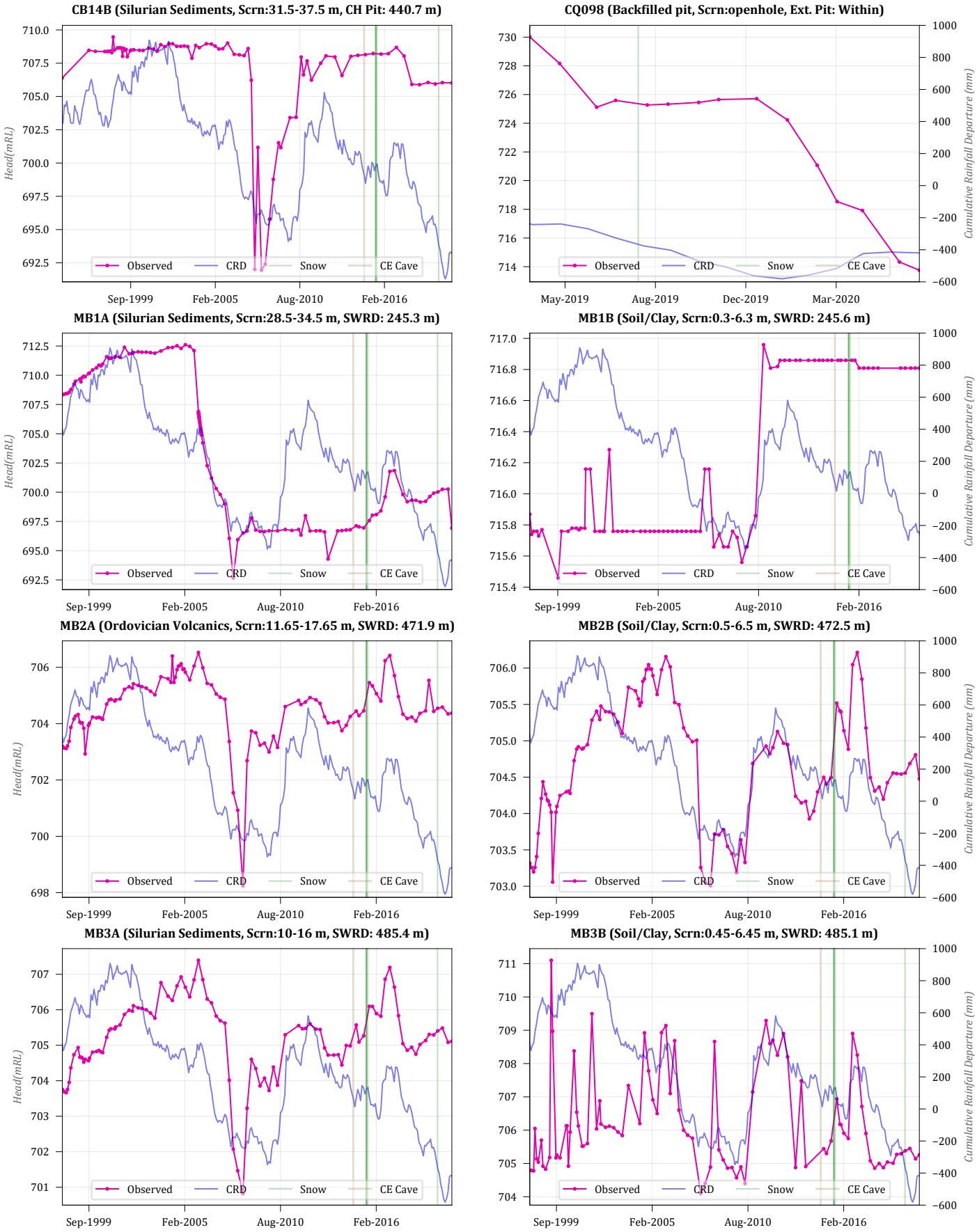

CB6A (Silurian Sediments, Scrn:0.5-38 m, SWRD: 254.1 m)
685
680
675
670
665
1000
800
600
400
200
0
−200
−400
−600
Cumulative Rainfall Departure (mm)
Observed
CRD
Snow
CE Cave
Sep-1999
Feb-2005
Aug-2010
Feb-2016

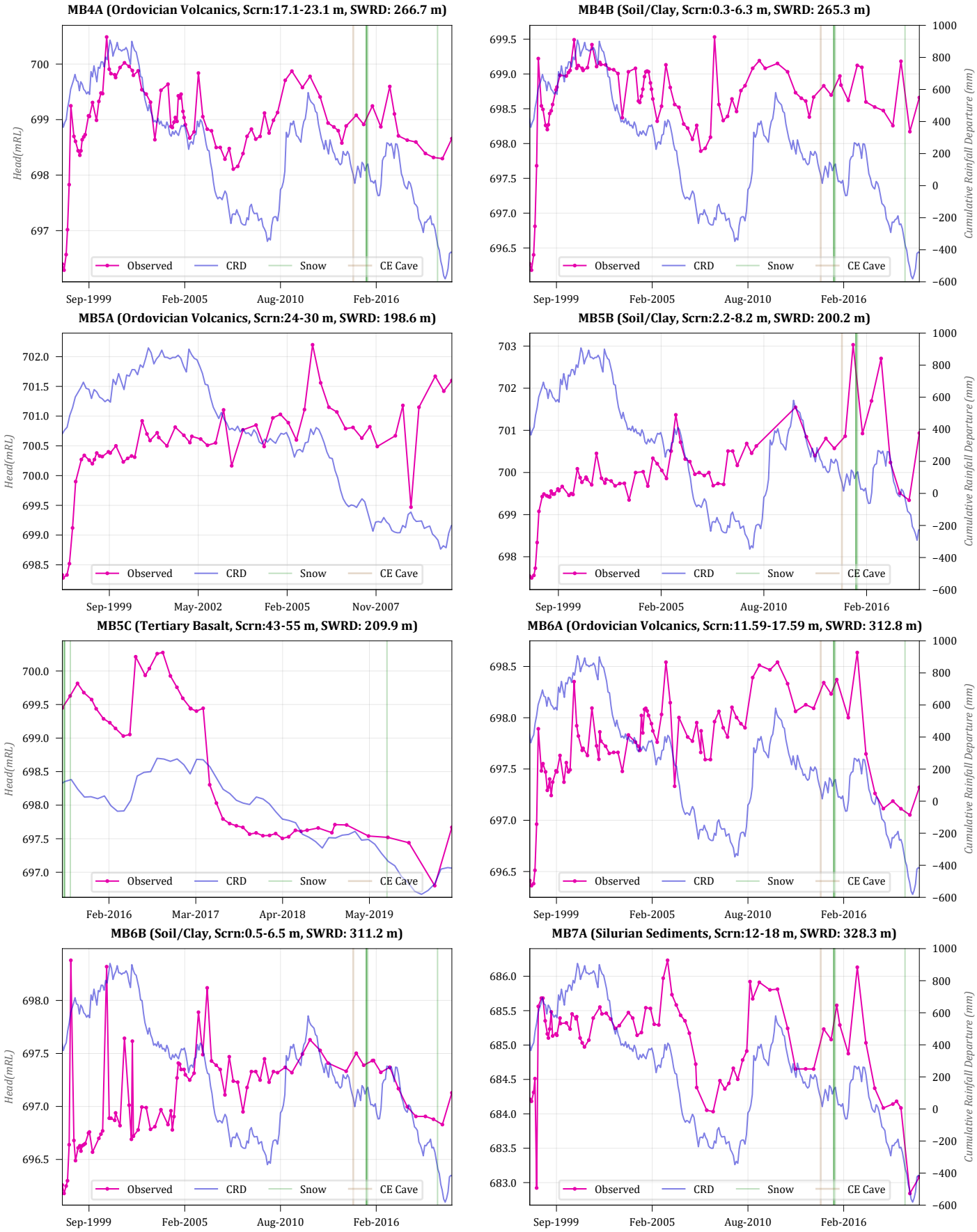

CB8A (Silurian Sediments, Scrn:NoData, Ext. Pit: 146.1 m)
Head(mRL)
735.0
732.5
730.0
727.5
725.0
722.5
720.0
717.5
Observed
CRD
Snow
CE Cave
Sep-1999
Feb-2005
Aug-2010
Feb-2016

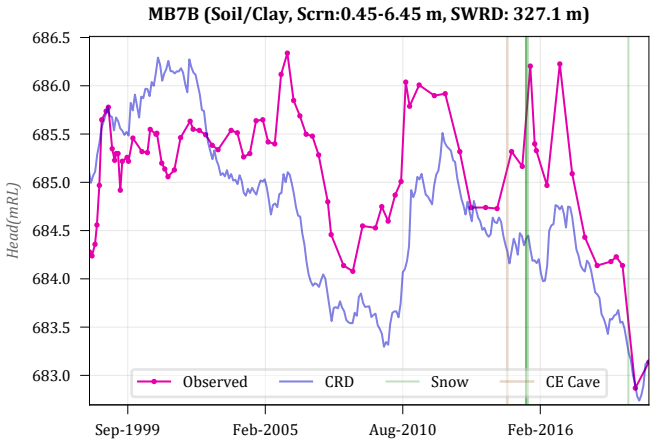

CB8B (Soil/Clay, Scrn:0.3-6 m, Ext. Pit: 142.9 m)
737
736
735
734
733
732
1000
800
600
400
200
0
−200
−400
−600
Cumulative Rainfall Departure (mm)
Observed
CRD
Snow
CE Cave
Sep-1999
Feb-2005
Aug-2010
Feb-2016

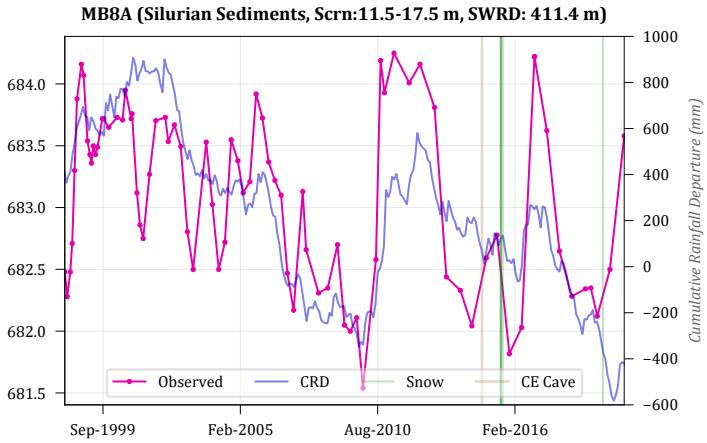

CB14 (Silurian Sediments, Scrn:48-92 m, CH Pit: 444.7 m)
Head(mRL)
708
706
704
702
700
Observed
CRD
Snow
CE Cave
Jul-1995
Dec-1996
Apr-1998
Sep-1999

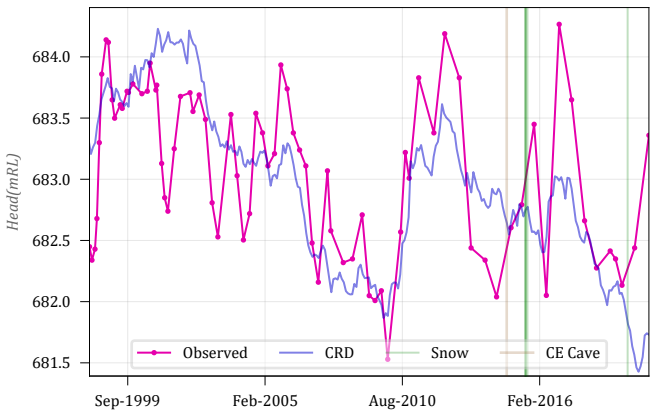

CB14A (Silurian Sediments, Scrn:6.3-12.3 m, CH Pit: 443.0 m)
710
708
706
704
702
1000
800
600
400
200
0
−200
−400
−600
Cumulative Rainfall Departure (mm)
Observed
CRD
Snow
CE Cave
Sep-1999
Feb-2005
Aug-2010
Feb-2016

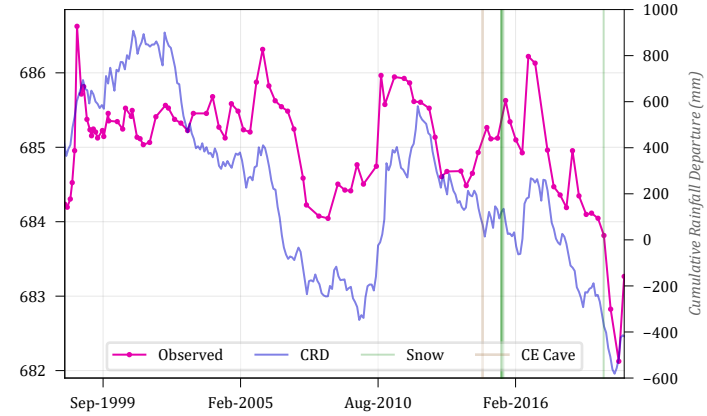

CB14B (Silurian Sediments, Scrn:31.5-37.5 m, CH Pit: 440.7 m)
CQ098 (Backfilled pit, Scrn:openhole, Ext. Pit: Within)
MB1A (Silurian Sediments, Scrn:28.5-34.5 m, SWRD: 245.3 m)
MB1B (Soil/Clay, Scrn:0.3-6.3 m, SWRD: 245.6 m)
MB2A (Ordovician Volcanics, Scrn:11.65-17.65 m, SWRD: 471.9 m)
MB2B (Soil/Clay, Scrn:0.5-6.5 m, SWRD: 472.5 m)
MB3A (Silurian Sediments, Scrn:10-16 m, SWRD: 485.4 m)
MB3B (Soil/Clay, Scrn:0.45-6.45 m, SWRD: 485.1 m)
Head(mRL)
Cumulative Rainfall Departure (mm)
Observed
CRD
Snow
CE Cave
Sep-1999
Feb-2005
Aug-2010
Feb-2016
May-2019
Aug-2019
Dec-2019
Mar-2020

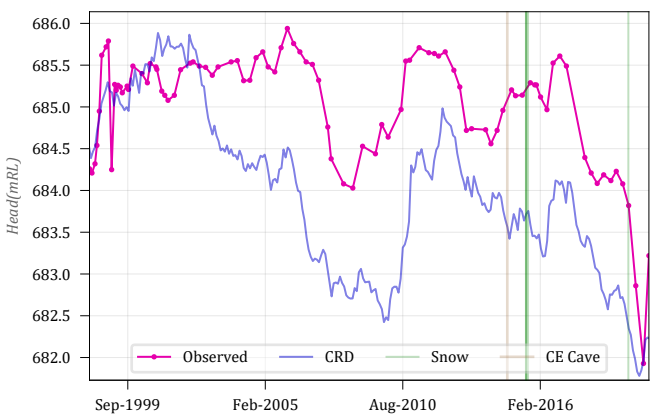

MB4A (Ordovician Volcanics, Scrn:17.1-23.1 m, SWRD: 266.7 m)
MB4B (Soil/Clay, Scrn:0.3-6.3 m, SWRD: 265.3 m)
MB5A (Ordovician Volcanics, Scrn:24-30 m, SWRD: 198.6 m)
MB5B (Soil/Clay, Scrn:2.2-8.2 m, SWRD: 200.2 m)
MB5C (Tertiary Basalt, Scrn:43-55 m, SWRD: 209.9 m)
MB6A (Ordovician Volcanics, Scrn:11.59-17.59 m, SWRD: 312.8 m)
MB6B (Soil/Clay, Scrn:0.5-6.5 m, SWRD: 311.2 m)
MB7A (Silurian Sediments, Scrn:12-18 m, SWRD: 328.3 m)
Head(mRL)
Cumulative Rainfall Departure (mm)
Observed
CRD
Snow
CE Cave
Sep-1999
Feb-2005
Aug-2010
Feb-2016
May-2002
Nov-2007
Mar-2017
Apr-2018
May-2019

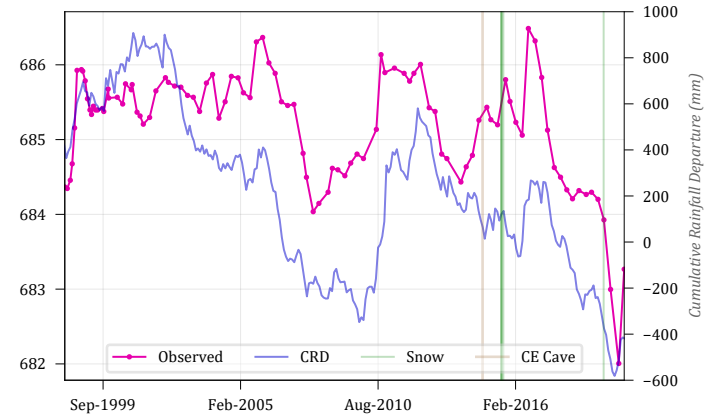

MB7B (Soil/Clay, Scrn:0.45-6.45 m, SWRD: 327.1 m)
Head(mRL)
Observed
CRD
Snow
CE Cave
Sep-1999
Feb-2005
Aug-2010
Feb-2016

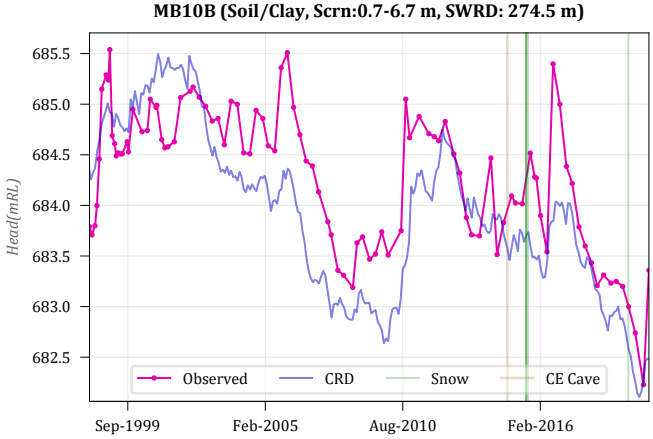

MB8A (Silurian Sediments, Scrn:11.5-17.5 m, SWRD: 411.4 m)
Cumulative Rainfall Departure (mm)
Observed
CRD
Snow
CE Cave
Sep-1999
Feb-2005
Aug-2010
Feb-2016

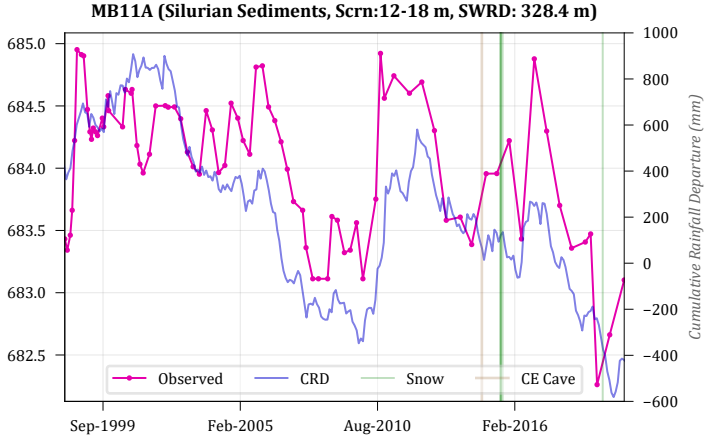

MB8B (Soil/Clay, Scrn:0.4-4.4 m, SWRD: 412.4 m)
Head(mRL)
Observed
CRD
Snow
CE Cave
Sep-1999
Feb-2005
Aug-2010
Feb-2016

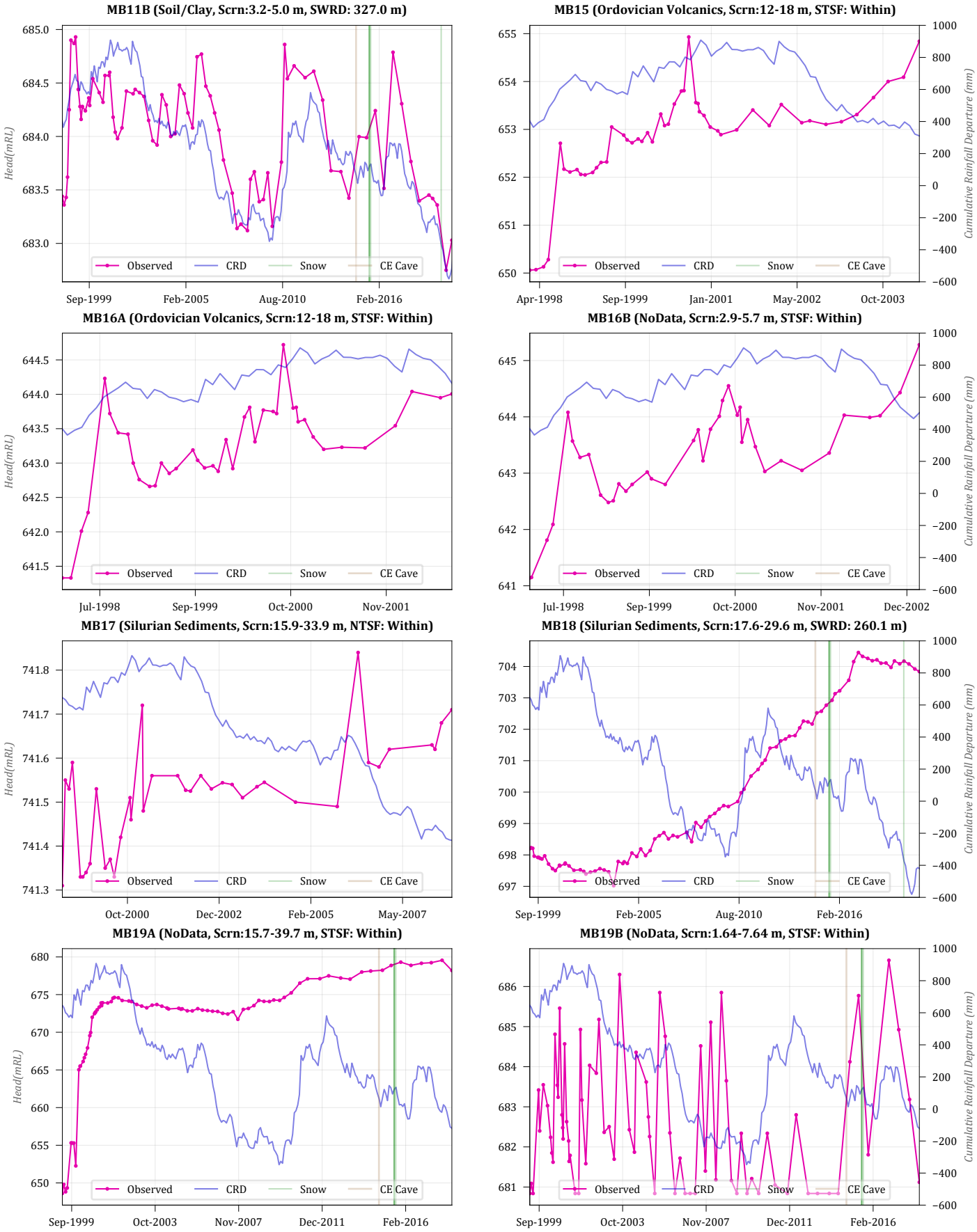

MB9A (Ordovician Volcanics, Scrn:10.5-16.5 m, SWRD: 289.3 m)
Cumulative Rainfall Departure (mm)
Observed
CRD
Snow
CE Cave
Sep-1999
Feb-2005
Aug-2010
Feb-2016

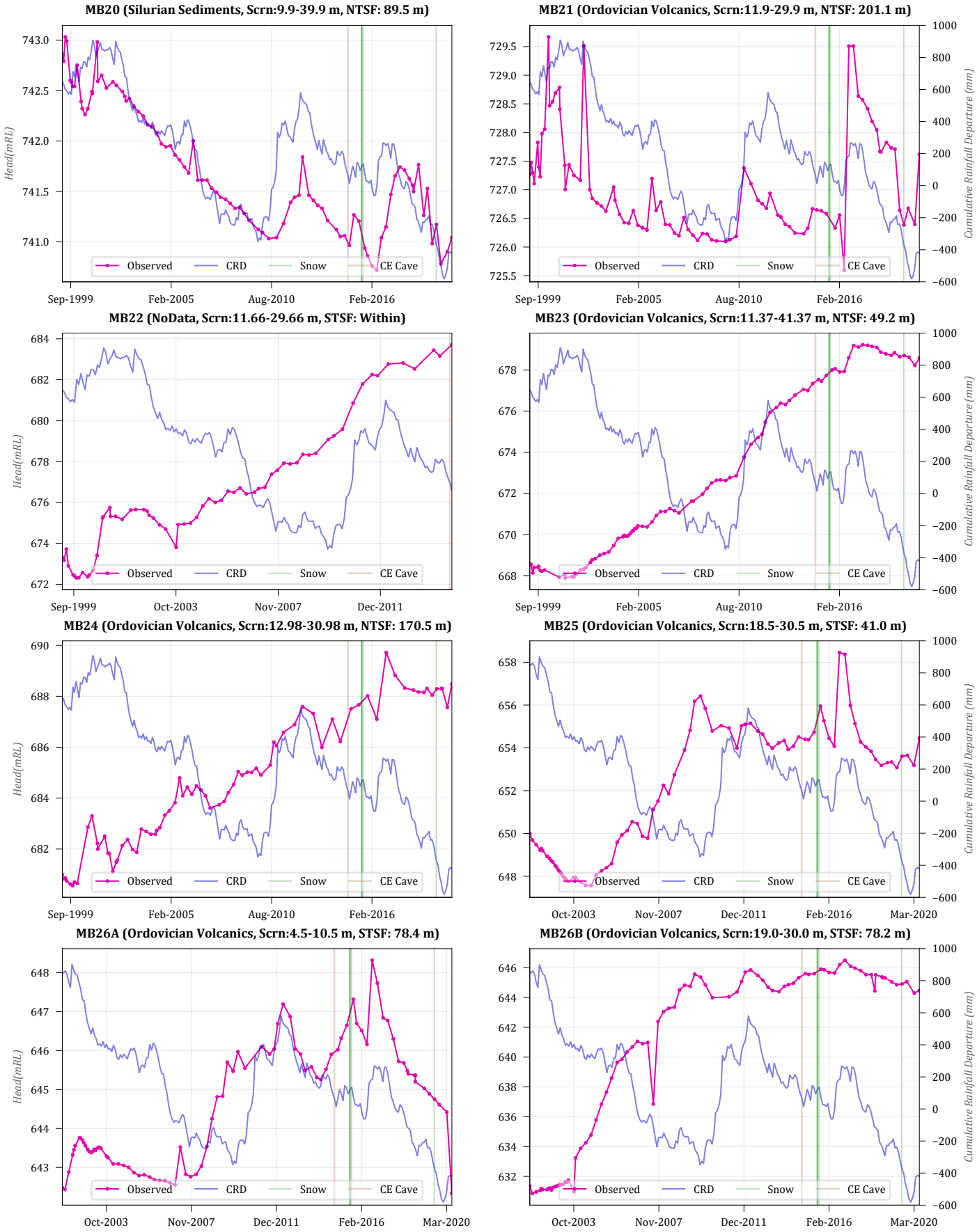

MB9B (Soil/Clay, Scrn:0.2-6.2 m, SWRD: 287.1 m)
Head(mRL)
Observed
CRD
Snow
CE Cave
Sep-1999
Feb-2005
Aug-2010
Feb-2016

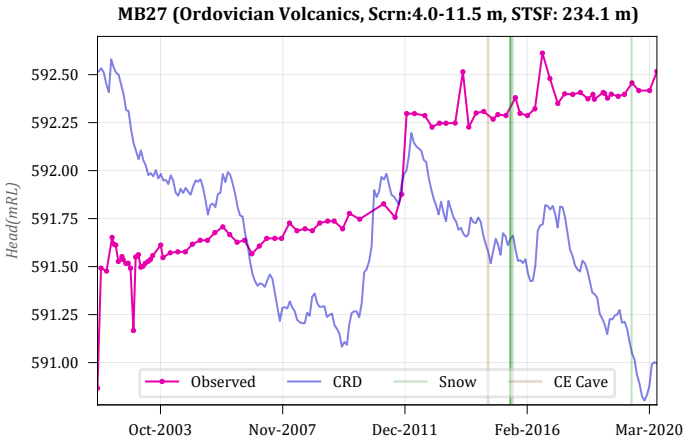

MB10A (Silurian Sediments, Scrn:12-18 m, SWRD: 275.9 m)
Cumulative Rainfall Departure (mm)
Observed
CRD
Snow
CE Cave
Sep-1999
Feb-2005
Aug-2010
Feb-2016

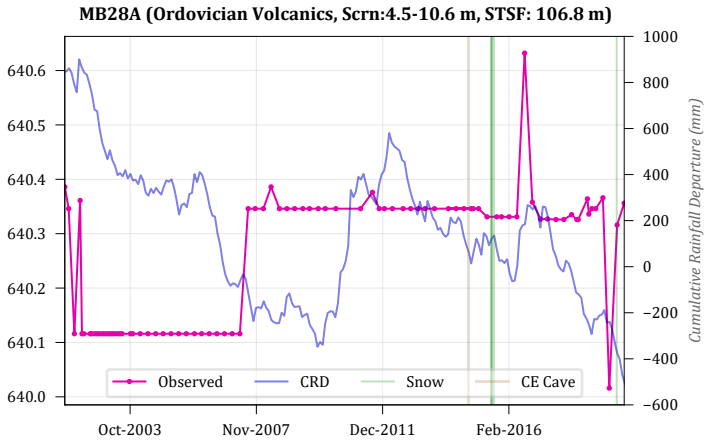

MB10B (Soil/Clay, Scrn:0.7-6.7 m, SWRD: 274.5 m)
Head(mRL)
Observed
CRD
Snow
CE Cave
Sep-1999
Feb-2005
Aug-2010
Feb-2016

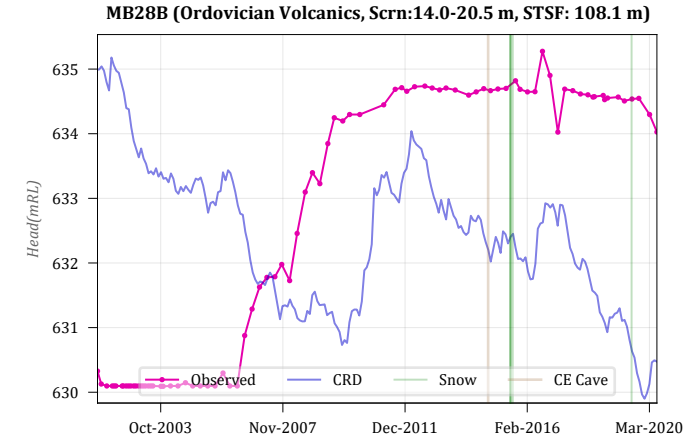

MB11A (Silurian Sediments, Scrn:12-18 m, SWRD: 328.4 m)
Cumulative Rainfall Departure (mm)
Observed
CRD
Snow
CE Cave
Sep-1999
Feb-2005
Aug-2010
Feb-2016

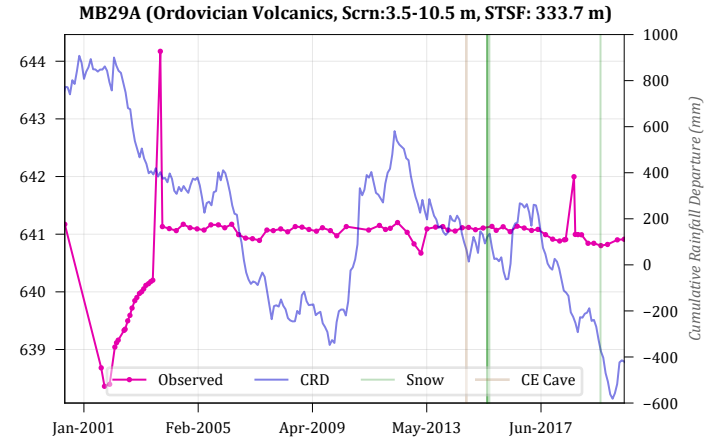

MB11B (Soil/Clay, Scrn:3.2-5.0 m, SWRD: 327.0 m)
MB15 (Ordovician Volcanics, Scrn:12-18 m, STSF: Within)
MB16A (Ordovician Volcanics, Scrn:12-18 m, STSF: Within)
MB16B (NoData, Scrn:2.9-5.7 m, STSF: Within)
MB17 (Silurian Sediments, Scrn:15.9-33.9 m, NTSF: Within)
MB18 (Silurian Sediments, Scrn:17.6-29.6 m, SWRD: 260.1 m)
MB19A (NoData, Scrn:15.7-39.7 m, STSF: Within)
MB19B (NoData, Scrn:1.64-7.64 m, STSF: Within)
Head(mRL)
Cumulative Rainfall Departure (mm)
Observed
CRD
Snow
CE Cave

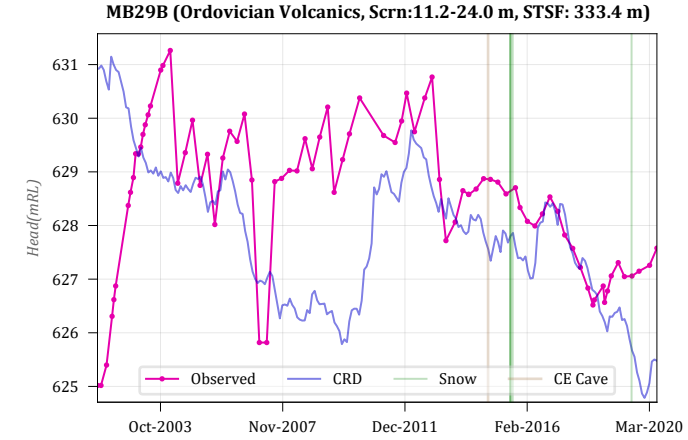

MB20 (Silurian Sediments, Scrn:9.9-39.9 m, NTSF: 89.5 m)
MB21 (Ordovician Volcanics, Scrn:11.9-29.9 m, NTSF: 201.1 m)
MB22 (NoData, Scrn:11.66-29.66 m, STSF: Within)
MB23 (Ordovician Volcanics, Scrn:11.37-41.37 m, NTSF: 49.2 m)
MB24 (Ordovician Volcanics, Scrn:12.98-30.98 m, NTSF: 170.5 m)
MB25 (Ordovician Volcanics, Scrn:18.5-30.5 m, STSF: 41.0 m)
MB26A (Ordovician Volcanics, Scrn:4.5-10.5 m, STSF: 78.4 m)
MB26B (Ordovician Volcanics, Scrn:19.0-30.0 m, STSF: 78.2 m)
Head(mRL)
Cumulative Rainfall Departure (mm)
Observed
CRD
Snow
CE Cave

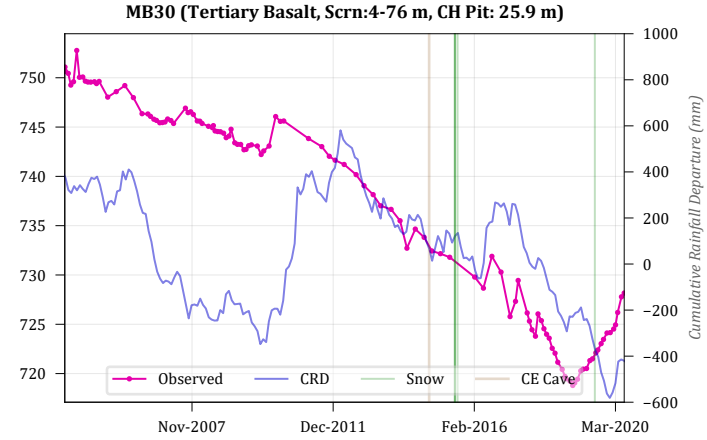

MB27 (Ordovician Volcanics, Scrn:4.0-11.5 m, STSF: 234.1 m)
Head(mRL)
592.50
592.25
592.00
591.75
591.50
591.25
591.00
Observed
CRD
Snow
CE Cave
Oct-2003
Nov-2007
Dec-2011
Feb-2016
Mar-2020

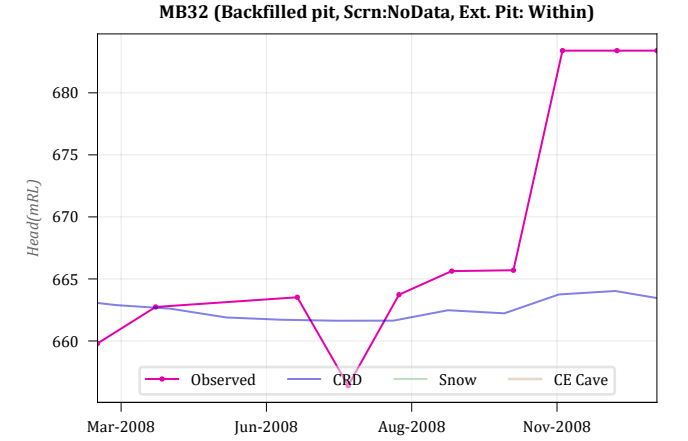

MB28A (Ordovician Volcanics, Scrn:4.5-10.6 m, STSF: 106.8 m)
640.6
640.5
640.4
640.3
640.2
640.1
640.0
Cumulative Rainfall Departure (mm)
1000
800
600
400
200
0
−200
−400
−600
Observed
CRD
Snow
CE Cave
Oct-2003
Nov-2007
Dec-2011
Feb-2016

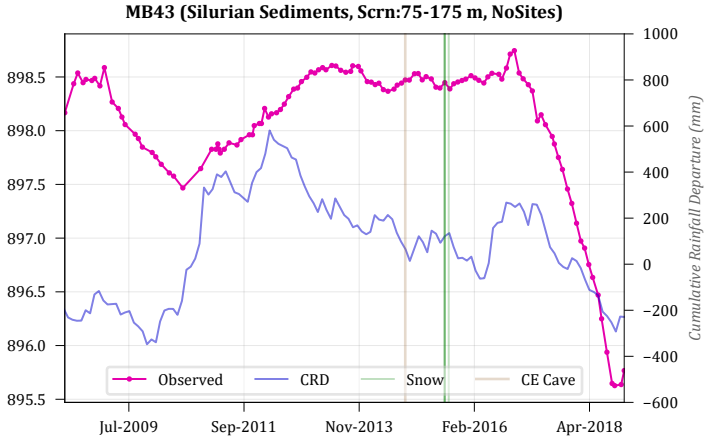

MB28B (Ordovician Volcanics, Scrn:14.0-20.5 m, STSF: 108.1 m)
Head(mRL)
635
634
633
632
631
630
Observed
CRD
Snow
CE Cave
Oct-2003
Nov-2007
Dec-2011
Feb-2016
Mar-2020

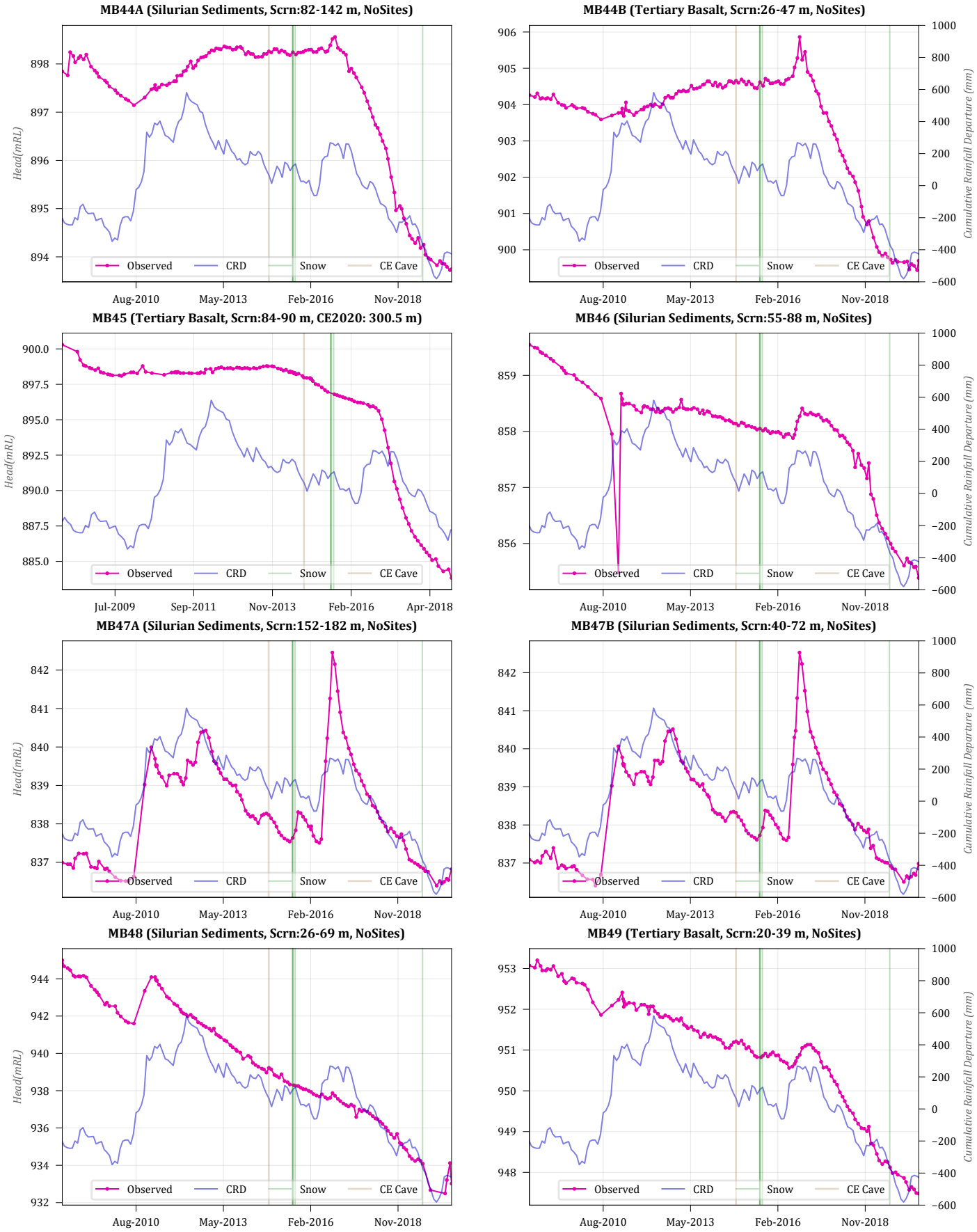

MB29A (Ordovician Volcanics, Scrn:3.5-10.5 m, STSF: 333.7 m)
644
643
642
641
640
639
Cumulative Rainfall Departure (mm)
1000
800
600
400
200
0
−200
−400
−600
Observed
CRD
Snow
CE Cave
Jan-2001
Feb-2005
Apr-2009
May-2013
Jun-2017


MB29B (Ordovician Volcanics, Scrn:11.2-24.0 m, STSF: 333.4 m)
Head(mRL)
631
630
629
628
627
626
625
Observed
CRD
Snow
CE Cave
Oct-2003
Nov-2007
Dec-2011
Feb-2016
Mar-2020

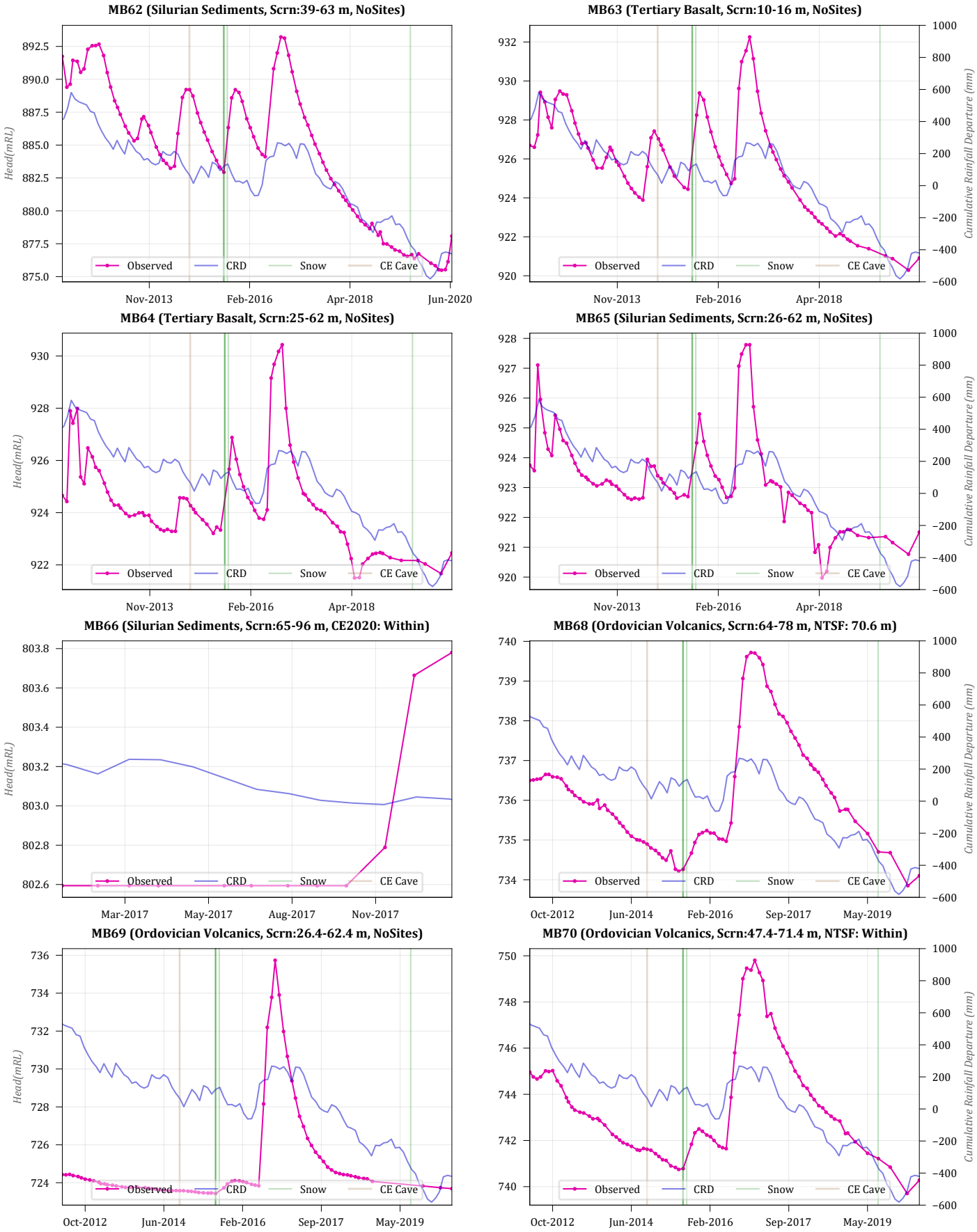

MB30 (Tertiary Basalt, Scrn:4-76 m, CH Pit: 25.9 m)
750
745
740
735
730
725
720
Cumulative Rainfall Departure (mm)
1000
800
600
400
200
0
−200
−400
−600
Observed
CRD
Snow
CE Cave
Nov-2007
Dec-2011
Feb-2016
Mar-2020

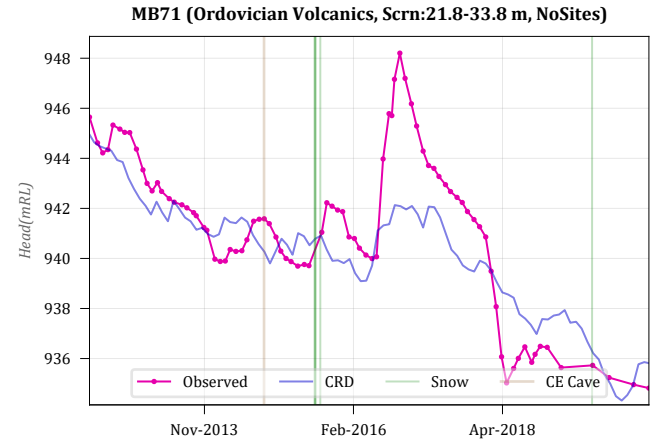

MB32 (Backfilled pit, Scrn:NoData, Ext. Pit: Within)
Head(mRL)
680
675
670
665
660
Observed
CRD
Snow
CE Cave
Mar-2008
Jun-2008
Aug-2008
Nov-2008

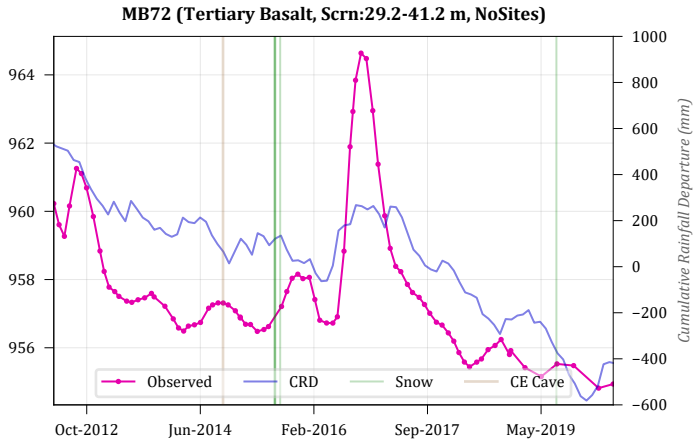

MB43 (Silurian Sediments, Scrn:75-175 m, NoSites)
898.5
898.0
897.5
897.0
896.5
896.0
895.5
Cumulative Rainfall Departure (mm)
1000
800
600
400
200
0
−200
−400
−600
Observed
CRD
Snow
CE Cave
Jul-2009
Sep-2011
Nov-2013
Feb-2016
Apr-2018

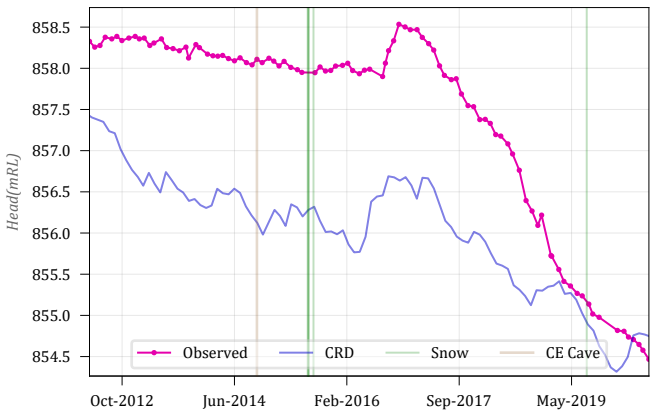

MB44A (Silurian Sediments, Scrn:82-142 m, NoSites)
MB44B (Tertiary Basalt, Scrn:26-47 m, NoSites)
MB45 (Tertiary Basalt, Scrn:84-90 m, CE2020: 300.5 m)
MB46 (Silurian Sediments, Scrn:55-88 m, NoSites)
MB47A (Silurian Sediments, Scrn:152-182 m, NoSites)
MB47B (Silurian Sediments, Scrn:40-72 m, NoSites)
MB48 (Silurian Sediments, Scrn:26-69 m, NoSites)
MB49 (Tertiary Basalt, Scrn:20-39 m, NoSites)
Head(mRL)
Cumulative Rainfall Departure (mm)
Observed
CRD
Snow
CE Cave
Aug-2010
May-2013
Feb-2016
Nov-2018
Jul-2009
Sep-2011
Apr-2018

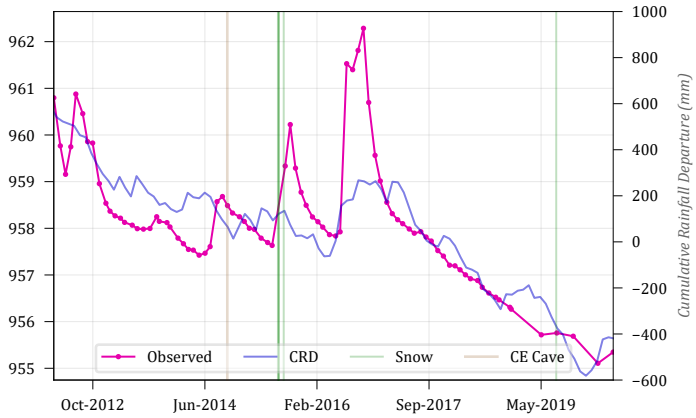
MB50 (Silurian Sediments, Scrn:197-217 m, CE2020: 26.7 m)
MB51 (Silurian Sediments, Scrn:42-54 m, CE2020: 29.2 m)
MB52 (Silurian Sediments, Scrn:35-55 m, SWRD: 24.5 m)
MB53 (Tertiary Basalt, Scrn:27-45 m, NoSites)
MB54 (Tertiary Basalt, Scrn:15-21 m, NoSites)
MB55 (Tertiary Basalt, Scrn:6-9 m, NoSites)
MB56 (Tertiary Basalt, Scrn:23-30 m, NoSites)
MB60 (Tertiary Basalt, Scrn:44-56 m, CE2020: Within)
Head(mRL)
Cumulative Rainfall Departure (mm)
Observed
CRD
Snow
CE Cave

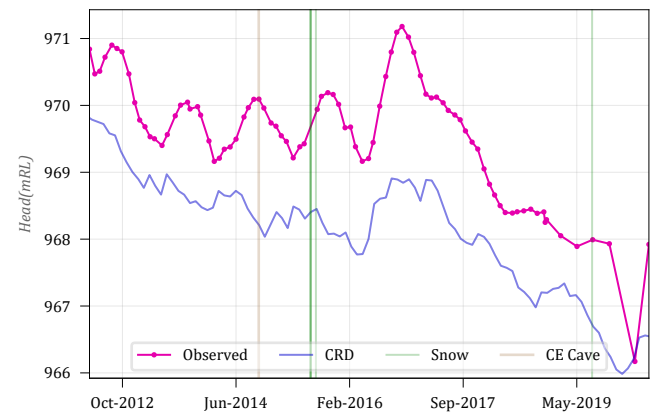

MB62 (Silurian Sediments, Scrn:39-63 m, NoSites)
MB63 (Tertiary Basalt, Scrn:10-16 m, NoSites)
MB64 (Tertiary Basalt, Scrn:25-62 m, NoSites)
MB65 (Silurian Sediments, Scrn:26-62 m, NoSites)
MB66 (Silurian Sediments, Scrn:65-96 m, CE2020: Within)
MB68 (Ordovician Volcanics, Scrn:64-78 m, NTSF: 70.6 m)
MB69 (Ordovician Volcanics, Scrn:26.4-62.4 m, NoSites)
MB70 (Ordovician Volcanics, Scrn:47.4-71.4 m, NTSF: Within)
Head(mRL)
Cumulative Rainfall Departure (mm)
Observed
CRD
Snow
CE Cave

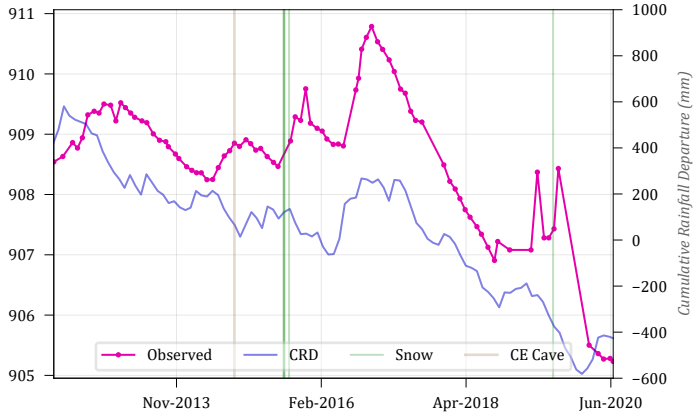

MB71 (Ordovician Volcanics, Scrn:21.8-33.8 m, NoSites)
Head(mRL)
948
946
944
942
940
938
936
Observed
CRD
Snow
CE Cave
Nov-2013
Feb-2016
Apr-2018

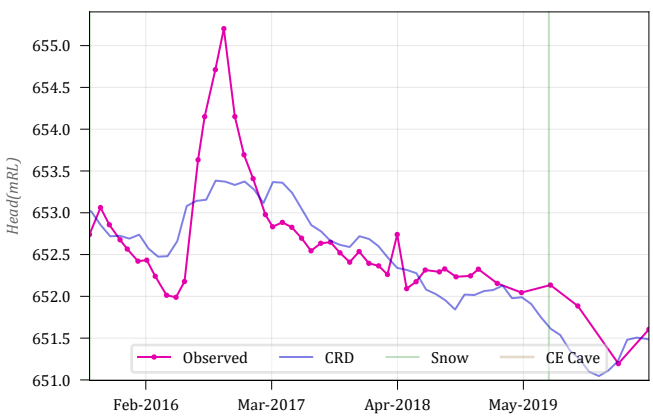

MB72 (Tertiary Basalt, Scrn:29.2-41.2 m, NoSites)
964
962
960
958
956
1000
800
600
400
200
0
−200
−400
−600
Cumulative Rainfall Departure (mm)
Observed
CRD
Snow
CE Cave
Oct-2012
Jun-2014
Feb-2016
Sep-2017
May-2019

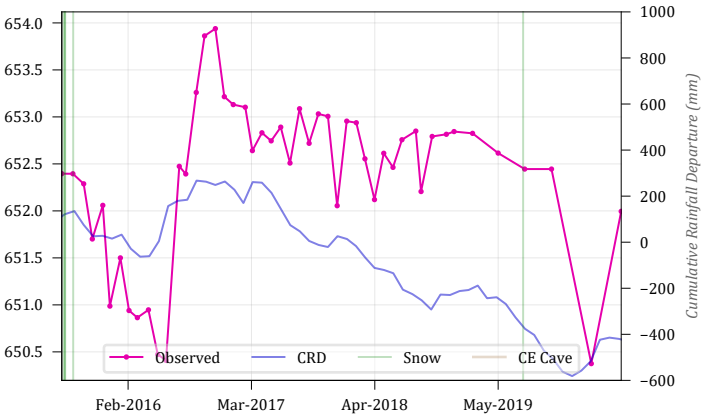

MB73 (Silurian Sediments, Scrn:75.35-94.35 m, NoSites)
Head(mRL)
858.5
858.0
857.5
857.0
856.5
856.0
855.5
855.0
854.5
Observed
CRD
Snow
CE Cave
Oct-2012
Jun-2014
Feb-2016
Sep-2017
May-2019

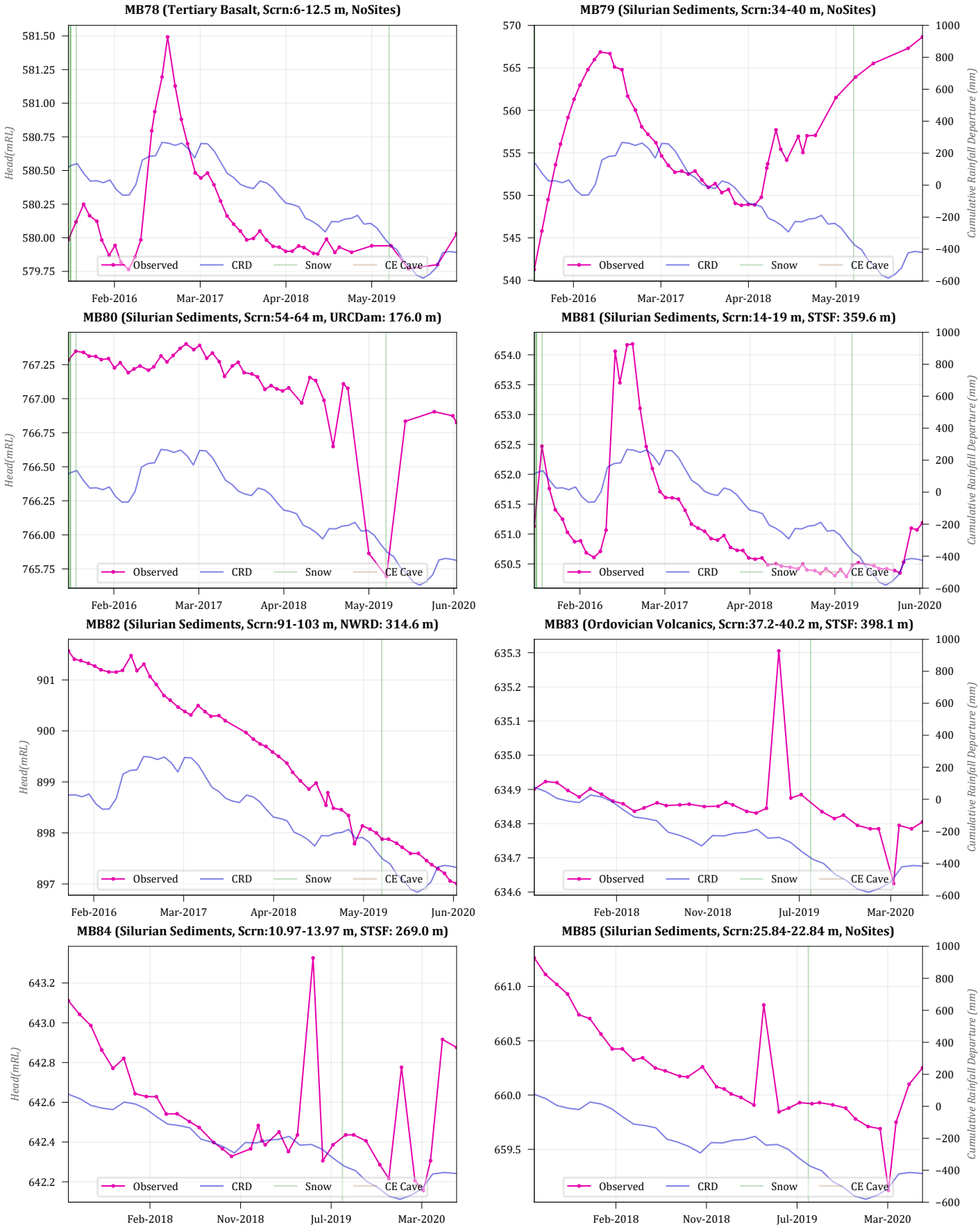

MB74 (Tertiary Basalt, Scrn:6.6-24.6 m, NoSites)
962
961
960
959
958
957
956
955
1000
800
600
400
200
0
−200
−400
−600
Cumulative Rainfall Departure (mm)
Observed
CRD
Snow
CE Cave
Oct-2012
Jun-2014
Feb-2016
Sep-2017
May-2019

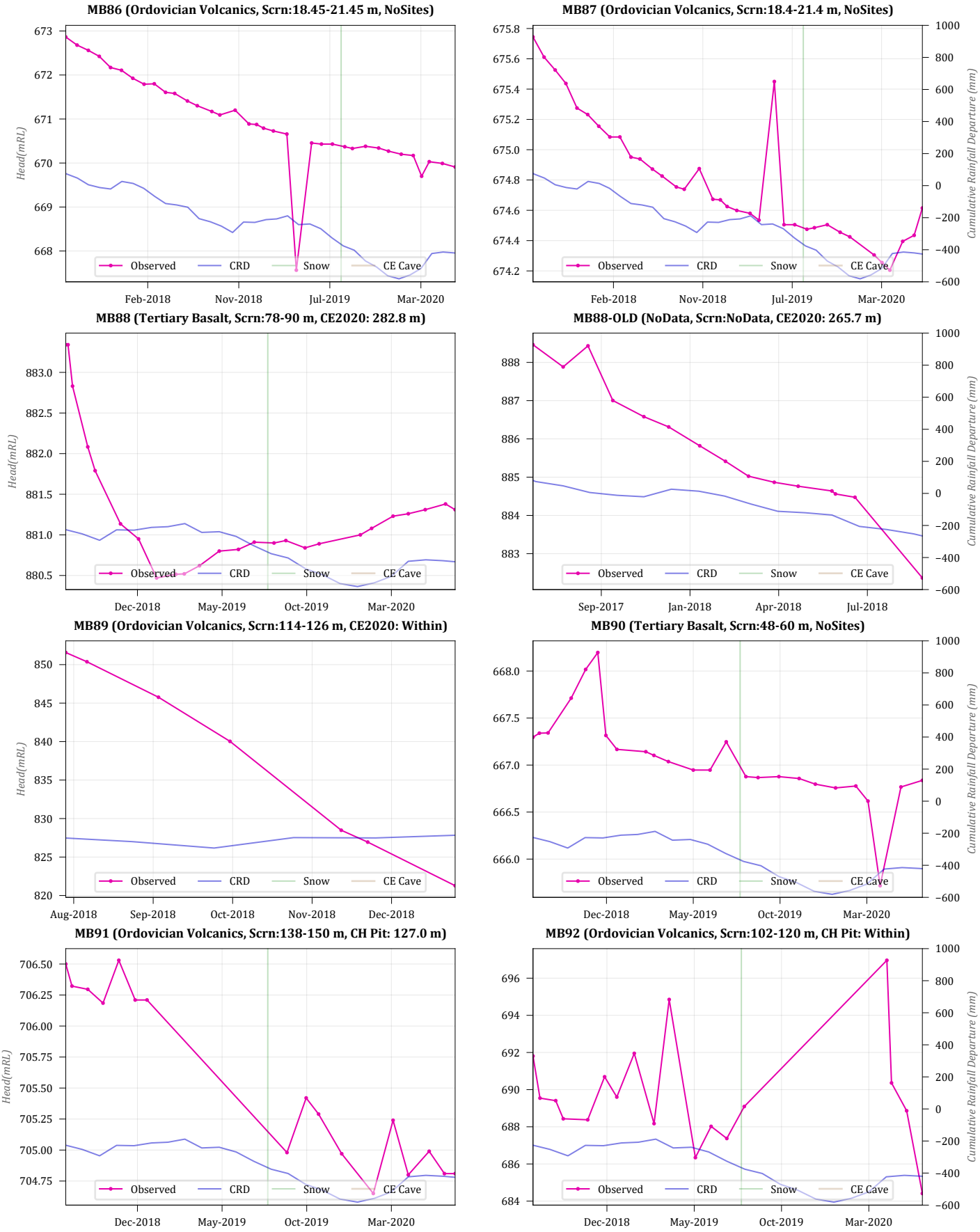

MB75 (Ordovician Volcanics, Scrn:43.9-58.9 m, NoSites)
Head(mRL)
971
970
969
968
967
966
Observed
CRD
Snow
CE Cave
Oct-2012
Jun-2014
Feb-2016
Sep-2017
May-2019

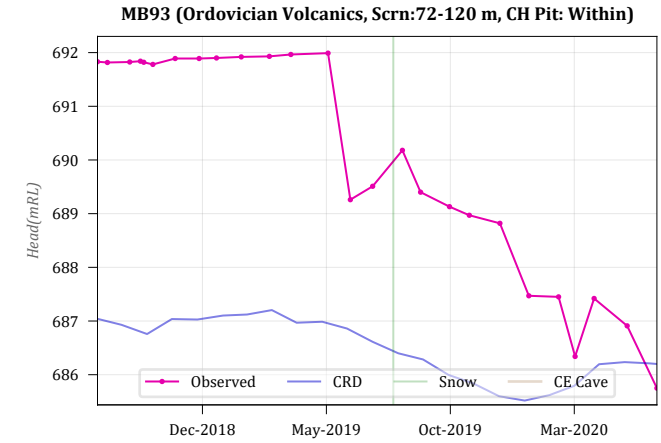

MB76 (Silurian Sediments, Scrn:25-26 m, NoSites)
911
910
909
908
907
906
905
1000
800
600
400
200
0
−200
−400
−600
Cumulative Rainfall Departure (mm)
Observed
CRD
Snow
CE Cave
Nov-2013
Feb-2016
Apr-2018
Jun-2020

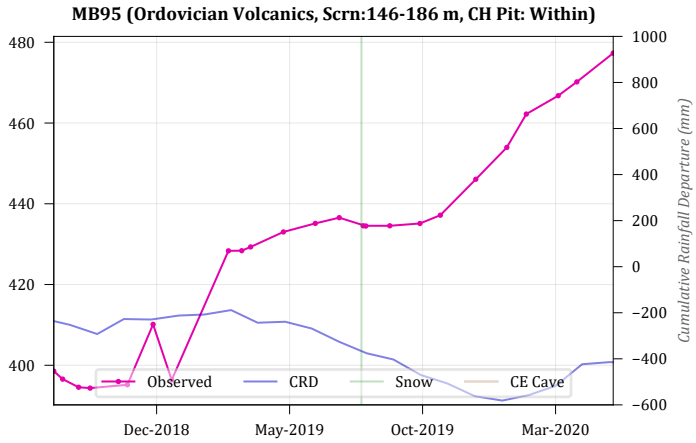

MB77A (Silurian Sediments, Scrn:6-12 m, STSF: 146.3 m)
Head(mRL)
655.0
654.5
654.0
653.5
653.0
652.5
652.0
651.5
651.0
Observed
CRD
Snow
CE Cave
Feb-2016
Mar-2017
Apr-2018
May-2019

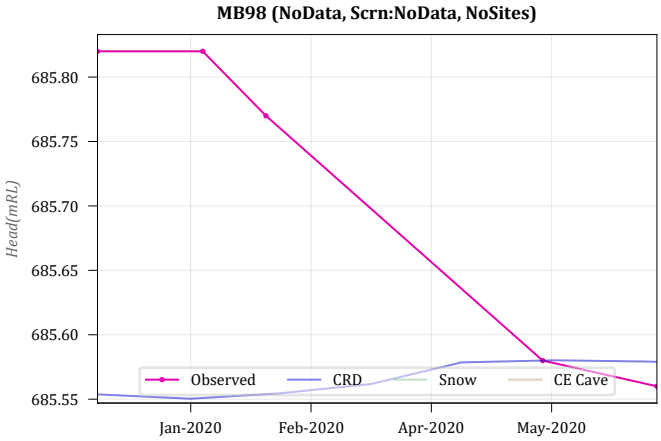

MB77B (Silurian Sediments, Scrn:23-29 m, STSF: 145.6 m)
654.0
653.5
653.0
652.5
652.0
651.5
651.0
650.5
1000
800
600
400
200
0
−200
−400
−600
Cumulative Rainfall Departure (mm)
Observed
CRD
Snow
CE Cave
Feb-2016
Mar-2017
Apr-2018
May-2019

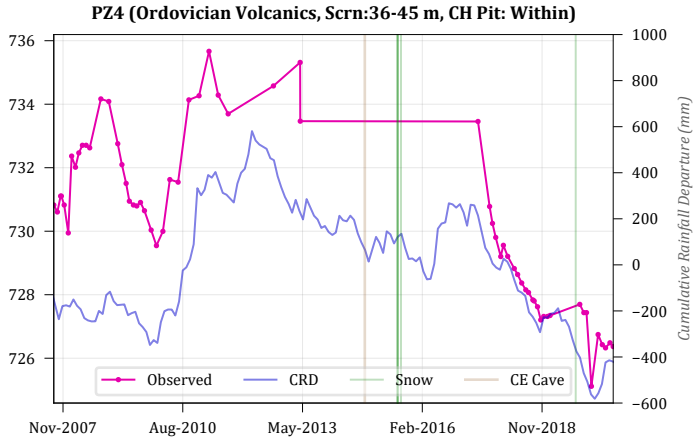

MB78 (Tertiary Basalt, Scrn:6-12.5 m, NoSites)
MB79 (Silurian Sediments, Scrn:34-40 m, NoSites)
MB80 (Silurian Sediments, Scrn:54-64 m, URCDam: 176.0 m)
MB81 (Silurian Sediments, Scrn:14-19 m, STSF: 359.6 m)
MB82 (Silurian Sediments, Scrn:91-103 m, NWRD: 314.6 m)
MB83 (Ordovician Volcanics, Scrn:37.2-40.2 m, STSF: 398.1 m)
MB84 (Silurian Sediments, Scrn:10.97-13.97 m, STSF: 269.0 m)
MB85 (Silurian Sediments, Scrn:25.84-22.84 m, NoSites)
Head(mRL)
Cumulative Rainfall Departure (mm)
Observed
CRD
Snow
CE Cave

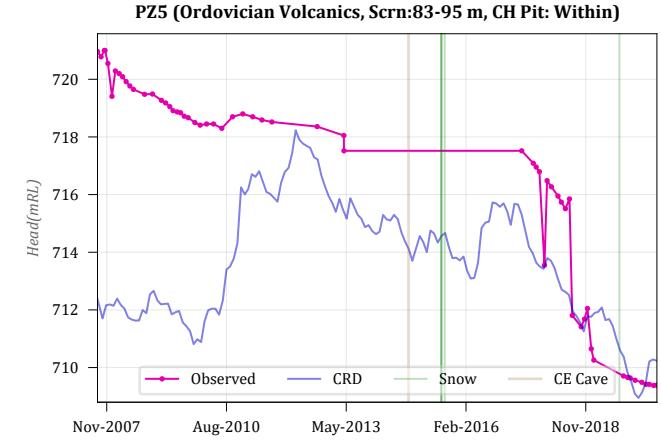

MB86 (Ordovician Volcanics, Scrn:18.45-21.45 m, NoSites)
MB87 (Ordovician Volcanics, Scrn:18.4-21.4 m, NoSites)
MB88 (Tertiary Basalt, Scrn:78-90 m, CE2020: 282.8 m)
MB88-OLD (NoData, Scrn:NoData, CE2020: 265.7 m)
MB89 (Ordovician Volcanics, Scrn:114-126 m, CE2020: Within)
MB90 (Tertiary Basalt, Scrn:48-60 m, NoSites)
MB91 (Ordovician Volcanics, Scrn:138-150 m, CH Pit: 127.0 m)
MB92 (Ordovician Volcanics, Scrn:102-120 m, CH Pit: Within)
Head(mRL)
Cumulative Rainfall Departure (mm)
Observed
CRD
Snow
CE Cave

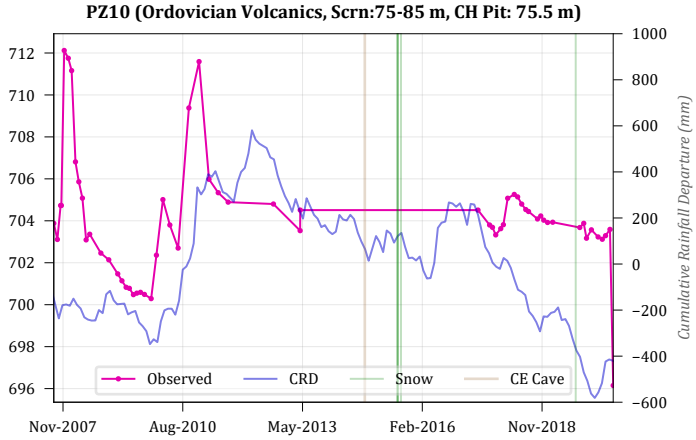

MB93 (Ordovician Volcanics, Scrn:72-120 m, CH Pit: Within)
Head(mRL)
692
691
690
689
688
687
686
Observed
CRD
Snow
CE Cave
Dec-2018
May-2019
Oct-2019
Mar-2020

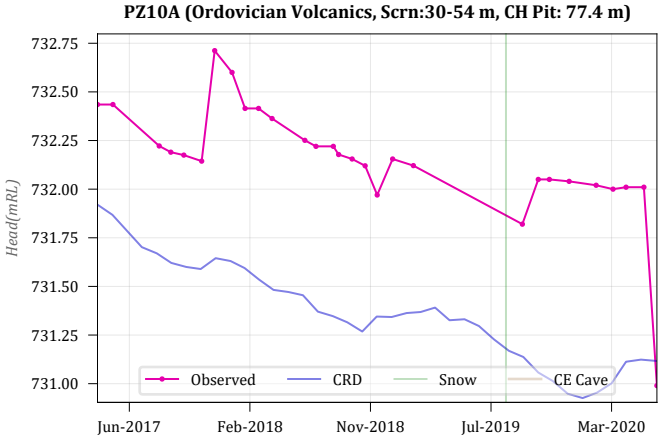

MB95 (Ordovician Volcanics, Scrn:146-186 m, CH Pit: Within)
480
460
440
420
400
1000
800
600
400
200
0
−200
−400
−600
Cumulative Rainfall Departure (mm)
Observed
CRD
Snow
CE Cave
Dec-2018
May-2019
Oct-2019
Mar-2020

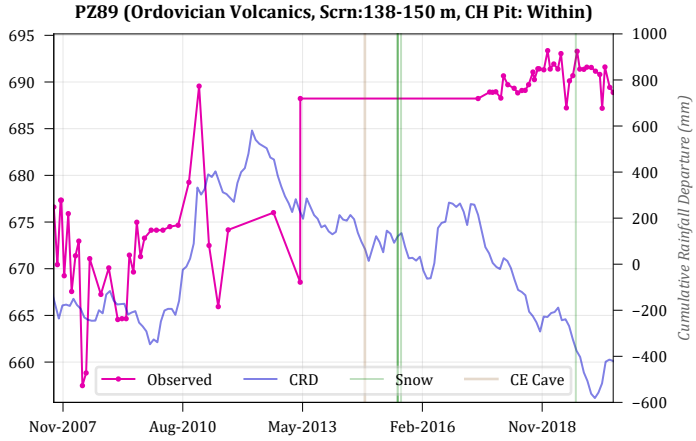

MB98 (NoData, Scrn:NoData, NoSites)
Head(mRL)
685.80
685.75
685.70
685.65
685.60
685.55
Observed
CRD
Snow
CE Cave
Jan-2020
Feb-2020
Apr-2020
May-2020

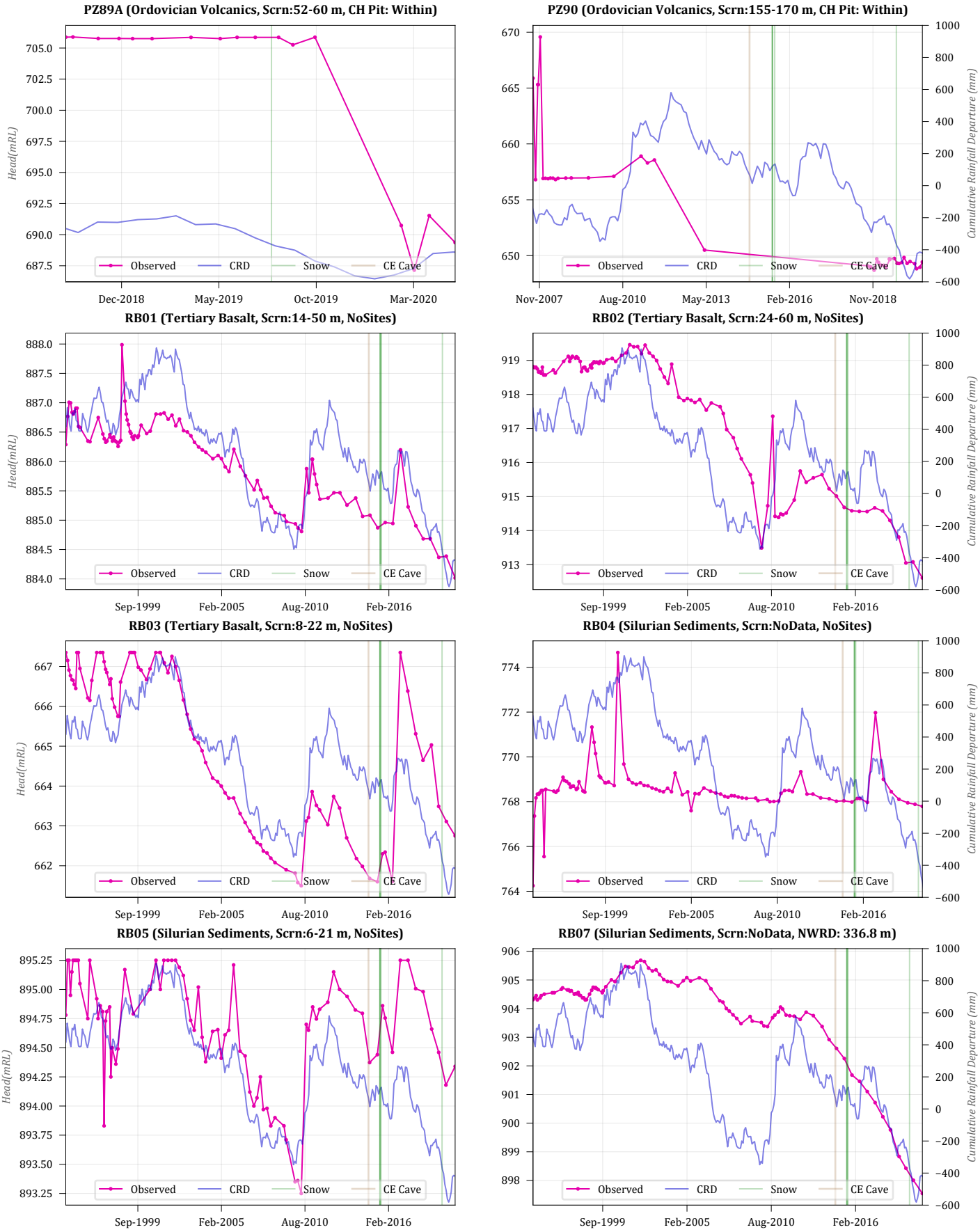

PZ4 (Ordovician Volcanics, Scrn:36-45 m, CH Pit: Within)
736
734
732
730
728
726
1000
800
600
400
200
0
−200
−400
−600
Cumulative Rainfall Departure (mm)
Observed
CRD
Snow
CE Cave
Nov-2007
Aug-2010
May-2013
Feb-2016
Nov-2018

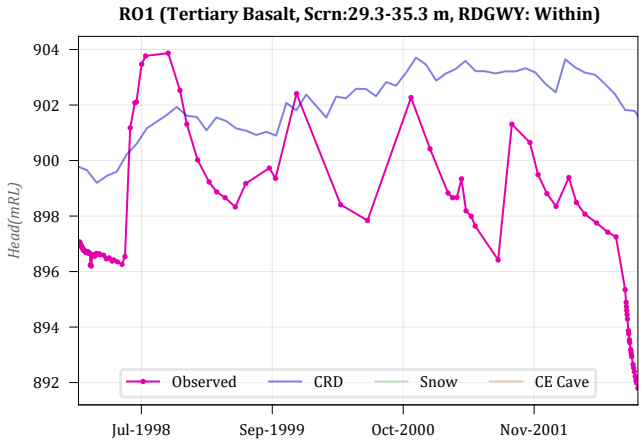

PZ5 (Ordovician Volcanics, Scrn:83-95 m, CH Pit: Within)
Head(mRL)
720
718
716
714
712
710
Observed
CRD
Snow
CE Cave
Nov-2007
Aug-2010
May-2013
Feb-2016
Nov-2018

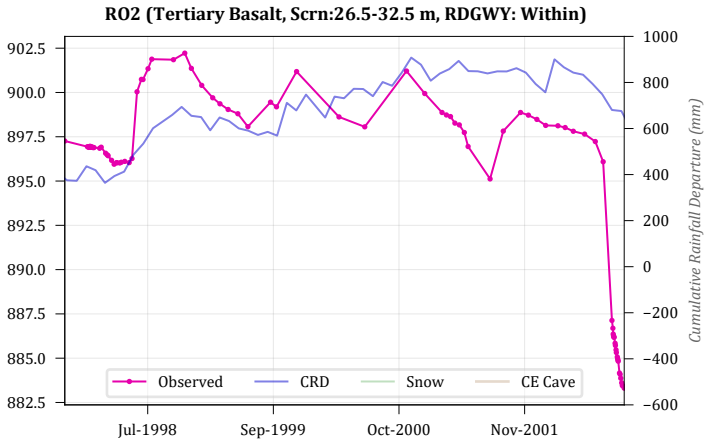

PZ10 (Ordovician Volcanics, Scrn:75-85 m, CH Pit: 75.5 m)
712
710
708
706
704
702
700
698
696
1000
800
600
400
200
0
−200
−400
−600
Cumulative Rainfall Departure (mm)
Observed
CRD
Snow
CE Cave
Nov-2007
Aug-2010
May-2013
Feb-2016
Nov-2018

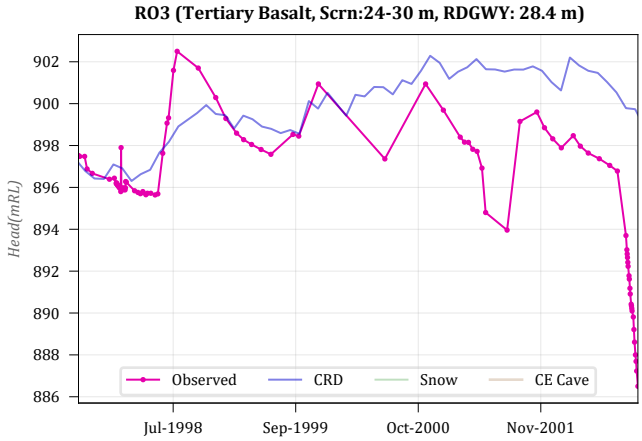

PZ10A (Ordovician Volcanics, Scrn:30-54 m, CH Pit: 77.4 m)
Head(mRL)
732.75
732.50
732.25
732.00
731.75
731.50
731.25
731.00
Observed
CRD
Snow
CE Cave
Jun-2017
Feb-2018
Nov-2018
Jul-2019
Mar-2020

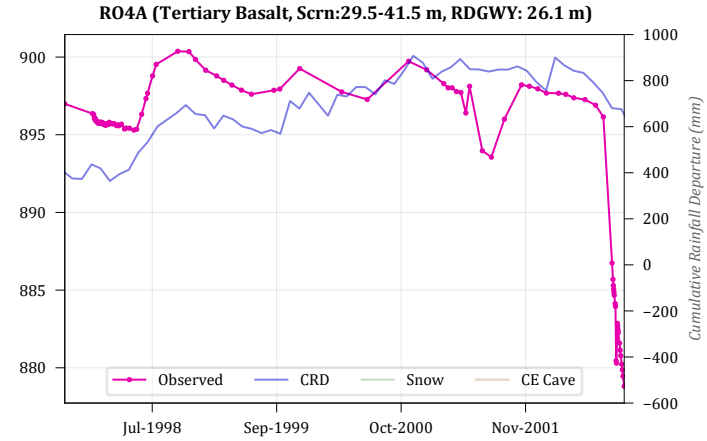

PZ89 (Ordovician Volcanics, Scrn:138-150 m, CH Pit: Within)
695
690
685
680
675
670
665
660
1000
800
600
400
200
0
−200
−400
−600
Cumulative Rainfall Departure (mm)
Observed
CRD
Snow
CE Cave
Nov-2007
Aug-2010
May-2013
Feb-2016
Nov-2018

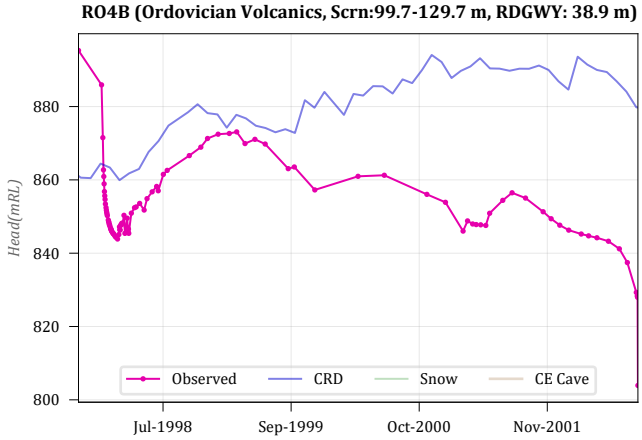

PZ89A (Ordovician Volcanics, Scrn:52-60 m, CH Pit: Within)
PZ90 (Ordovician Volcanics, Scrn:155-170 m, CH Pit: Within)
RB01 (Tertiary Basalt, Scrn:14-50 m, NoSites)
RB02 (Tertiary Basalt, Scrn:24-60 m, NoSites)
RB03 (Tertiary Basalt, Scrn:8-22 m, NoSites)
RB04 (Silurian Sediments, Scrn:NoData, NoSites)
RB05 (Silurian Sediments, Scrn:6-21 m, NoSites)
RB07 (Silurian Sediments, Scrn:NoData, NWRD: 336.8 m)
Head(mRL)
Cumulative Rainfall Departure (mm)
Observed
CRD
Snow
CE Cave

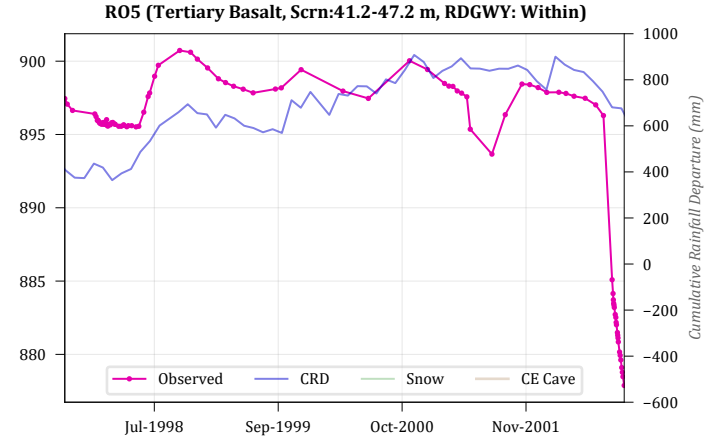

RO1 (Tertiary Basalt, Scrn:29.3-35.3 m, RDGWY: Within)
Head(mRL)
Observed
CRD
Snow
CE Cave
Jul-1998
Sep-1999
Oct-2000
Nov-2001

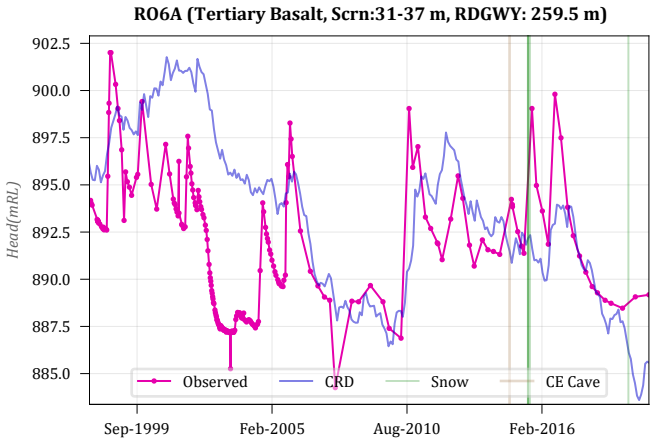

RO2 (Tertiary Basalt, Scrn:26.5-32.5 m, RDGWY: Within)
Cumulative Rainfall Departure (mm)
Observed
CRD
Snow
CE Cave
Jul-1998
Sep-1999
Oct-2000
Nov-2001

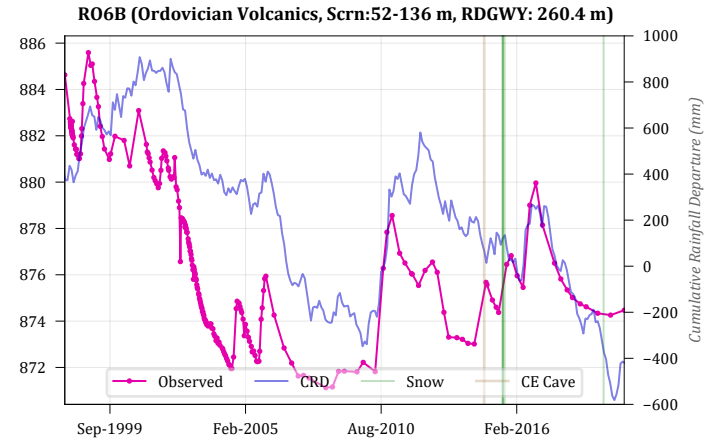

RO3 (Tertiary Basalt, Scrn:24-30 m, RDGWY: 28.4 m)
Head(mRL)
Observed
CRD
Snow
CE Cave
Jul-1998
Sep-1999
Oct-2000
Nov-2001


RO4A (Tertiary Basalt, Scrn:29.5-41.5 m, RDGWY: 26.1 m)
Cumulative Rainfall Departure (mm)
Observed
CRD
Snow
CE Cave
Jul-1998
Sep-1999
Oct-2000
Nov-2001

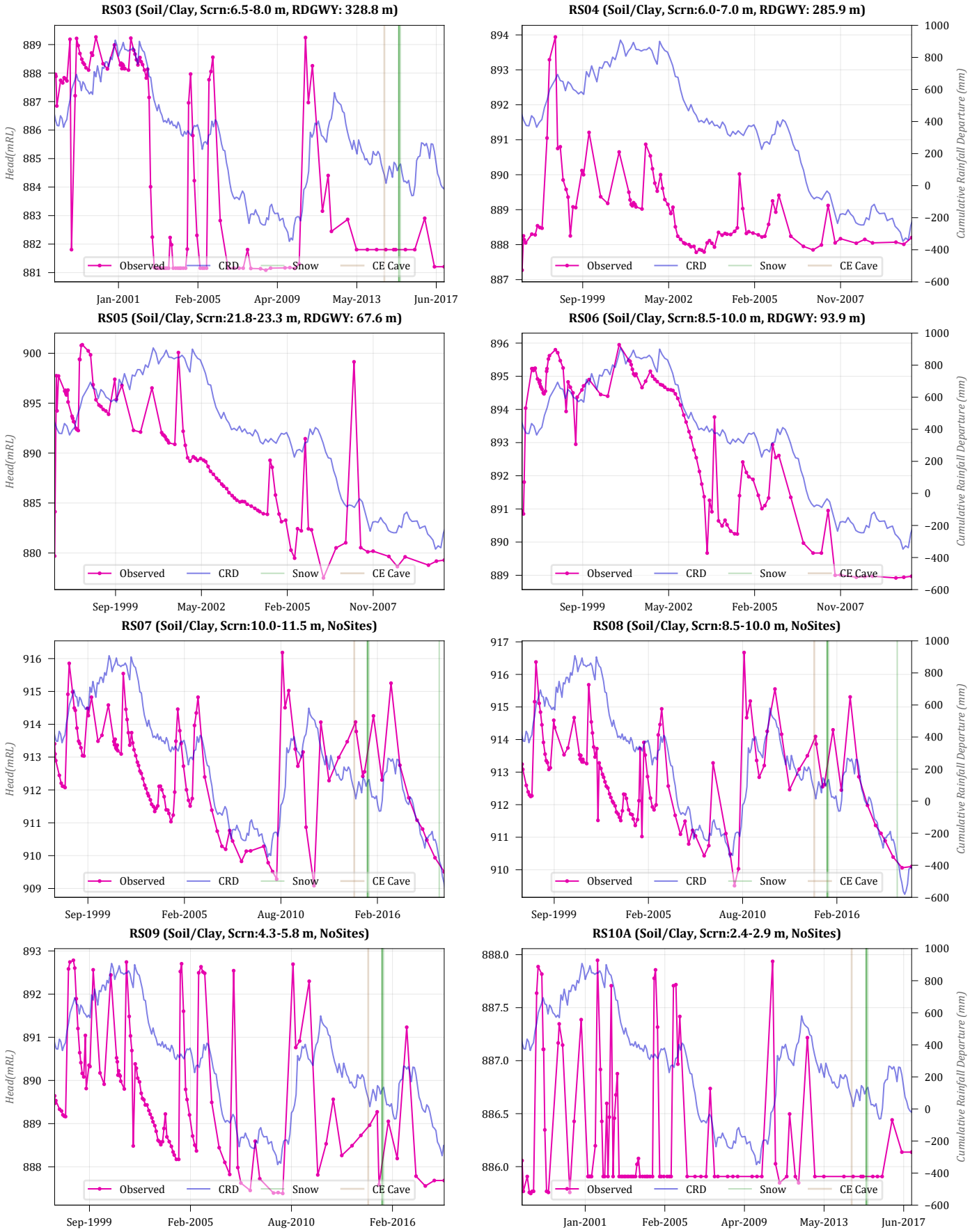

RO4B (Ordovician Volcanics, Scrn:99.7-129.7 m, RDGWY: 38.9 m)
Head(mRL)
Observed
CRD
Snow
CE Cave
Jul-1998
Sep-1999
Oct-2000
Nov-2001

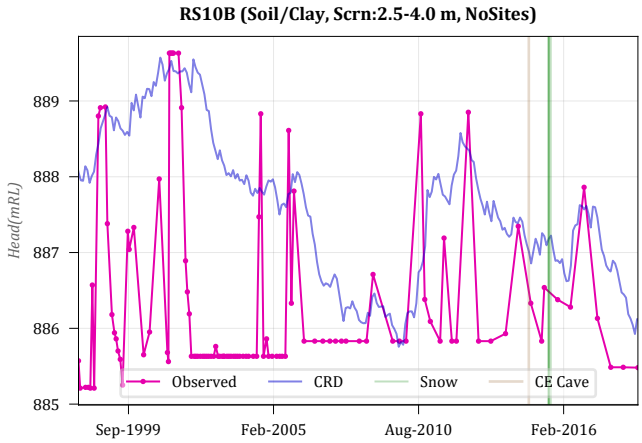

RO5 (Tertiary Basalt, Scrn:41.2-47.2 m, RDGWY: Within)
Cumulative Rainfall Departure (mm)
Observed
CRD
Snow
CE Cave
Jul-1998
Sep-1999
Oct-2000
Nov-2001

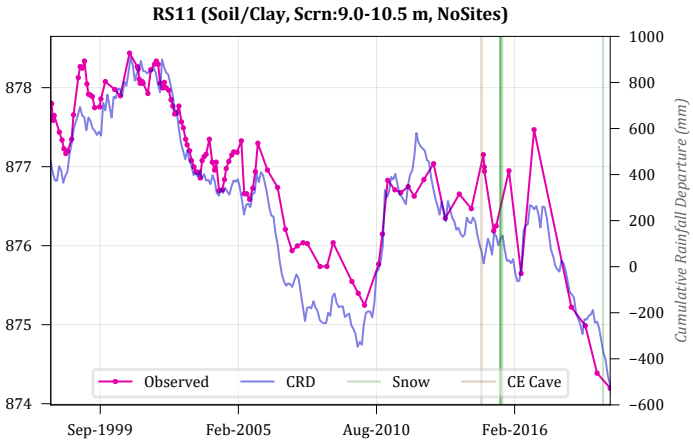

RO6A (Tertiary Basalt, Scrn:31-37 m, RDGWY: 259.5 m)
Head(mRL)
Observed
CRD
Snow
CE Cave
Sep-1999
Feb-2005
Aug-2010
Feb-2016

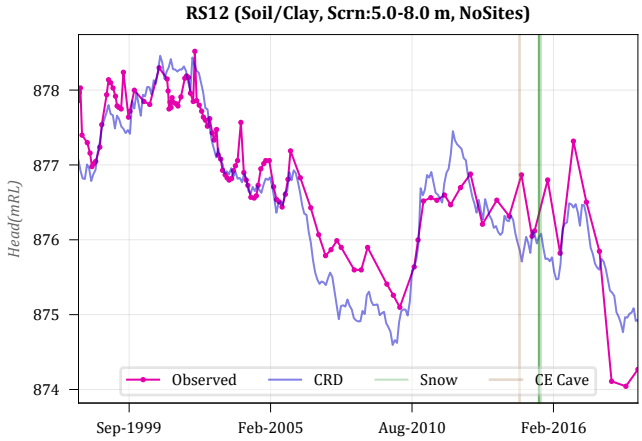

RO6B (Ordovician Volcanics, Scrn:52-136 m, RDGWY: 260.4 m)
Cumulative Rainfall Departure (mm)
Observed
CRD
Snow
CE Cave
Sep-1999
Feb-2005
Aug-2010
Feb-2016

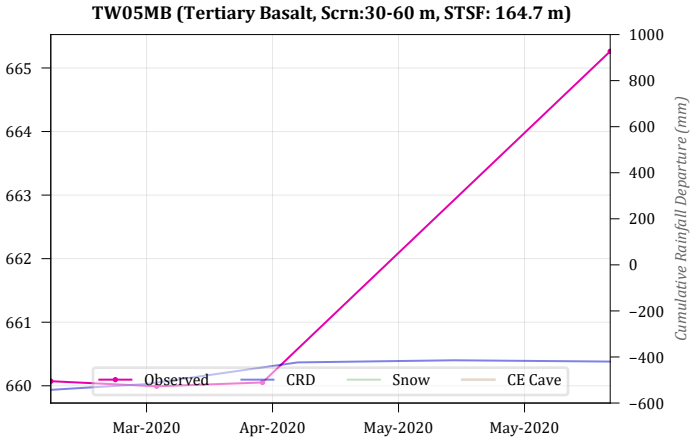
RO7 (Tertiary Basalt, Scrn:50-62 m, NoSites)
RO8 (Tertiary Basalt, Scrn:11.5-17.5 m, RDGWY: 281.4 m)
RO10A (Tertiary Basalt, Scrn:39-44 m, NoSites)
RO10B (Ordovician Volcanics, Scrn:89-136 m, NoSites)
RO11 (Tertiary Basalt, Scrn:24-36 m, NoSites)
RO12 (Tertiary Basalt, Scrn:25.4-31.4 m, NoSites)
RO13 (Tertiary Basalt, Scrn:52.5-65.5 m, RDGWY: 34.1 m)
RS01 (Soil/Clay, Scrn:6.5-8.0 m, RDGWY: Within)
Head(mRL)
Cumulative Rainfall Departure (mm)
Observed
CRD
Snow
CE Cave
Sep-1999
Feb-2005
Aug-2010
Feb-2016
Jan-2001
Apr-2009
May-2013
Jun-2017
Jul-1998
Oct-2000
Nov-2001


RS03 (Soil/Clay, Scrn:6.5-8.0 m, RDGWY: 328.8 m)
RS04 (Soil/Clay, Scrn:6.0-7.0 m, RDGWY: 285.9 m)
RS05 (Soil/Clay, Scrn:21.8-23.3 m, RDGWY: 67.6 m)
RS06 (Soil/Clay, Scrn:8.5-10.0 m, RDGWY: 93.9 m)
RS07 (Soil/Clay, Scrn:10.0-11.5 m, NoSites)
RS08 (Soil/Clay, Scrn:8.5-10.0 m, NoSites)
RS09 (Soil/Clay, Scrn:4.3-5.8 m, NoSites)
RS10A (Soil/Clay, Scrn:2.4-2.9 m, NoSites)
Head(mRL)
Cumulative Rainfall Departure (mm)
Observed
CRD
Snow
CE Cave


RS10B (Soil/Clay, Scrn:2.5-4.0 m, NoSites)
Head(mRL)
889
888
887
886
885
Observed
CRD
Snow
CE Cave
Sep-1999
Feb-2005
Aug-2010
Feb-2016


RS11 (Soil/Clay, Scrn:9.0-10.5 m, NoSites)
878
877
876
875
874
1000
800
600
400
200
0
−200
−400
−600
Cumulative Rainfall Departure (mm)
Observed
CRD
Snow
CE Cave
Sep-1999
Feb-2005
Aug-2010
Feb-2016


RS12 (Soil/Clay, Scrn:5.0-8.0 m, NoSites)
Head(mRL)
878
877
876
875
874
Observed
CRD
Snow
CE Cave
Sep-1999
Feb-2005
Aug-2010
Feb-2016


TW05MB (Tertiary Basalt, Scrn:30-60 m, STSF: 164.7 m)
665
664
663
662
661
660
1000
800
600
400
200
0
−200
−400
−600
Cumulative Rainfall Departure (mm)
Observed
CRD
Snow
CE Cave
Mar-2020
Apr-2020
May-2020
May-2020

Appendix B Average groundwater levels and calibration residuals

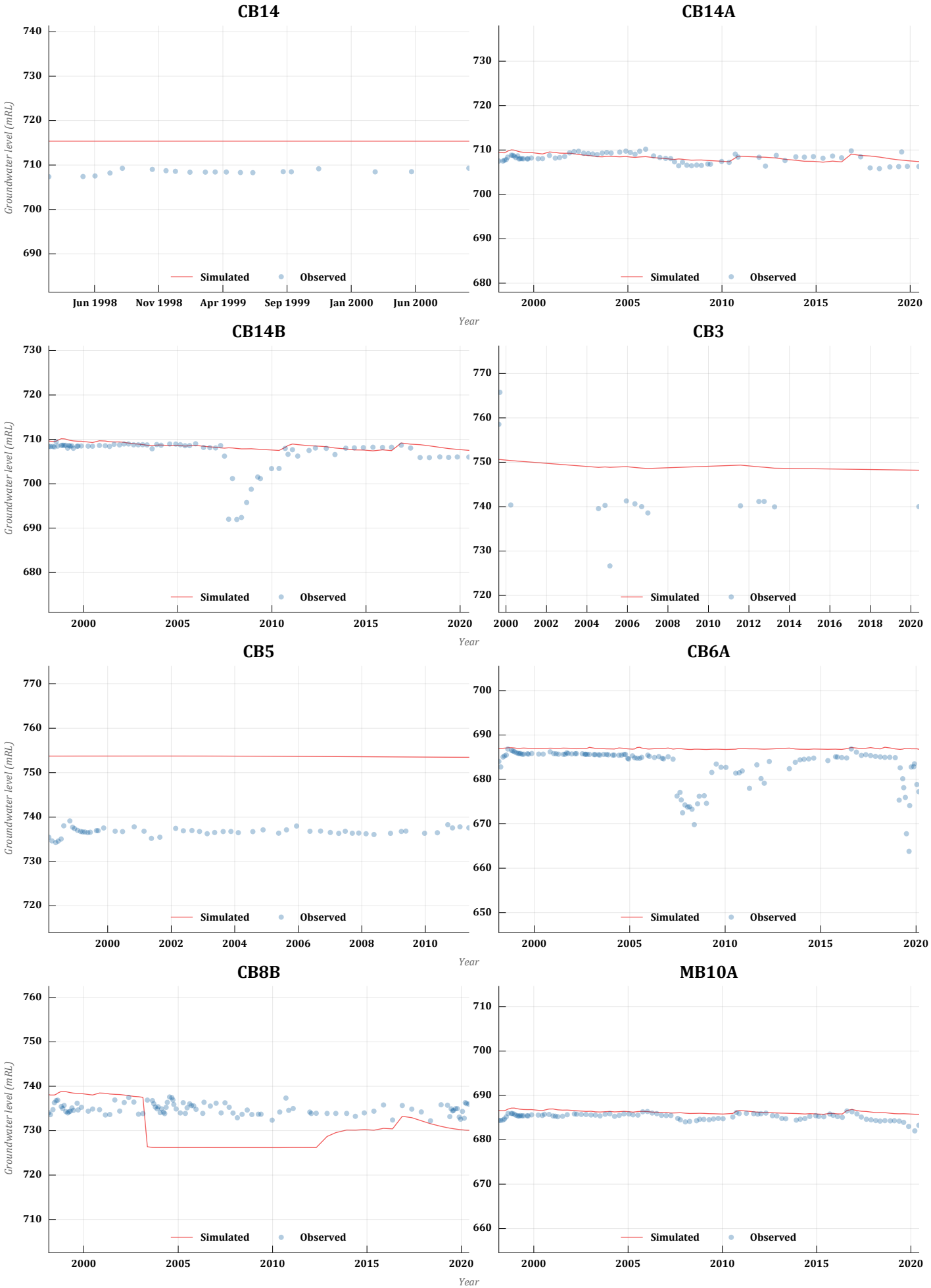
Bore ID	Easting (GAD94 z55)	Northing (GAD94 z55)	Observed WL (mAHD)	Simulated WL (mAHD)	Residual (m)
CB14	684937	6295314	708.44	715.37	-6.937
CB14A	684907	6295331	708.15	708.57	-0.422
CB14B	684909	6295333	706.82	708.75	-1.922
CB3	685654	6297811	742.28	749.17	-6.888
CB5	685588	6297872	736.69	753.67	-16.978
CB6A	684407	6293813	682.96	686.94	-3.974
CB8B	685456	6297539	734.87	730.82	4.056
MB10A	684516	6293538	685.20	686.32	-1.119
MB10B	684517	6293540	684.30	686.31	-2.019
MB11A	684450	6293529	684.03	685.73	-1.703
MB11B	684452	6293529	684.05	685.73	-1.687
MB15	685505	6290404	652.82	650.10	2.721
MB16A	685282	6290086	643.23	650.01	-6.779
MB16B	685283	6290086	643.29	650.01	-6.720
MB17	685860	6293174	741.52	733.11	8.405
MB18	684985	6292785	700.09	695.72	4.373
MB19A	685131	6291009	671.58	670.99	0.590
MB19B	685130	6291007	682.62	671.42	11.201
MB1A	684980	6294930	703.87	719.05	-15.182
MB1B	684978	6294930	716.17	718.98	-2.813
MB20	687798	6290242	741.74	735.43	6.315
MB21	687286	6290278	727.08	716.75	10.327
MB22	686726	6290162	676.61	659.04	17.572
MB23	684908	6291554	672.98	684.36	-11.378
MB24	684839	6292112	684.54	687.58	-3.041
MB25	684425	6289890	652.00	657.71	-5.709
MB26A	684524	6289077	644.54	633.74	10.799
MB26B	684525	6289077	640.38	633.27	7.111
MB27	684590	6288855	591.92	596.11	-4.193
MB28A	684976	6288933	640.26	638.16	2.092
MB28B	684976	6288932	632.60	637.84	-5.242
MB29A	684912	6288686	640.75	631.78	8.964
MB29B	684911	6288688	628.52	631.33	-2.809
MB2A	684780	6295099	704.54	706.93	-2.394
MB2B	684781	6295099	704.71	706.92	-2.207
MB30	685817	6296923	736.93	749.46	-12.528
MB3A	684827	6295130	705.18	707.81	-2.636

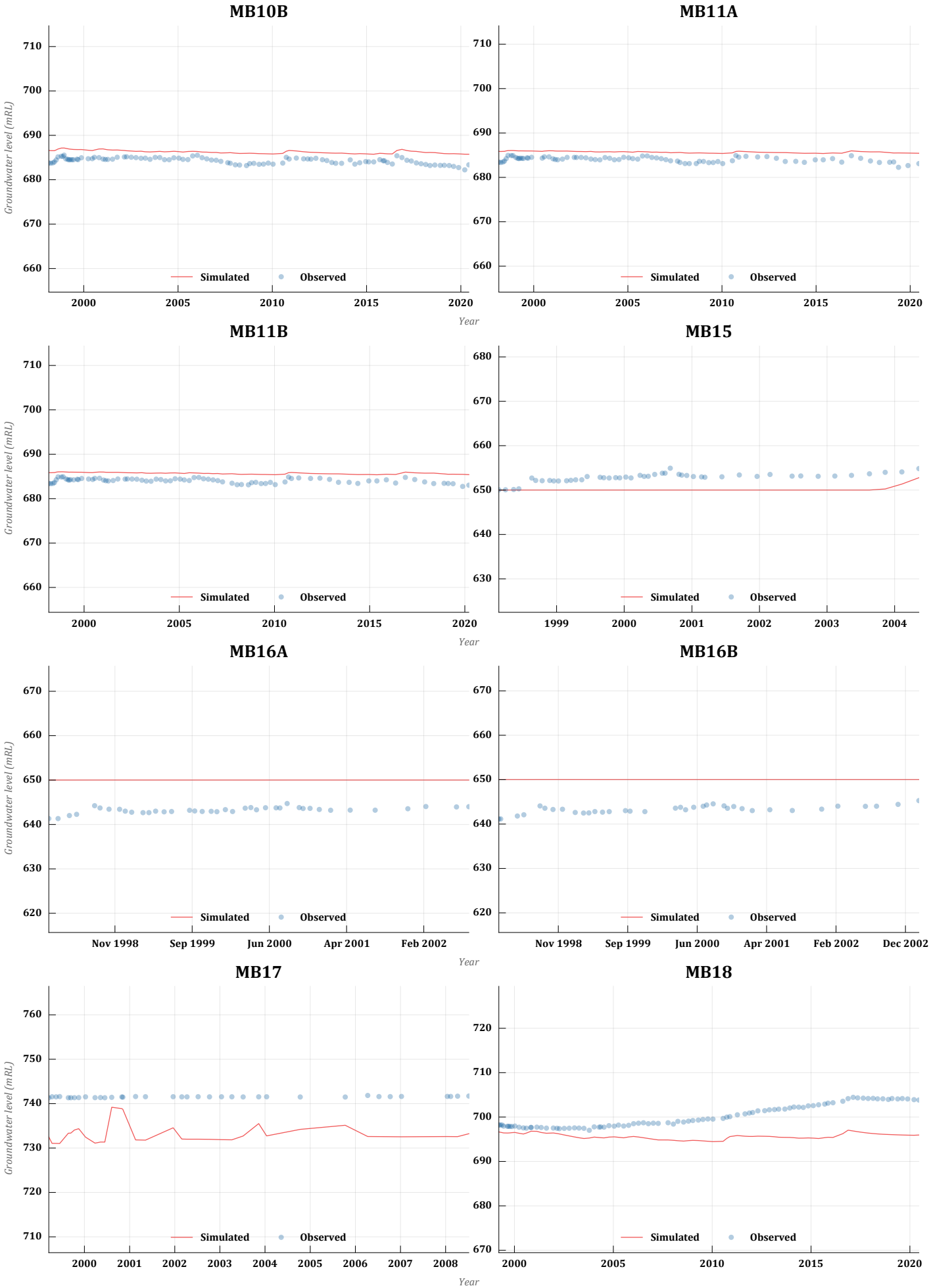
Bore ID	Easting (GAD94 z55)	Northing (GAD94 z55)	Observed WL (mAHD)	Simulated WL (mAHD)	Residual (m)
MB3B	684829	6295131	706.23	707.85	-1.617
MB43	688945	6295921	898.07	885.07	13.000
MB44A	688951	6295907	897.29	884.74	12.547
MB44B	688951	6295916	903.48	897.25	6.234
MB45	688078	6296328	895.89	895.01	0.876
MB46	689834	6295944	857.97	876.43	-18.454
MB47A	690384	6296020	838.30	859.95	-21.646
MB47B	690380	6296020	838.38	860.03	-21.654
MB48	688651	6297936	939.31	955.58	-16.266
MB49	687959	6297415	950.87	944.12	6.748
MB4A	684510	6294619	698.95	700.48	-1.533
MB4B	684510	6294618	698.64	700.41	-1.773
MB53	689622	6302657	971.24	975.24	-4.002
MB54	689515	6302625	982.64	978.68	3.963
MB55	689507	6302626	984.83	988.63	-3.799
MB56	689500	6302628	981.93	979.12	2.802
MB5A	684515	6294524	700.54	700.57	-0.023
MB5B	684514	6294525	699.96	700.37	-0.413
MB5C	684521	6294548	698.56	705.17	-6.610
MB60	687487	6295380	859.31	846.94	12.364
MB62	689648	6296955	884.58	883.66	0.917
MB63	689087	6299793	925.73	935.18	-9.445
MB64	689327	6299876	924.33	925.32	-0.993
MB65	689344	6299606	923.19	922.16	1.024
MB66	687479	6295360	802.80	820.58	-17.777
MB68	688363	6290132	736.16	744.03	-7.874
MB69	688092	6289494	725.03	733.01	-7.980
MB6A	684422	6294590	697.73	699.10	-1.369
MB6B	684424	6294589	697.10	699.58	-2.480
MB70	688240	6291147	743.54	741.48	2.065
MB71	694087	6295182	941.15	942.88	-1.733
MB72	693061	6300963	957.70	965.80	-8.097
MB73	689736	6295235	857.42	872.93	-15.510
MB74	693501	6298198	958.20	960.76	-2.561
MB75	691195	6303380	969.57	974.43	-4.858
MB76	689080	6296332	908.60	895.95	12.645
MB77A	685278	6288427	652.66	649.74	2.915

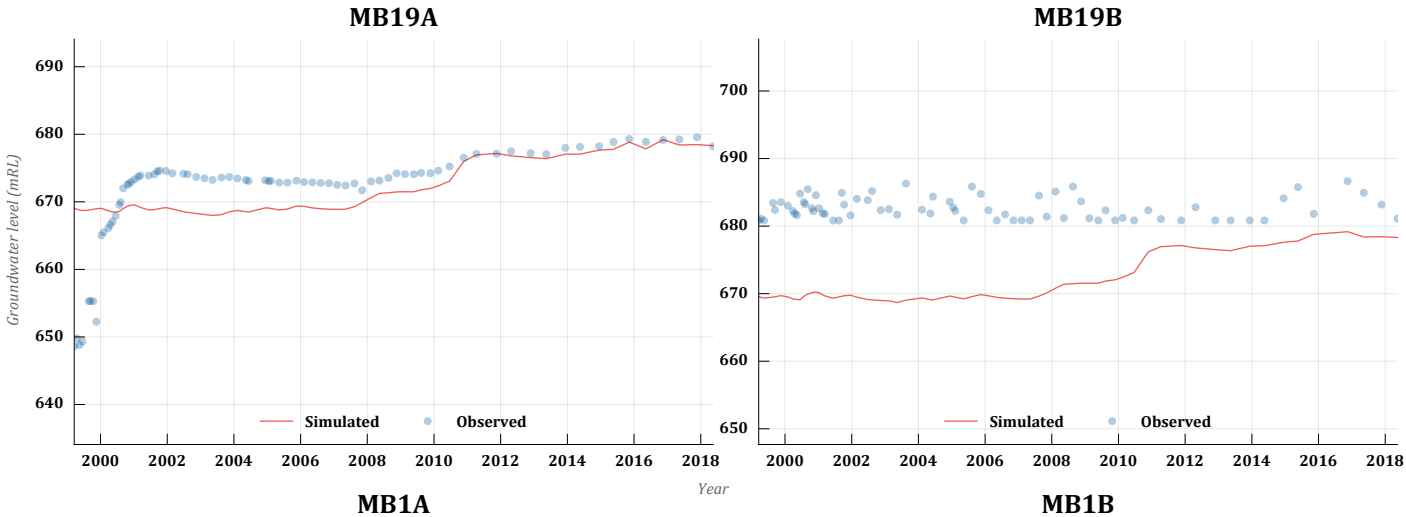
Bore ID	Easting (GAD94 z55)	Northing (GAD94 z55)	Observed WL (mAHD)	Simulated WL (mAHD)	Residual (m)
MB77B	685280	6288426	652.38	649.82	2.558
MB78	684496	6288441	580.16	589.59	-9.429
MB79	684296	6288041	556.47	583.91	-27.441
MB7A	684588	6293430	685.03	686.07	-1.037
MB7B	684590	6293430	685.15	686.10	-0.948
MB80	688301	6292840	767.12	779.25	-12.131
MB81	684153	6290069	651.13	652.27	-1.145
MB82	687648	6297324	899.48	924.13	-24.656
MB83	685040	6288275	634.86	632.94	1.916
MB84	684139	6289326	642.56	644.25	-1.688
MB85	684175	6290626	660.21	660.83	-0.625
MB86	684261	6291865	670.95	675.40	-4.453
MB87	684375	6292516	674.80	680.08	-5.279
MB88	688067	6296313	881.13	888.44	-7.317
MB89	687517	6296042	837.15	830.93	6.224
MB8A	684452	6293416	683.09	683.89	-0.801
MB8B	684453	6293415	683.07	683.88	-0.808
MB90	684297	6291255	667.02	674.51	-7.485
MB91	685820	6295564	705.49	727.08	-21.590
MB92	684934	6295941	689.37	696.32	-6.948
MB93	685276	6296919	689.81	681.01	8.800
MB95	685399	6295992	431.92	431.62	0.304
MB9A	684538	6293506	685.04	686.19	-1.149
MB9B	684538	6293507	685.03	686.21	-1.183
PZ10	685826	6295622	703.80	714.85	-11.060
PZ10A	685826	6295619	732.15	718.99	13.166
PZ4	686021	6295821	730.27	707.53	22.738
PZ5	686011	6295816	716.16	702.15	14.018
PZ89	685100	6296767	681.79	662.99	18.797
PZ89A	685100	6296767	701.99	677.50	24.492
PZ90	684959	6296549	653.18	658.17	-4.990
RB01	687935	6300012	885.88	899.76	-13.885
RB02	687982	6298603	917.06	926.45	-9.387
RB03	683340	6291777	664.41	666.99	-2.579
RO1	683743	6298484	899.58	892.15	7.423
RO10A	682569	6299366	896.72	889.22	7.499
RO10B	682567	6299383	883.89	875.02	8.876

Bore ID	Easting (GAD94 z55)	Northing (GAD94 z55)	Observed WL (mAHD)	Simulated WL (mAHD)	Residual (m)
RO11	683764	6299739	882.90	895.22	-12.324
RO12	683144	6299709	900.68	911.18	-10.498
RO13	683692	6298898	890.26	872.04	18.212
RO2	683683	6298495	899.22	892.68	6.540
RO3	683760	6298429	897.76	886.14	11.617
RO4A	683826	6298471	897.97	890.10	7.869
RO4B	683828	6298457	861.86	864.37	-2.509
RO5	683777	6298510	898.15	891.79	6.360
RO6A	683151	6298576	892.13	889.87	2.261
RO6B	683150	6298583	876.72	870.23	6.491
RO7	682918	6298935	891.35	874.16	17.187
RO8	683670	6298150	886.64	883.62	3.025
RS01	683907	6298670	893.48	891.84	1.638
RS03	683891	6299170	884.59	881.02	3.570
RS04	683870	6299131	888.93	890.23	-1.306
RS05	683367	6298551	888.35	889.91	-1.560
RS06	683379	6298489	892.95	895.88	-2.935
RS07	682993	6299731	912.56	905.73	6.821
RS08	683018	6299720	912.78	906.63	6.151
RS09	682700	6298840	889.69	883.71	5.971
RS10A	682662	6298860	886.28	881.48	4.801
RS10B	682670	6298855	886.29	881.77	4.514
RS11	682622	6298881	877.08	881.00	-3.919
RS12	682596	6298894	876.95	881.09	-4.142
TW05MB	686633	6289135	661.34	667.47	-6.129

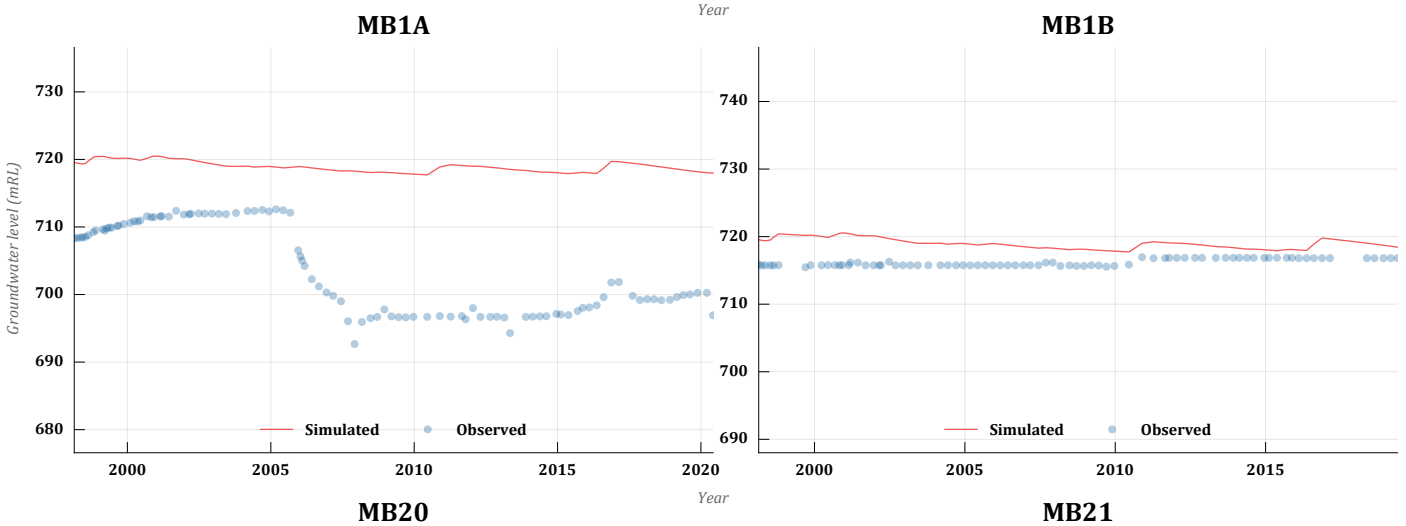
Appendix C Calibration hydrographs


CB14
CB14A
CB14B
CB3
CB5
CB6A
CB8B
MB10A
Groundwater level (mRL)
Year
Simulated
Observed

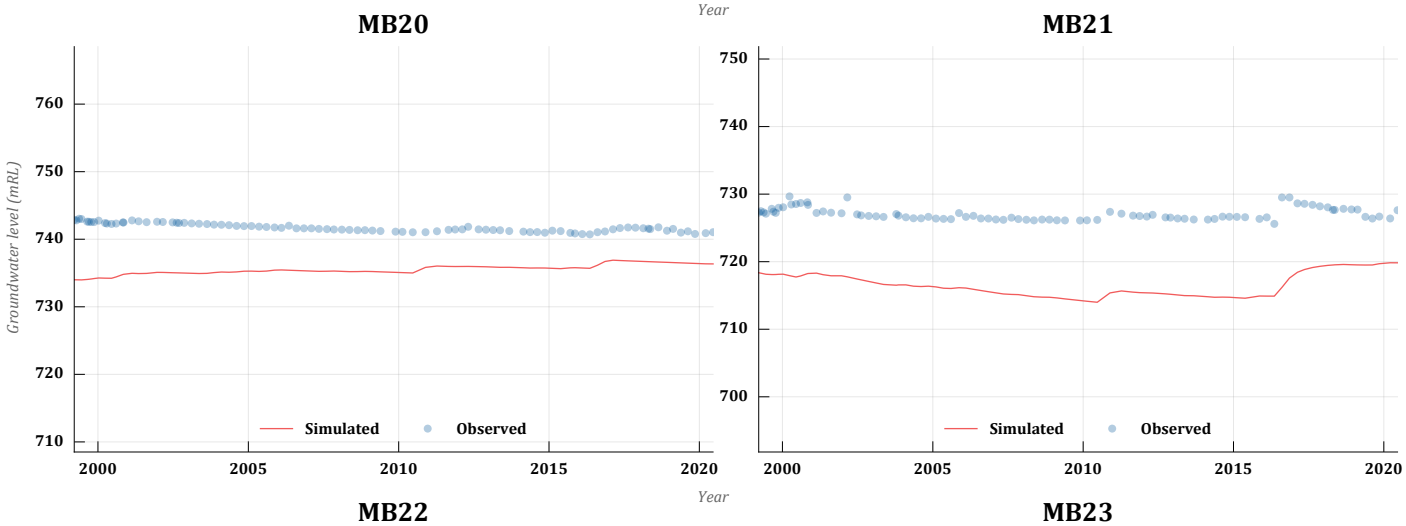

MB10B
MB11A
MB11B
MB15
MB16A
MB16B
MB17
MB18
Groundwater level (mRL)
Year
Simulated
Observed


MB19A
Groundwater level (mRL)
690
680
670
660
650
640
Simulated
Observed
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Year

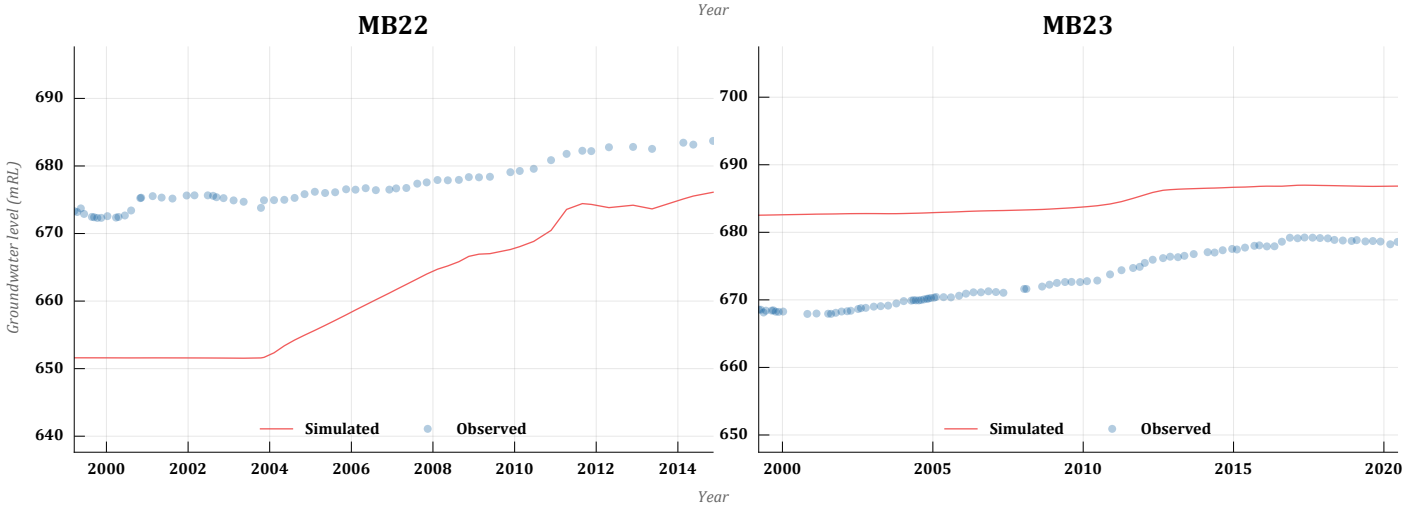
MB19B
700
690
680
670
660
650
Simulated
Observed
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018


MB1A
Groundwater level (mRL)
730
720
710
700
690
680
Simulated
Observed
2000
2005
2010
2015
2020
Year

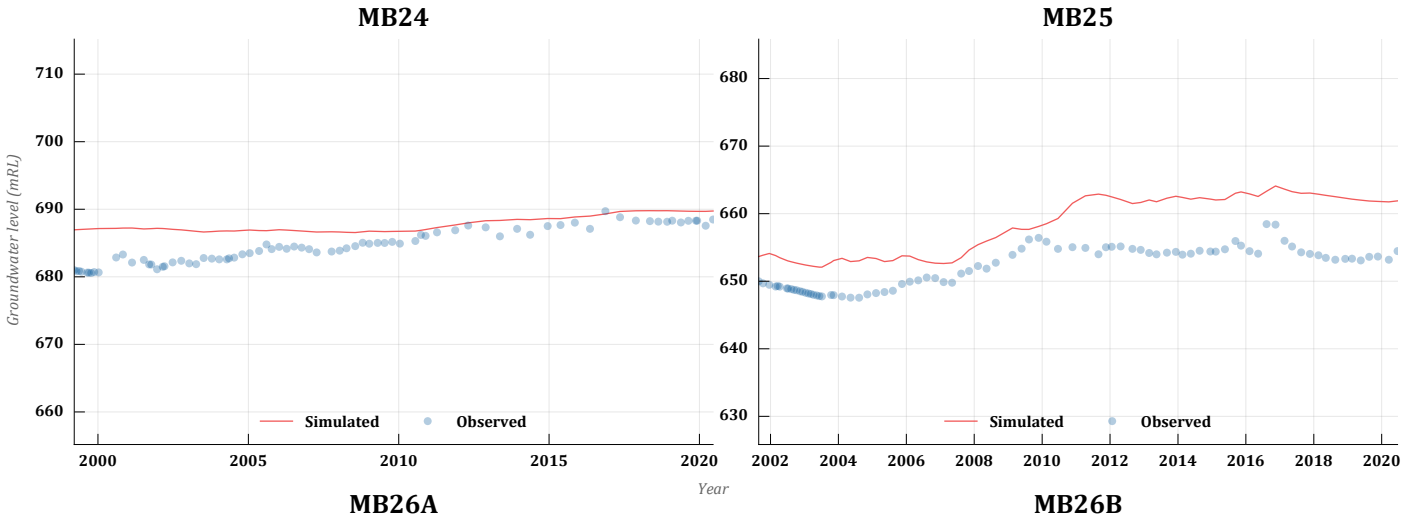
MB1B
740
730
720
710
700
690
Simulated
Observed
2000
2005
2010
2015

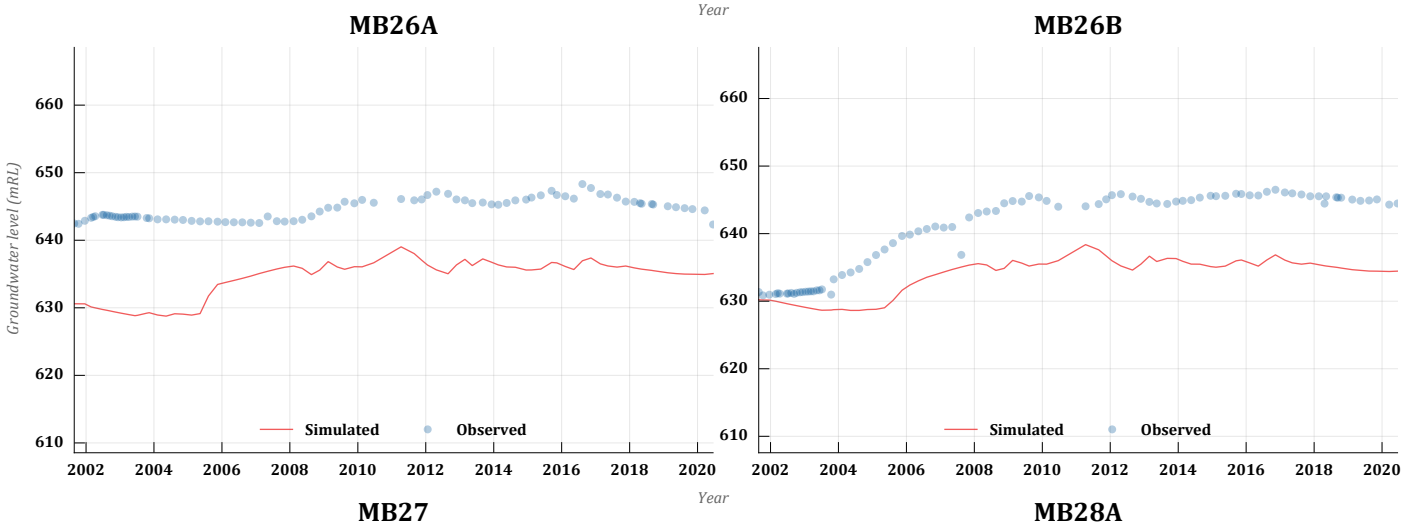

MB20
Groundwater level (mRL)
760
750
740
730
720
710
Simulated
Observed
2000
2005
2010
2015
2020
Year

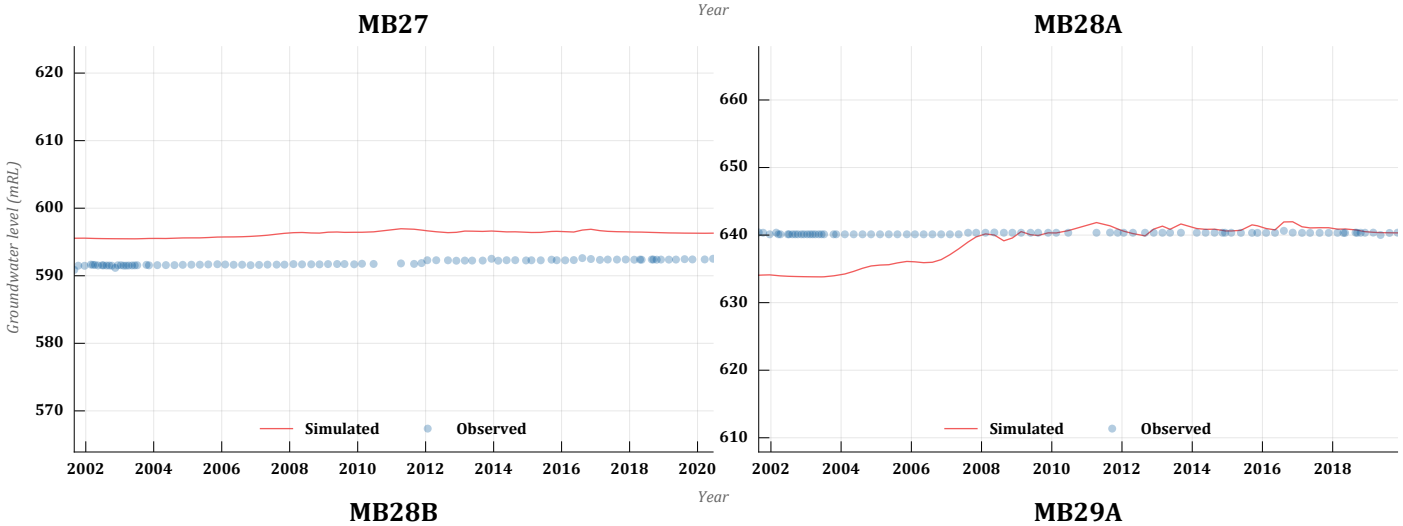
MB21
750
740
730
720
710
700
Simulated
Observed
2000
2005
2010
2015
2020

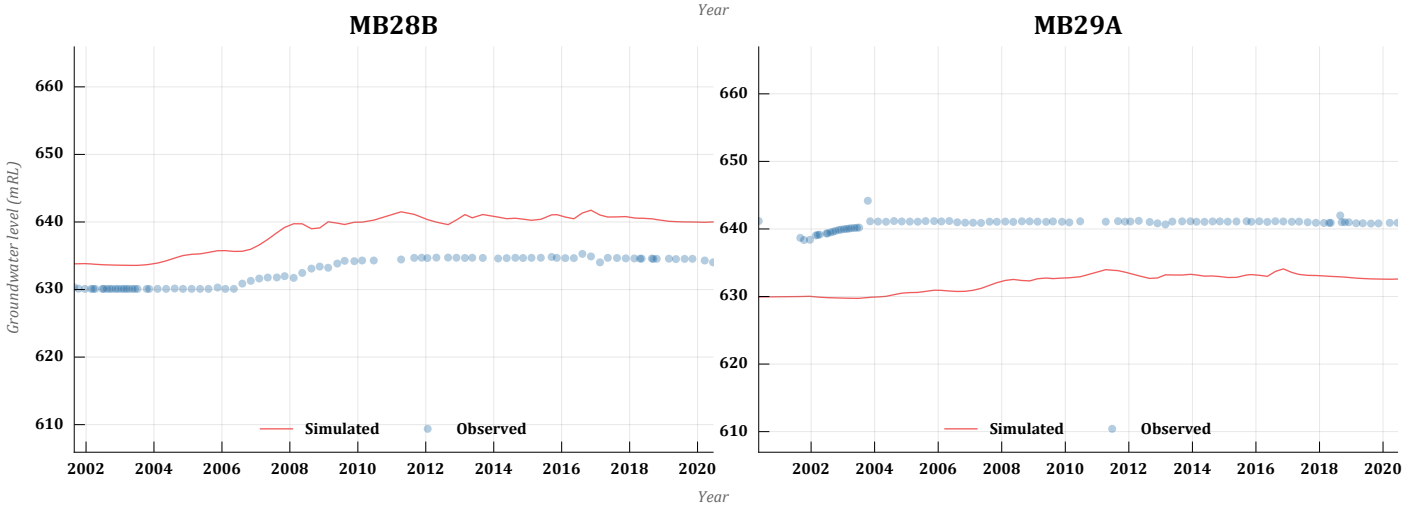

MB22
Groundwater level (mRL)
690
680
670
660
650
640
Simulated
Observed
2000
2002
2004
2006
2008
2010
2012
2014
Year

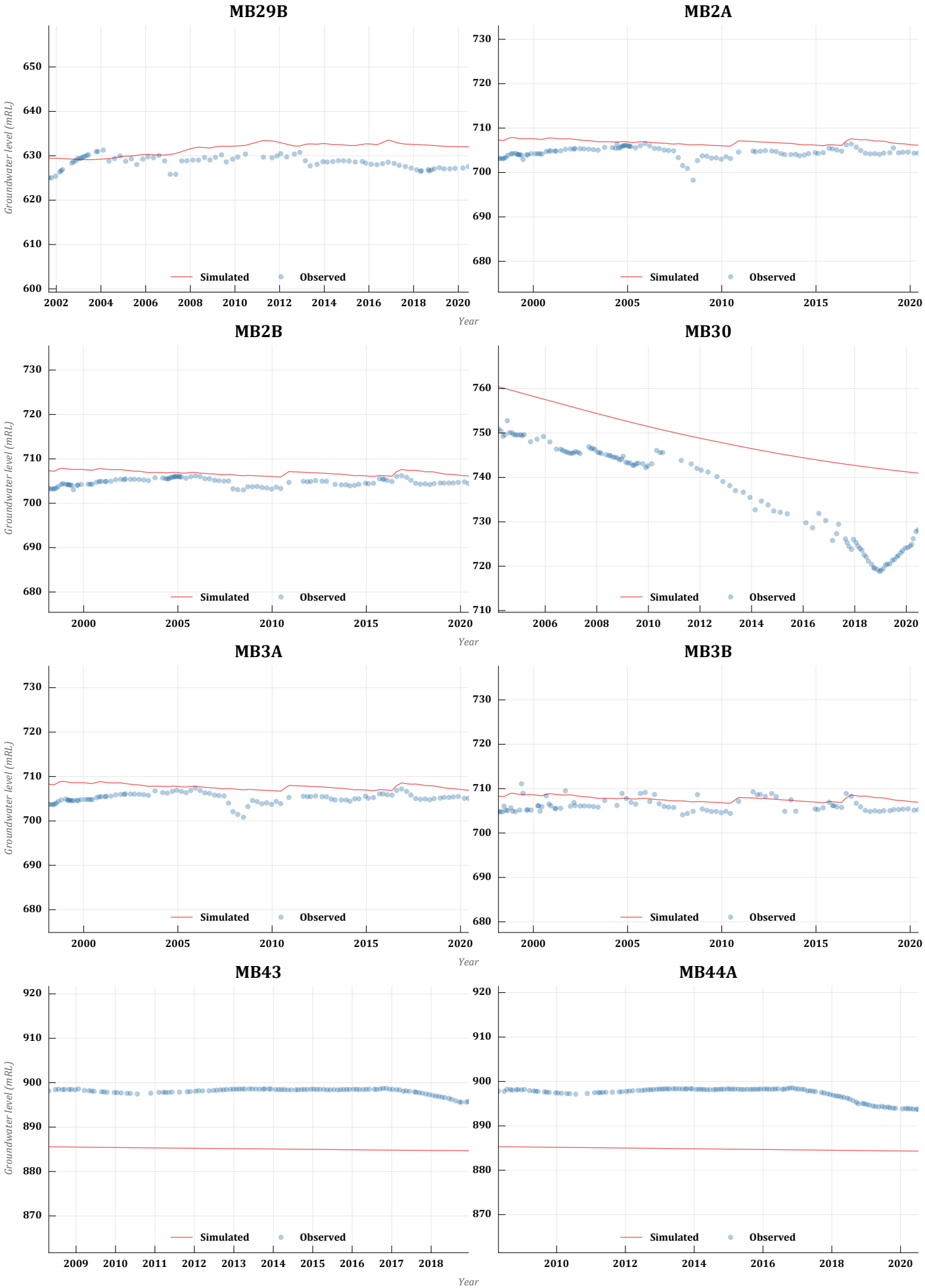
MB23
700
690
680
670
660
650
Simulated
Observed
2000
2005
2010
2015
2020

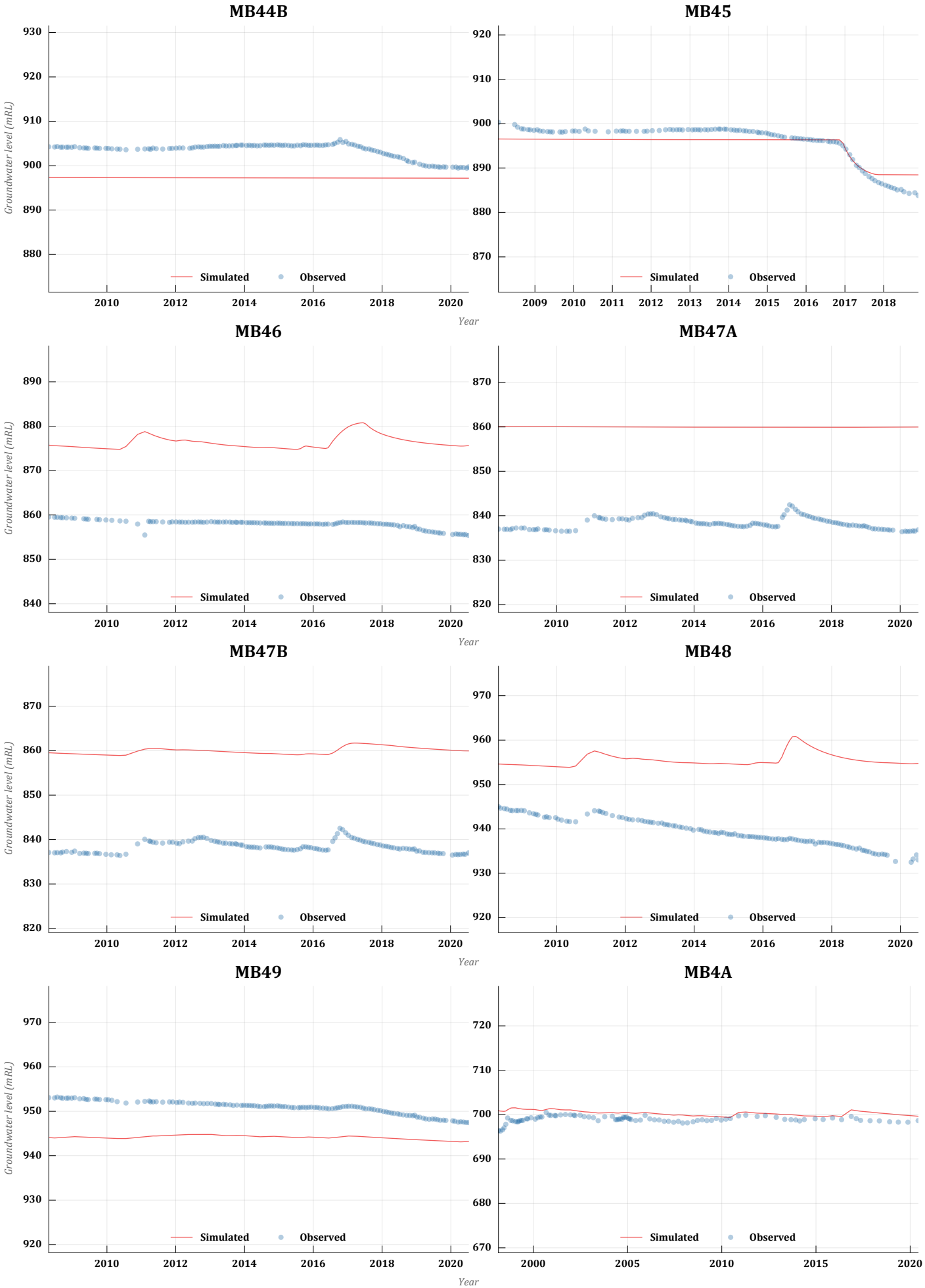

MB24
Groundwater level (mRL)
710
700
690
680
670
660
Simulated
Observed
2000
2005
2010
2015
2020
MB25
680
670
660
650
640
630
Simulated
Observed
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Year

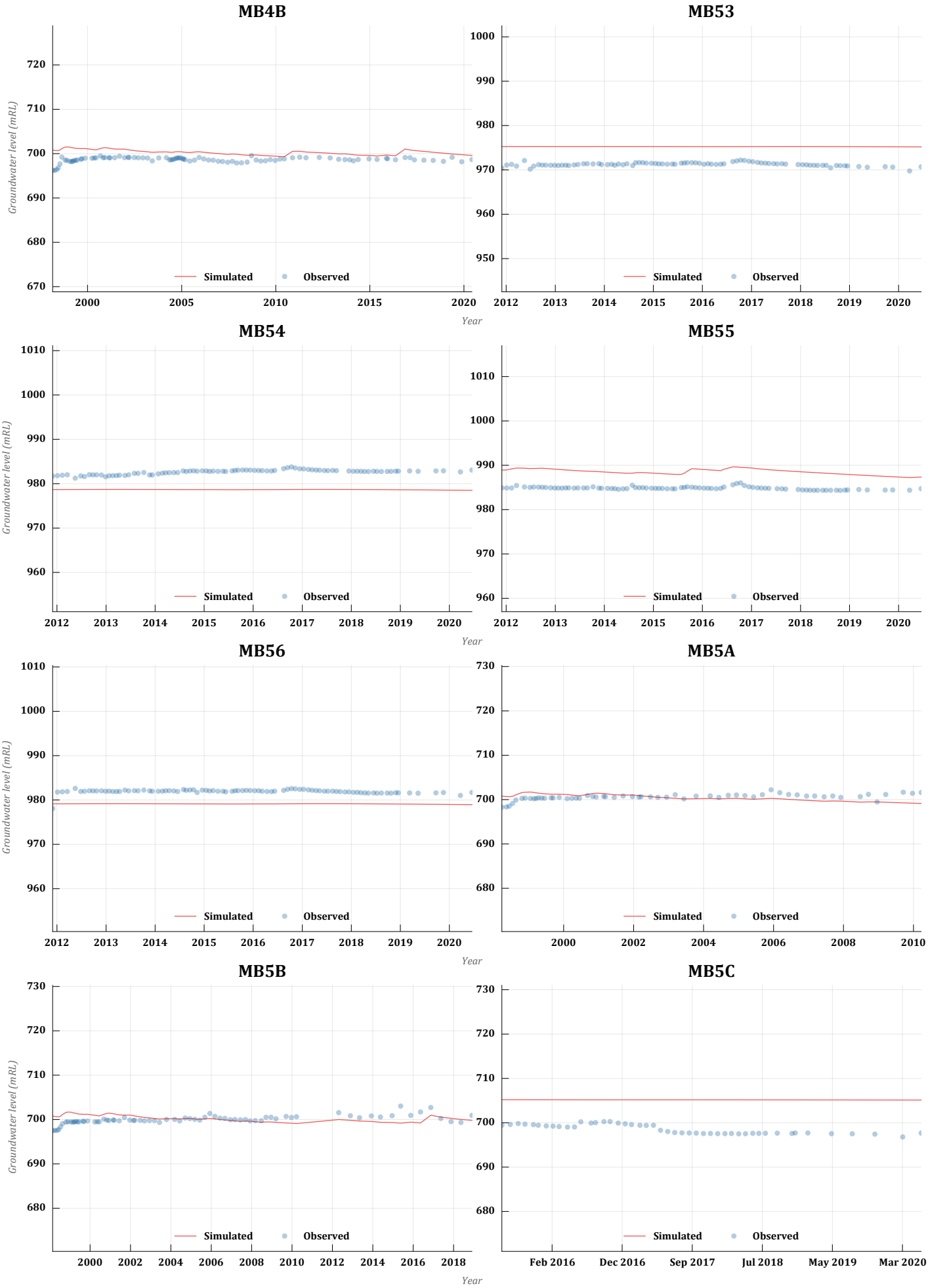

MB26A
Groundwater level (mRL)
660
650
640
630
620
610
Simulated
Observed
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
MB26B
660
650
640
630
620
610
Simulated
Observed
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Year

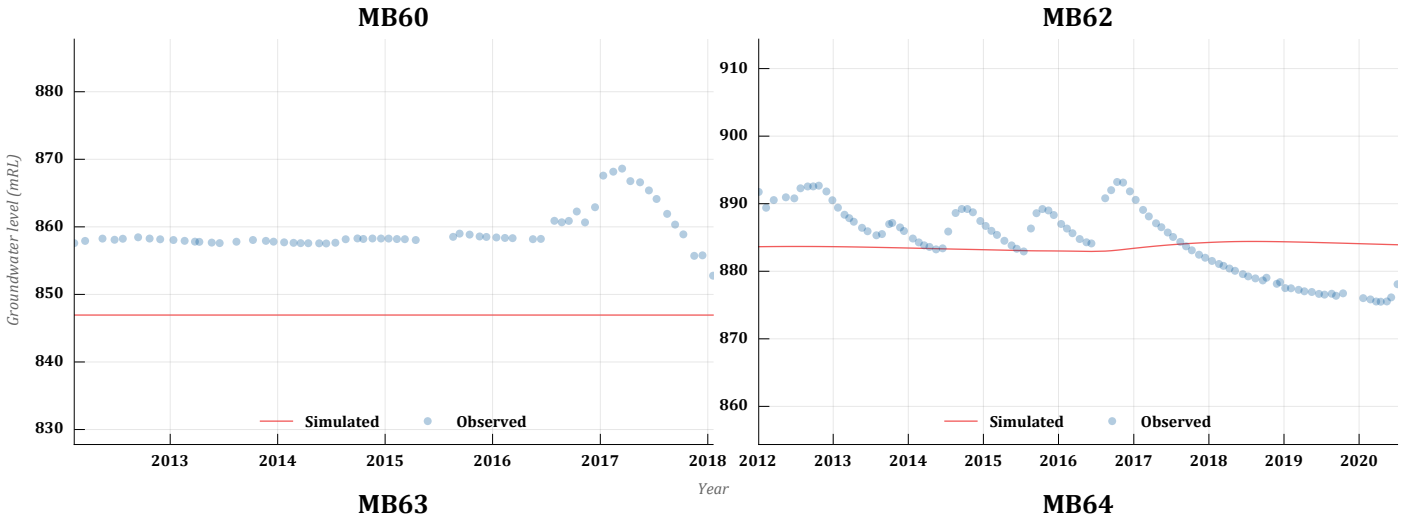

MB27
Groundwater level (mRL)
620
610
600
590
580
570
Simulated
Observed
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
MB28A
660
650
640
630
620
610
Simulated
Observed
2002
2004
2006
2008
2010
2012
2014
2016
2018
Year

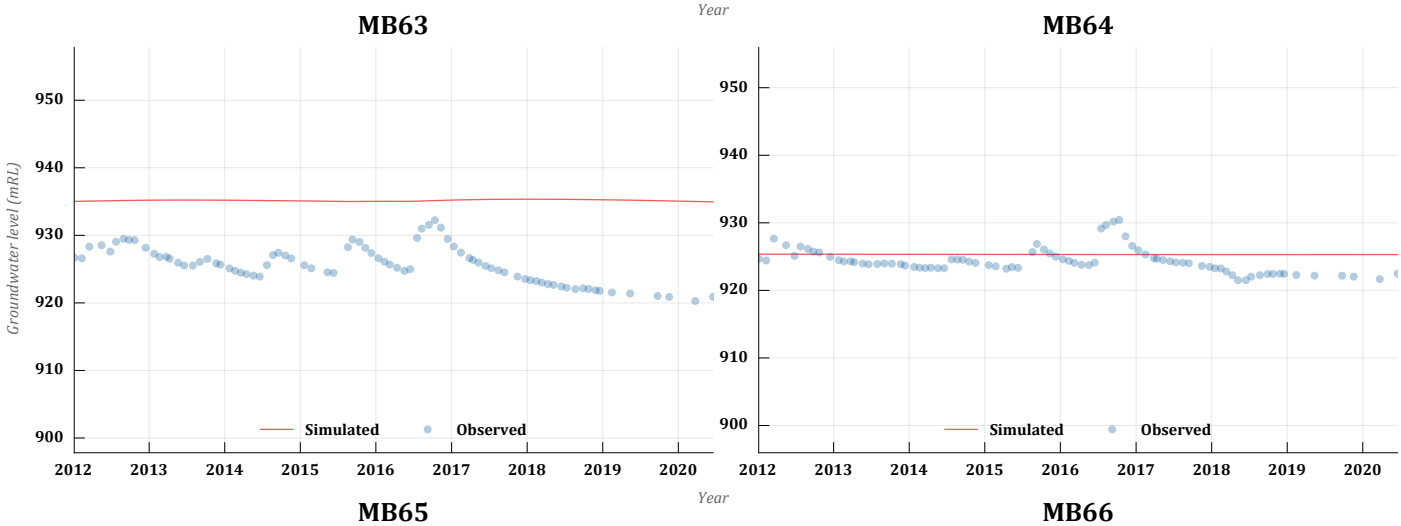

MB28B
Groundwater level (mRL)
660
650
640
630
620
610
Simulated
Observed
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
MB29A
660
650
640
630
620
610
Simulated
Observed
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Year

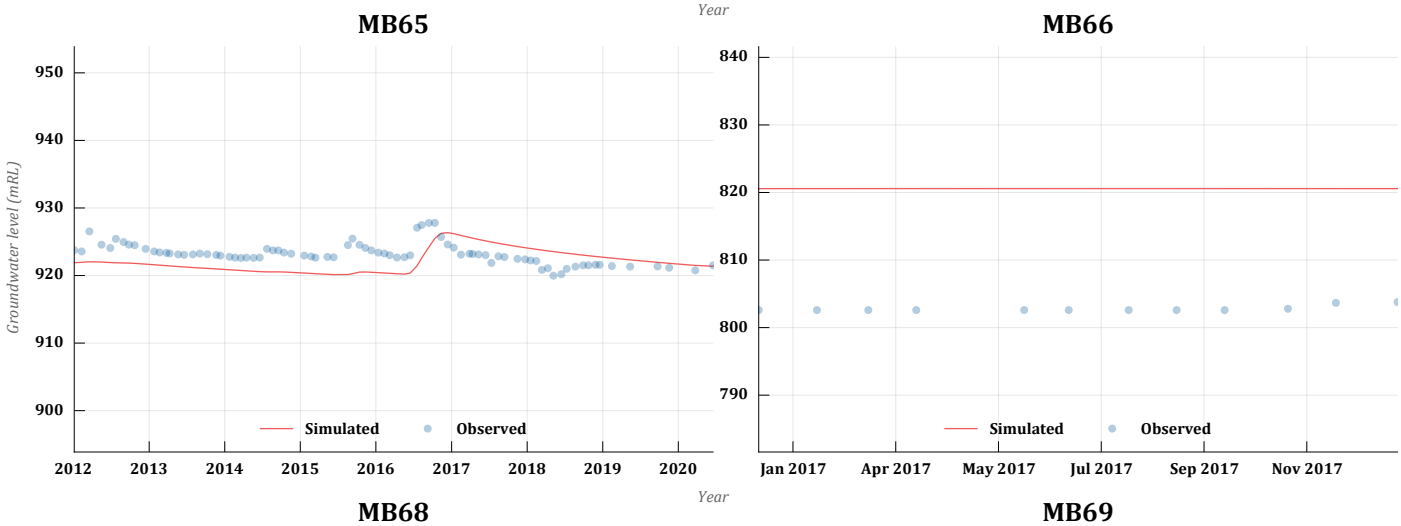

MB29B
MB2A
MB2B
MB30
MB3A
MB3B
MB43
MB44A
Groundwater level (mRL)
Year
Simulated
Observed

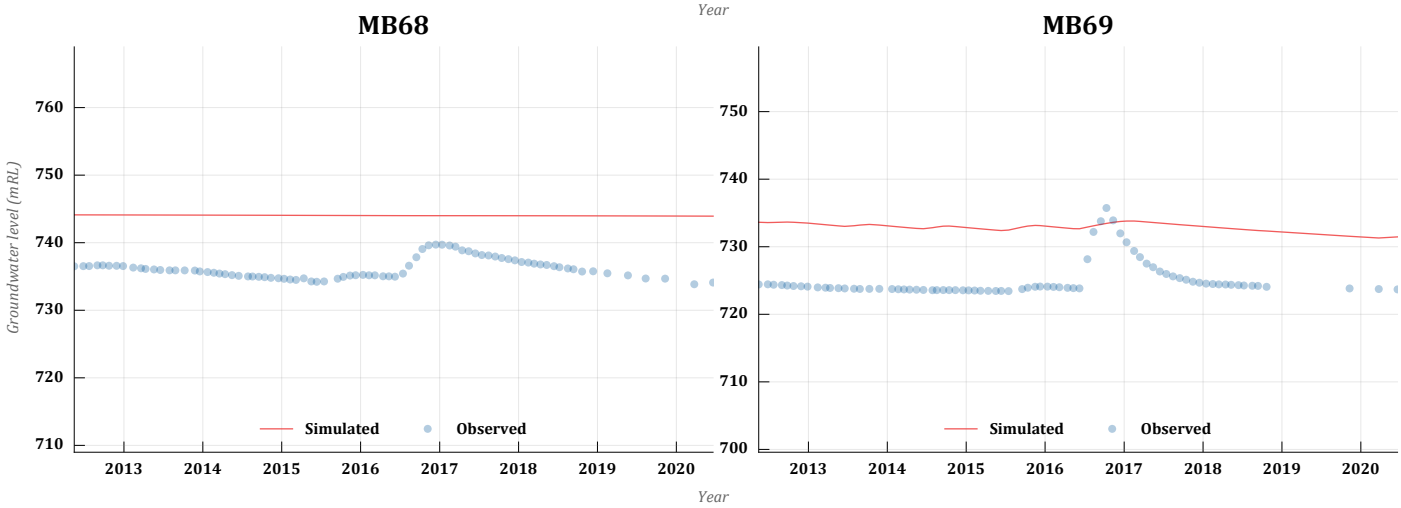

MB44B
MB45
MB46
MB47A
MB47B
MB48
MB49
MB4A
Groundwater level (mRL)
Year
Simulated
Observed

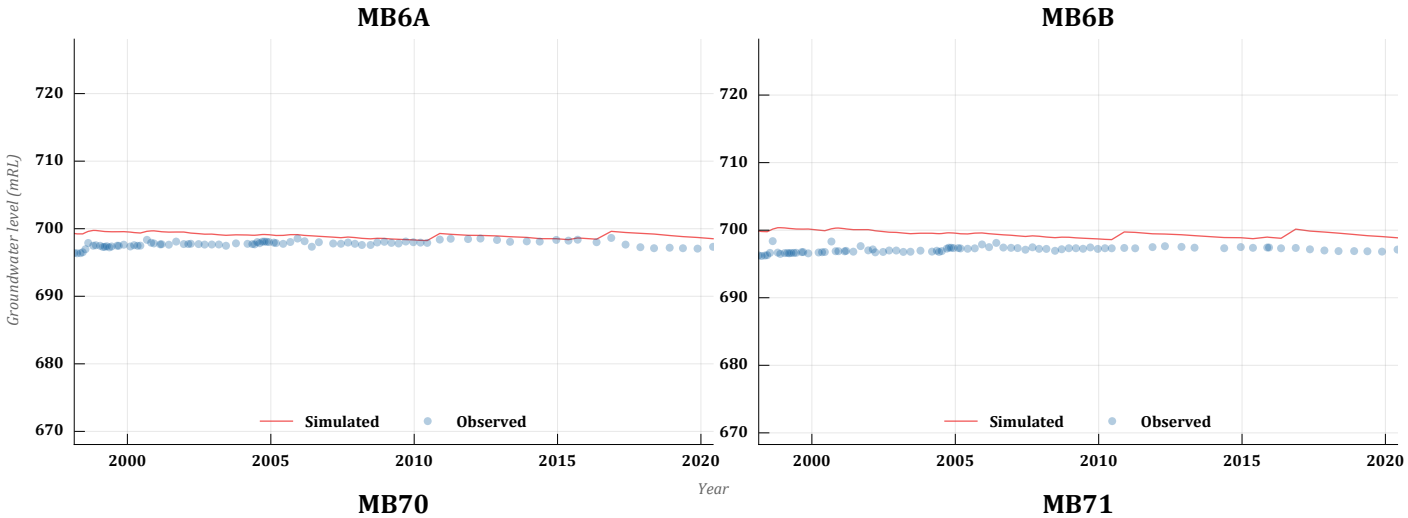

MB4B
MB53
MB54
MB55
MB56
MB5A
MB5B
MB5C
Groundwater level (mRL)
Year
Simulated
Observed


MB60
Groundwater level (mRL)
880
870
860
850
840
830
2013
2014
2015
2016
2017
2018
Simulated
Observed
MB62
910
900
890
880
870
860
2012
2013
2014
2015
2016
2017
2018
2019
2020
Simulated
Observed
Year

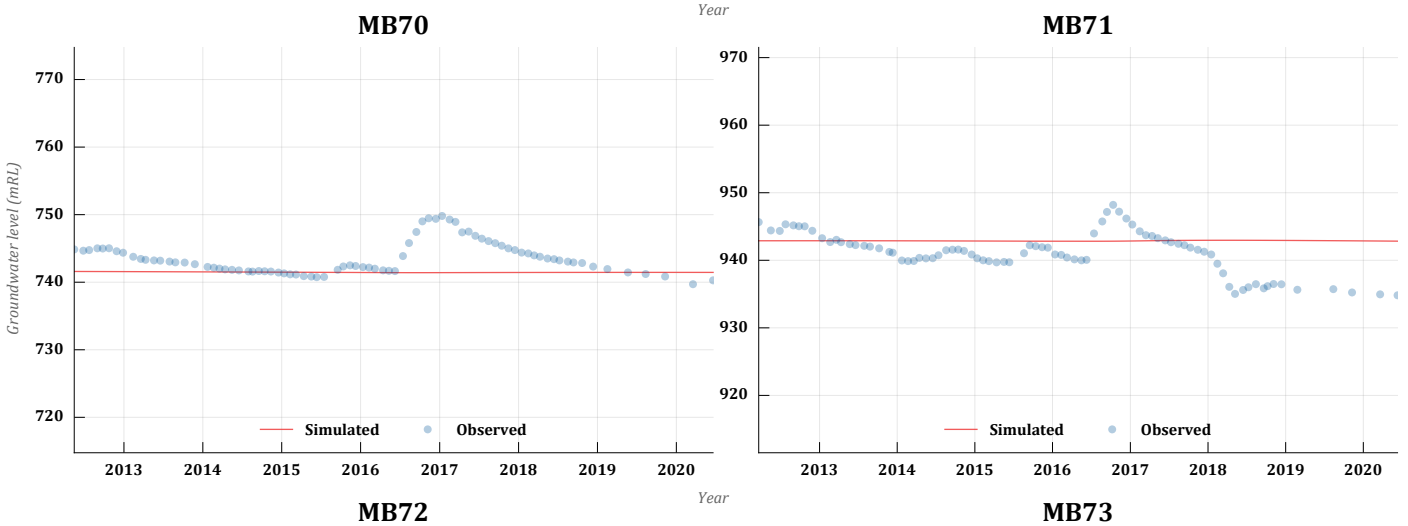

MB63
Groundwater level (mRL)
950
940
930
920
910
900
2012
2013
2014
2015
2016
2017
2018
2019
2020
Simulated
Observed
MB64
950
940
930
920
910
900
2012
2013
2014
2015
2016
2017
2018
2019
2020
Simulated
Observed
Year


MB65
Groundwater level (mRL)
950
940
930
920
910
900
2012
2013
2014
2015
2016
2017
2018
2019
2020
Simulated
Observed
MB66
840
830
820
810
800
790
Jan 2017
Apr 2017
May 2017
Jul 2017
Sep 2017
Nov 2017
Simulated
Observed
Year

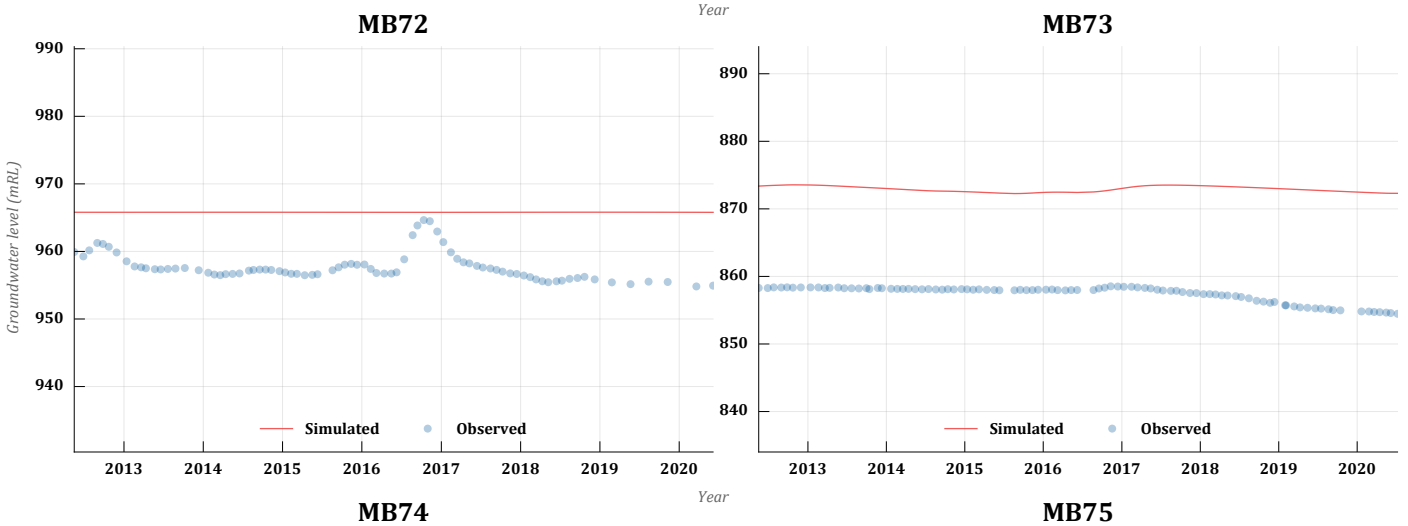

MB68
Groundwater level (mRL)
760
750
740
730
720
710
2013
2014
2015
2016
2017
2018
2019
2020
Simulated
Observed
MB69
750
740
730
720
710
700
2013
2014
2015
2016
2017
2018
2019
2020
Simulated
Observed
Year


MB6A
Groundwater level (mRL)
720
710
700
690
680
670
Simulated
Observed
2000
2005
2010
2015
2020
Year

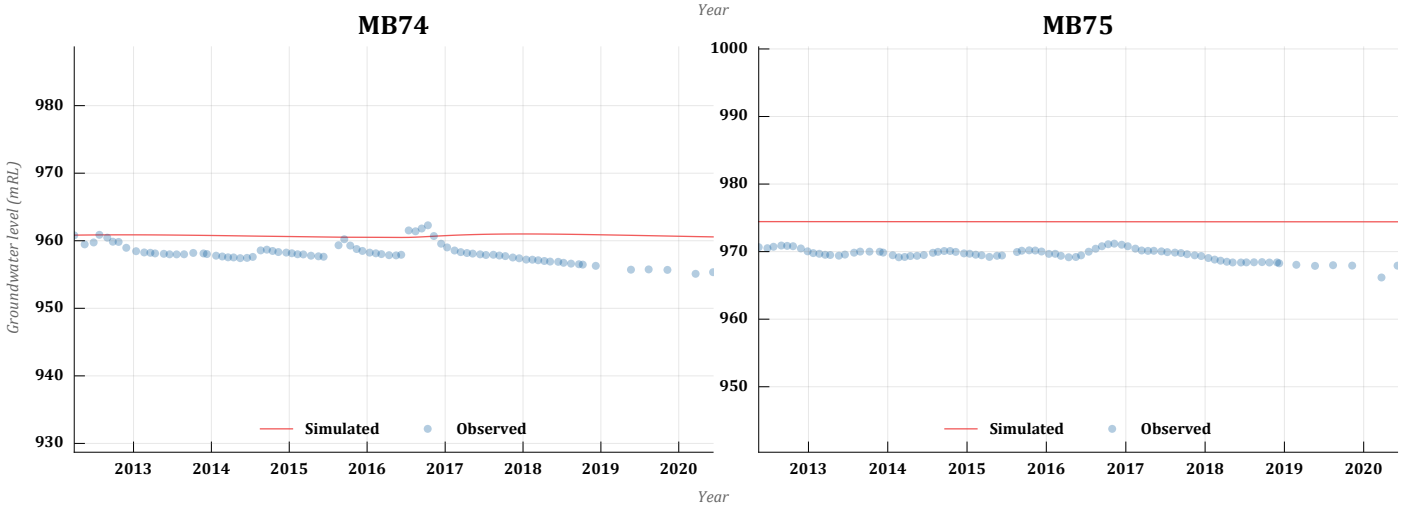
MB6B
720
710
700
690
680
670
Simulated
Observed
2000
2005
2010
2015
2020


MB70
Groundwater level (mRL)
770
760
750
740
730
720
Simulated
Observed
2013
2014
2015
2016
2017
2018
2019
2020
Year

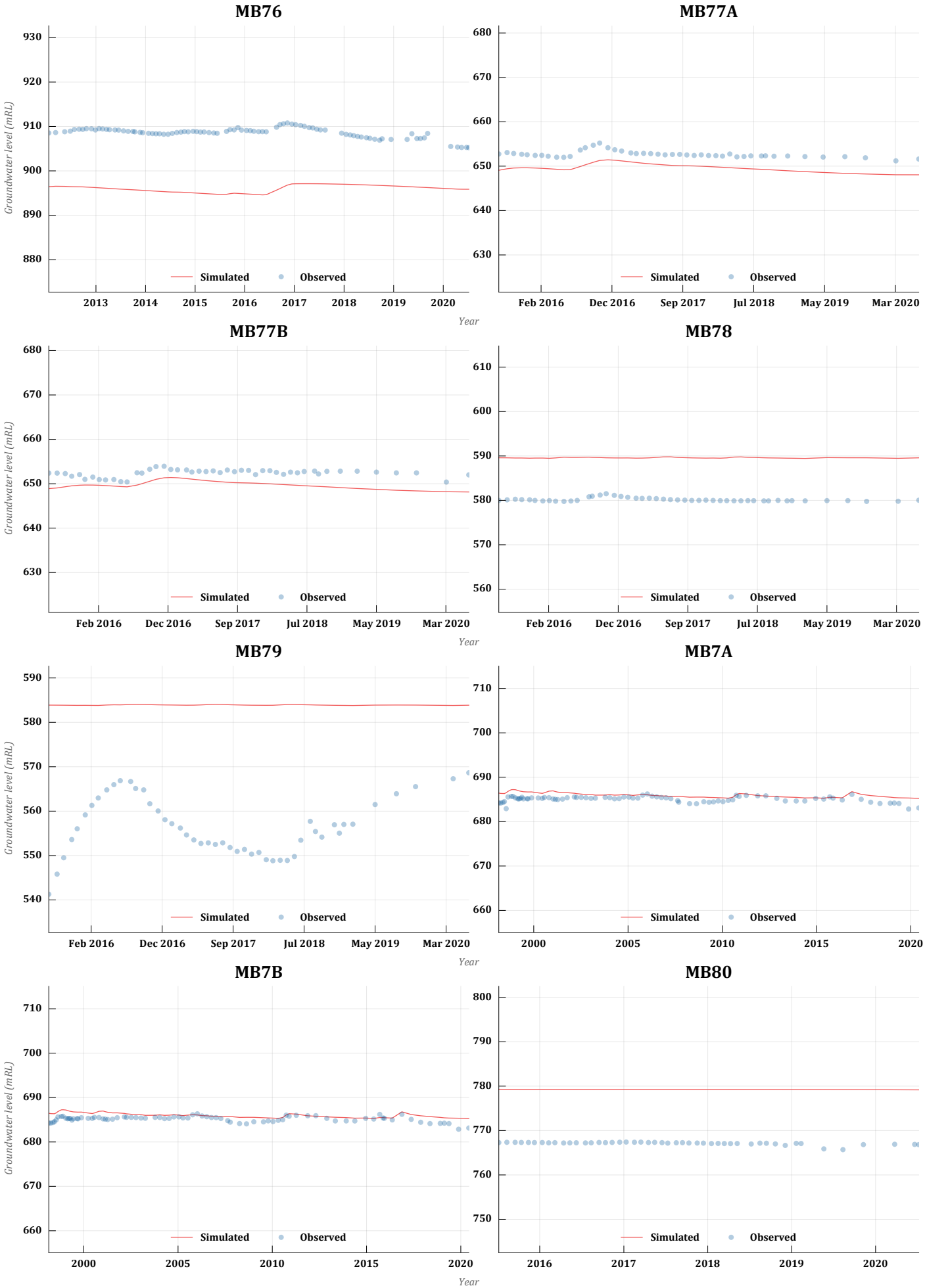
MB71
970
960
950
940
930
920
Simulated
Observed
2013
2014
2015
2016
2017
2018
2019
2020

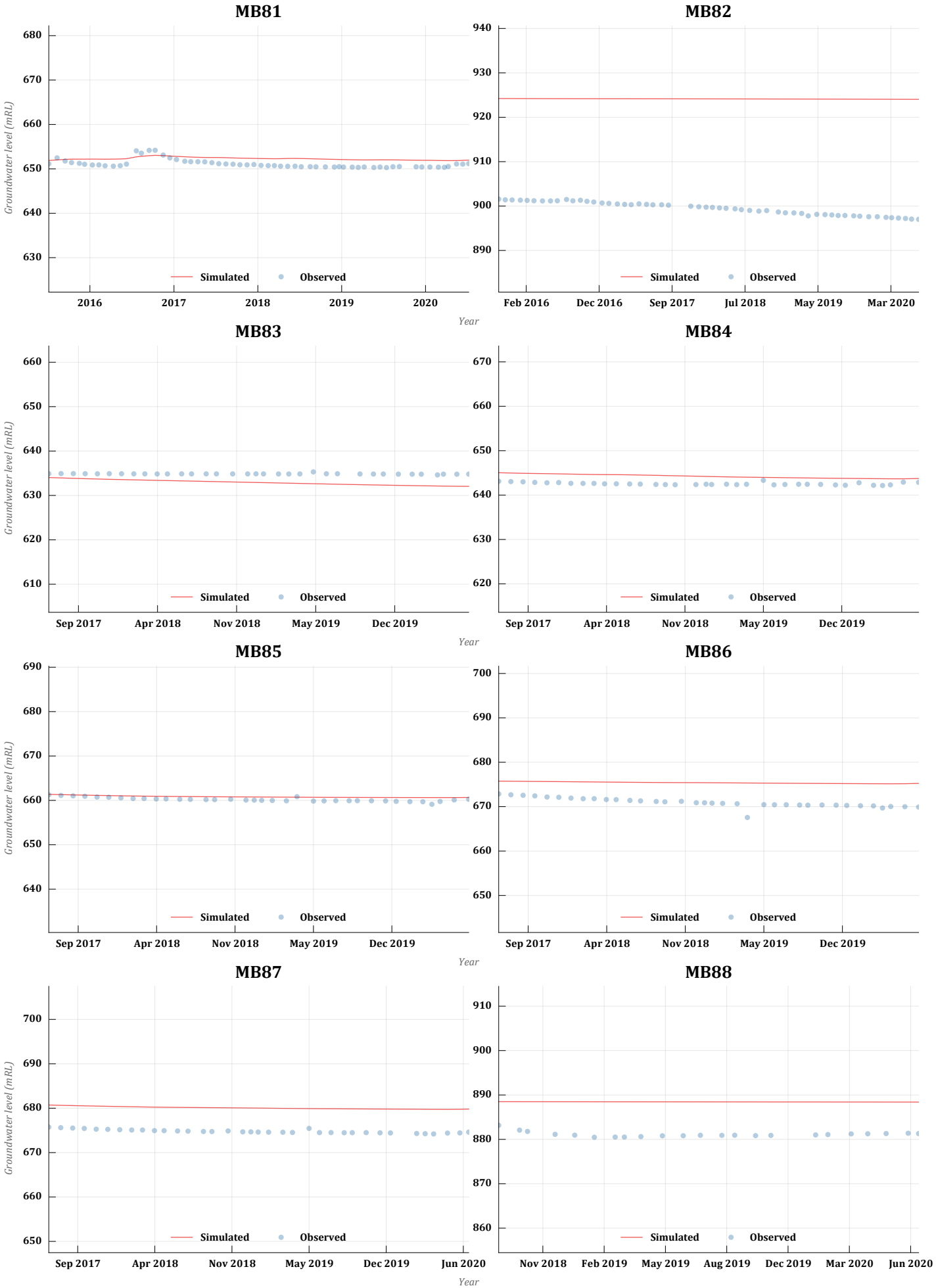

MB72
Groundwater level (mRL)
990
980
970
960
950
940
Simulated
Observed
2013
2014
2015
2016
2017
2018
2019
2020
Year

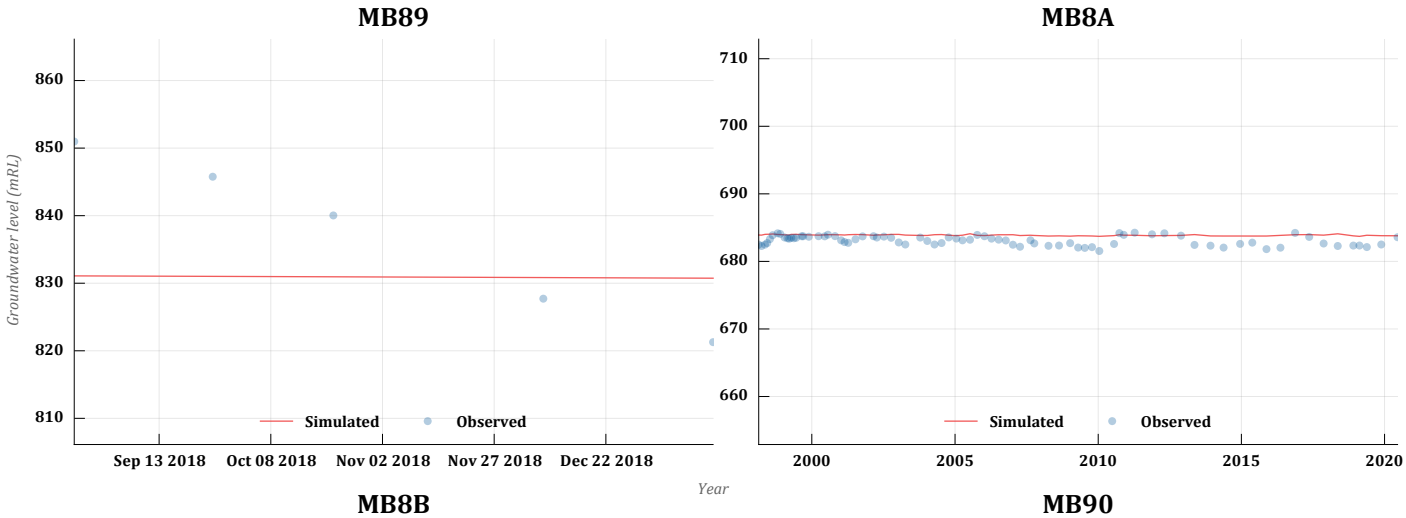
MB73
890
880
870
860
850
840
Simulated
Observed
2013
2014
2015
2016
2017
2018
2019
2020


MB74
Groundwater level (mRL)
980
970
960
950
940
930
Simulated
Observed
2013
2014
2015
2016
2017
2018
2019
2020
Year

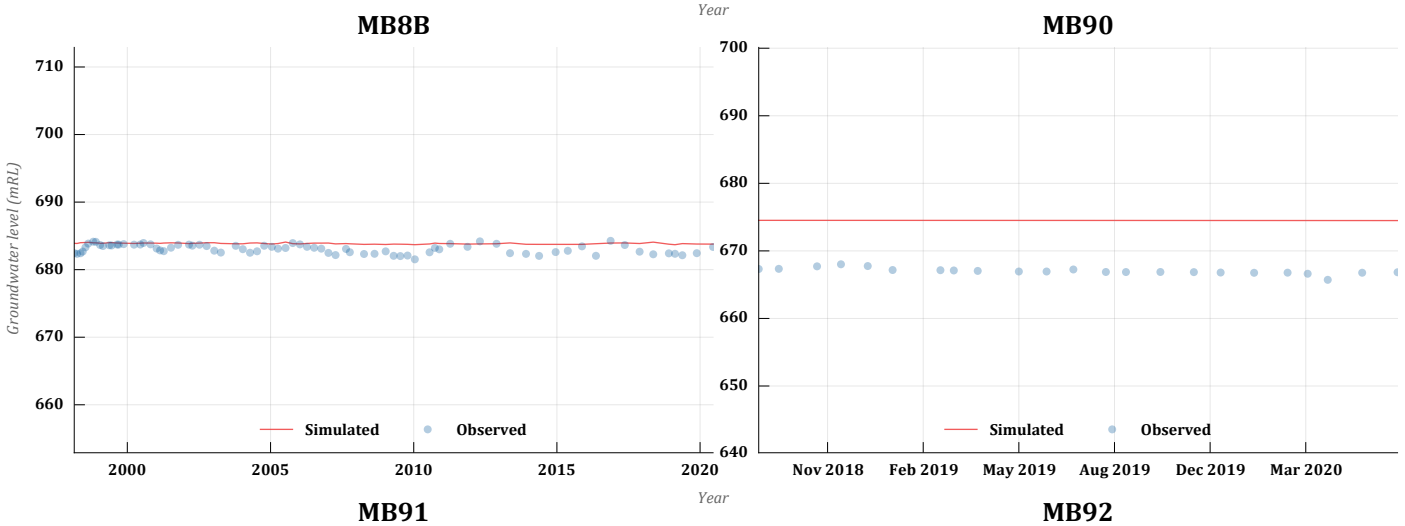
MB75
1000
990
980
970
960
950
Simulated
Observed
2013
2014
2015
2016
2017
2018
2019
2020


MB76
MB77A
MB77B
MB78
MB79
MB7A
MB7B
MB80
Groundwater level (mRL)
Year
Simulated
Observed

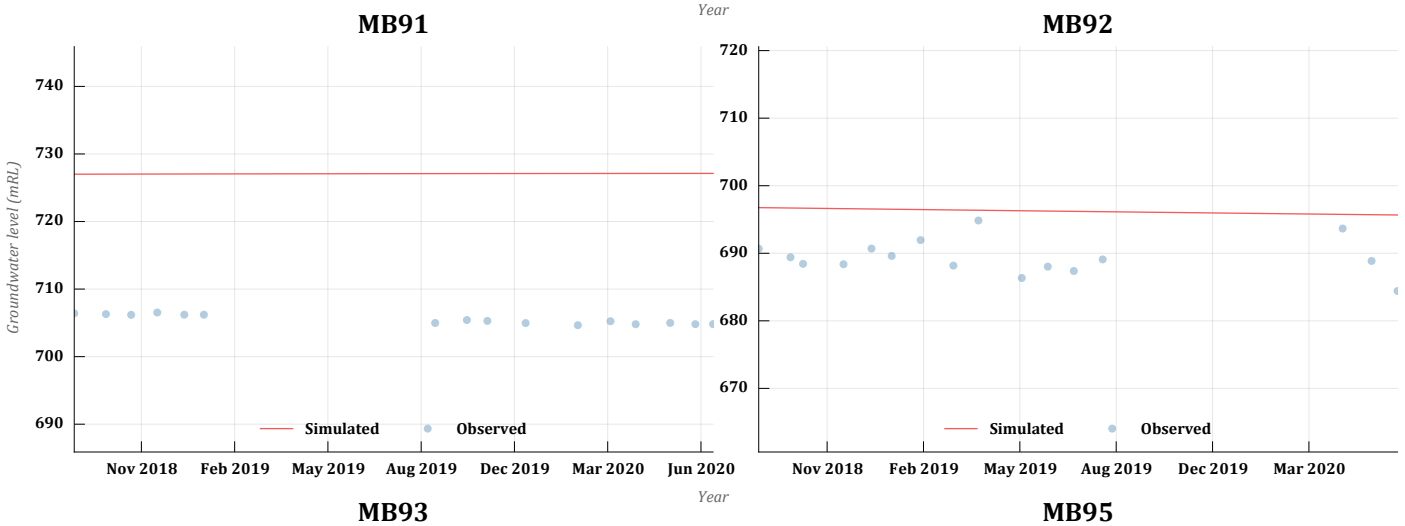

MB81
MB82
MB83
MB84
MB85
MB86
MB87
MB88
Groundwater level (mRL)
Year
Simulated
Observed
2016
2017
2018
2019
2020
Feb 2016
Dec 2016
Sep 2017
Jul 2018
May 2019
Mar 2020
Apr 2018
Nov 2018
Dec 2019
Jun 2020
Feb 2019
Aug 2019


MB89
Groundwater level (mRL)
860
850
840
830
820
810
Simulated
Observed
Sep 13 2018
Oct 08 2018
Nov 02 2018
Nov 27 2018
Dec 22 2018

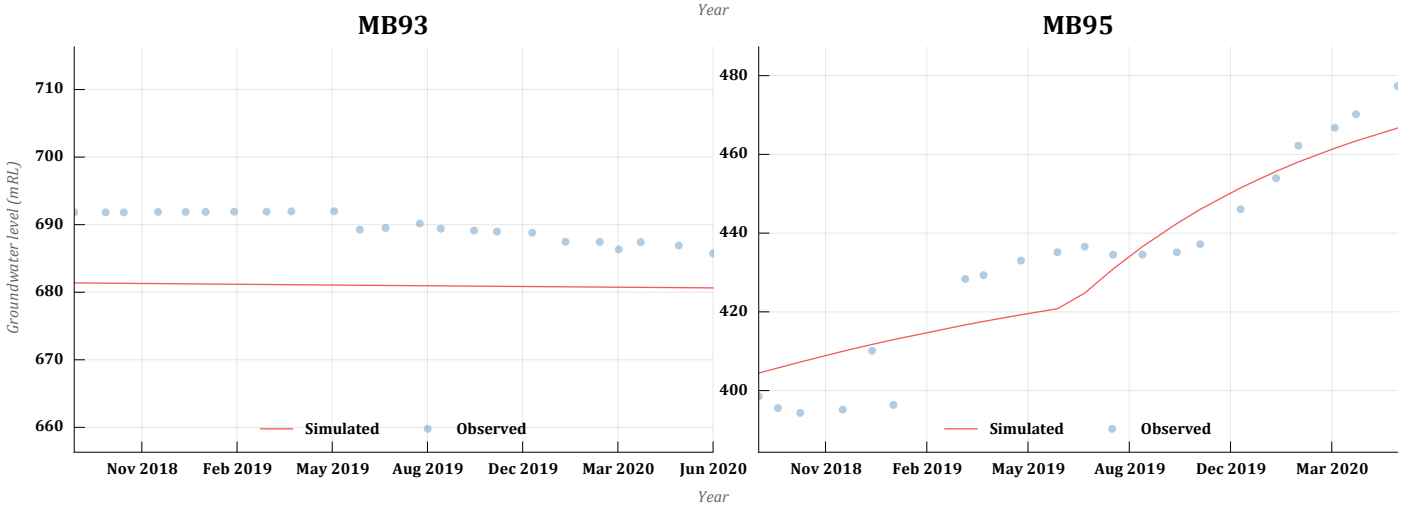
MB8A
710
700
690
680
670
660
Simulated
Observed
2000
2005
2010
2015
2020
Year


MB8B
Groundwater level (mRL)
710
700
690
680
670
660
Simulated
Observed
2000
2005
2010
2015
2020

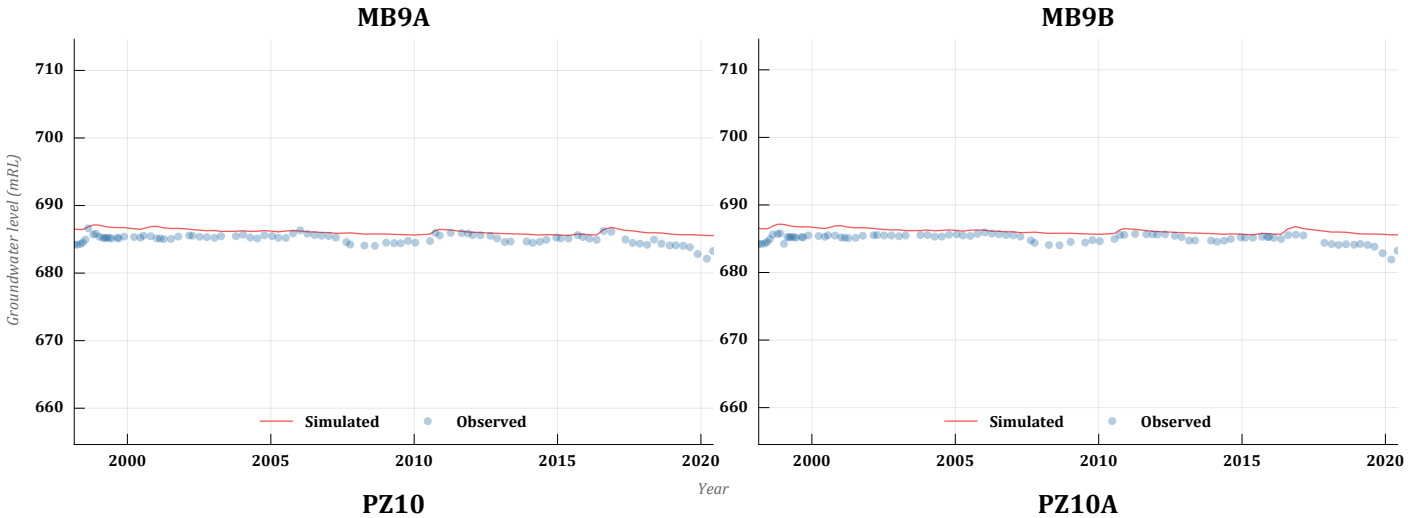
MB90
700
690
680
670
660
650
640
Simulated
Observed
Nov 2018
Feb 2019
May 2019
Aug 2019
Dec 2019
Mar 2020
Year

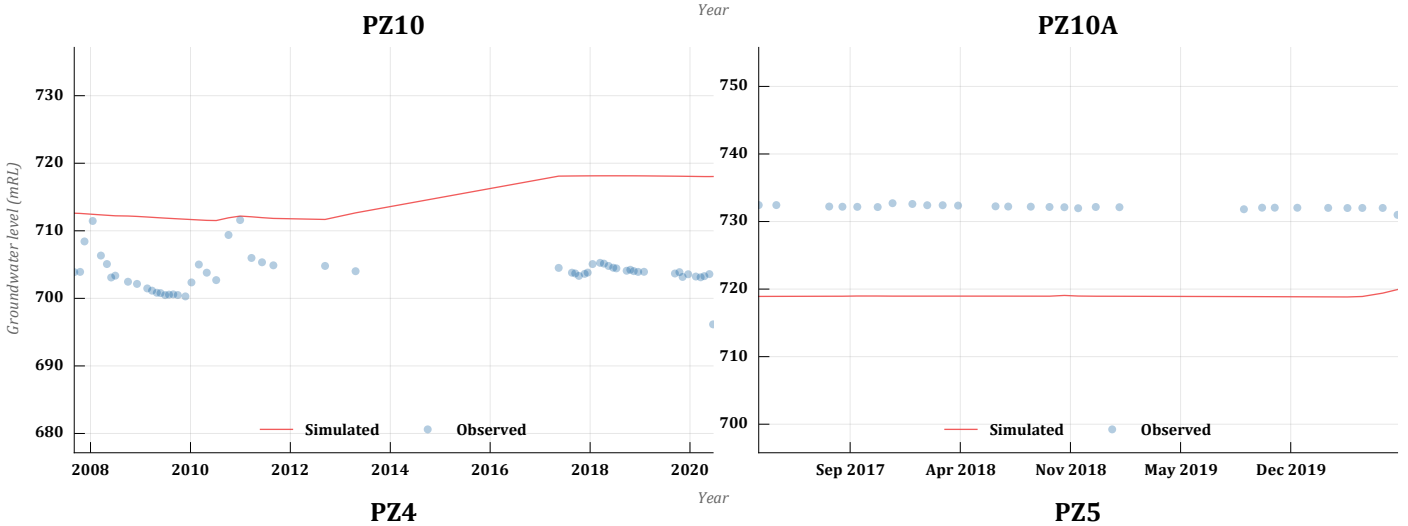

MB91
Groundwater level (mRL)
740
730
720
710
700
690
Simulated
Observed
Nov 2018
Feb 2019
May 2019
Aug 2019
Dec 2019
Mar 2020
Jun 2020

MB92
720
710
700
690
680
670
Simulated
Observed
Nov 2018
Feb 2019
May 2019
Aug 2019
Dec 2019
Mar 2020
Year


MB93
Groundwater level (mRL)
710
700
690
680
670
660
Simulated
Observed
Nov 2018
Feb 2019
May 2019
Aug 2019
Dec 2019
Mar 2020
Jun 2020

MB95
480
460
440
420
400
Simulated
Observed
Nov 2018
Feb 2019
May 2019
Aug 2019
Dec 2019
Mar 2020
Year


MB9A
MB9B
Groundwater level (mRL)
Simulated
Observed
Year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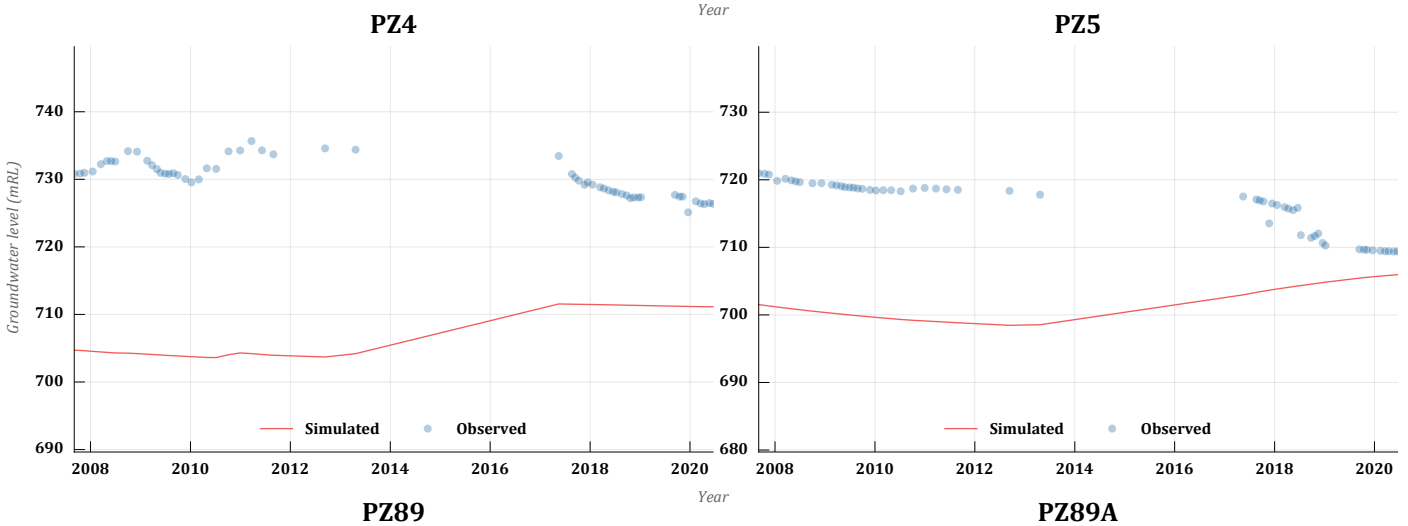
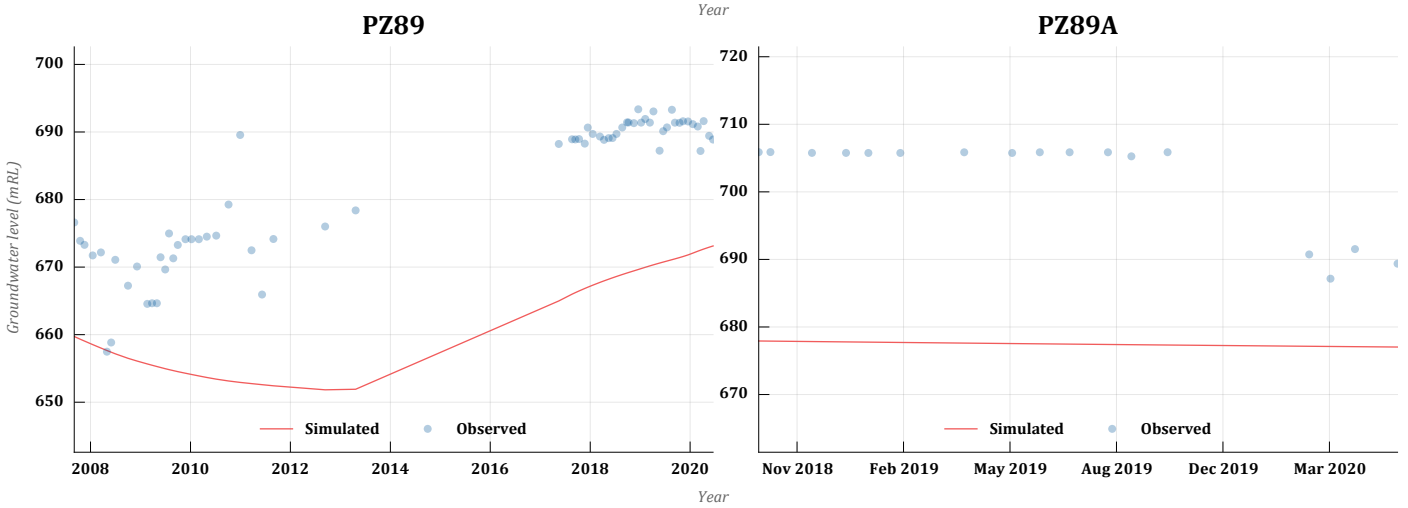
PZ10A
Groundwater level (mRL)
Simulated
Observed
Year


PZ4
PZ5
Groundwater level (mRL)
Simulated
Observed
Year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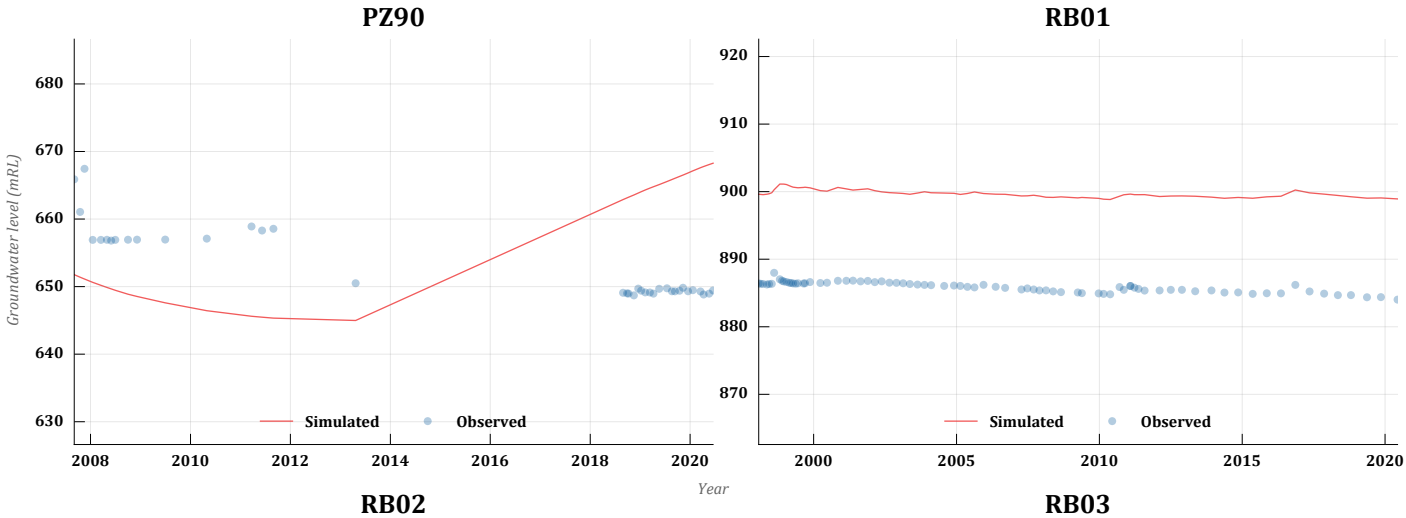
PZ89A
Groundwater level (mRL)
Simulated
Observed
Year



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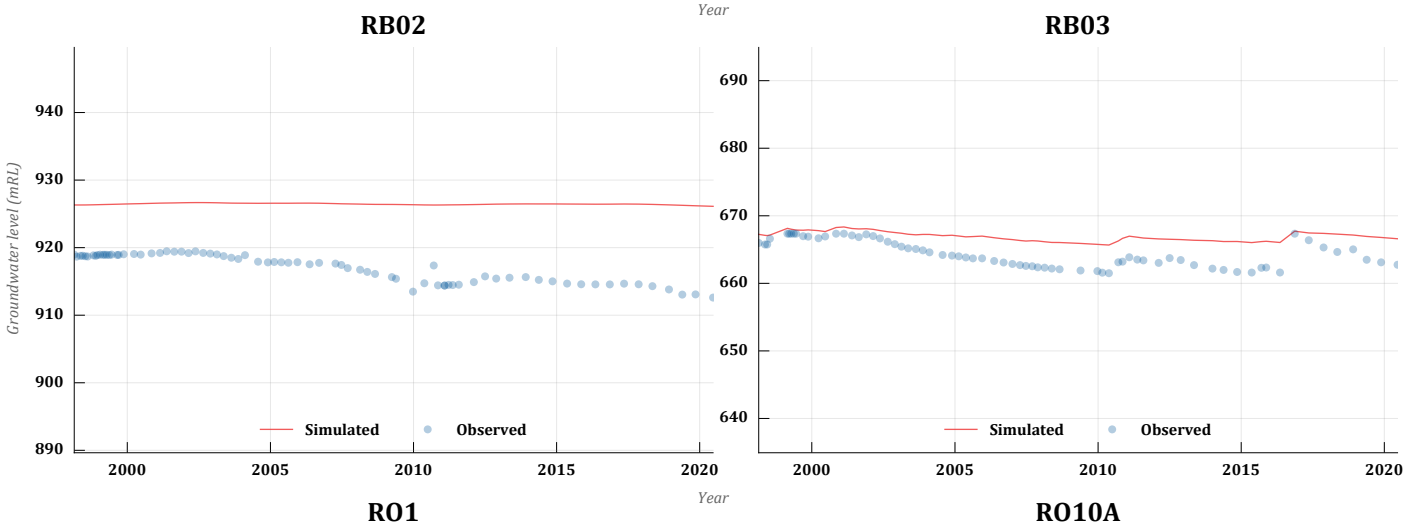
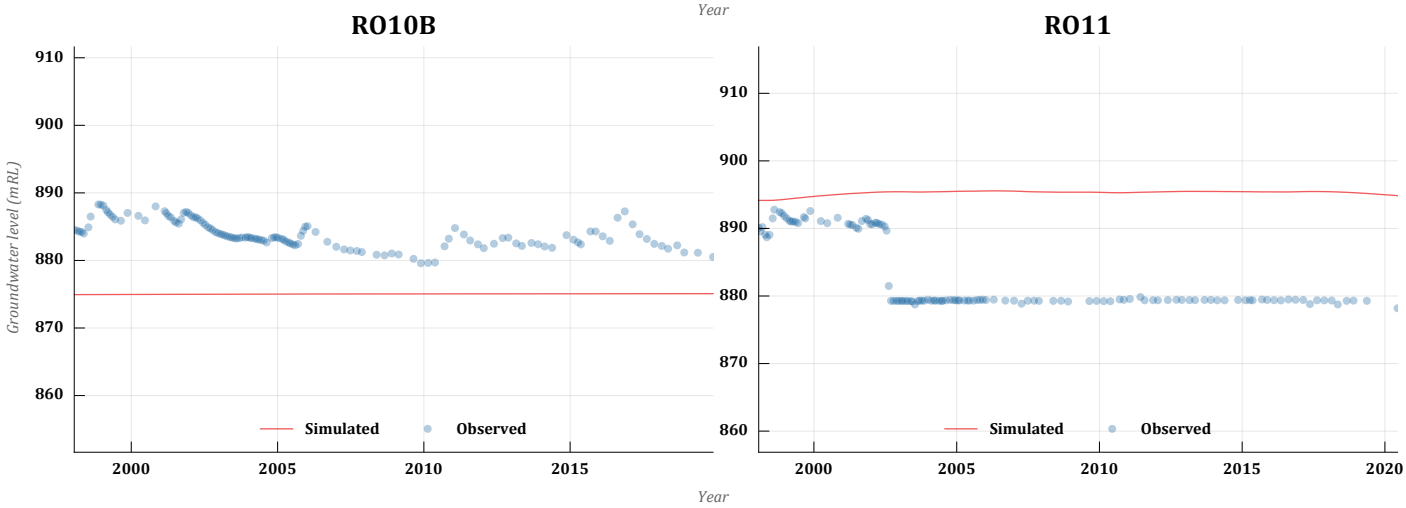


Year

Year



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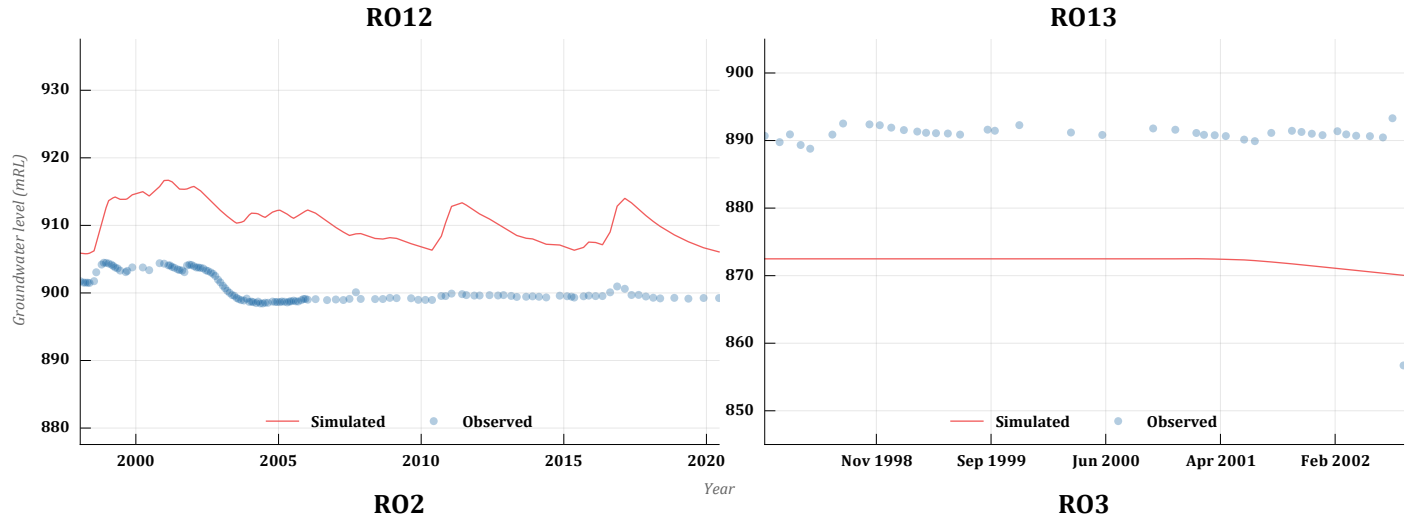
RO12
Groundwater level (mRL)
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920
910
900
890
880
2000
2005
2010
2015
2020
Simulated
Observed
Year

RO13
900
890
880
870
860
850
Nov 1998
Sep 1999
Jun 2000
Apr 2001
Feb 2002
Simulated
Observed

RO2
Groundwater level (mRL)
900
800
700
600
500
Nov 1998
Sep 1999
Jun 2000
Apr 2001
Feb 2002
Simulated
Observed
Year

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900
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860
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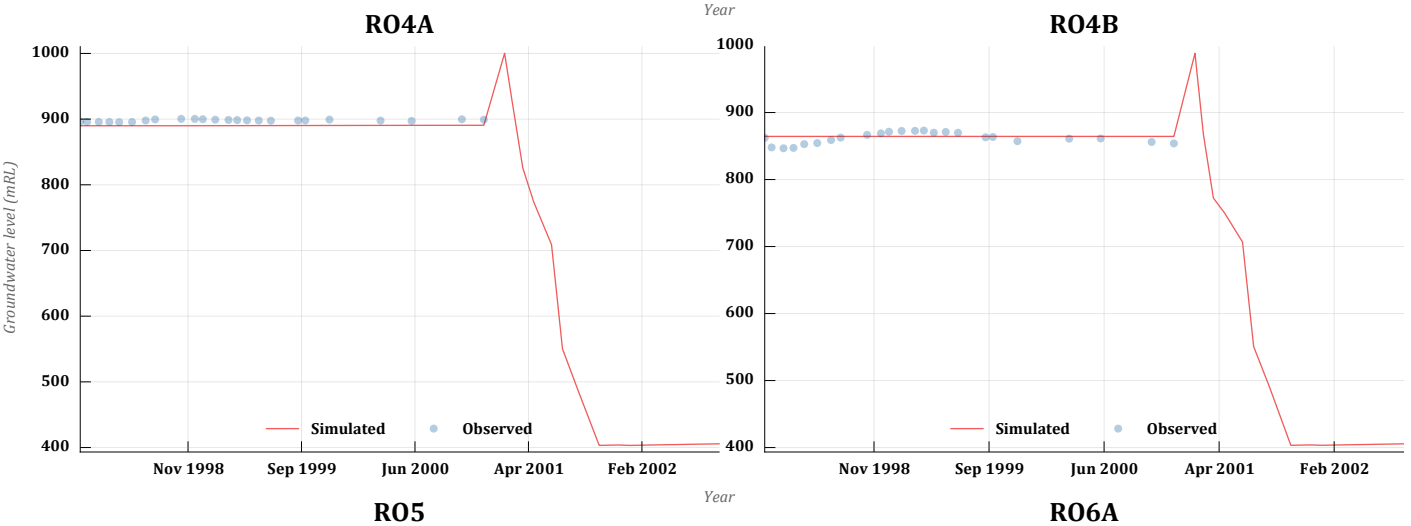
Sep 1999
Jun 2000
Apr 2001
Feb 2002
Simulated
Observed


RO4A
Groundwater level (mRL)
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900
800
700
600
500
400
Nov 1998
Sep 1999
Jun 2000
Apr 2001
Feb 2002
Simulated
Observed
Year

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600
500
400
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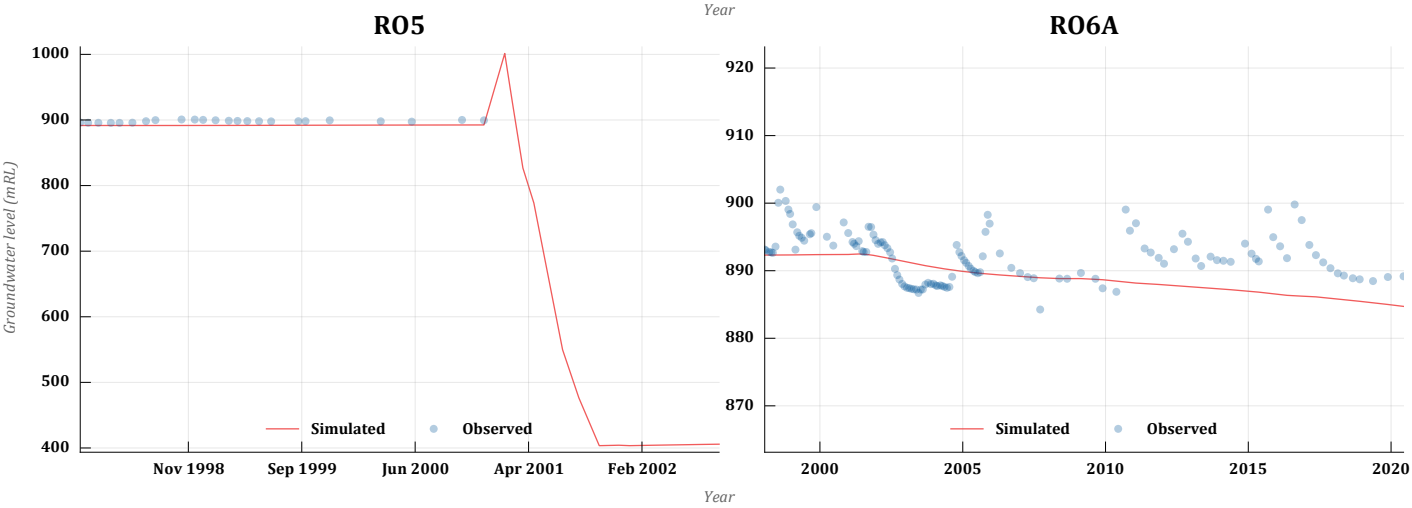
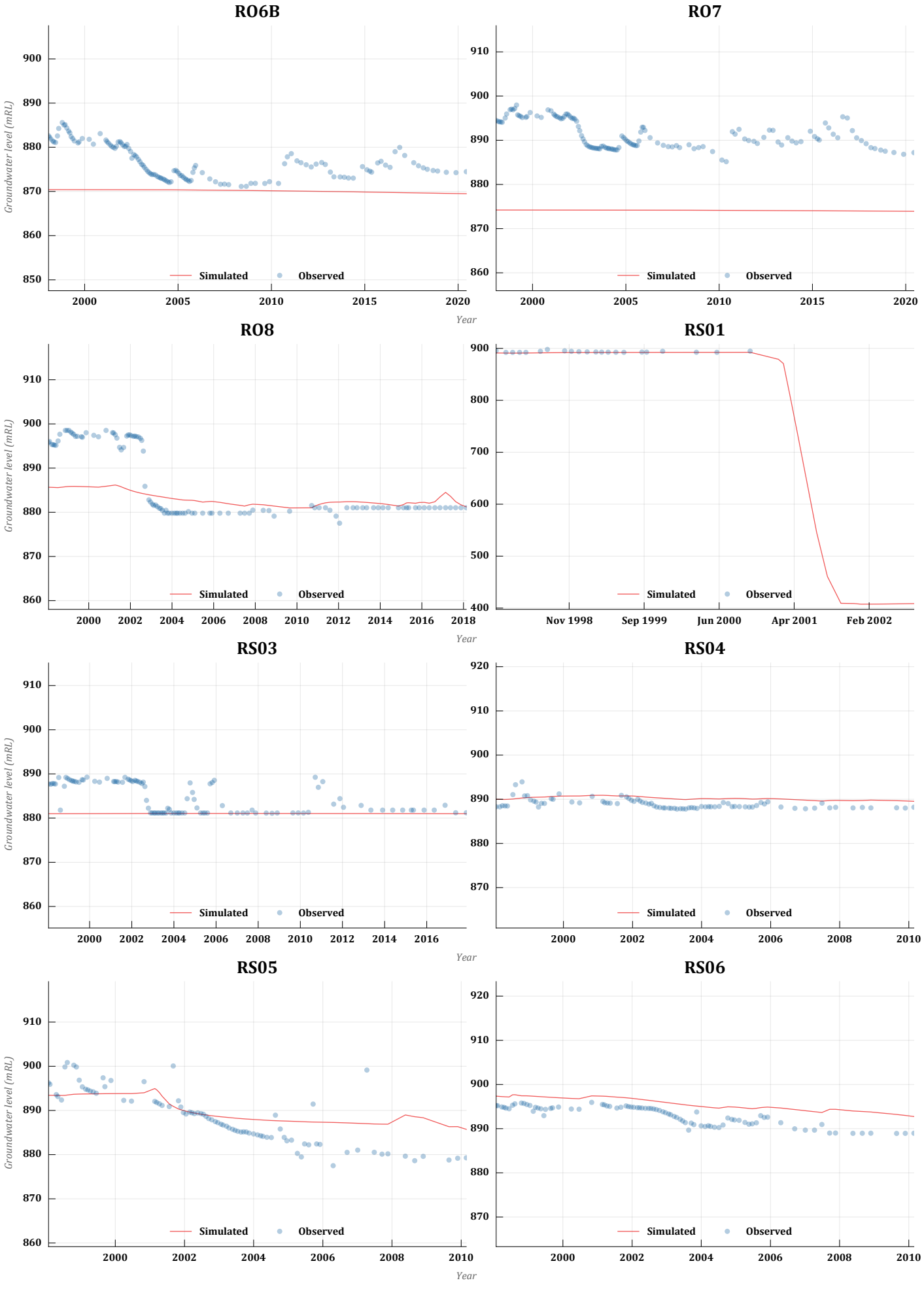
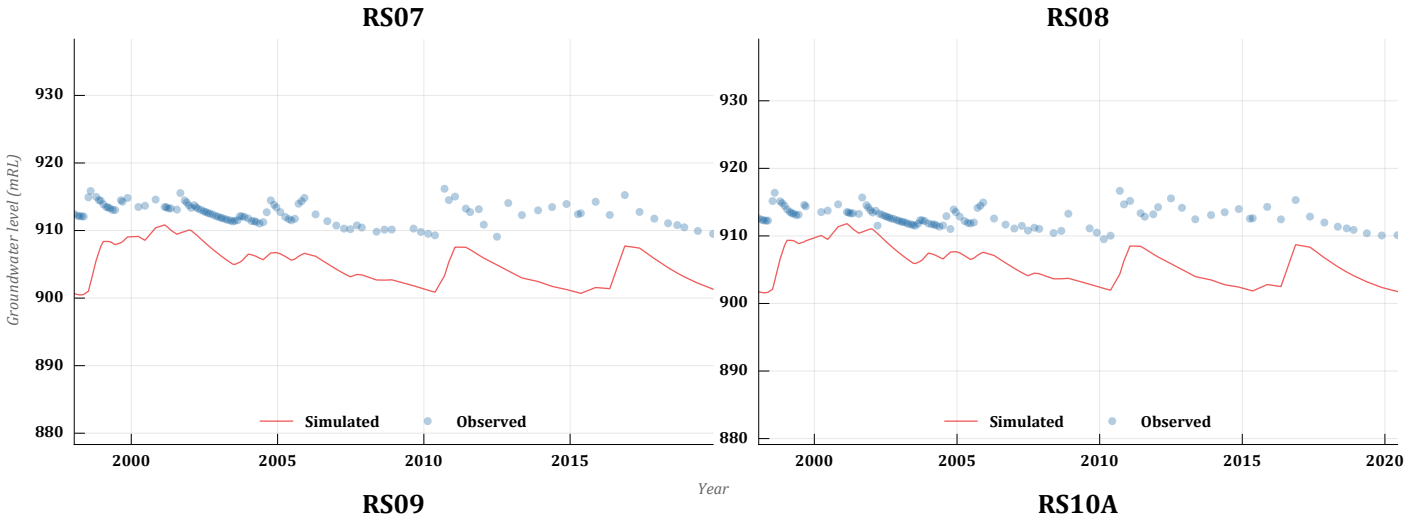
Sep 1999
Jun 2000
Apr 2001
Feb 2002
Simulated
Observed

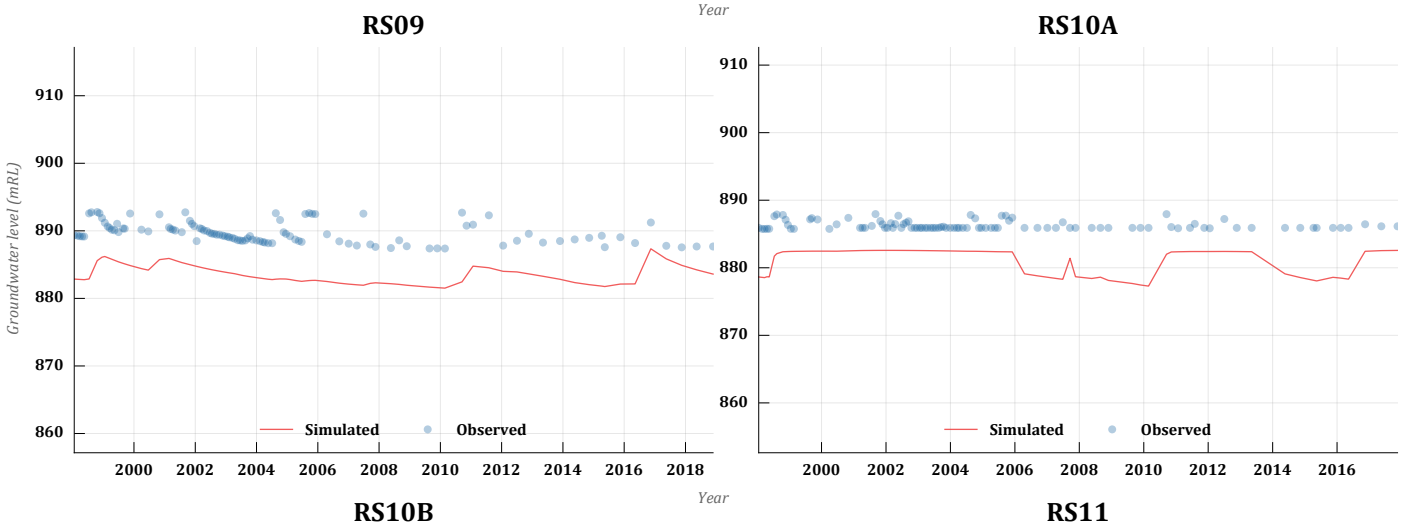

RO5
Groundwater level (mRL)
1000
900
800
700
600
500
400
Nov 1998
Sep 1999
Jun 2000
Apr 2001
Feb 2002
Simulated
Observed
Year

RO6A
920
910
900
890
880
870
2000
2005
2010
2015
2020
Simulated
Observed


RO6B
RO7
RO8
RS01
RS03
RS04
RS05
RS06
Groundwater level (mRL)
Year
Simulated
Observed
Nov 1998
Sep 1999
Jun 2000
Apr 2001
Feb 2002


RS07
Groundwater level (mRL)
930
920
910
900
890
880
2000
2005
2010
2015
Simulated
Observed

RS08
930
920
910
900
890
880
2000
2005
2010
2015
2020
Simulated
Observed


RS09
Groundwater level (mRL)
910
900
890
880
870
860
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Simulated
Observed

RS10A
910
900
890
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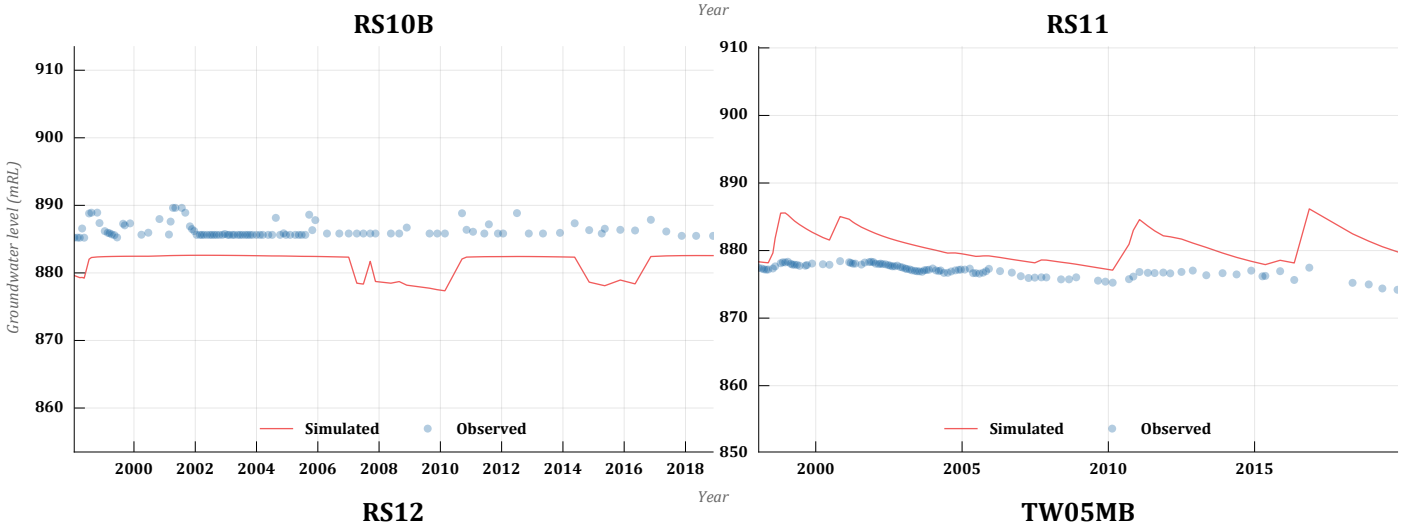
870
860
2000
2002
2004
2006
2008
2010
2012
2014
2016
Simulated
Observed


RS10B
Groundwater level (mRL)
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900
890
880
870
860
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Simulated
Observed

RS11
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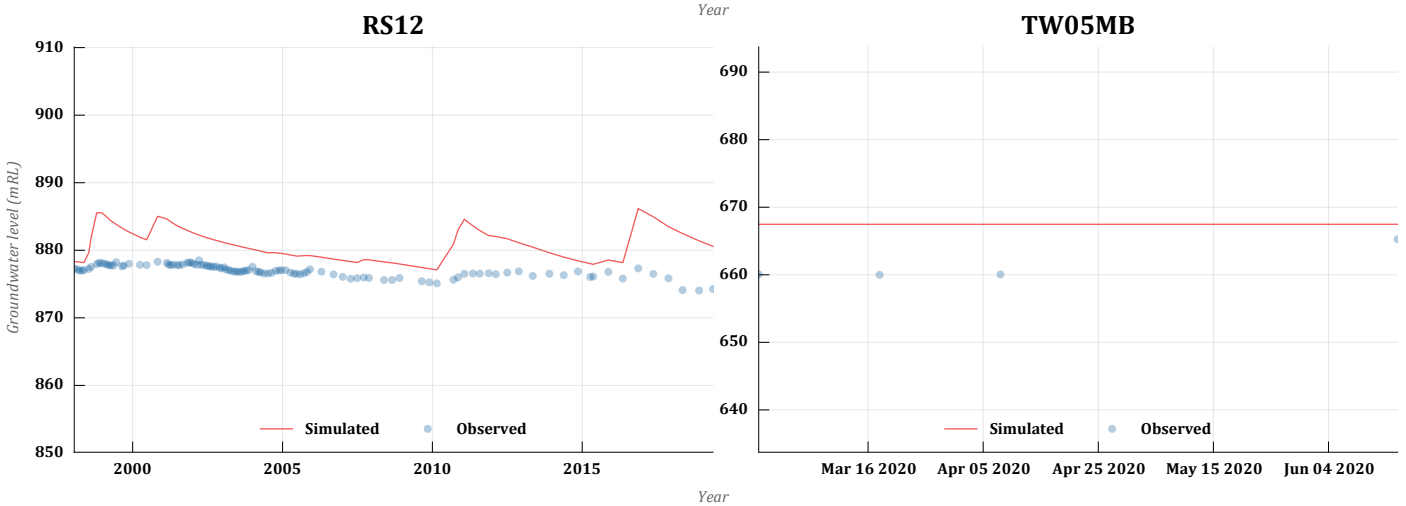
900
890
880
870
860
850
2000
2005
2010
2015
Simulated
Observed


RS12
Groundwater level (mRL)
910
900
890
880
870
860
850
2000
2005
2010
2015
Simulated
Observed

TW05MB
690
680
670
660
650
640
Mar 16 2020
Apr 05 2020
Apr 25 2020
May 15 2020
Jun 04 2020
Simulated
Observed

Year

CVO AEMR 2020-2021

Surface Water Assessment

Newcrest Mining Limited

15 October 2021

The Power of Commitment

GHD Pty Ltd | ABN 39 008 488 373
270 Summer Street,
Orange, New South Wales 2800, Australia
T +61 2 6393 6400 | **F** +61 2 9475 0725 | **E** oagmail@ghd.com | **ghd.com**

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Executive summary

GHD Pty Ltd were engaged by Cadia Holdings Pty Limited (CHPL) to undertake an assessment of surface water quality to meet internal and annual reporting requirements for the 2020-2021 reporting period.

Surface water quality for the reporting period as well as historical data have been assessed based on key zones at the Cadia Valley Operations (Cadia) site. The findings of these assessments are summarised below.

Upper Cadiangullong Creek

This zone contains only surface water monitoring sites, which are located on Cadiangullong Dam, Upper Cadiangullong Creek, and a tributary of the creek which receives seepage from an historic mine adit.

Water quality data for this zone indicate a potential impact of historical mining in the catchment in 1998, based on peaks in the concentrations of nitrogen and chromium observed at all sites. Historical water quality results have shown influence of the historical mine adit seepage on the tributary of Upper Cadiangullong Creek based on elevated cadmium, copper, zinc, molybdenum and nickel concentrations. There has been no impact of the historic mine adit evident on the concentration of these parameters at the nearest downstream Cadiangullong Creek monitoring site.

Cadia Hill Pit

The influence of tailings deposition in the pit is evident in the water quality results for the standing water in the pit. Results show this includes increased salinity, and elevated concentrations of antimony, arsenic, molybdenum, nickel and total suspended solids.

There was no impact from tailings deposition on surface water in Cadiangullong Creek given the pit standing water level was lower than adjacent surface water storages and watercourses.

Ore Processing area

Water quality trends at the Site Runoff Pond (SROP) were observed, including variable concentrations of nitrogen oxides. Dissolved metal and major cation concentrations showed decreasing trends at all monitoring locations. The SROP is a zero discharge stormwater runoff dam that captures water form ore processing and other disturbed areas, where poor water quality is expected. There was no influence on Cadiangullong Creek by runoff from the Ore Processing Area as evidenced by review of the upstream (CAWS79) and downstream (CAWS78) monitoring locations.

Short-duration changes in water quality were evident from the unlicensed discharge (see section 3.1) at CAWS78 with select dissolved metals and EC showing a brief increase in concentrations. The discharge did not pose a risk to aquatic ecosystems, due to concentrations in the waterways remaining below relevant guidelines.

Waste rock dumps

There were instances of elevated dissolved molybdenum concentrations at Rodds Creek Dam (CAWS52) over the reporting period, potentially due to increased pumping of TSF decant water to Rodds Creek Dam (operating as a zero discharge water storage dam) in times of high rainfall. Downstream monitoring results show no influence of waste rock leachate on Cadiangullong Creek water quality.

TSF Eastern Zone

Dissolved molybdenum concentrations have generally increased since 2016 in the NTSF (CAWS42) and STSF (CAWS43) decant surface water monitoring sites. A somewhat similar trend is seen downstream at CAWS31 where molybdenum concentrations have shown an increase over the period. However, molybdenum concentrations at CAWS31 are less than the guideline and does not pose a risk to downstream receiving waters as this water is fully contained within the mines water capture system and returned to the processing plant for reuse.

TSF Western Zone

Molybdenum concentrations at sites CAWS67, CAWS68, CAWS69 and CAWS76 were elevated compared to other sites within the TSF western zone. The source of elevated molybdenum is potentially the TSF waste rock embankments. However, there is no indication of elevated molybdenum concentrations at CAWS61 on Cadiangullong Creek which is the nearest downstream receptor for any potential water quality impact from the western zone of the TSFs.

TSF Southern Zone

The surface water monitoring site CAWS31, showed increased molybdenum concentrations over the reporting period. However, as mentioned above, molybdenum concentrations at CAWS31 are less than the guideline and do not pose a further risk to downstream receiving waters as this water is fully contained and returned to the processing plant for reuse.

There was no impact of seepage from the STSF on water quality evident in the receiving environment at site 412702, based on the monitoring records for key parameters associated with the TSF decant water, including nitrogen oxides, molybdenum and the ratios of major ions.

Blayney Dewatering Facility

Copper concentrations were generally higher at downstream monitoring location NEC062. The higher copper concentrations at the downstream monitoring location likely reflect the influence of the facility due to contamination. Though, since remedial action including removal of contaminated soil has been undertaken, copper concentrations downstream at NEC062 has shown a declining trend.

Overall, a weight of evidence assessment indicated that the ecological risks posed by the copper concentrations identified within Abattoir Creek were low, relative to the risks posed by external inputs to the creek.

Cadia Dewatering Facility

The potential influence of the Cadia Dewatering Facility (CDF) on water quality has been observed at the now decommissioned on site monitoring location closest to the CDF (CDW02), based on elevated concentrations of copper and molybdenum with reference to ANZG (2018) default toxicant guidelines for freshwaters. These trends are yet to be observed in the downstream receiving environment, Belubula River, indicating that they are likely localised in nature and have not migrated downstream to sensitive watercourses. Drainage improvement works at the CDF area, to contain stormwater runoff, have been completed and were aimed at reducing the risk of impacts on the downstream receiving environment.

Site Specific Guideline Value (SSGV) Assessment

The Cadia Water Management Plan specifies SSGVs for five surface water monitoring sites (412702, CAWS63, CAWS10, 412166, 412167). Results for the reporting period for these sites have been compared against the relevant SSGVs, and exceedances have been detailed in this report. The details of the level one investigations undertaken by Cadia, and the outcomes and recommendations from the investigations have been included in this report.

– SSGV exceedances occurred at 412702 as a result of an unlicensed discharge, though concentrations did not pose a risk to downstream beneficial uses with respect to aquatic ecosystems, livestock, and short-term irrigation beneficial uses.
– No SSGV exceedances occurred at CAWS63.
– SSGV exceedances occurred at CAWS10, though there are no clear pathways for mine derived pollutants to impact on this creek system.
– SSGV exceedances occurred at 412166 and 412167, though are considered to be outside of the area of impact of the mine. Laboratory interference or error was determined to be responsible for the exceedances.

Overall, SSGV exceedances did not pose a risk to downstream beneficial uses with respect to aquatic ecosystems, livestock, and short-term irrigation beneficial uses.

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Appendices

Appendix A Surface water quality graphs

1. Introduction

1.1 Background

Cadia Valley Operations (Cadia) is a gold and copper mining and processing operation. Cadia is located approximately 25 km south west of Orange, in the central tablelands of NSW. Cadia Holdings Pty Limited (CHPL) is the owner and operator of Cadia and is a wholly owned subsidiary of Newcrest Mining Limited (Newcrest). Cadia operates under six Mining Leases (ML): ML1405, ML1449, ML1472, ML1481, ML1689 and ML1690.

The site comprises the Cadia Hill open cut (commenced in 1998 and completed in 2013), the Ridgeway underground mine (commenced in 2002) and the Cadia East underground mine (commenced in 2012). The site also maintains two waste rock emplacements (the rehabilitated North Waste Rock Dump (NWRD) and the active South Waste Rock Dump (SWRD)), as well as the Northern Tailings Storage Facility (NTSF) and Southern Tailings Storage Facility (STSF) which commenced in 1998 and 2002 respectively.

The NTSF is currently offline following a failure of a section of the NTSF on 9 March 2018, with tailings placed in the Cadia Hill Pit (PTSF) since this time. The Ridgeway operations were placed into care and maintenance in March 2016. Cadia East is a panel cave mining operation to extract approximately 450 million tonnes (Mt) of ore over a period of 21 years, with current approvals taking the project through to June 2031. The ore body contains gold, copper and other trace metals.

Land use in the vicinity of Cadia is dominated by sheep and cattle grazing in the more gently undulating areas, and private and state forestry operations to the north and east.

GHD Pty Ltd (GHD) were engaged by CHPL to undertake an assessment of surface water quality to meet internal and annual reporting requirements for the 2020-2021 reporting period. The 2020-2021 AEMR monitoring period extends from 1 July 2020 to 30 June 2021.

This report presents that review of surface water monitoring data from sites in the Cadia complex to assess the impacts of Cadia operations, compare the results for the 2020-2021 reporting period to those from previous years, and identify any long-term trends.

For the purpose of reporting, Cadia have separated the surface water monitoring locations into discrete zones that incorporate potential sources of pollution and receptors such as local creeks. All surface water monitoring sites are shown in Figure 1.1. The zones and their respective figures showing surface monitoring sites are listed in Table 1.1.

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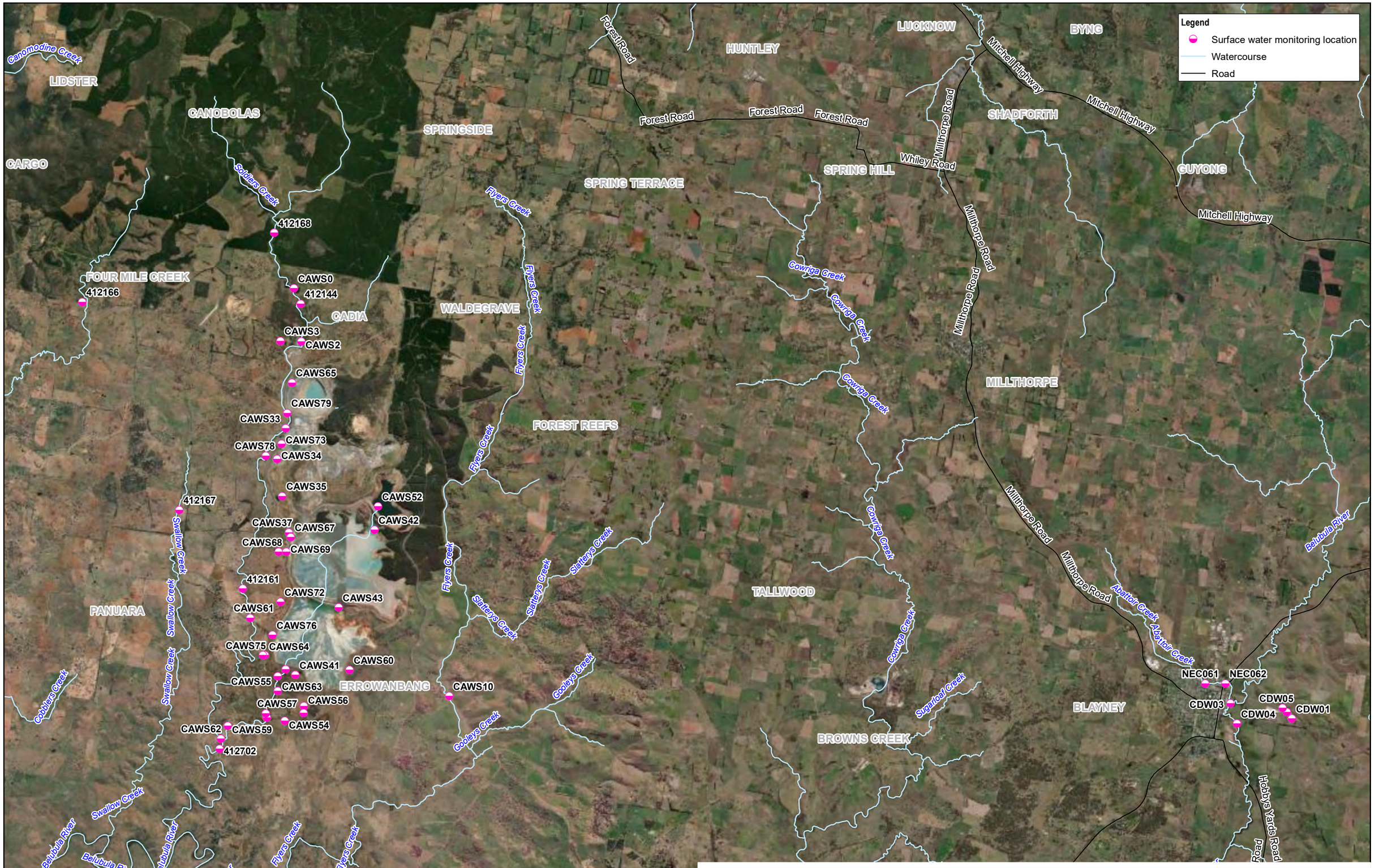

Paper Size ISO A3

0 1 2 3

Kilometers

Map Projection: Mercator Auxiliary Sphere
Horizontal Datum: WGS 1984
Grid: WGS 1984 Web Mercator Auxiliary Sphere

N

GHD

Newcrest Mining Limited
CVO AEMR –
Surface and Groundwater Assessment

Overview

Project No. **12553243**
Revision No. **0**
Date **18 Oct 2021**

FIGURE 1-1

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Print date: 18 Oct 2021 - 10:11

Data source: Newcrest: Bores, 2019. LPI:DCDB/DTDB, 2017. Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.
Created by: tmorton

2. Environmental conditions

2.1 Topography

Cadia is situated within and around the Cadiangullong Creek Valley. The Cadiangullong Creek Valley is generally orientated from north to south with elevations within the mining lease boundaries ranging from approximately 1000 m AHD in the north east down to 450 m AHD in the south west.

2.2 Climate

For this assessment, historical rainfall and evaporation data have been compared to investigate any potential influences in monitoring results over the period.

Cadiangullong Creek Valley has a temperate climate characterised by hot, dry summers and cold winters. The rainfall is influenced by topography and generally increases with elevation and decreases with lower land elevation.

Review of meteorological data provided by Cadia found that the average temperature at Cadia during the 2020-2021 AEMR monitoring period was 13 ºC, while the annual maximum was 34.5 ºC in December 2020 and annual minimum was -1.7 ºC in August 2020.

2.2.1 Rainfall

For this assessment, historical rainfall data have been obtained from the Bureau of Meteorology (BOM) website. Monthly data is the total of all available daily rainfall data for each calendar month (and includes all forms of precipitation such as rain, snow and hail) and has undergone quality assurance processes through the BOM.

Historical data has been obtained from BOM station 63113 Orange (Angullong) which is located approximately 12.7 km south west from Cadia Valley Operations. This station was selected based on its proximity to the site and length and quality of data.

The historical data period extends from July 1965 to June 2020. The statistics for this data set are:

– Minimum annual rainfall of 288.6 mm in 1982
– Average annual rainfall of 738.5 mm
– Median annual rainfall of 740.0 mm
– Maximum annual rainfall of 1159.0 mm in 2010

Rainfall data over the 2020-2021 monitoring period was provided by Cadia from the Southern Lease Boundary weather station. Data from July 2020 to April 2021 has undergone quality control reviews with raw data (not quality controlled) implemented for May and June 2021.

Total rainfall over the 2020-2021 monitoring period was 872 mm, above the historical annual average. The minimum monthly rainfall total occurred in April 2021 where 1.2 mm of rainfall was received. The monthly maximum received during the monitoring period occurred in January 2021 where 127 mm was recorded.

A graphical comparison of site monthly rainfall data between the 2020-2021 AEMR monitoring period, and long-term monthly average historical data from BOM station 63113 Orange (Angullong) has been undertaken. This comparison is shown in Figure 2.1.

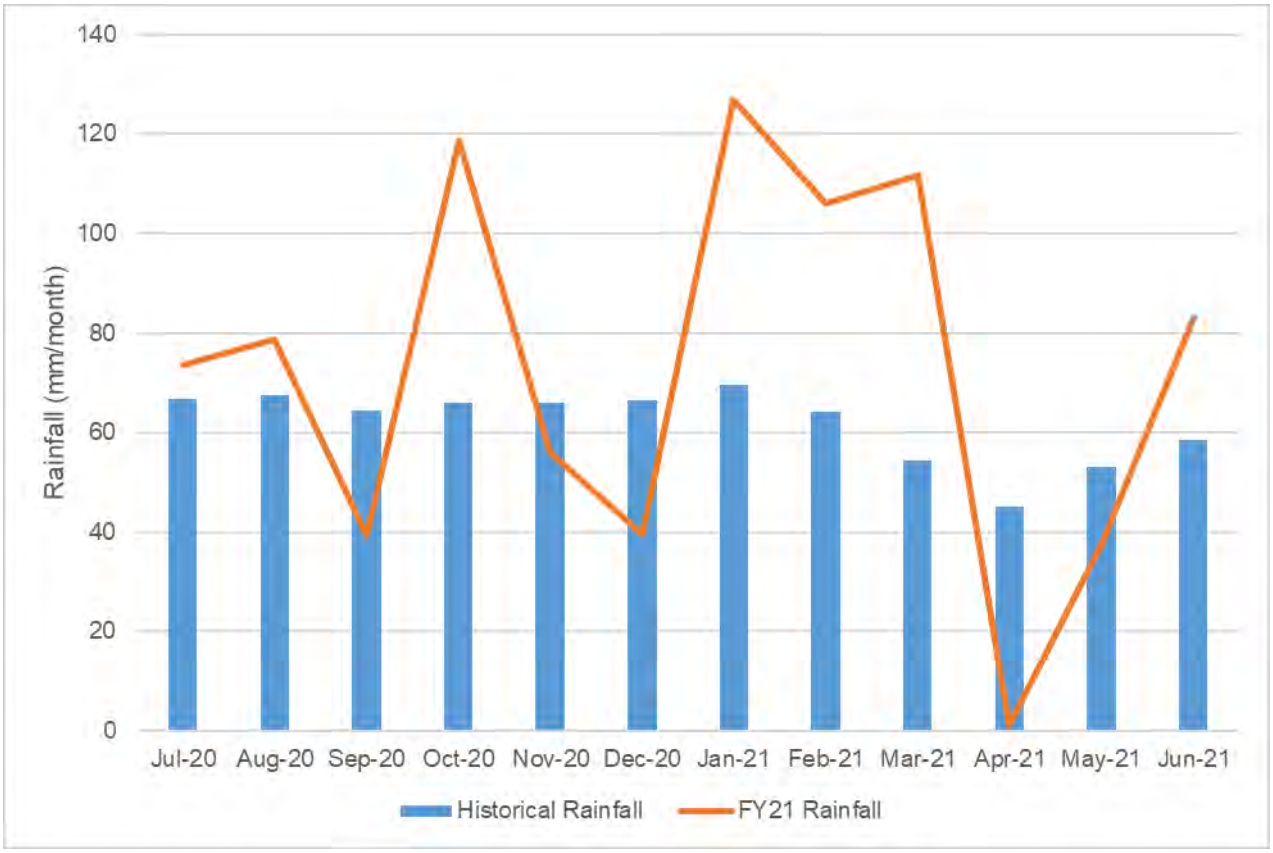

Figure 2.1 Comparison of historical and 2020-2021 monitoring period rainfall

As shown in Figure 2.1, precipitation during the monitoring period was above the historical average in July, August and October 2020, as well as in January, February, March and June 2021. In all other months, rainfall was just below the long-term monthly average historical data from BOM station 63113 Orange (Angullong) (with the exception of April 2021).

2.2.2 Evaporation

Grid point data have been obtained from the Scientific Information for Land Owners (SILO) database operated by the Queensland Department of Science, Information Technology and Innovation. SILO grid point data is based on historical data from nearby BOM stations with data consisting entirely of interpolated estimates from the station's observations. Evaporation data has been sourced from SILO grid point data at a location nearest to CVO at SILO grid reference point -33.45 N, 149.00 E.

Historical monthly evaporation data for a period of January 1960 and June 2021 have been obtained. Statistics for this data set include

- Minimum annual evaporation of 1042.7 mm in 1974
- Average annual evaporation of 1399.8 mm
- Median annual evaporation of 1393 mm
- Maximum annual evaporation of 1713.3 mm in 1982

Total annual evaporation during the 2020-2021 monitoring period was 1187 mm, which was less than the historical average at this site. The minimum evaporation occurred during winter in June 2021 for a total of 35.3 mm while the maximum occurred in January 2021 for a total of 179.3 mm.

A graphical comparison of monthly total rainfall and evaporation over the monitoring period has been undertaken. This comparison is shown in Figure 2.2.

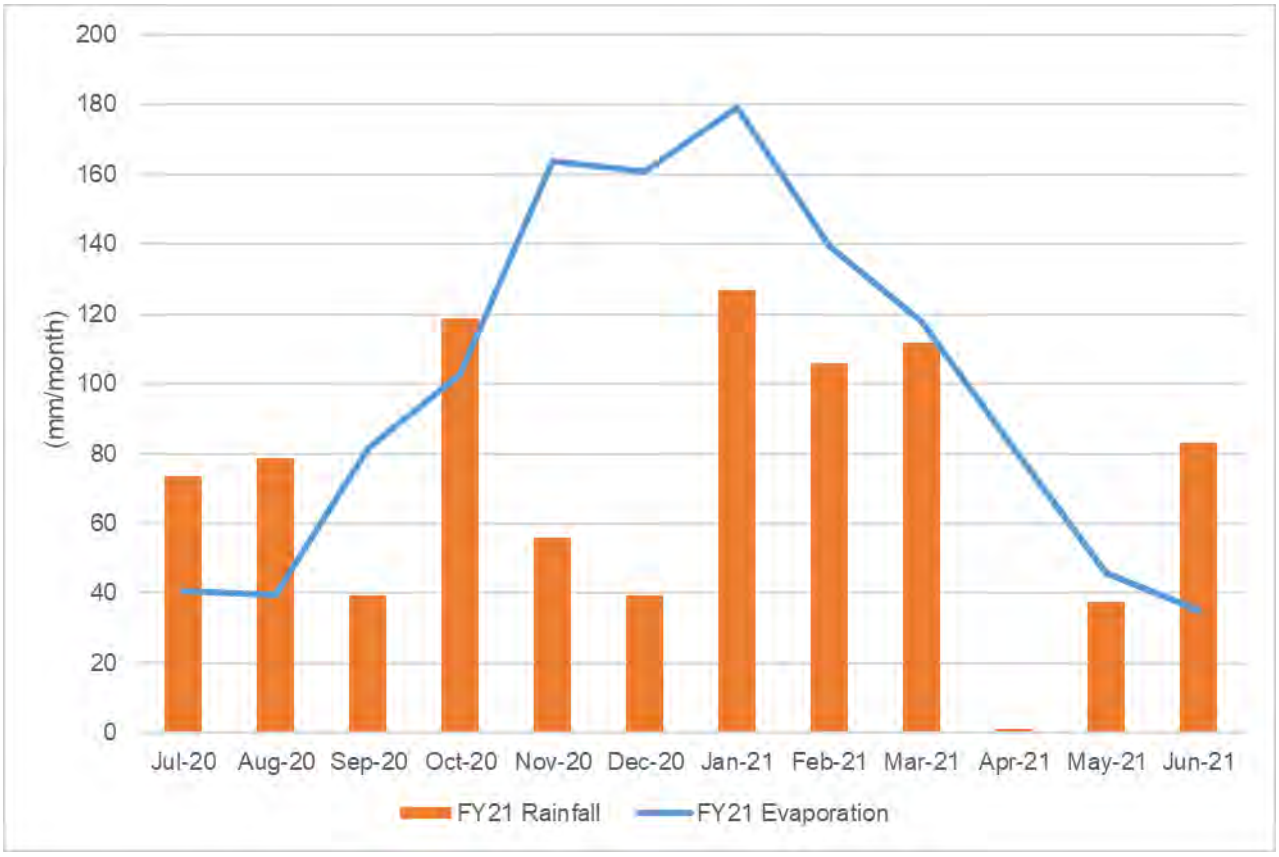

Figure 2.2 Comparison of rainfall and evaporation during 2020-2021 monitoring period

As shown in Figure 2.2 evaporation in the vicinity of surface water facilities at Cadia exceeded the monthly rainfall totals in months of September, November and December 2020, and January to May 2021. During these months, evaporation from surface water facilities and surface water catchments is greater than rainfall into the catchments. In other months, rainfall replenishes surface water catchments.

2.3 Surface water catchments

There are potential interactions between Cadia and the surface water catchments of Flyers, Cadiangullong, Swallow and Diggers Creeks, within which the dominant land use is agriculture.

At the northern end of the Cadiangullong Creek Valley are Mt Canobolas and Mt Towac, which are situated within the confines of Canobolas State Forest. From here, the headwaters of the Cadiangullong Creek begin. Cadiangullong Creek flows north to south through the Cadia mining lease area, passing to the west of the Tailings Storage Facilities (TSFs), before discharging into the Belubula River which is located approximately 14 km downstream of the Cadia southern lease boundary. The Belubula River forms part of the Lachlan River catchment.

The TSFs are located along Rodds Creek, a tributary of Cadiangullong Creek. Rodds Creek flows into Cadiangullong Creek about 2.5 km downstream of the STSF embankment.

Swallow Creek and Diggers Creek lie to the west of the Cadia operations. Flyers Creek flows along the eastern extent of the Cadia operations. These creek systems are also tributaries of the Belubula River. These catchments are not directly impacted by Cadia's operations, with the only potential influences of the site being changes to groundwater baseflows, and reduced surface flows in Flyers Creek due to licensed extractions. Land use within the catchments is dominated by agriculture.

2.4 Geology

The geology of Cadia's mining areas contains copper-gold mineralisation. These rocks are mainly of Ordovician and Silurian age. Cadia is situated within the eastern Lachlan Fold Belt of NSW. The Lachlan Fold Belt is divided into northerly trending metamorphic, volcanic and sedimentary belts intruded by numerous igneous rocks.

In the vicinity of the Rodds Creek catchment, in which the TSFs are located, the basement rocks are overlain by Quaternary alluvial soils. The basement rocks comprise of shale, siltstone and mudstone (from Silurian age) in the north and Ordovician volcanics, dominated by volcanoclastic rocks of andesitic composition in the south. Tertiary basalt outcropping is evident in the northern part of the Cadia boundary.

3. Surface water assessment

Surface water quality monitoring and assessment of data is undertaken in accordance with the Newcrest Mining Limited, Cadia Water Management Plan (WMP) (Newcrest, 2019). Monitoring at Cadia commenced in 1994 and the program has been continually expanded since then. Surface water quality sampling points include locations along Cadiangullong Creek, Flyers Creek, Diggers Creek and Swallow Creek, as well as a number of locations across the mine site. Water quality monitoring is routinely conducted at these locations at either monthly or quarterly intervals as per the WMP requirements. Water quality parameters were selected based on the potential mining operations contaminants as identified in the Cadia East Geochemistry Assessment (Mesh Environmental, 2009).

Surface water monitoring locations are grouped by mine area which are defined by physical location, potential source of contamination and surrounding watercourse impact. Table 3.1 shows the identification and purpose description of each surface water quality monitoring site and the mine area grouping. Time series surface water quality graphs are presented in Appendix A and analysed to assess whether mine operations have influenced surface water monitoring results, or whether external environmental and/or neighbouring operations are likely to influence trends.

Notable increasing and decreasing trends in analyte concentrations are presented and discussed in this manner, and summarised for each area. Discussion of water quality results that show no change in trend or are levels less than guidelines values from ANZG 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018) have generally been omitted from this report. Watercourse monitoring sites are compared against ANZG (2018) guidance to assess the potential for offsite environmental impact. Surface water storages or sites impacted by historical seepages are assessed based on trends given their purpose to contain potentially contaminated water from operational seepages or runoff.

Table 3.1 Surface water monitoring sites

Site ID	Purpose / Description	Area
412168	Background water quality reference location located upstream from Cadiangullong Dam	Upper Cadiangullong Creek
CAWS0	Water quality for process raw water. Farthest upstream surface water monitoring location on Cadiangullong Creek	
CAWS2	Potential for impact from historical mining activities located along Cadiangullong Creek	
CAWS3		
412144	Water quality discharging or spilling from Cadiangullong Dam and upstream of active mine operations areas	
CAWS65	Cadia Hill Pit. TSF decant water quality	Cadia Hill Pit
CAWS73	Site Runoff Pond	Ore Processing Area
CAWS33	Potential for impact from open pit and ore processing area	
CAWS78	Potential for impact from open pit and ore processing area	
CAWS79	Potential for impact from open pit. Background reference location for ore processing area impact	
412161	Potential for impact from mining, processing & Southern Waste Rock Dumps (SWRDs)	Waste Rock Dumps
CAWS34	Monitor development of leachate water quality from waste rock dumps	
CAWS35		
CAWS37	Monitor for potential seepage impacts from SWRD and NTSF	
CAWS52	Water quality in the mixed water storage dam (Rodds Creek Dam)	
CAWS42	Monitor development of TSF decant water quality. Used to determine potential impacts of the TSF on surface and/or groundwater quality	TSF Eastern Zone
CAWS43		

Site ID	Purpose / Description	Area
CAWS60	Assess potential for seepage contributions on eastern side of southern TSF	
CAWS61	Potential impact from mining, processing and TSF	TSF Western Zone
CAWS62		
CAWS64	Assess any influence of TSF on surrounding groundwater quality	
CAWS67	Monitor for potential for seepage impacts on the western side of the NTSF and STSF	
CAWS68		
CAWS69		
CAWS72		
CAWS75		
CAWS76		
CAWS28	Assess the impact of TSF on surface water quality in Rodds Creek (tributary of Cadiangullong Creek)	TSF Southern Zone
CAWS54	Assess the impact of TSF on surface water quality in Rodds Creek (tributary of Cadiangullong Creek)	
CAWS55		
CAWS56		
CAWS57		
CAWS59		
CAWS30		
CAWS31	Determine the influence of STSF water on groundwater contributing to base flow in creek	
CAWS41		
CAWS63	Assess the impact of TSF on surface water quality in Rodds Creek	
412702	Potential impacts from entire site (most downstream monitoring location in Cadiangullong Creek)	
CDW01	Assess potential impact from NEW Blayney Dewatering Facility – Newbridge Rd	Cadia Dewatering Facility
CDW02		
CDW03		
CDW04		
CDW05		
NEC061	Upstream water quality	Blayney Dewatering Facility
NEC062	Assess potential impact from Blayney Dewatering Facility	

3.1 Discharge to Cadiangullong Creek

On 21 January 2021 a process water pipe ruptured which resulted in an unlicensed discharge of mine water to Cadiangullong Creek. The Environment Protection Authority (EPA) was immediately notified of the incident and attended Cadia to inspect the area. A report of the incident and all water quality monitoring results were provided to the EPA and Department of Planning, Industry and Environment (DPIE). An investigation was undertaken to determine any potential environmental impact caused by the unlicensed discharge event, including an independent Environmental Risk Assessment by GHD (GHD, 2021a). The environmental risk assessment determined that the discharge did not pose a risk to aquatic ecosystems or downstream beneficial users with respect to livestock watering and short-term irrigation. Investigations and conclusions for individual analyte trends between 21 and 27 January 2021 have been drawn from GHD 2021a.

3.2 Upper Cadiangullong Creek

Upper Cadiangullong Creek runs from the Cadiangullong Dam to the Cadia Hill Pit. This reach of the creek adjoins ore processing facilities, office areas, the Cadia Extended Pit and the Cadia Hill Pit, as well as historical mining areas to the west of the creek line which all present potential sources of pollution. Cadia Creek meets Cadiangullong Creek within this reach. The focus of assessment is identifying potential impacts from mine derived pollutants on the creek as a receptor.

The following surface water sites are within the Upper Cadiangullong Creek area:

– 412168, which is upstream of Cadiangullong Dam
– CAWS0, which is a site on Cadiangullong Dam
– 412144, which is on Cadiangullong Creek downstream of the dam
– CAWS2, which is on Cadiangullong Creek upstream of the Cadia Extended Pit
– CAWS3, an historical mine adit

CAWS3 results were excluded from the 2019-2020 AEMR as the samples were inadvertently collected from an incorrect location. The correct surface water monitoring location was sampled from July 2020 and hence the results have been reported in this 2020-2021 AEMR.

Paper Size ISO A4

0 250 500 750

Metres

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

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Newcrest Mining Limited
CVO AEMR –
Surface Water Assessment

Cadia Hill Pit and Upper Cadiangullong Creek

Project No. **12553243**
Revision No. **0**
Date **18 Oct 2021**

FIGURE 3-1

Data source: Newcrest: Bores, 2019. LPI: DCDB/DTDB, 2017. Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. Created by: pkiem, fmackay, tmorton

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3.2.1 Physicochemical parameters

pH in Upper Cadiangullong Creek has been relatively stable in the reporting period, ranging from 6.36 to 8.26.

EC was variable at the Upper Cadiangullong Creek sites during this reporting period, with site maximums ranging between 138.3 and 1,764 µS/cm, see Figure 3.2. EC was within historical ranges at all locations. EC was elevated at CAWS3 during the reporting period ranging between 400 to 1539 µS/cm, consistent with historical ranges pre 2019-2020, which indicates seepage from the historical mine adit at the correct monitoring location.

Increased EC was seen at 412144 and CAWS2 from August to October 2020, consistent with low flows in these months. Once flows increased in late October 2020, EC results in Upper Cadiangullong Creek reduced to historical levels.

Occasionally elevated TSS concentrations have been observed at CAWS0, CAWS2 and CAWS3, though there has been no temporal trends observed, indicating that elevated TSS concentrations in Upper Cadiangullong Creek likely occur in response to rainfall.

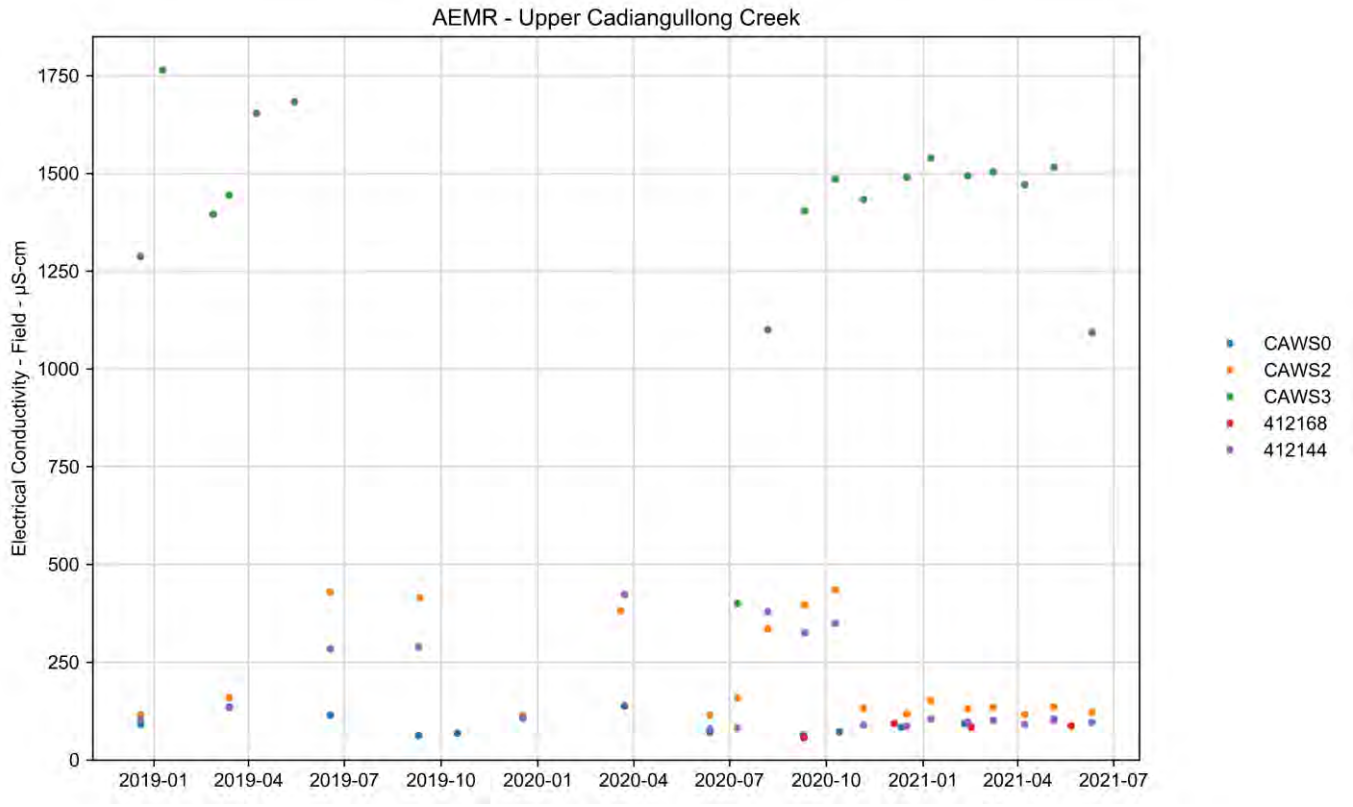

Figure 3.2 EC concentrations in the Upper Cadiangullong Creek Area

3.2.2 Nutrients

Nutrient concentrations were consistent with historical levels in Upper Cadiangullong Creek. There has been no temporal trend in nutrient concentrations observed in the Upper Cadiangullong Creek area in recent years.

A slight increase in total nitrogen and Total Kjehldahl Nitrogen (TKN) was observed at CAWS3 in June 2021, though concentrations did not exceed the ANZG (2018) default guideline for freshwaters of 0.6 mg/L.

3.2.3 Dissolved metals

Elevated aluminium concentrations have been observed at all sites, except CAWS3 during the 2020-2021 reporting period, greater than the 0.055 mg/L ANZG (2018) default toxicant guideline for freshwaters, though no trend has been observed. The elevated results are consistent with historical results. Aluminium concentrations decrease spatially upstream to downstream, suggesting the source originates from Cadiangullong Dam.

Elevated cadmium, molybdenum, nickel and zinc concentrations at CAWS3 indicates influence of seepage from the historical mine adit. All results for these analytes are within historical ranges.

Elevated copper results have been observed historically at CAWS2 and CAWS3 likely due to the influence of historic mine seepage. A decreasing trend has been observed since September 2020 at both CAWS2 and CAWS3.

A general trend of decreasing manganese is observed at Upper Cadiangullong Creek monitoring locations and remain below the ANZG (2018) default toxicant guideline for freshwaters of 1.9 mg/L following elevated historical results at 412144.

3.2.4 Summary

The water quality data for Upper Cadiangullong Creek indicate a potential impact of historical mining in the catchment. The influence of the historical mine adit seepage at CAWS3 has been evident in the reporting period with elevated cadmium, copper, molybdenum, nickel and zinc concentrations observed. There has however been no impact of the historic mine adit on the concentration of these parameters at the nearest downstream Cadiangullong Creek monitoring site (CAWS79).

3.3 Cadia Hill Pit

Operations at the Cadia Hill Pit ceased in 2012 and the pit is currently being used for tailings disposal from which water is reclaimed.

In March 2018, a failure of a section of the Northern Tailings Storage Facility (NTSF) led to a modification of the Cadia East Project Approval to allow the deposition of tailings in the Cadia Hill Pit up to 713 m AHD. Baseline pit pond chemistry and background groundwater samples were analysed to enable assessment of any potential impacts from placing tailings in the Cadia Hill Pit.

Since the start of deposition (4 May 2018) the pit decant pond level has risen by approximately 250 m and was estimated to be approximately 26 m above the settled tailings level at 30 June 2021.

The only surface water monitoring site in the Cadia Hill Pit area is CAWS65 (shown in Figure 3.1), which monitors the TSF decant pond water. This represents process water within the mine's closed process water system.

3.3.1 Physicochemical parameters

Elevated TSS concentrations (representing suspended tailings) have been observed in the pit at site CAWS65 following the deposition of tailings in the pit, with concentrations regularly exceeding 100 g/L up until June 2019. TSS concentrations have since generally reduced to concentrations less than 600 mg/L. TSS results have been variable over the 2020-2021 monitoring period, with concentrations generally remaining below 150 mg/L, reflecting low suspended tailings in the water (Figure 3.3).

EC in the pit steadily increased from approximately 2000 µS/cm to 4000 µS/cm between March and December 2019. In March 2020, EC began to decline. During the reporting period results remained relatively steady between 2,200 µS/cm and 2,800 µS/cm.

pH has typically remained pH circumneutral to slightly alkaline, between 7.6 and 8.7. This trend continued over the 2020-2021 monitoring period with the exception of two slightly acidic results of 6.5 and 6.6 pH units in September and November 2020 respectively.

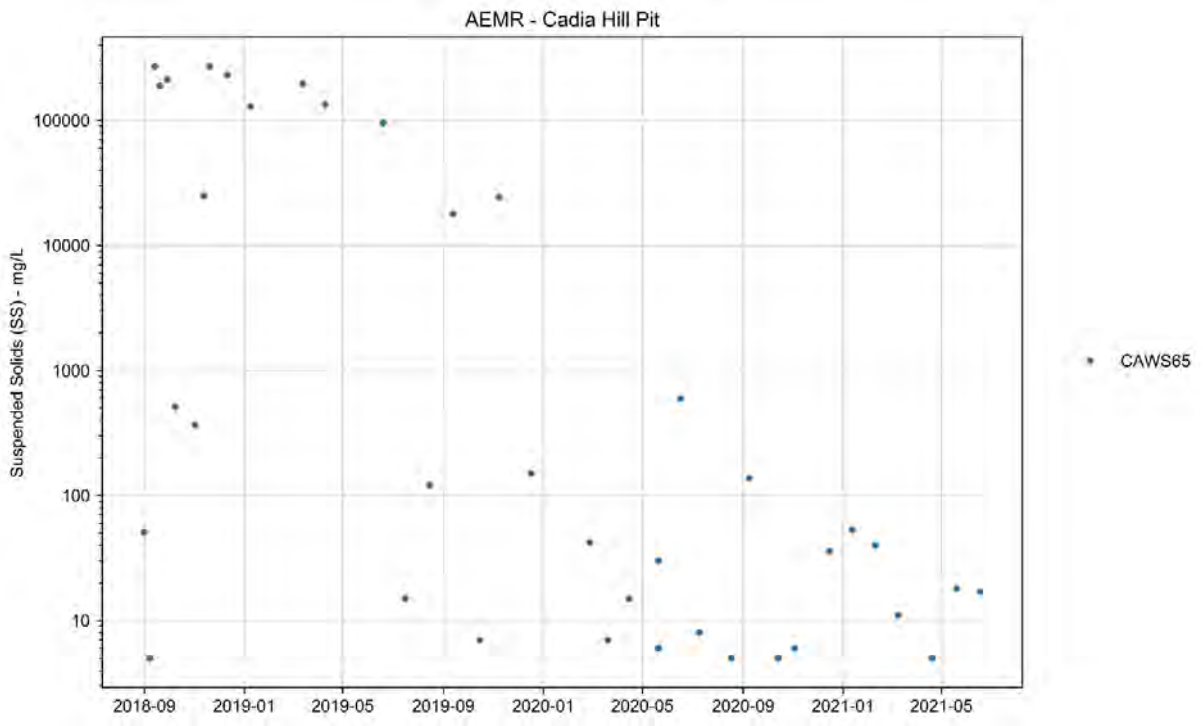

Figure 3.3 TSS concentrations in the Cadia Hill Pit Area.

3.3.2 Nutrients

Nitrogen data for CAWS65 indicates that the majority of the nitrogen present in the tailings decant water is inorganic in nature. All speciated forms of nitrogen were steady in the 2020-2021 reporting period, showing no concentration trend.

Total phosphorous concentrations were elevated at CAWS65 following the deposition of tailings in the pit in 2018. However, as with TSS concentrations, phosphorus results have since reduced, with results for the current reporting period continuing to decrease, ranging between the laboratory limit of reporting (LOR) of 0.01 mg/L and 0.24 mg/L.

3.3.3 Dissolved metals

Concentrations of all metals have been consistent across the 2020-2021 reporting period, showing similar trends over time, with no notable increasing or decreasing trend.

3.3.4 Major ion composition

Based on major ion concentrations, the water in the pit was calcium sulfate dominant prior to the deposition of tailings and this has changed to sodium sulfate dominant since deposition commenced, refer to Figure 3.4. Sodium sulfate dominance is consistent with historical Cadia tailings.

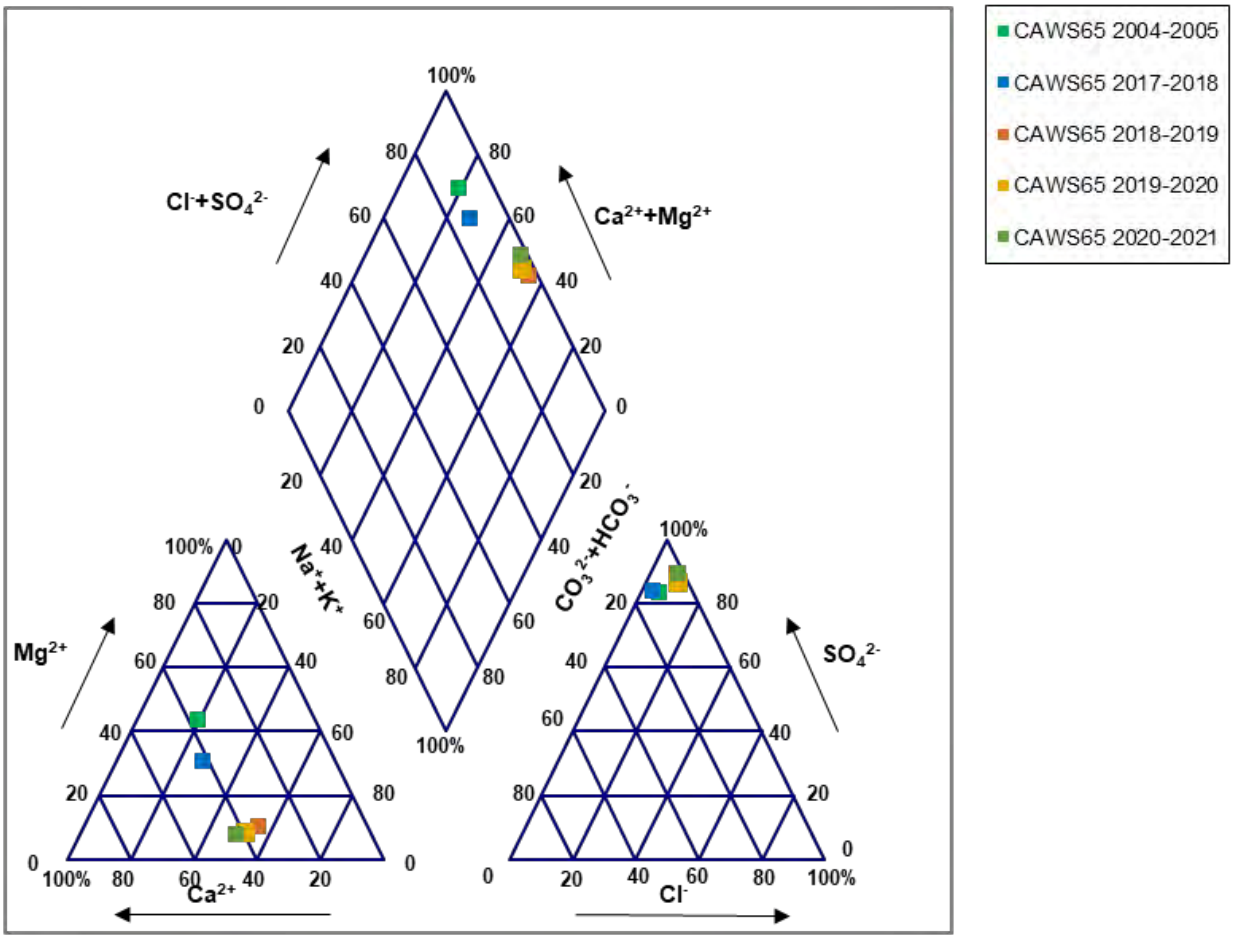

Figure 3.4 Piper chart showing differences in major ion compositions following tailings deposition

3.3.5 Summary

Water quality at CAWS65 is reflective of tailings decant water monitoring in 2020-2021, showing stable water quality over the reporting period. The water level within the PTSF remains below surface operations.

3.4 Ore processing area

The ore processing area consists of the ore crushing and treatment facilities, office areas, laydown yard, workshops, process water ponds, sediment dams and ROM pads. All runoff from this area is captured within the Site Runoff Pond (SROP).

The SROP (CAWS73) is a zero discharge stormwater runoff dam. The SROP is clay lined and captures site runoff and leakage from the processing plant. A comparison of the water at CAWS73 was made with downstream and upstream locations in Cadiangullong Creek at CAWS78 and CAWS79 respectively (previously location CAWS33).

CAWS33 was removed from the surface water monitoring program as the location would not have effectively isolated any potential influence from the Ore Processing Area. CAWS78 (impact monitoring location) and CAWS79 (background monitoring location) were introduced to assess the quality of water in Cadiangullong Creek prior to the reach of influence, and immediately downstream of the zone of influence. Historical CAWS33 results are provided for trend analysis context with the new monitoring locations.

Paper Size ISO A4

0 50 100 150 200 250

Metres

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

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Surface Water Assessment

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Date **18 Oct 2021**

Ore Processing Area

FIGURE 3-5

Data source: Newcrest: Bores, 2019. LPI: DCDB/DTDB, 2017. Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. Created by: pkiem, fmackay, tmorton

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3.4.1 Physicochemical parameters

EC results for CAWS73 range between 908 and 1,560 µS/cm. CAWS79 and CAWS78 range between 117 and 829 µS/cm during the reporting period, which is similar to historical CAWS33 results. EC is higher at CAWS73 due to it being a sediment dam that experiences greater evaporation and is influenced by runoff from the ore processing area, in comparison to CAWS79 and CAWS78 which are surface water monitoring locations on Cadiangullong Creek. EC levels at CAWS79 and CAWS78 remained steady, with a slightly elevated concentration observed at CAWS78 due to the unlicensed discharge introducing saline water upstream of this location on 21 January 2021 (refer to Section 3.1 for further information). EC levels returned results consistently less than 300 µS/cm for the remainder of the 2020-2021 reporting period.

TSS concentrations at CAWS78 and CAWS79 have remained low throughout the period of monitoring, with a maximum of 23 mg/L recorded at CAWS79 in January 2021. TSS concentrations at CAWS73 have been more variable, ranging between 22 and 216 mg/L in the dataset, though no trend has been observed. Variable TSS results are expected at CAWS73 as the location is where all runoff from the ore processing area is captured.

pH results for all sites remain steady, trending in the pH circumneutral range for CAWS78 and CAWS79, and slightly alkaline at CAWS73.

3.4.2 Nutrients

Elevated nitrogen concentrations have been regularly observed at CAWS73, as shown Figure 3.6. Nitrogen oxides have been the dominant form of nitrogen observed at CAWS73. Concentrations of nitrogen oxides were observed to be generally decreasing from 2011 to late 2018. Since that time nitrogen oxide concentrations have shown variable results, likely due to the dilution effect of rainfall runoff at CAWS73.

No similar trend was observed in total phosphorous concentrations at CAWS73. No trend in nutrient concentrations at CAWS 78 and CAWS79 has been observed across the period of monitoring.

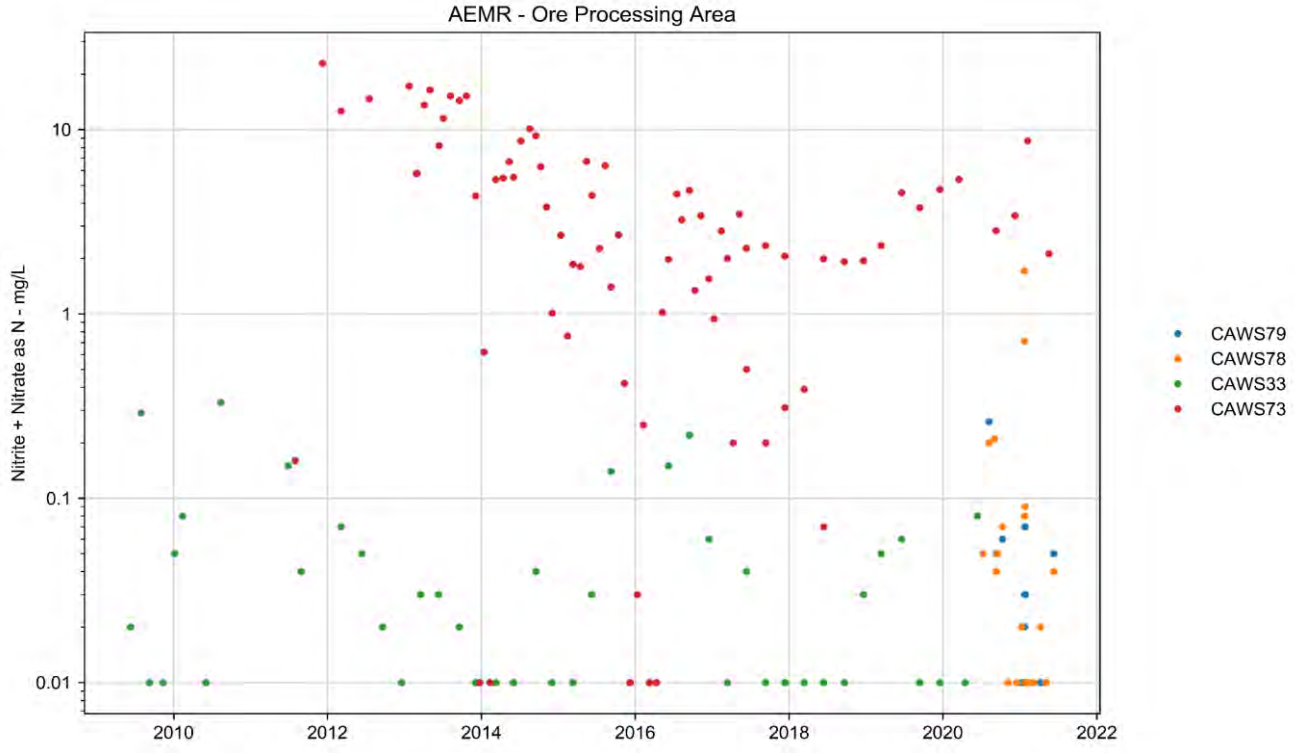

Figure 3.6 Nitrogen oxides concentrations in the Ore Processing Area

3.4.3 Dissolved metals

CAWS78 showed minor increases in dissolved metals; aluminium, cobalt, copper, iron, and manganese following the unlicensed discharge in January 2021. Results at the nearest downstream monitoring location of 412161 showed concentrations of these dissolved metals within historical ranges. Following this event, concentrations returned to historical levels in subsequent monitoring events. Refer to Section 3.1 for further information.

Dissolved aluminium concentrations have been occasionally elevated at CAWS78 and CAWS79, likely indicative of the influence of local soils and lithology, as similar aluminium concentrations have been observed at upstream Cadiangullong Creek monitoring sites CAWS2 and 412144.

3.4.4 Major ion composition

Decreasing trends in the concentrations of major cations sodium, magnesium, calcium and potassium have been observed at all Ore Processing Area monitoring locations over the 2020-2021 reporting period. This is likely due to above average rainfall resulting in dilution at these locations.

3.4.5 Summary

CAWS73 (the SROP) showed variable concentrations of nitrogen oxides in the 2020-2021 reporting period. No elevated nitrogen oxide results have been observed at the impact monitoring location CAWS78, with results here comparable to background monitoring at CAWS79.

Dissolved metal concentrations and major cations generally showed decreasing trends at all sites which are likely associated with increased rainfall in the period, causing a dilution effect.

Short-duration changes in water quality were evident from the unlicensed discharge at CAWS78 with select dissolved metals and EC showing a brief increase in concentrations. This increase subsided in subsequent monitoring events, back to historical levels. GHD 2021a concluded that the discharge did not pose a risk to aquatic ecosystems, due to concentrations in the waterways remaining below relevant guidelines. No influence on Cadiangullong Creek by runoff from the Ore Processing Area was evident between upstream (CAWS79) and downstream (CAWS78) monitoring locations.

3.5 Waste rock dumps

The Southern Waste Rock Dumps (SWRDs) are drained by the Northern Leachate Dam (CAWS34), Southern Leachate Dam (CAWS35), H19 Sediment Dam (CAWS37) and Rodds Creek Dam (CAWS52). The waste rock dumps have been partially rehabilitated. Note that waste rock dump leachate dams are operated as zero-discharge water storages and Rodds Creek dam is a mixed water storage that receives river water extracted under licence and rainfall runoff from mine areas.

The nearest downstream Cadiangullong Creek site is 412161, which is the potential receptor for any impact of the SWRDs on surface water quality (Figure 3.7).

Paper Size ISO A4

0 150 300 450 600

Metres

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

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Project No. **12553243**
Revision No. **0**
Date **18 Oct 2021**

Waste Rock Dumps

FIGURE 3-7

Data source: Newcrest: Bores, 2019. LPI: DCDB/DTDB, 2017. Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. Created by: pkiem, fmackay, tmorton

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3.5.1 Physicochemical parameters

The pH of the monitoring all sites is generally in the pH circumneutral range.

The salinity of the waste rock dump leachate at CAWS34 and CAWS35 is in the brackish to slightly saline range, with EC values regularly exceeding 3,000 µS/cm. EC at CAWS52 has recently showed a decreasing trend in 2020-2021 with above average rainfall following a period of increasing EC in 2019-2020 attributed to drought conditions (see Figure 3.8). A similar trend of decreasing EC was observed at the downstream impact location 412161 through the reporting period.

No trends were observed in the TSS concentrations at CAWS34 and CAWS35, which is to be expected as the leachate is not likely to carry suspended solids into the surface water in the leachate dams.

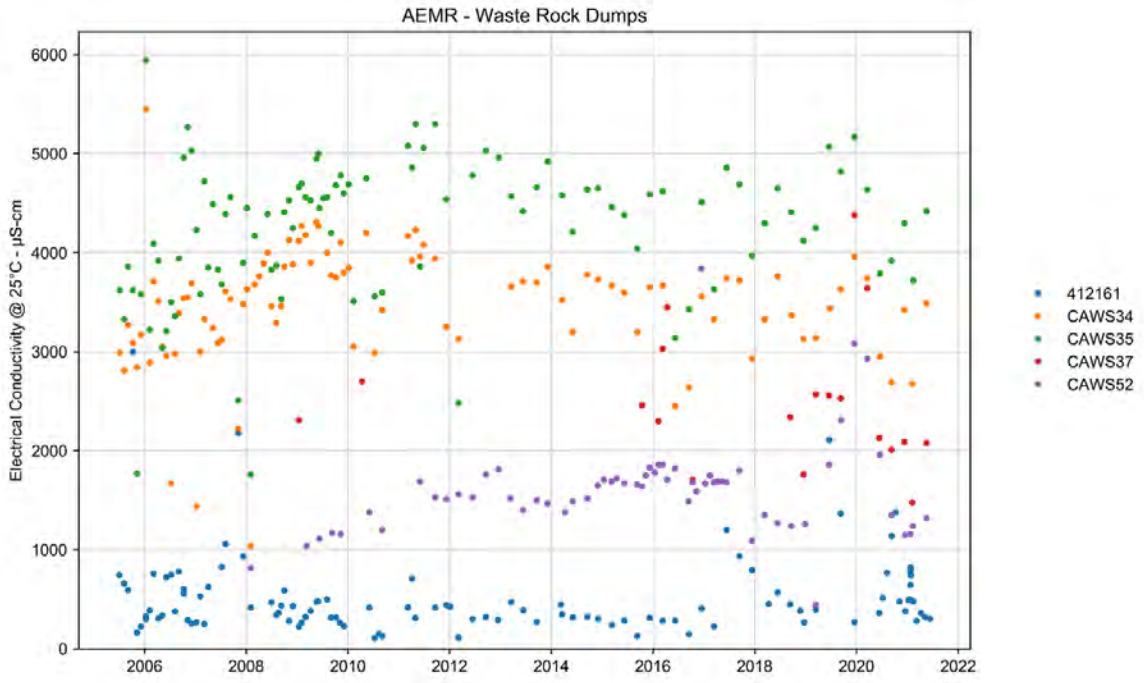


Figure 3.8 Electrical conductivity in the waste rock dumps area

3.5.2 Nutrients

The waste rock dump leachate contains very high concentrations of nitrogen oxides, as shown in Figure 3.9 These concentrations are associated with the WRDs and have generally been higher at CAWS35 than at CAWS34. The nitrogen oxide concentrations have been decreasing gradually over time and are now commonly below 50 mg/L in both leachate dams. Inspection of the available data indicates that nitrate is the dominant nitrogen species in the leachate. At the downstream Cadiangullong Creek monitoring site 412161, nitrogen oxide concentrations are more variable and occasionally exceed the ANZG (2018) default guideline for freshwaters of 0.6 mg/L. Upon comparison of total Kjehldahl nitrogen to nitrogen oxides at 412161, there is more influence of organic nitrogen species at 412161 then is evident at WRD runoff storages CAWS35 and CAWS34. This suggests that agricultural runoff nutrient inputs to Cadiangullong Creek are influencing variable elevated nitrogen levels at 412161. A decreasing long-term trend in nitrogen oxide concentrations has also been observed at Rodds Creek Dam (CAWS52)

Total phosphorous concentrations do not appear to be impacted by the leachate, as concentrations at CAWS34 and CAWS35 are similar to those observed at upstream and downstream sites on Cadiangullong Creek, and no temporal trend has been observed.

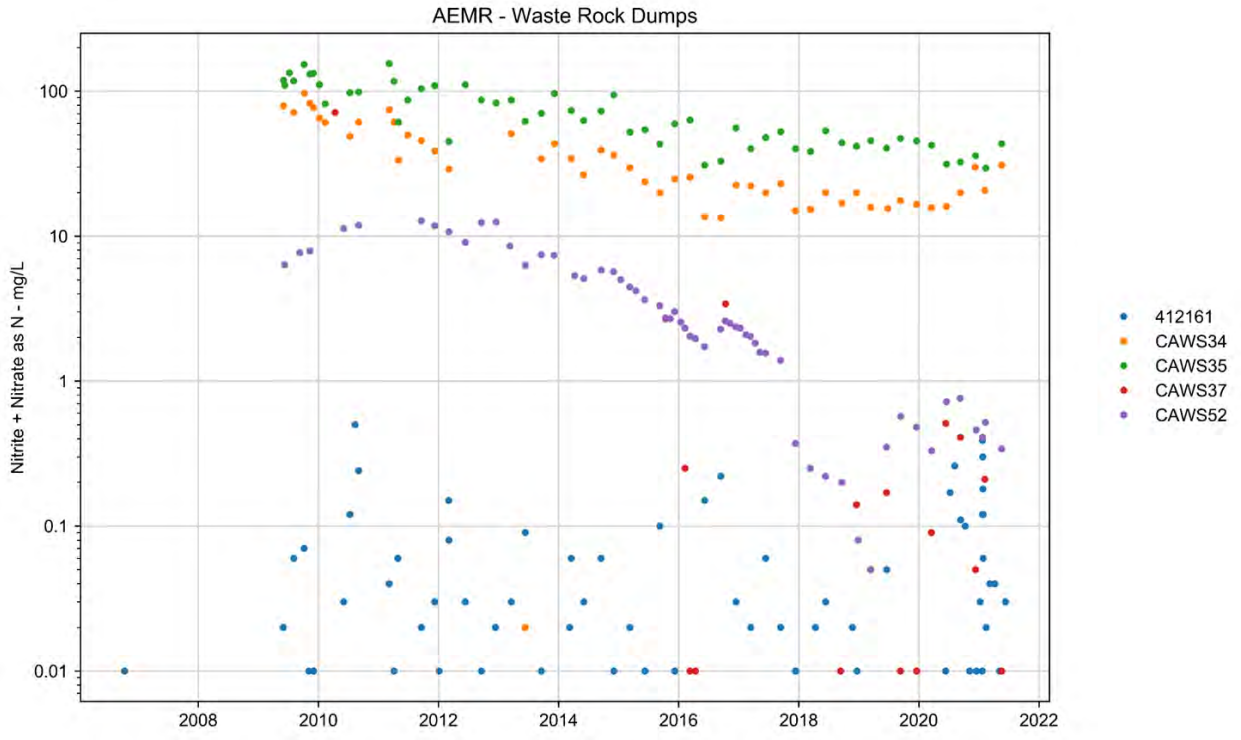


Figure 3.9 *Nitrogen oxide concentrations in the waste rock dumps area*

3.5.3 Dissolved metals

Elevated concentrations of many metals have been observed at CAWS34 and CAWS35, which are attributable to the water having leached through waste rock. These metals are cadmium, cobalt, copper, manganese, nickel, selenium and zinc; concentrations of each have generally been higher at CAWS34. The concentrations of these metals have been generally decreasing over time. Elevated copper, generally exceeding the ANZG (2018) default toxicant guideline for freshwaters of 0.0014 mg/L, is also seen in the Cadiangullong downstream monitoring site 412161 consistent with upstream concentrations in the creek system and not indicating an impact from the WRDs.

Molybdenum (Figure 3.10), has remained steady at CAWS35, however there is some sinuosity suggesting an annual cycle (i.e. diluted in winter months of higher rainfall). Molybdenum concentrations have been higher at CAWS52 than at the leachate dams which, considering that molybdenum is associated with the ore mined at Cadia, indicates the influence of tailings decant water pumped to Rodds Creek Dam from the NTSF in times of increased rainfall. The CAWS52 molybdenum results have historically shown an increasing trend since monitoring records began, however 2020-2021 results show variable results within the historical range. Molybdenum concentrations at 412161 are below the ANZG (2018) default toxicant guideline for freshwaters of 0.034 mg/L.

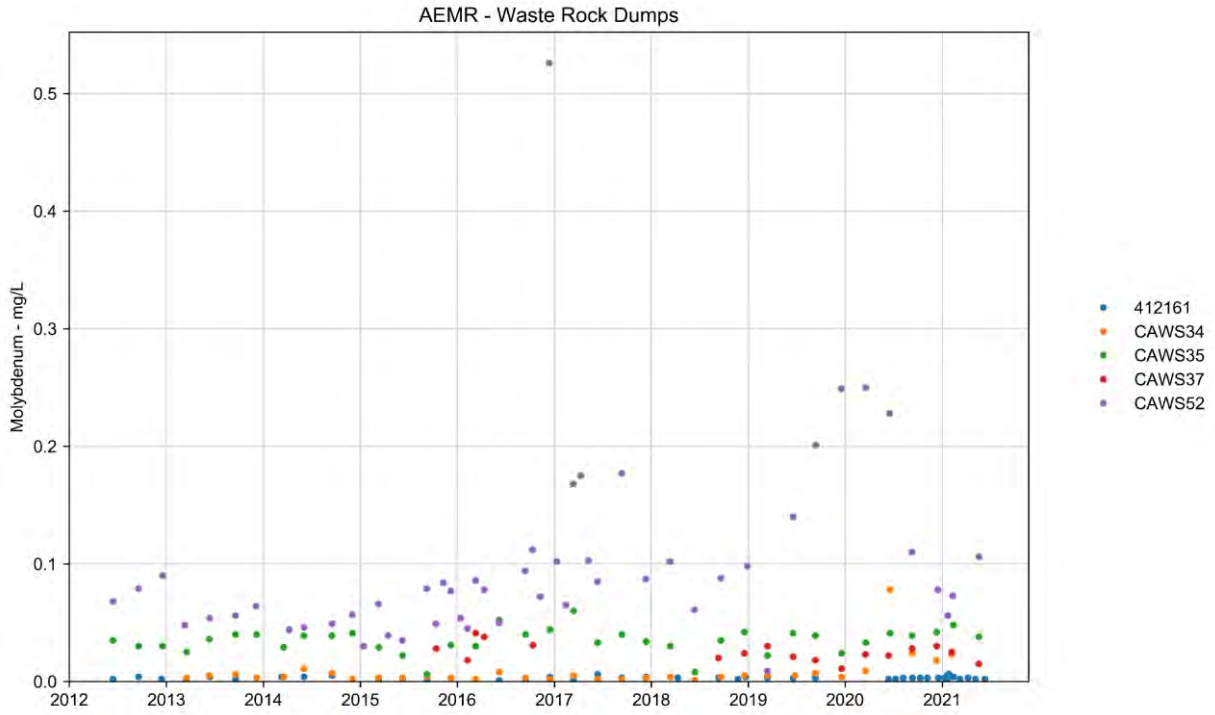


Figure 3.10 Molybdenum concentrations in the waste rock dumps area

3.5.4 Major ion composition

Average major ion (calcium, magnesium, sodium, potassium, chloride, bicarbonate and sulfate) concentrations at CAWS34, CAWS35, CAWS52 and 412161 using all available historical data for each site was used to create the Piper chart presented as Figure 3.11. The Piper chart shows that the waste rock dump leachate is not ionically similar to the water in Cadiangullong Creek at 412161, which indicates that there has been no significant influence of the leachate on the creek between 1994 and 2021.

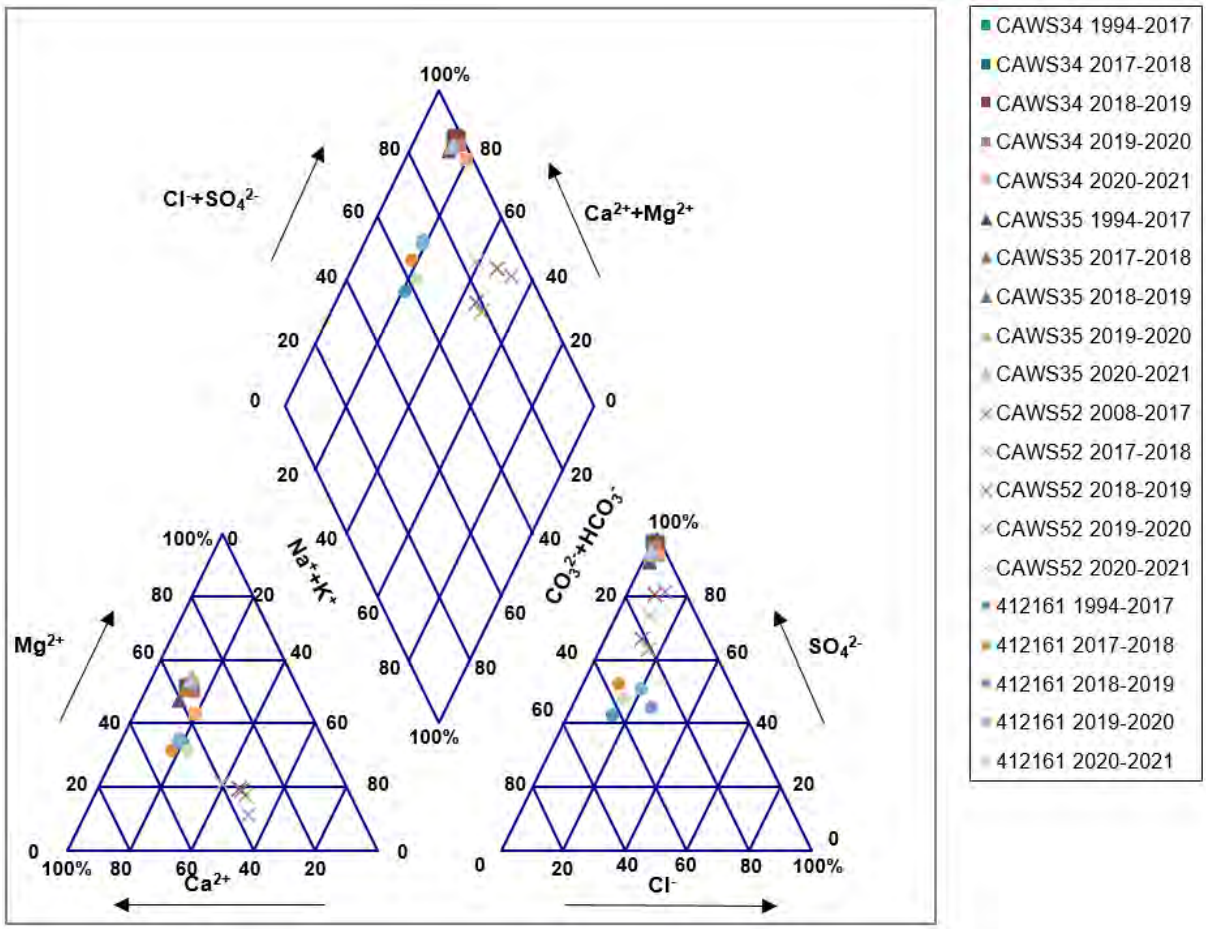


Figure 3.11 Piper chart showing differences in major ion compositions at CAWS34, CAWS35, CAWS52 and 412161

3.5.5 Summary

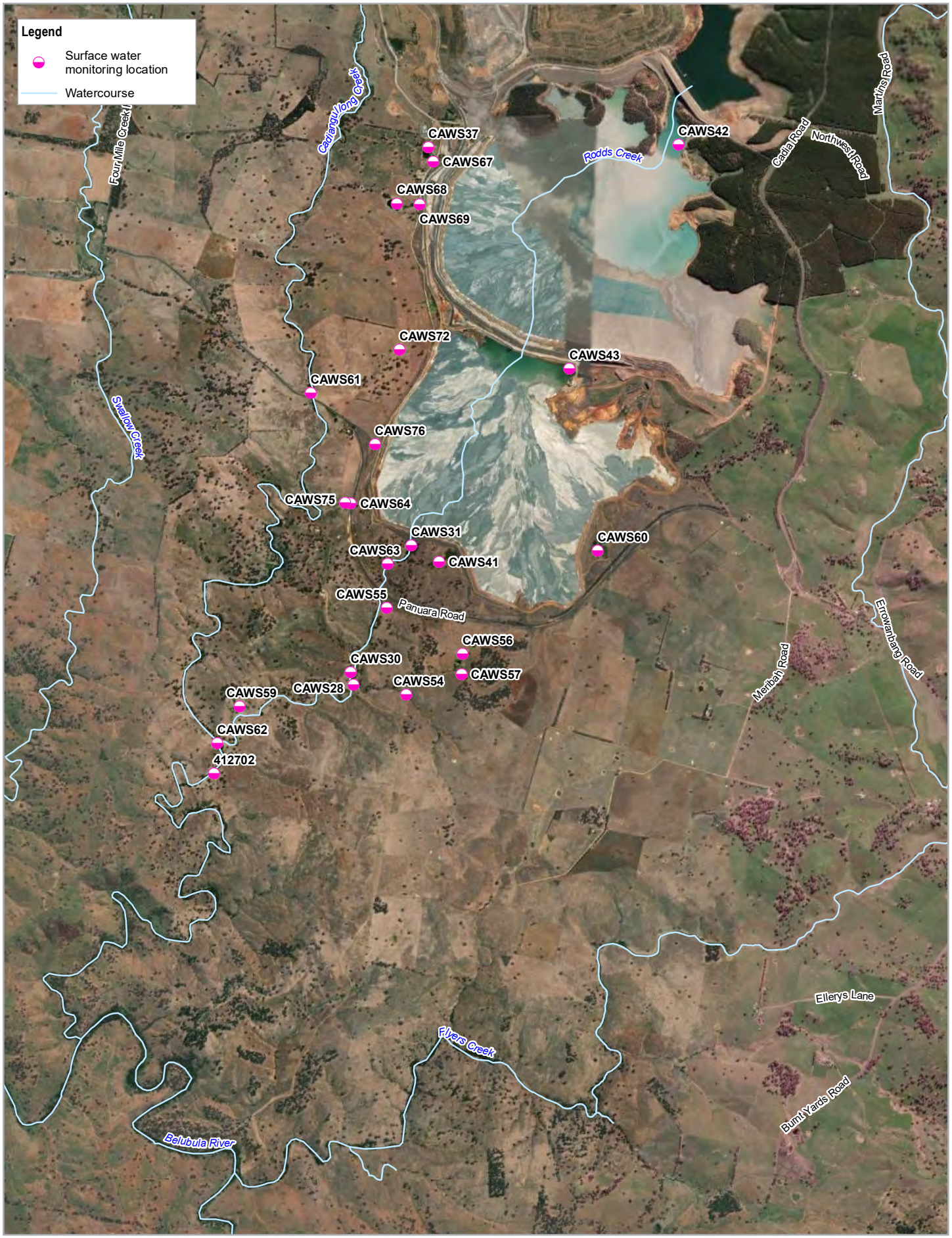
There were instances of elevated dissolved molybdenum concentrations at Rodds Creek Dam (CAWS52) over the reporting period. Downstream monitoring results show no influence of waste rock leachate on Cadiangullong Creek water quality.

ANZG (2018) exceedances of nitrogen oxides at 412161 were observed in the reporting period, though are likely influenced by agricultural inputs given the interrogation of nitrogen species.

3.6 Tailings storage facilities

CHPL monitors seepage, surface water and groundwater around the STSF and NTSF to assess potential impacts on surface water and groundwater from tailings deposition.

The NTSF commenced in 1998 and the STSF in 2002. The NTSF wall slumped on 9 March 2018, and tailings deposition in the NTSF has since ceased, with tailings placed in the Cadia Hill Pit and STSF since this time.



Paper Size ISO A4

0 500 1,000 1,500

Metres

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

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GHD

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Surface Water Assessment

Project No.	**12553243**
Revision No.	**0**
Date	**18 Oct 2021**

Tailings Storage Facilities

FIGURE 3-12

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Print date: 18 Oct 2021 - 10:14

Data source: Newcrest: Bores, 2019. LPI: DCDB/DTDB, 2017. Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. Created by: pkiem, fmackay, tmorton

3.6.1 TSF Eastern Zone

Surface water is monitored at the following sites within the TSF eastern zone:

– CAWS60 – Dyke Pond east of the Southern TSF to assess potential for seepage contributions
– CAWS42 – Monitor development of Northern TSF decant water quality
– CAWS43 – Monitor development of Southern TSF decant water quality

Physicochemical parameters

No temporal trends were observed in the pH or EC of the tailings decant pond water (CAWS42 and CAWS43) and the dyke pond (CAWS60). All sites generally have an EC of over 1,500 µS/cm, with CAWS60 having the lowest EC.

Water at all sites is slightly alkaline. There were no trends observed in suspended solids concentrations in the TSF eastern zone.

Nutrients

Nitrogen oxide concentrations in the decant pond water have generally decreased across the period of monitoring and have remained below 5 mg/L since March 2015 (refer Figure 3.13). CAWS60 has been monitored since November 2015 and has generally had low nitrogen oxide concentrations which is one line of evidence indicating that it is not influenced by tailings decant water. Total nitrogen concentrations have followed a similar trend to that of nitrogen oxides indicating that NOx is the dominant form of nitrogen at the eastern TSF zone.

Total phosphorous concentrations have been more variable, and CAWS60 has generally had higher concentrations than CAWS42 and CAWS43 during the period of monitoring (refer Figure 3.14). This likely reflects the influence of surrounding land use, such as agriculture runoff to the dyke pond.

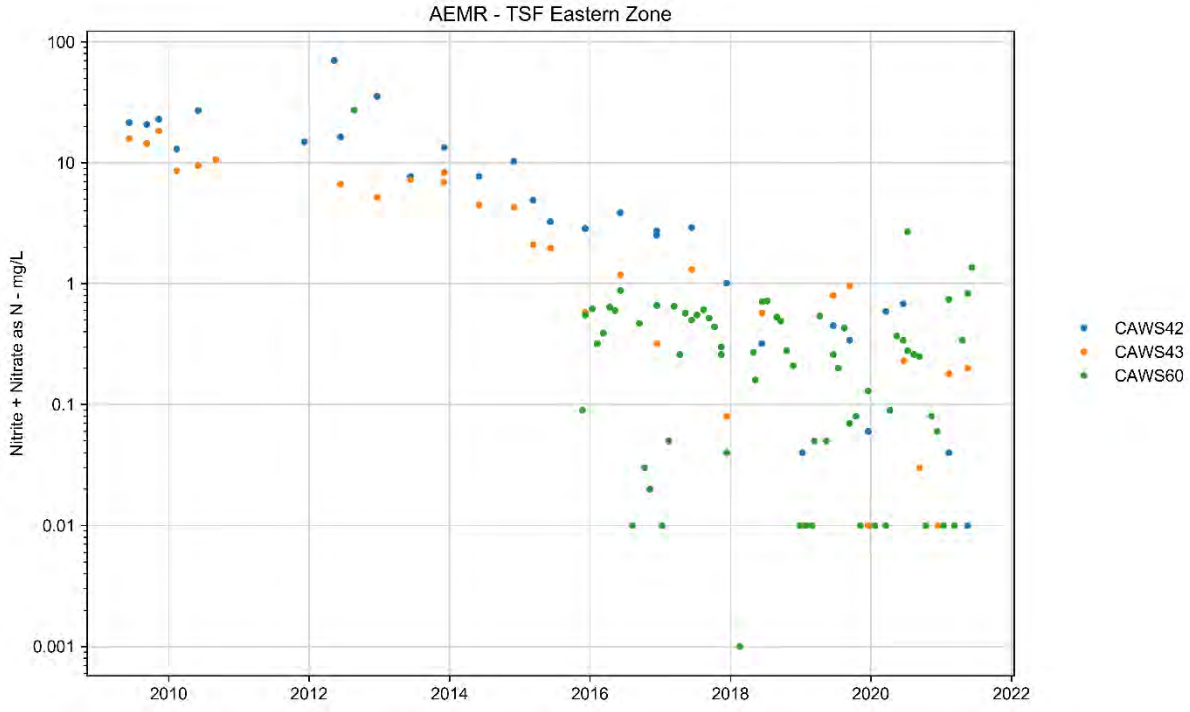

Figure 3.13 Nitrogen oxides concentrations in the TSF eastern zone

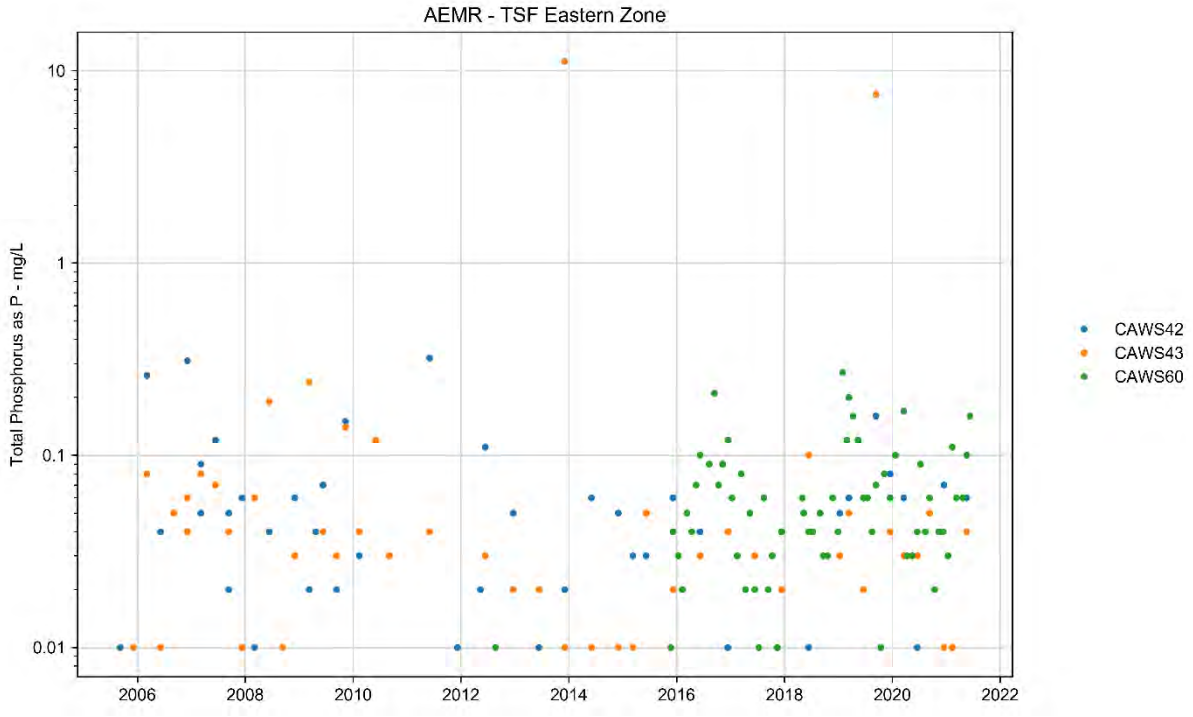

Figure 3.14 Total phosphorous concentrations in the TSF eastern zone

Dissolved metals

There were no trends evident in dissolved metal concentrations in the TSF eastern zone with the exception of dissolved copper at CAWS42 slightly increasing over the 2020-2021 reporting period. Such a trend is not apparent at CAWS31, which is designed to capture potential seepage from the STSF. Downstream of this is Rodds Creek (CAWS63) which regularly reports dissolved copper result less than the LOR.

Elevated molybdenum concentrations have been recorded at CAWS42 and CAWS43 which is typical of tailings associated with the ore mined at Cadia (refer to Figure 3.15). Downstream at CAWS31, molybdenum concentrations are slightly higher than surrounding surface water monitoring points, but at concentrations below the ANZG (2018) default toxicant guideline for freshwaters of 0.034 mg/L therefore these are not of concern. A decreasing trend has been observed in the data at CAWS43 in recent times.

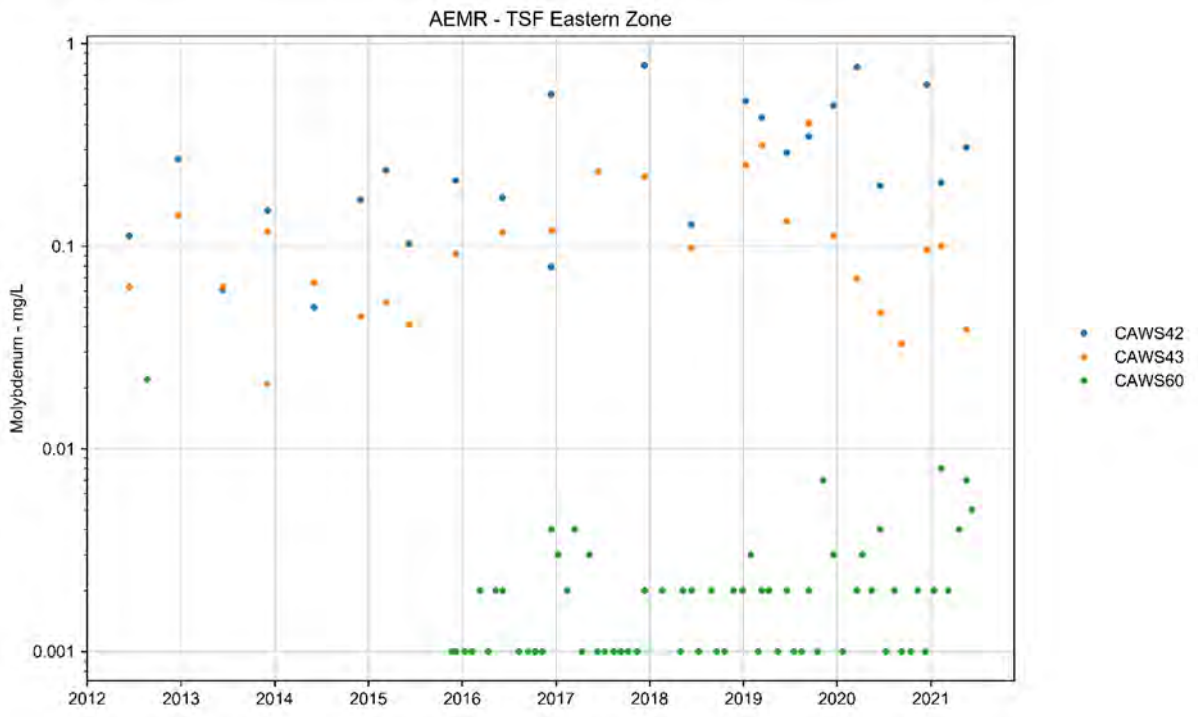

Figure 3.15 Molybdenum concentrations in the TSF eastern zone

Major ion composition

Average major ion (calcium, magnesium, sodium, potassium, chloride, bicarbonate and sulfate) concentrations at CAWS42, CAWS43 and CAWS60 using all available historical data were used to create the Piper chart presented as Figure 3.16. The Piper chart shows that tailings decant pond water is ionically dissimilar from the dyke pond, and that there has been no substantial change in ionic chemistry at any of these sites over the period of monitoring. TSF decant water is sodium sulfate dominant.

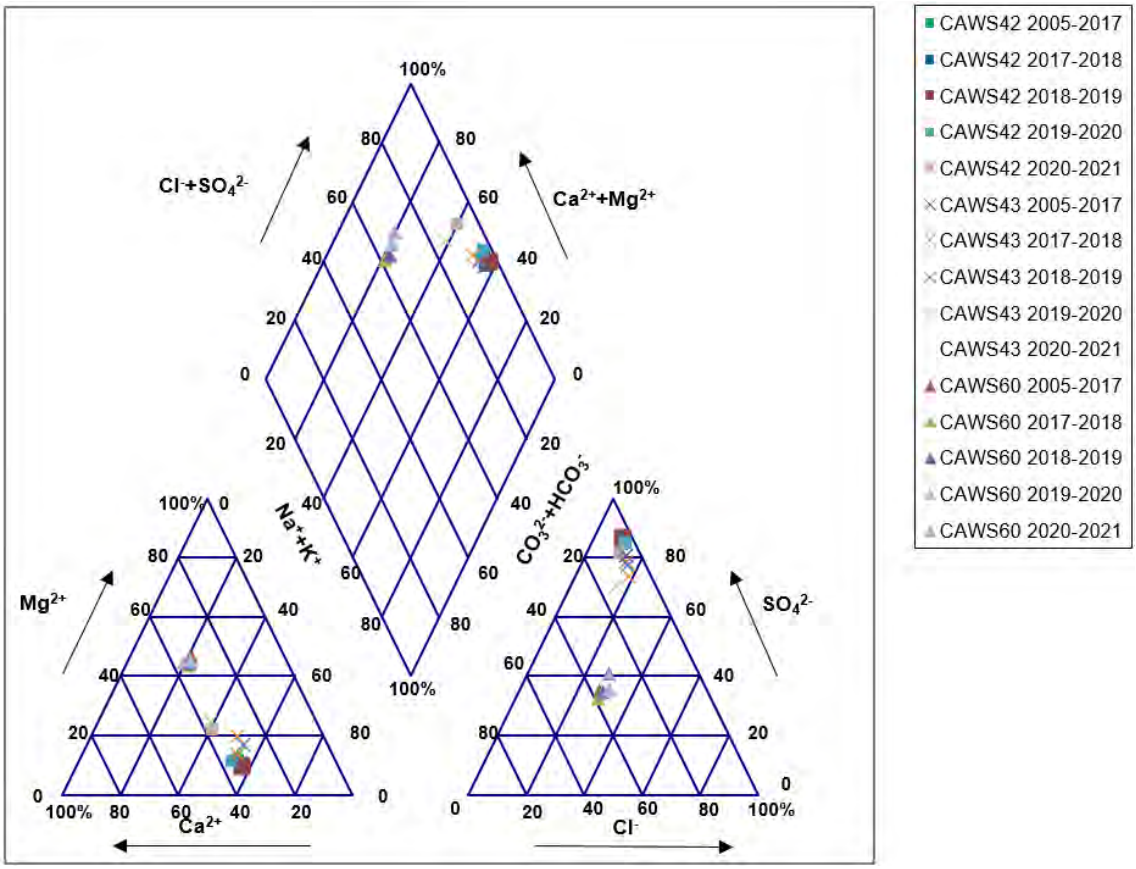

Figure 3.16 Piper chart showing differences in major ion composition in the TSF eastern zone in the reporting period

Summary

Comparison of the major ion compositions of the TSF eastern zone sites indicated that there is no apparent influence of the decant ponds on surface water in the dyke pond, noting that the dyke pond is part of the mine's internal water system and cannot discharge off site due to its location.

Dissolved molybdenum concentrations have generally increased since 2016 in the NTSF (CAWS42) and STSF (CAWS43) decant surface water monitoring sites. A somewhat similar trend is seen downstream at CAWS31 where molybdenum concentrations have shown an increase over this period. However, molybdenum concentrations at CAWS31 are less than the ANZG 2018 default toxicant guideline for freshwaters of 0.034 mg/L and currently does not pose a further risk to downstream receiving waters.

3.6.2 TSF Western Zone

Surface water is monitored at the following sites in TSF western zone:

– Watercourses: CAWS61, CAWS62.
– Surface water storages: CAWS64, CAWS67, CAWS68, CAWS69, CAWS72, CAWS75, CAWS76.

Physicochemical parameters

pH at the TSF western zone sites has been stable in the reporting period and has generally been pH circumneutral to slightly alkaline.

EC has generally decreased over the 2020-2021 reporting period due to above average rainfall resulting in dilution of flows, as shown in Figure 3.17.

TSS concentrations in the TSF western zone have been variable.

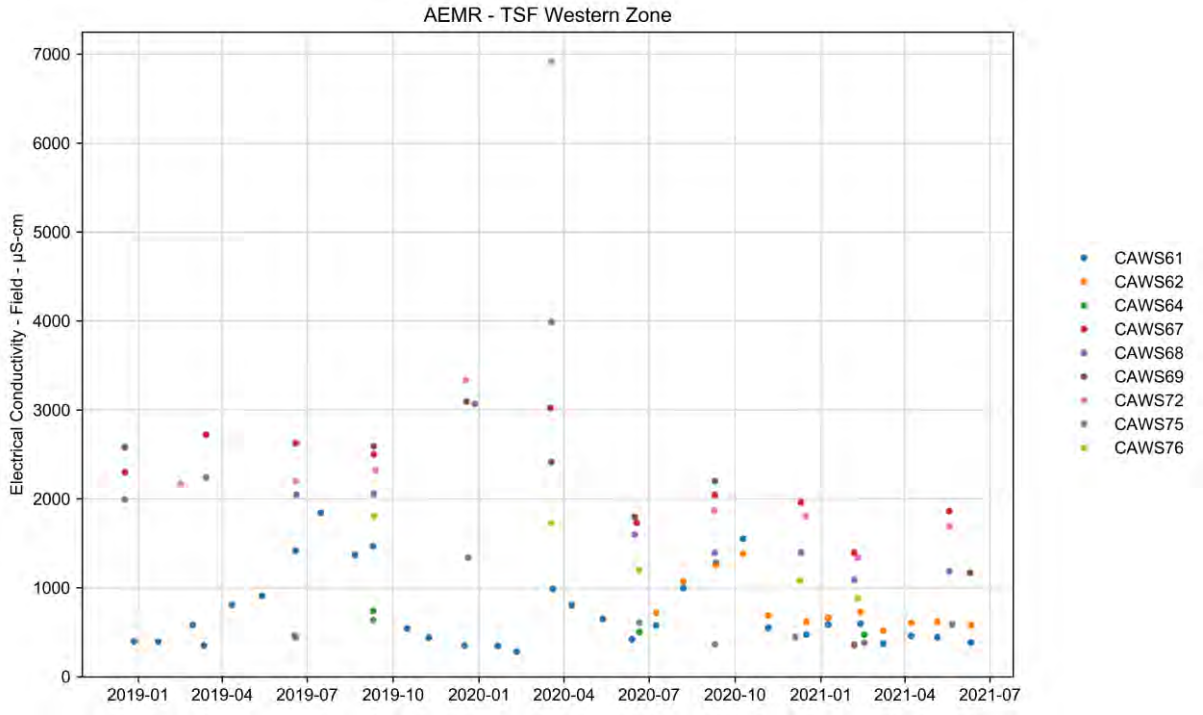

Figure 3.17 EC at TSF western zone sites

Nutrients

Elevated total nitrogen concentrations at CAWS37, CAWS64, CAWS68, CAWS69, CAWS72, CAWS75 and CAWS76 have been recorded both historically and in the 2020-2021 reporting period. The total nitrogen is mainly comprised of organic nitrogen as indicated by the elevated total Kjehldahl nitrogen in Figure 3.18. The highest concentrations typically are observed in the summer months, which might be showing nutrient concentrating from evapotranspiration and surrounding agricultural inputs to the CAWS75 storage. It appears this effect is localised to storages in the TSF western zone as no downstream impact of elevated total Kjehldahl Nitrogen is seen at the Cadiangullong Creek monitoring sites, CAWS61 and CAWS62.

A similar trend in total phosphorus is observed for the same TSF western zone storages as is seen for total nitrogen.

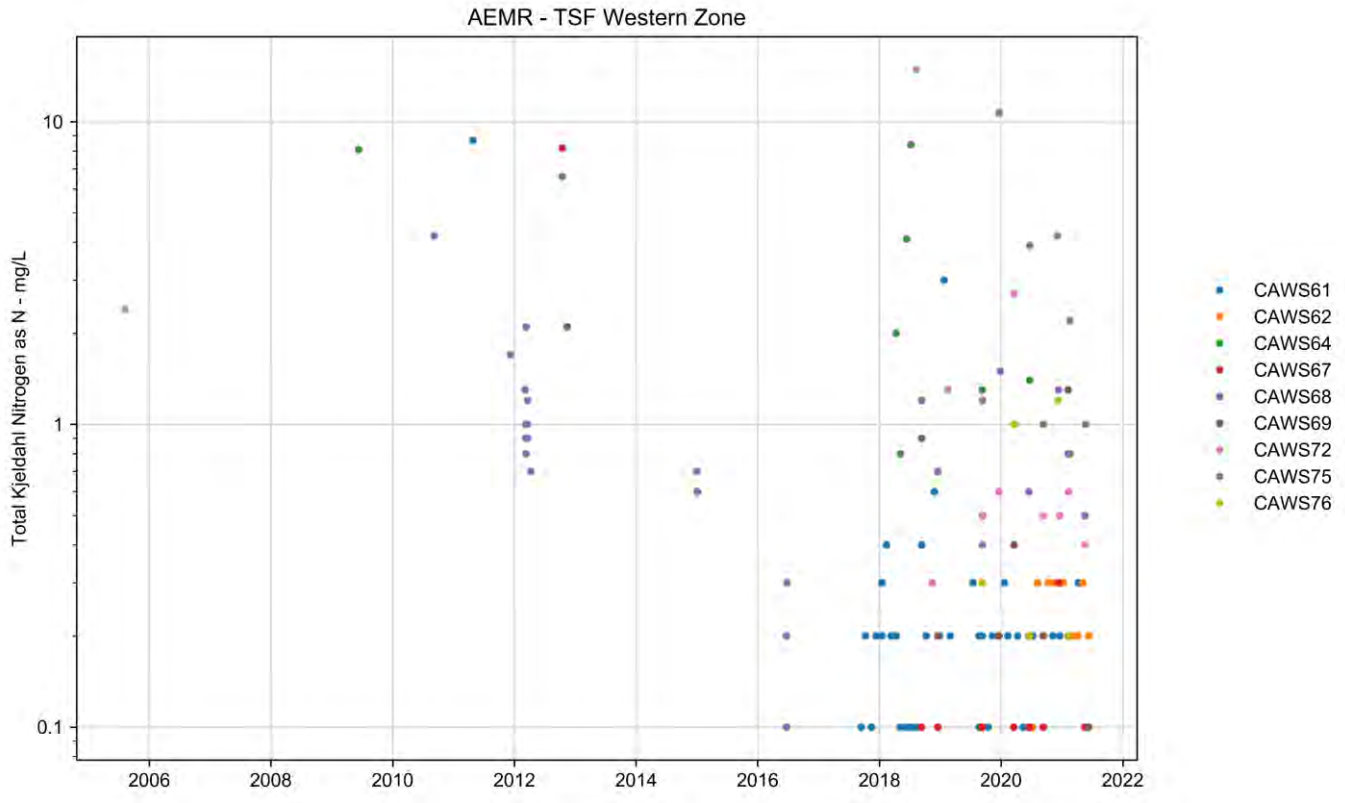

Figure 3.18 Total Kjeldahl Nitrogen as N concentrations at TSF Western Zone Area

Dissolved metals

Scattered elevated copper results have been observed at all TSF western zone monitoring locations, however concentrations are less than upstream levels influenced by historical mine seepages.

Similar to copper, historical scattered elevated manganese concentrations have been observed at all locations for the 2020-2021 reporting period, though these concentrations have remained below the ANZG 2018 default toxicant guideline for freshwaters of 1.9 mg/L. Manganese has generally shown a decreasing trend since late 2019.

Molybdenum concentrations at sites CAWS67, CAWS68, CAWS69 and CAWS76 have been elevated both historically and over the 2020-2021 reporting period compared to other sites within the TSF western zone (Figure 3.19), though results are within the historical range. Considering the consistently elevated molybdenum concentrations in TSF decant water and WRD leachate, these elevated levels indicate possible surface water drainage/runoff from the TSF embankments, which are made from non-acid forming (NAF) waste rock. No trend in molybdenum concentrations during the reporting period was evident however, indicating that the degree of the NAF waste rock runoff influence has not increased during the reporting period. Furthermore, molybdenum concentrations remain low at CAWS61 (the downstream Cadiangullong Creek indicator for any seepages in the western TSF area) with results < 0.005 mg/L, well below the ANZG 2018 default toxicant guideline for freshwaters of 0.034 mg/L. Therefore there is no inferred surface water contamination impact from the TSF western zone on the receiving watercourse.

A single elevated zinc result (0.085 mg/L) was observed at CAWS69 during the 2020-2021 reporting period; however no trend was evident at this location and this value is considered an outlier.

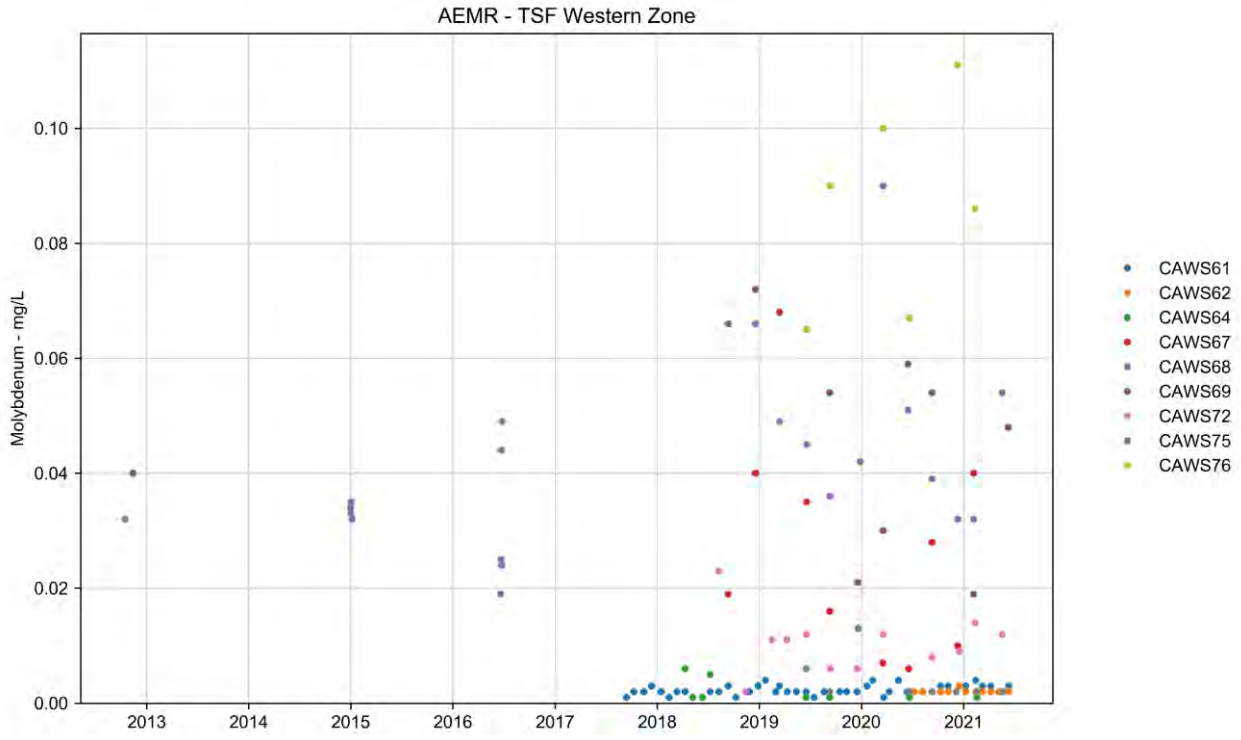

Figure 3.19 Dissolved molybdenum concentrations at TSF western zone sites

Major ion composition

Average major ion concentrations at each of the TSF western zone sites for the reporting period were used to create the Piper chart presented as Figure 3.20. The Piper chart indicates some possible influence from the waste rock embankments on the sediment dams at CAWS68, CAWS69 and CAWS72. This is as a result of elevated sulfate concentrations. It is noted in previous AEMR's that the groundwater in the area is naturally elevated in sulfate and there is dissimilarity between the major cation chemistry of the surface water seepages and TSF decant water, therefore it is unlikely that there is influence of TSF seepage on CAWS68, CAWS69 and CAWS72.

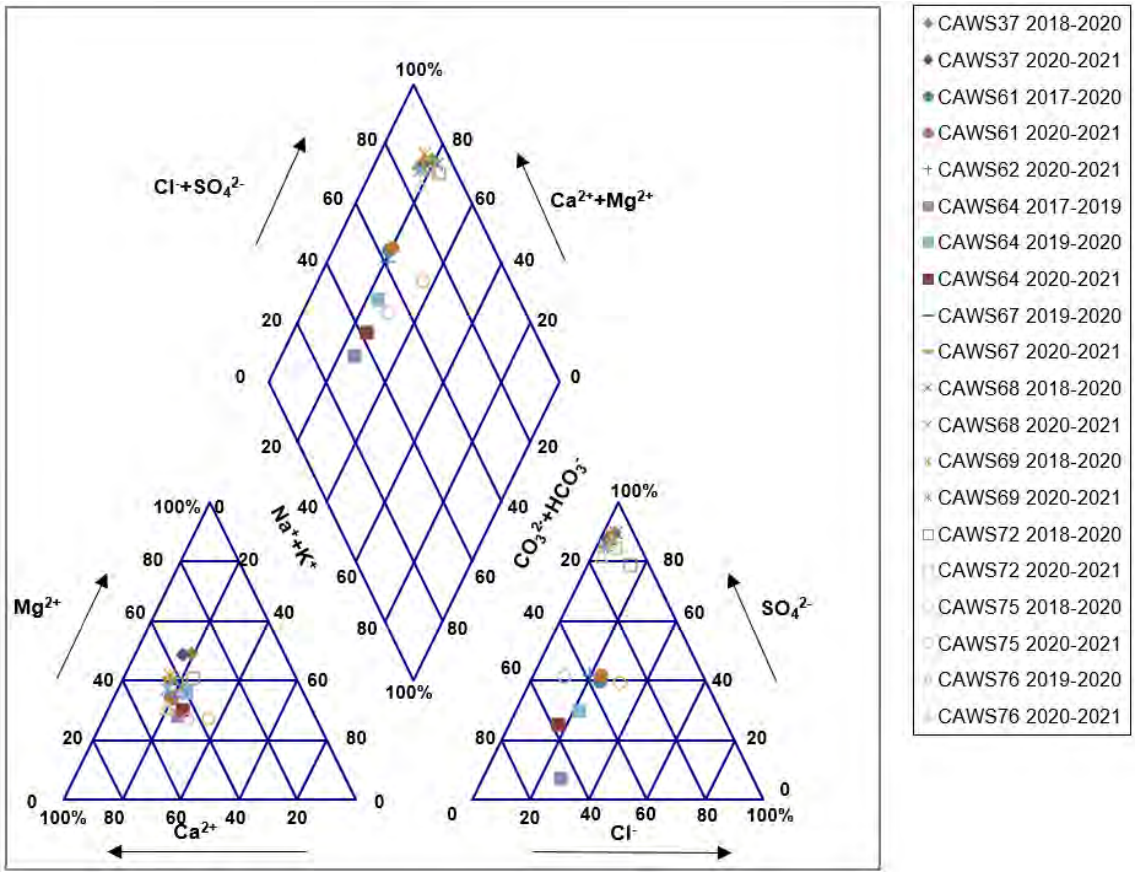

Figure 3.20 Piper chart showing differences in major ion composition in the TSF western zone in the reporting period

Summary

Surface water monitoring sites showed many instances of elevated dissolved metals during the reporting period with sporadic elevated concentrations of copper, manganese, molybdenum, and zinc. Molybdenum concentrations at sites CAWS67, CAWS68, CAWS69 and CAWS76 have been elevated compared to other sites within the TSF western zone which is potentially sourced from TSF and waste rock embankments. However, there is no indication of elevated molybdenum concentrations at CAWS61 on Cadiangullong Creek which is the nearest downstream receptor for any potential water quality impact from the western zone of the TSFs.

Overall, while it appears that there is an influence of waste rock runoff/drainage from TSF embankments at a seepage monitoring location and two dams to the west of the TSFs, this influence appears to be limited spatially, and to fully contained surface water bodies from which water is recovered for re-use. Therefore, the TSFs are not having an adverse impact on the receiving watercourse in the western zone.

3.6.3 TSF Southern Zone

Surface water is monitored at the following sites within the TSF southern zone:

– Watercourses: CAWS28, CAWS30, CAWS55, CAWS59, CAWS63, 412702.
– Surface water storages: CAWS31, CAWS41, CAWS54, CAWS56, CAWS57.

Physicochemical parameters

pH has been stable in the TSF southern zone, with all observations for the reporting period indicating circumneutral to slightly alkaline water.

EC values have been relatively stable in the TSF southern zone, ranging from about 500 µS/cm at site 412702, to about 4,000 µS/cm at CAWS57. EC across all southern TSF sites has generally shown a slight decreasing trend over the reporting period, likely from above average rainfall having dilution effects on surface water salinity.

There were no temporal trends in TSS observed for the TSF southern zone. The highest TSS concentrations were reported in a tributary of Rodds Creek at CAWS57 and is likely associated with livestock accessing the pond.

Nutrients

The highest concentrations of nitrogen oxides in the TSF southern zone have been observed at CAWS31 and CAWS54. Nitrogen oxide concentrations in the seepage collection dam on Rodds Creek, CAWS31, are elevated as expected with tailings decant pond water upstream at CAWS42 and CAWS43 showing much higher concentrations of nitrogen oxides. This is likely due to dilution of the decant water seepage with background groundwater seepage into CAWS31 (GHD, 2018), however nitrogen oxide concentrations have been gradually reducing in the TSF southern zone (Figure 3.21). Elevated concentrations at CAWS54 are likely occurring as it is often sampled as a stagnant tributary in farm paddocks.

Elevated total nitrogen concentrations have been observed at all locations in the TSF southern zone, with similar trends to those observed for nitrogen oxides, however much higher concentrations of total nitrogen indicate that substantial concentrations of unoxidised nitrogen (i.e. organic nitrogen or ammonia) are often present. The influence of organic nitrogen is most likely due to the impact of surrounding agricultural land with increased nutrient runoff into and through surface water monitoring sites. Importantly, the lowest total nitrogen concentrations in the TSF southern zone are observed at Rodds Creek locations CAWS63 and CAWS55. These locations are the nearest downstream from the seepage collection dam, CAWS31, and confirm that elevated total nitrogen concentrations are not likely influenced from STSF seepage.

No trends in total phosphorous concentrations were observed, though elevated concentrations were recorded, most recently at CAWS55, CAWS57, CAWS56 and CAWS28. These sites are all located on the eastern tributary of Rodds Creek, where the elevated total phosphorous concentrations are most likely indicative of the influence of grazing within the catchment.

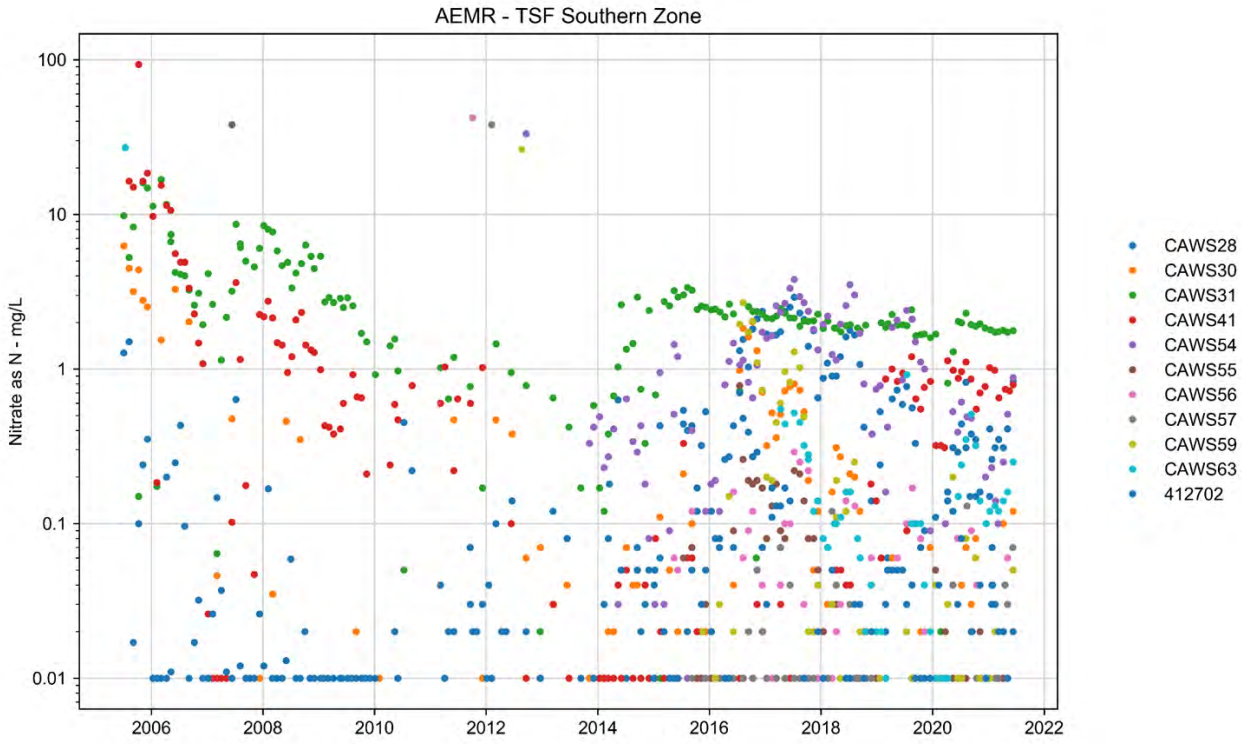

Figure 3.21 Nitrate concentrations in the TSF southern zone

Dissolved metals

Molybdenum concentrations are highest in the tailings decant water at CAWS42 and CAWS43 (refer to Figure 3.15). As has been observed in previous reporting periods, influence of seepage from the tailings is evident with molybdenum concentrations at contained systems CAWS31 and CAWS41, though there is no influence on sites further downstream (Figure 3.22). The same trend is observed for copper concentrations within the STSF system.

A series of elevated zinc concentrations were observed at all locations in May and June 2021 in the southern zone, though no spatial or temporal trends are apparent. The source of the zinc is unknown and is isolated with no apparent trend. Given that no other dissolved metal analyte showed elevated levels consistent with the zinc concentrations in May and June 2021, sample contamination or laboratory error are potential causes for these outlier zinc results. The offsite downstream indicator monitoring point 412702 shows zinc concentrations at or less than 0.006 mg/L, so the elevated zinc is not migrating offsite.

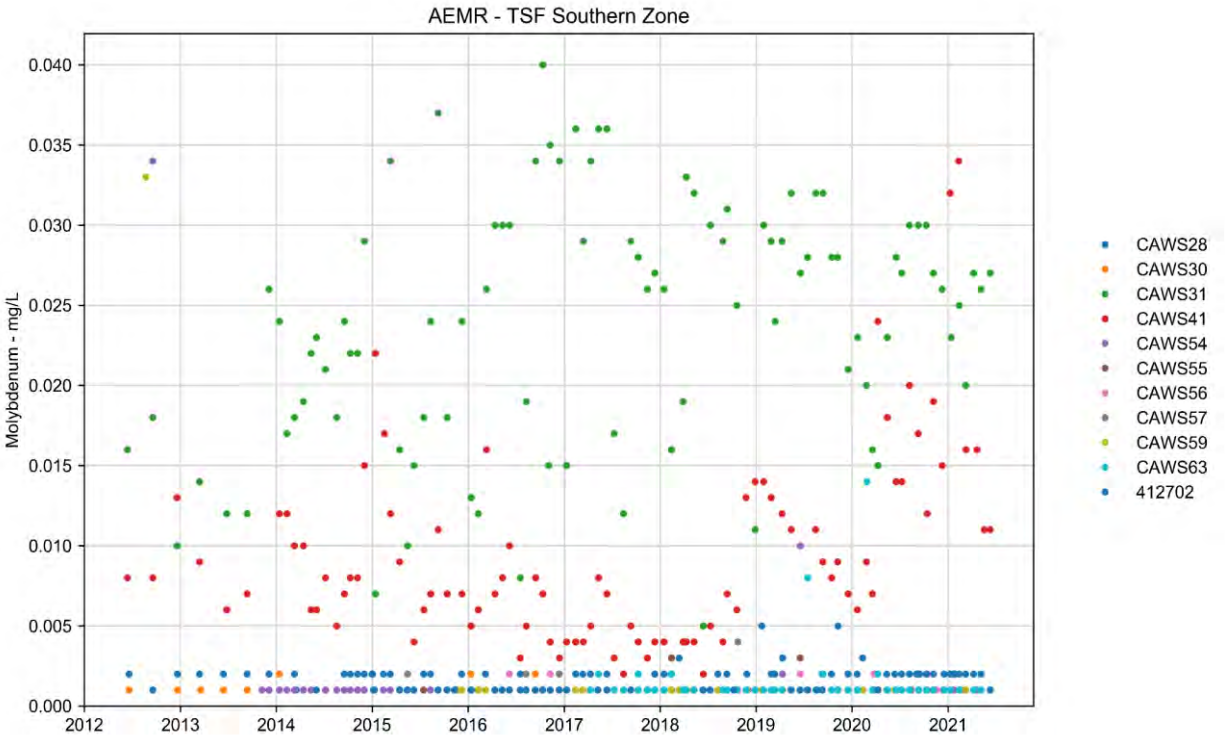

Figure 3.22 Molybdenum concentrations in the TSF southern zone.

Major ion composition

Average major ion concentrations at select TSF southern zone sites and the STSF site CAWS43 for the 2020/2021 reporting period were used to create the Piper chart presented as Figure 3.20. The Piper chart indicates some possible influence from the STSF on CAWS31, which acts as a seepage collection pond for the STSF. There isn't indication of STSF seepage influence on either CAWS63 (Rodds Creek downstream) or 412702 (Cadiangullong Creek downstream from Rodds Creek), as CAWS43 shows a much greater anionic sulfate dominance in comparison to CAWS63 and 412702.

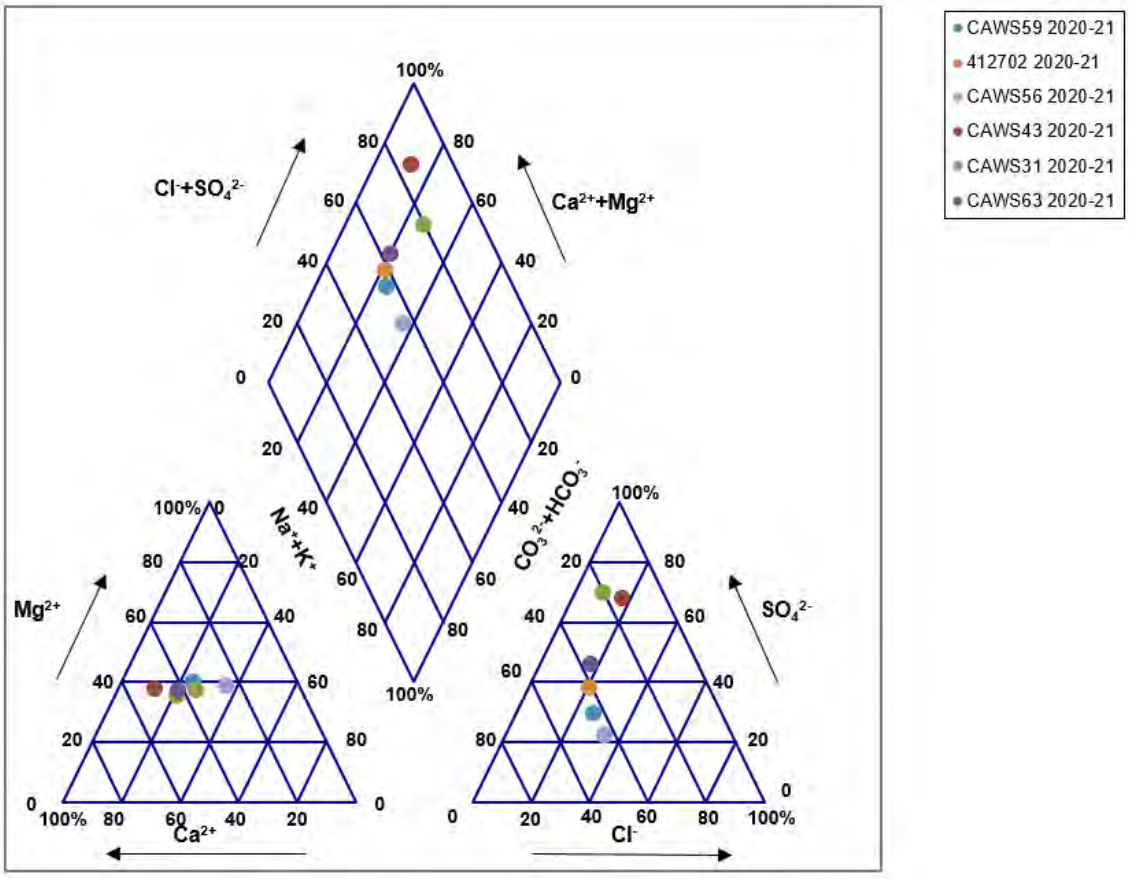

Figure 3.23 Piper chart showing differences in major ion composition in the TSF southern zone in the reporting period

Summary

The surface water monitoring site CAWS31, which represents a mix of background groundwater and seepage from the STSF showed increased molybdenum concentrations over the reporting period. However, as mentioned above, molybdenum concentrations at CAWS31 are less than the ANZG (2018) default toxicant guideline for freshwaters of 0.034 mg/L and currently does not pose a further risk to downstream receiving waters as this water is fully contained and returned to the processing plant for reuse. There are no other concerning results at other surface water monitoring locations within the TSF Southern Zone.

No impact of seepage from the STSF on water quality was evident in the receiving environment at site 412702, based on the monitoring records for key parameters associated with the TSF decant water, including nitrogen oxides, molybdenum and the ratios of major ions.

3.7 Dewatering facilities

The Blayney and Cadia Dewatering Facilities are located approximately 21 km and 23.5 km respectively to the east of the Cadia mine in the town of Blayney. The Cadia Dewatering Facility was commissioned in June 2016. Mineral concentrate containing gold and copper is pumped from Cadia to the Cadia Dewatering Facility, where it is dewatered and then loaded onto trains for transport to Port Kembla on the eastern seaboard. The Blayney Dewatering Facility was demolished between March and April 2020. Remediation works followed the site's decommissioning, and the site has now been relinquished to its owner. Monitoring sites at the dewatering facilities are shown in Figure 3.24.

Paper Size ISO A4

0 150 300 450 600

Metres

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

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Surface Water Assessment

Project No. **12553243**
Revision No. **0**
Date **18 Oct 2021**

Blayney Dewatering Facility and Cadia Dewatering Facility

FIGURE 3-24

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Print date: 18 Oct 2021 - 10:13

3.7.1 Blayney Dewatering Facility

Surface water is monitored at NEC061 and NEC062 in the Blayney Dewatering Facility (BDF) area and are shown in Figure 3.24.

Physicochemical parameters

pH at the BDF sites was near neutral, ranging between 7.1 and 7.8 in the reporting period. pH remained relatively consistent at both sites during the reporting period.

EC at these monitoring locations has ranged between 380 and 650 µS/cm and shows a general decreasing trend since the start of 2017 until April 2020, where levels were consistent with historical averages. EC has generally decreased throughout the 2020-2021 reporting period.

No temporal trends in TSS concentrations were observed, though concentrations have generally been highest at NEC061, with the highest result in the reporting period occurring in January 2021 (14 mg/L). Comparably, the highest result this reporting period at NEC062 was 9 mg/L in December 2020. All TSS concentrations were within historical ranges.

Nutrients

No temporal trends were observed in the concentrations of nitrogen oxides, total nitrogen or total phosphorous at NEC061 and NEC062. A similar level of variability was observed for these parameters at both monitoring locations which suggests influence from upstream sources, such as industrial and agricultural runoff, is causing some sporadic elevated nutrient concentrations.

Dissolved metals

The upstream monitoring location (NEC061) has historically shown elevated arsenic concentrations which suggests there is an arsenic source impacting Abattoir Creek upstream of the BDF. Arsenic concentrations are less at the downstream monitoring location (NEC062).

Copper concentrations have been occasionally elevated at NEC061 and NEC062, with higher concentrations observed at the latter (downstream) monitoring location (Figure 3.25). Copper concentrations at NEC62 reduced in 2017 and 2018, though rose again during 2019-20 monitoring period with results up to 0.022 mg/L, likely as a result of the ongoing drought conditions, the historical contamination of creek sediments from the operation of the facility, and mobilisation of copper contaminated soils in the demolition and remediation phases of the site decommissioning. Copper concentrations at NEC062 remain at or below 0.006 mg/L for the 2020-2021 reporting period. An Ecological Risk Assessment for Abattoir Creek (GHD, 2020b) was undertaken in 2020 to assess copper concentrations within Abbatoir Creek. Similar to the above discussion, it concluded that dissolved copper concentrations measured downstream of the BDF have, on average, been more elevated that those measured upstream, with the facility likely contributing to elevated copper concentrations in the creek. Overall, the weight of evidence assessment indicated that the ecological risks posed by the copper concentrations identified within Abattoir Creek were low, relative to the risks posed by external inputs to the creek, potentially including urban and agricultural runoff and wastewater discharges (GHD, 2020b).

Following demolition of the facility, Cadia undertook removal of copper contaminated onsite soils. As anticipated in GHD 2020b, copper discharges from the site and the water quality downstream of the monitoring location improved subsequent to the completion of the onsite remediation works September 2020 (GHD, 2020c).

Manganese and iron concentrations have been occasionally elevated at NEC061 and generally higher than those observed at NEC062. Elevated iron concentrations during the reporting period were observed at NEC061 recording 2.11 mg/L (December 2020), 2.66 mg/L (January 2021), and 1.49 mg/L (February 2021) shown in Figure 3.26. Concentrations downstream at NEC062 remained unaffected. Increased manganese concentrations have been observed at both monitoring locations during the reporting period, with the maximum recorded at NEC062 of 1.71 mg/L in December 2020 and similar concentrations observed at NEC061 of 1.36 mg/L as shown in Figure 3.27. The source of the elevated iron and manganese originates upstream of the BDF. Concentrations of iron and manganese at both monitoring locations decreased by the end of the 2020-2021 reporting period to typically low levels.

Elevated zinc concentrations were observed at both monitoring locations prior to the 2017-2018 reporting period. In the last three reporting periods, zinc concentrations have lowered significantly and remained < 0.03 mg/L. At the downstream site, NEC062, during the 2020-2021 reporting period, zinc results have remained less than the ANZG 2018 freshwater toxicant guideline of 0.008 mg/L

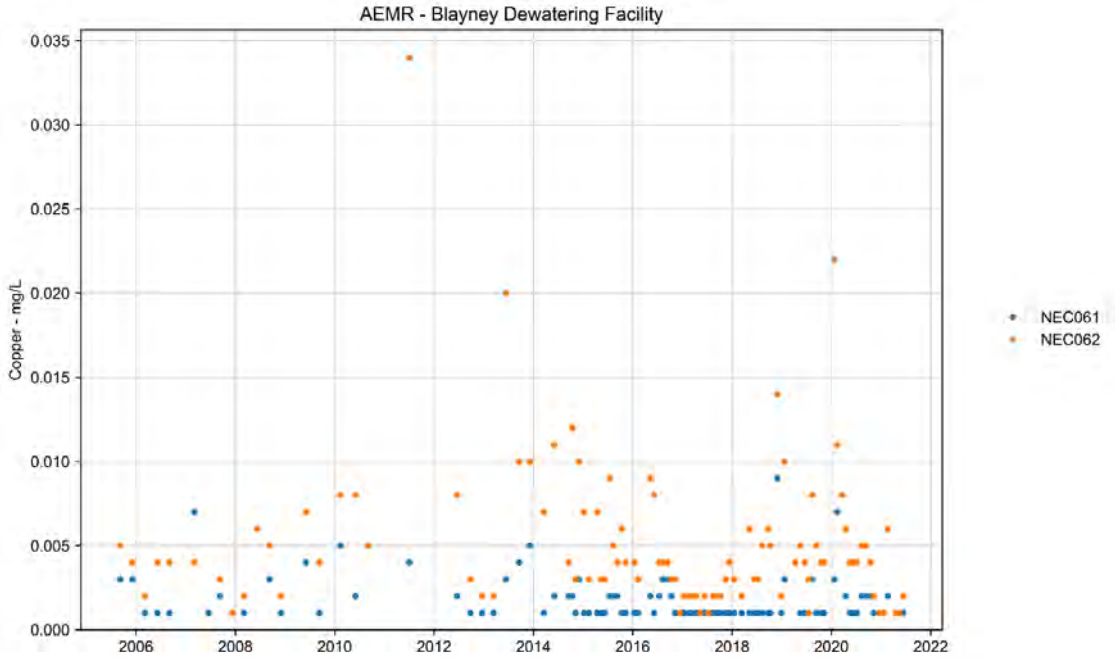


Figure 3.25 Dissolved copper concentrations in the Blayney Dewatering Facility Area

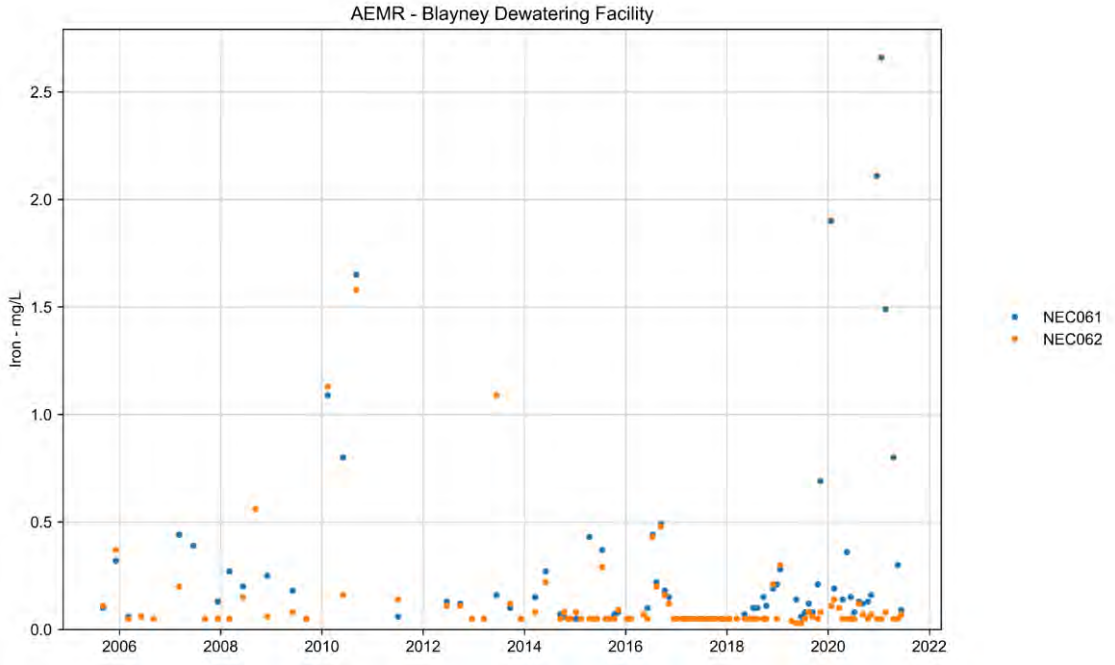


Figure 3.26 Dissolved iron concentrations in the Blayney Dewatering Facility Area

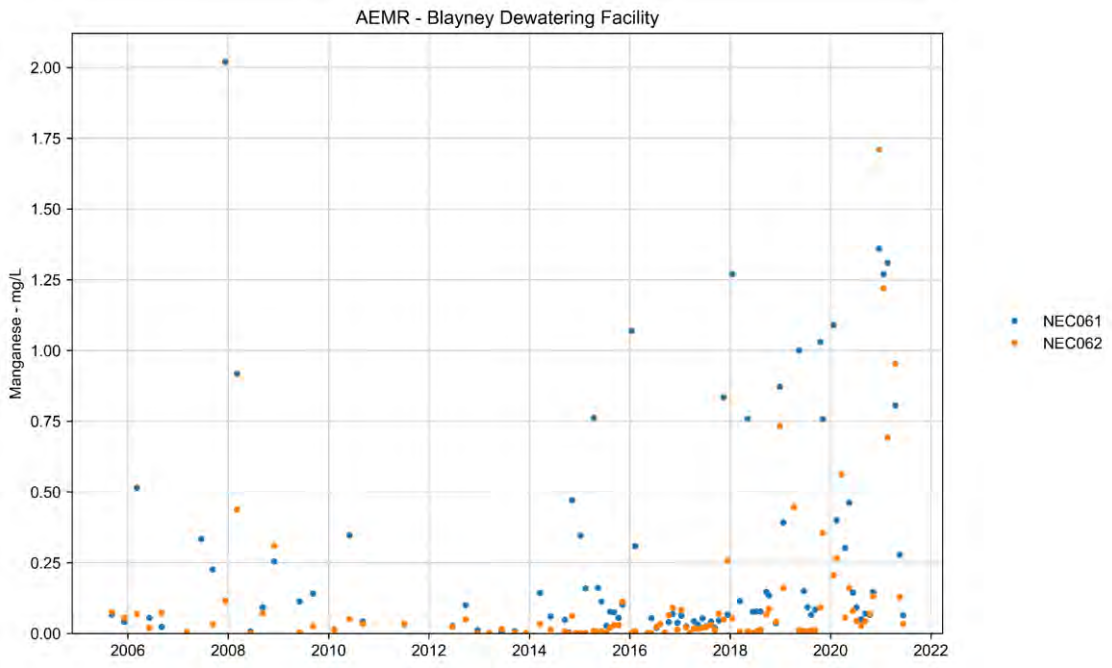


Figure 3.27 Dissolved manganese concentrations in the Blayney Dewatering Facility Area

Summary

Water quality at the BDF monitoring locations has been generally stable, with few temporal trends observed. Similar variability in water quality parameters is generally observed at both monitoring locations, though some spatial trends are apparent, such as copper concentrations generally being higher at downstream monitoring location NEC062, and arsenic and iron concentrations higher at NEC061. The higher copper concentrations at the downstream monitoring location likely reflect the influence of the facility due to contamination as identified and assessed in the Ecological Risk Assessment for Abattoir Creek (GHD, 2020b). Though, since remedial action in soil removal was implemented, copper concentrations downstream at NEC062 has shown a reducing trend.

3.7.2 Cadia Dewatering Facility

Surface water is monitored at CDW01, CDW02, CDW03, CDW04 and CDW05 in the Cadia Dewatering Facility (CDF) area which are all potential impacts sites as they can be influenced by site operations. CDF monitoring sites are shown in Figure 3.24. No upstream background sites have been monitored as there is no continuous watercourse upgradient of the site. From farthest upstream to downstream along the onsite drainage channel is CDW01, CDW02, and CDW05. CDW03 is located upstream of the Belubula River and Abattoir Creek confluence, on the Belubula River. CDW04 is located downstream of the drainage channel's assumed discharge point to the Belubula River, on the Belubula River. CDW01 and CDW02 were removed from the monitoring program in March 2020 and November 2020 respectively, due to physical removal of the dams which they represented as part of on site stormwater upgrades to contain runoff. CDW05 represents the offsite discharge point from the CDF, and is retained as a monitoring location. CDW01 is included in the dataset for historical context and will be removed upon approval of the revised Cadia WMP.

Physicochemical parameters

pH in the CDF area ranges from slightly acidic at CDW03 to slightly alkaline at CDW02. pH generally ranges from highest at the furthest upstream monitoring location (CDW02) to lowest at the upstream Belubula River monitoring location CDW03 from 2020/2021 monitoring period results.

No trends were evident in EC values, though it is noted that EC has generally been lowest at the impact monitoring location closest to the CDF (CDW02) suggesting that any runoff or discharge from the facility is of low salinity.

The highest TSS concentrations have been observed at CDW05, though no temporal trend is evident which suggests that spikes in TSS are linked to rainfall events. Similar concentrations of TSS were recorded at CDW03 and CDW05 during the monitoring period.

Nutrients

The concentrations of nitrogen oxides have been consistently highest at CDW05 (Figure 3.28). Elevated nitrogen oxide concentrations are considered to be indicative of inputs from widespread industrial, agricultural and urban pollution (GHD, 2020b). This is likely indicative of uptake of nitrite and nitrate by algae and macrophytes, which occurs at a greater rate with higher temperatures and more daylight. A similar trend was observed for total nitrogen but not total Kjeldahl nitrogen, which supports the theory that the nitrogen is being incorporated into biomass rather than transformed to ammonia or organic nitrogen.

A general increase in the concentrations of total phosphorous was observed in 2021, however, elevated concentrations exist at all monitoring points including the upstream monitoring point on the Belubula River (CDW03). This suggests that background levels of phosphorus in watercourses is naturally elevated in the catchment. This reporting period, two elevated spikes in phosphorus were recorded at CDW03 compared to background levels.

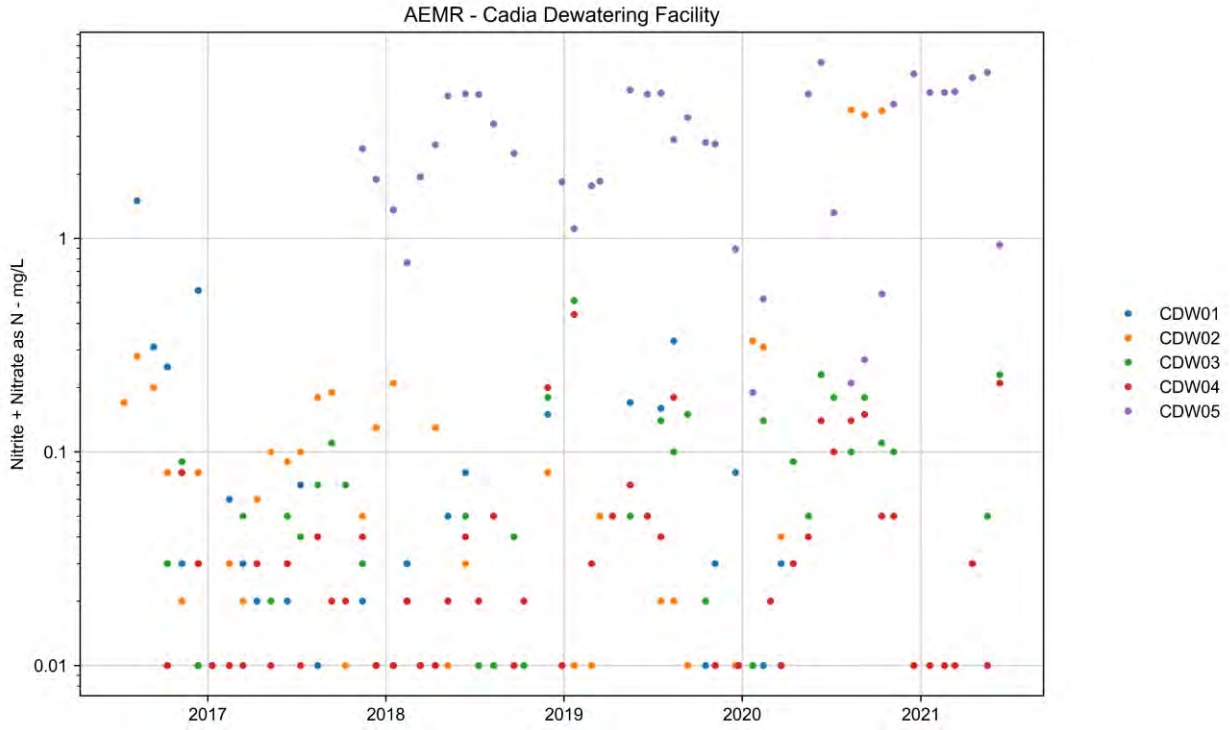


Figure 3.28 Nitrogen oxide concentrations in the Cadia Dewatering Facility Area

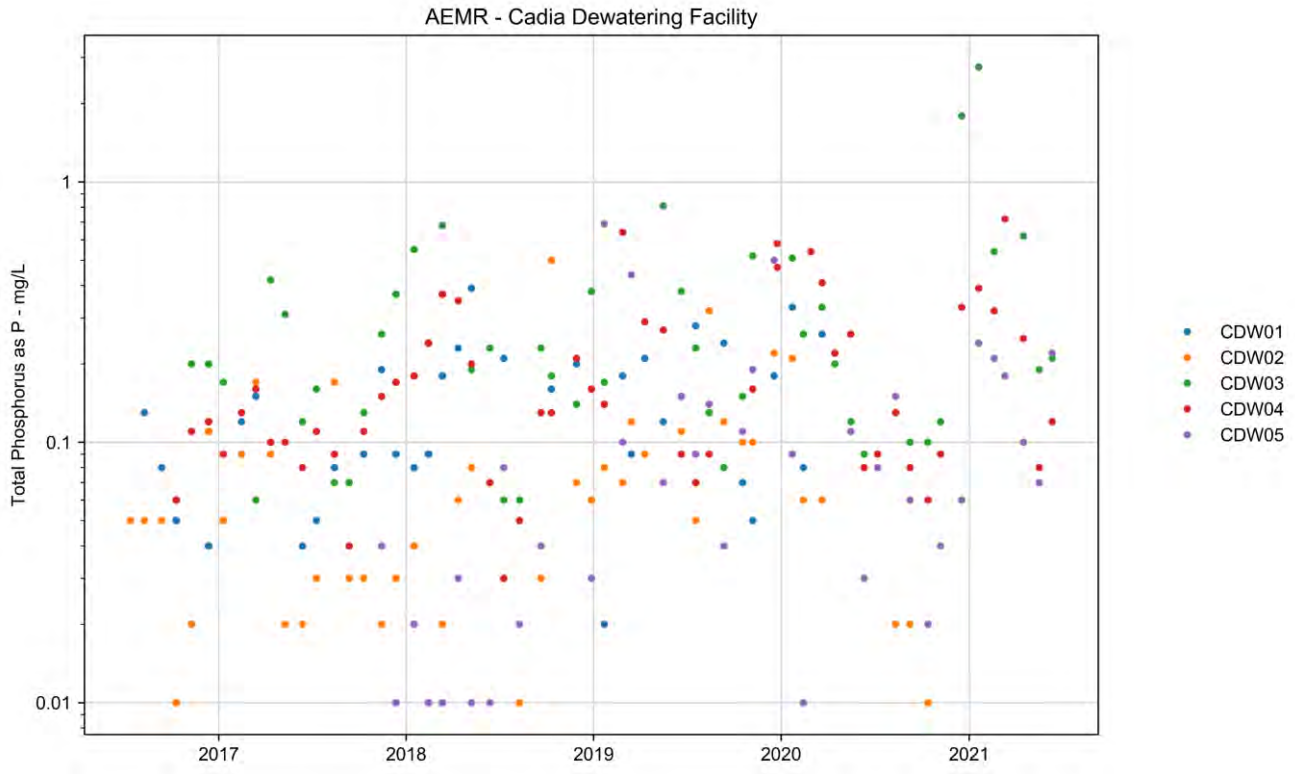


Figure 3.29 Total Phosphorus concentrations at Cadia Dewatering Facility

Dissolved metals

The highest iron and manganese concentrations have typically been observed in the Belubula River at CDW03, which is likely indicative of the influence of surrounding land use. Concentrations were significantly elevated at CDW03 in January 2021 (>12 mg/L) but have since recovered to previous levels (Figure 3.30).

Copper concentrations have generally been highest at CDW02, though a general decreasing trend was indicated prior to the cessation of sampling at the monitoring location in October 2020. Concentrations have been historically low at CDW05 (downstream of CDW02) which suggested that the elevated copper concentrations are localised in the proximity of the CDF and do not migrate downstream to sensitive watercourses. However, over the reporting period, copper concentrations at CDW05 have been variable, with results ranging from <0.001 mg/L to a maximum of 0.007 mg/L in June 2021.

Elevated copper concentrations have been observed at the Belubula River monitoring location upstream of the facility (CDW03) compared with the downstream monitoring location (CDW04), which indicates that the exceedances of the ANZG (2018) 95% species protection for freshwaters default guideline value (0.0014 mg/L) observed in the river were unlikely to be associated with the CDF. There appears to be a relationship between the trends in dissolved copper concentrations observed at NEC062 and those observed at CDW04, indicating that decreased copper concentrations from the BDF align with decreased copper concentrations in the Belubula River at CDW04. This is likely due to the remedial work discussed in section 3.7.1.

Molybdenum concentrations have historically been highest at CDW02, though were higher at CDW01, refer to Figure 3.32. Considering the presence of molybdenum in the ore at Cadia these observations may reflect the influence of the dewatering facility's operation at CDW02, though no such influence has been observed at CDW05 or in the receiving environment of Belubula River at site CDW04. During the reporting period, concentrations were at or below the LOR with the exception of some results at CDW02, in the second half of 2020 where concentrations were equal to or less than 0.003 mg/L.

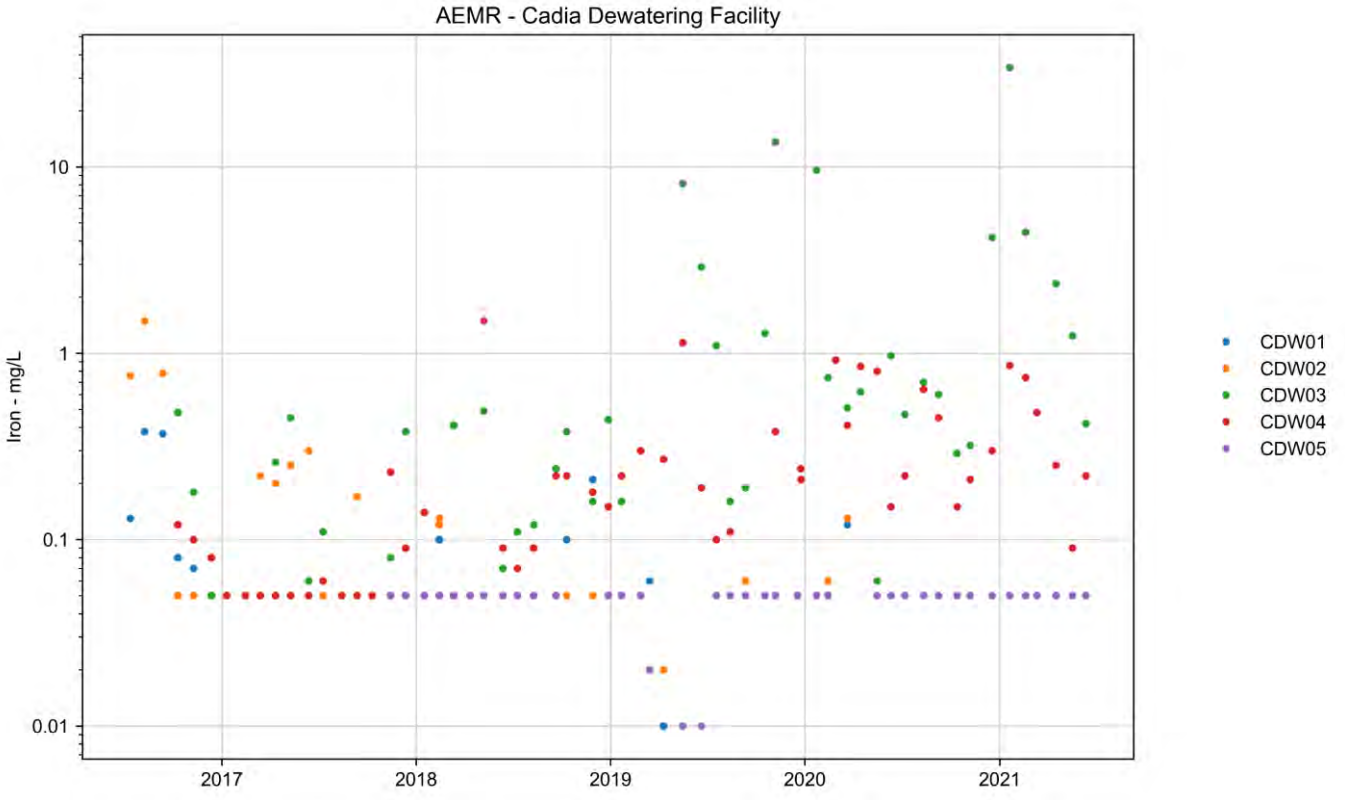


Figure 3.30 Dissolved iron concentrations in the Cadia Dewatering Facility Area

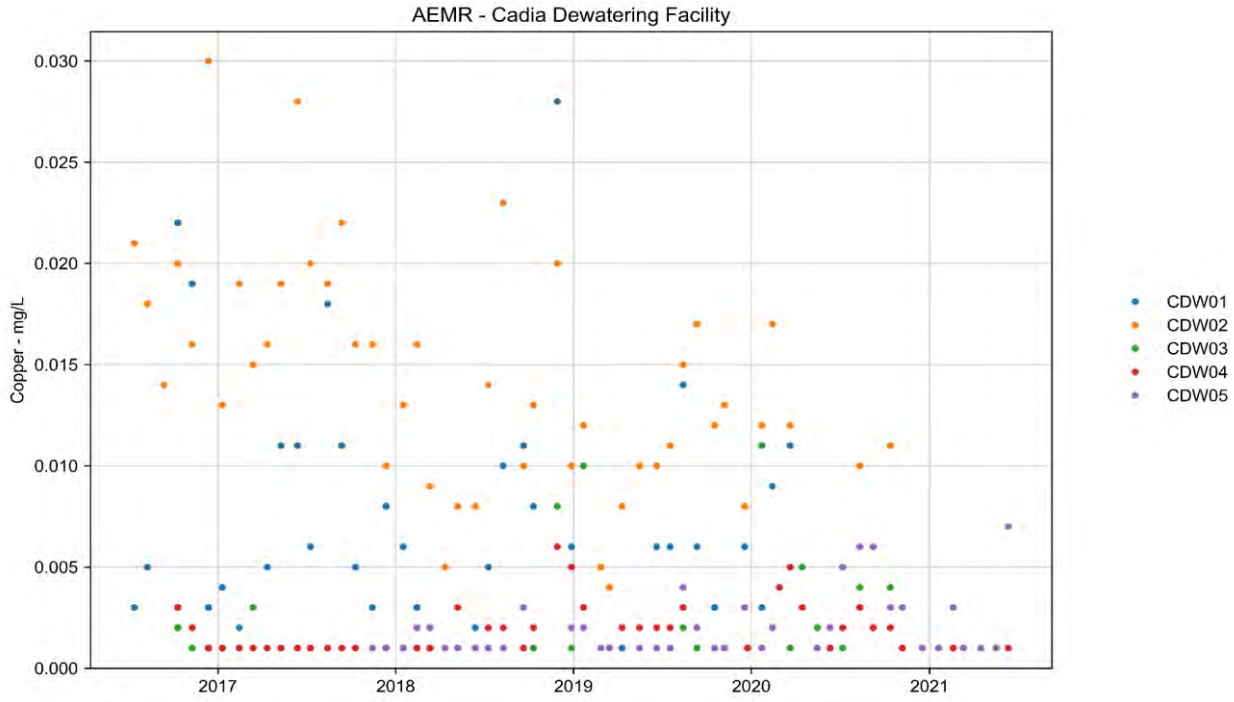


Figure 3.31 Dissolved copper concentrations in the Cadia Dewatering Facility Area

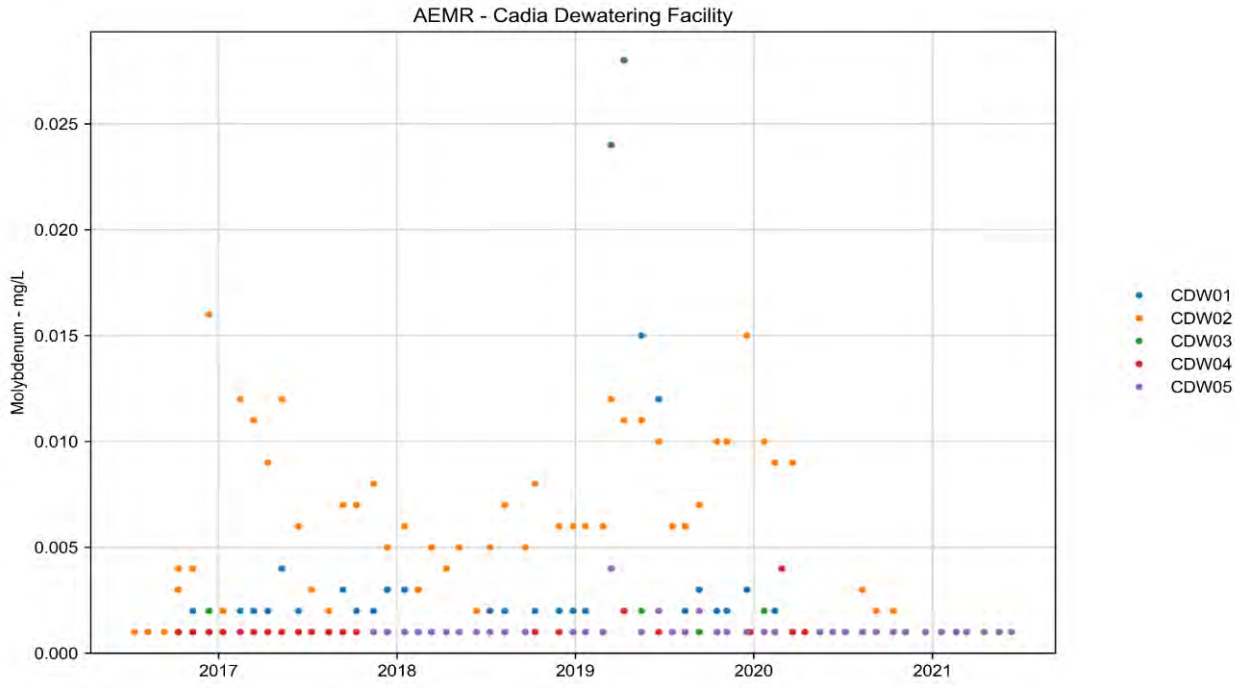


Figure 3.32 Dissolved molybdenum concentrations in the Cadia Dewatering Facility Area

Summary

The potential influence of the CDF on water quality has been observed at CDW02, based on elevated concentrations of copper and molybdenum. There has been minimal influence on the concentrations of these parameters observed in the downstream receiving environment of Belubula River. Drainage improvement works at the CDF area have further reduced the risk of impacts on the downstream receiving environment.

4. SSGV assessment

4.1 Site specific guideline values

Site specific guideline values (SSGVs) have been determined from the baseline data in accordance with ANZG 2018. A review of SSGVs for the downstream Oaky Creek site was conducted in 2018 (GHD, 2018a). This review was as part of a 10-year review of the aquatic ecosystem monitoring program and the findings indicated that there was no degradation of the downstream aquatic environment despite the exceedances of some SSGVs at this location.

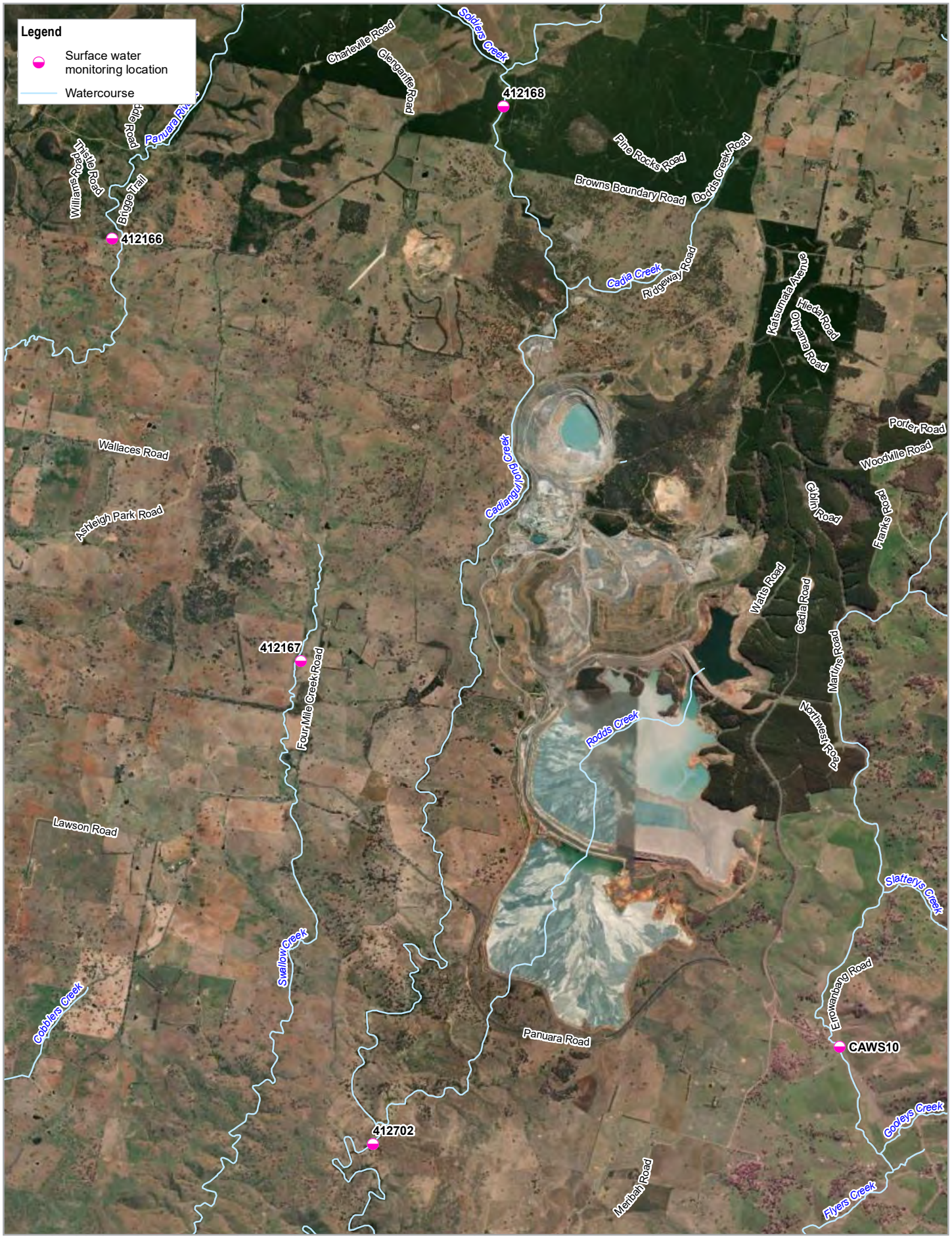
The approved SSGVs, as presented in the WMP (Cadia, 2019), are shown in Table 4.1 for each monitoring location. The location of the SSGV monitoring locations are shown in Figure 4.1. These SSGVs provide an indicator of changes in downstream water quality and an initial trigger for investigation where exceedances are identified.

The environmental health of the rivers around Cadia is primarily assessed via aquatic ecology and river health surveys conducted by specialised ecologists (GHD, 2021b). Surveys were conducted in Spring 2020 and Autumn 2021. These surveys showed that there was no evidence to suggest mining activities have impacted on water quality of Cadiangullong Creek or Rodds Creek.

The following sections present a report of exceedances of these SSGVs. SSGV graphs are presented in Appendix A, showing the reporting period data in comparison with the applicable SSGV. Summaries of the level one investigations that occurred in response to the exceedances, and the outcomes and recommendations from the investigations are provided in the sections below. This information has been supplied by CVO. None of the level one investigations triggered a level two response according to the WMP.

Table 4.1 Surface water quality SSGVs

Parameter	Unit	412702 (Oaky Creek Gauging Station)	Diggers Creek 412166	Rodds Creek CAWS63	Flyers Creek CAWS10	Swallow Creek 412167
Physicochemical						
pH	pH	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5
EC	µS/cm	875	1,960	2,950	965	1,960
TSS	mg/L	50	50	80	50	50
Nutrients						
Nitrogen oxides	mg/L as N	0.25	0.25	-	0.25	0.25
Total nitrogen	mg/L as N	0.6	0.6	9.0	0.6	0.6
Total phosphorous	mg/L as P	0.06	0.09	0.4	0.09	0.09
Dissolved metals						
Aluminium	mg/L	0.055	0.055	0.15	0.055	0.055
Arsenic	mg/L	0.013	0.013	0.005	0.013	0.013
Cadmium	mg/L	0.0002	0.0002	-	0.0002	0.0002
Copper	mg/L	0.009	0.0014	0.1	0.0014	0.0014
Iron	mg/L	0.12	1.65	0.73	1.65	1.65
Lead	mg/L	0.0034	0.0034	0.002	0.0034	0.0034
Manganese	mg/L	1.9	1.9	0.37	1.9	1.9
Zinc	mg/L	0.057	0.077	0.2	0.077	0.077
Molybdenum	mg/L	0.034	0.034	-	0.034	0.034



Paper Size ISO A4

0 500 1,000 1,500 2,000 2,500

Metres

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

N

Newcrest Mining Limited
CVO AEMR –
Surface Water Assessment

SSGV Assessment

Project No. **12553243**
Revision No. **0**
Date **18 Oct 2021**

FIGURE 4-1

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Print date: 18 Oct 2021 - 10:15

Data source: Newcrest: Bores, 2019. LPI: DCDB/DTDB, 2017. Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. Created by: pkiem, fmackay, tmorton

4.2 Cadiangullong Creek

Cadiangullong Creek flows north to south through Cadia mine. Potential mine derived sources of pollution are discussed throughout Sections 3.2 to 3.6.

At Oaky Creek Gauging Station (412702), the following exceedances of the SSGVs observed during the reporting are presented in Table 4.2 with investigation conclusions.

Table 4.2 412702 (Oaky Creek Gauging Station) SSGV exceedances

Analyte	SSGV	Sample date	Result	Investigation
Nitrogen oxides	0.25 mg/L	6/08/2020	0.33 mg/L	Total oxidised nitrogen concentrations in many Cadiangullong Creek surface water monitoring locations were elevated above the SSGV on 06/08/2020, including locations upstream of CVO mine impacted areas. The highest concentration was recorded at location 412144 (0.44 mg/L) that monitors water discharging or spilling from Cadiangullong Dam, upstream of active mine operation areas. This suggests that the source of the elevated total oxidised nitrogen originated either upstream of mine influenced reaches of Cadiangullong Creek, or from nutrient rich grazing land adjacent to Cadiangullong Creek.
		23/01/2021	0.26 mg/L	GHD 2021 concluded that while the SSGV exceedance of total oxidised nitrogen was likely caused by the unlicensed discharge, it was not considered to pose a significant risk to aquatic ecosystems as previous biological monitoring in Cadiangullong Creek has demonstrated a capacity to tolerate short-term increases in nutrients.
Electrical conductivity	875 µS/cm	6/08/2020	1181 µS/cm	The value is within range of background variation. EC increases from upstream to downstream along Cadiangullong Creek and is presumed to be due to the baseflow contribution of saline groundwater into Cadiangullong Creek.
		10/09/2020	1368.5 µS/cm	
		9/10/2020	1490 µS/cm	
		21/01/2021	961.4 µS/cm	GHD 2021 concluded that while the SSGV exceedance of electrical conductivity was potentially caused by the unlicensed discharge (refer to section 3.1), it was not considered to pose a significant risk to aquatic ecosystems as EC results were within the historical range.
		23/01/2021	966 µS/cm	
		24/01/2021	974.5 µS/cm	
		22/01/2021	979.2 µS/cm	
		26/01/2021	990.3 µS/cm	
		26/01/2021	995.2 µS/cm	
		27/01/2021	937 µS/cm	
Dissolved iron	0.12 mg/L	10/09/2020	0.3 mg/L	The result was within the historical range for this location which has seen dissolved iron spikes in the past. Dissolved iron was also elevated on this date upstream at CAWS62 (0.39 mg/L). The result was unlikely due to STSF seepage as results in Rodds Creek were below the SSGV. Also, results further upstream on Cadiangullong Creek were less than the SSGV, suggesting the source was unlikely from the NTSF or processing areas. Results returned to concentrations less than the SSGV in October 2020.
		15/09/2020	0.27 mg/L	
		5/11/2020	0.14 mg/L	The result was within the historical range for this location which has seen dissolved iron spikes in the past. Dissolved iron was greatest upstream of potential mine impacted areas and decreased spatially downstream. This suggests that the source of the elevated dissolved iron originated upstream of mine influenced reaches of Cadiangullong Creek. Results returned to concentrations less than the SSGV in subsequent months.

Analyte	SSGV	Sample date	Result	Investigation
Total nitrogen	0.6 mg/L	6/08/2020	0.7 mg/L	Total nitrogen concentrations in many Cadiangullong Creek surface water monitoring locations were elevated on 06/08/2020, including locations upstream up CVO mine impacted areas. The greatest concentrations of total nitrogen were observed at downstream Cadiangullong Creek sites of CAWS62 and 412702. The result was unlikely due to STSF seepage as results in Rodds Creek were well below the SSGV. This suggests that the source of the elevated total nitrogen may have originated from nutrient rich grazing land adjacent to the southern reaches of Cadiangullong Creek.
		16/12/2020	0.8 mg/L	
Total phosphorus	0.06 mg/L	21/01/2021	0.07 mg/L	These SSGV exceedances occurred during the unlicensed discharge period, however it is unlikely that the discharge caused the exceedances as per the findings of GHD 2021: – Other monitoring locations upstream of the discharge showed total phosphorus results above the historical range. – Total phosphorus were within the historical range at 412702. – Other locations downstream of the discharge on these dates did not show elevated total phosphorus concentrations. This suggests that the source of the elevated total phosphorus may have originated from nutrient rich grazing land adjacent to the southern reaches of Cadiangullong Creek. GHD 2021 concluded that elevated total phosphorus concentrations did not pose a risk to downstream beneficial uses with respect to aquatic ecosystems, livestock, and short-term irrigation beneficial uses as total phosphorus results were well below guideline values in the waterway.
		23/01/2021	0.08 mg/L	
		22/01/2021	0.09 mg/L	
		26/01/2021	0.08 mg/L	
		26/01/2021	0.08 mg/L	

4.3 Rodds Creek

At Rodds Creek monitoring location CAWS63, SSGVs are based on EPL 5590 water quality concentration limits at EPA ID Point 19 for discharge to waters. There were no exceedances of the SSGVs during the reporting period at CAWS63.

4.4 Flyers Creek

Flyers Creek is located to the east of Cadia mine. There are no clear pathways for mine derived pollutants to impact on this creek system.

Exceedances are provided in Table 4.3, including investigation findings on potential non-mine related causes for the SSGV exceedance.

Table 4.3 CAWS10 (Flyers Creek) SSGV exceedances

CVO reference No.	Analyte	SSGV	Sample date	Result	Investigation
10	Dissolved aluminium	0.055 mg/L	9/09/2020	0.06 mg/L	A duplicate sample was collected with the primary sample and returned a 0.05 mg/L dissolved aluminium which is below the SSGV. No further records showed elevated dissolved aluminium in subsequent monthly monitoring. Sample contamination was deemed the most credible source of the exceedance.
11		0.0014 mg/L	9/09/2020	0.003 mg/L	

CVO reference No.	Analyte	SSGV	Sample date	Result	Investigation
154	Dissolved copper		15/02/2021	0.002 mg/L	All offsite monitoring locations recorded dissolved copper concentrations greater than the SSGV. This suggests that laboratory interference or error was responsible for the elevated readings, which usually return non-detects for dissolved copper.
12	Total nitrogen	0.6 mg/L	9/09/2020	0.7 mg/L	Nitrogen species in the Flyers Creek surface water monitoring location was elevated on 9/09/2020. This suggests that the source of the elevated nitrogen species may have originated from nutrient rich grazing land adjacent to all reaches of Flyers Creek.
15	Total oxidised nitrogen	0.25 mg/L	9/09/2020	0.32 mg/L	

4.5 Diggers Creek and Swallow Creek

Diggers Creek and Swallow Creek are located to the west of Cadia mine. These monitoring locations are considered to be outside of the area of impact of the mine and are included in the monitoring program as reference sites for offsite impacts on water quality. GHD (2019b) has recommended that SSGVs for these locations be removed in the next version of the WMP. Exceedances are provided in Table 4.4, including investigation findings on potential non-mine related causes for dissolved copper SSGV exceedances.

Table 4.4 412166 (Diggers Creek) and 412167 (Swallows Creek) SSGV exceedances

CVO reference No.	Analyte	SSGV	Sample date	Result	Investigation
1	Dissolved copper	0.0014 mg/L	9/09/2020	0.002 mg/L	All offsite monitoring locations recorded dissolved copper concentrations greater than the SSGV. This suggests that laboratory interference or error was responsible for the elevated readings, which usually return non-detects for dissolved copper.
2			9/09/2020	0.002 mg/L	
152			15/02/2021	0.002 mg/L	
153			15/02/2021	0.003 mg/L	

5. Recommendations and conclusions

5.1 Key performance and/or management issues

The review of surface water and groundwater monitoring results for the 2020-2021 reporting period identified the following key performance/management issues:

– The WRDs and the TSFs appear to have localised influences of mine related chemistry on surface water quality. However, based on results from the 2020-2021 reporting period there is no evidence of impact to receiving environments in these zones.
– Elevated copper concentrations were recorded downstream of the BDF, with the BDF the likely contributor. Copper concentrations reduced following the completion of remedial works in September 2020. Overall, the weight of evidence assessment indicated that the ecological risks posed by the copper concentrations identified within Abattoir Creek are low, relative to the risks posed by external inputs to the creek.

5.2 Proposed improvements

There are no proposed improvements to surface water management provided that the new monitoring sites of CAWS78 and CAWS79 are maintained for the Ore Processing Area and included in the revised WMP.

6. References

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7. Limitations

This report has been prepared by GHD for Newcrest Mining Limited and may only be used and relied on by Newcrest Mining Limited for the purpose agreed between GHD and Newcrest Mining Limited as set out in section 1.1 of this report.

GHD otherwise disclaims responsibility to any person other than Newcrest Mining Limited arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

Specifically, this report does not take into account the effects, implications and consequences of or responses to COVID-19, which is a highly dynamic situation and rapidly changing. These effects, implications, consequences of and responses to COVID-19 may have a material effect on the opinions, conclusions, recommendations, assumptions, qualifications and limitations in this report, and the entire report must be re-examined and revisited in light of COVID-19. Where this report is relied on or used without obtaining this further advice from GHD, to the maximum extent permitted by law, GHD disclaims all liability and responsibility to any person in connection with, arising from or in respect of this report whether such liability arises in contract, tort (including negligence) or under statute.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

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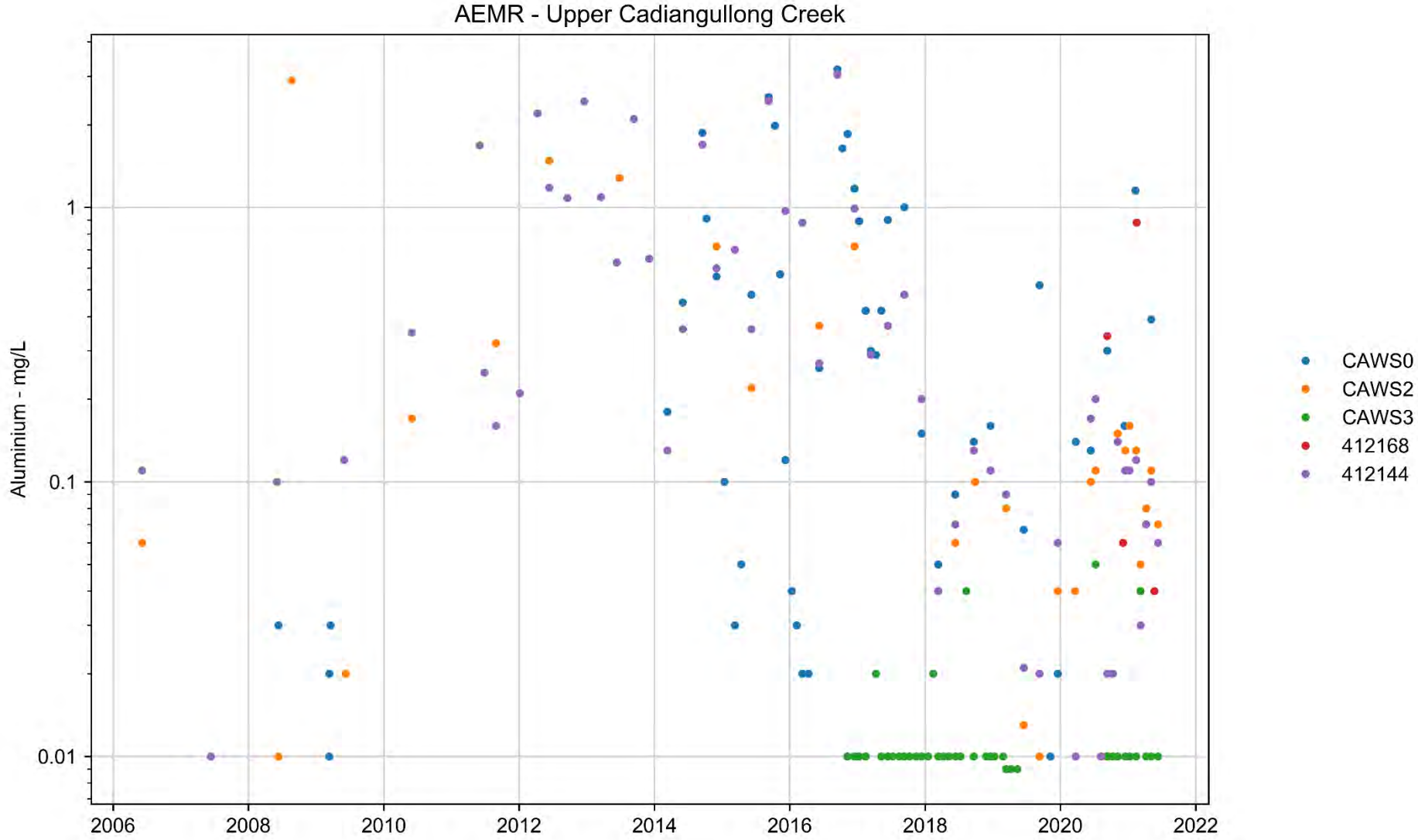
The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Appendices

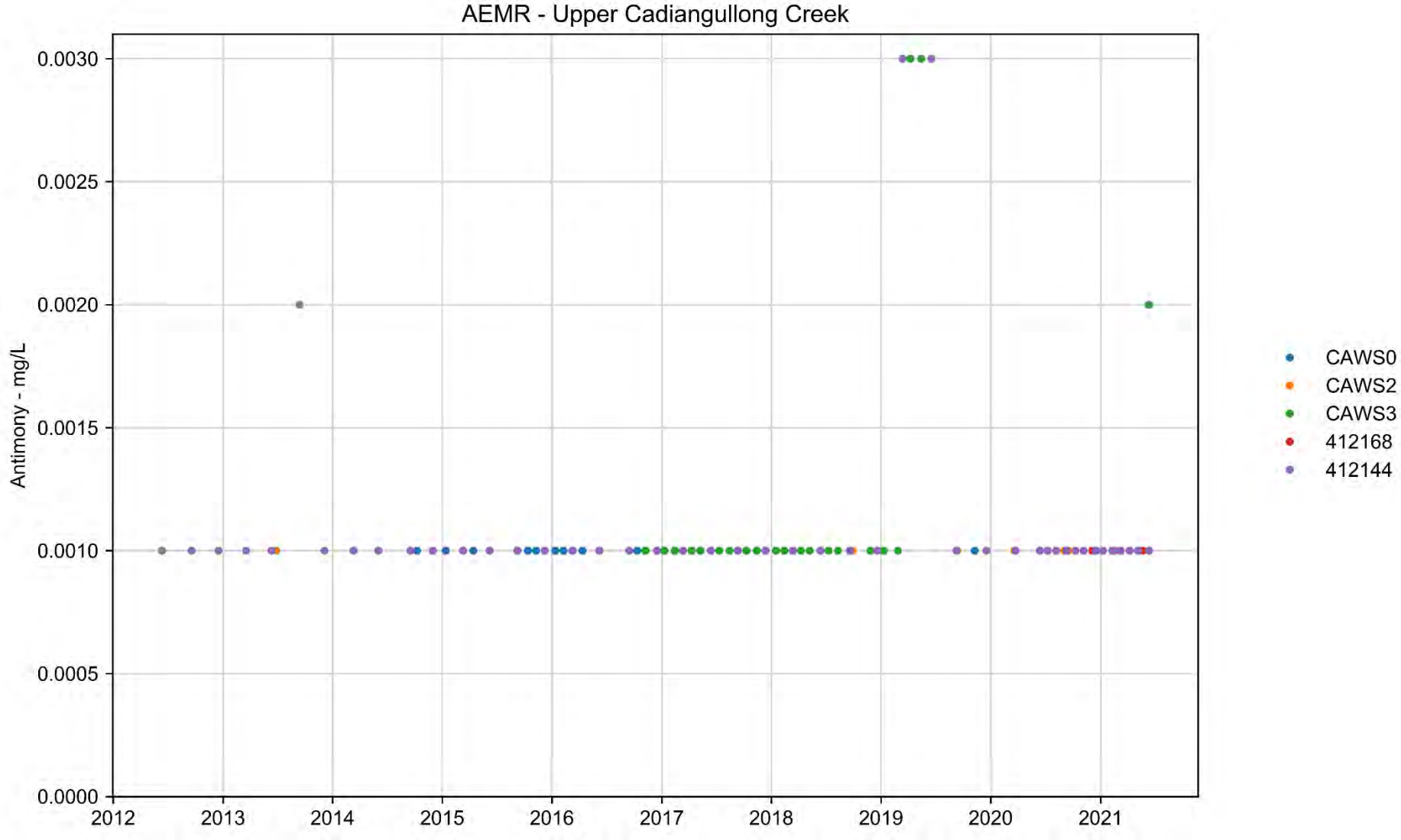
Appendix A

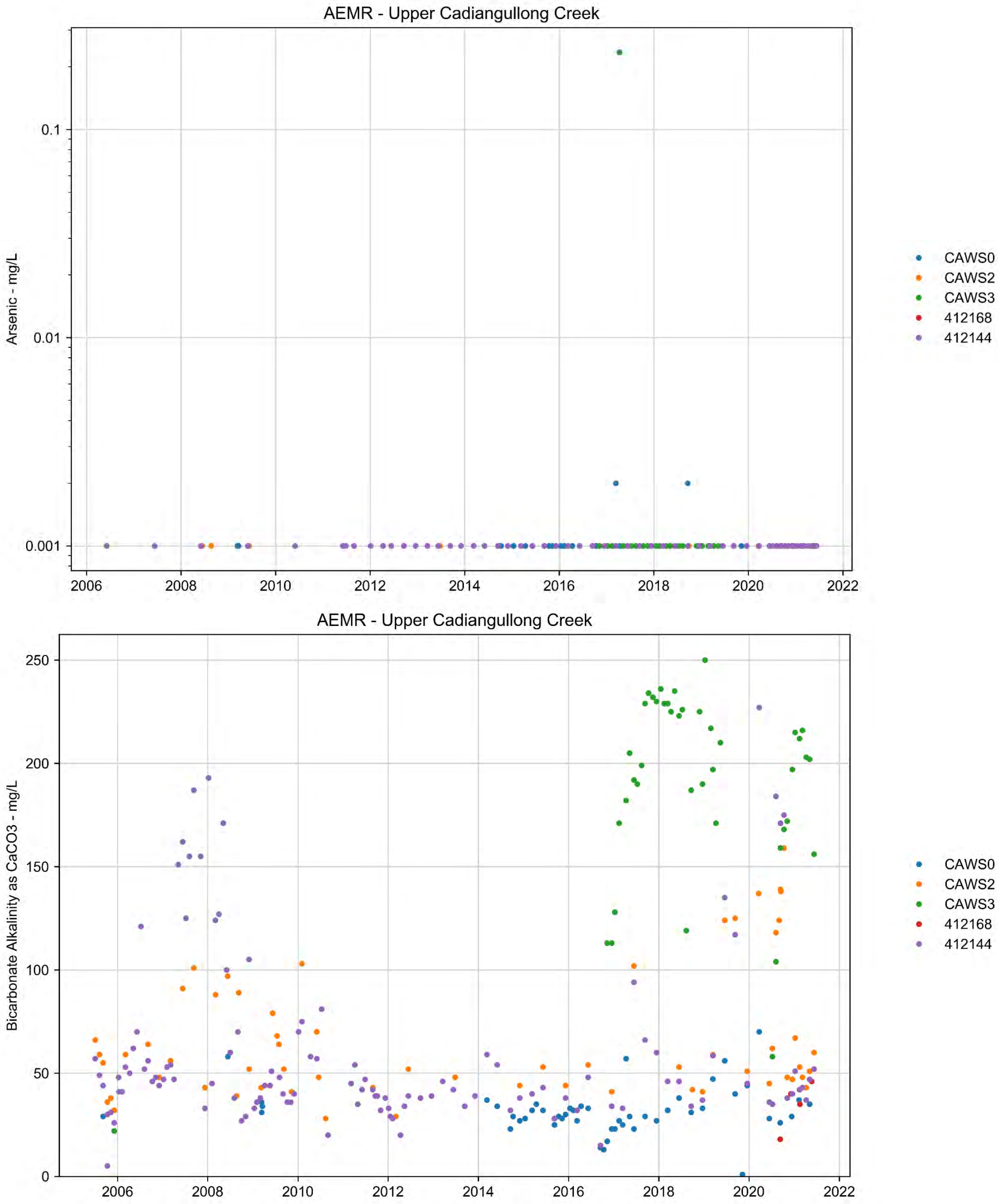
Surface water quality graphs

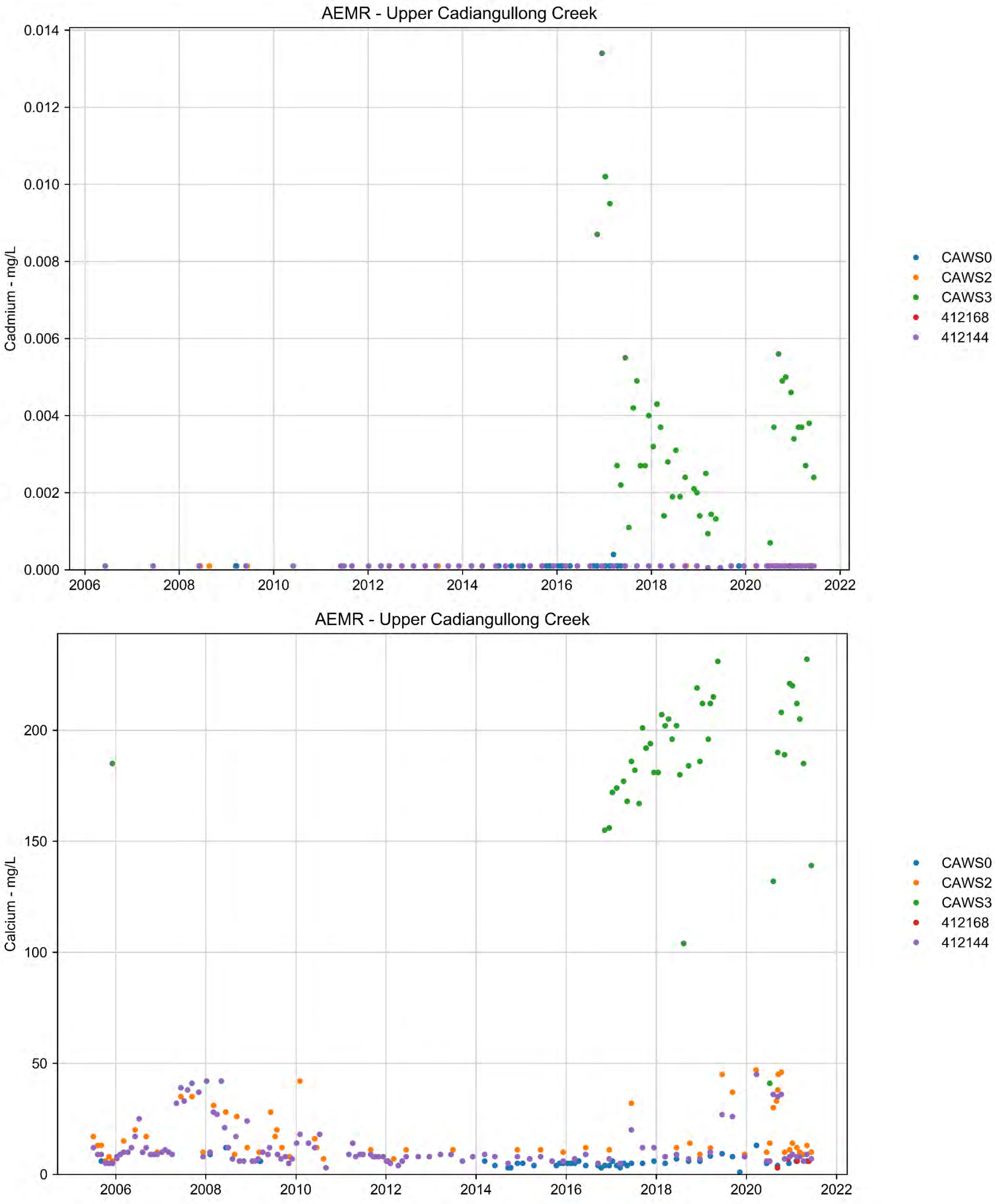
AEMR - Upper Cadiangullong Creek



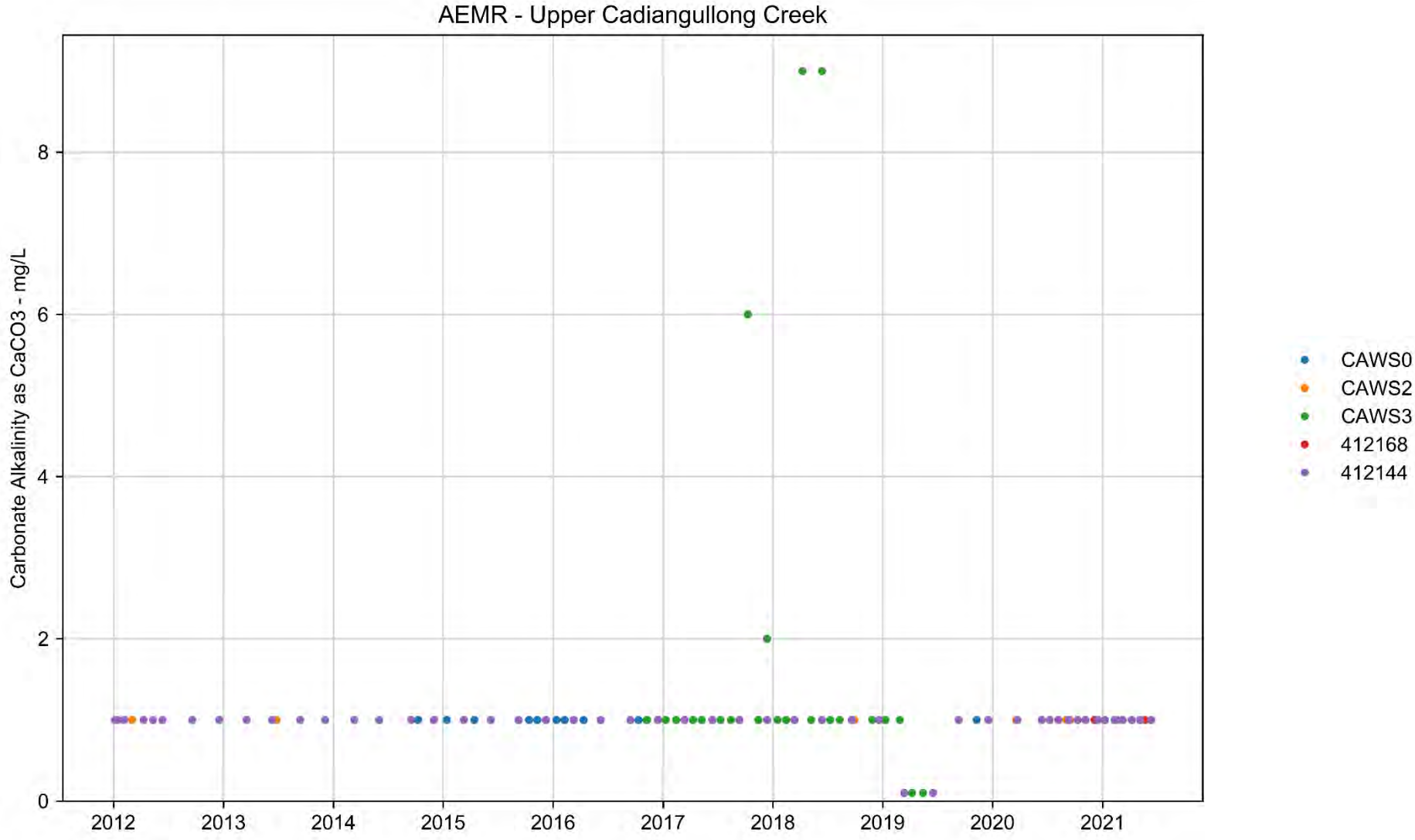
AEMR - Upper Cadiangullong Creek



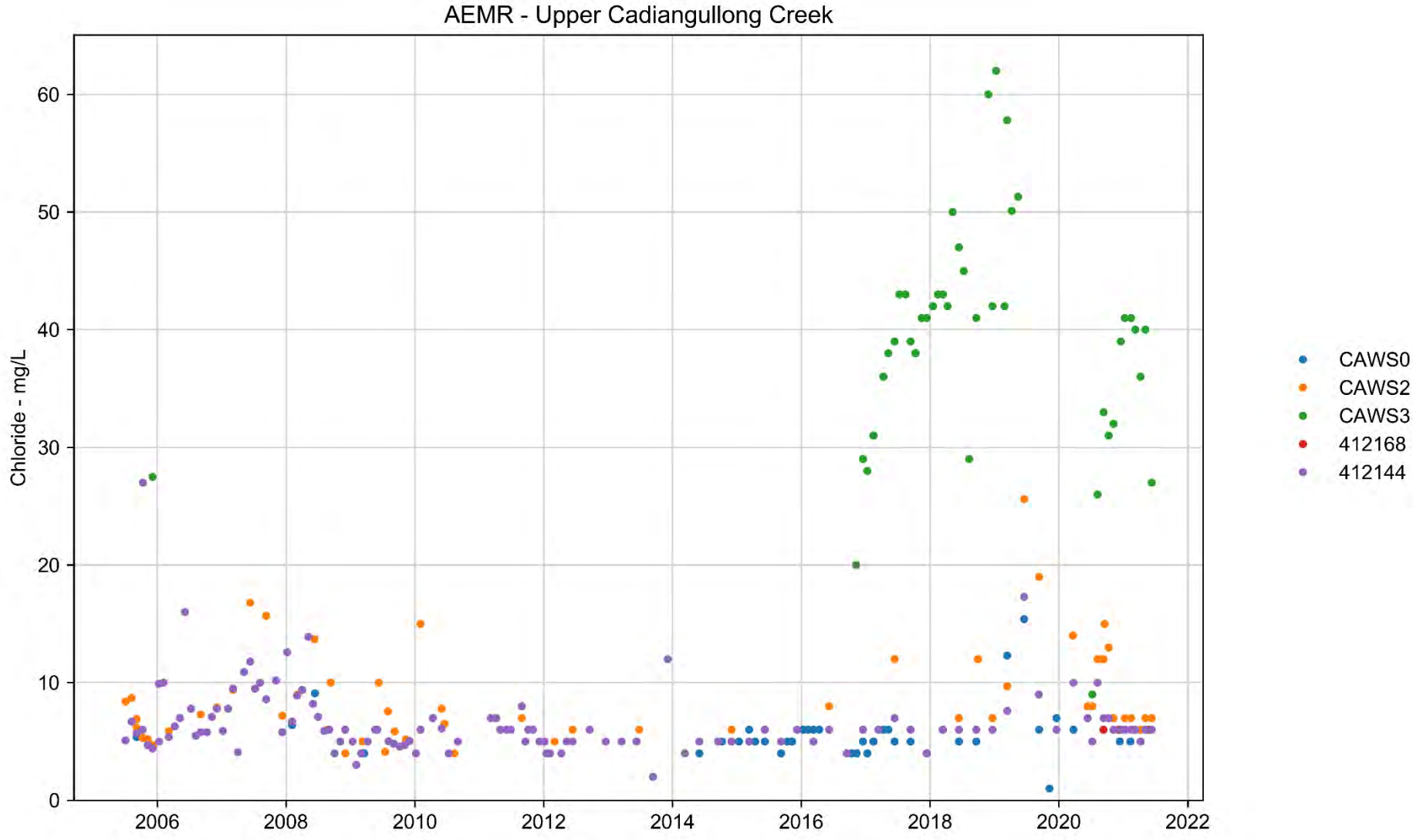

AEMR - Upper Cadiangullong Creek
Arsenic - mg/L
0.1
0.01
0.001
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS0
CAWS2
CAWS3
412168
412144
AEMR - Upper Cadiangullong Creek
Bicarbonate Alkalinity as CaCO3 - mg/L
250
200
150
100
50
0
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS0
CAWS2
CAWS3
412168
412144


AEMR - Upper Cadiangullong Creek
Cadmium - mg/L
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS0
CAWS2
CAWS3
412168
412144
AEMR - Upper Cadiangullong Creek
Calcium - mg/L
200
150
100
50
0
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS0
CAWS2
CAWS3
412168
412144

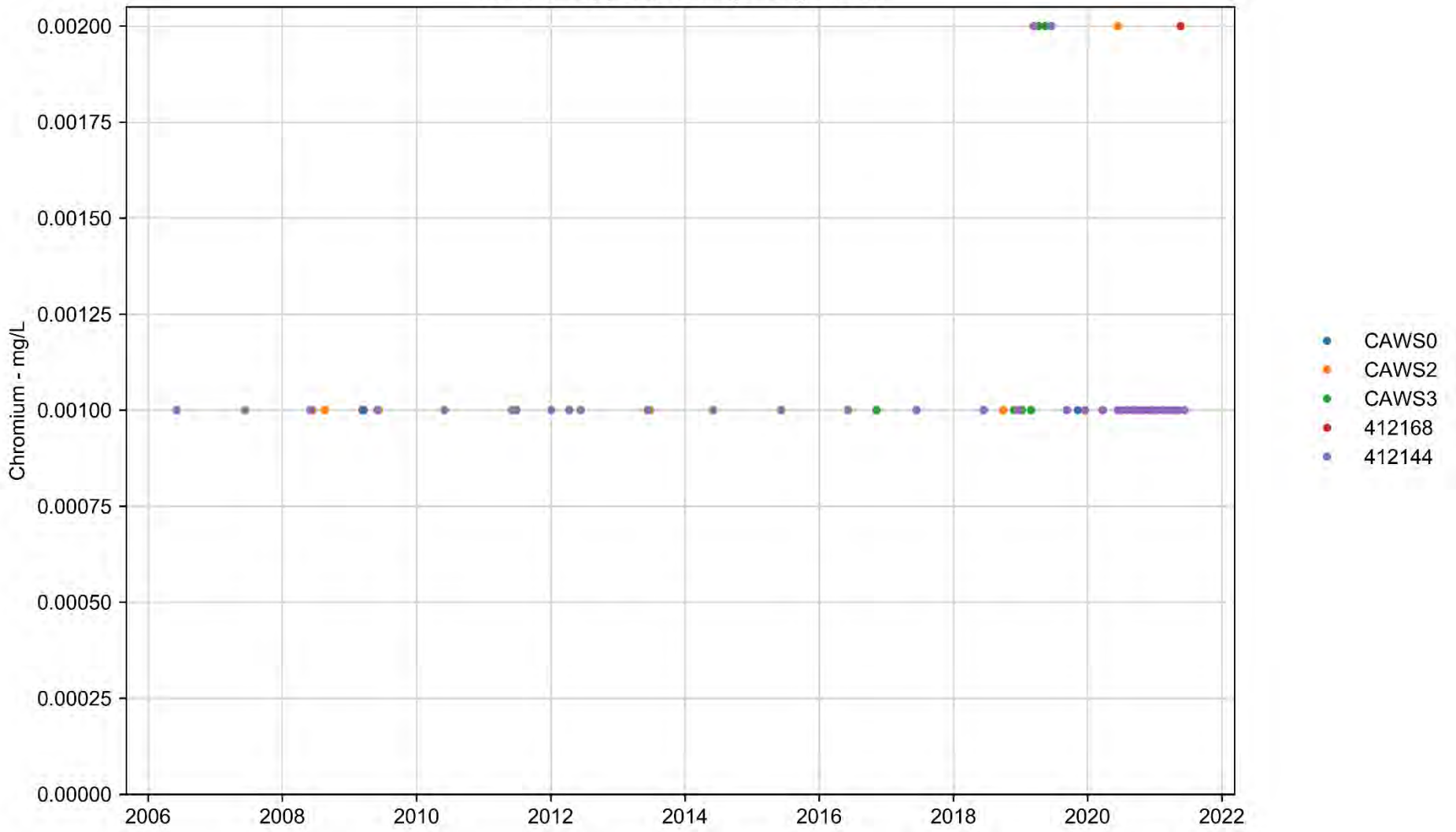
AEMR - Upper Cadiangullong Creek



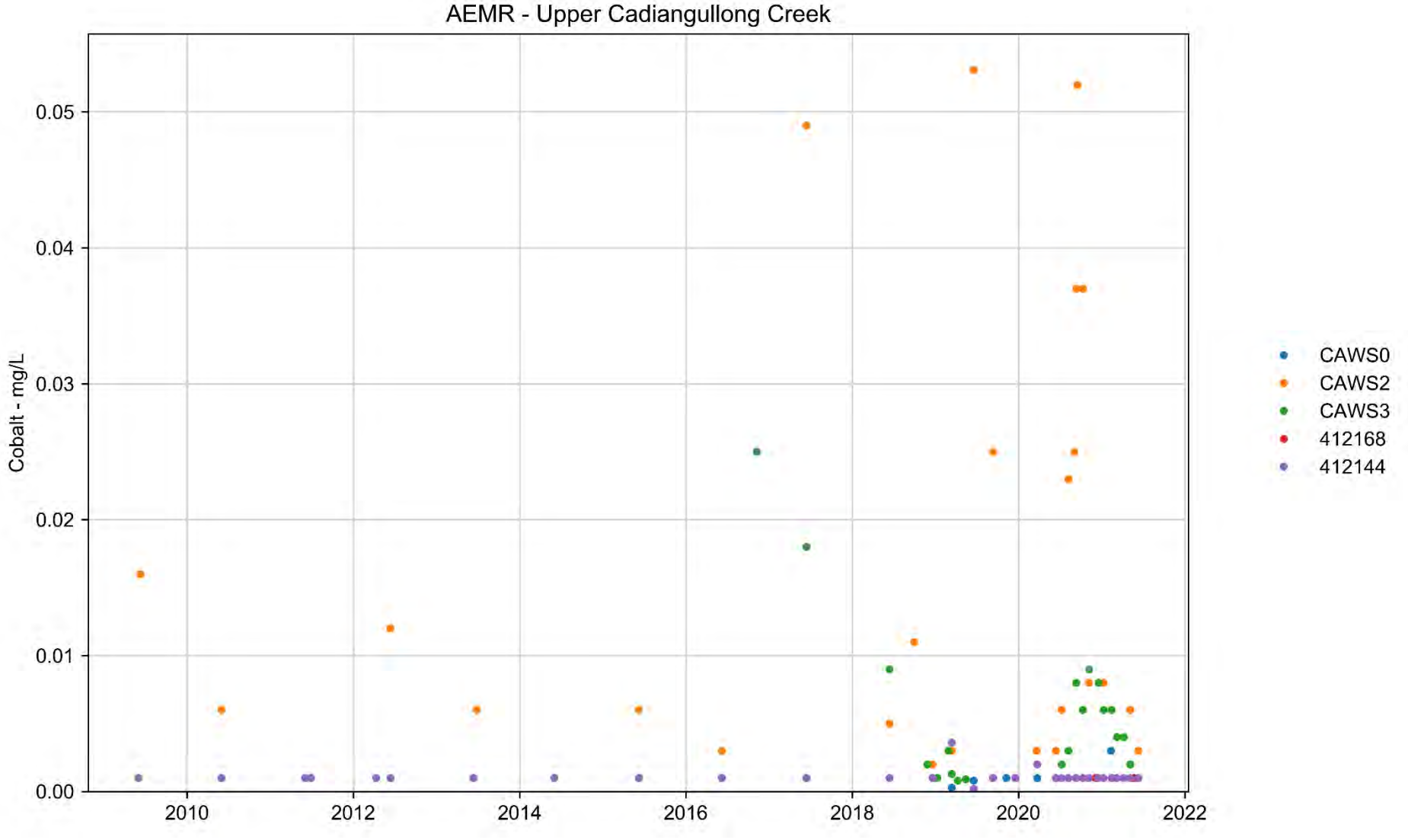
AEMR - Upper Cadiangullong Creek

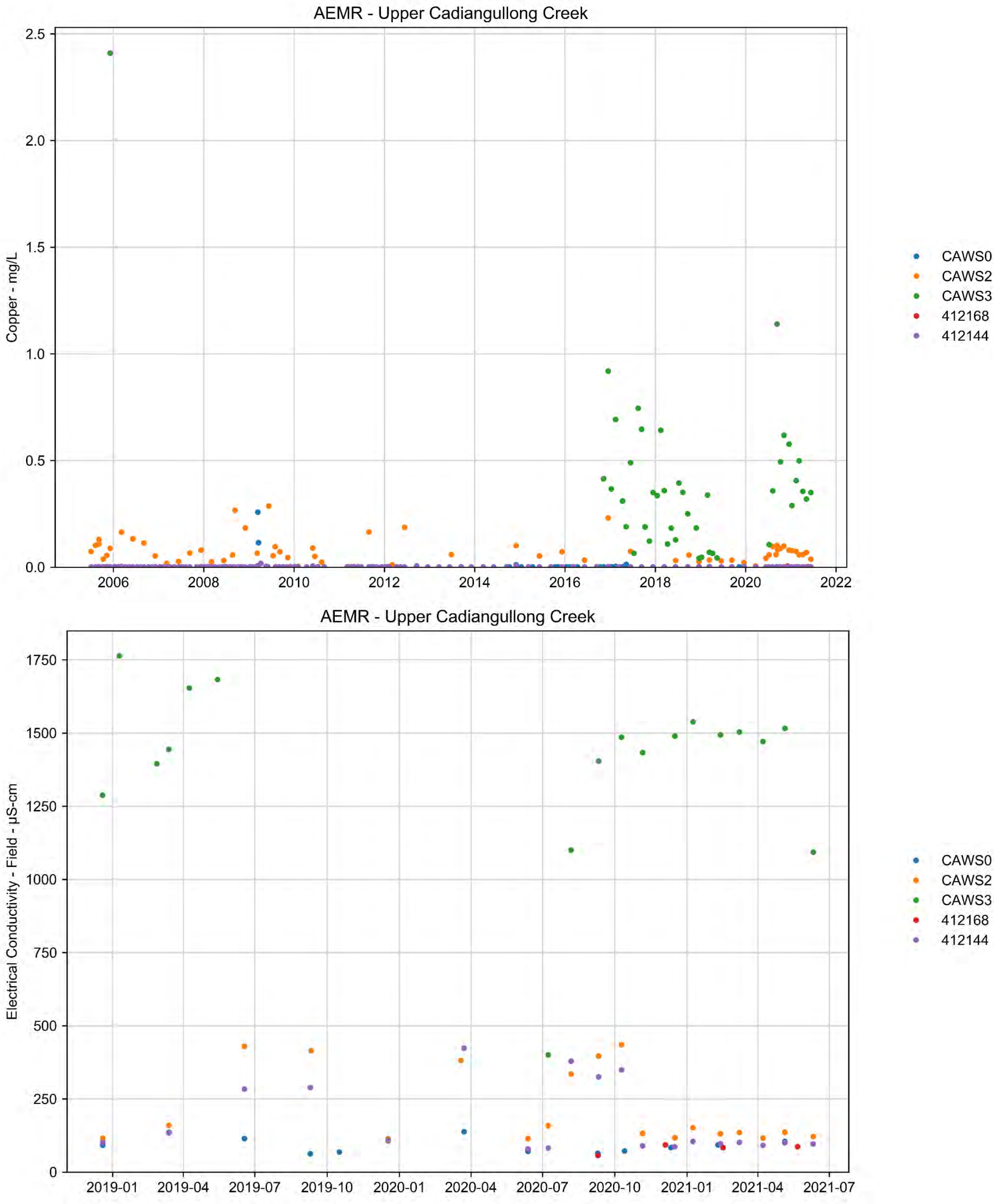


AEMR - Upper Cadiangullong Creek

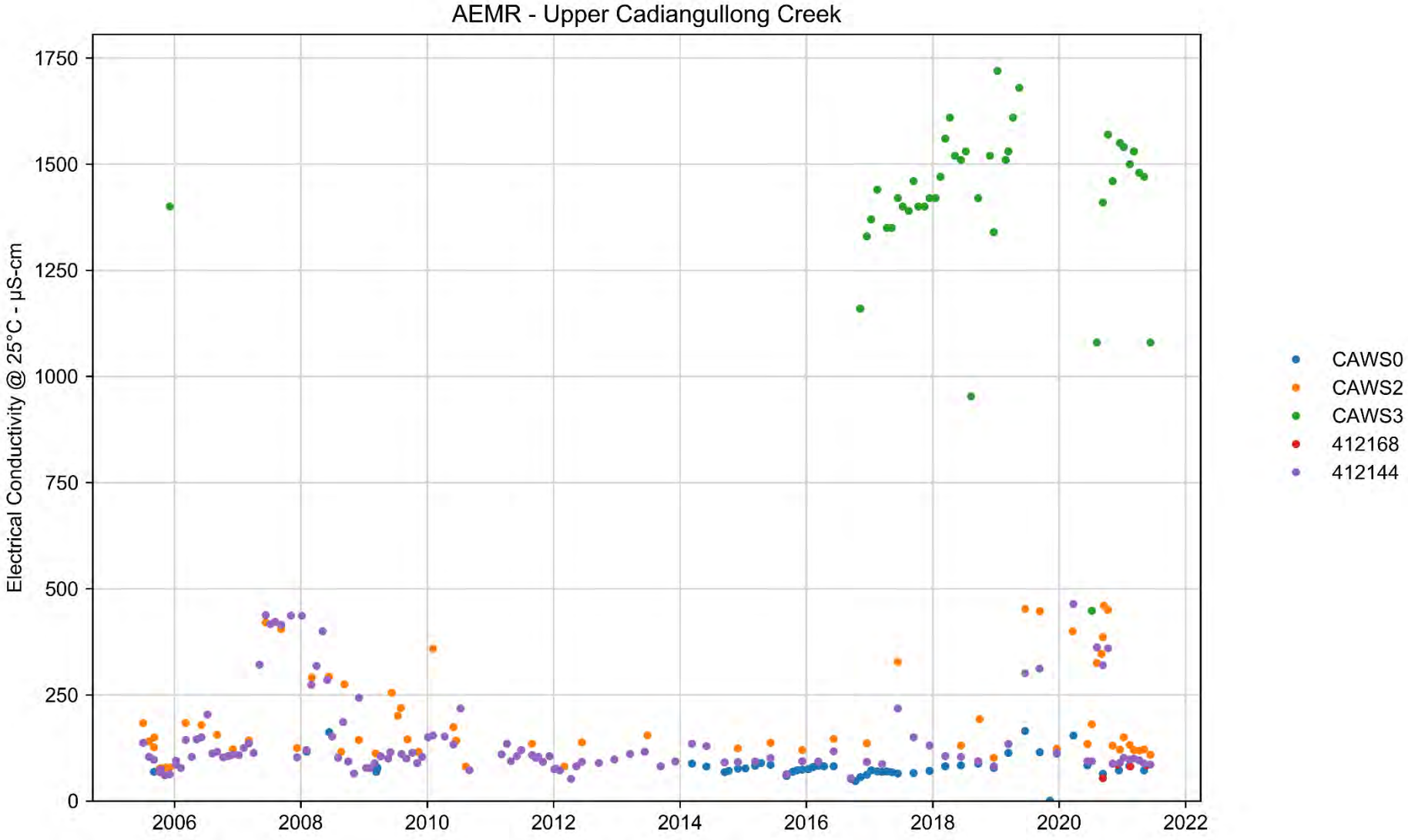


AEMR - Upper Cadiangullong Creek

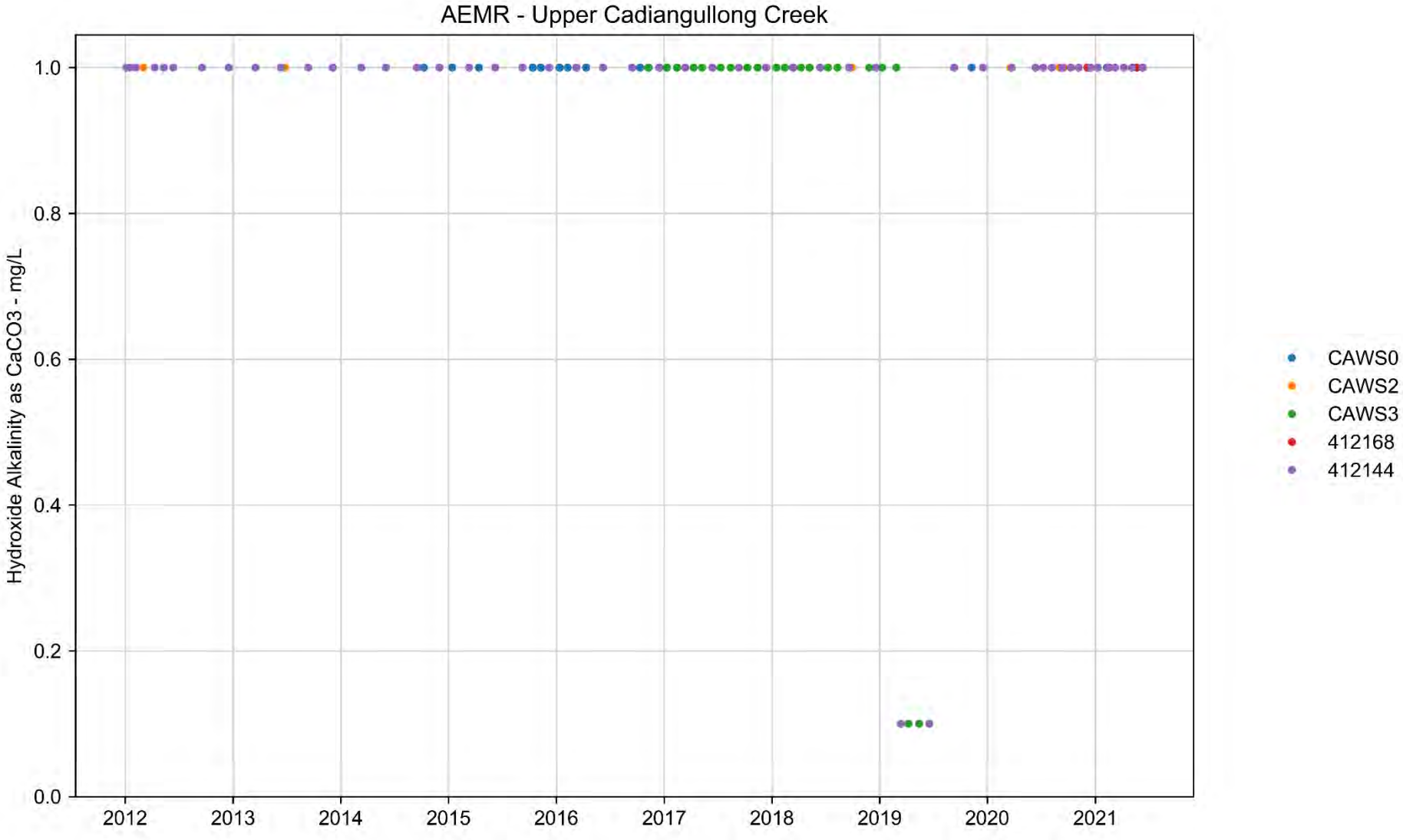


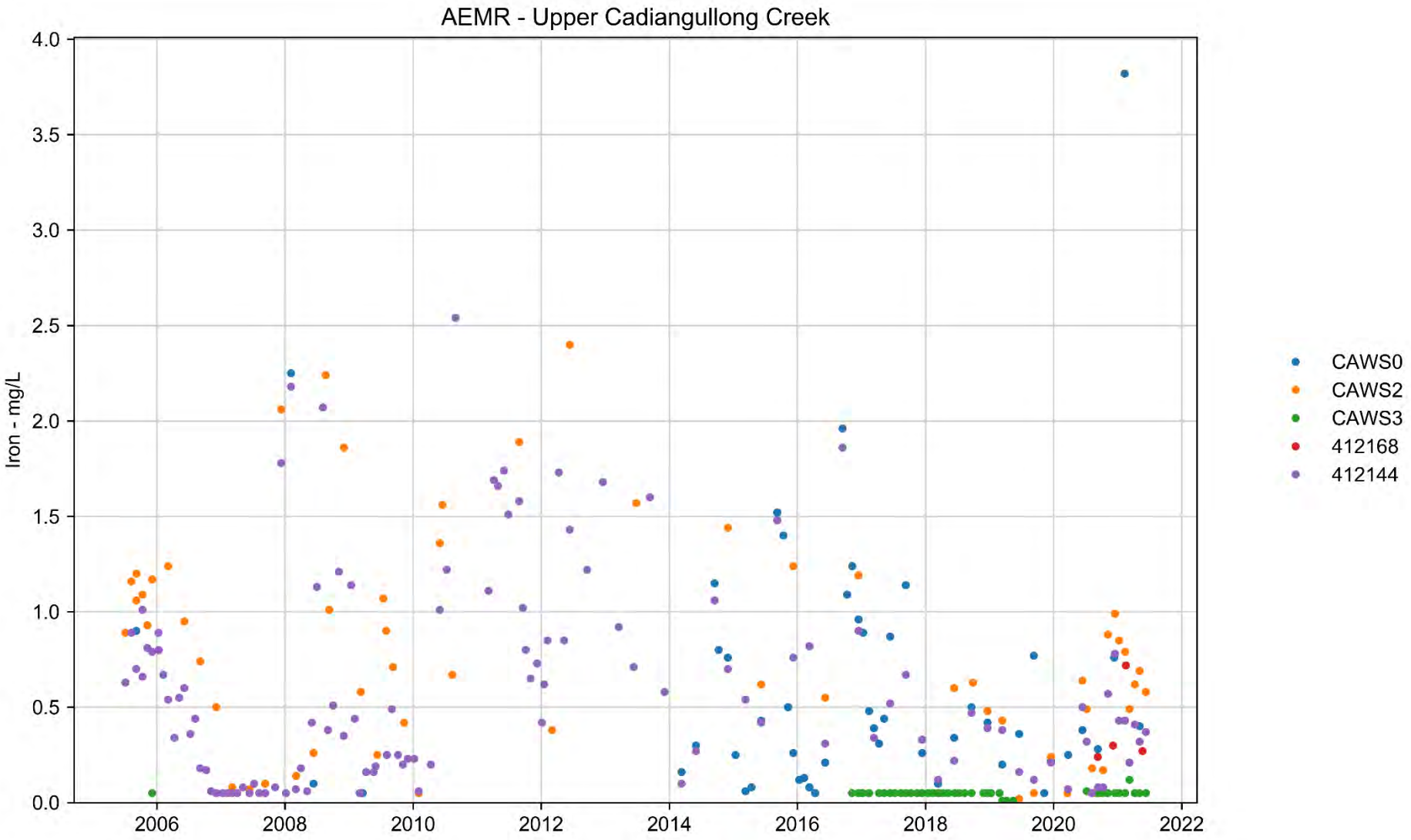

AEMR - Upper Cadiangullong Creek
Copper - mg/L
2.5
2.0
1.5
1.0
0.5
0.0
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS0
CAWS2
CAWS3
412168
412144
AEMR - Upper Cadiangullong Creek
Electrical Conductivity - Field - µS-cm
1750
1500
1250
1000
750
500
250
0
2019-01
2019-04
2019-07
2019-10
2020-01
2020-04
2020-07
2020-10
2021-01
2021-04
2021-07
CAWS0
CAWS2
CAWS3
412168
412144

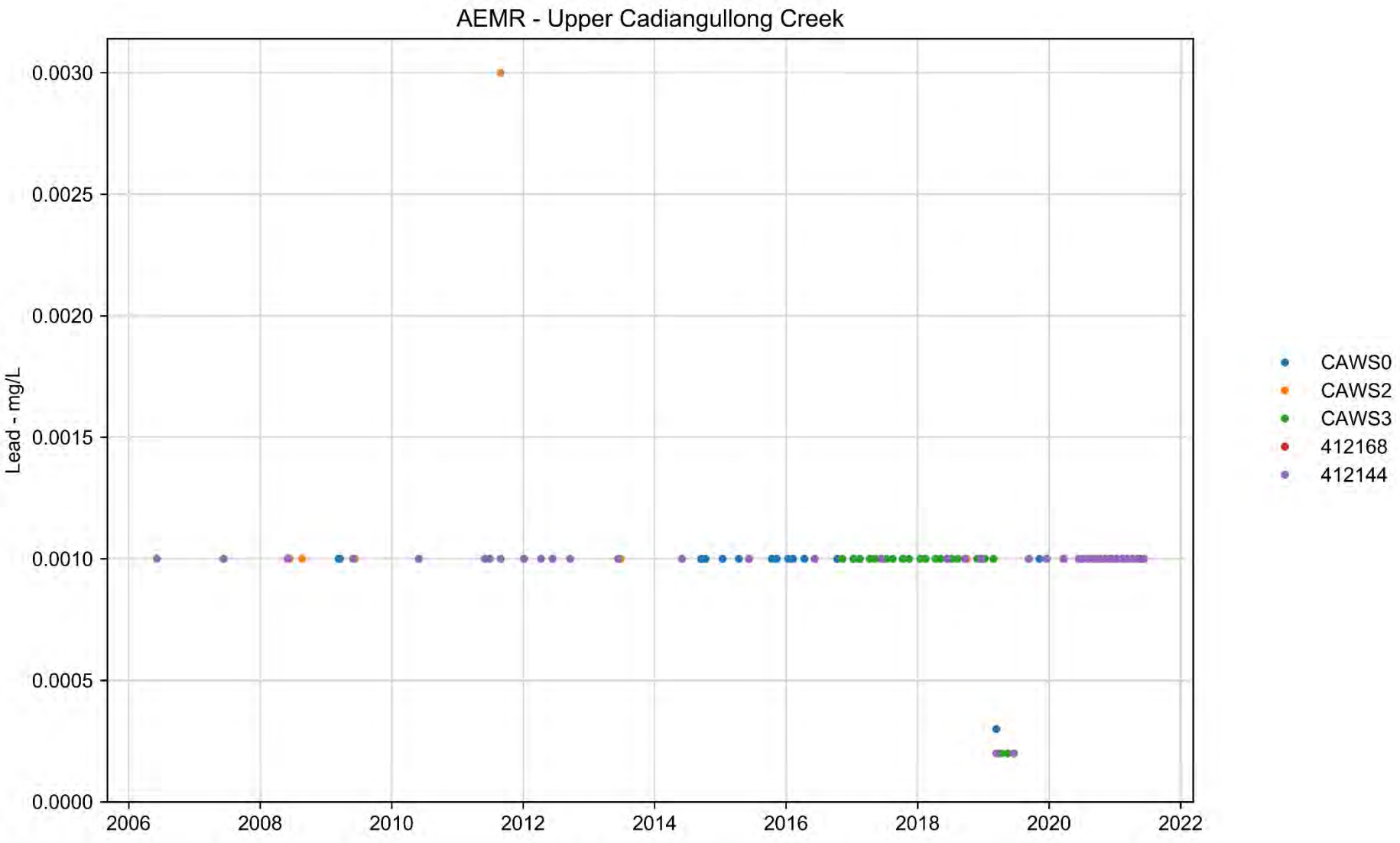
AEMR - Upper Cadiangullong Creek



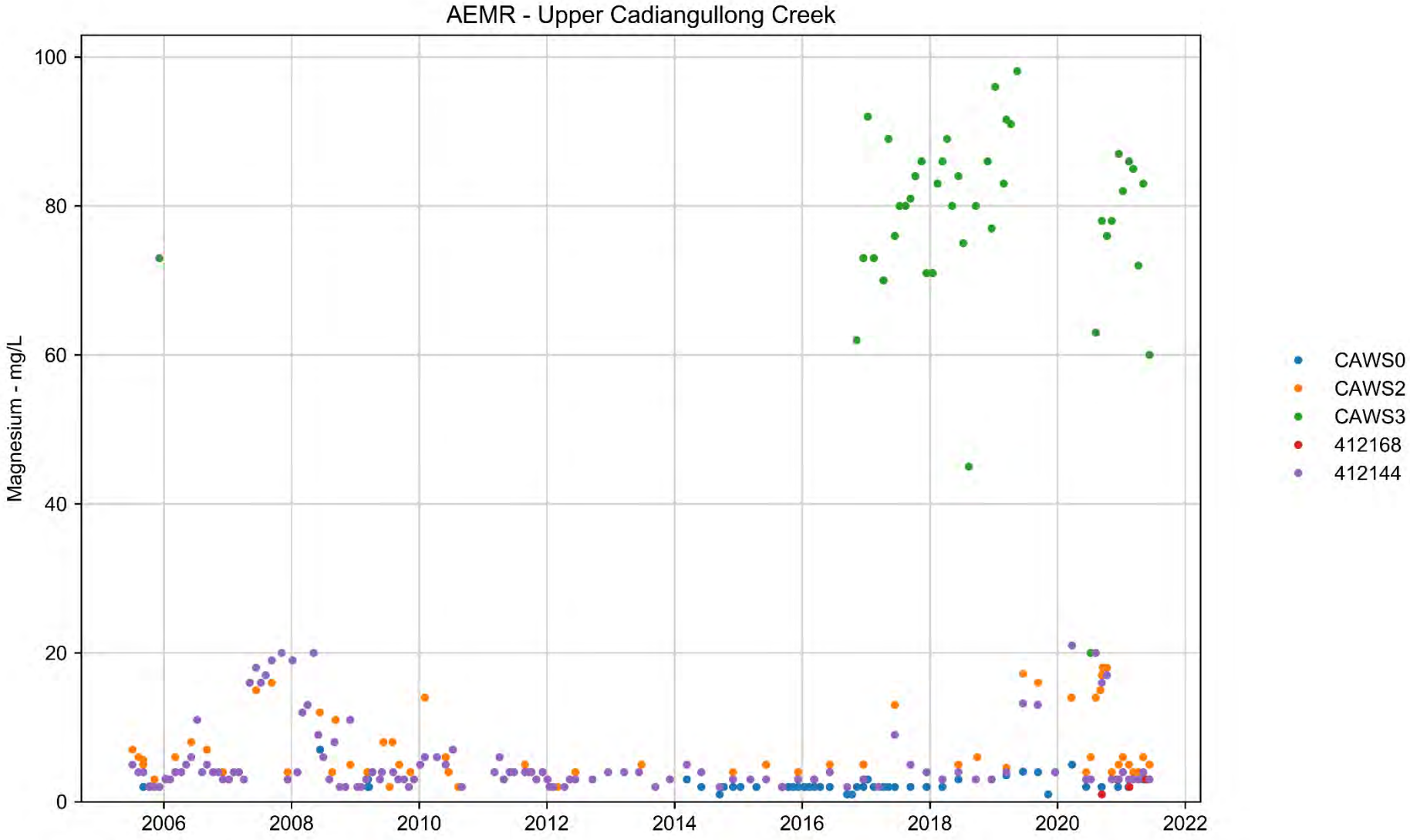
AEMR - Upper Cadiangullong Creek



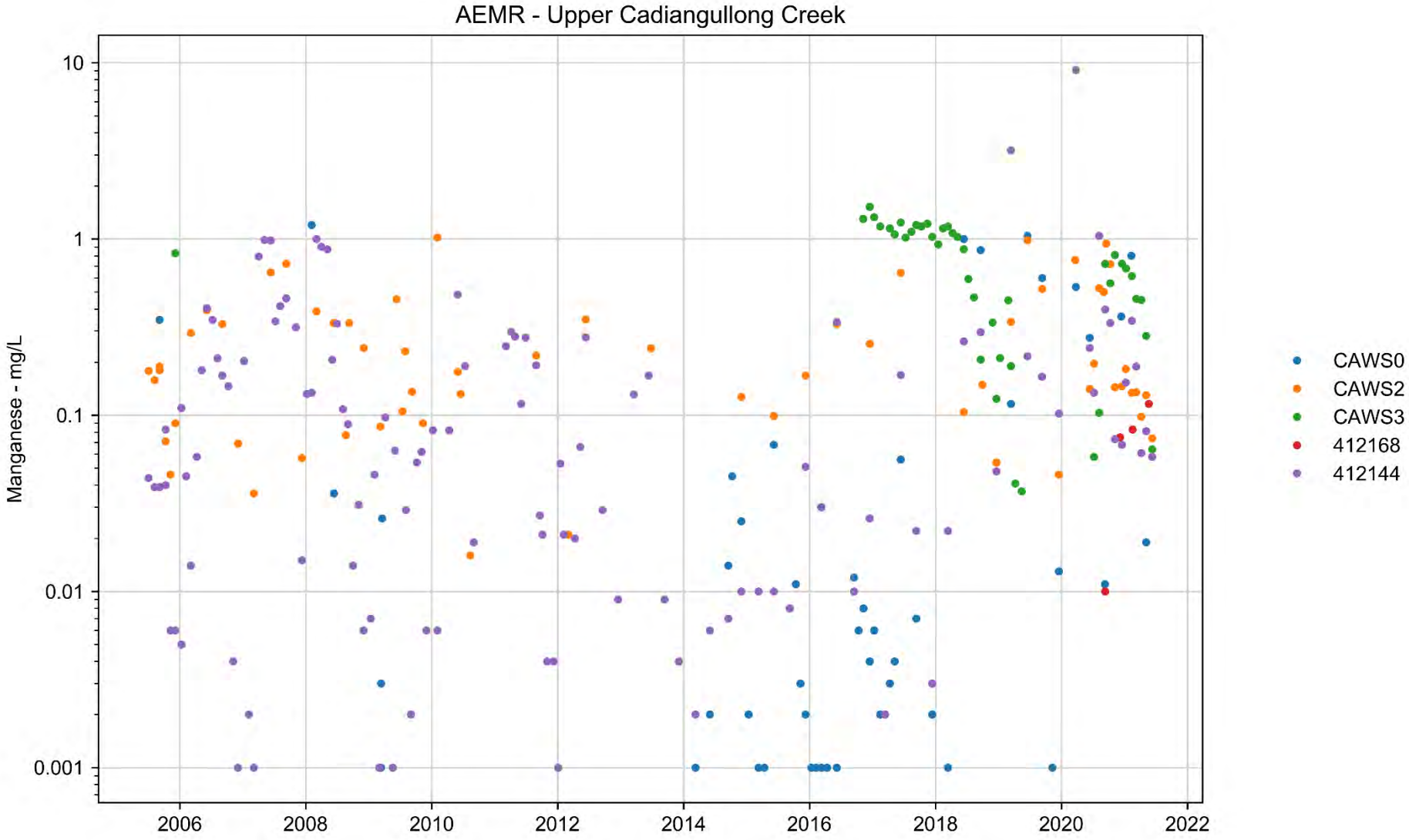

AEMR - Upper Cadiangullong Creek
Iron - mg/L
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS0
CAWS2
CAWS3
412168
412144


AEMR - Upper Cadiangullong Creek
Lead - mg/L
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS0
CAWS2
CAWS3
412168
412144

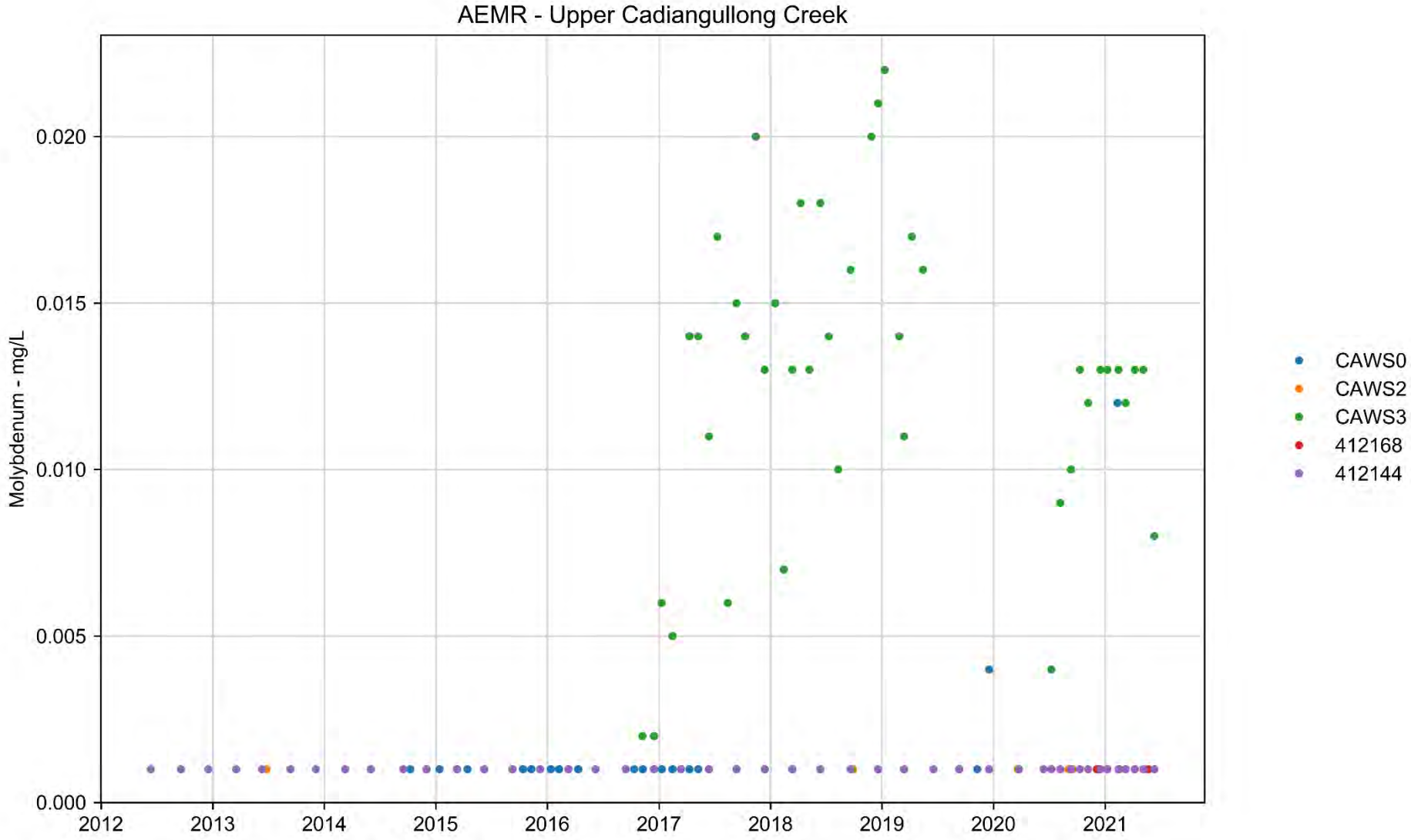
AEMR - Upper Cadiangullong Creek



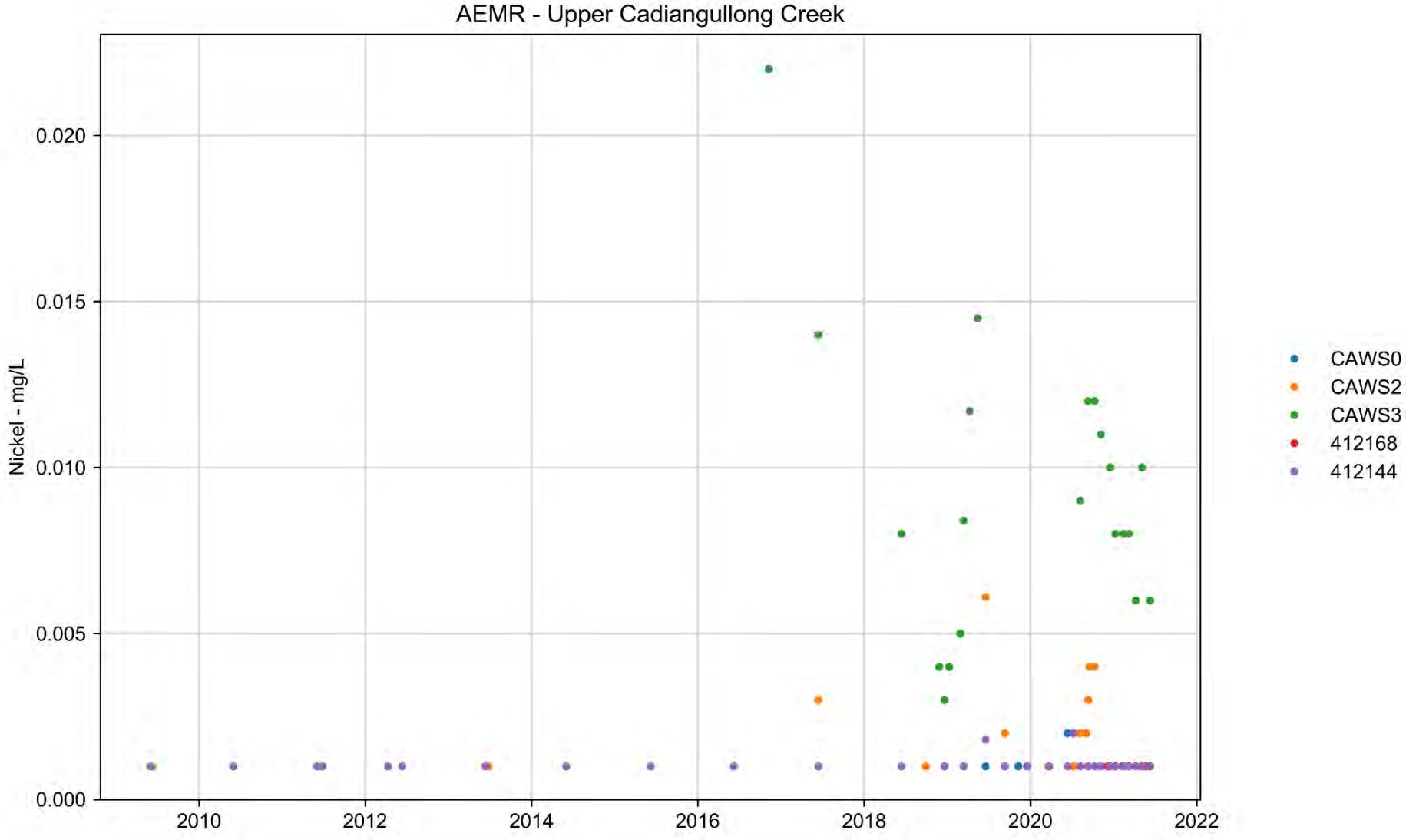
AEMR - Upper Cadiangullong Creek



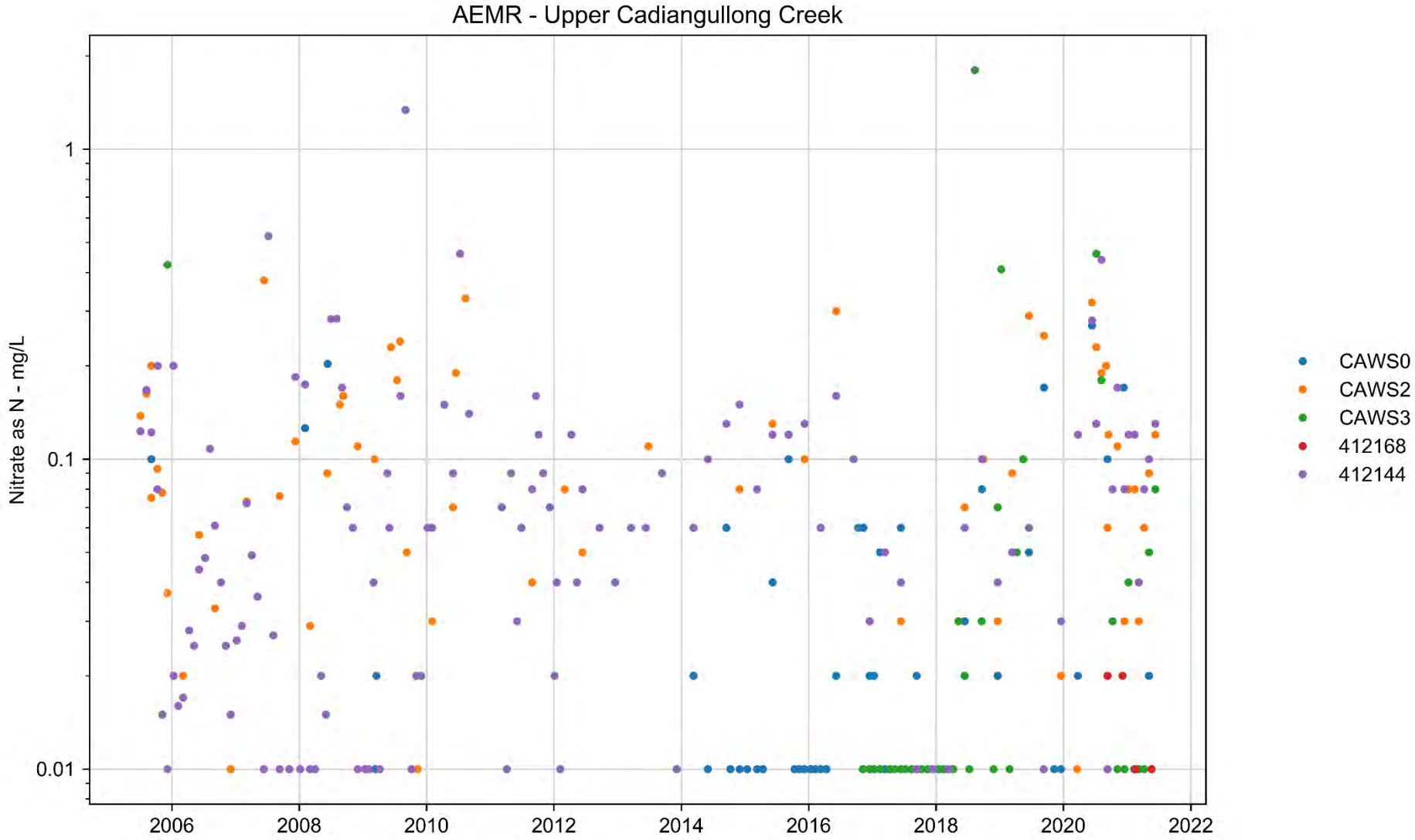
AEMR - Upper Cadiangullong Creek



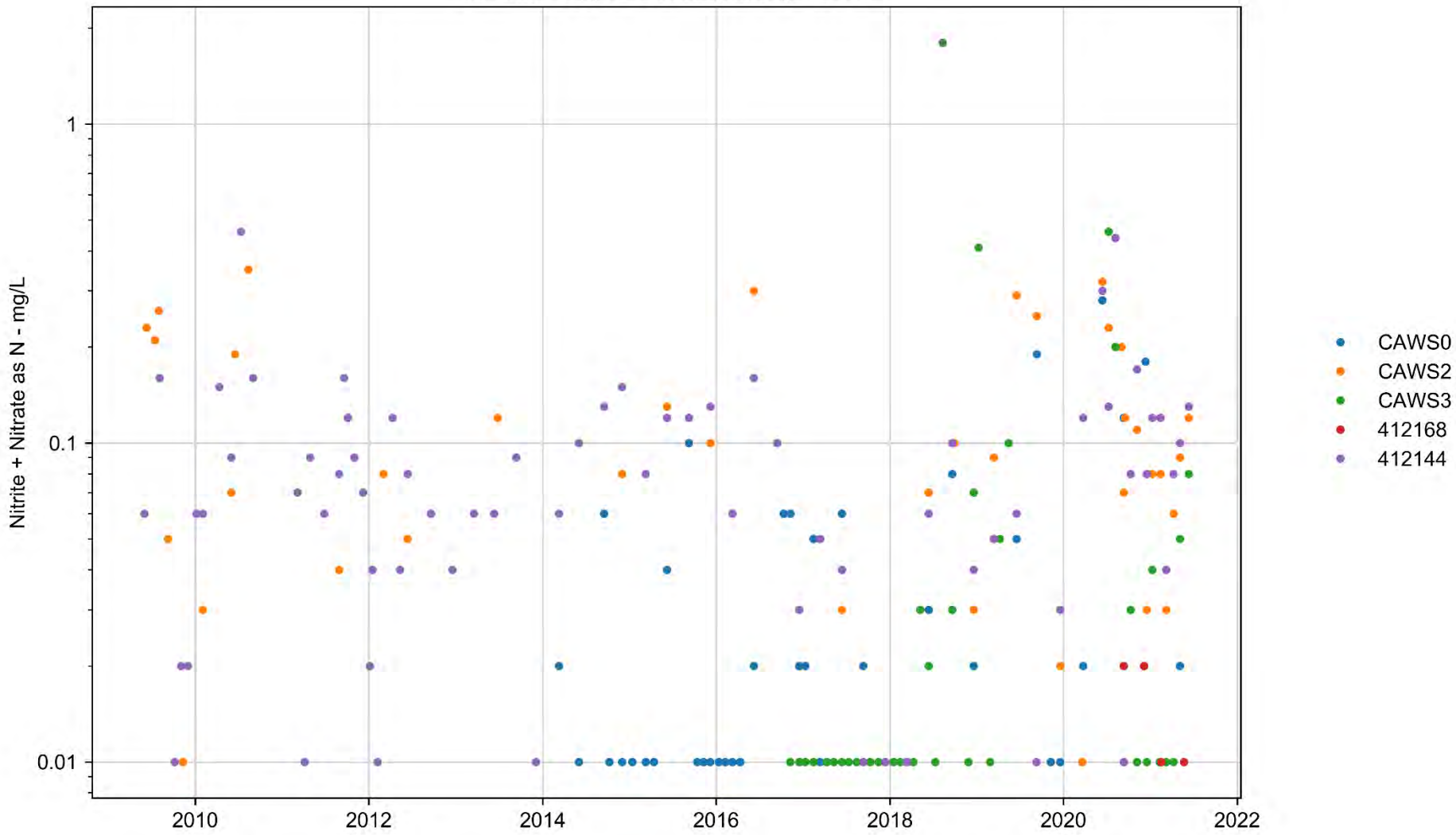
AEMR - Upper Cadiangullong Creek



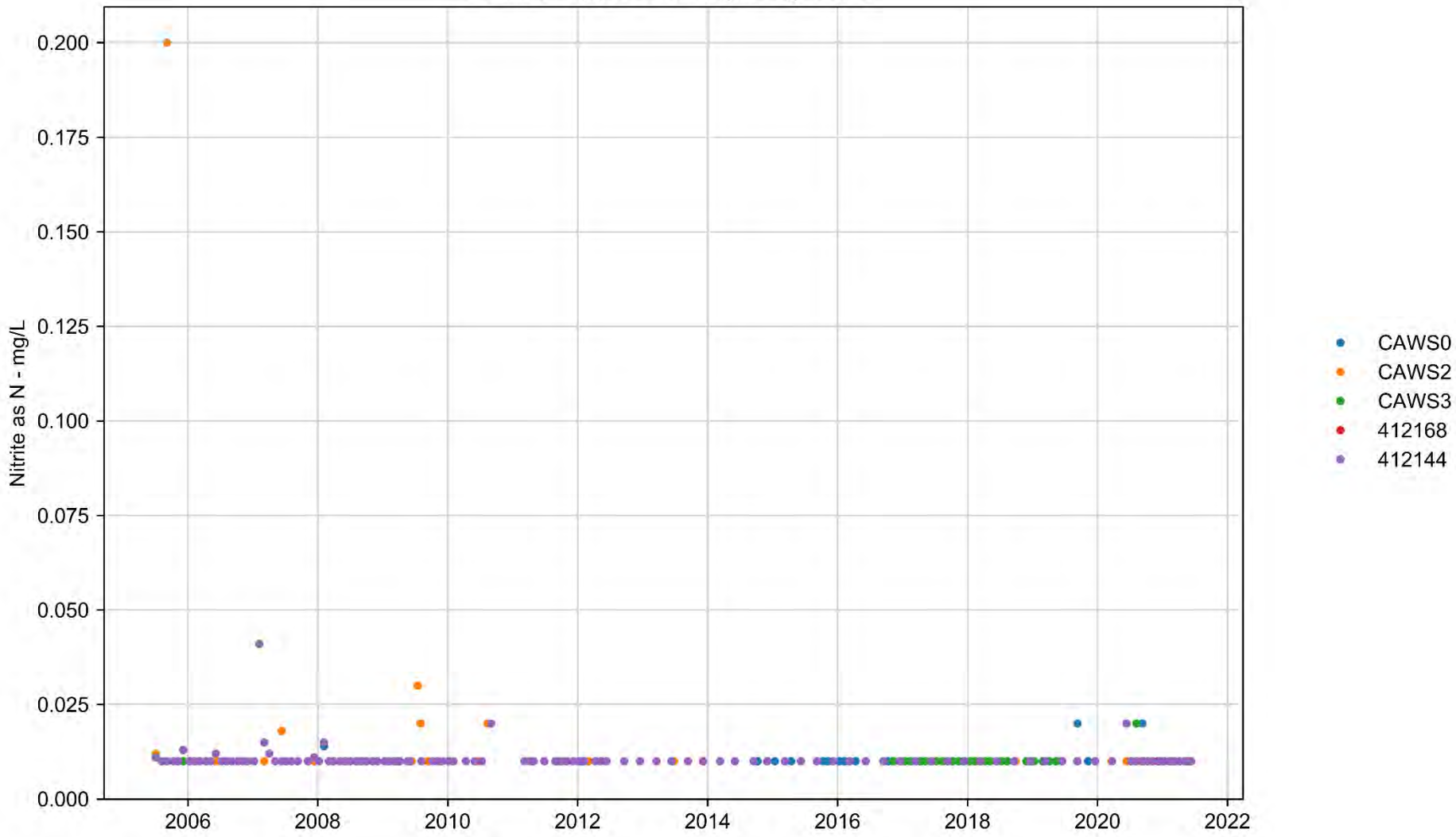
AEMR - Upper Cadiangullong Creek



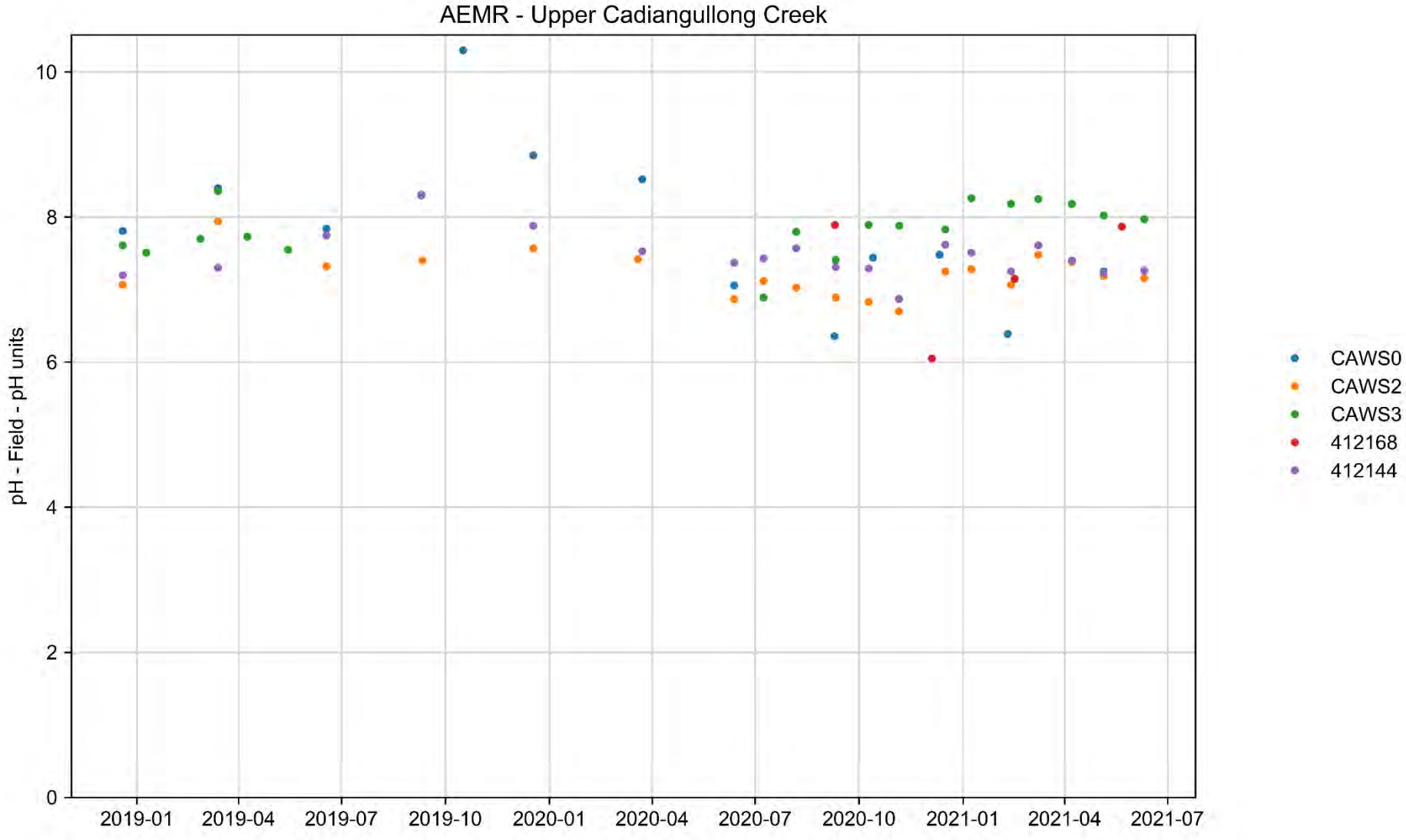
AEMR - Upper Cadiangullong Creek

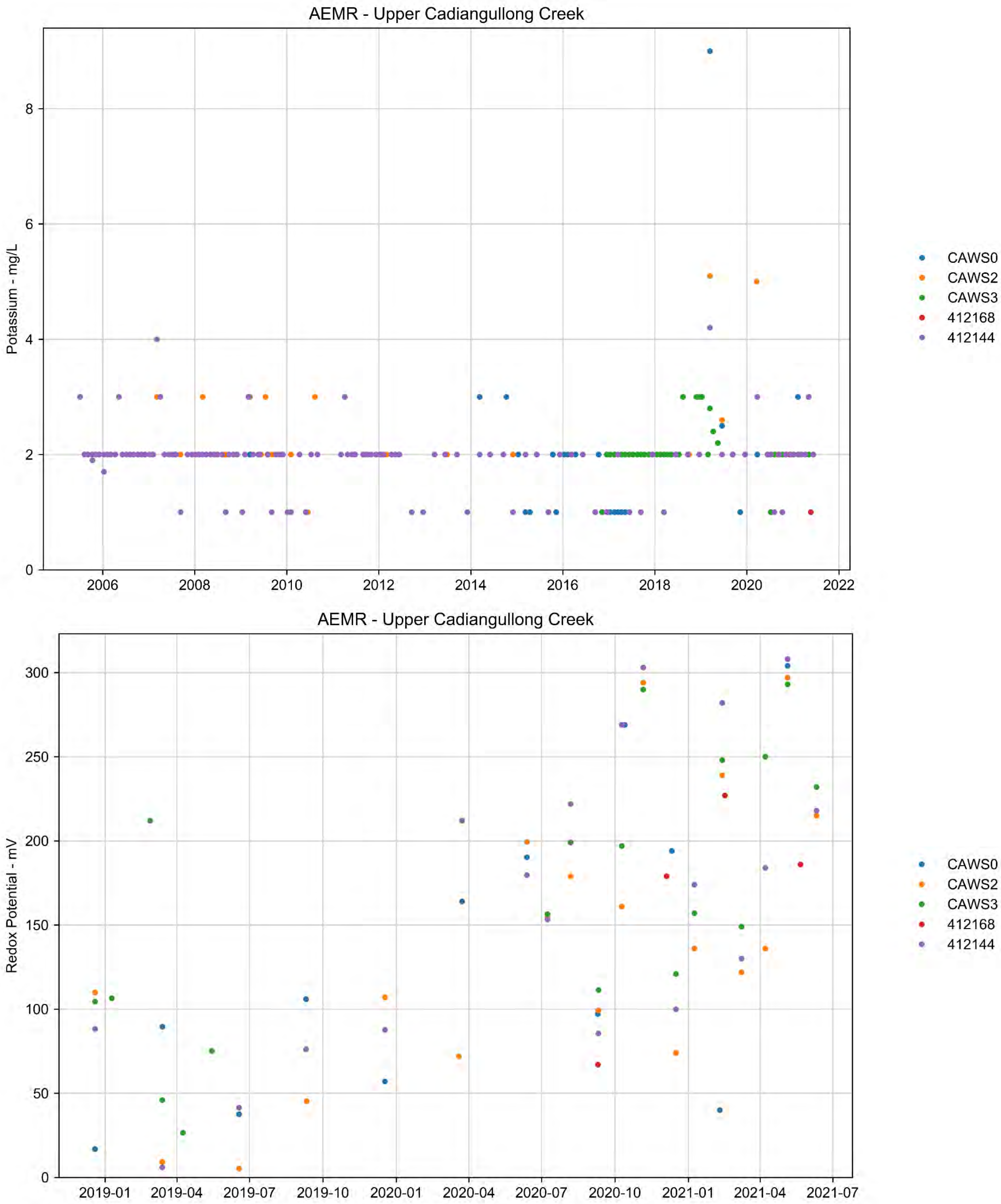


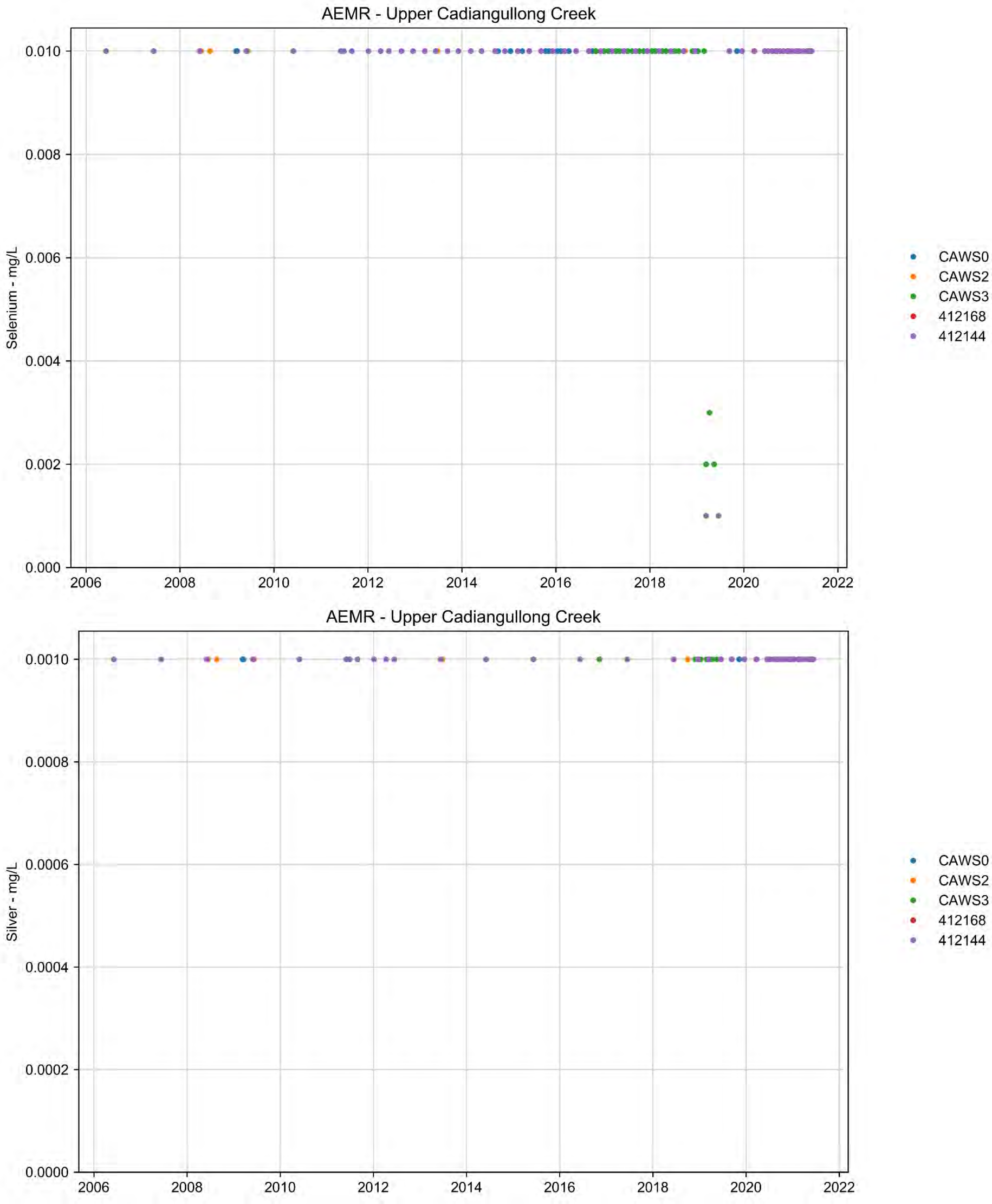
AEMR - Upper Cadiangullong Creek



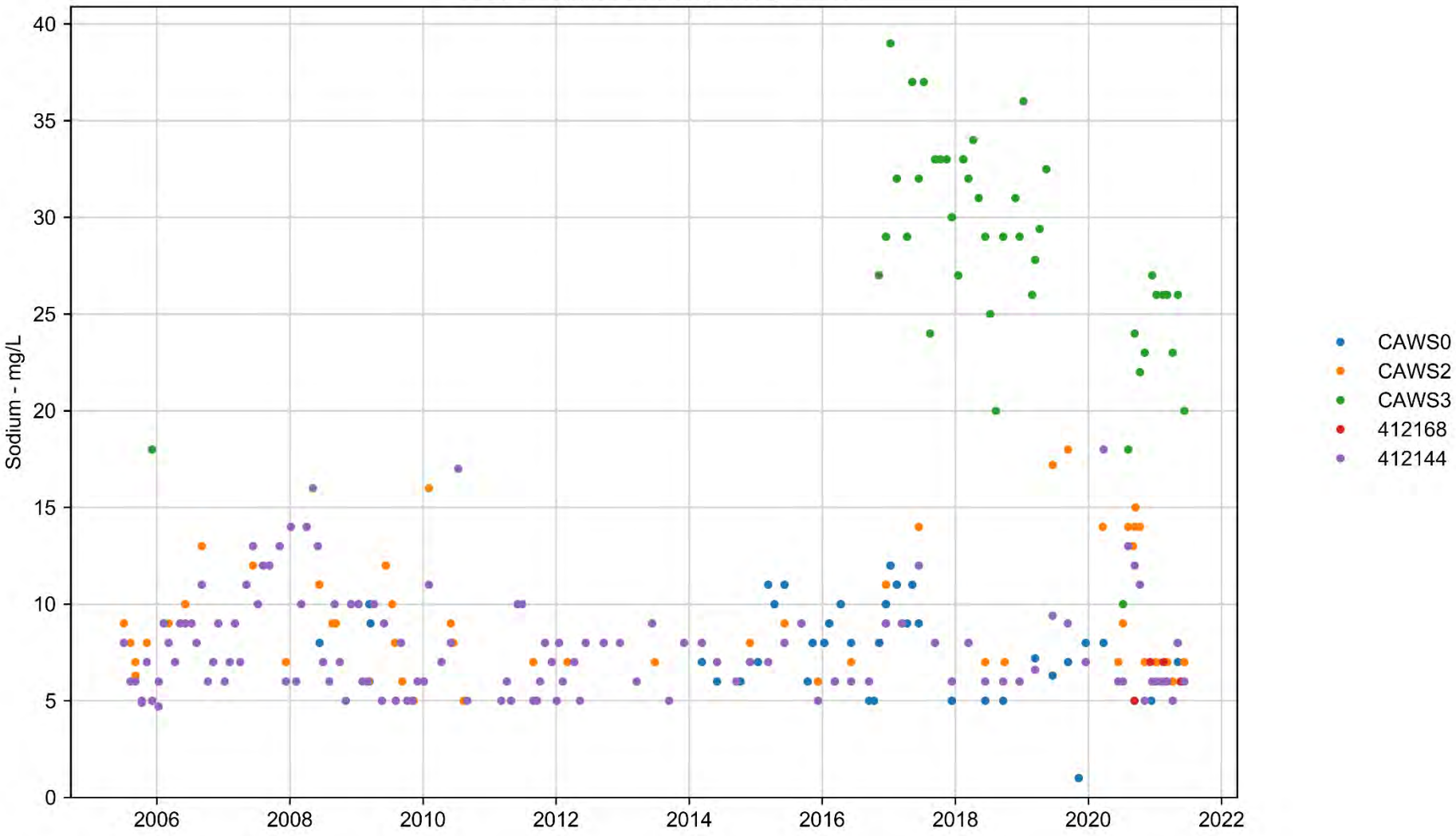
AEMR - Upper Cadiangullong Creek



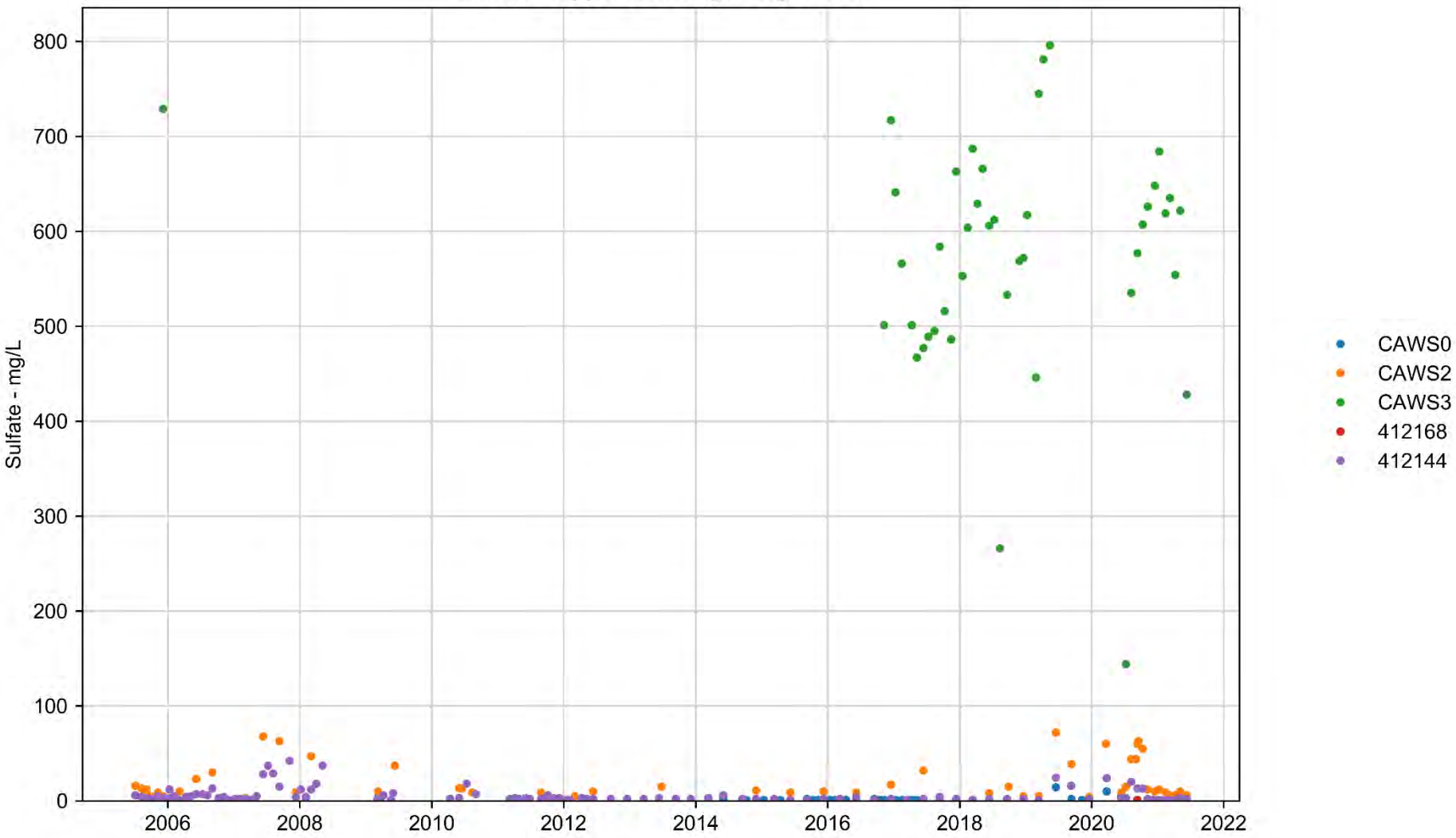

AEMR - Upper Cadiangullong Creek
Potassium - mg/L
0
2
4
6
8
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS0
CAWS2
CAWS3
412168
412144
AEMR - Upper Cadiangullong Creek
Redox Potential - mV
0
50
100
150
200
250
300
2019-01
2019-04
2019-07
2019-10
2020-01
2020-04
2020-07
2020-10
2021-01
2021-04
2021-07
CAWS0
CAWS2
CAWS3
412168
412144


AEMR - Upper Cadiangullong Creek
Selenium - mg/L
0.010
0.008
0.006
0.004
0.002
0.000
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS0
CAWS2
CAWS3
412168
412144
AEMR - Upper Cadiangullong Creek
Silver - mg/L
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS0
CAWS2
CAWS3
412168
412144

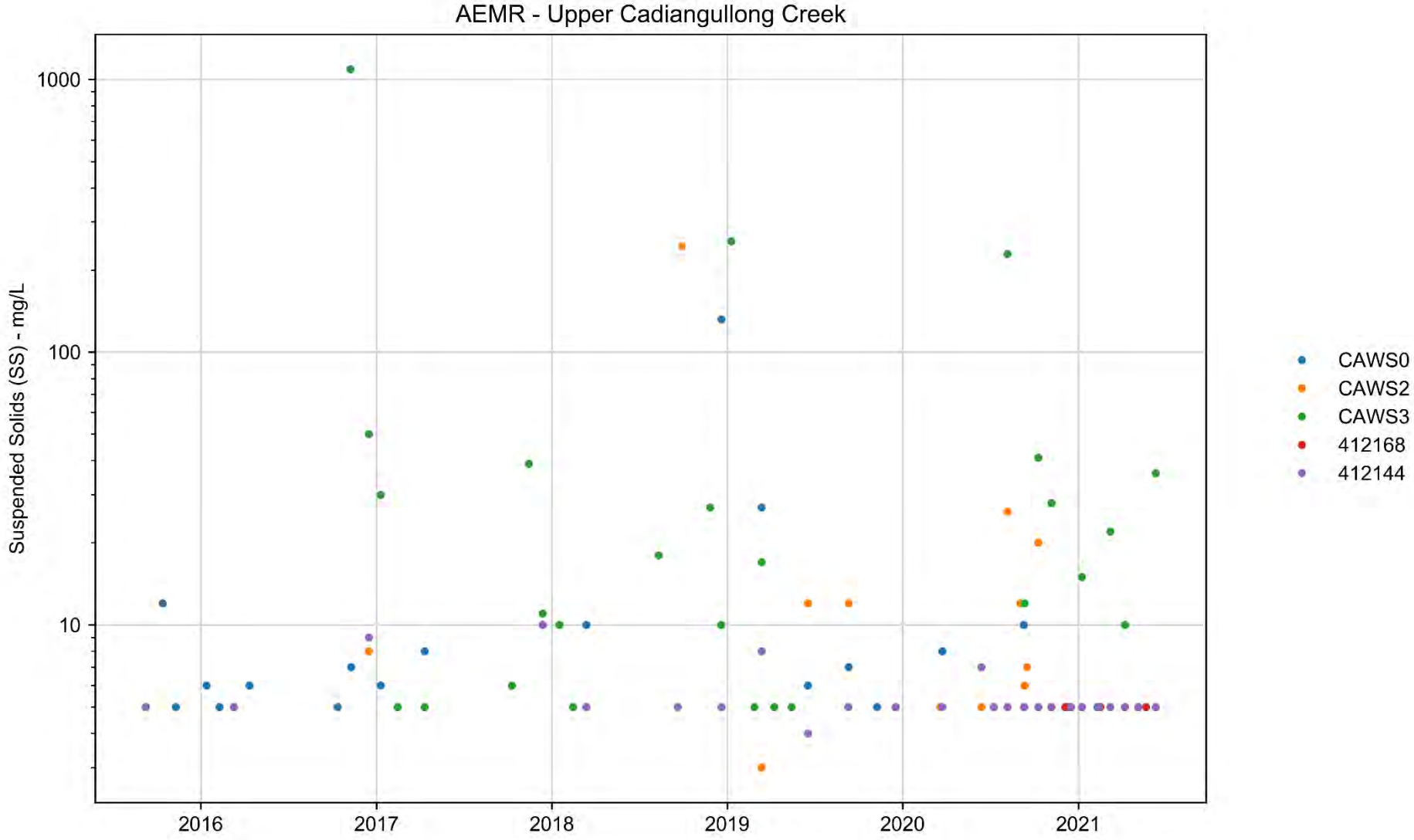
AEMR - Upper Cadiangullong Creek



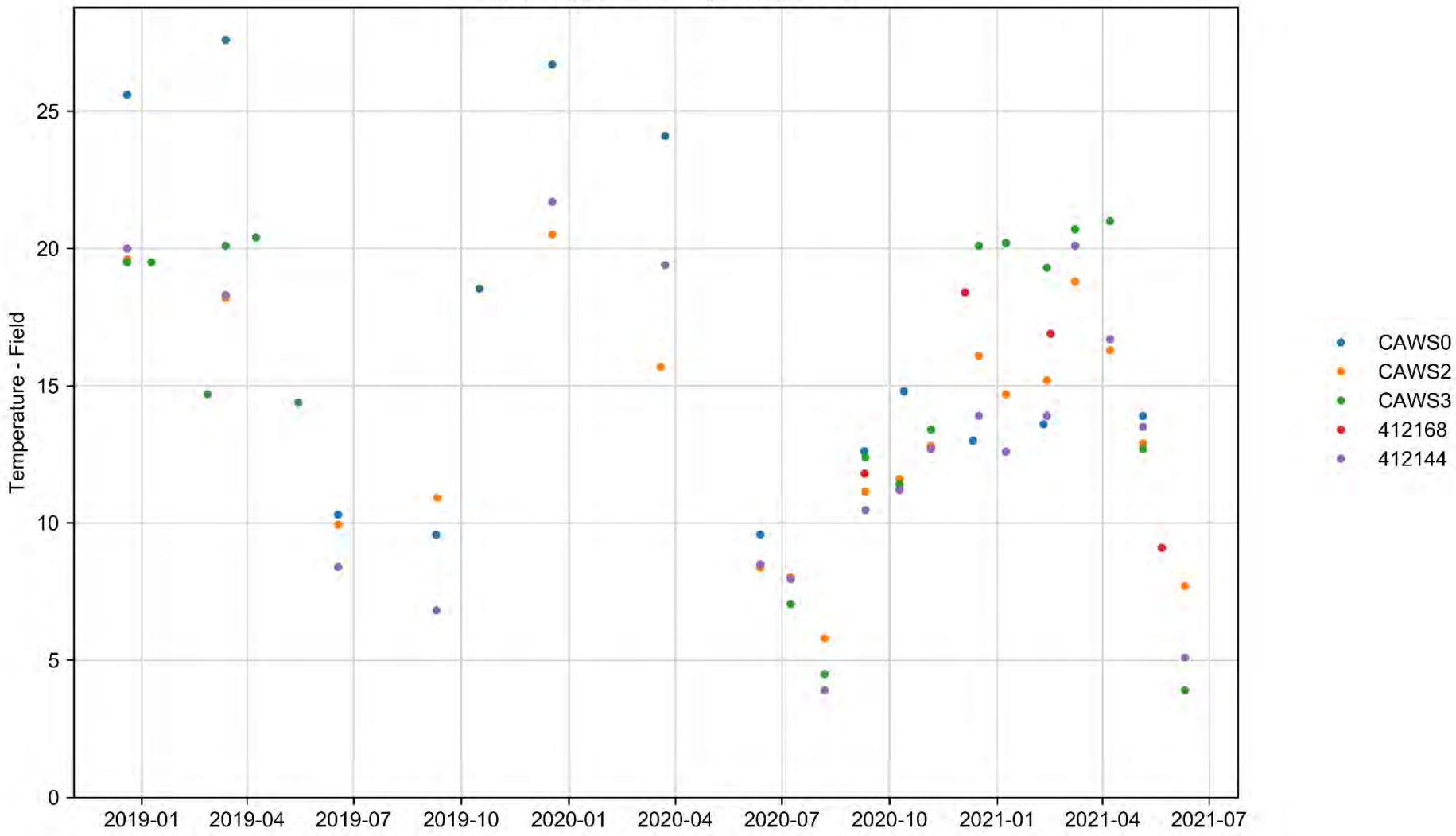
AEMR - Upper Cadiangullong Creek



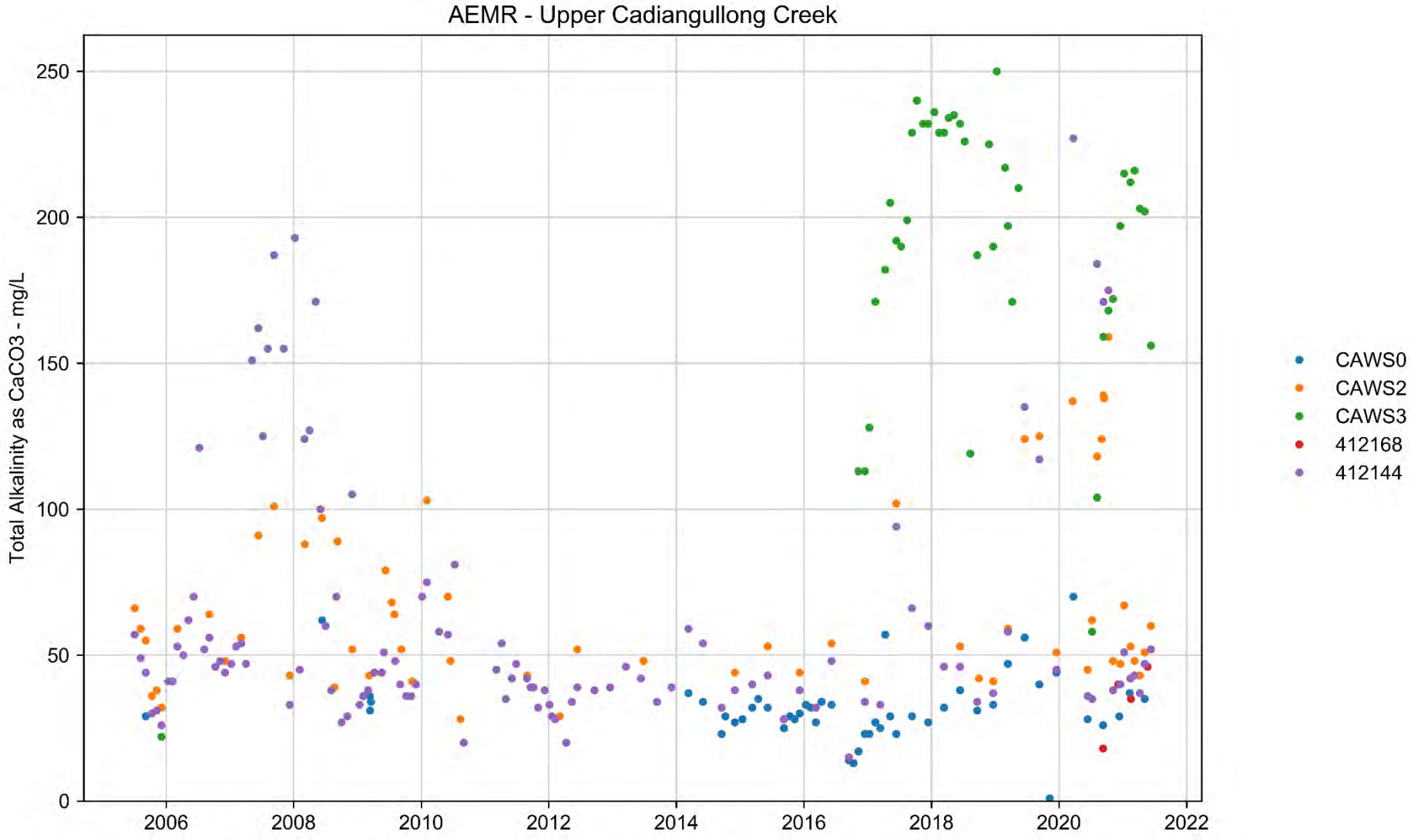
AEMR - Upper Cadiangullong Creek



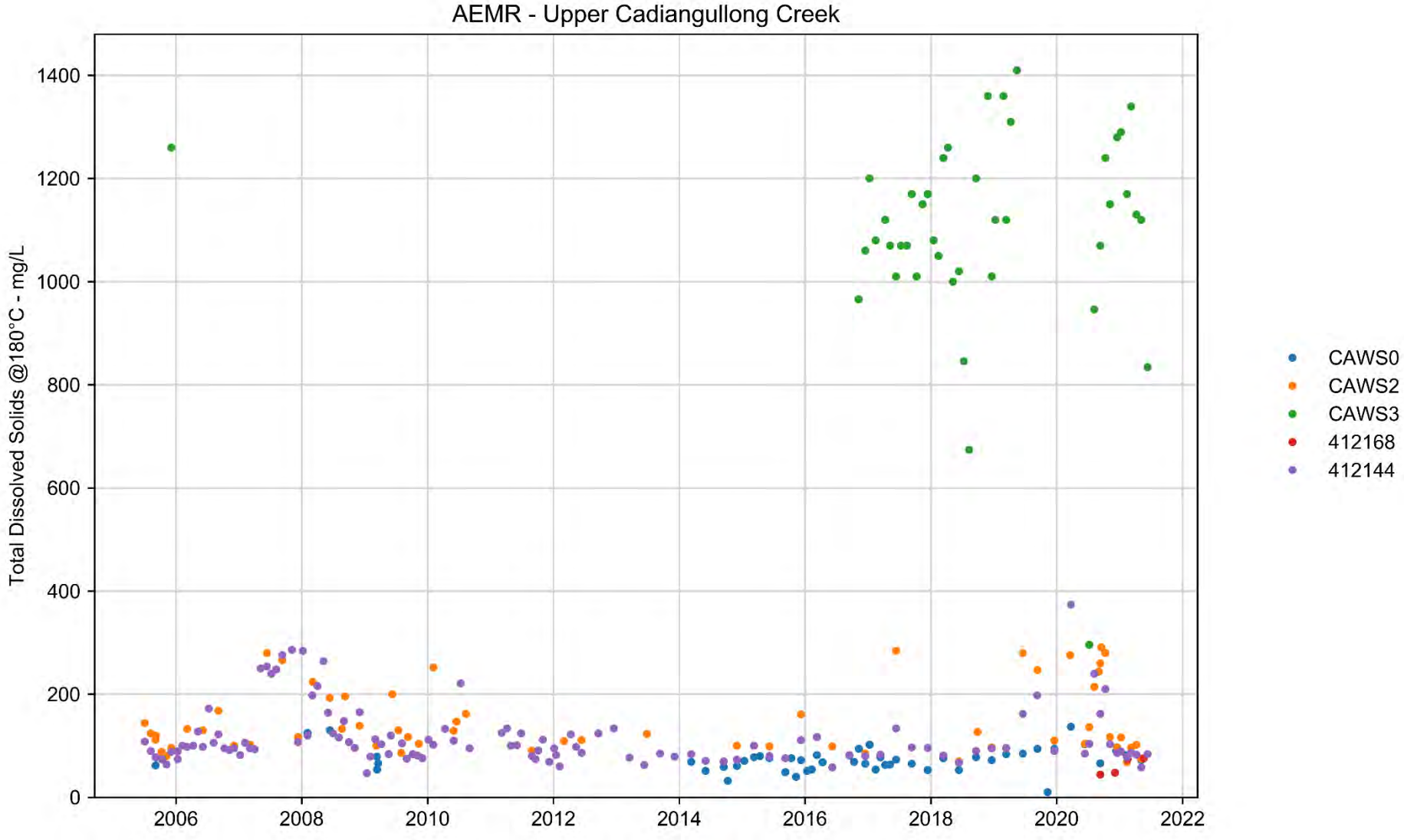
AEMR - Upper Cadiangullong Creek

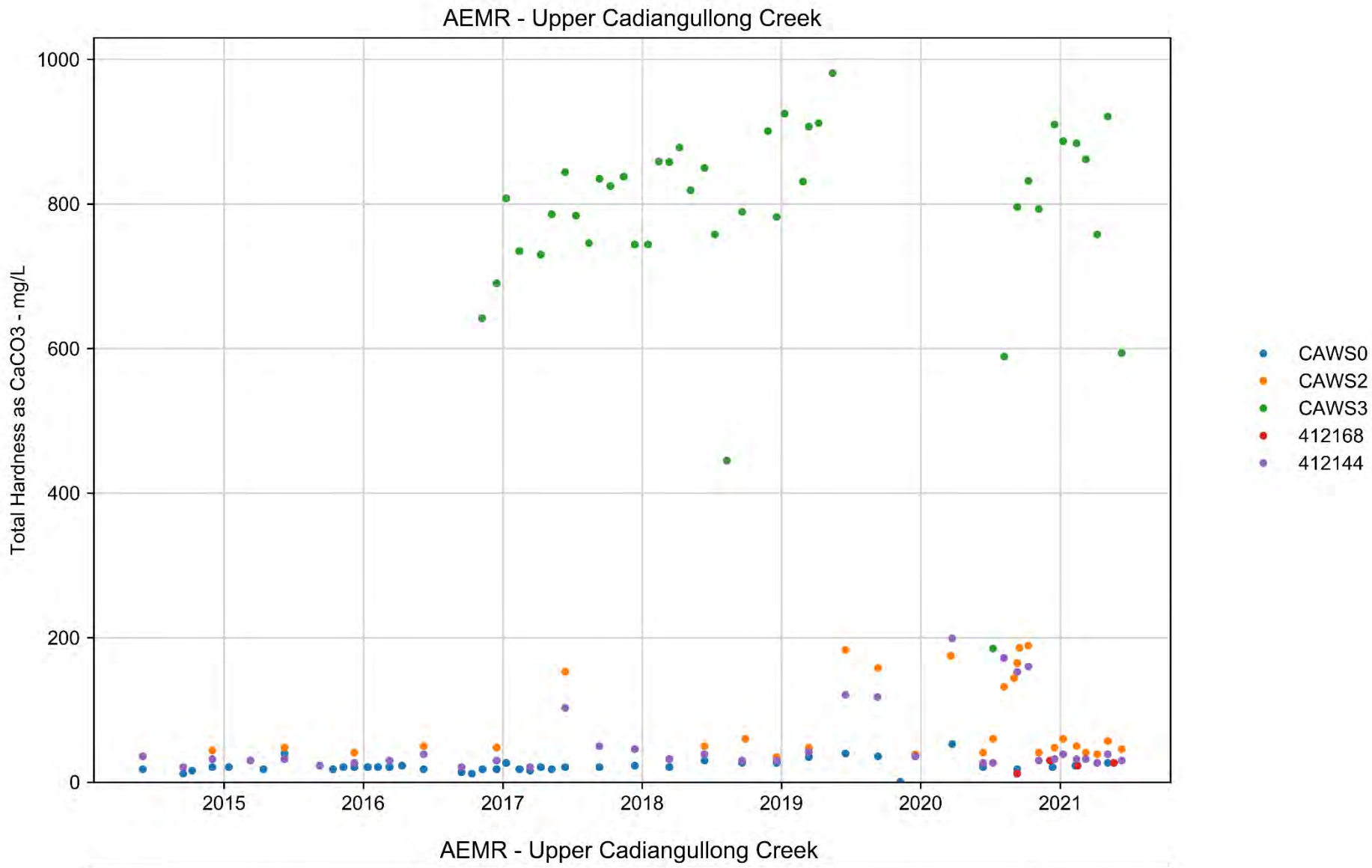


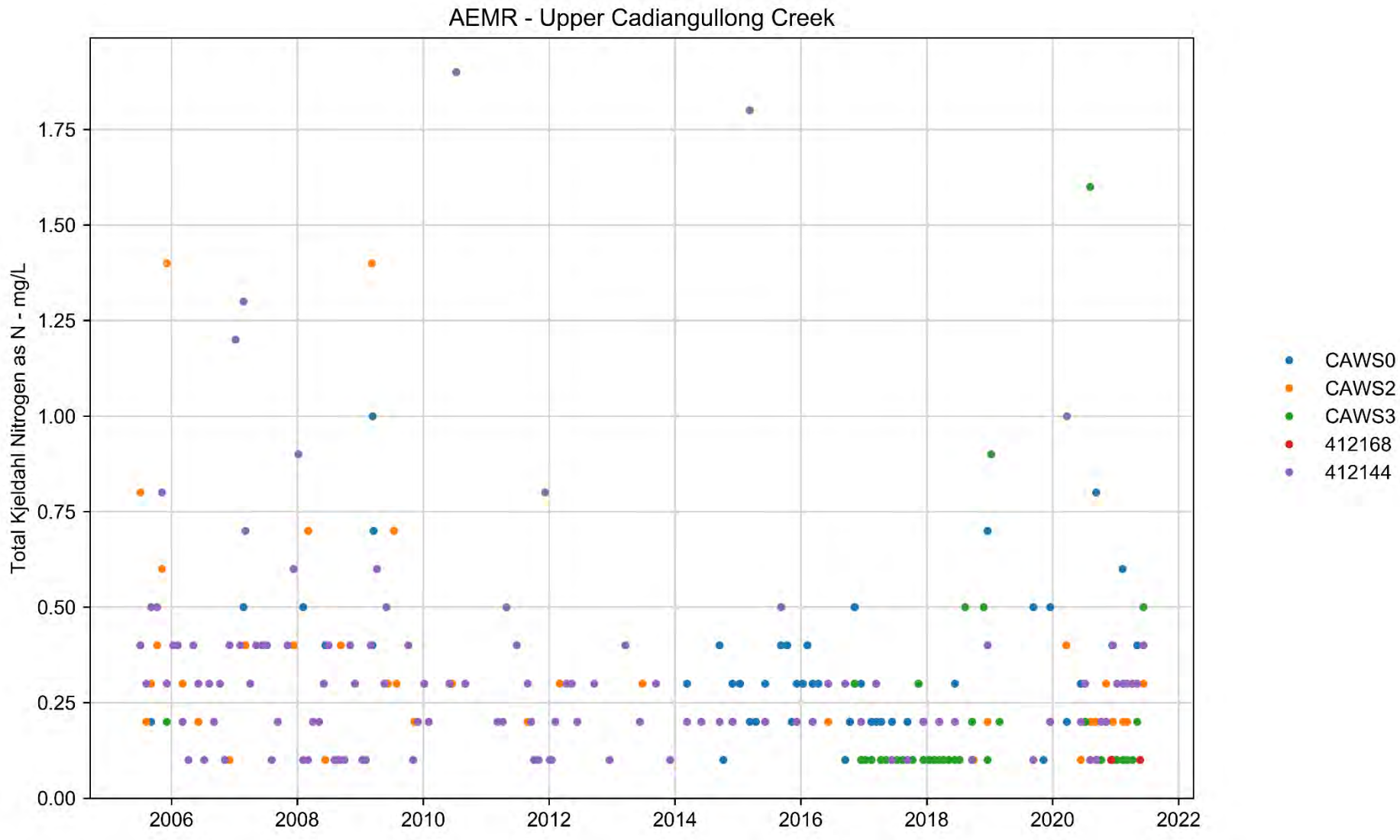
AEMR - Upper Cadiangullong Creek

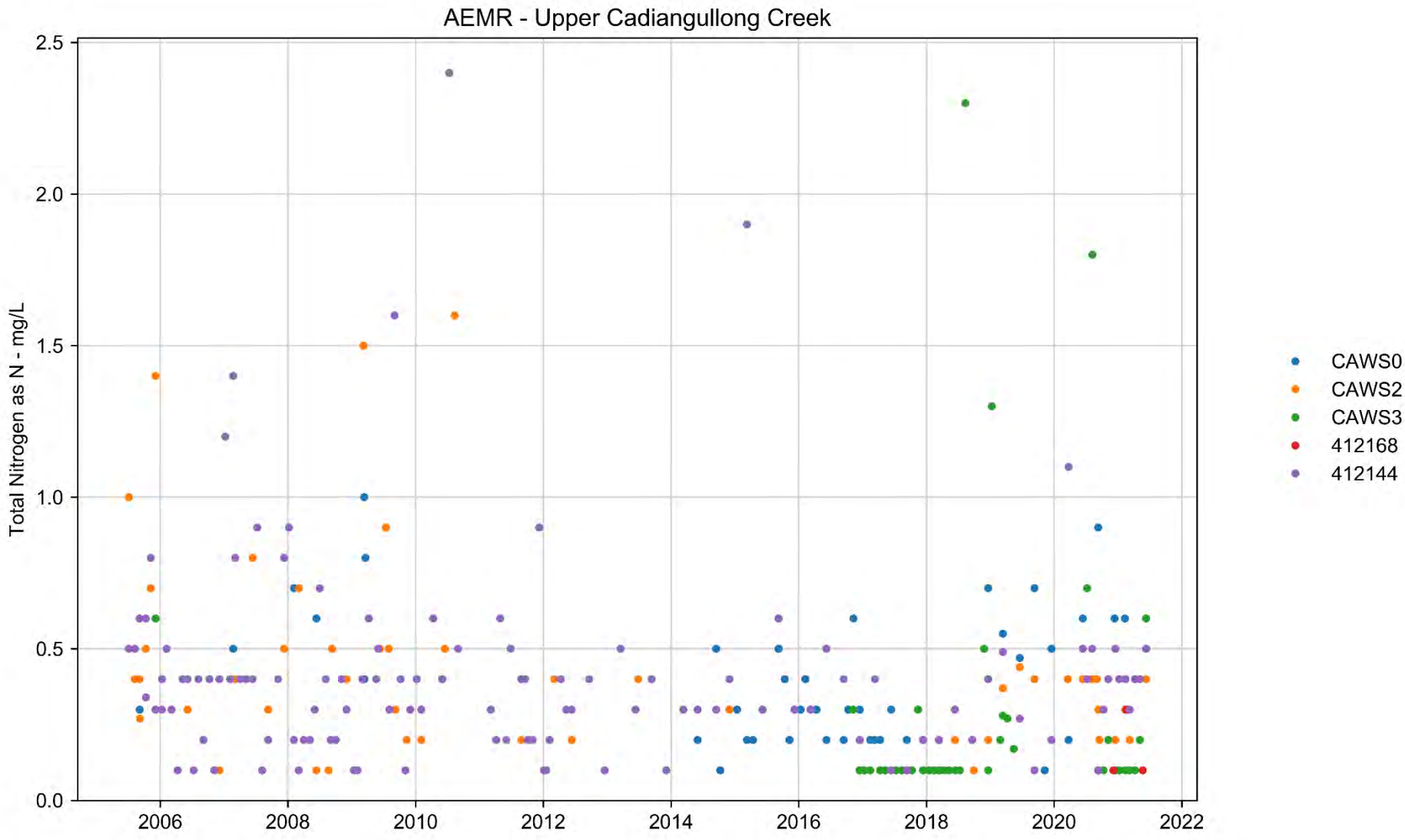


AEMR - Upper Cadiangullong Creek

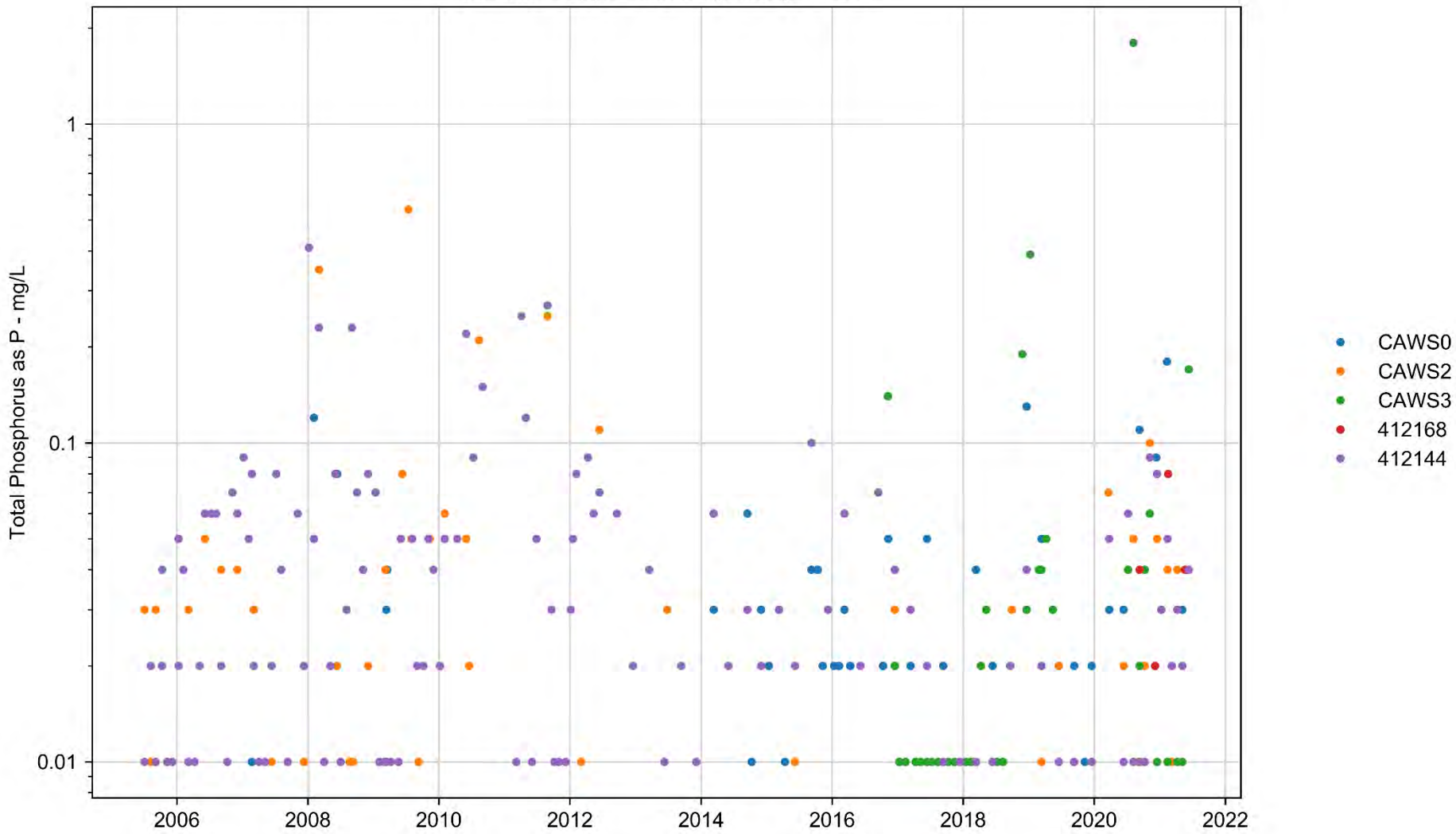



AEMR - Upper Cadiangullong Creek
Total Hardness as CaCO3 - mg/L
1000
800
600
400
200
0
2015
2016
2017
2018
2019
2020
2021
CAWS0
CAWS2
CAWS3
412168
412144

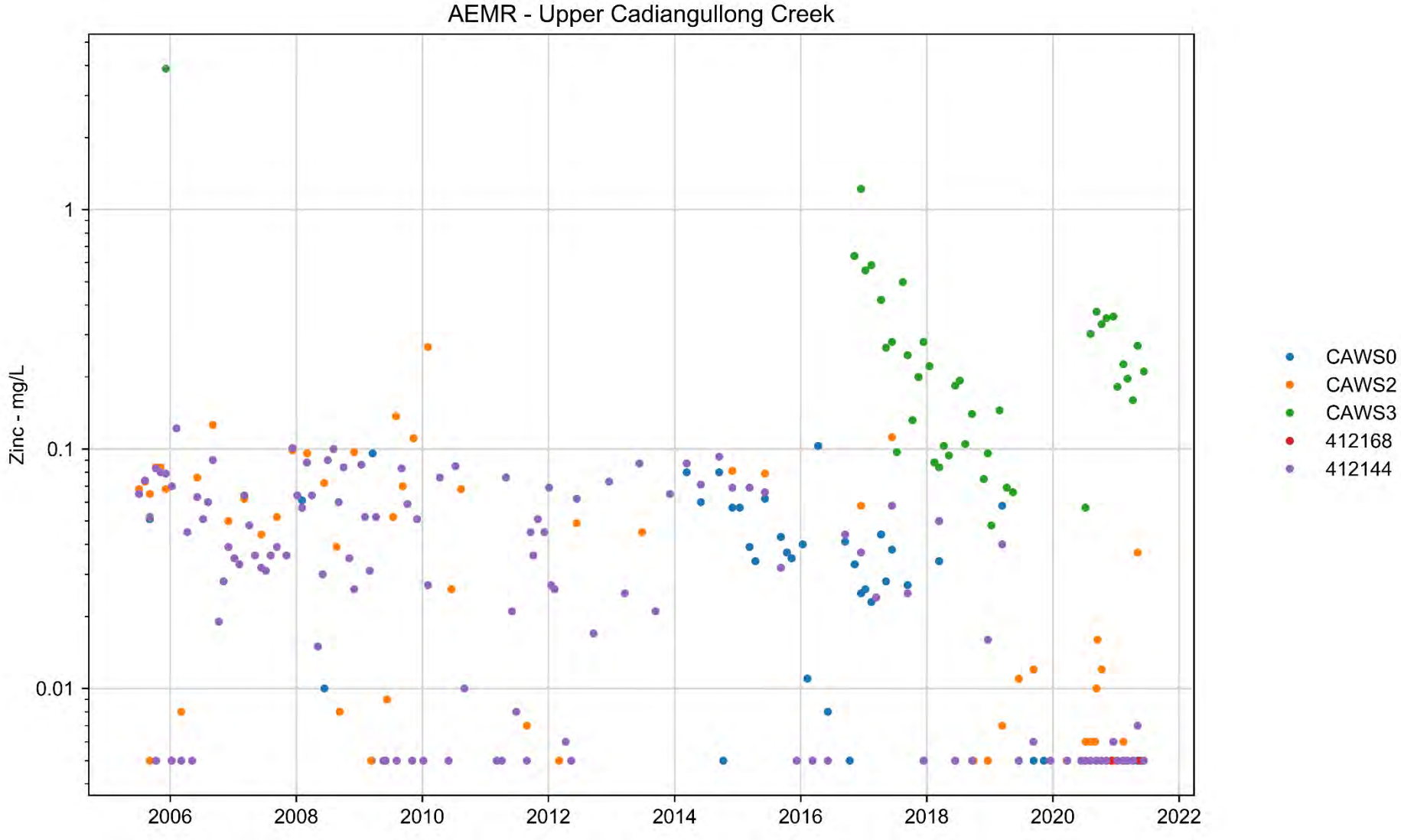

AEMR - Upper Cadiangullong Creek
Total Kjeldahl Nitrogen as N - mg/L
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS0
CAWS2
CAWS3
412168
412144

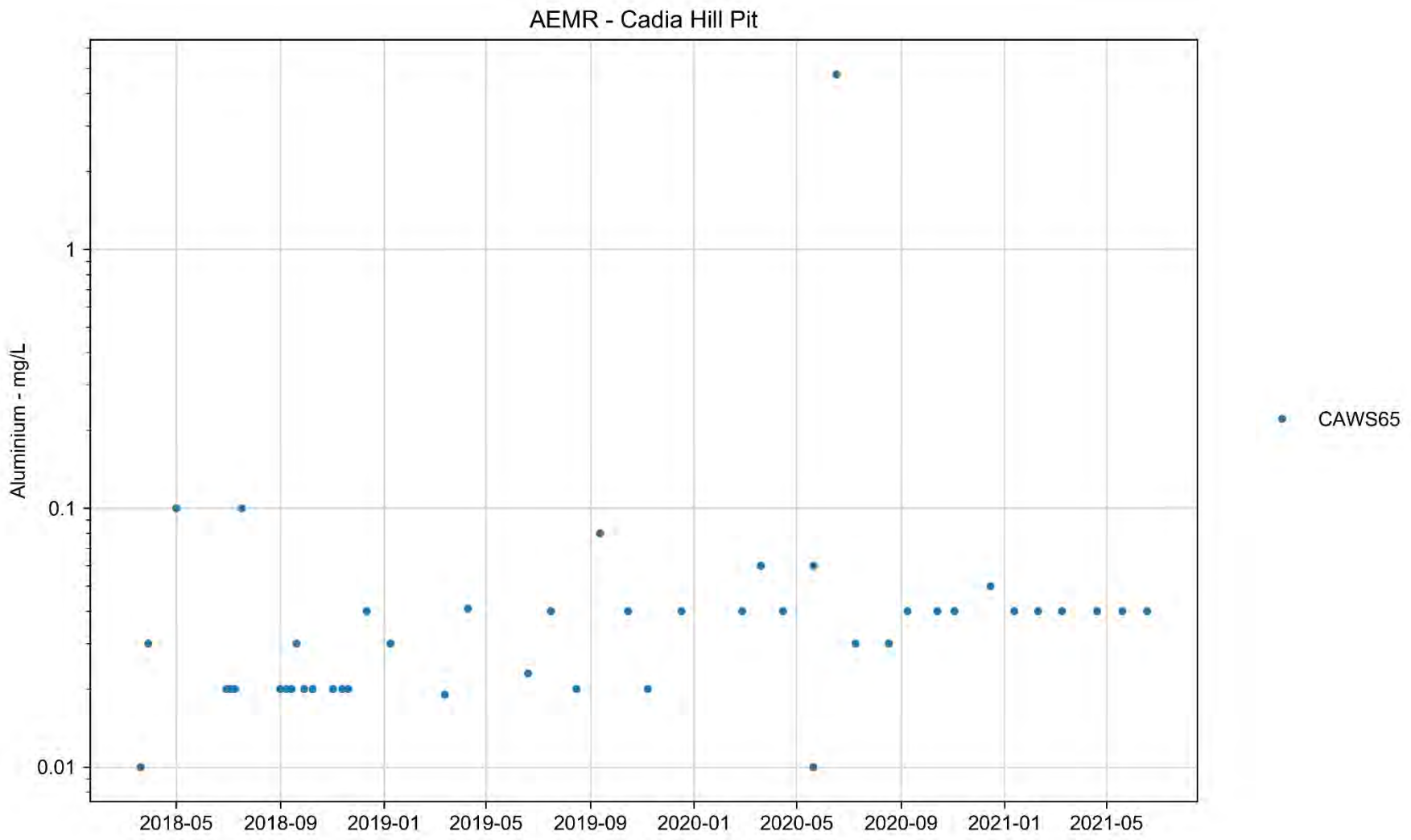

AEMR - Upper Cadiangullong Creek
Total Nitrogen as N - mg/L
2.5
2.0
1.5
1.0
0.5
0.0
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS0
CAWS2
CAWS3
412168
412144

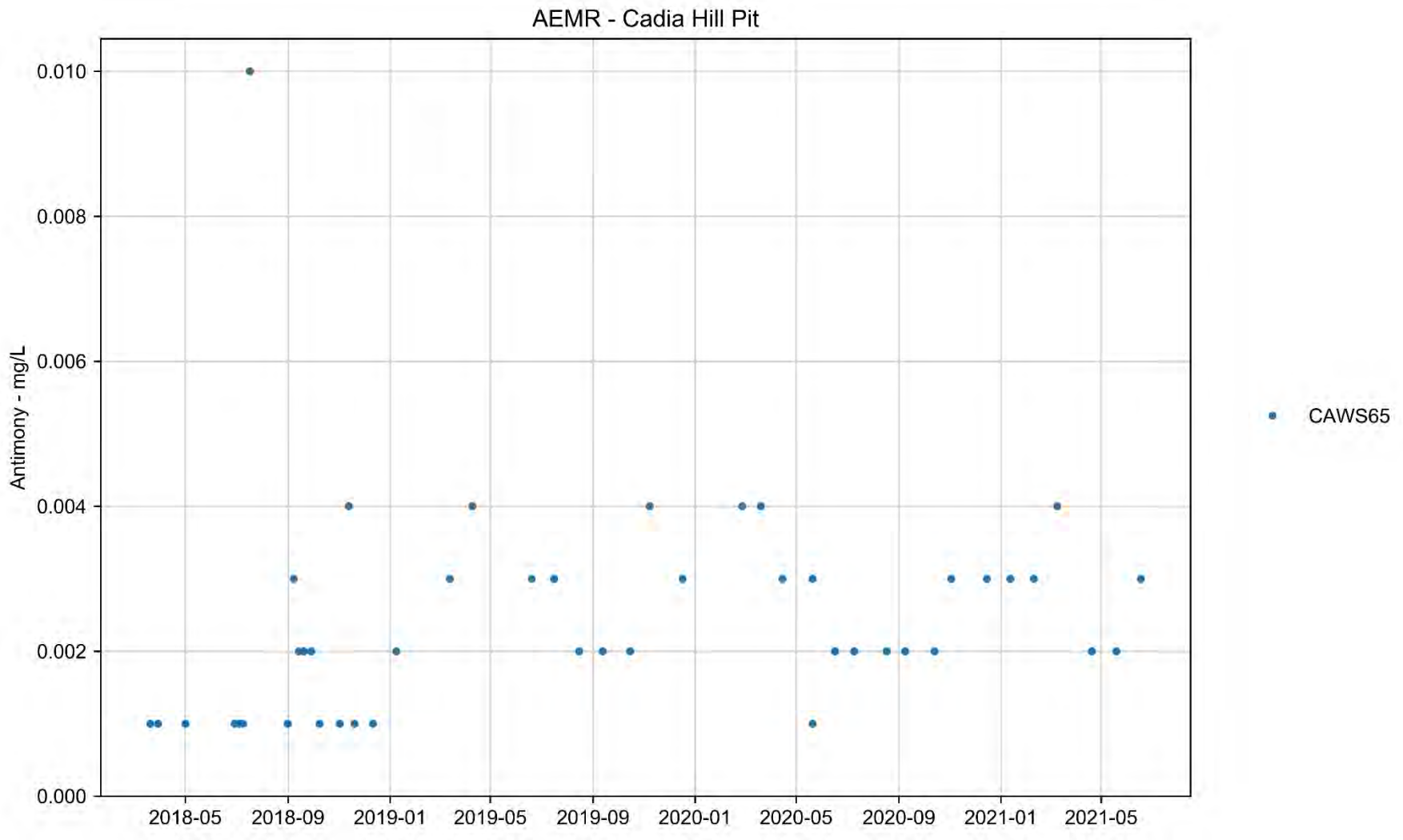
AEMR - Upper Cadiangullong Creek

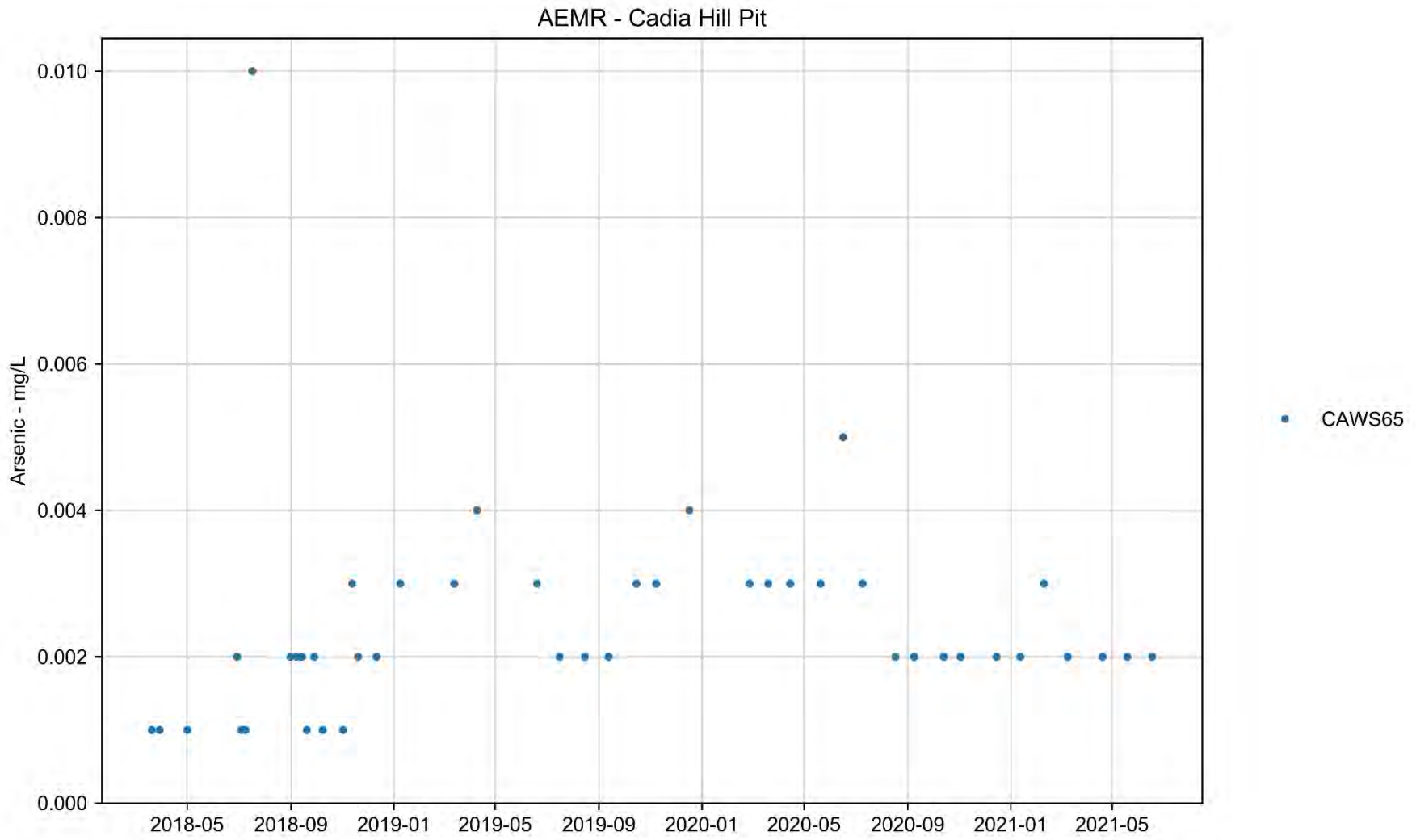


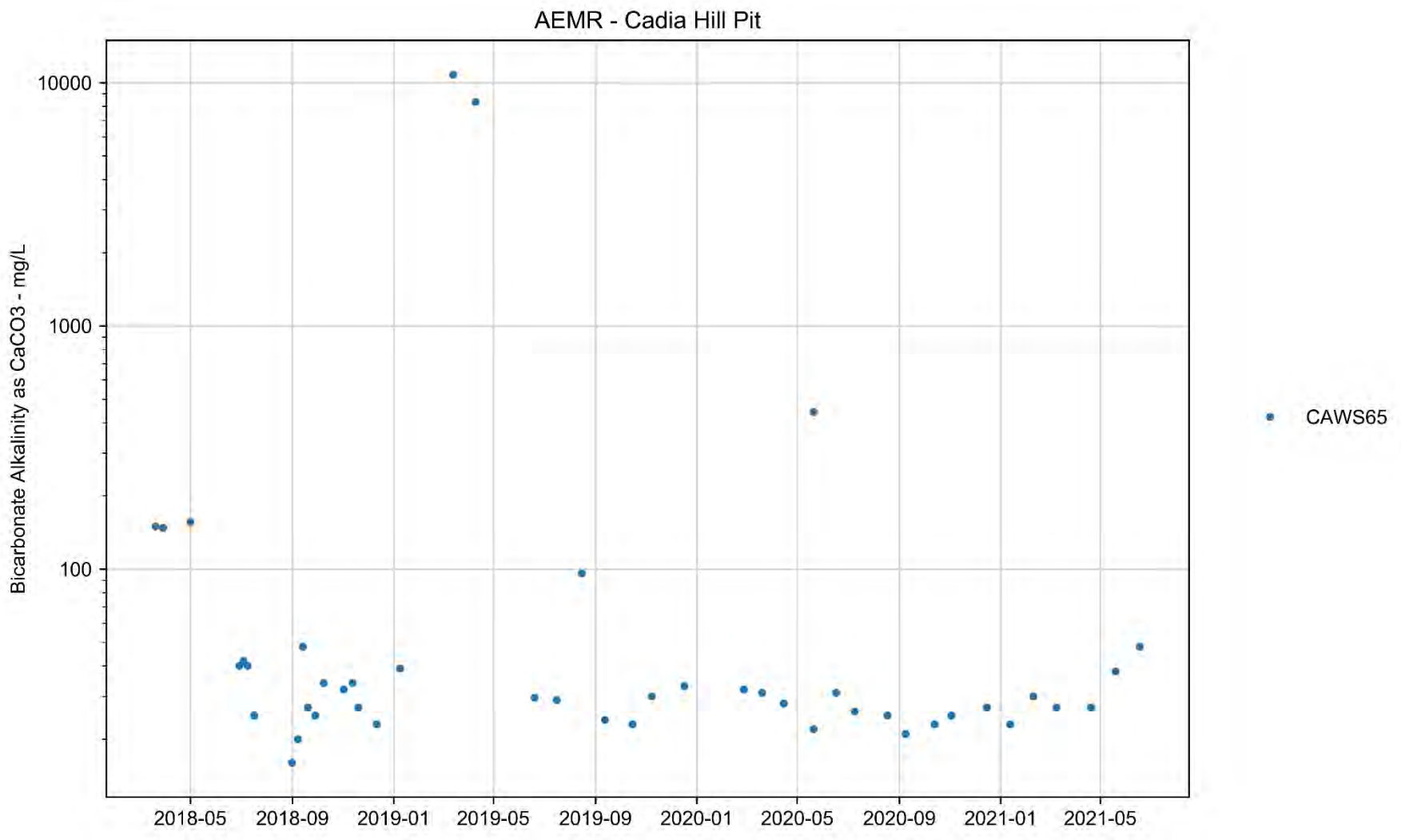
AEMR - Upper Cadiangullong Creek

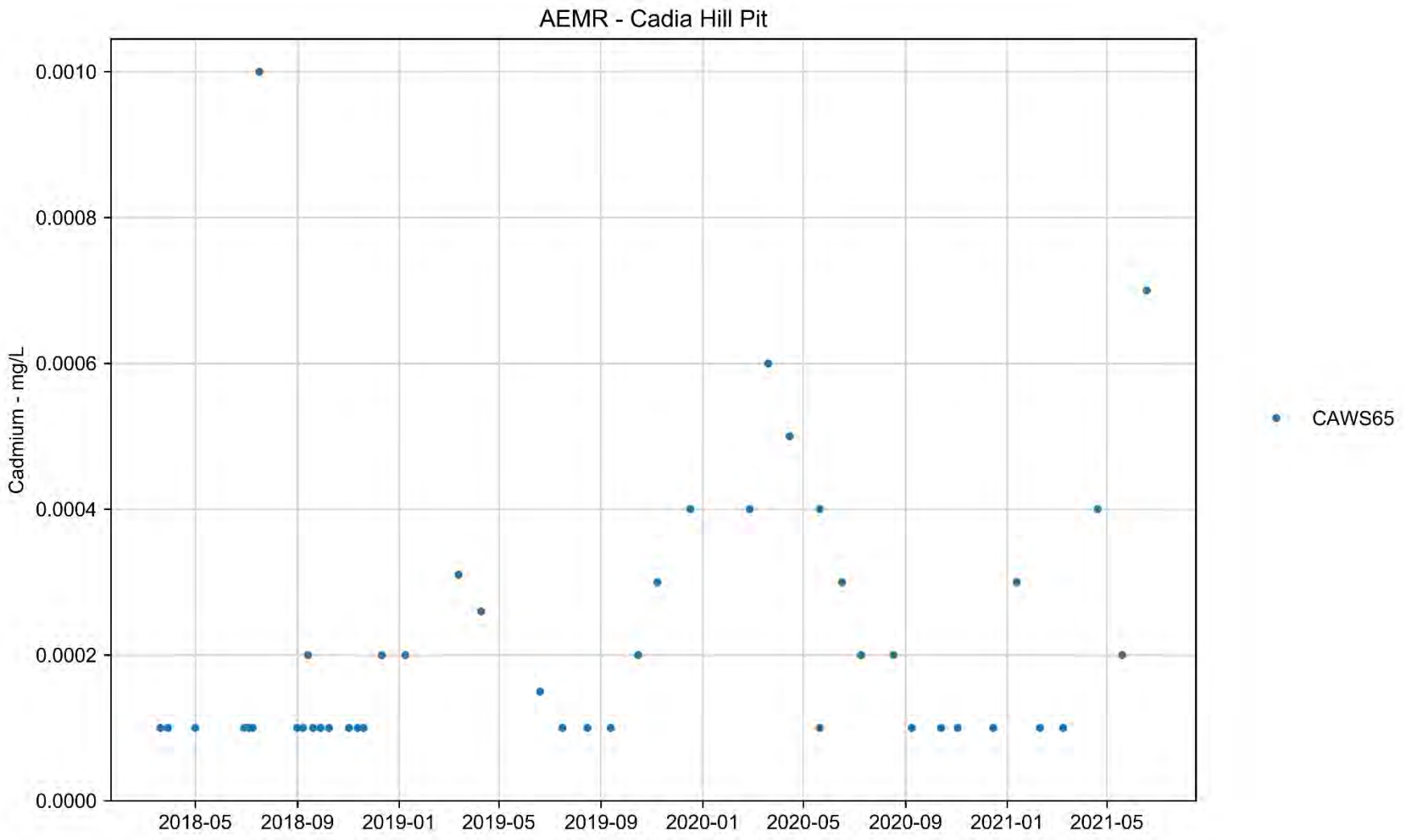


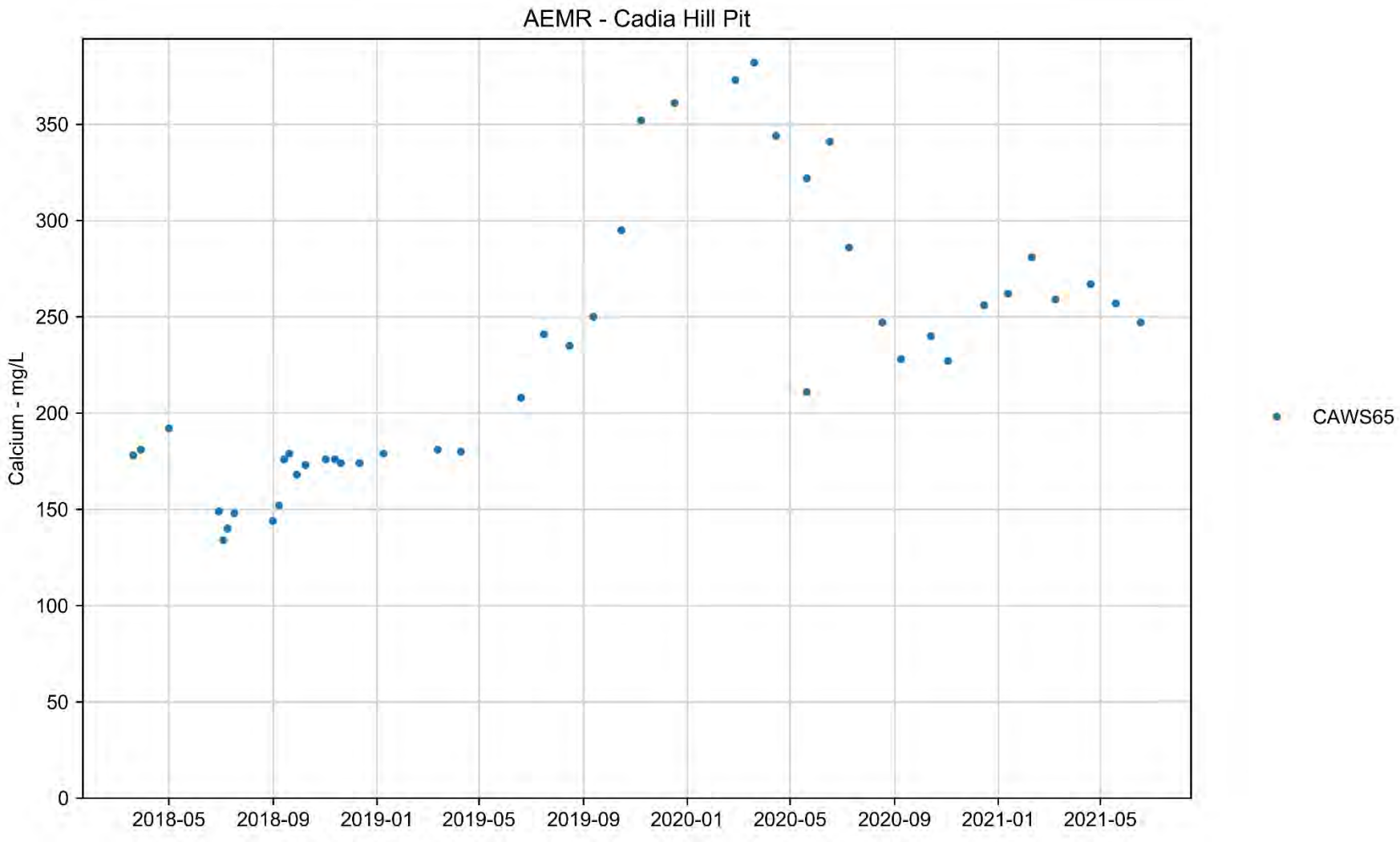

AEMR - Cadia Hill Pit
Aluminium - mg/L
1
0.1
0.01
2018-05
2018-09
2019-01
2019-05
2019-09
2020-01
2020-05
2020-09
2021-01
2021-05
CAWS65

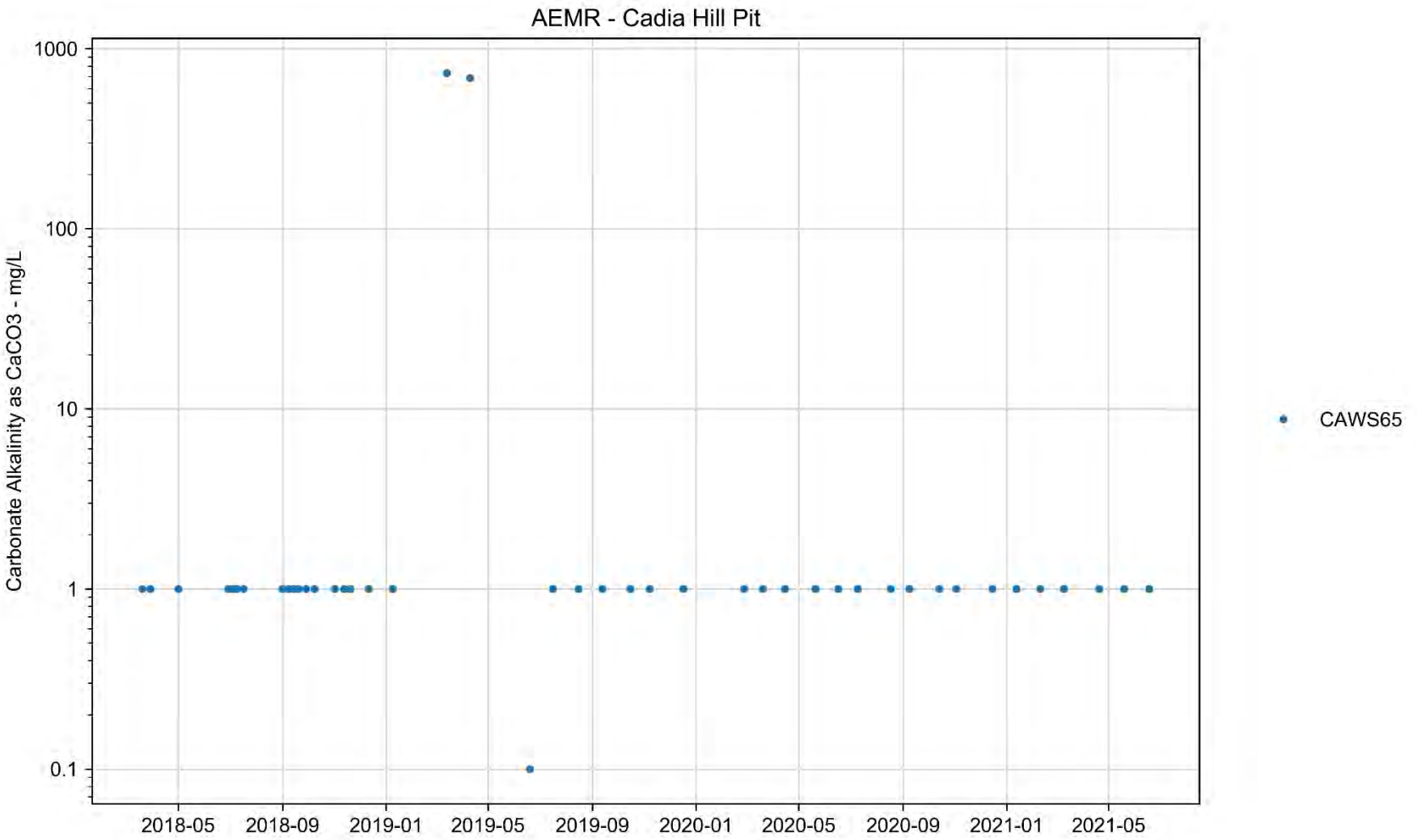

AEMR - Cadia Hill Pit
Antimony - mg/L
0.010
0.008
0.006
0.004
0.002
0.000
2018-05
2018-09
2019-01
2019-05
2019-09
2020-01
2020-05
2020-09
2021-01
2021-05
CAWS65

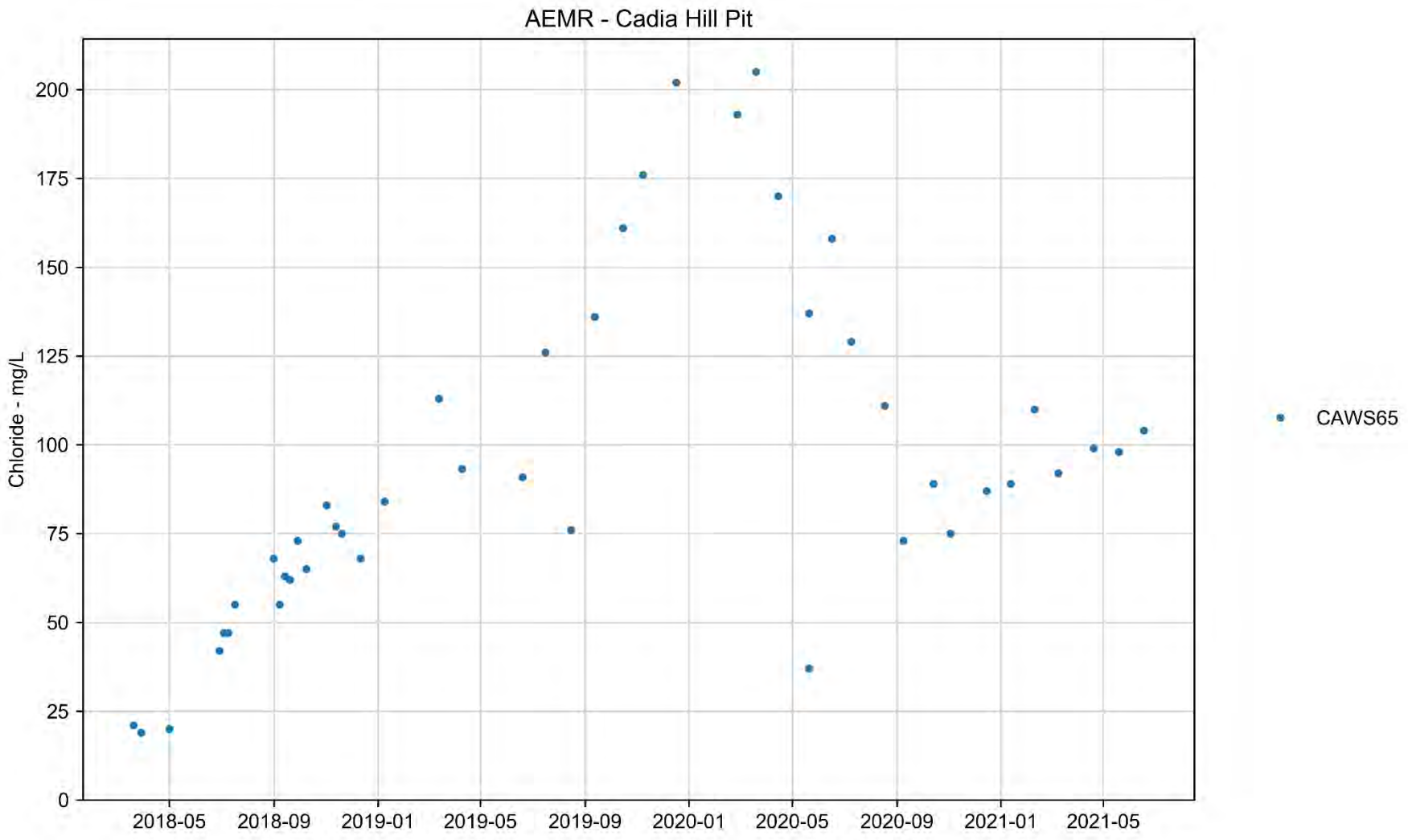

AEMR - Cadia Hill Pit
Arsenic - mg/L
0.010
0.008
0.006
0.004
0.002
0.000
2018-05
2018-09
2019-01
2019-05
2019-09
2020-01
2020-05
2020-09
2021-01
2021-05
CAWS65

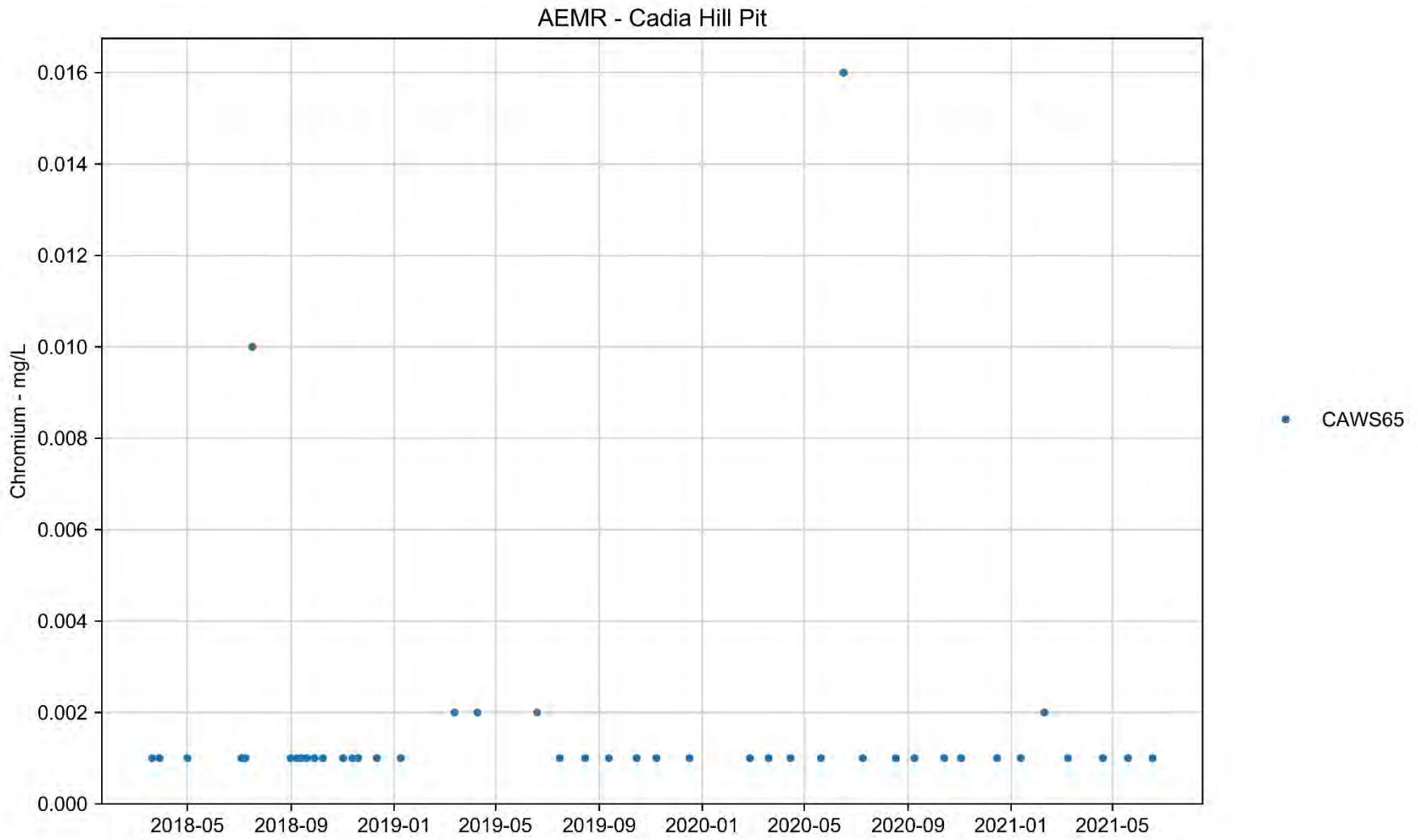

AEMR - Cadia Hill Pit
Bicarbonate Alkalinity as CaCO3 - mg/L
10000
1000
100
2018-05
2018-09
2019-01
2019-05
2019-09
2020-01
2020-05
2020-09
2021-01
2021-05
CAWS65

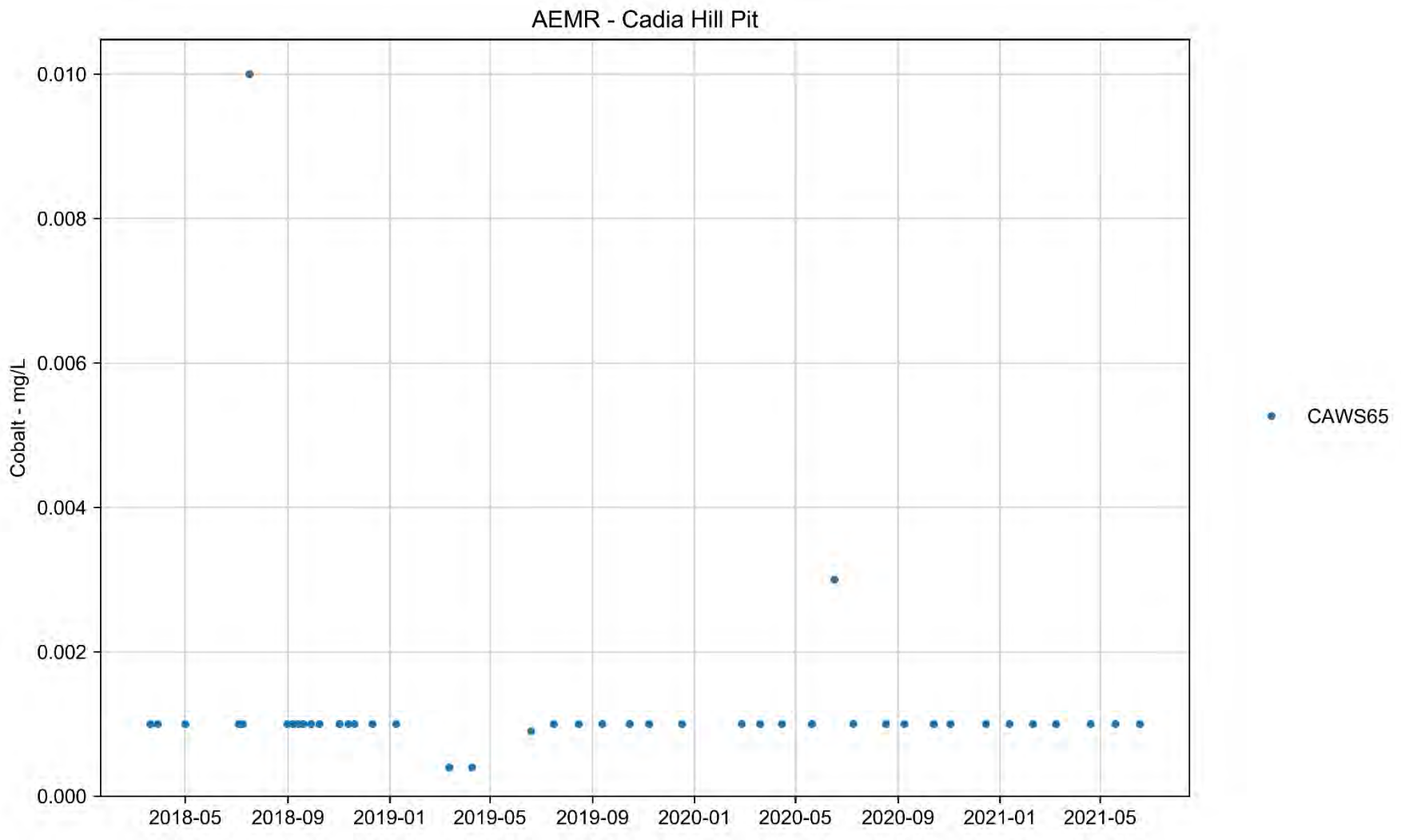

AEMR - Cadia Hill Pit
Cadmium - mg/L
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
2018-05
2018-09
2019-01
2019-05
2019-09
2020-01
2020-05
2020-09
2021-01
2021-05
CAWS65

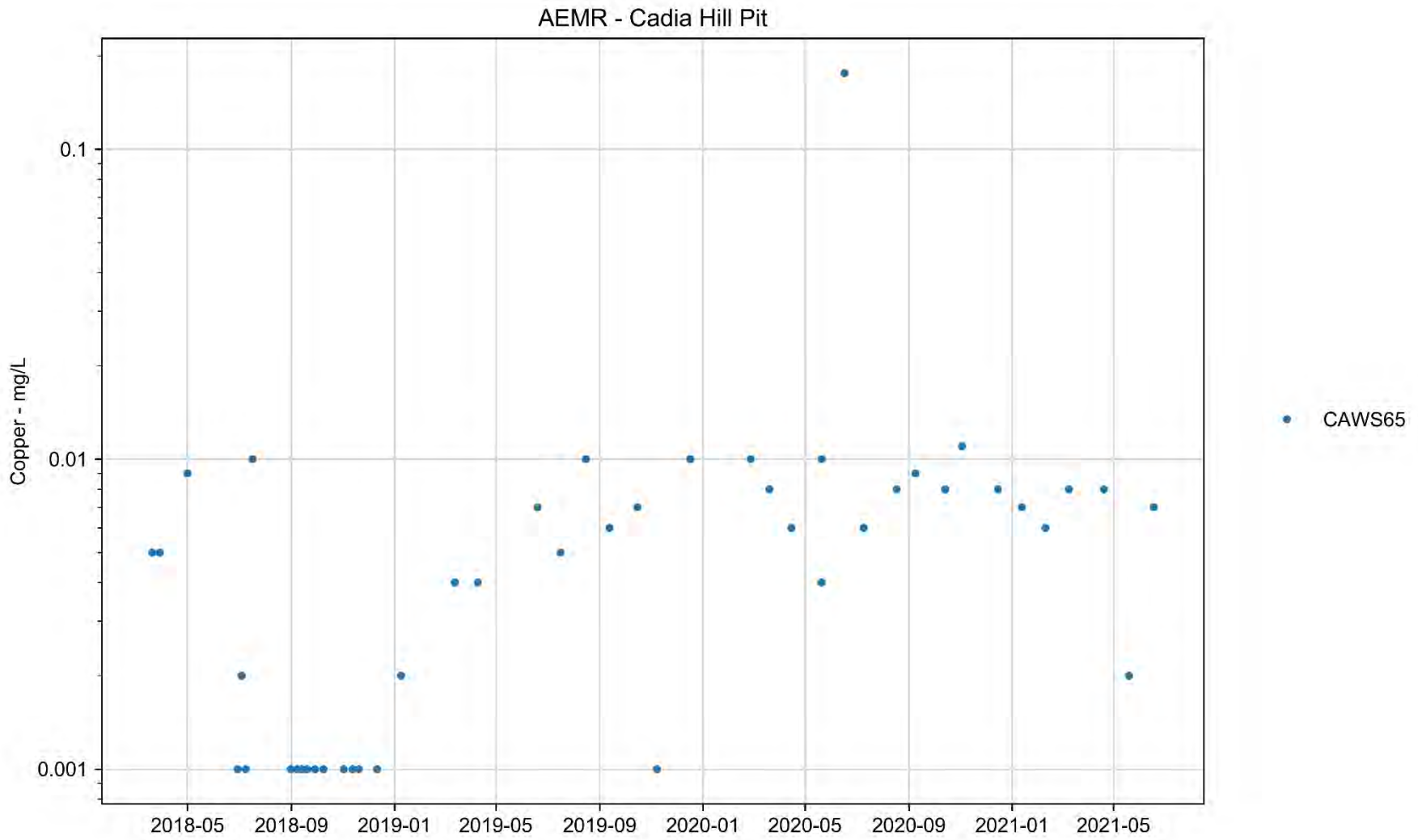

AEMR - Cadia Hill Pit
Calcium - mg/L
350
300
250
200
150
100
50
0
2018-05
2018-09
2019-01
2019-05
2019-09
2020-01
2020-05
2020-09
2021-01
2021-05
CAWS65

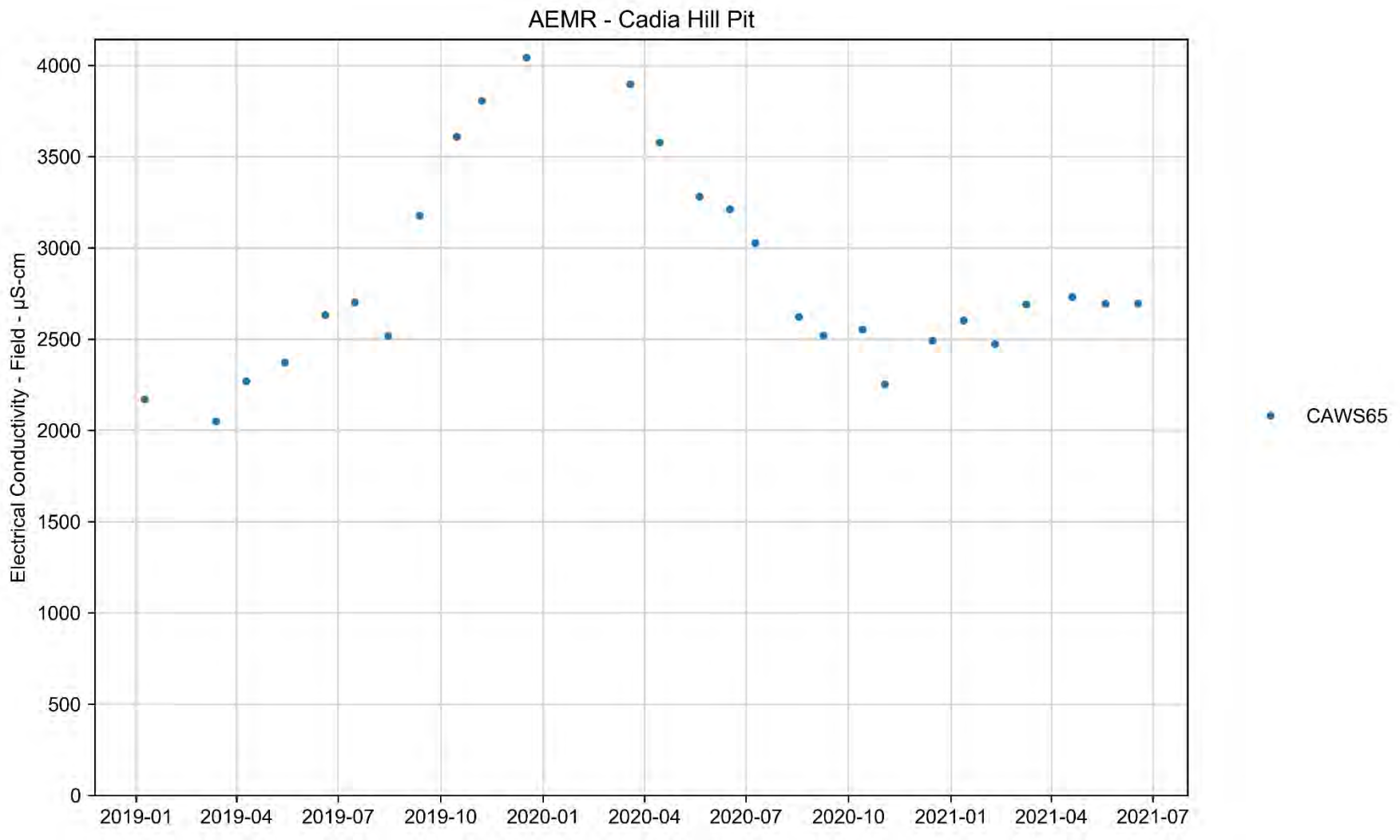

AEMR - Cadia Hill Pit
Carbonate Alkalinity as CaCO3 - mg/L
1000
100
10
1
0.1
2018-05
2018-09
2019-01
2019-05
2019-09
2020-01
2020-05
2020-09
2021-01
2021-05
CAWS65

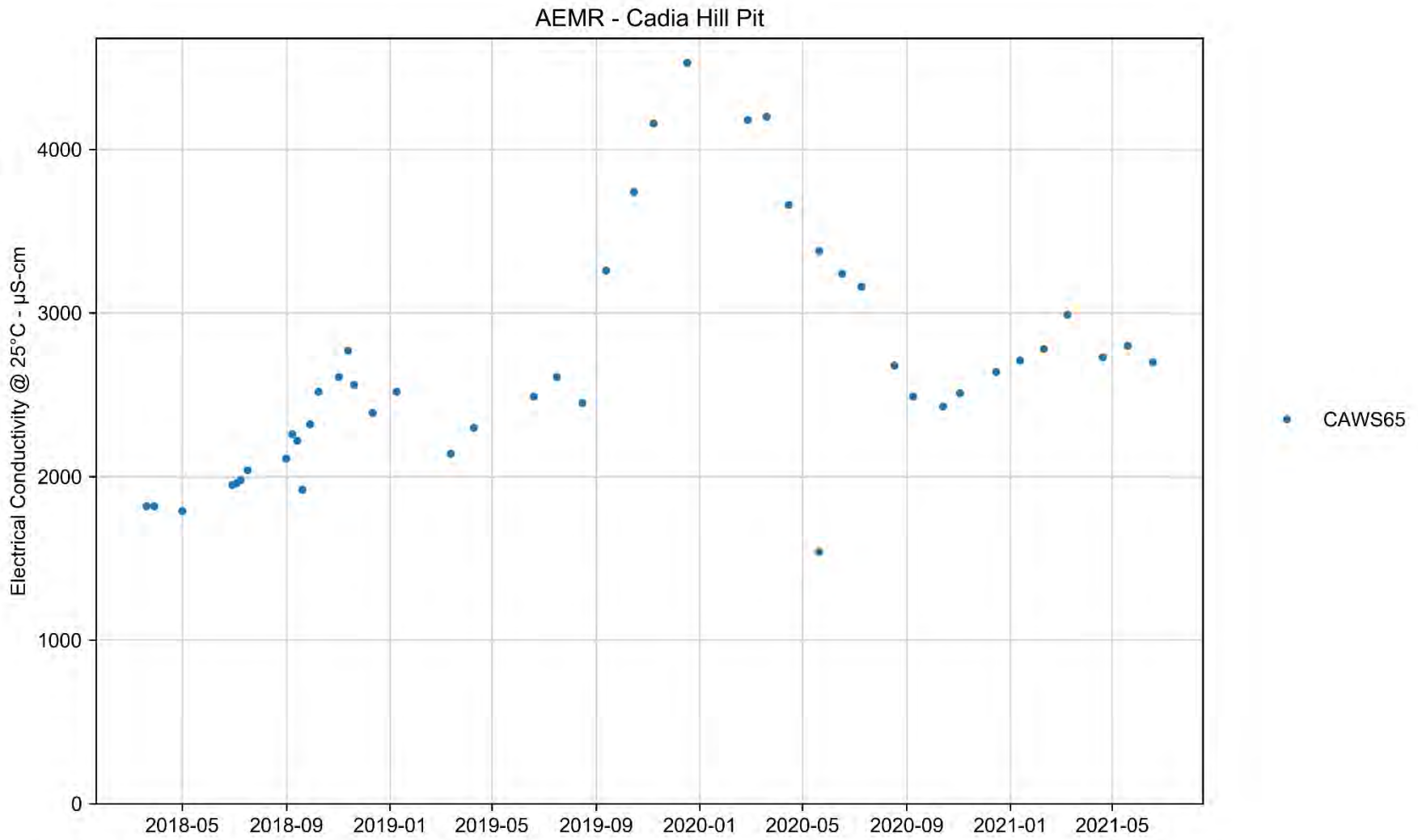

AEMR - Cadia Hill Pit
Chloride - mg/L
200
175
150
125
100
75
50
25
0
2018-05
2018-09
2019-01
2019-05
2019-09
2020-01
2020-05
2020-09
2021-01
2021-05
CAWS65

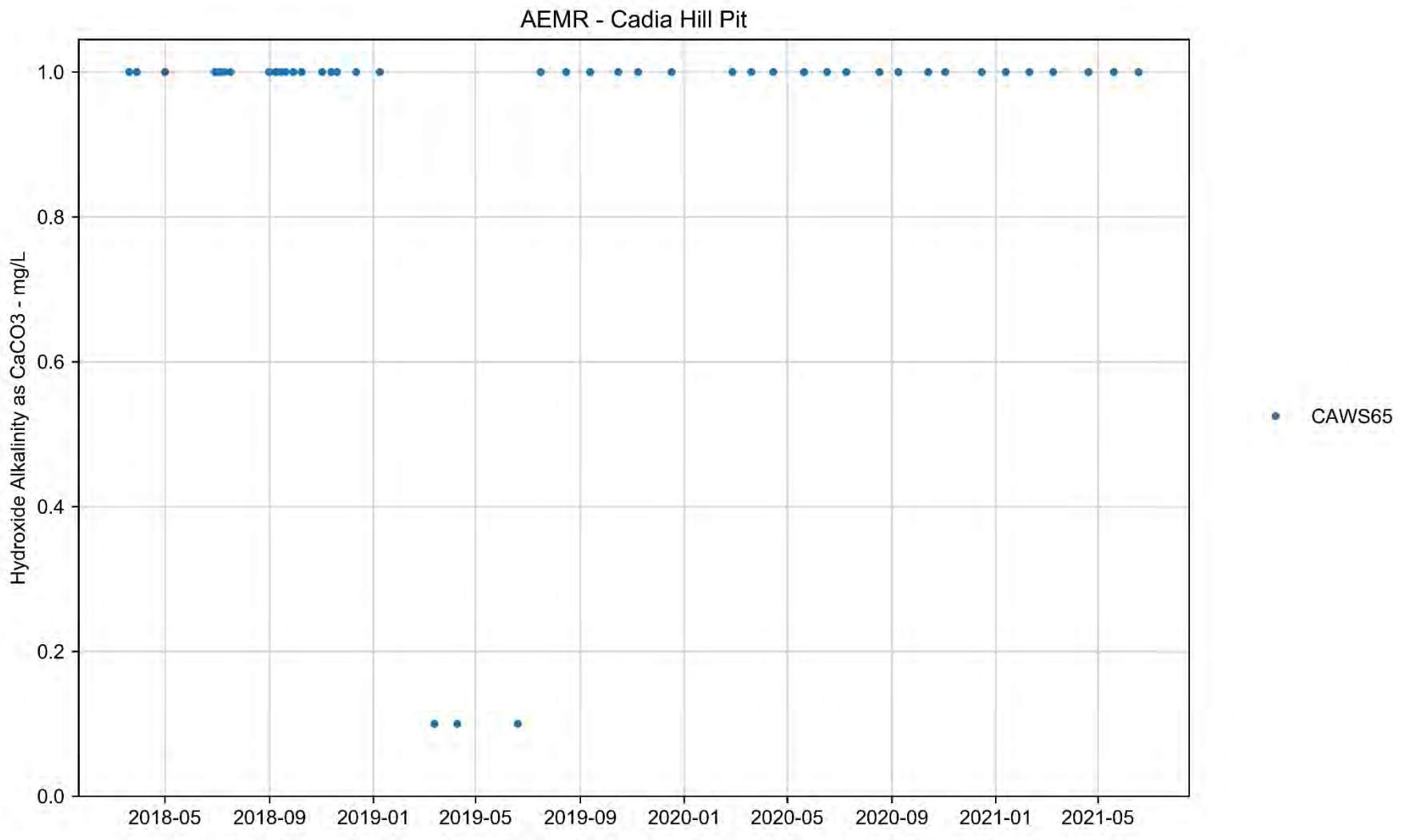

AEMR - Cadia Hill Pit
Chromium - mg/L
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
2018-05
2018-09
2019-01
2019-05
2019-09
2020-01
2020-05
2020-09
2021-01
2021-05
CAWS65

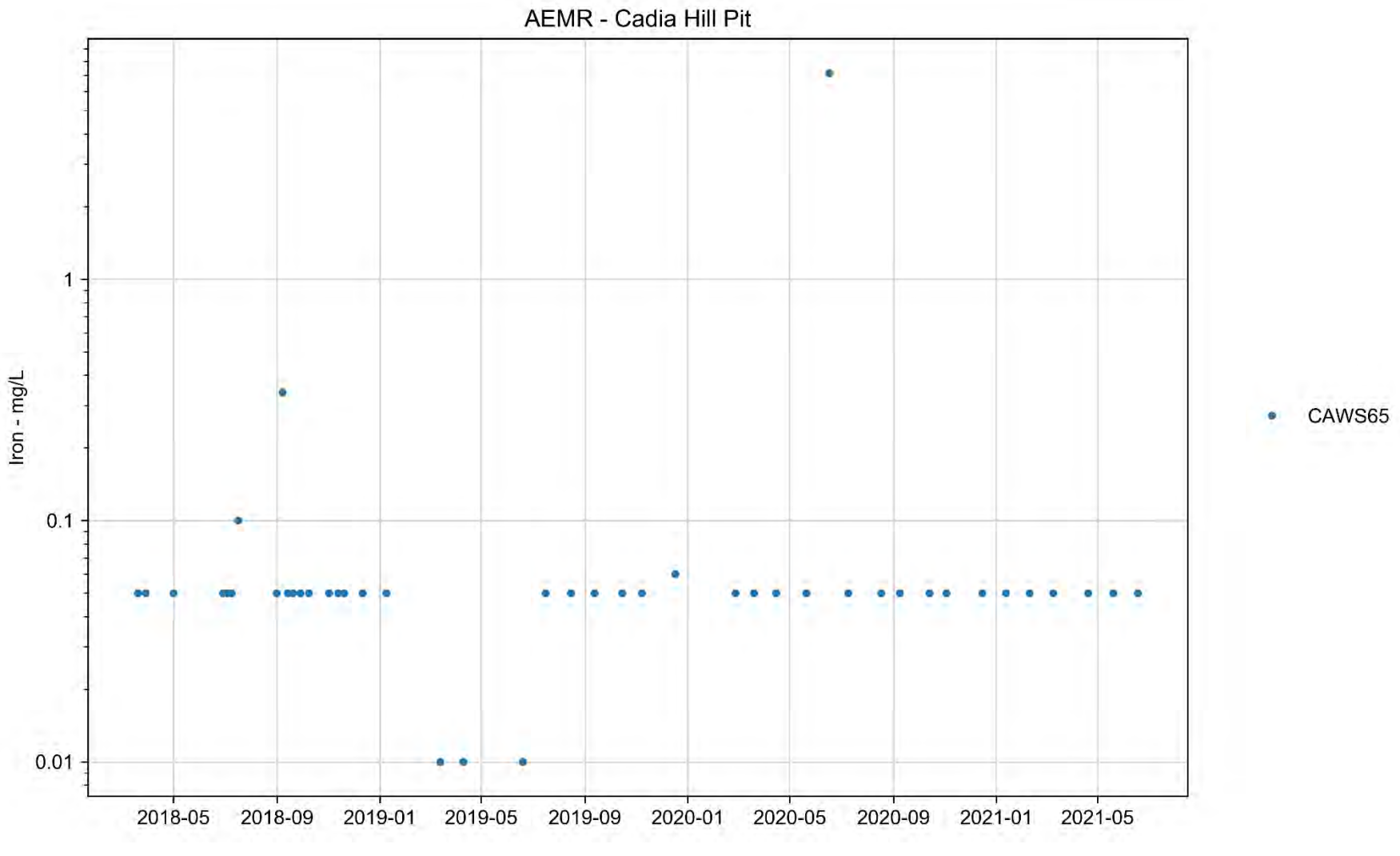

AEMR - Cadia Hill Pit
Cobalt - mg/L
0.010
0.008
0.006
0.004
0.002
0.000
2018-05
2018-09
2019-01
2019-05
2019-09
2020-01
2020-05
2020-09
2021-01
2021-05
CAWS65

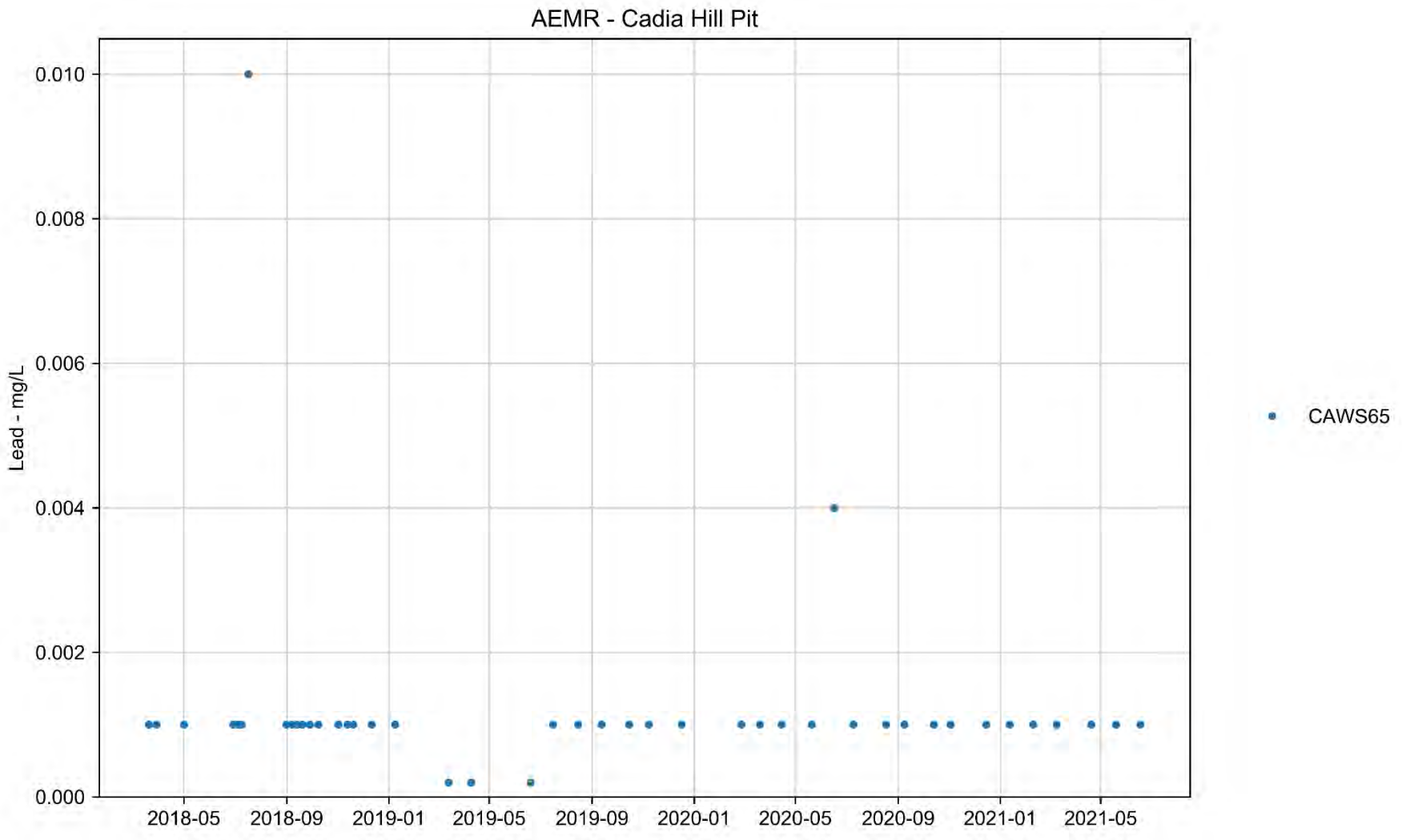

AEMR - Cadia Hill Pit
Copper - mg/L
0.1
0.01
0.001
2018-05
2018-09
2019-01
2019-05
2019-09
2020-01
2020-05
2020-09
2021-01
2021-05
CAWS65

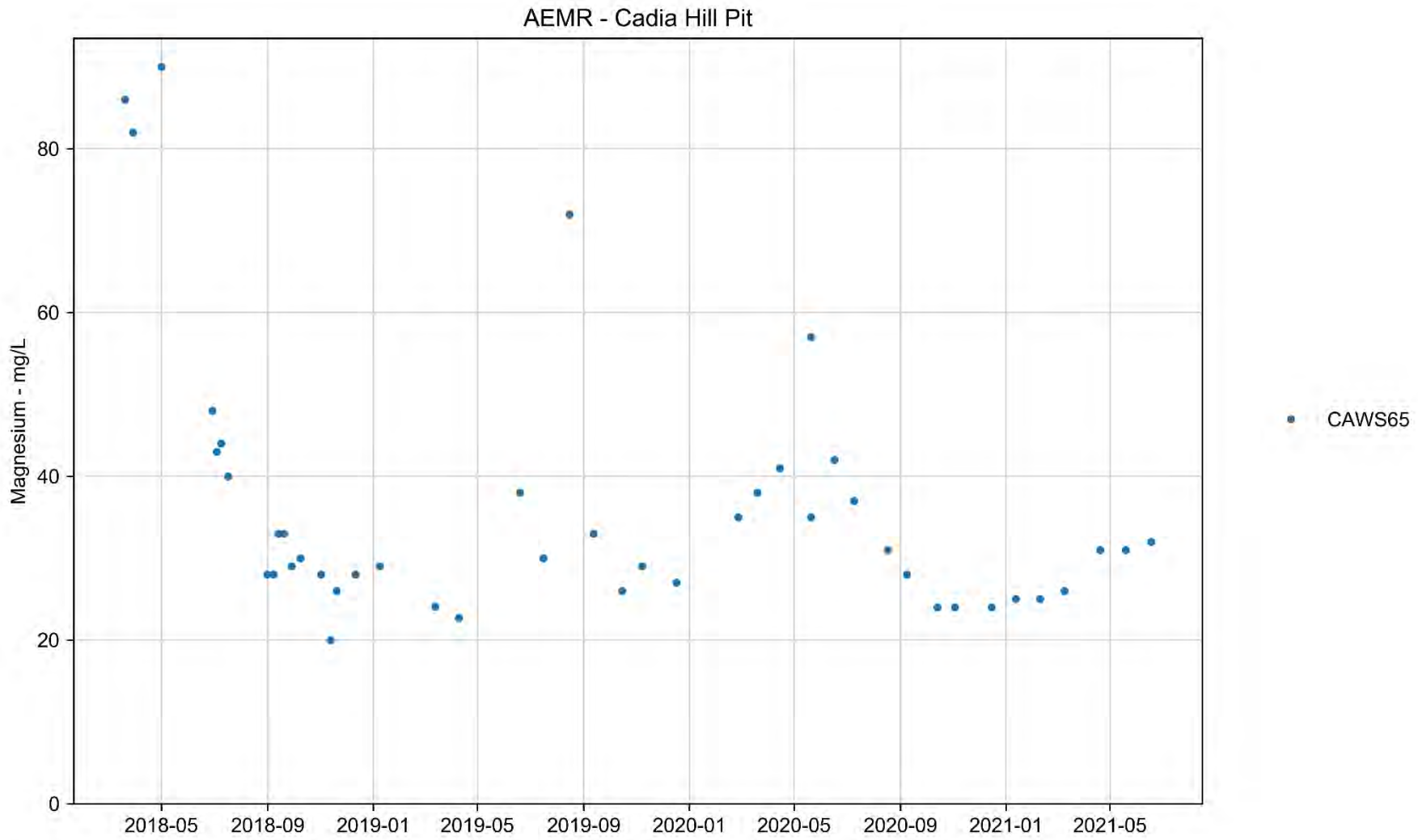

AEMR - Cadia Hill Pit
Electrical Conductivity - Field - µS-cm
4000
3500
3000
2500
2000
1500
1000
500
0
2019-01
2019-04
2019-07
2019-10
2020-01
2020-04
2020-07
2020-10
2021-01
2021-04
2021-07
CAWS65

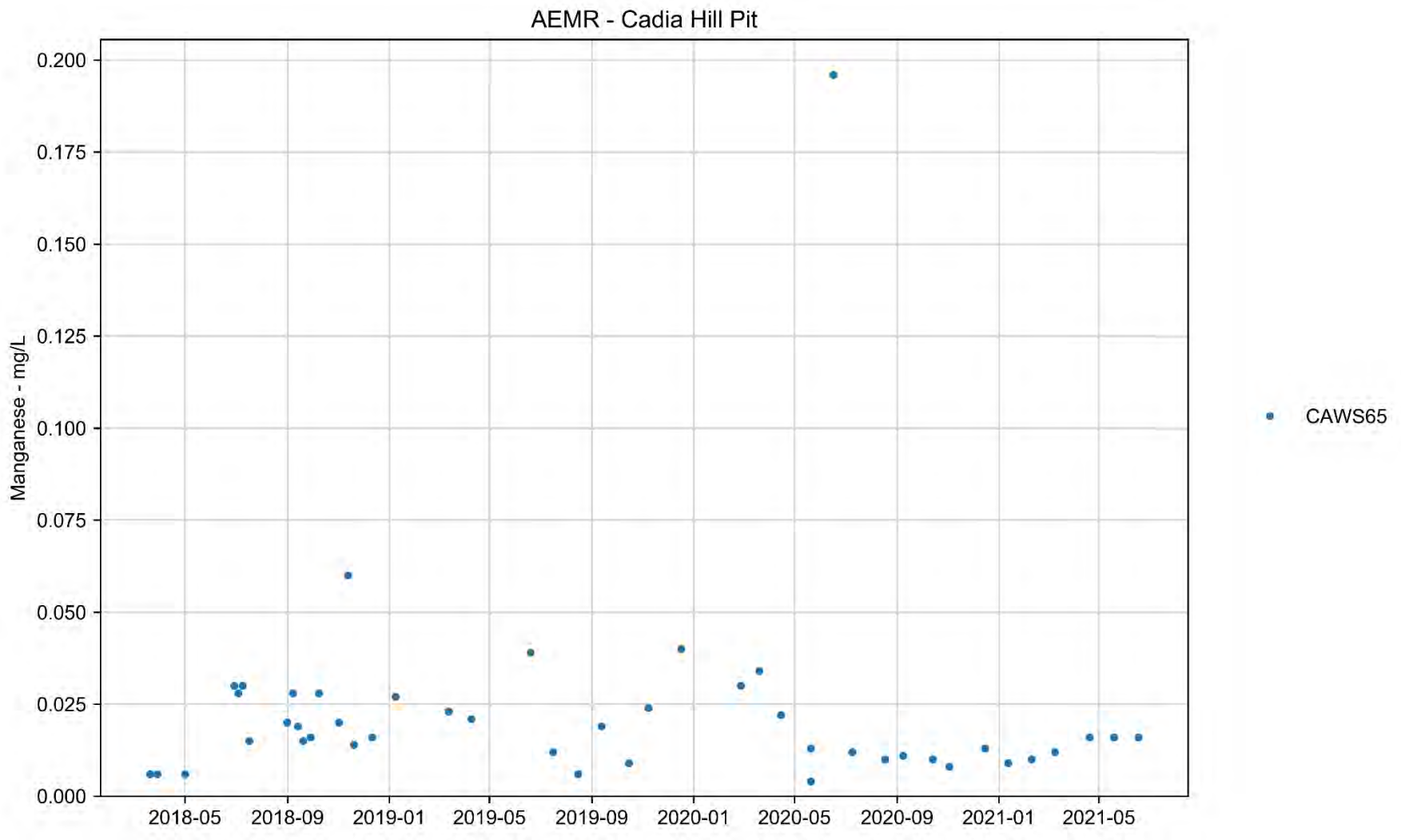

AEMR - Cadia Hill Pit
Electrical Conductivity @ 25°C - µS-cm
4000
3000
2000
1000
0
2018-05
2018-09
2019-01
2019-05
2019-09
2020-01
2020-05
2020-09
2021-01
2021-05
CAWS65

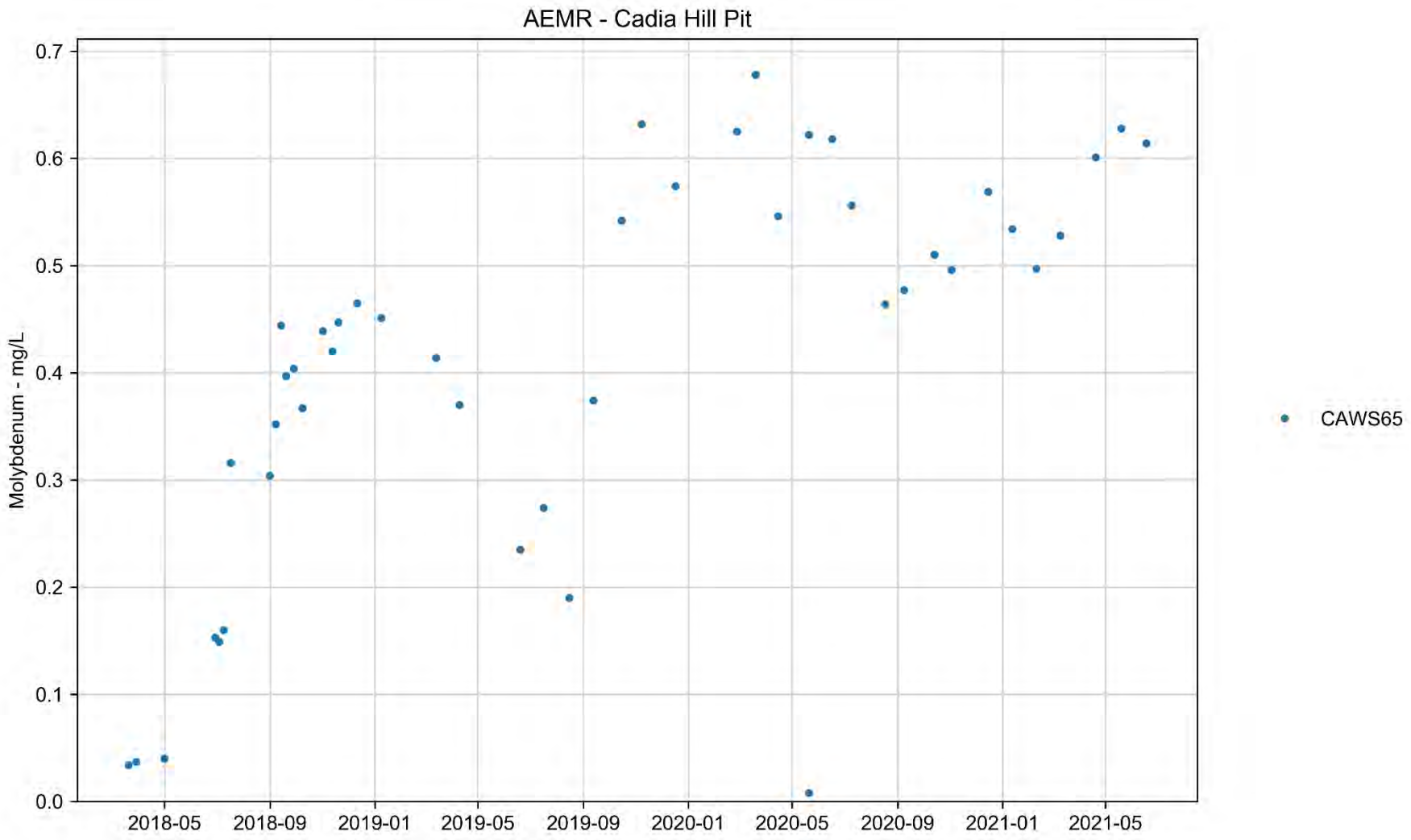

AEMR - Cadia Hill Pit
Hydroxide Alkalinity as CaCO3 - mg/L
1.0
0.8
0.6
0.4
0.2
0.0
2018-05
2018-09
2019-01
2019-05
2019-09
2020-01
2020-05
2020-09
2021-01
2021-05
CAWS65

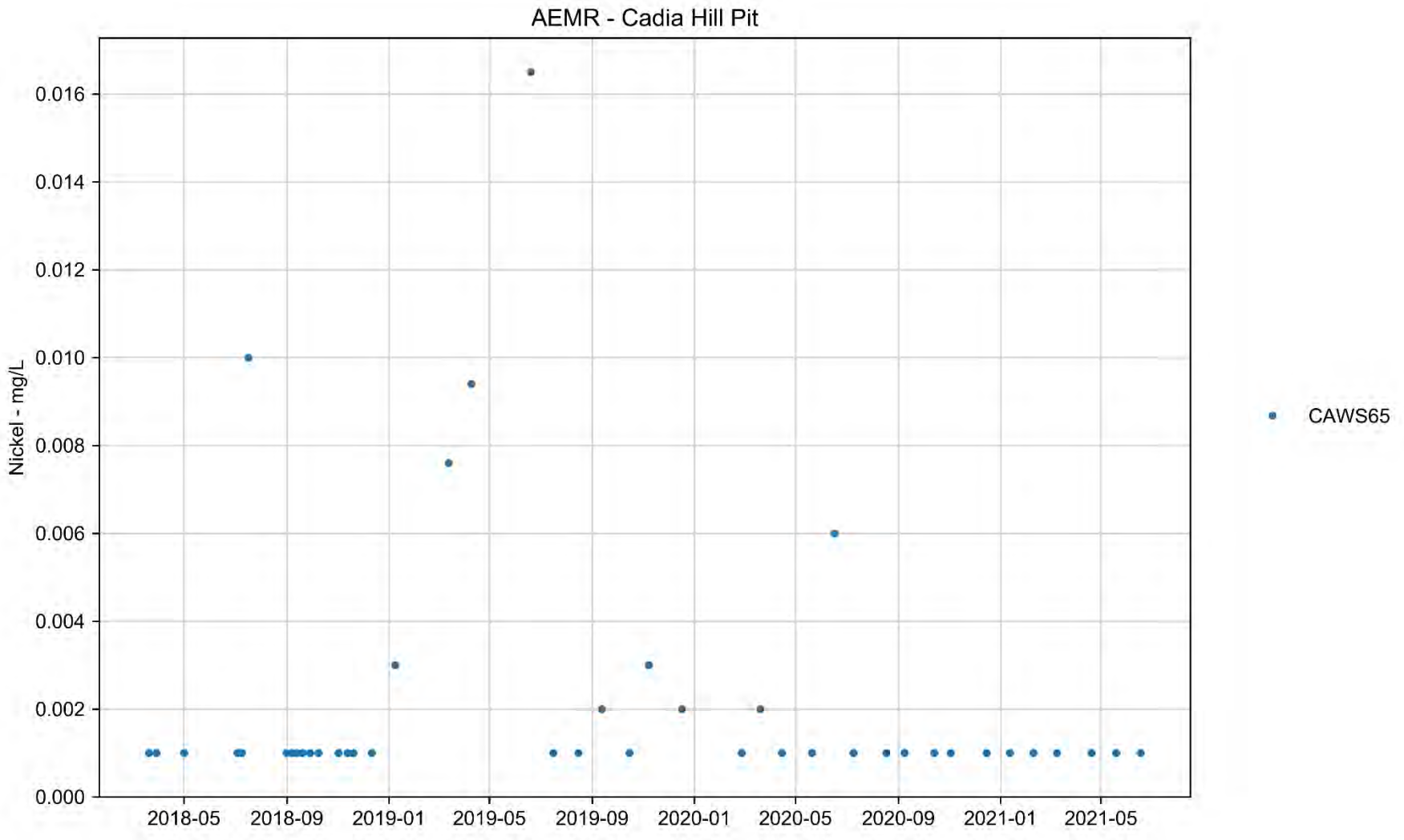

AEMR - Cadia Hill Pit
Iron - mg/L
1
0.1
0.01
2018-05
2018-09
2019-01
2019-05
2019-09
2020-01
2020-05
2020-09
2021-01
2021-05
CAWS65


AEMR - Cadia Hill Pit
Lead - mg/L
0.010
0.008
0.006
0.004
0.002
0.000
2018-05
2018-09
2019-01
2019-05
2019-09
2020-01
2020-05
2020-09
2021-01
2021-05
CAWS65

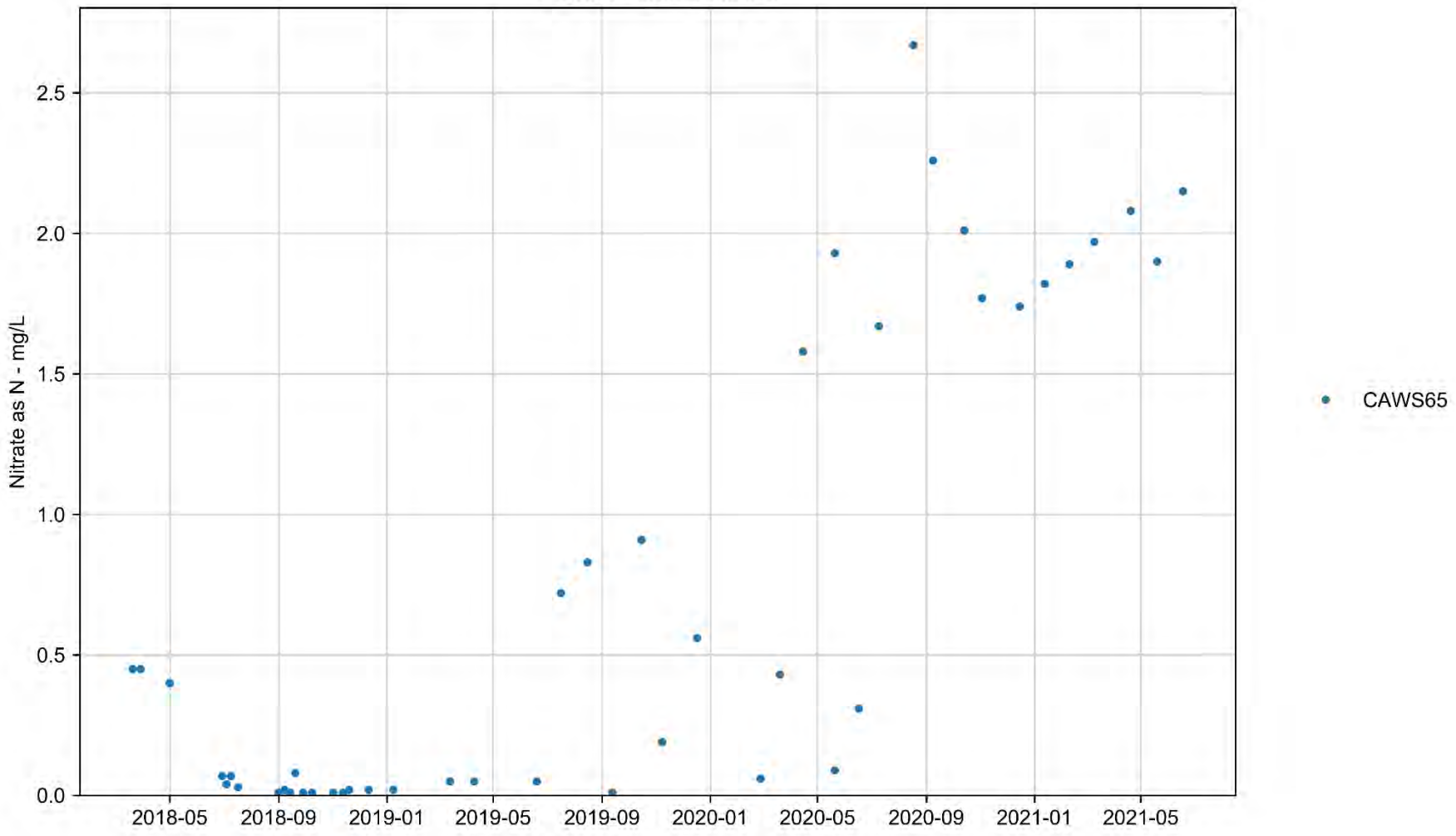

AEMR - Cadia Hill Pit
Magnesium - mg/L
0
20
40
60
80
2018-05
2018-09
2019-01
2019-05
2019-09
2020-01
2020-05
2020-09
2021-01
2021-05
CAWS65


AEMR - Cadia Hill Pit
Manganese - mg/L
0.000
0.025
0.050
0.075
0.100
0.125
0.150
0.175
0.200
2018-05
2018-09
2019-01
2019-05
2019-09
2020-01
2020-05
2020-09
2021-01
2021-05
CAWS65

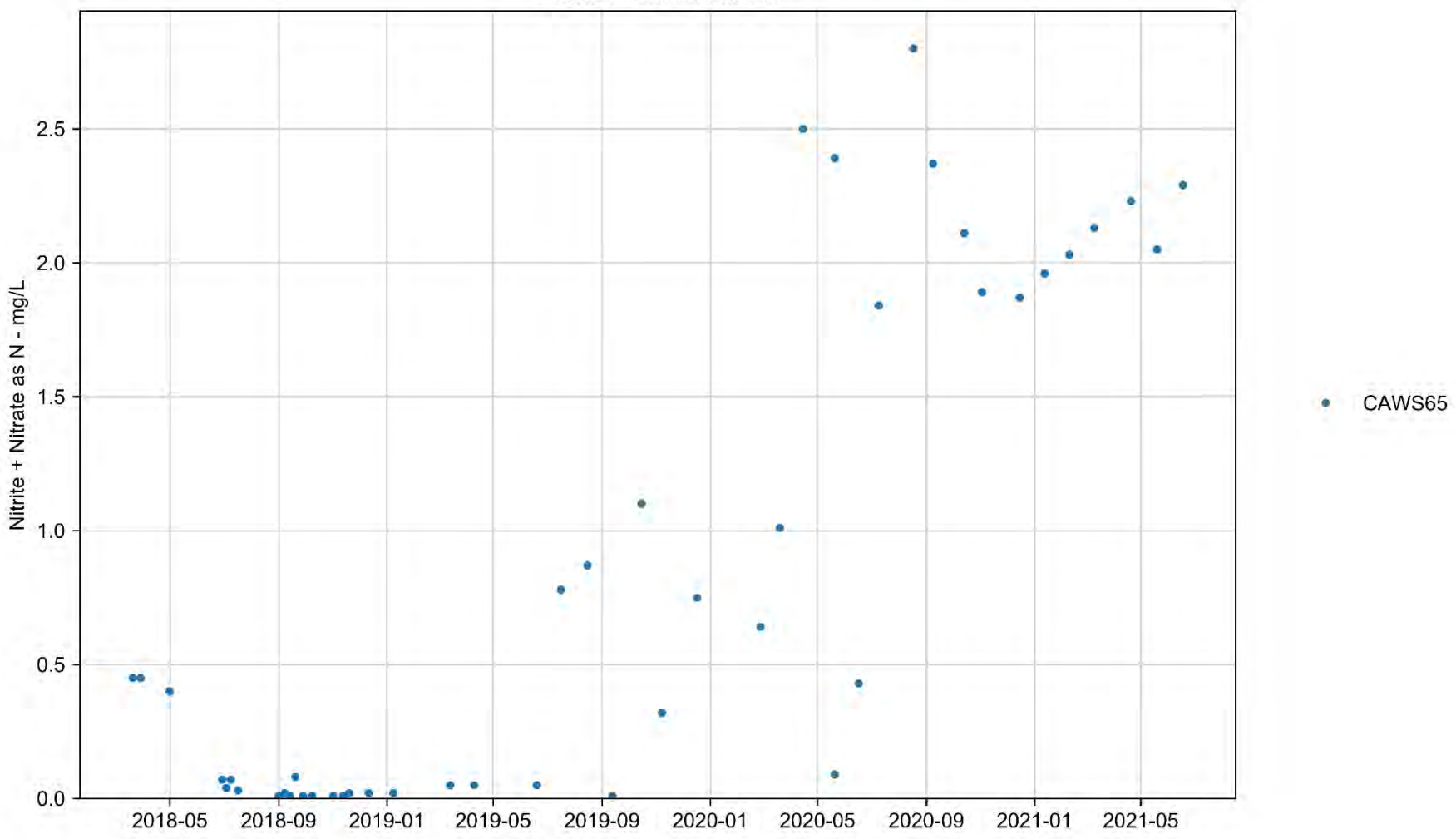

AEMR - Cadia Hill Pit
Molybdenum - mg/L
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
2018-05
2018-09
2019-01
2019-05
2019-09
2020-01
2020-05
2020-09
2021-01
2021-05
CAWS65


AEMR - Cadia Hill Pit
Nickel - mg/L
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
2018-05
2018-09
2019-01
2019-05
2019-09
2020-01
2020-05
2020-09
2021-01
2021-05
CAWS65

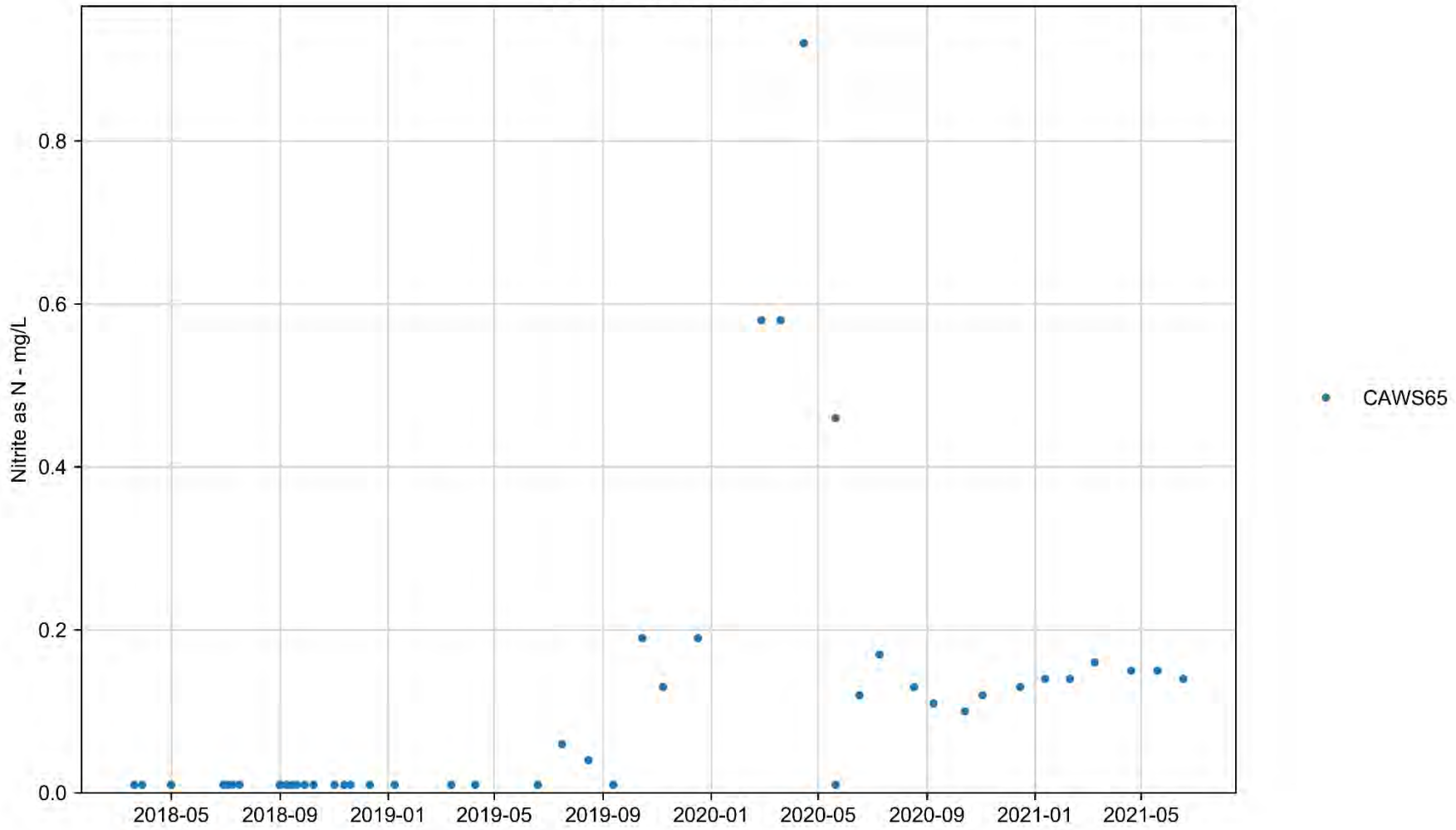
AEMR - Cadia Hill Pit



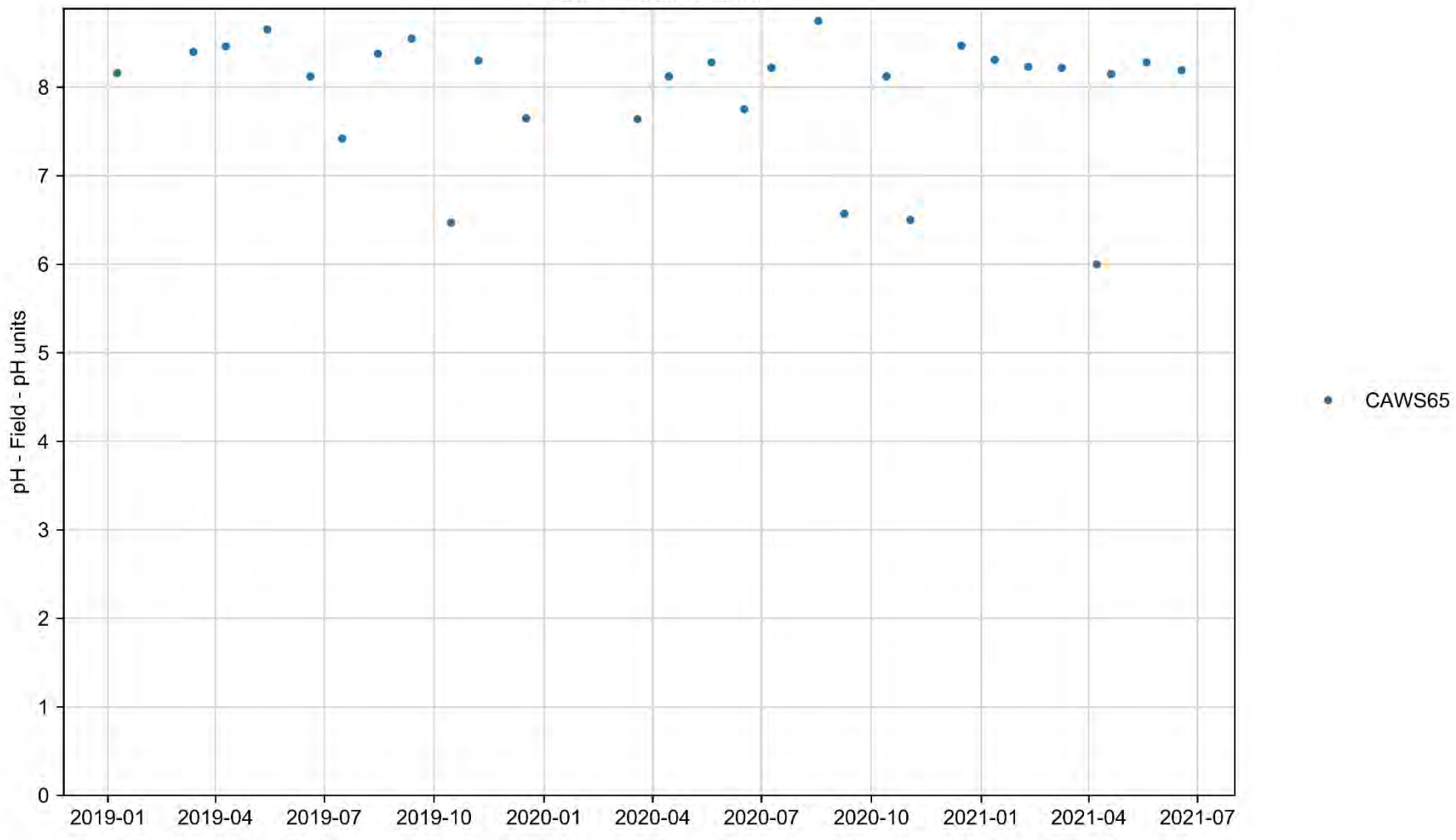
AEMR - Cadia Hill Pit

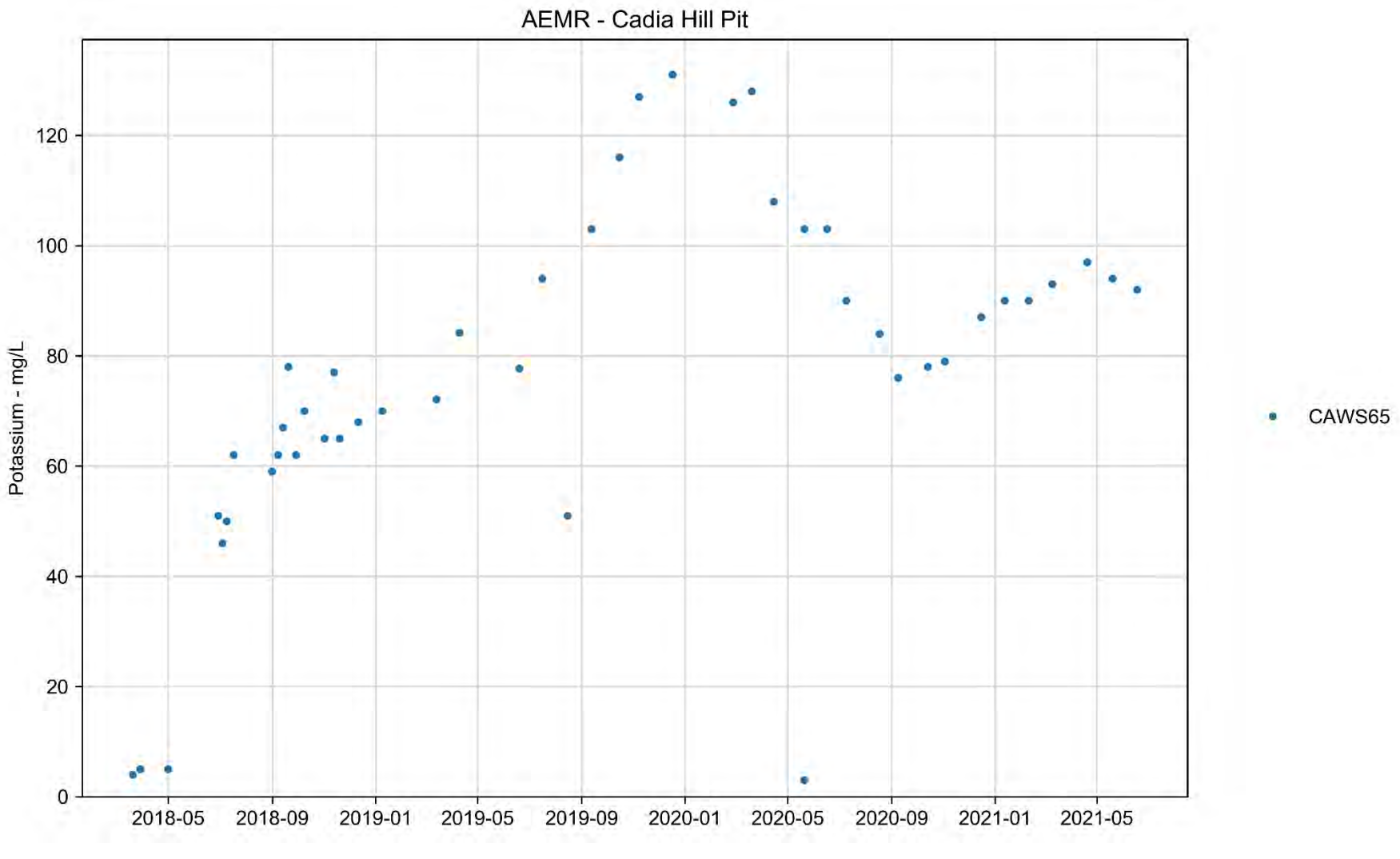


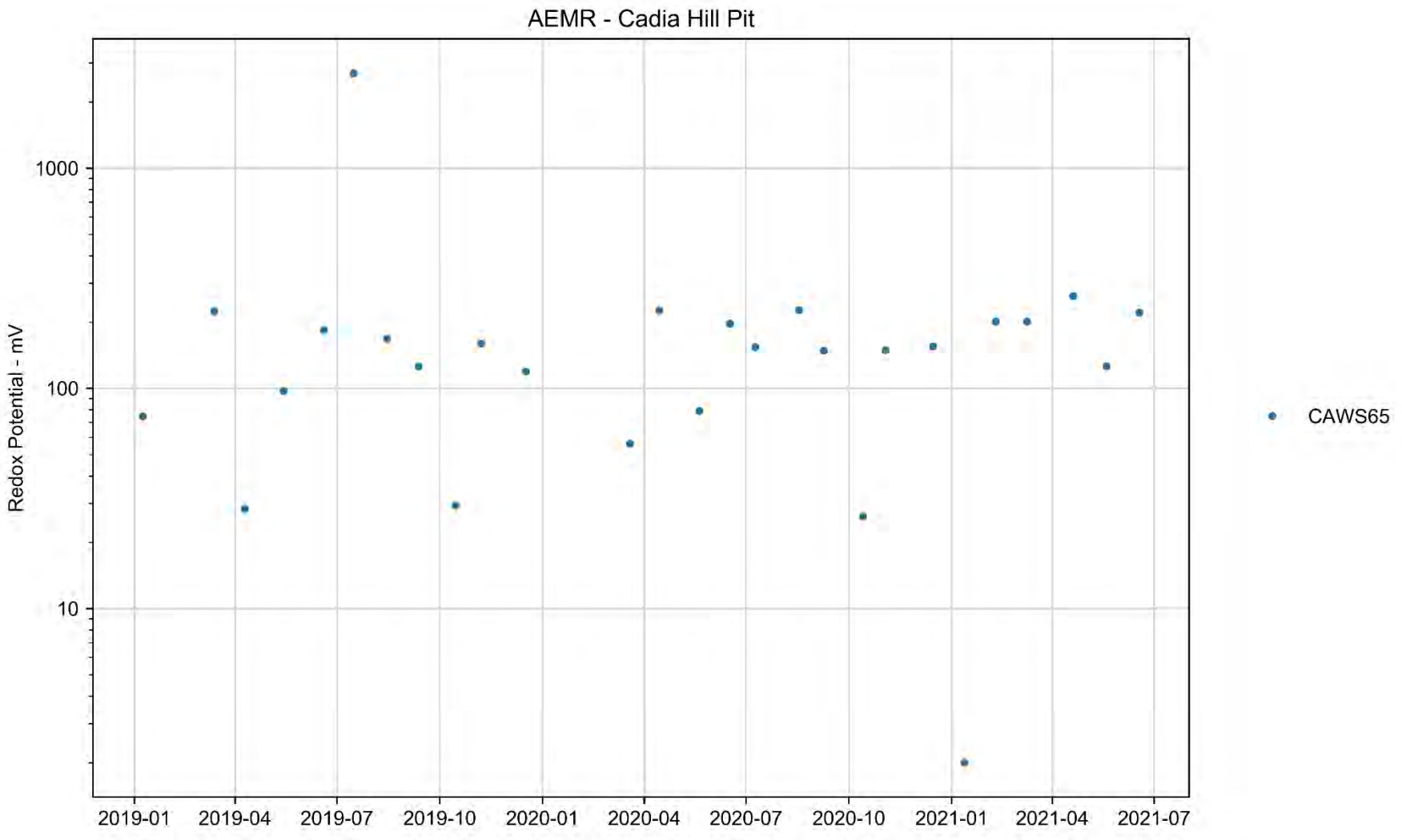
AEMR - Cadia Hill Pit

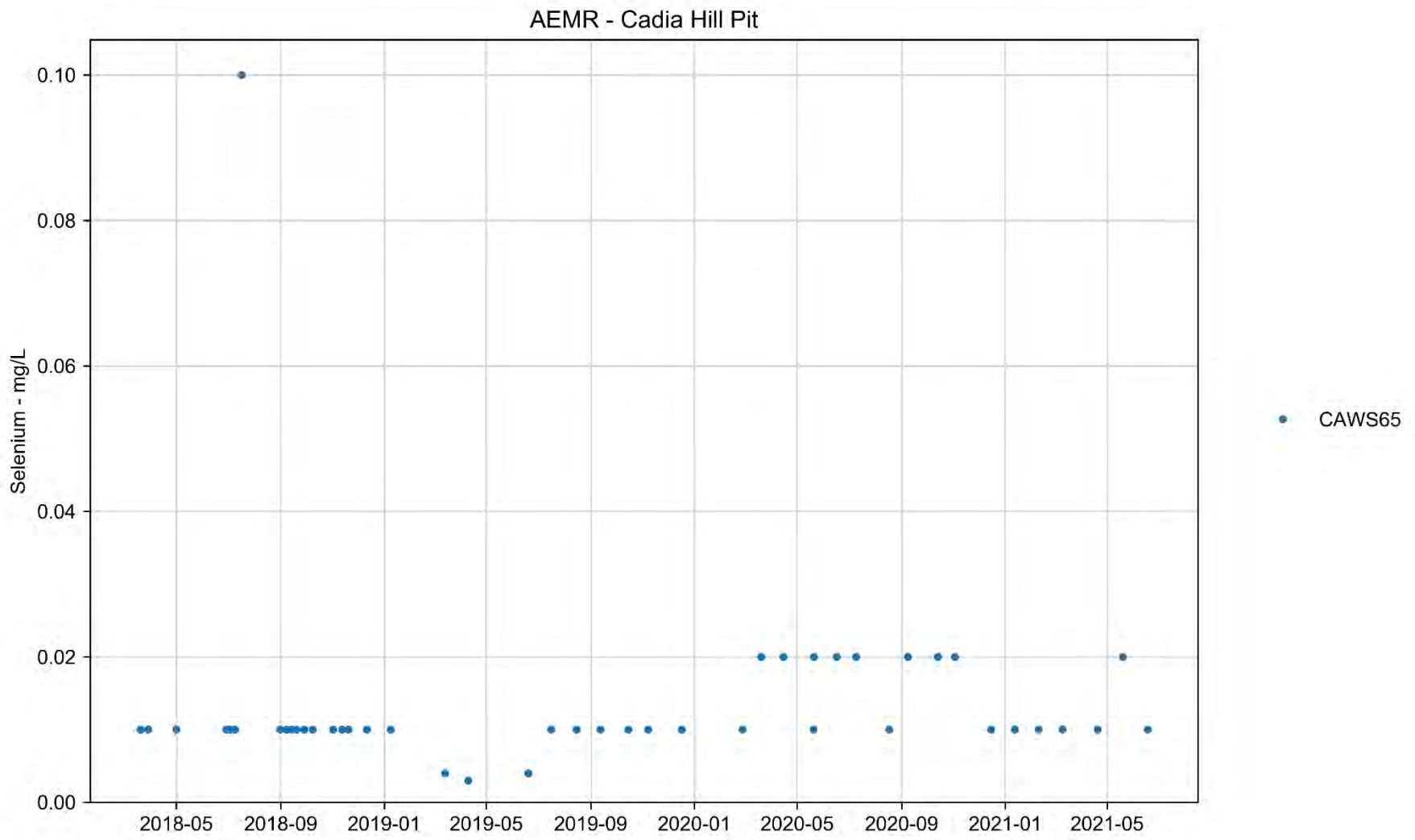


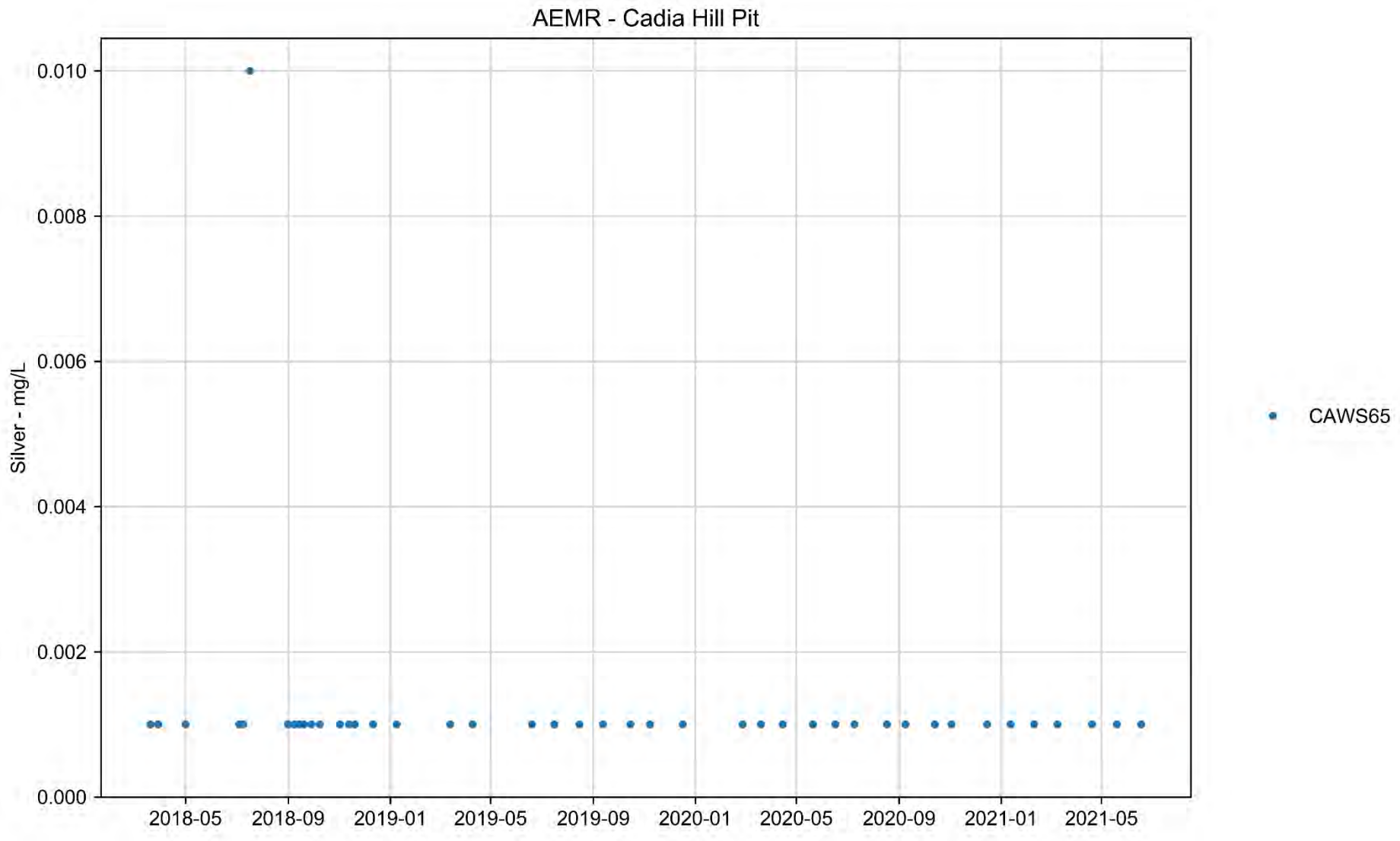
AEMR - Cadia Hill Pit

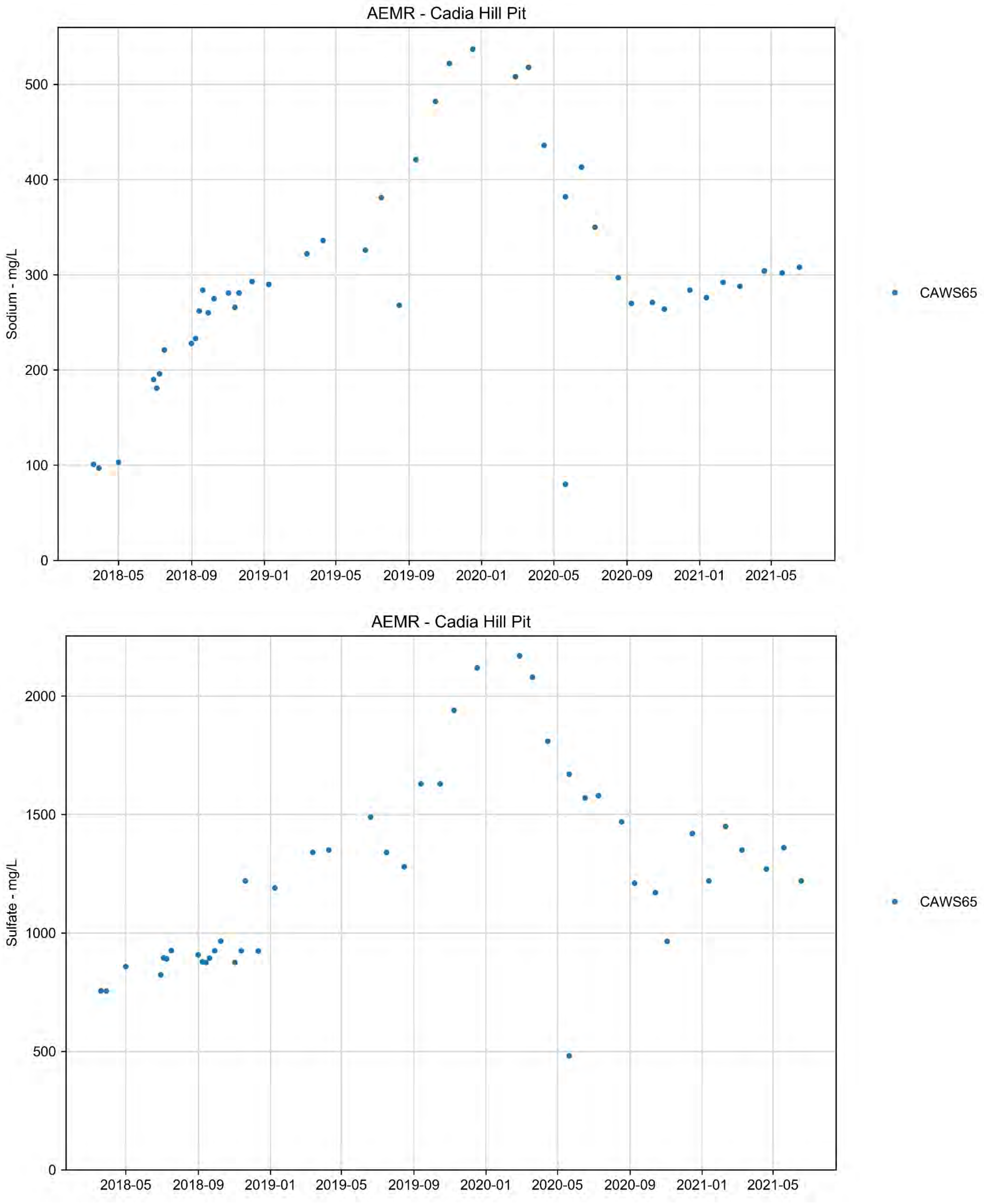



AEMR - Cadia Hill Pit
Potassium - mg/L
120
100
80
60
40
20
0
2018-05
2018-09
2019-01
2019-05
2019-09
2020-01
2020-05
2020-09
2021-01
2021-05
CAWS65

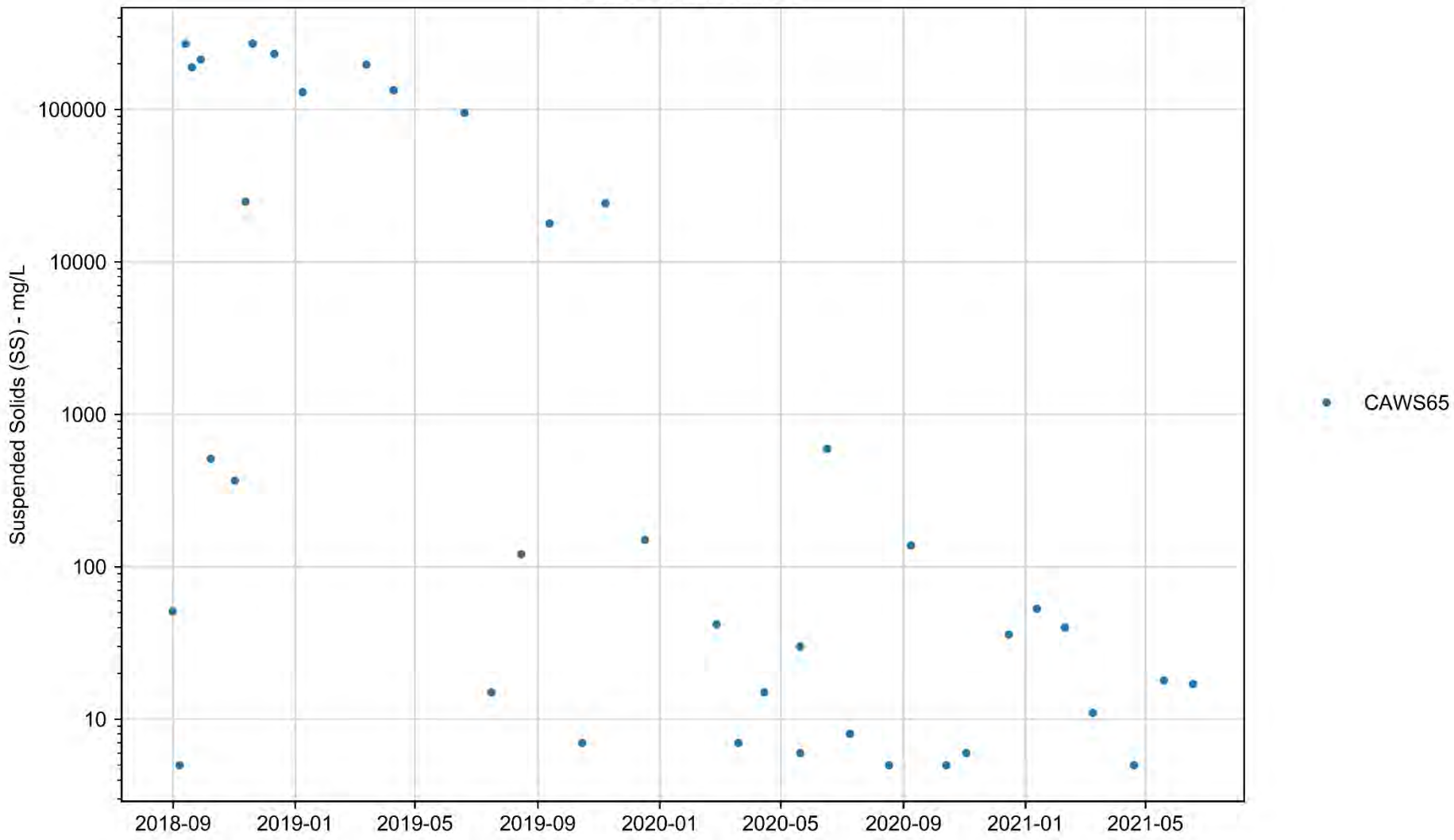

AEMR - Cadia Hill Pit
Redox Potential - mV
1000
100
10
2019-01
2019-04
2019-07
2019-10
2020-01
2020-04
2020-07
2020-10
2021-01
2021-04
2021-07
CAWS65


AEMR - Cadia Hill Pit
Selenium - mg/L
0.10
0.08
0.06
0.04
0.02
0.00
2018-05
2018-09
2019-01
2019-05
2019-09
2020-01
2020-05
2020-09
2021-01
2021-05
CAWS65

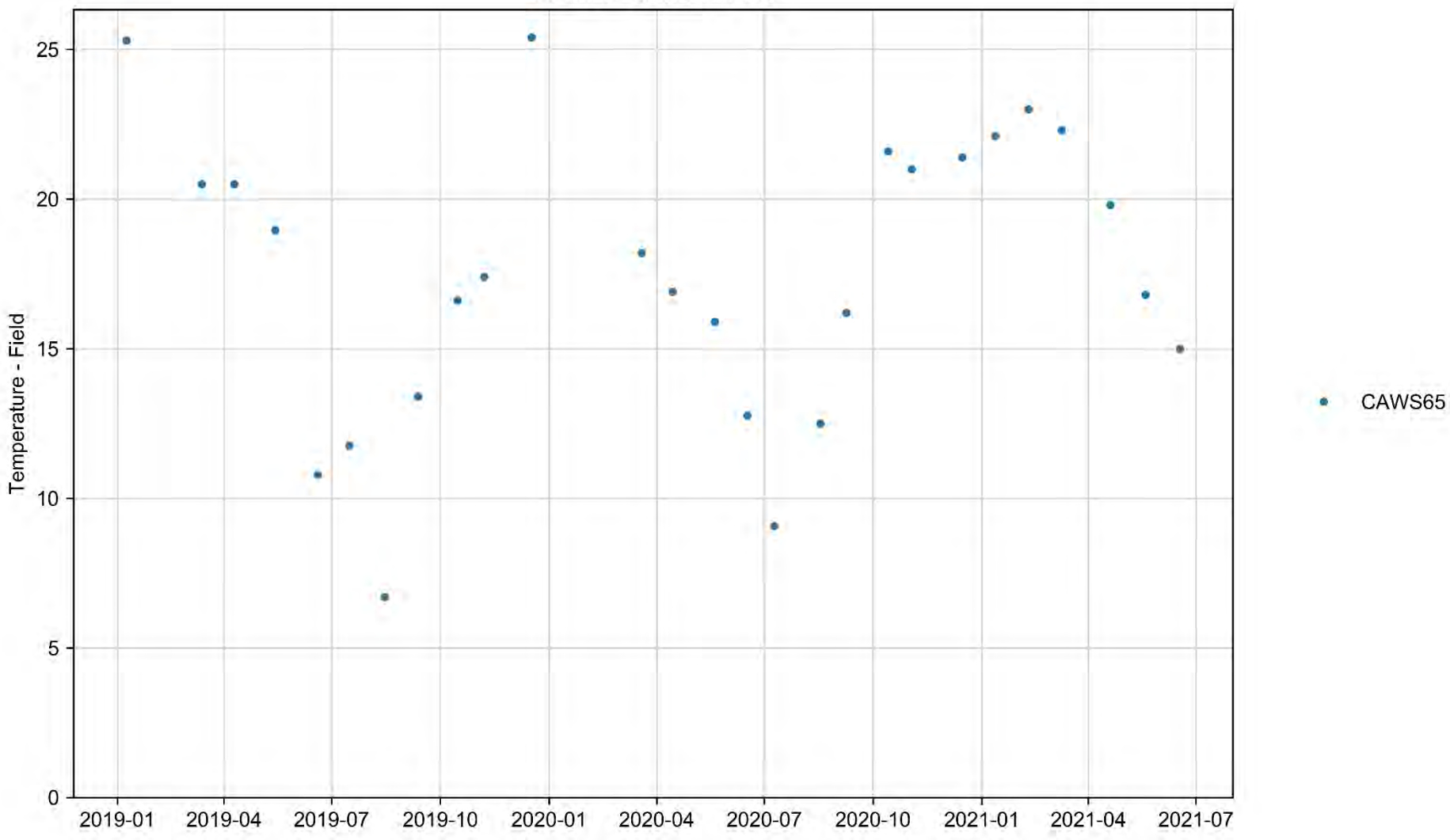

AEMR - Cadia Hill Pit
Silver - mg/L
0.010
0.008
0.006
0.004
0.002
0.000
2018-05
2018-09
2019-01
2019-05
2019-09
2020-01
2020-05
2020-09
2021-01
2021-05
CAWS65


AEMR - Cadia Hill Pit
Sodium - mg/L
500
400
300
200
100
0
2018-05
2018-09
2019-01
2019-05
2019-09
2020-01
2020-05
2020-09
2021-01
2021-05
CAWS65
AEMR - Cadia Hill Pit
Sulfate - mg/L
2000
1500
1000
500
0
2018-05
2018-09
2019-01
2019-05
2019-09
2020-01
2020-05
2020-09
2021-01
2021-05
CAWS65

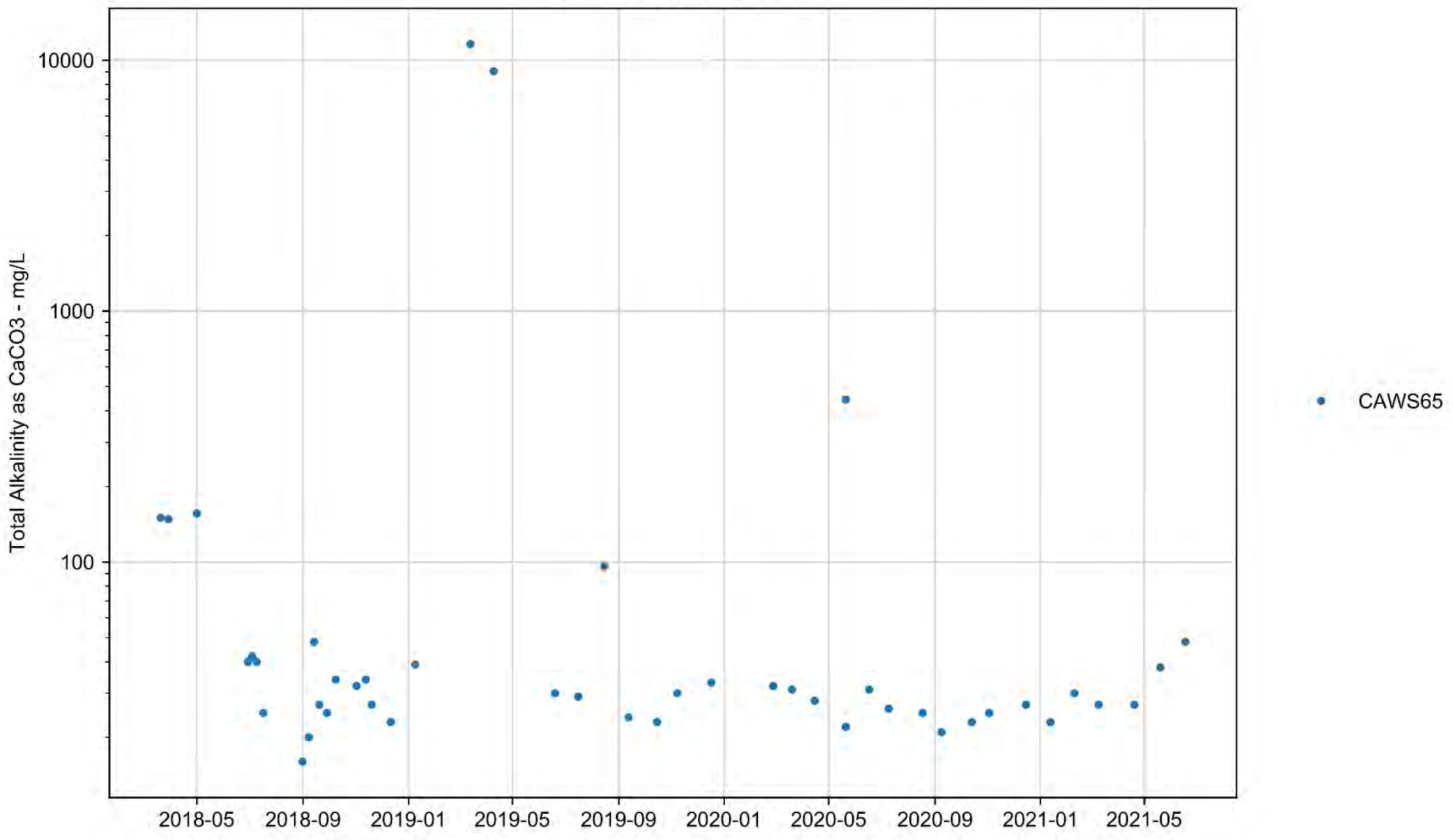
AEMR - Cadia Hill Pit



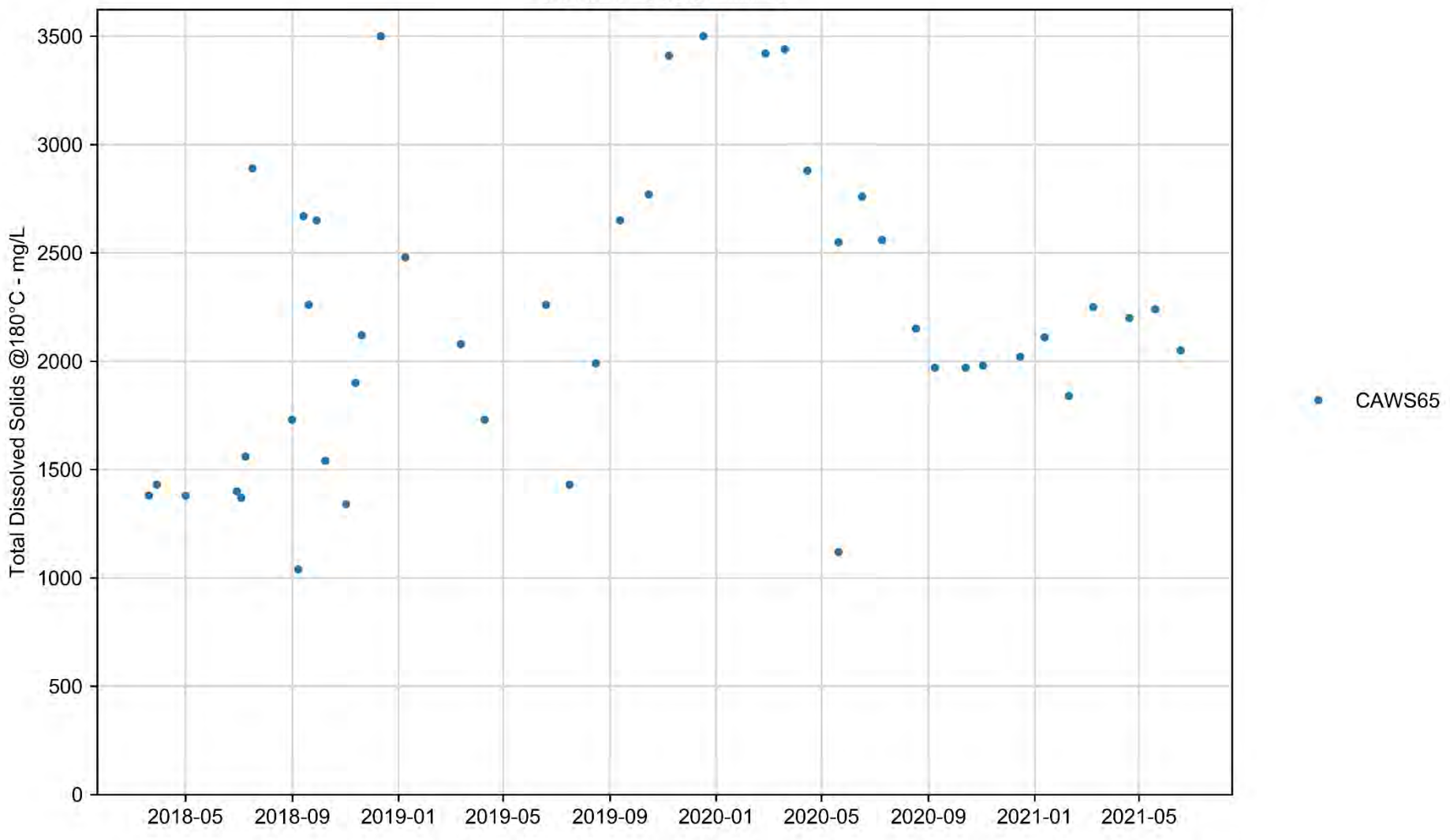
AEMR - Cadia Hill Pit

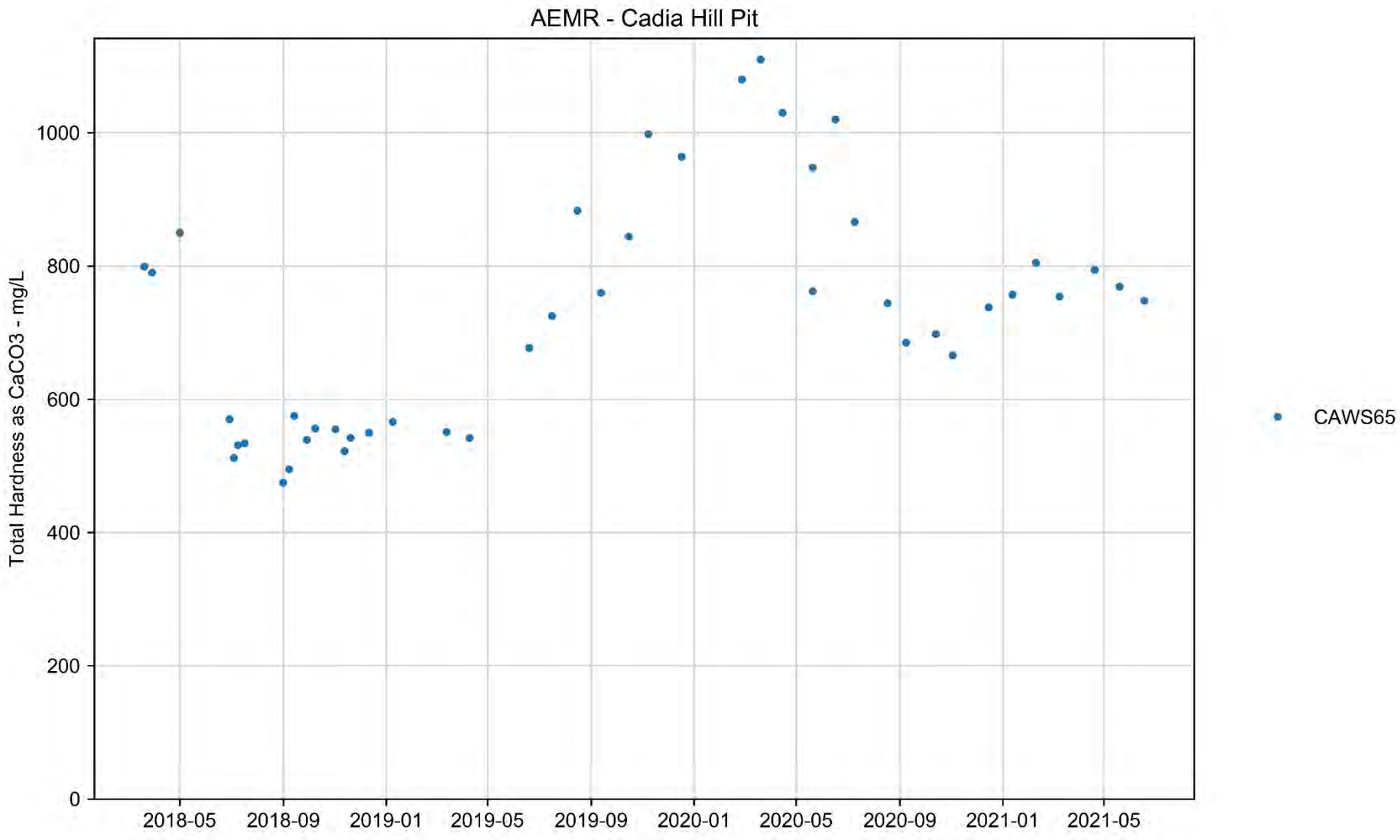


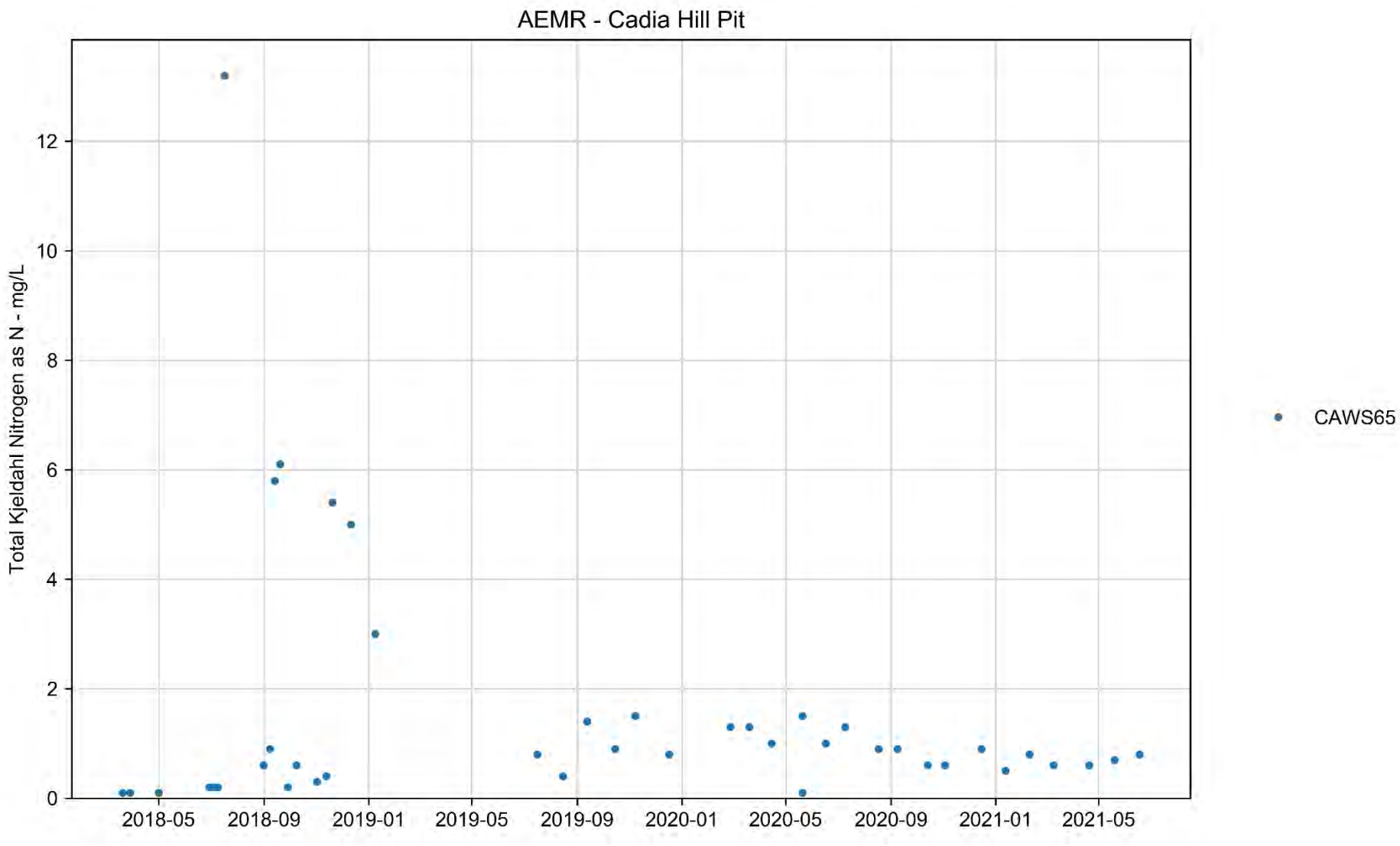
AEMR - Cadia Hill Pit



AEMR - Cadia Hill Pit




AEMR - Cadia Hill Pit
Total Hardness as CaCO3 - mg/L
1000
800
600
400
200
0
2018-05
2018-09
2019-01
2019-05
2019-09
2020-01
2020-05
2020-09
2021-01
2021-05
CAWS65


AEMR - Cadia Hill Pit
Total Kjeldahl Nitrogen as N - mg/L
12
10
8
6
4
2
0
2018-05
2018-09
2019-01
2019-05
2019-09
2020-01
2020-05
2020-09
2021-01
2021-05
CAWS65

AEMR - Cadia Hill Pit

Total Nitrogen as N - mg/L

12
10
8
6
4
2
0

2018-05 2018-09 2019-01 2019-05 2019-09 2020-01 2020-05 2020-09 2021-01 2021-05

CAWS65

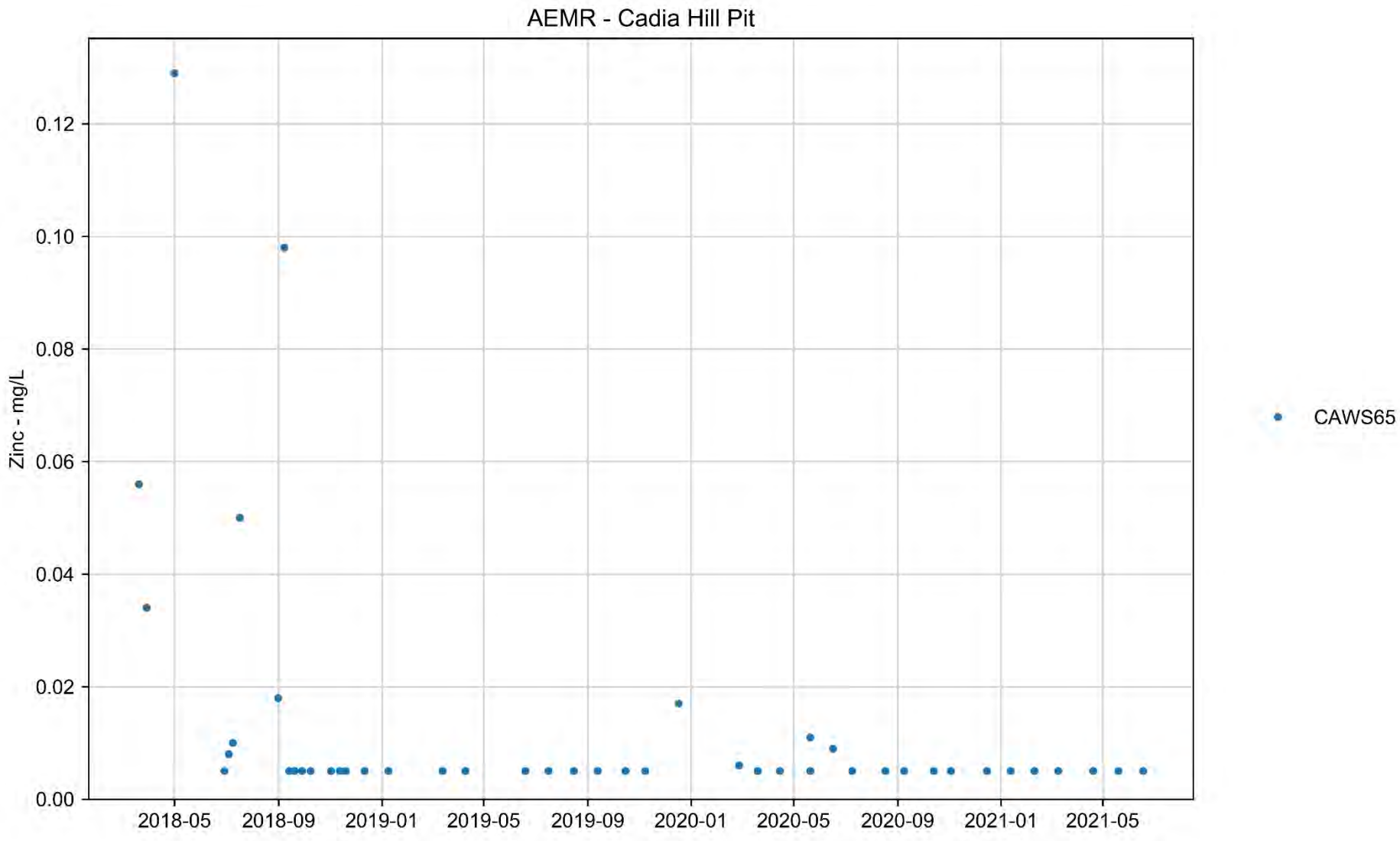
AEMR - Cadia Hill Pit

Total Phosphorus as P - mg/L

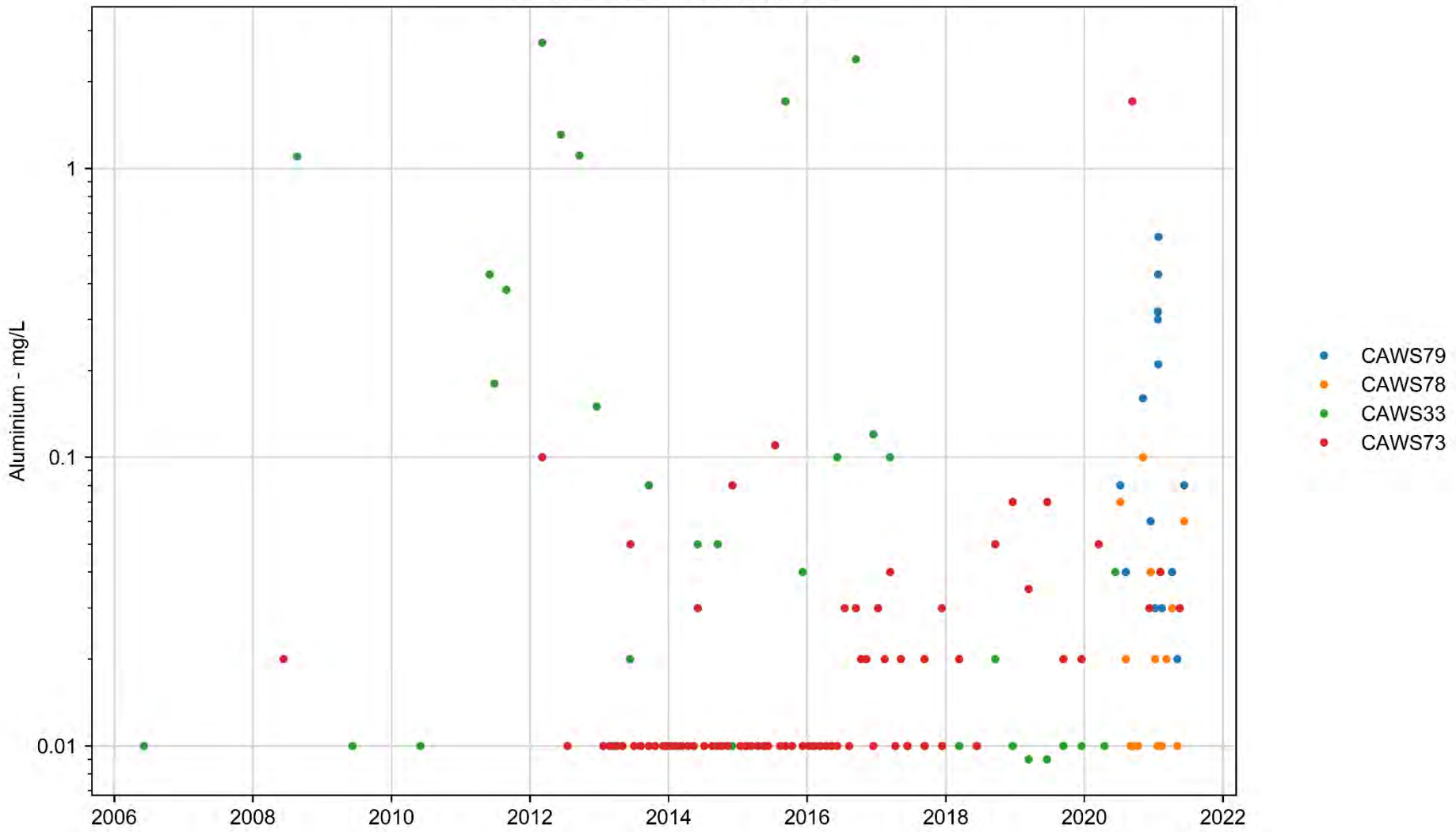
100
10
1
0.1
0.01

2018-05 2018-09 2019-01 2019-05 2019-09 2020-01 2020-05 2020-09 2021-01 2021-05

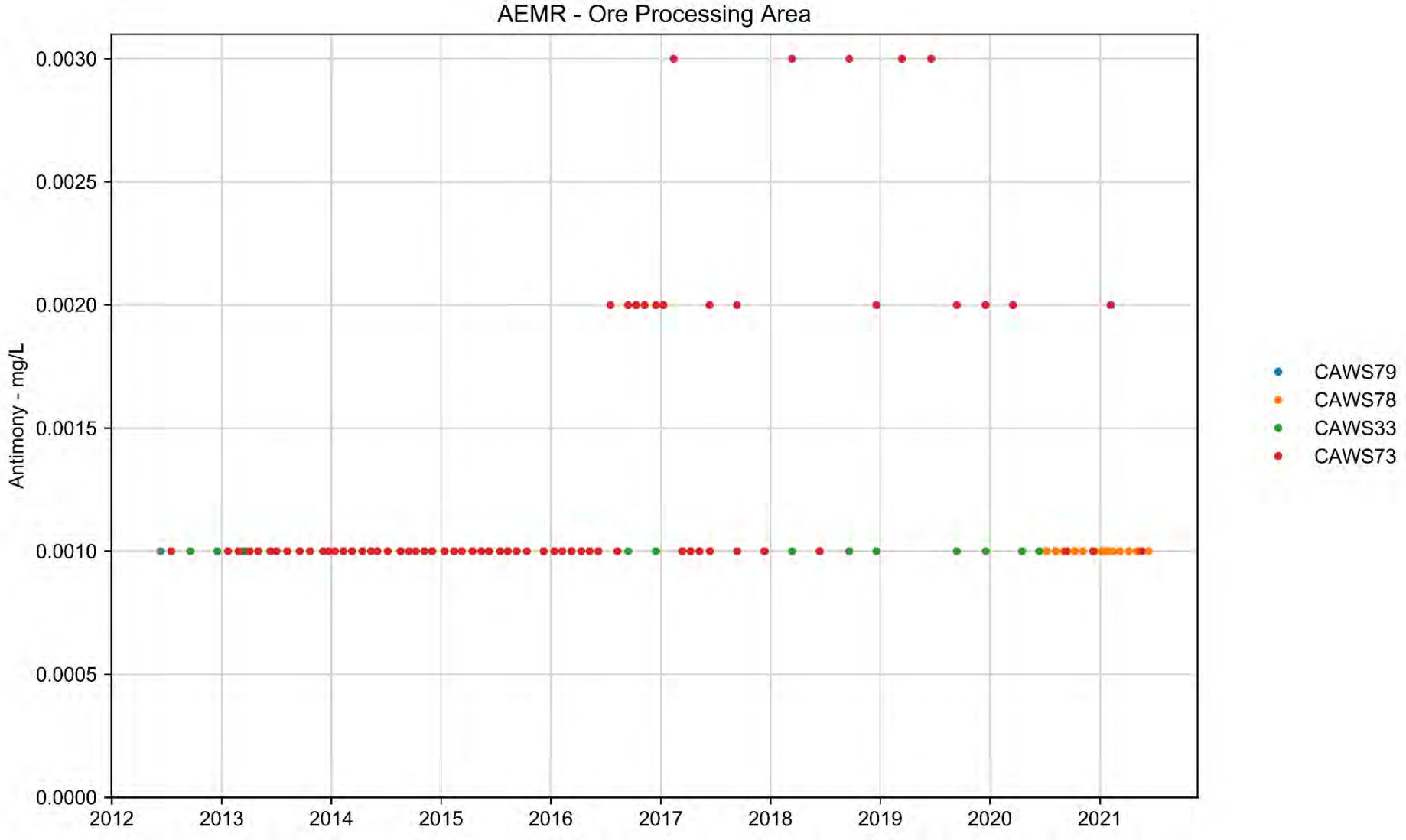
CAWS65

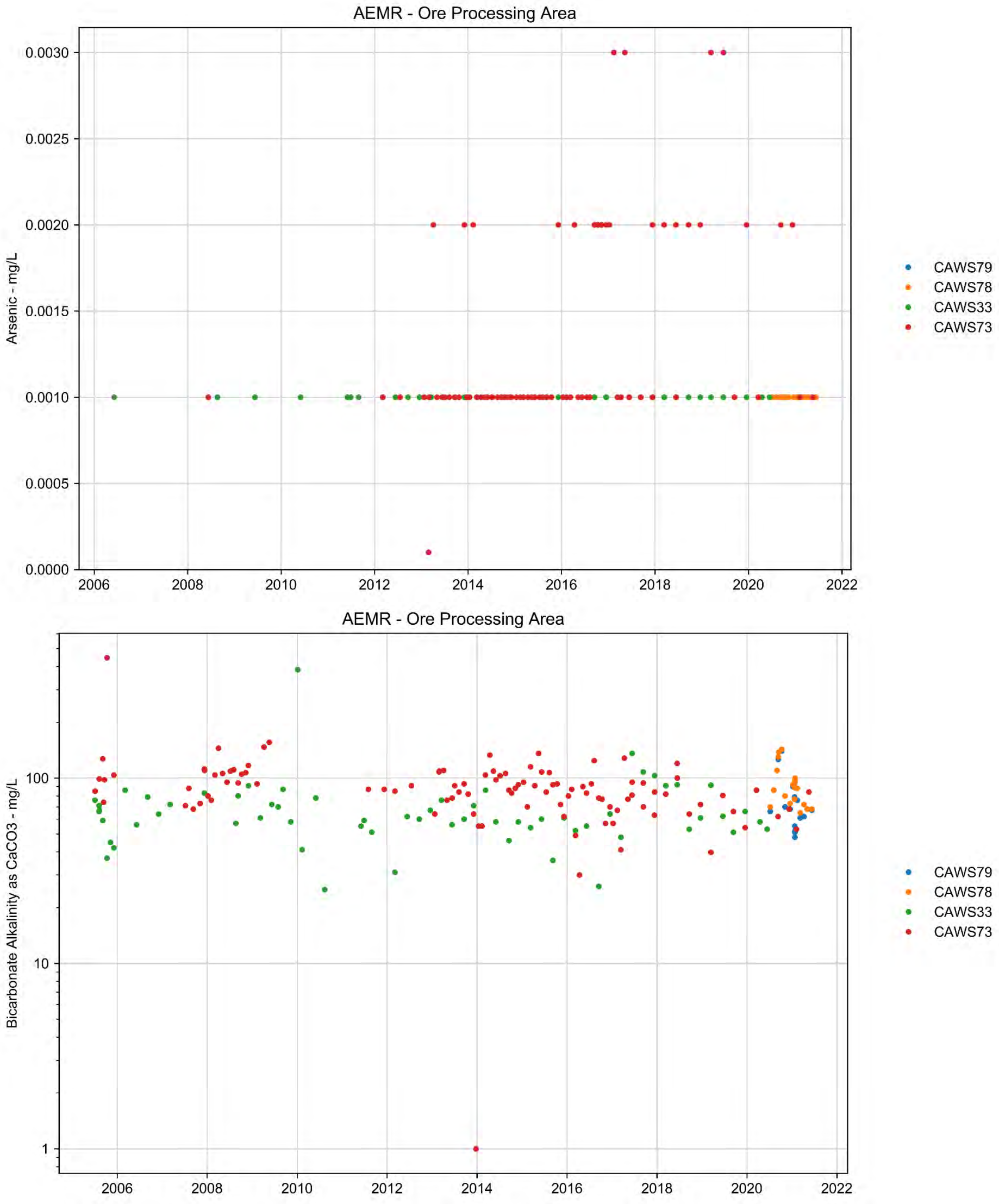

AEMR - Cadia Hill Pit
Zinc - mg/L
0.12
0.10
0.08
0.06
0.04
0.02
0.00
2018-05
2018-09
2019-01
2019-05
2019-09
2020-01
2020-05
2020-09
2021-01
2021-05
CAWS65

AEMR - Ore Processing Area

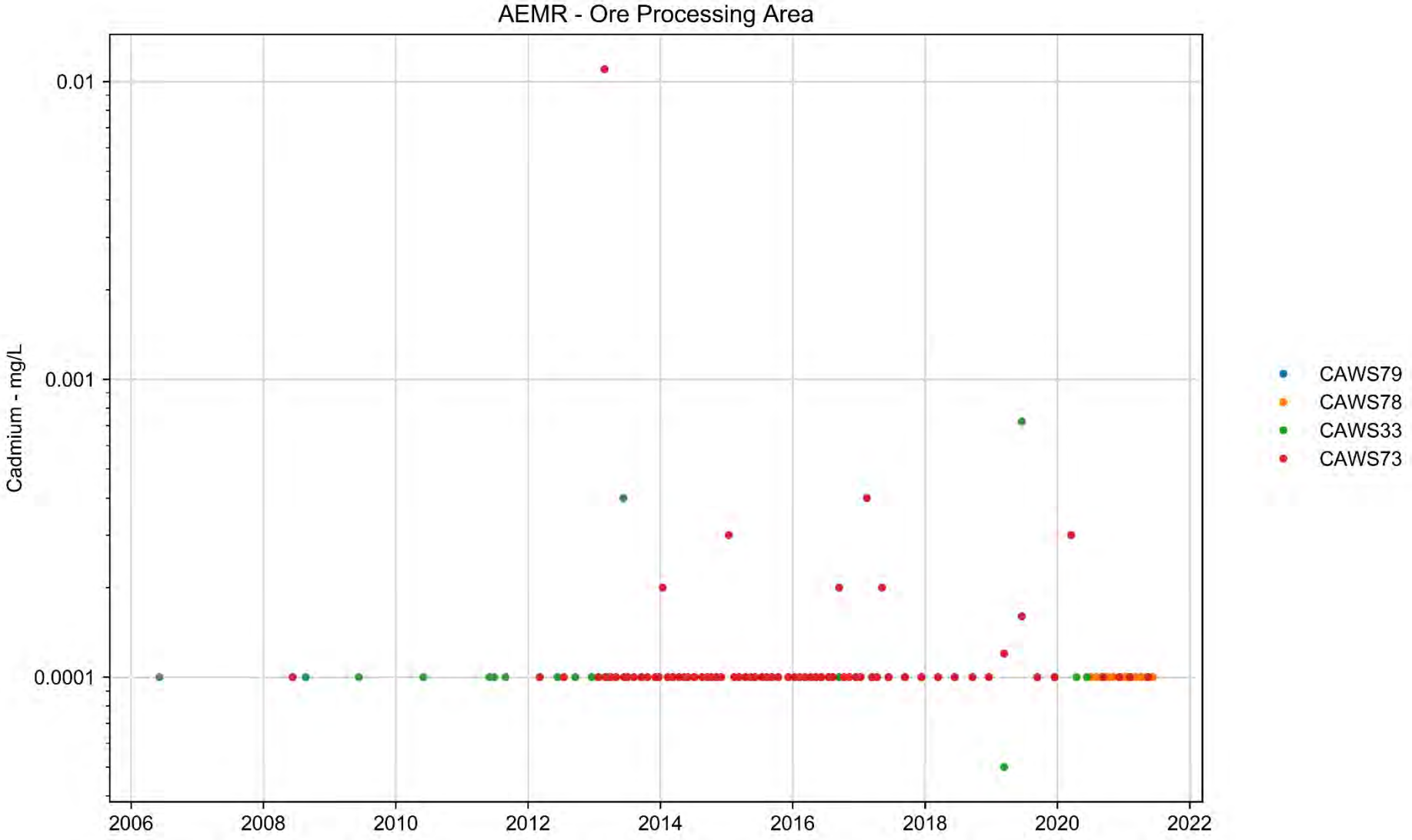


AEMR - Ore Processing Area

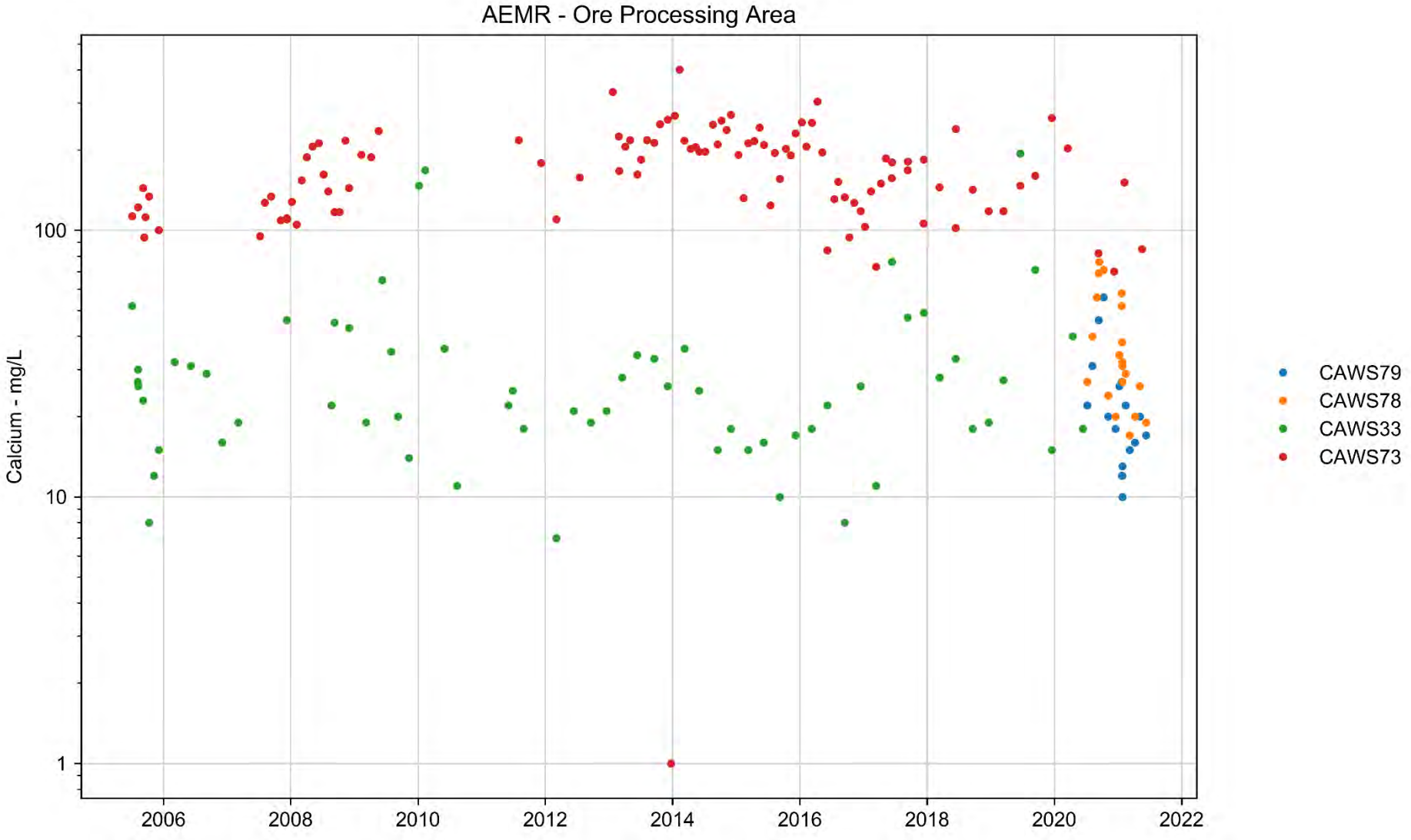


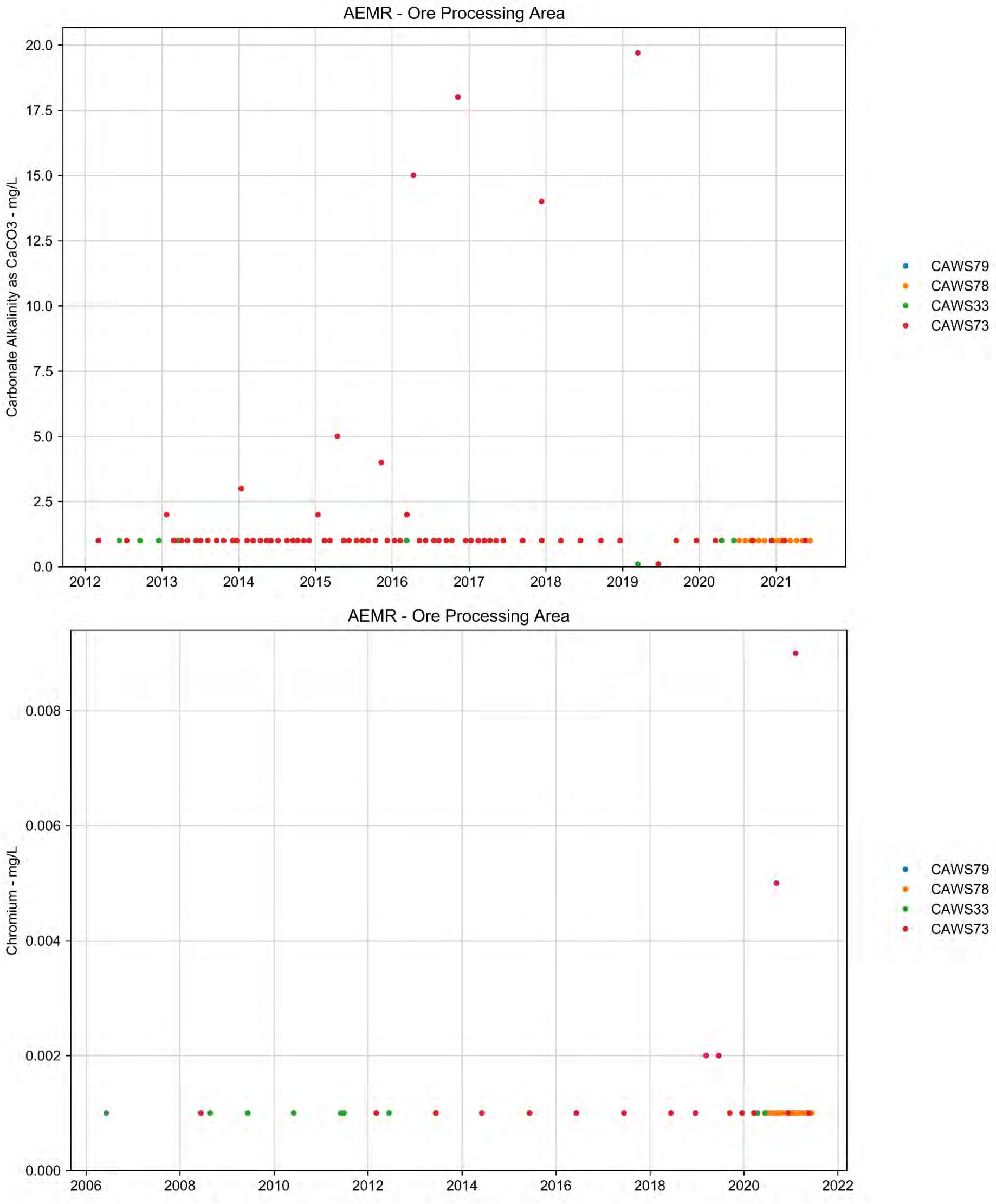

AEMR - Ore Processing Area
Arsenic - mg/L
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS79
CAWS78
CAWS33
CAWS73
AEMR - Ore Processing Area
Bicarbonate Alkalinity as CaCO3 - mg/L
100
10
1
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS79
CAWS78
CAWS33
CAWS73

AEMR - Ore Processing Area

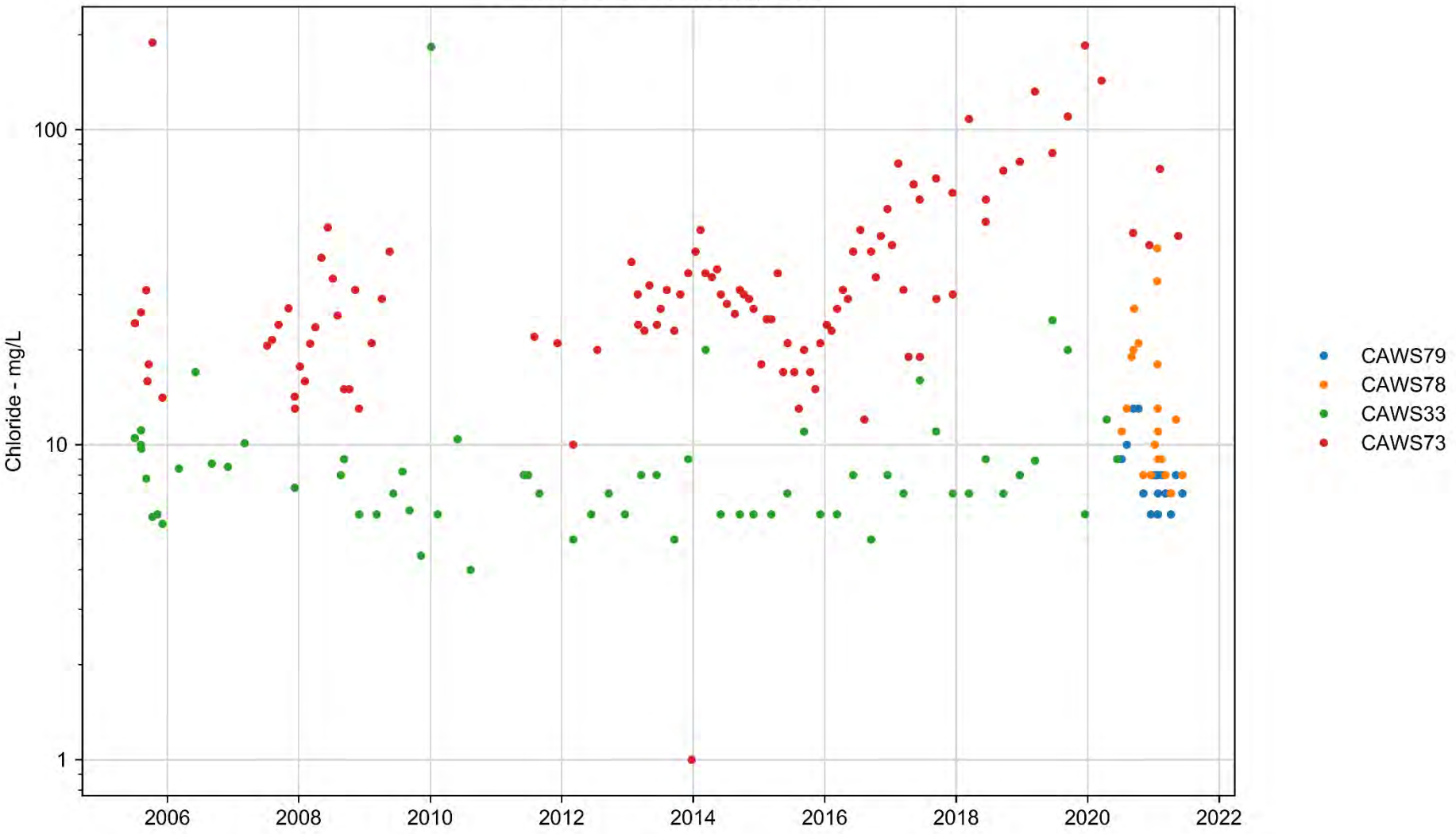


AEMR - Ore Processing Area

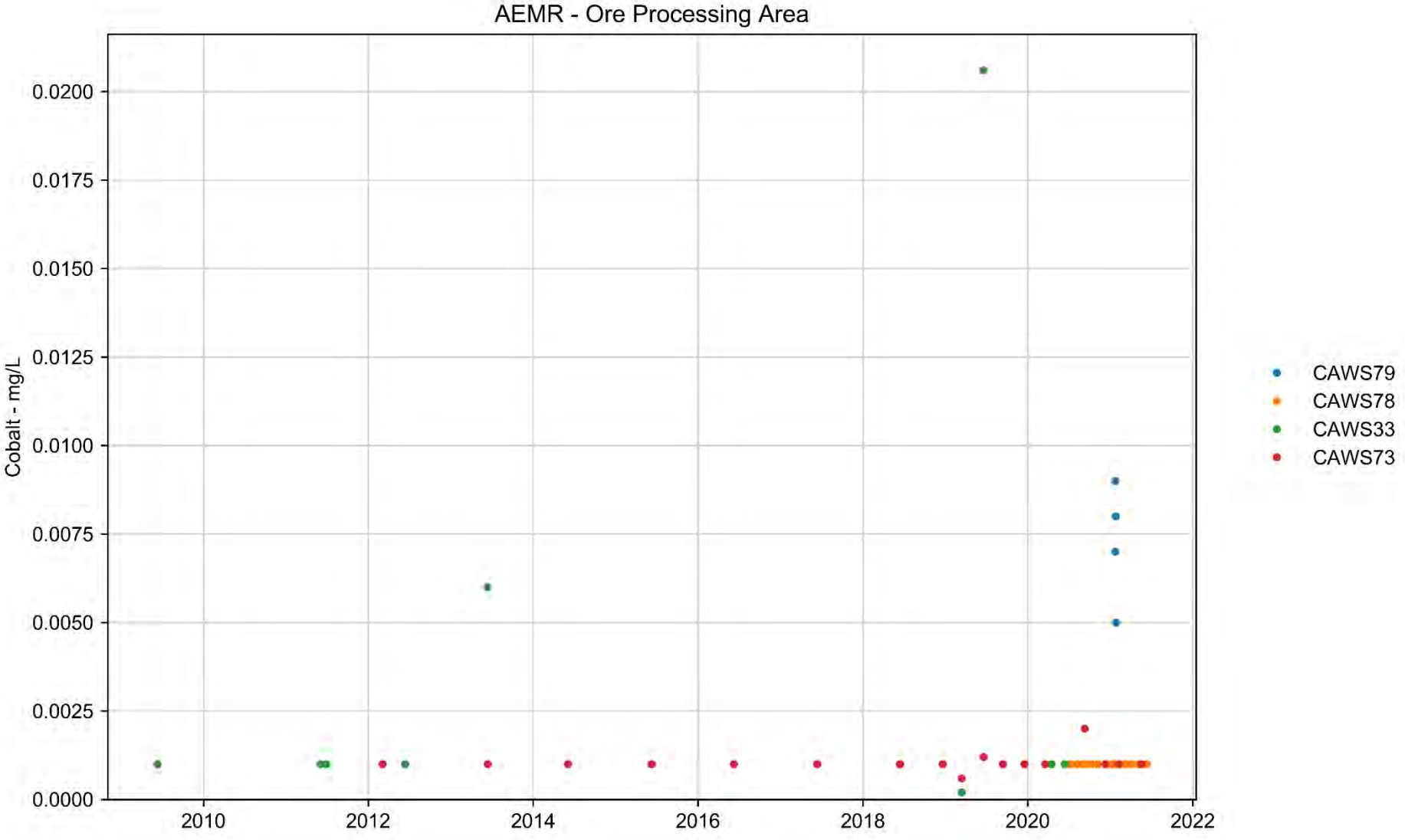



AEMR - Ore Processing Area
Carbonate Alkalinity as CaCO3 - mg/L
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
CAWS79
CAWS78
CAWS33
CAWS73
AEMR - Ore Processing Area
Chromium - mg/L
0.008
0.006
0.004
0.002
0.000
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS79
CAWS78
CAWS33
CAWS73

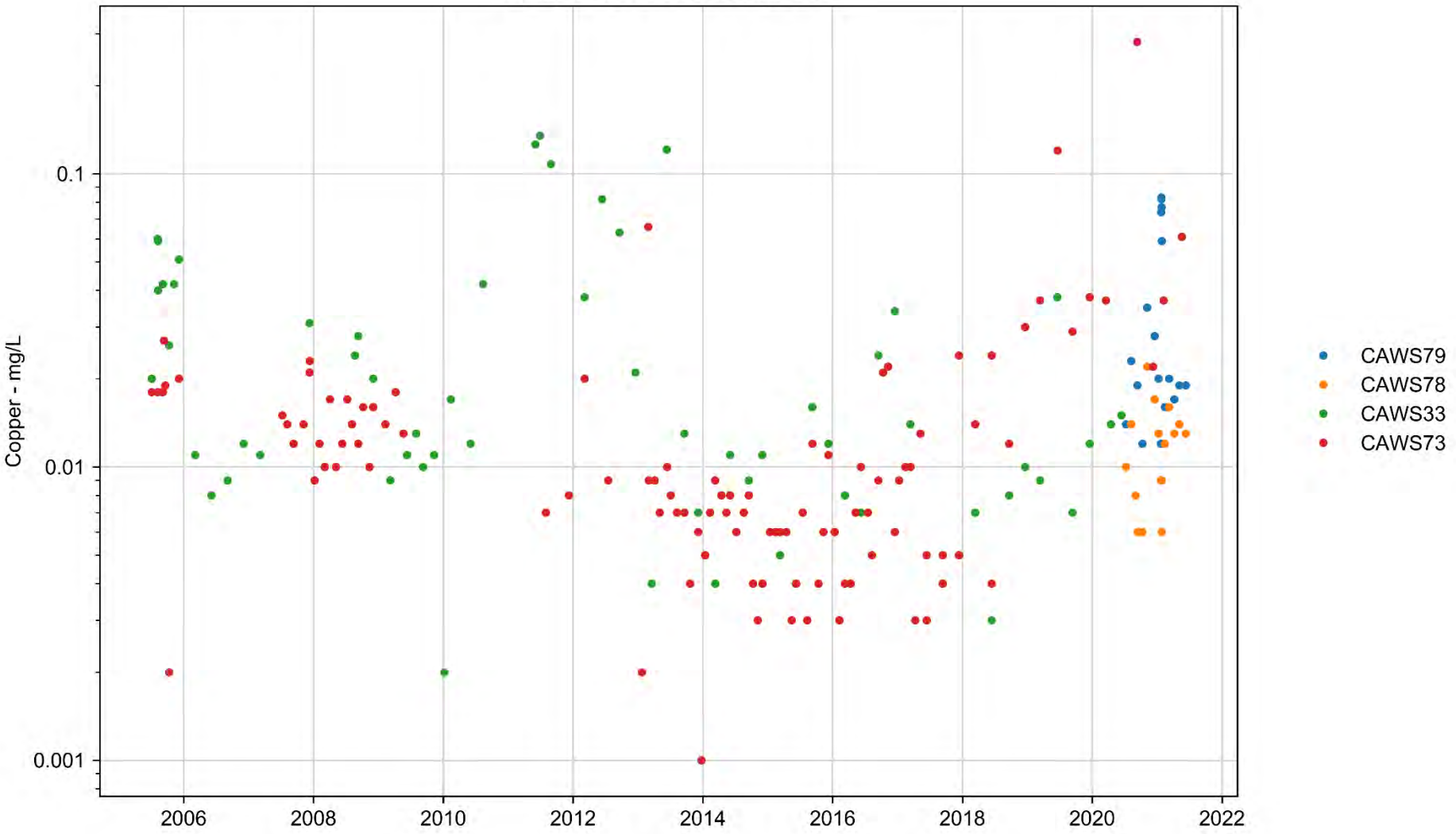
AEMR - Ore Processing Area



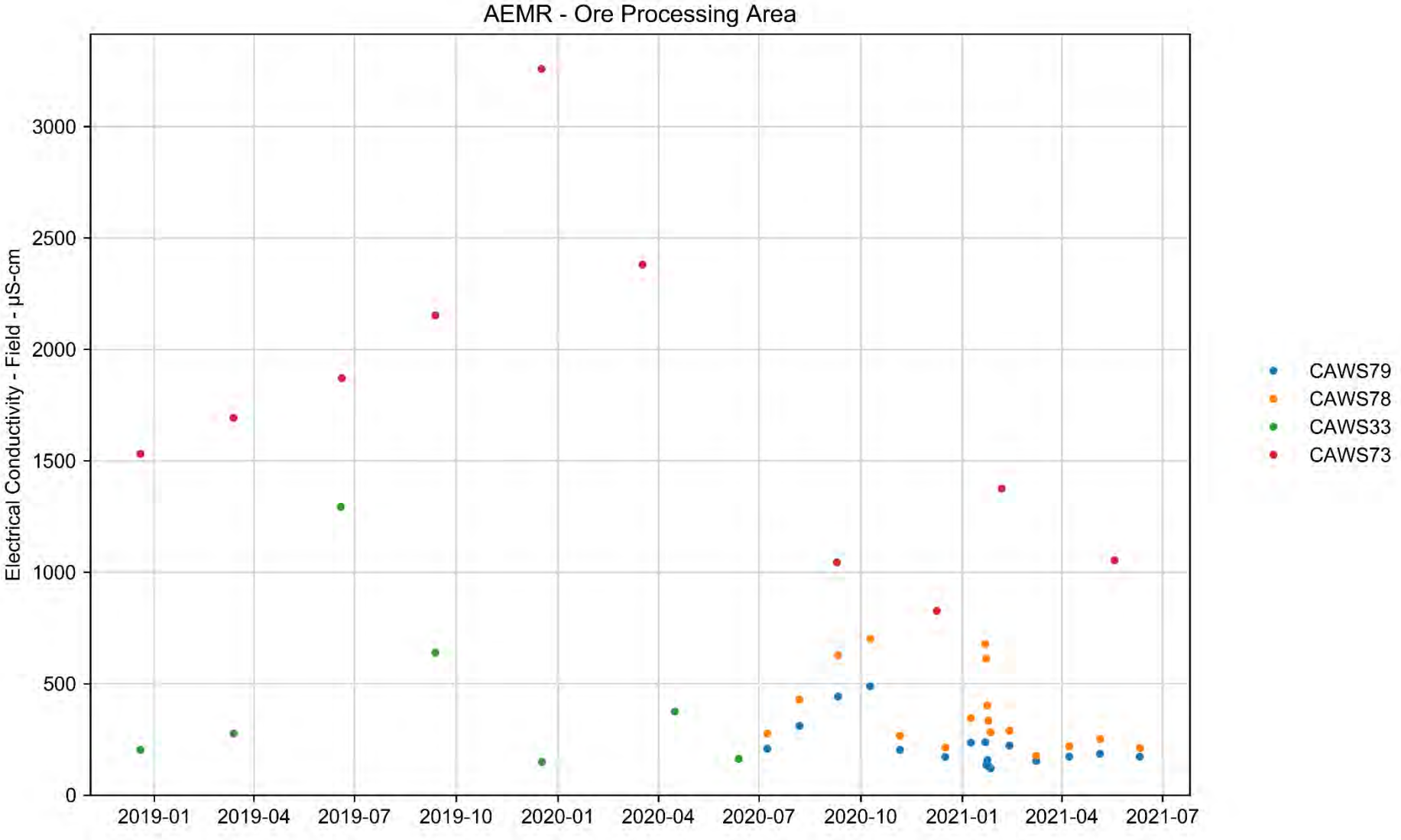
AEMR - Ore Processing Area



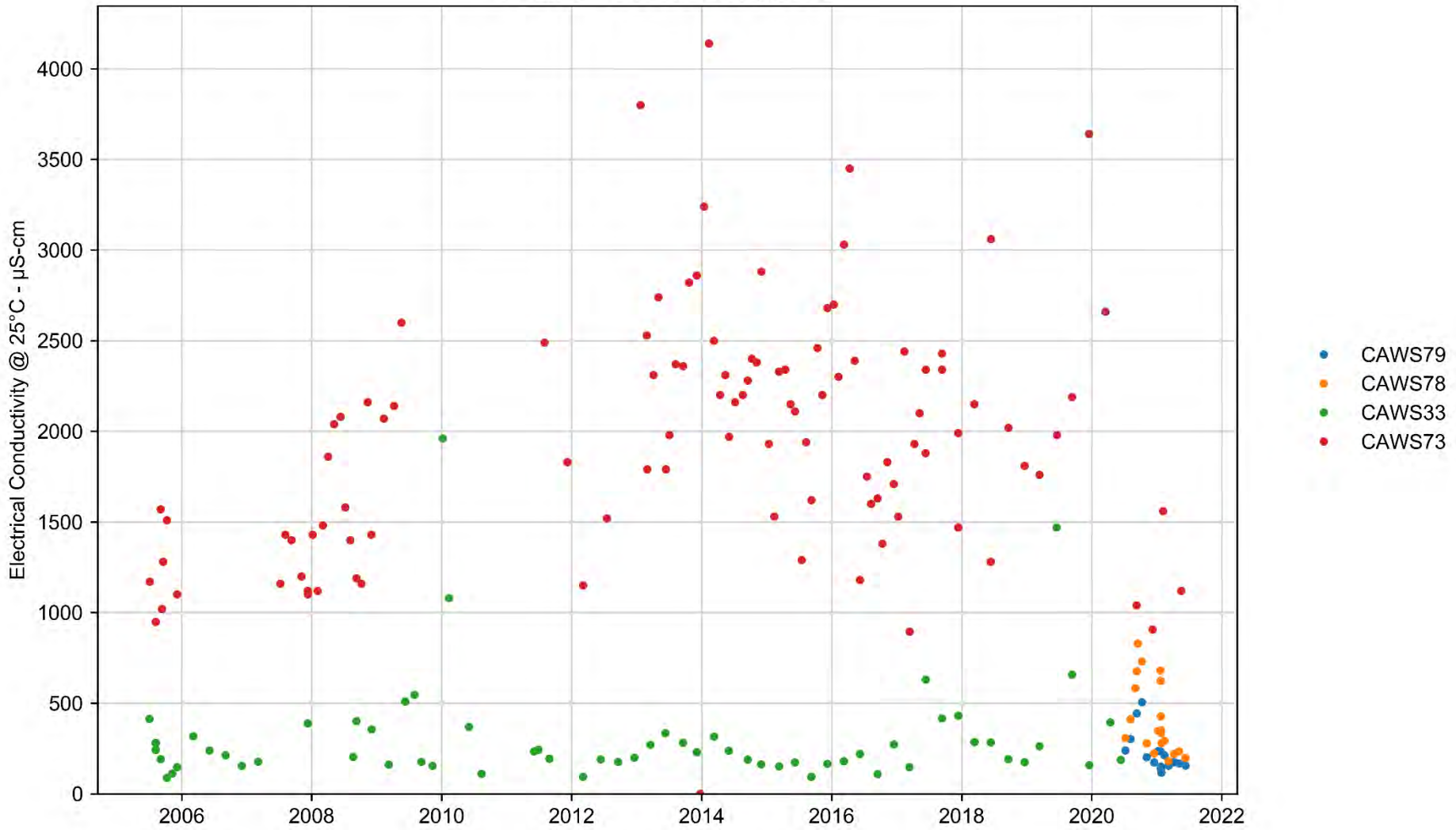
AEMR - Ore Processing Area



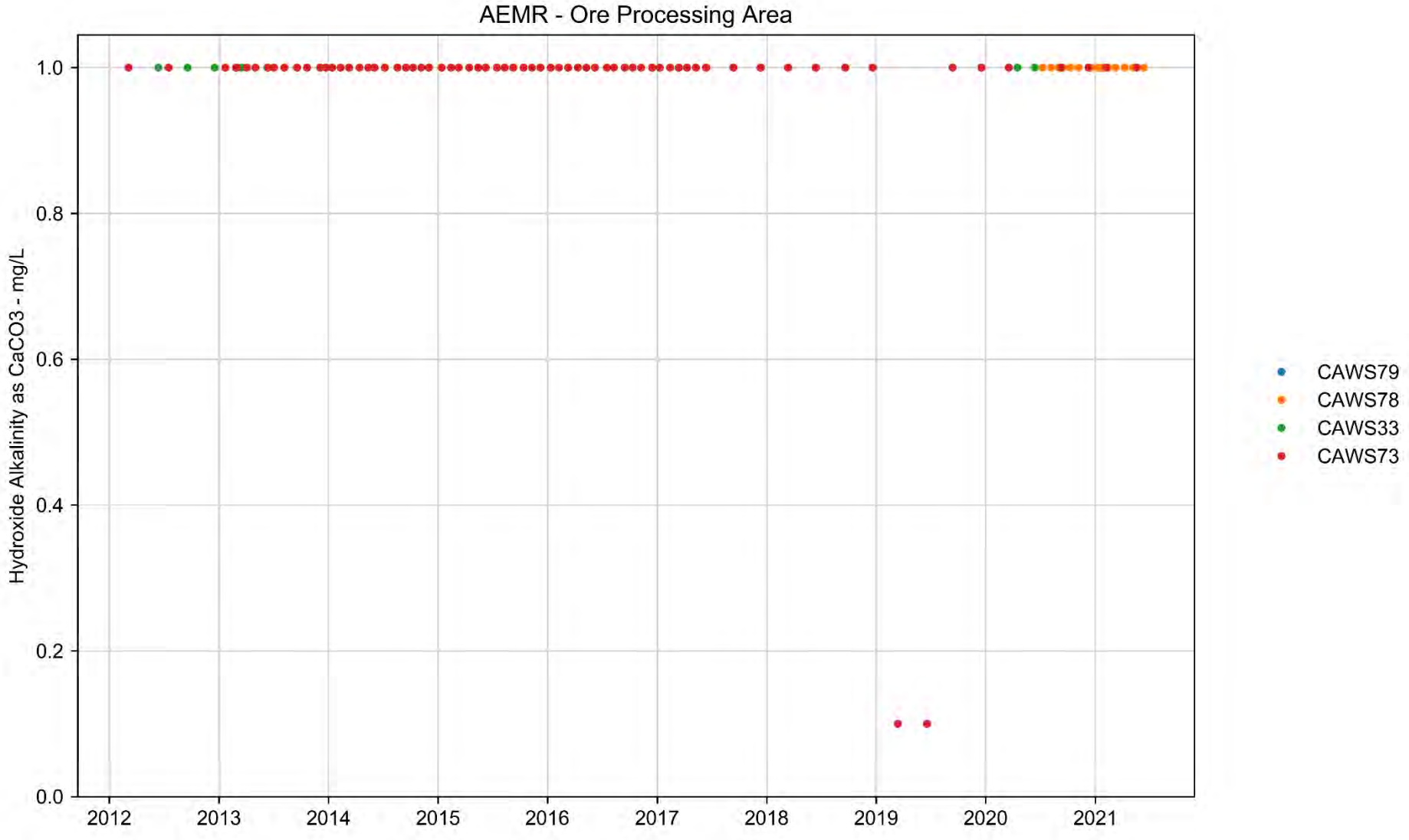
AEMR - Ore Processing Area



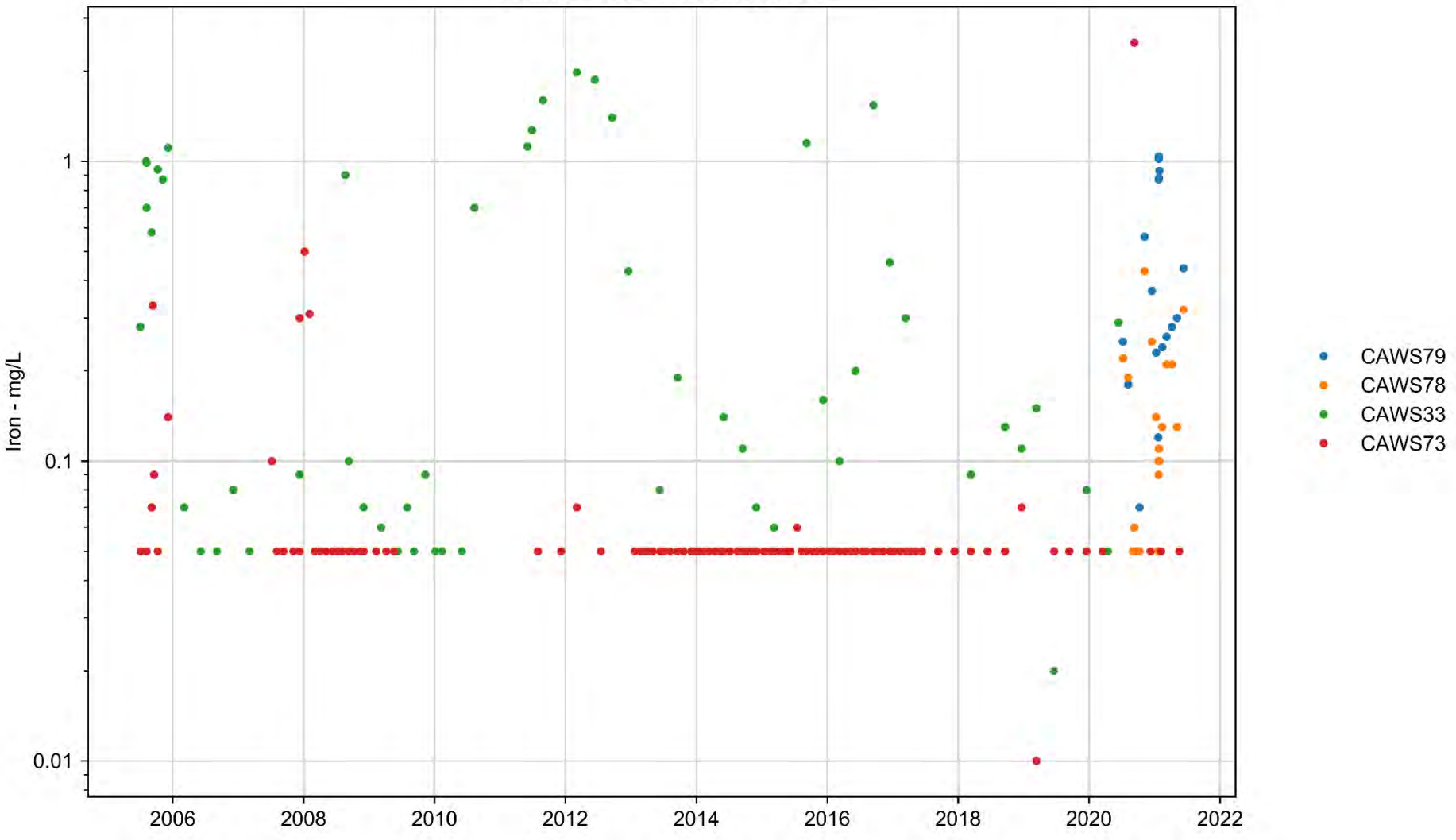
AEMR - Ore Processing Area



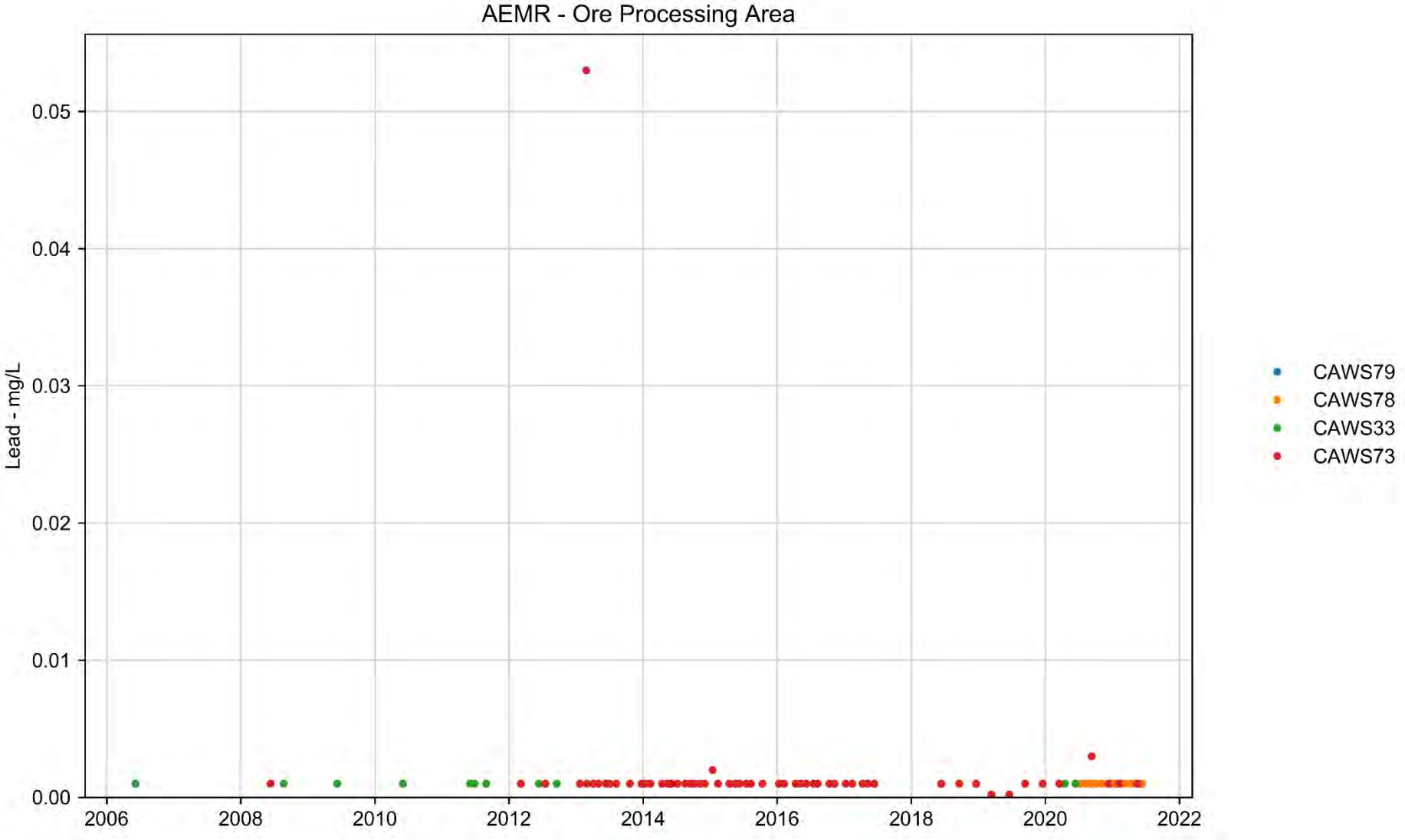
AEMR - Ore Processing Area



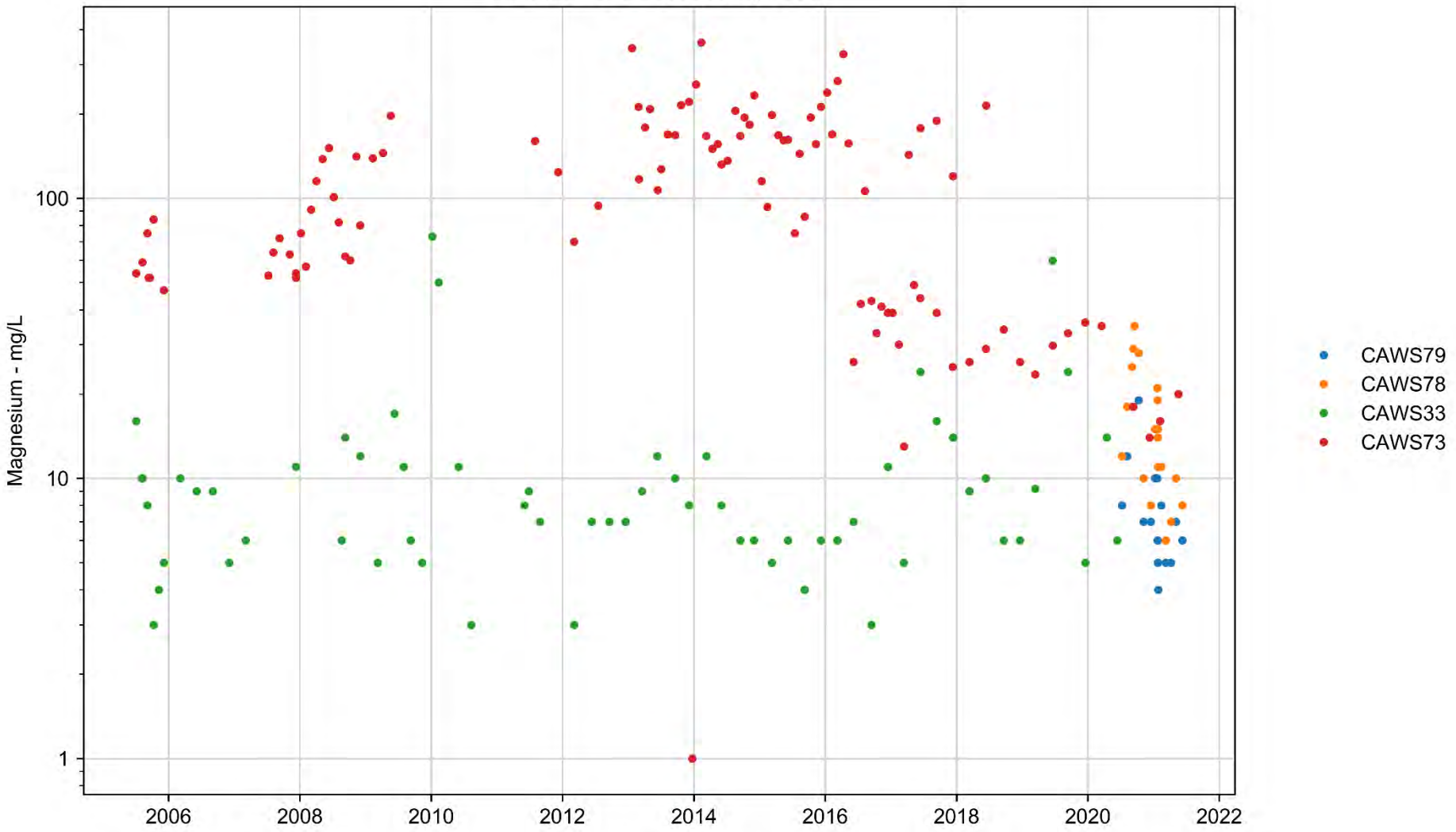
AEMR - Ore Processing Area



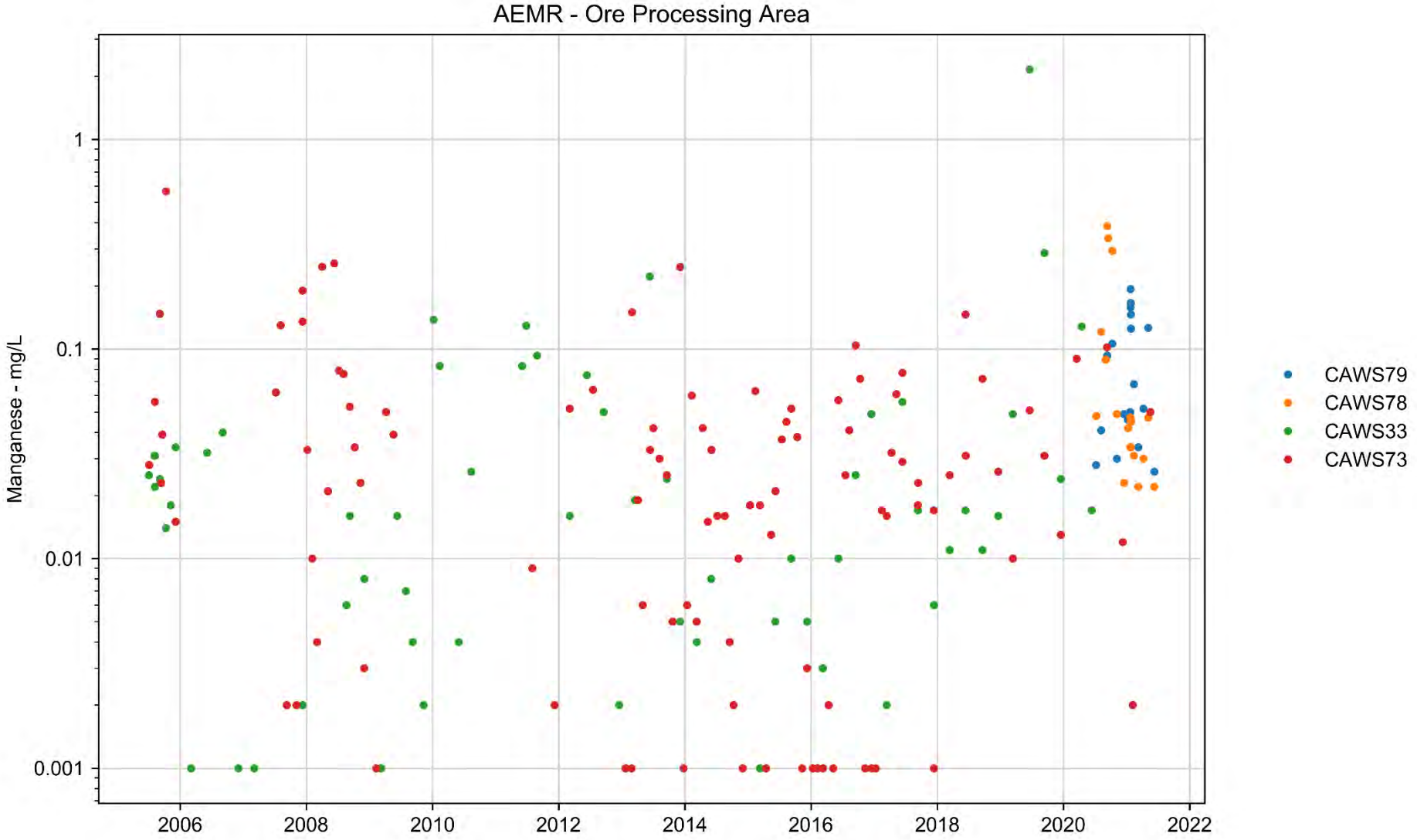
AEMR - Ore Processing Area



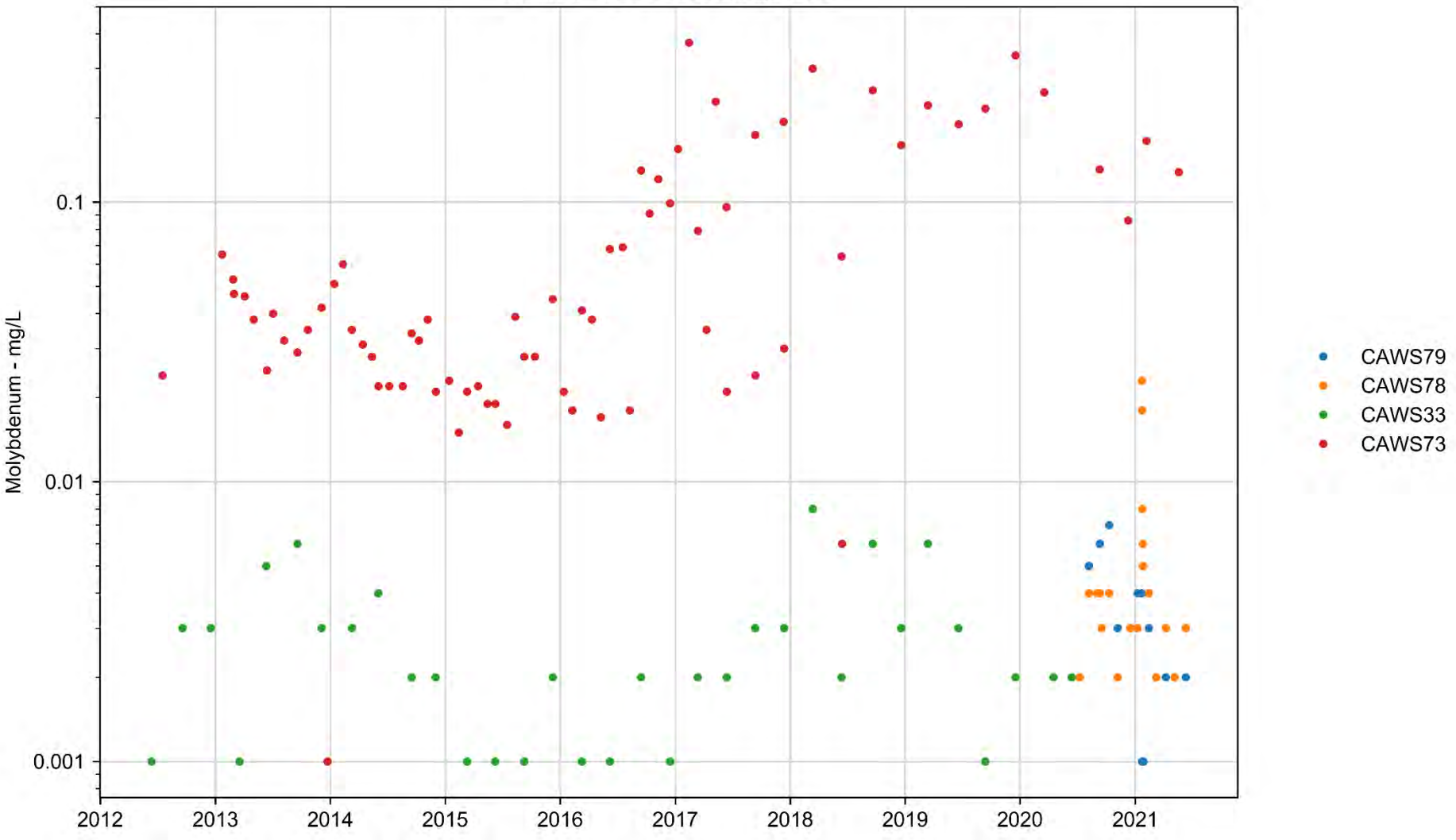
AEMR - Ore Processing Area



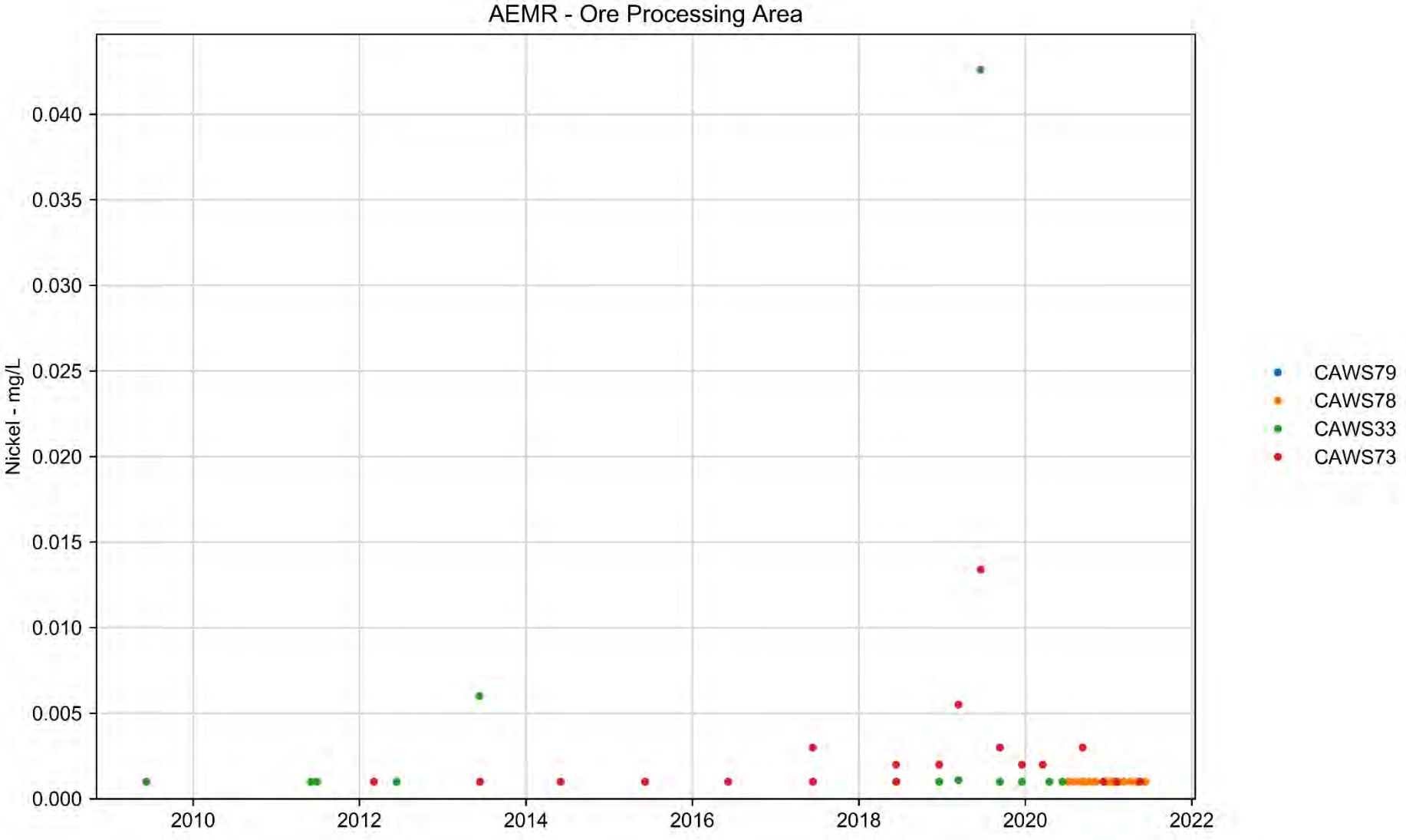
AEMR - Ore Processing Area



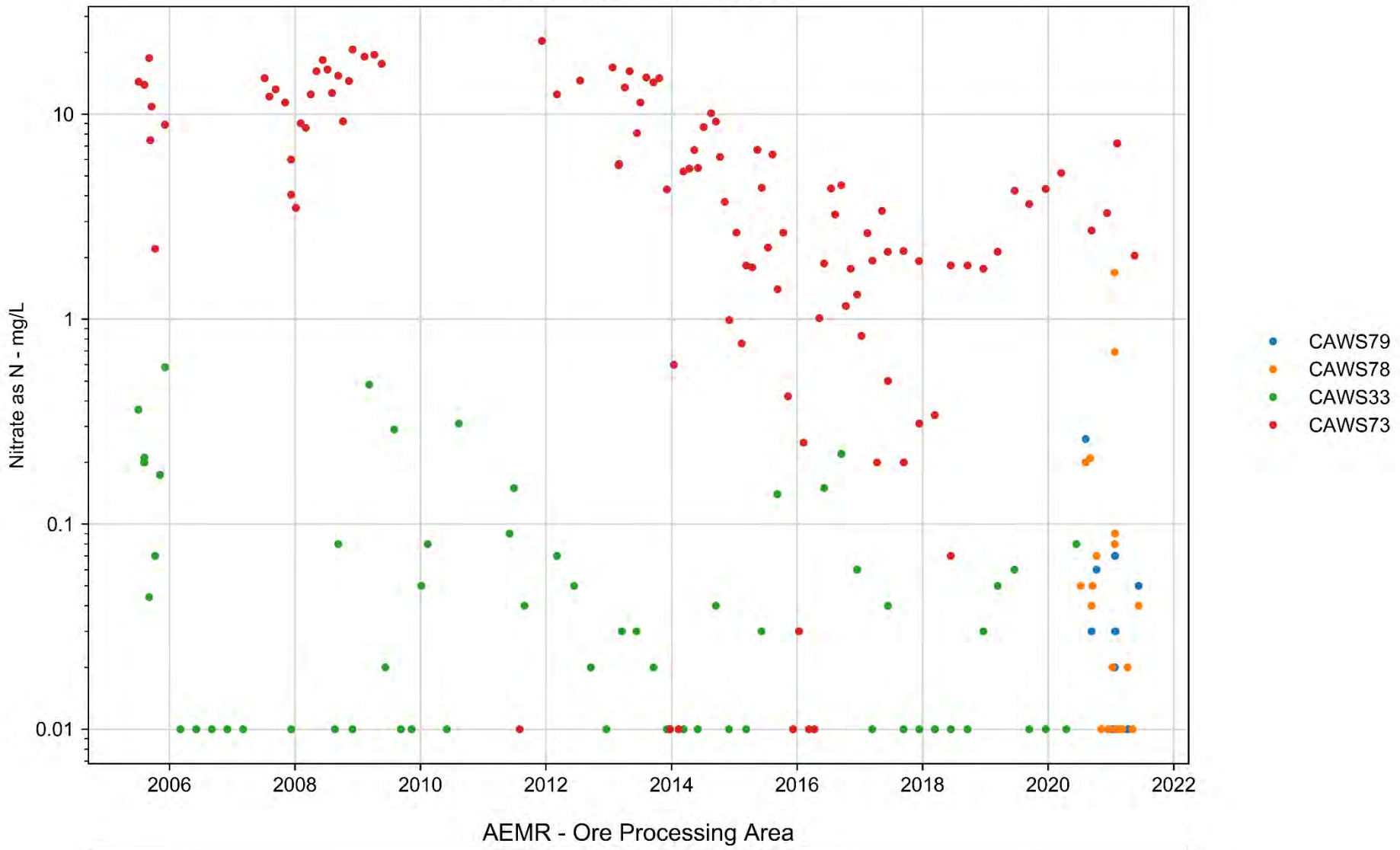
AEMR - Ore Processing Area



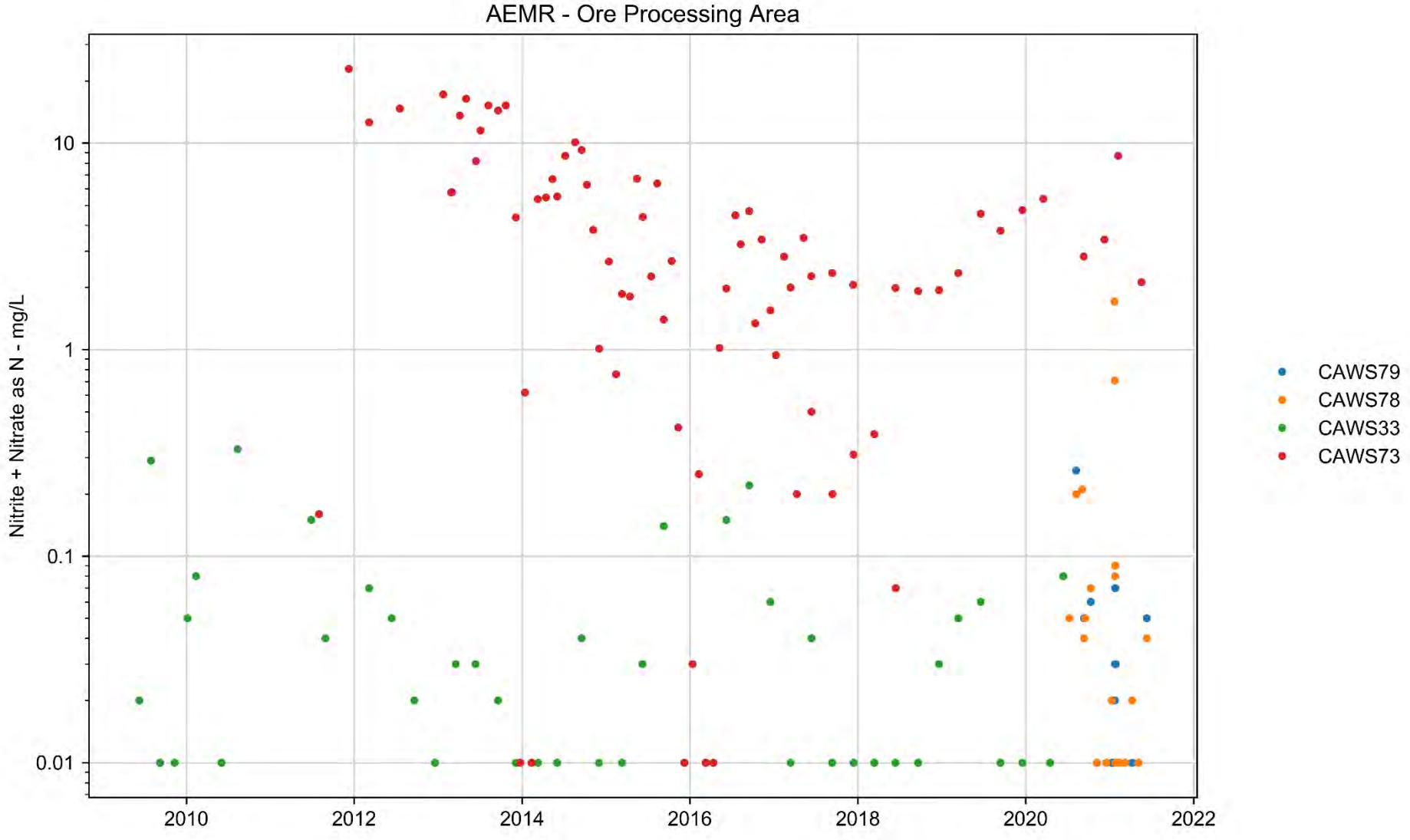
AEMR - Ore Processing Area



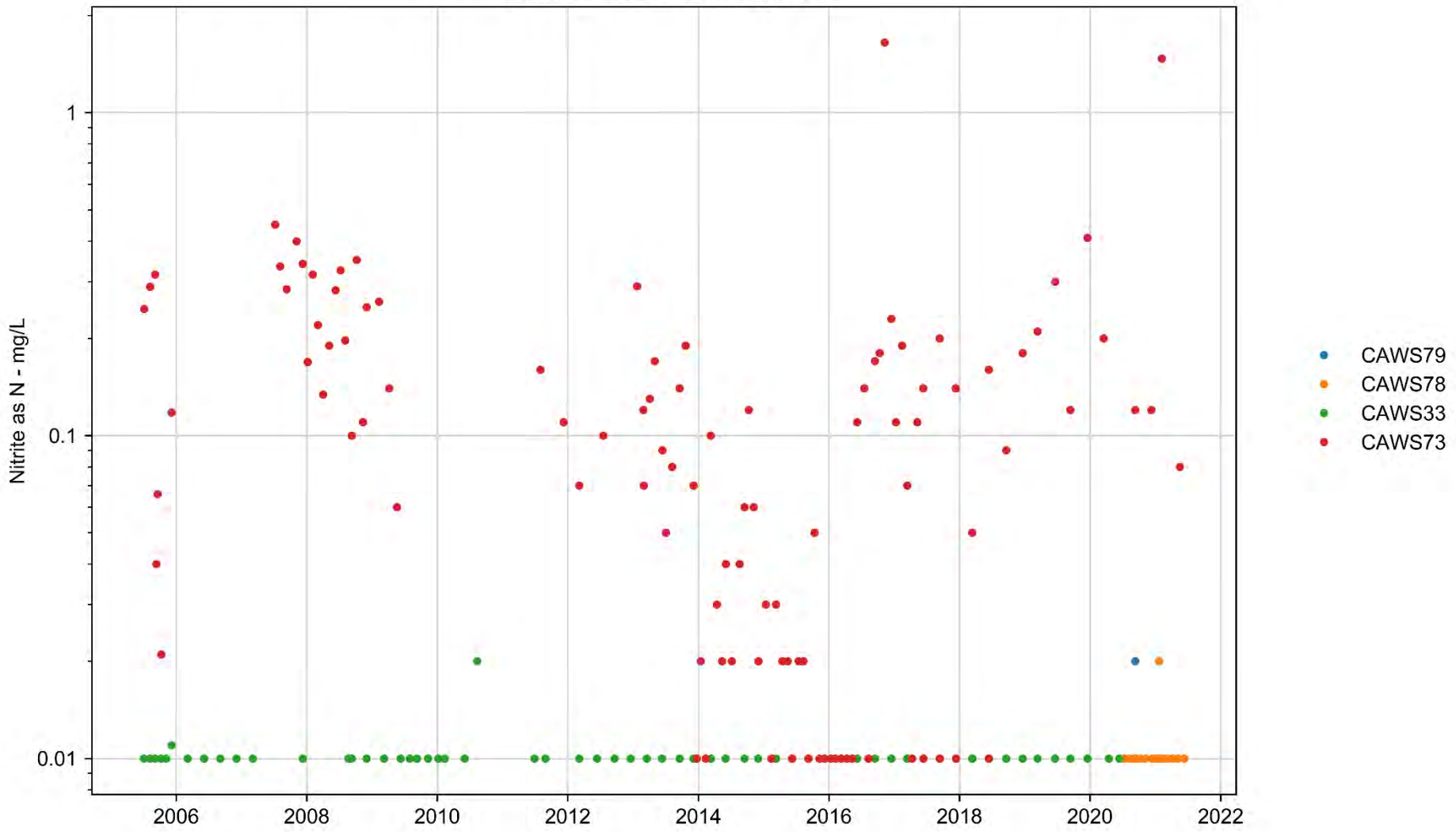
AEMR - Ore Processing Area



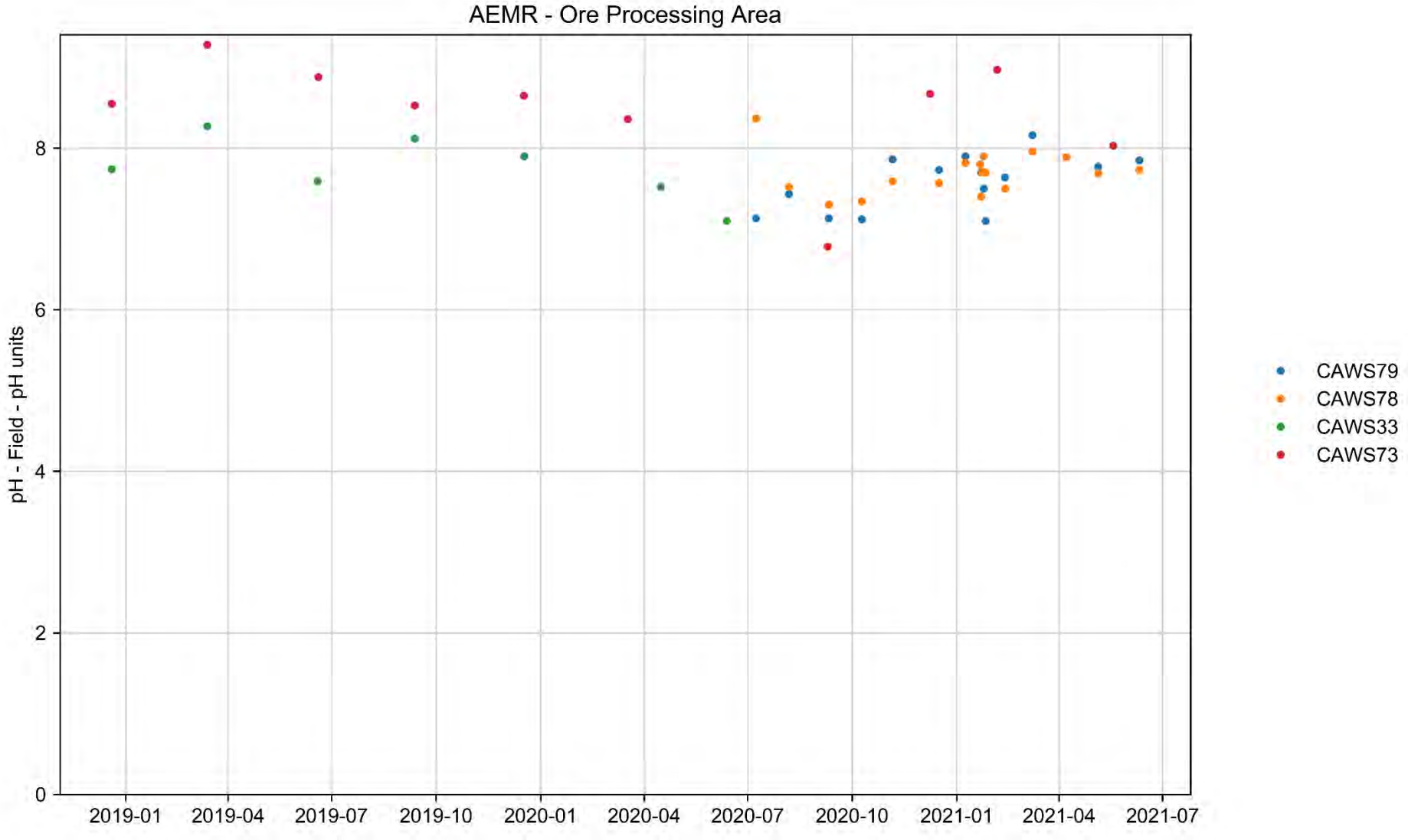
AEMR - Ore Processing Area

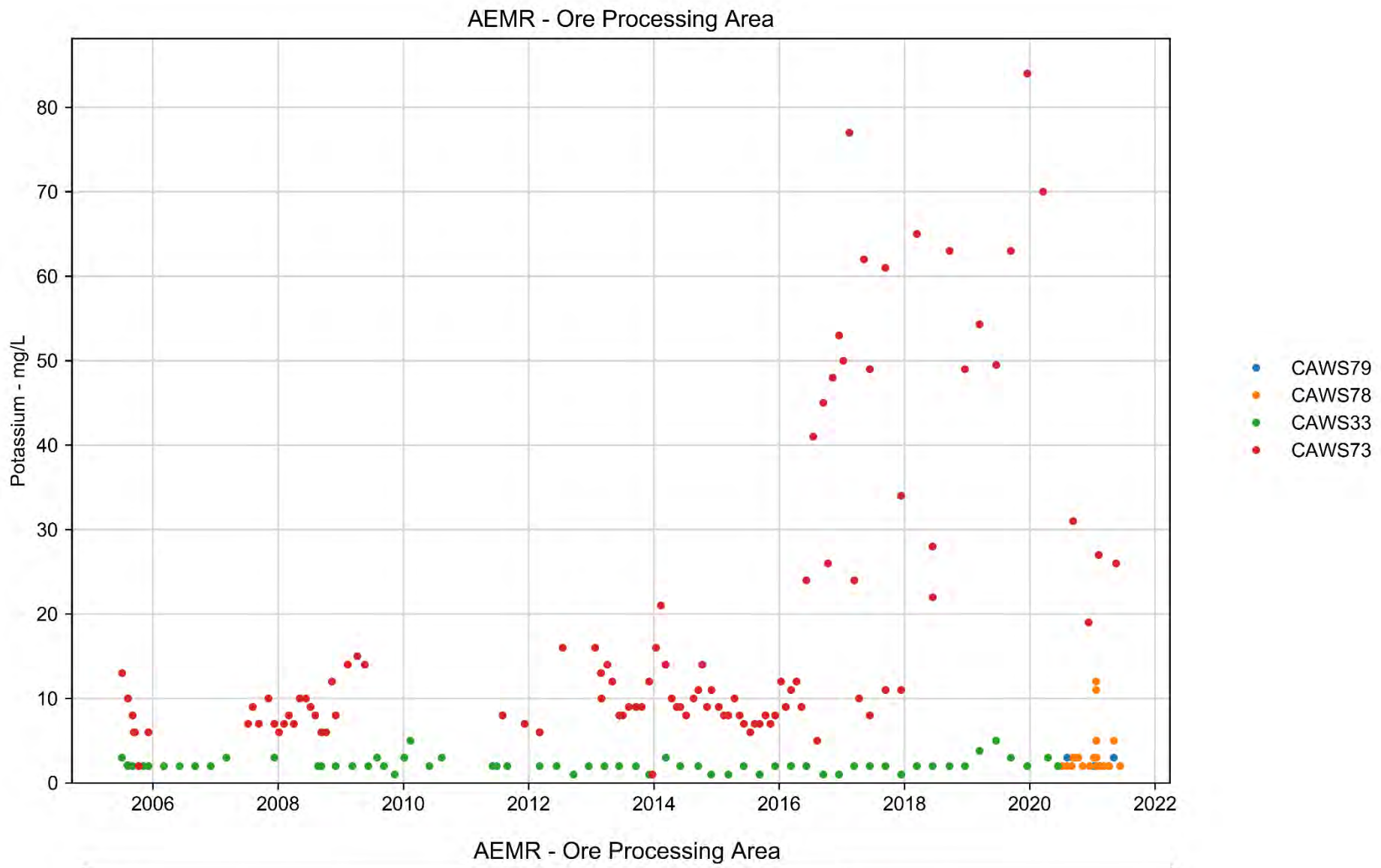


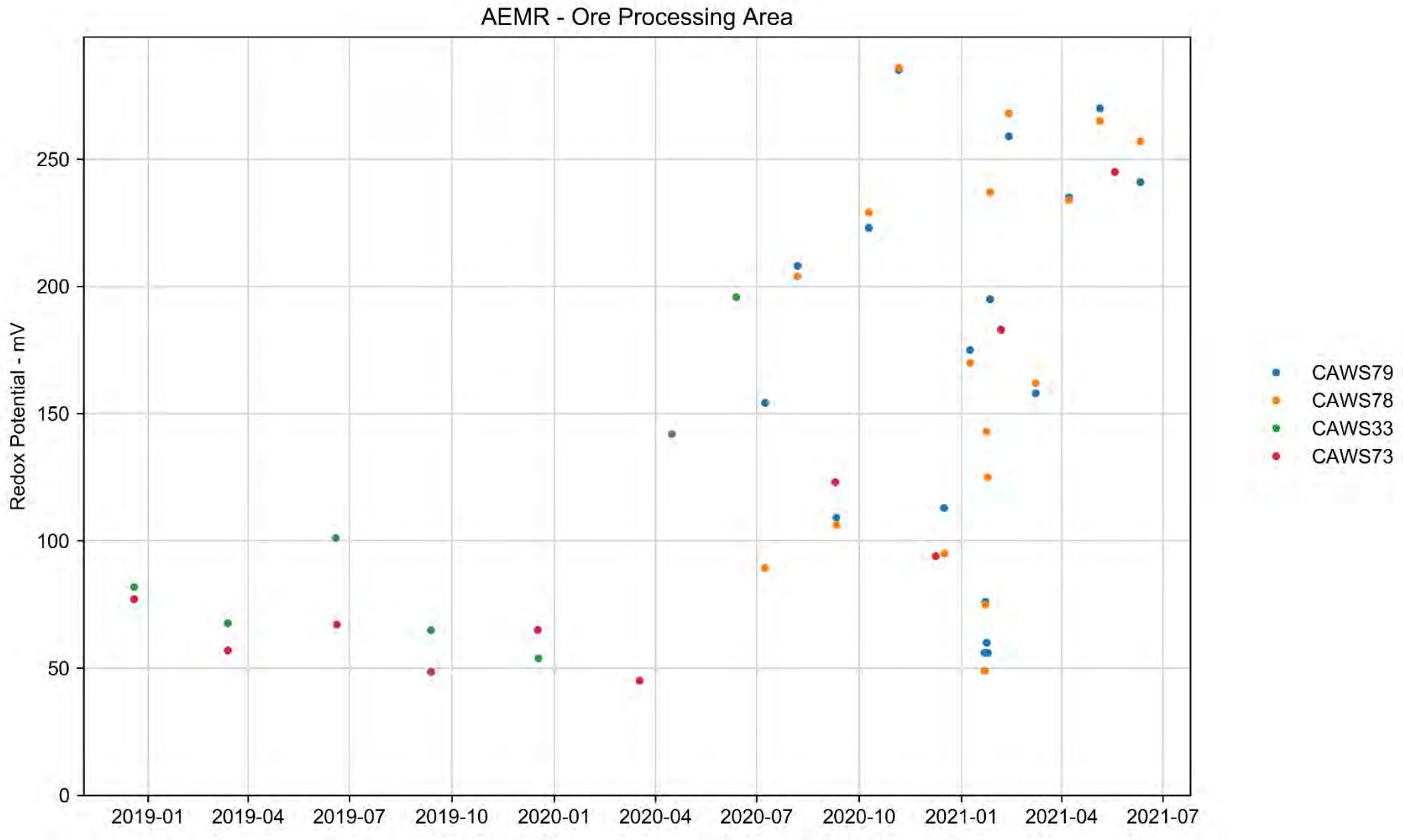
AEMR - Ore Processing Area

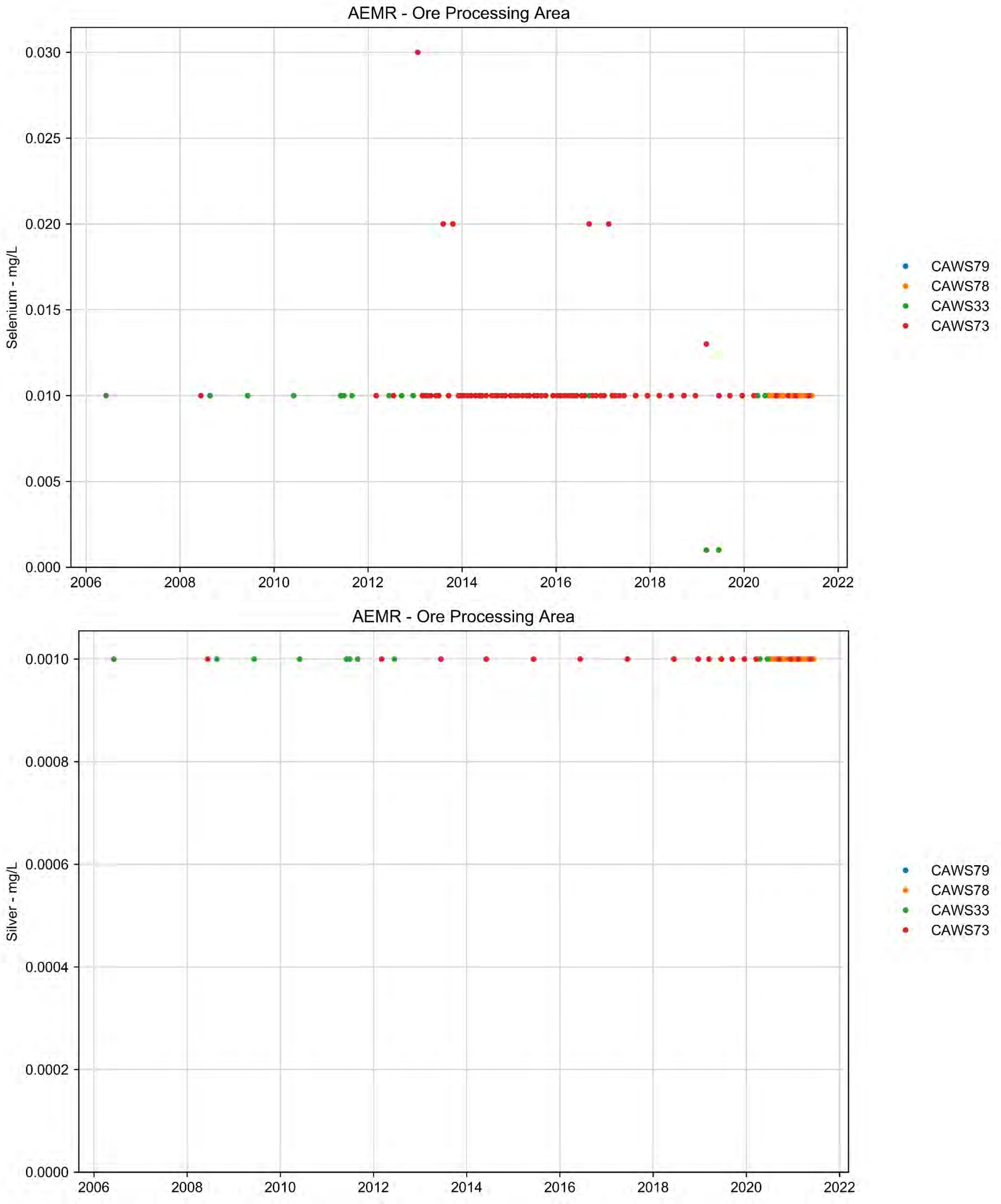


AEMR - Ore Processing Area

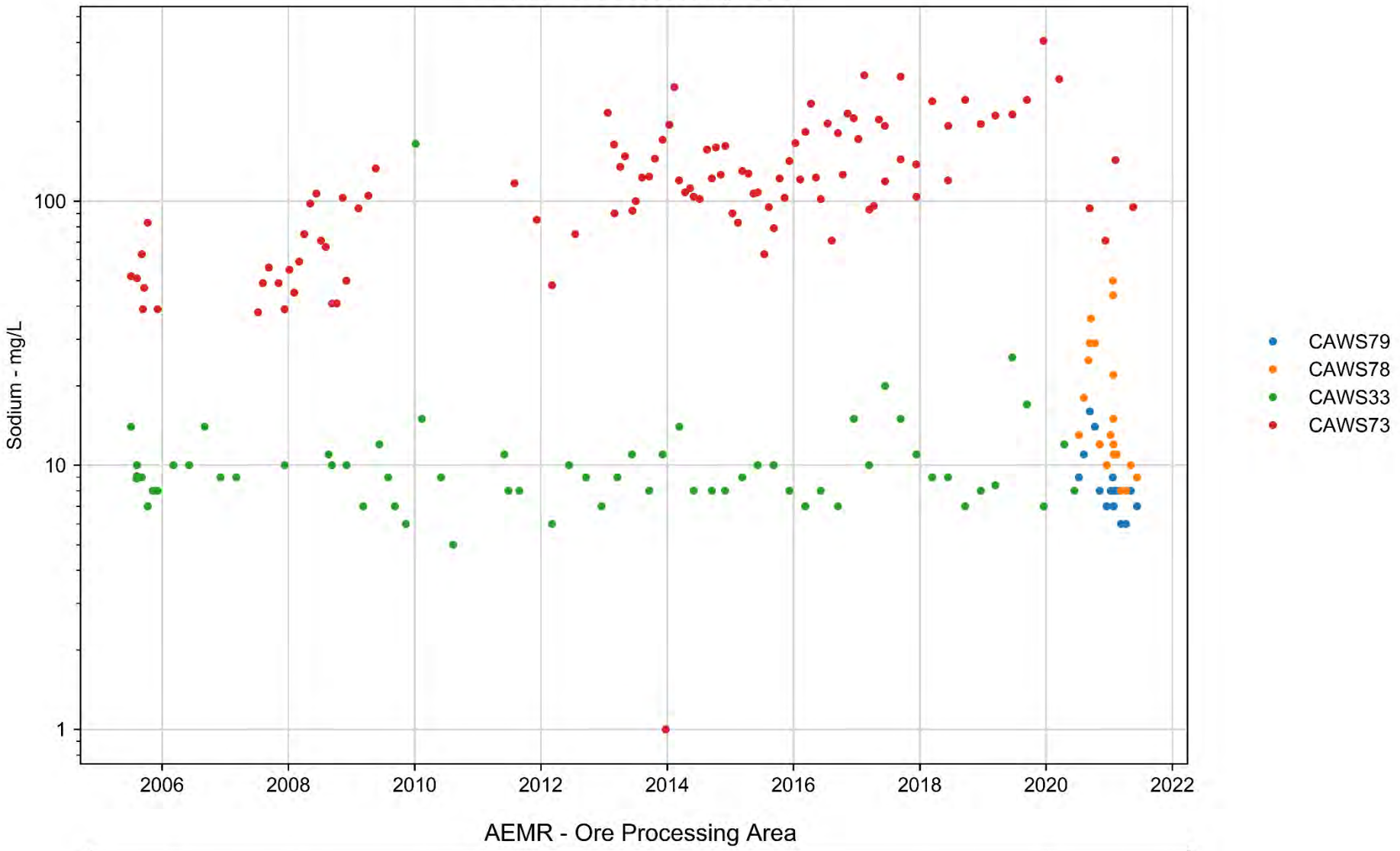



AEMR - Ore Processing Area
Potassium - mg/L
0
10
20
30
40
50
60
70
80
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS79
CAWS78
CAWS33
CAWS73

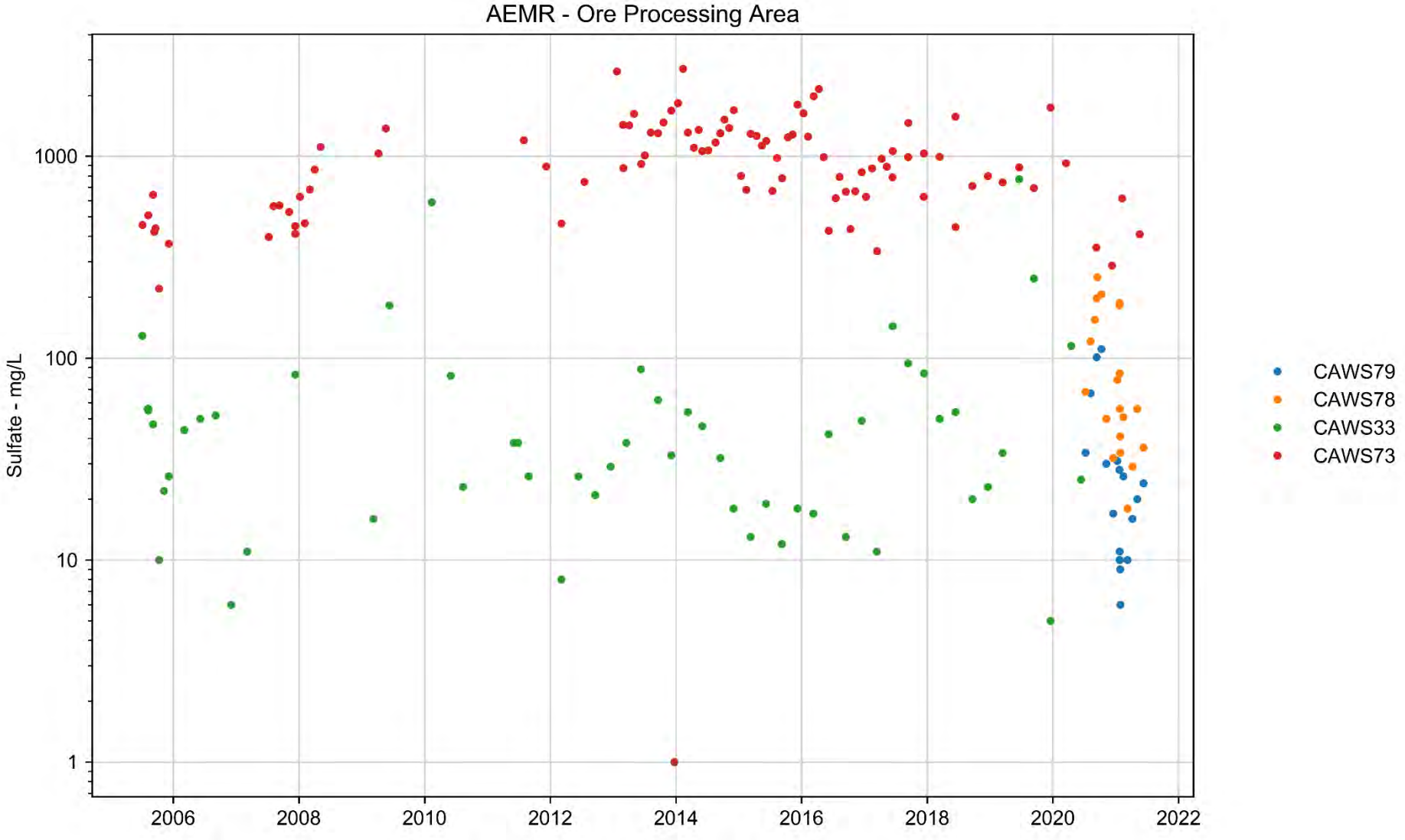

AEMR - Ore Processing Area
Redox Potential - mV
0
50
100
150
200
250
2019-01
2019-04
2019-07
2019-10
2020-01
2020-04
2020-07
2020-10
2021-01
2021-04
2021-07
CAWS79
CAWS78
CAWS33
CAWS73


AEMR - Ore Processing Area
Selenium - mg/L
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS79
CAWS78
CAWS33
CAWS73
AEMR - Ore Processing Area
Silver - mg/L
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS79
CAWS78
CAWS33
CAWS73

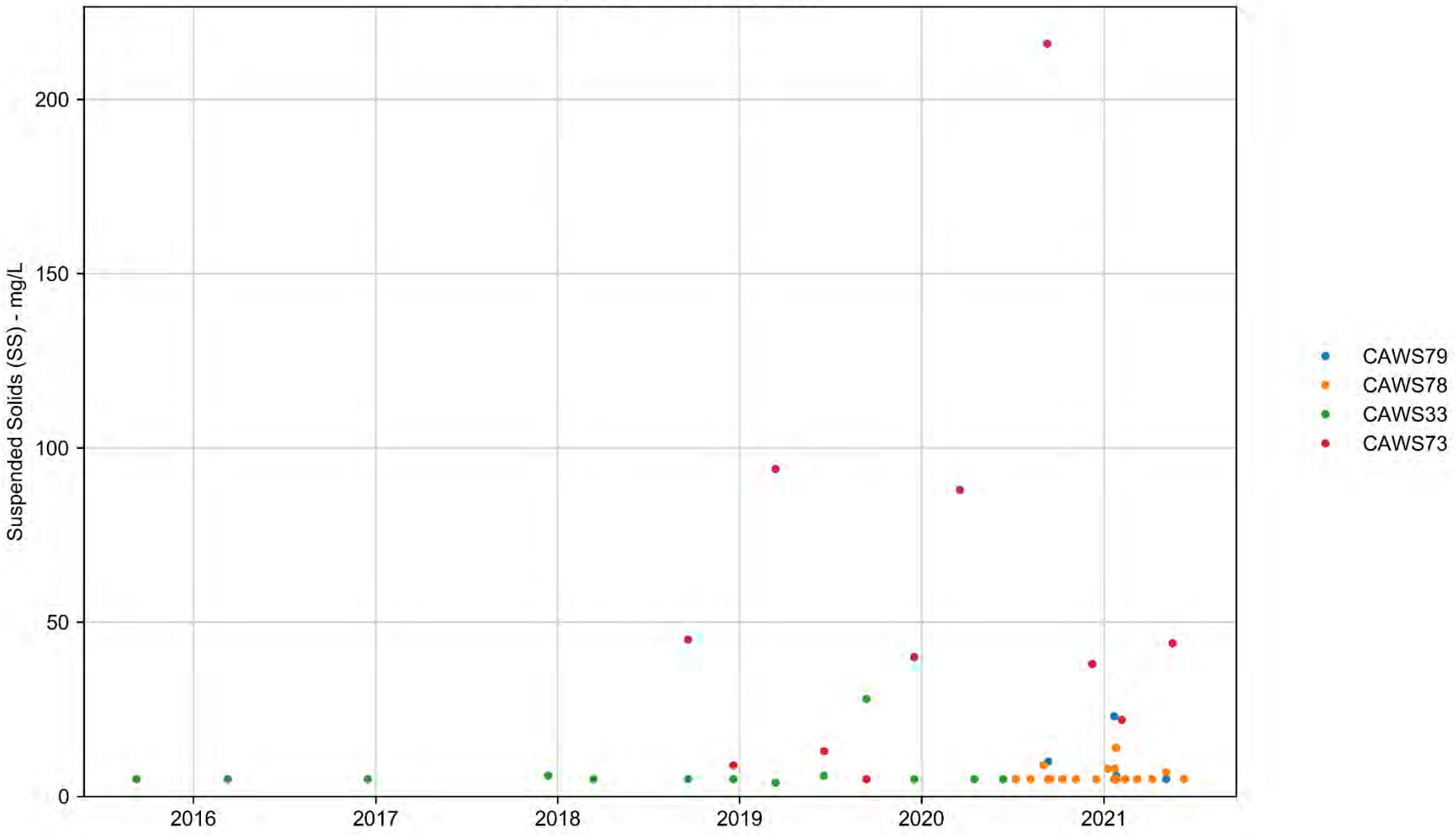
AEMR - Ore Processing Area



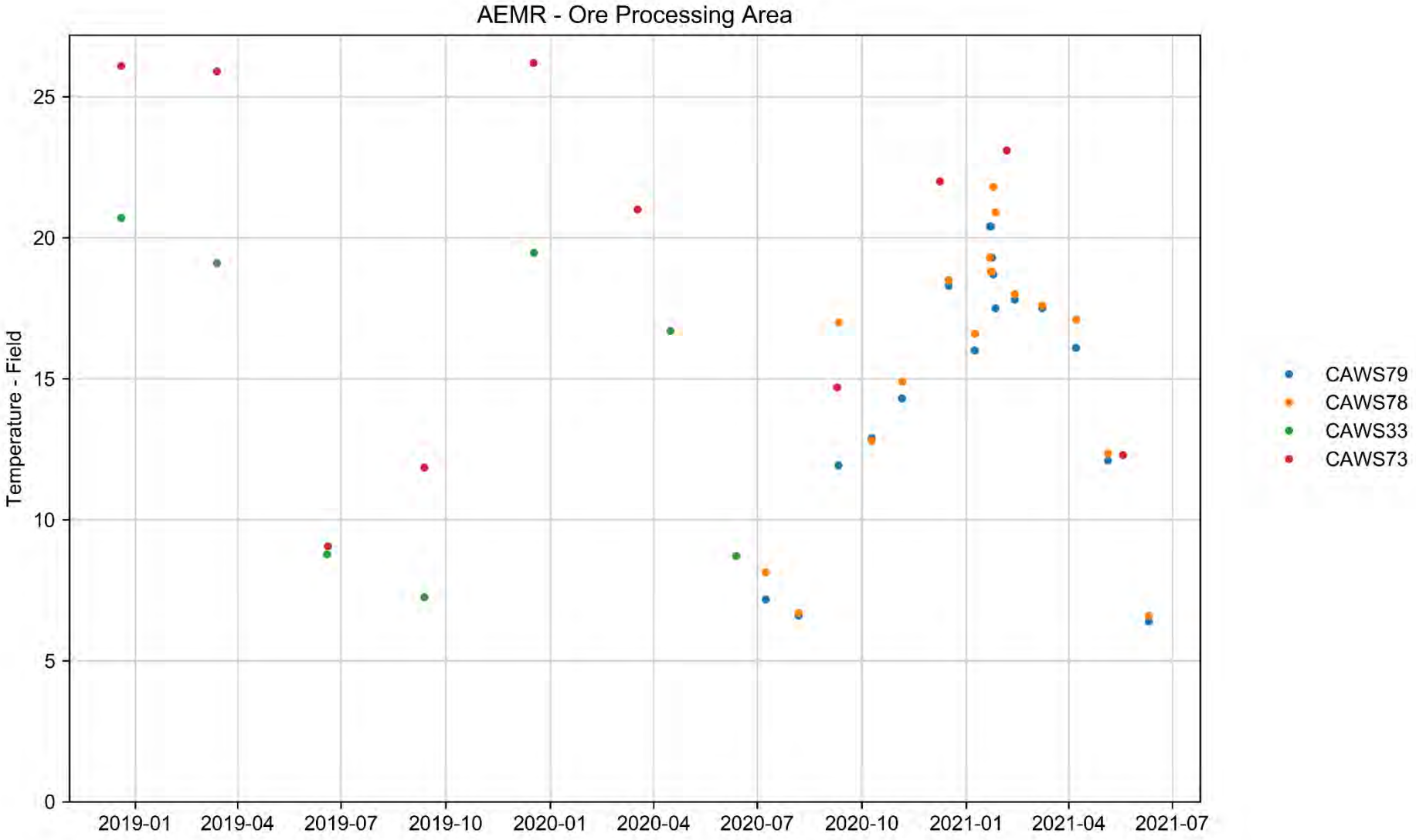
AEMR - Ore Processing Area



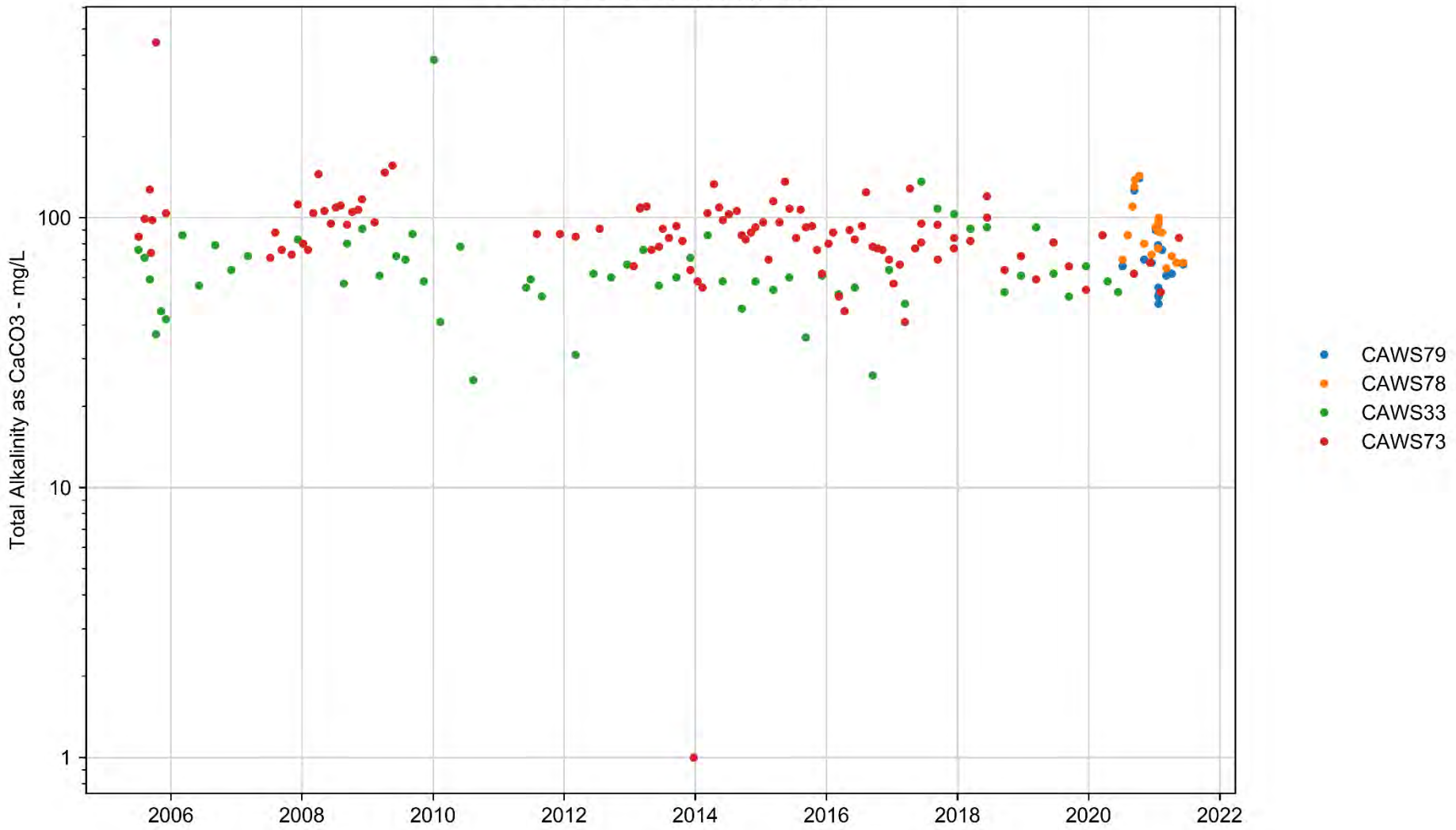
AEMR - Ore Processing Area



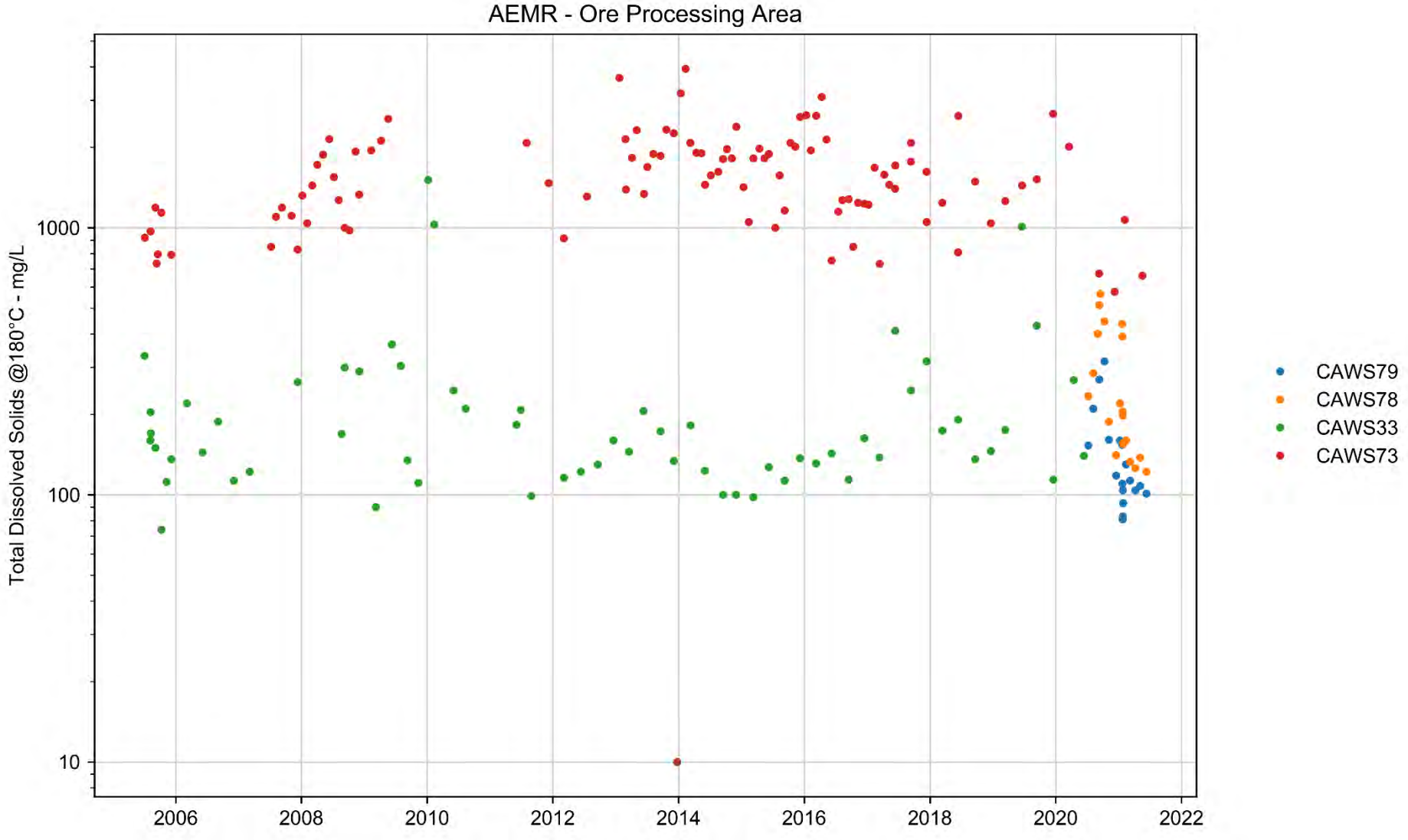
AEMR - Ore Processing Area

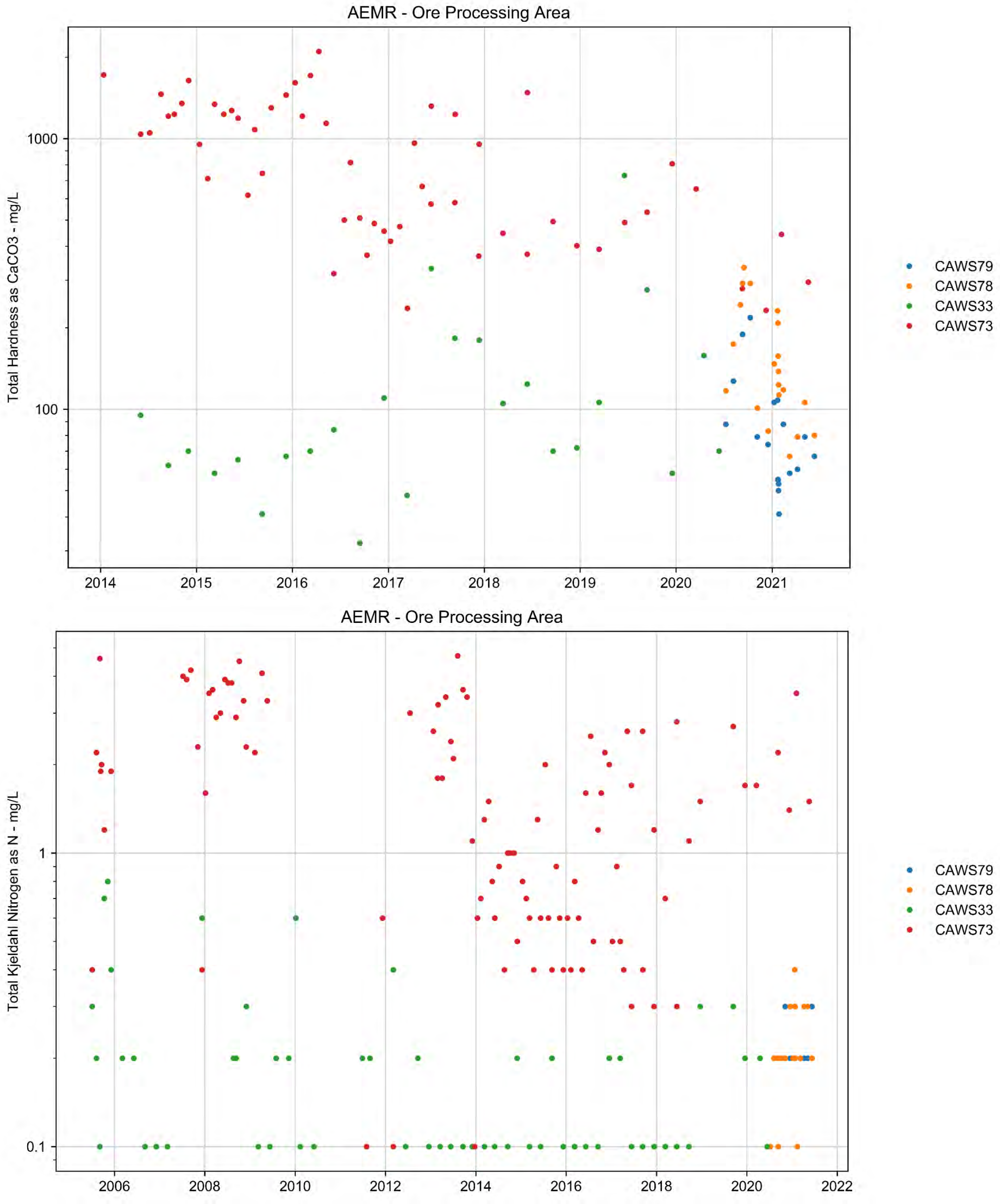


AEMR - Ore Processing Area

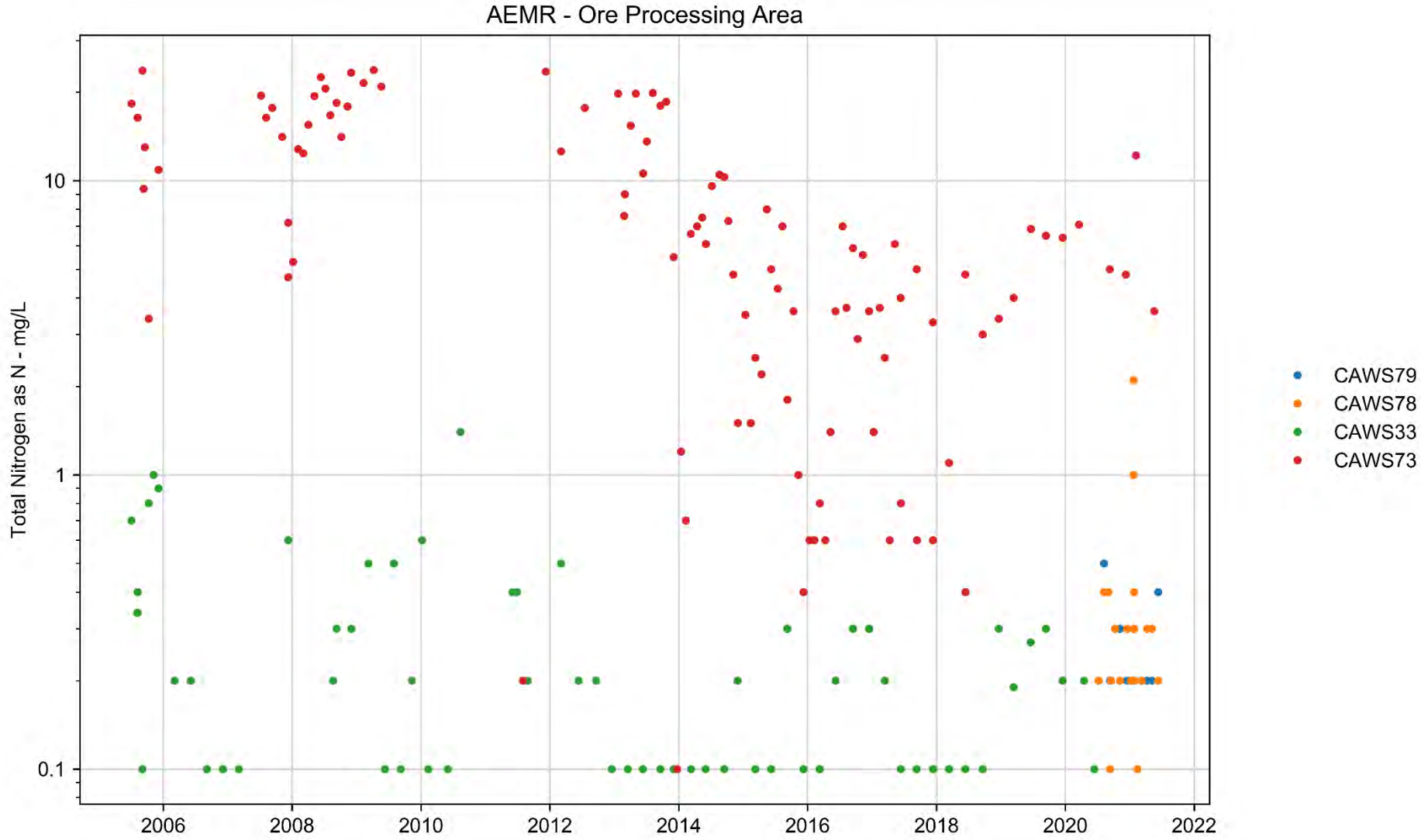


AEMR - Ore Processing Area

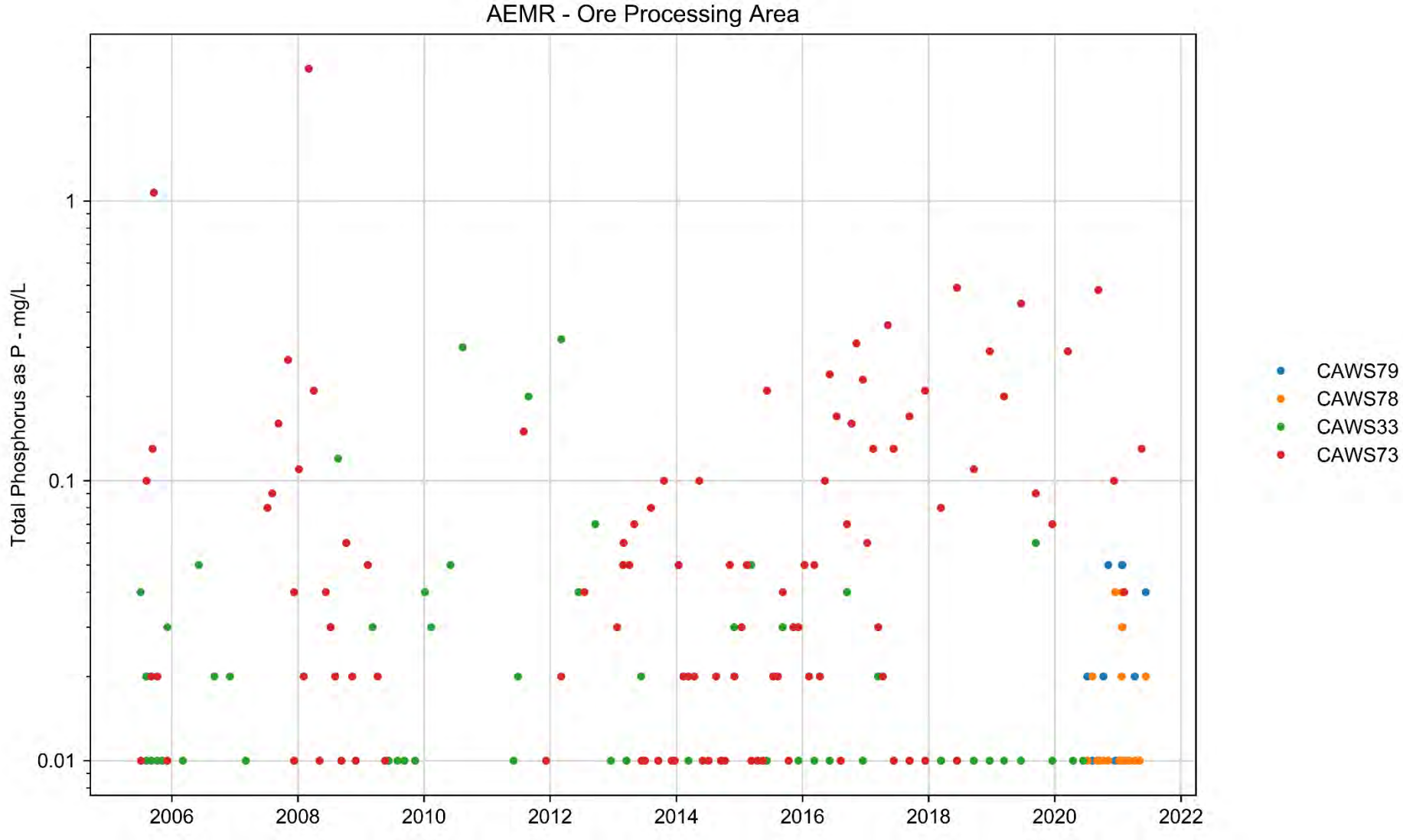


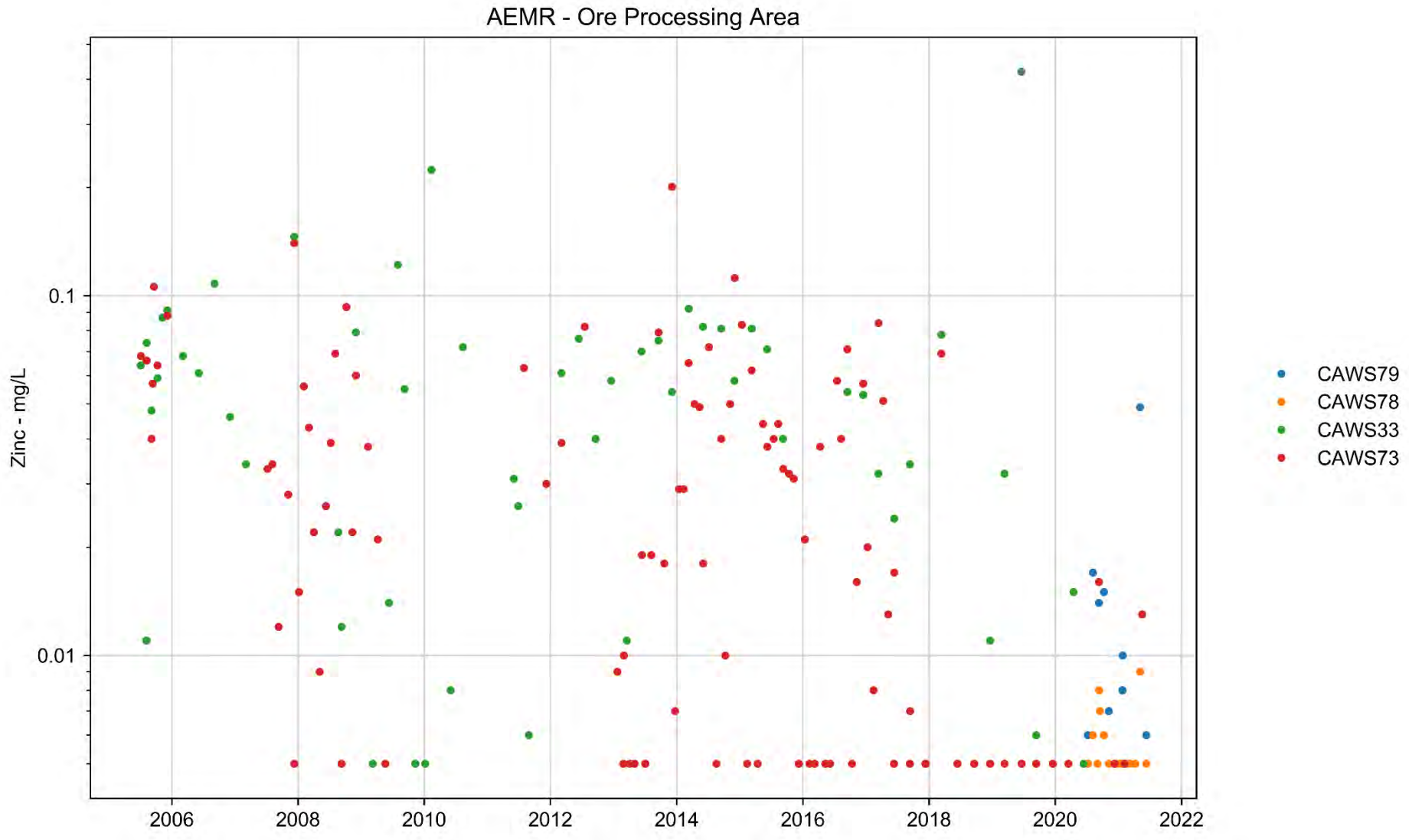

AEMR - Ore Processing Area
Total Hardness as CaCO3 - mg/L
1000
100
2014
2015
2016
2017
2018
2019
2020
2021
CAWS79
CAWS78
CAWS33
CAWS73
AEMR - Ore Processing Area
Total Kjeldahl Nitrogen as N - mg/L
1
0.1
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS79
CAWS78
CAWS33
CAWS73

AEMR - Ore Processing Area

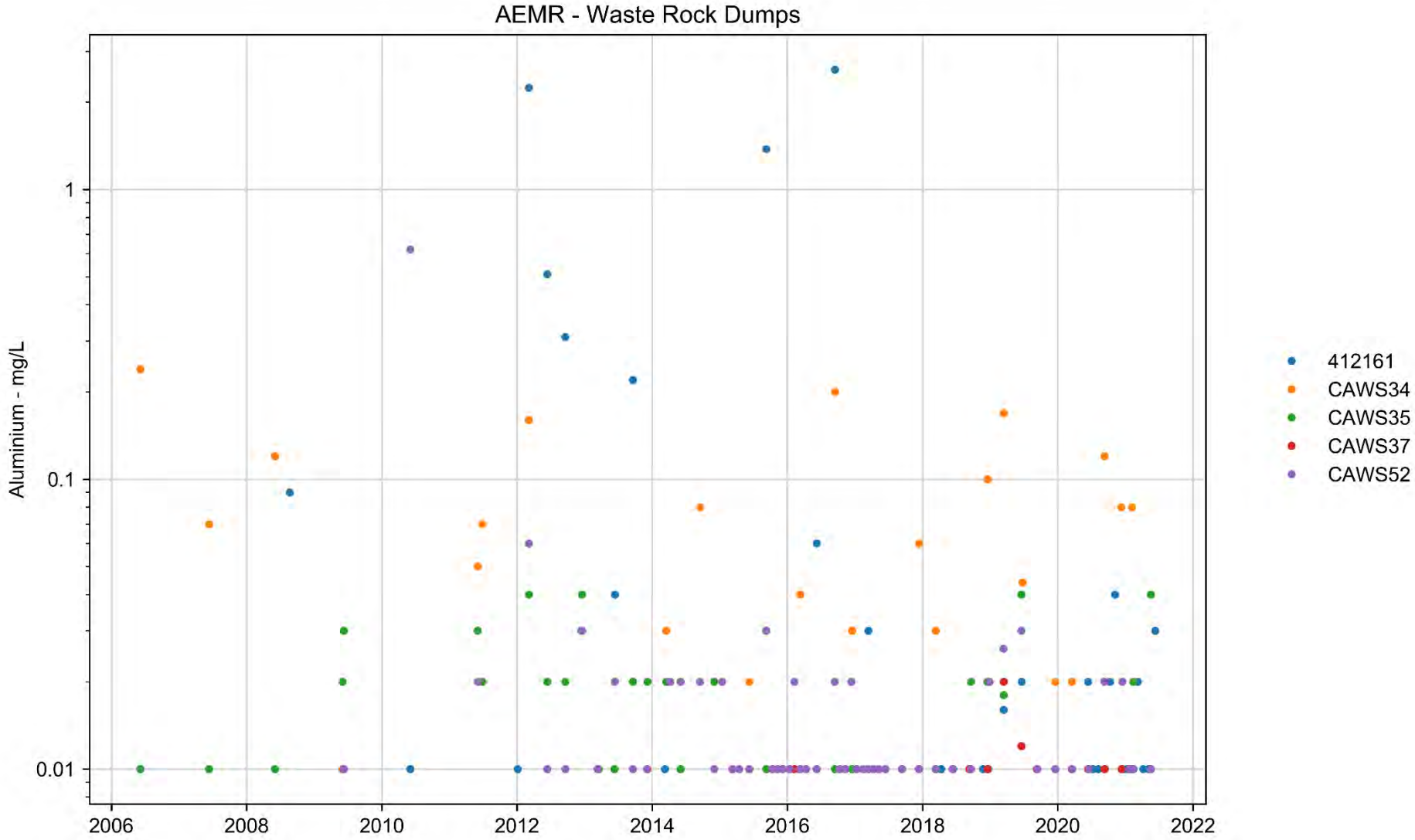


AEMR - Ore Processing Area

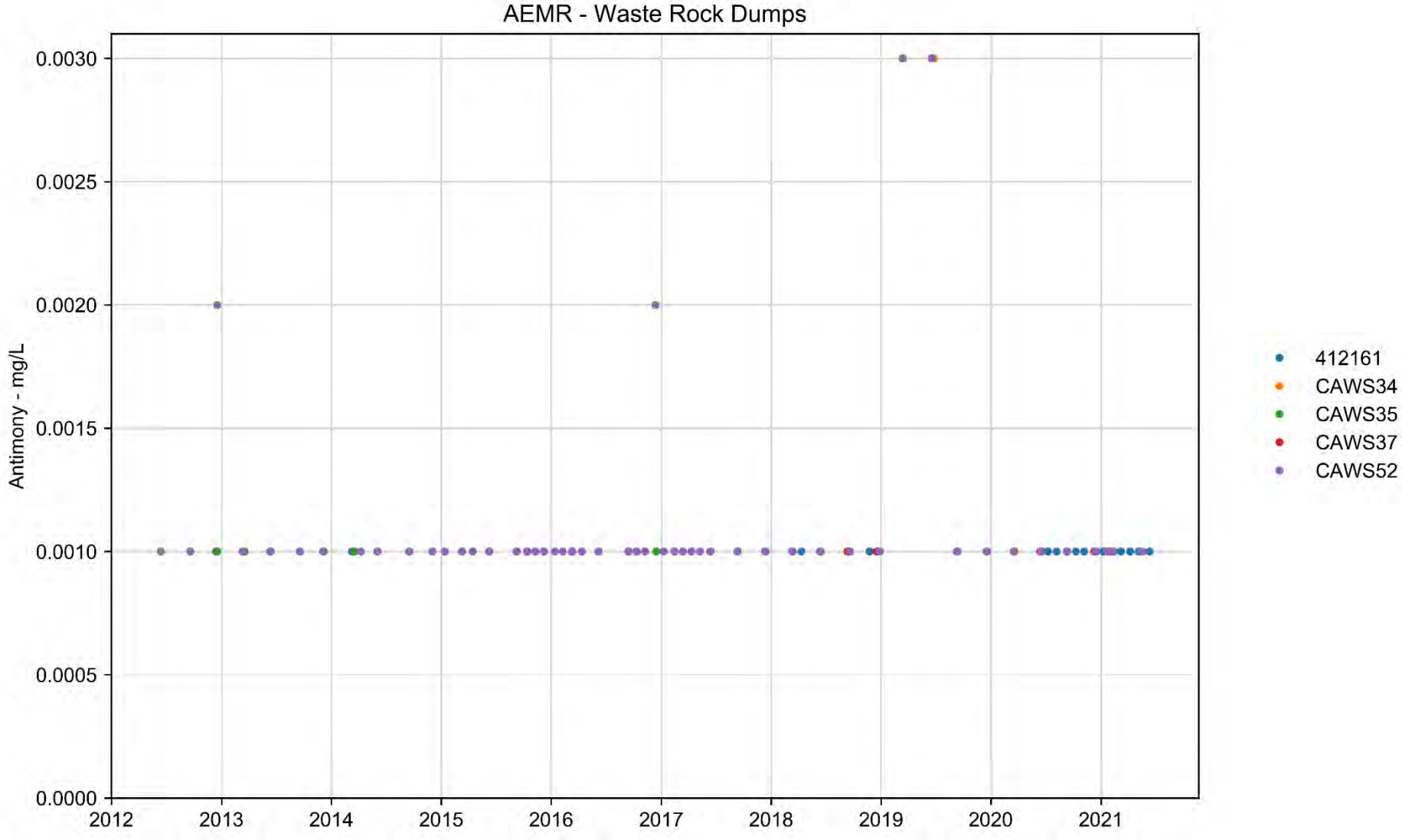



AEMR - Ore Processing Area
Zinc - mg/L
0.1
0.01
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS79
CAWS78
CAWS33
CAWS73

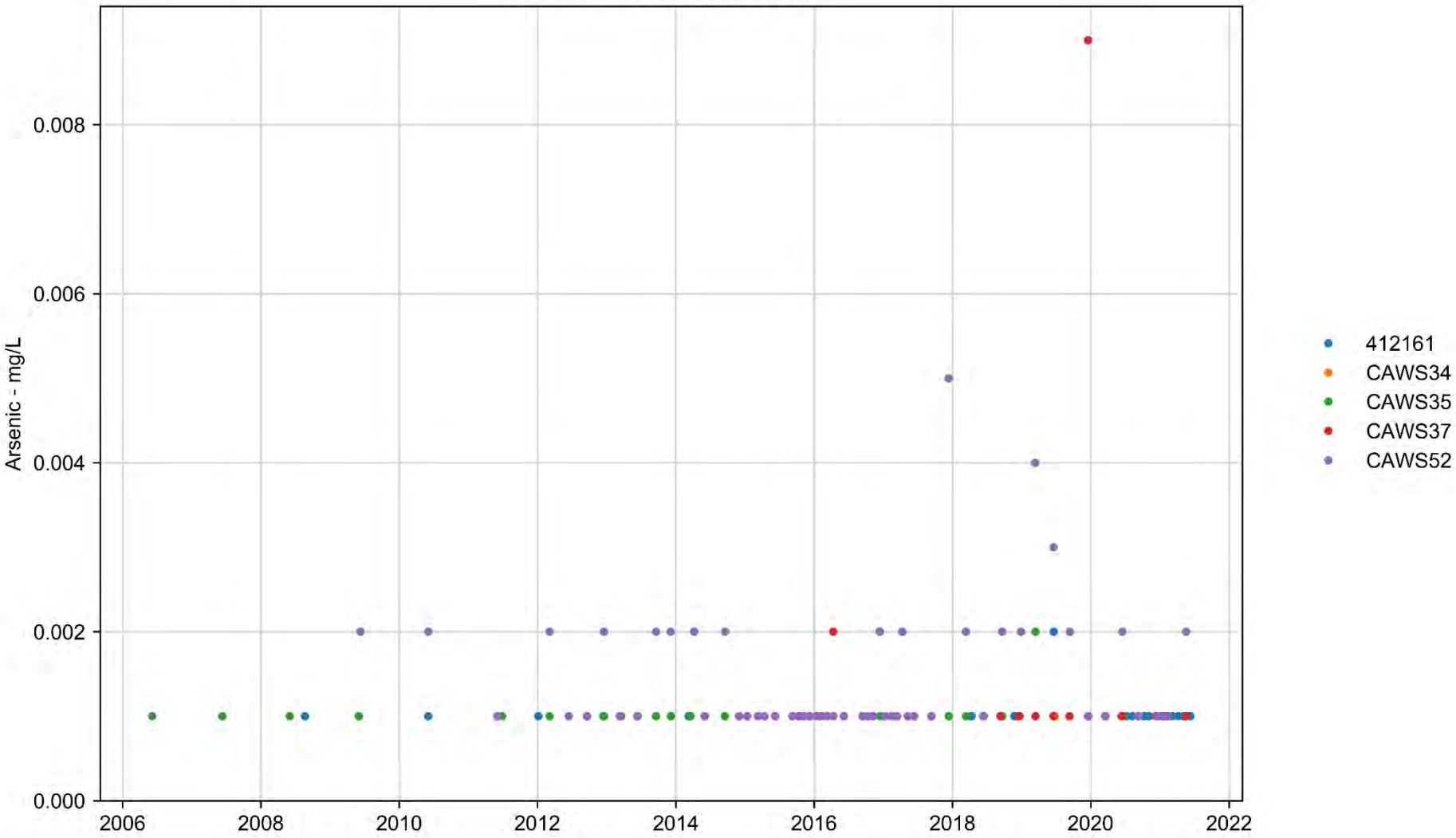
AEMR - Waste Rock Dumps



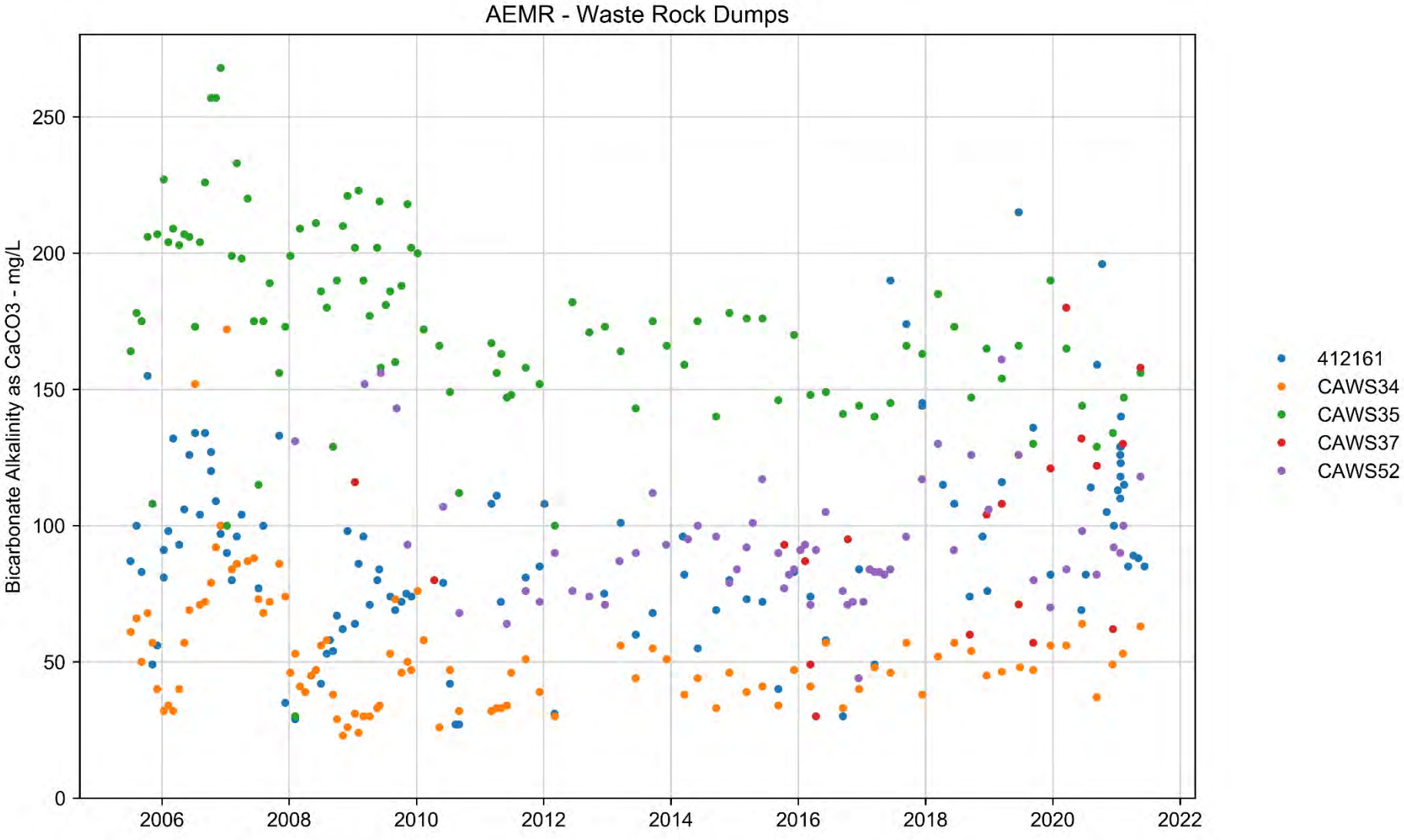
AEMR - Waste Rock Dumps



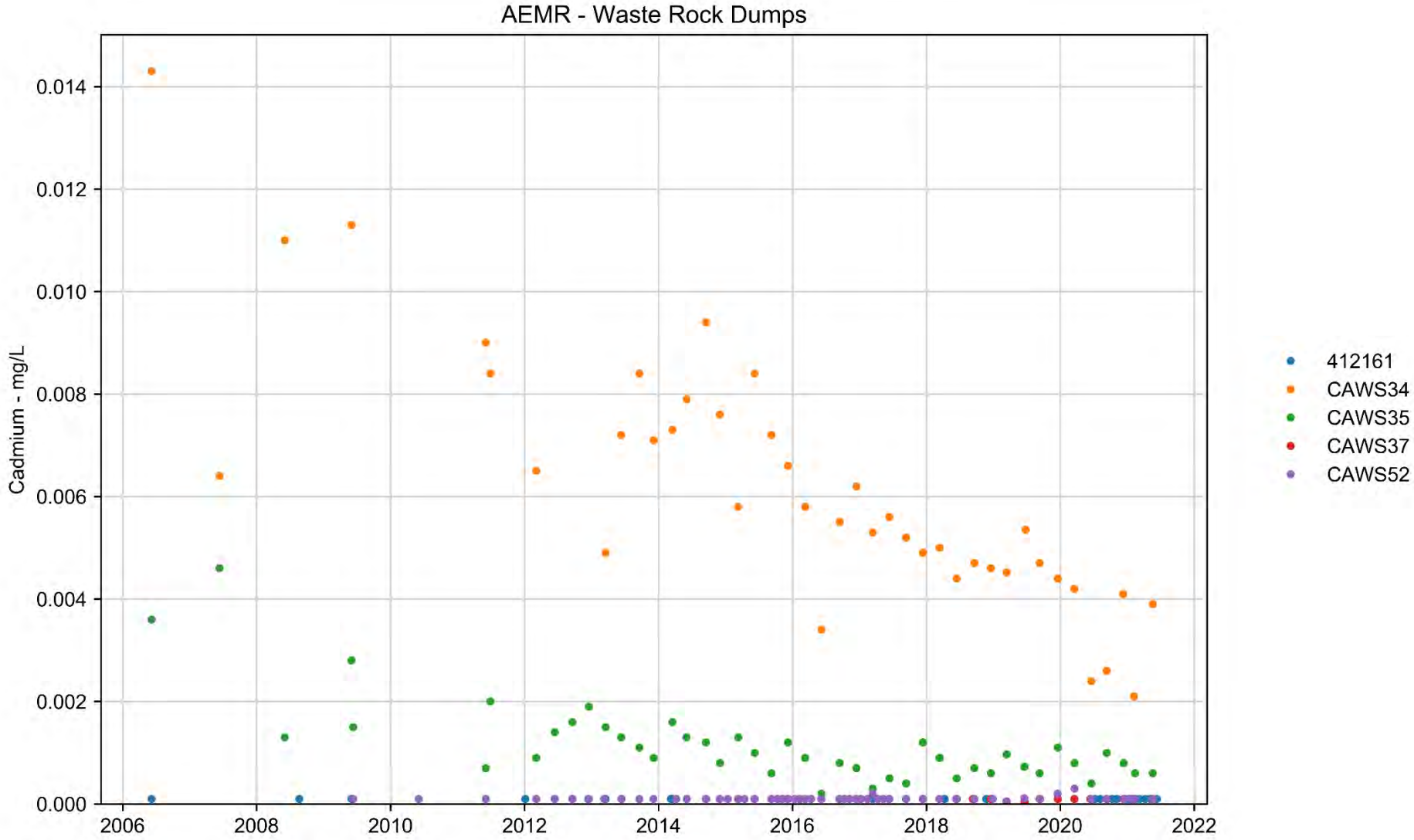
AEMR - Waste Rock Dumps



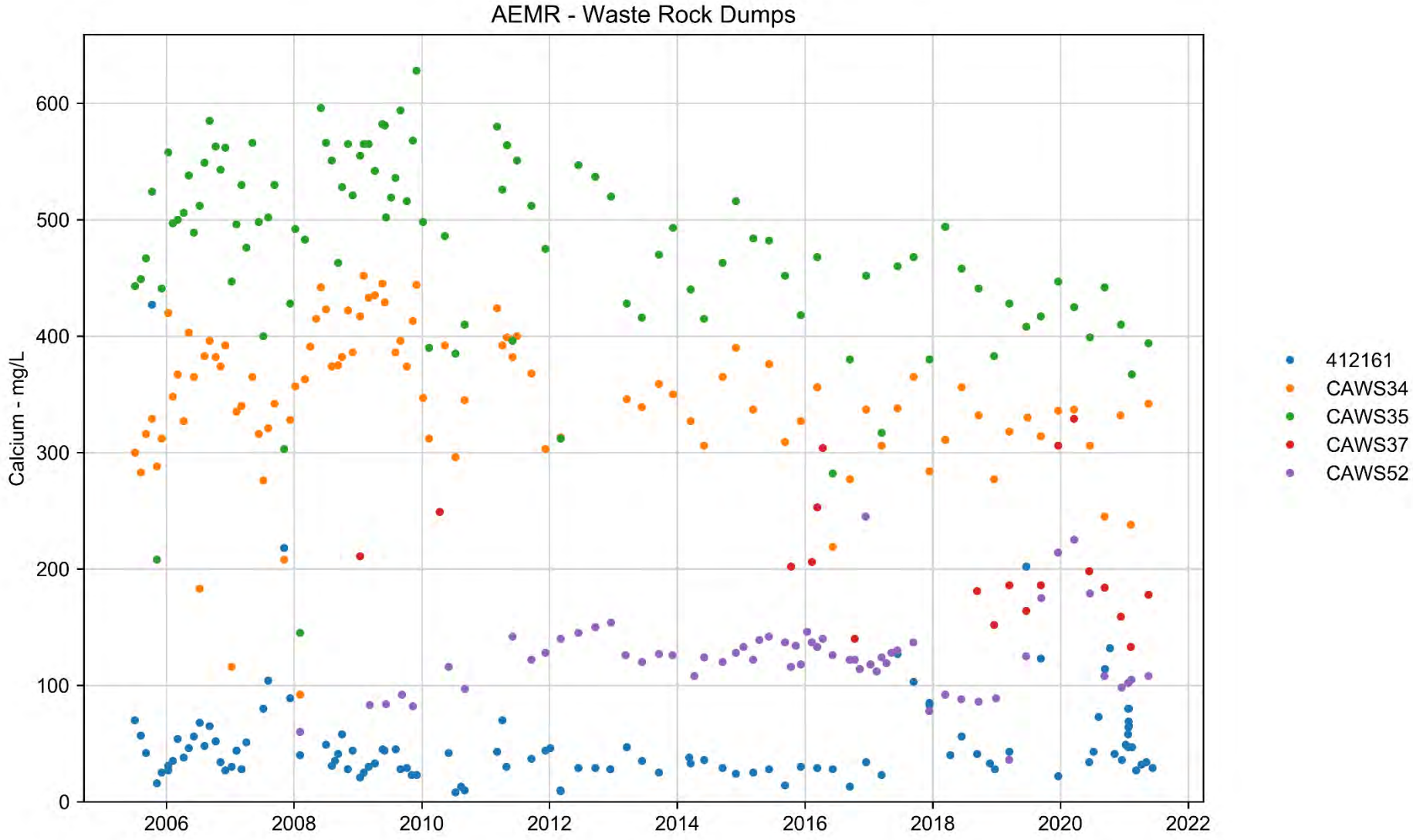
AEMR - Waste Rock Dumps



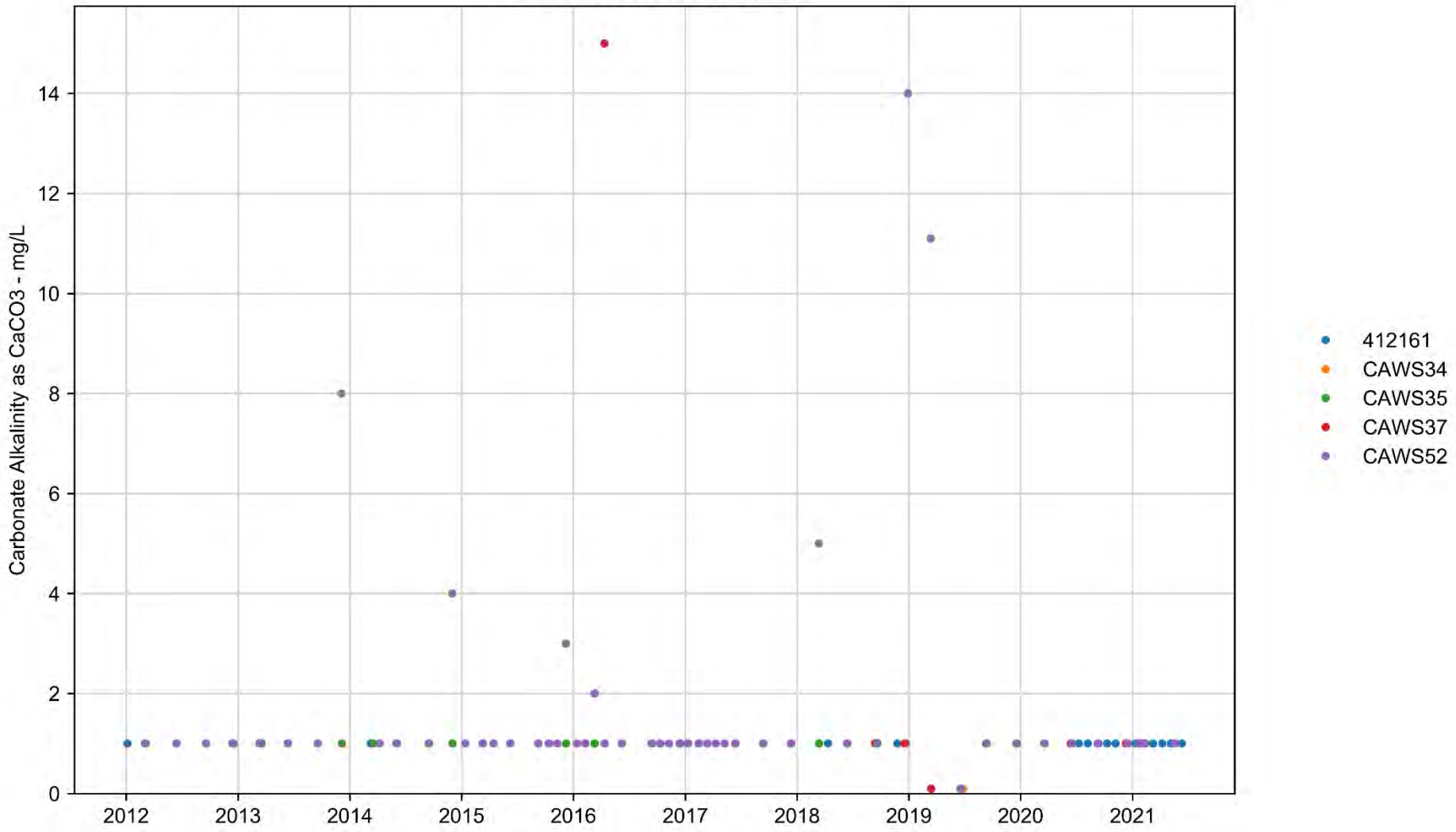
AEMR - Waste Rock Dumps



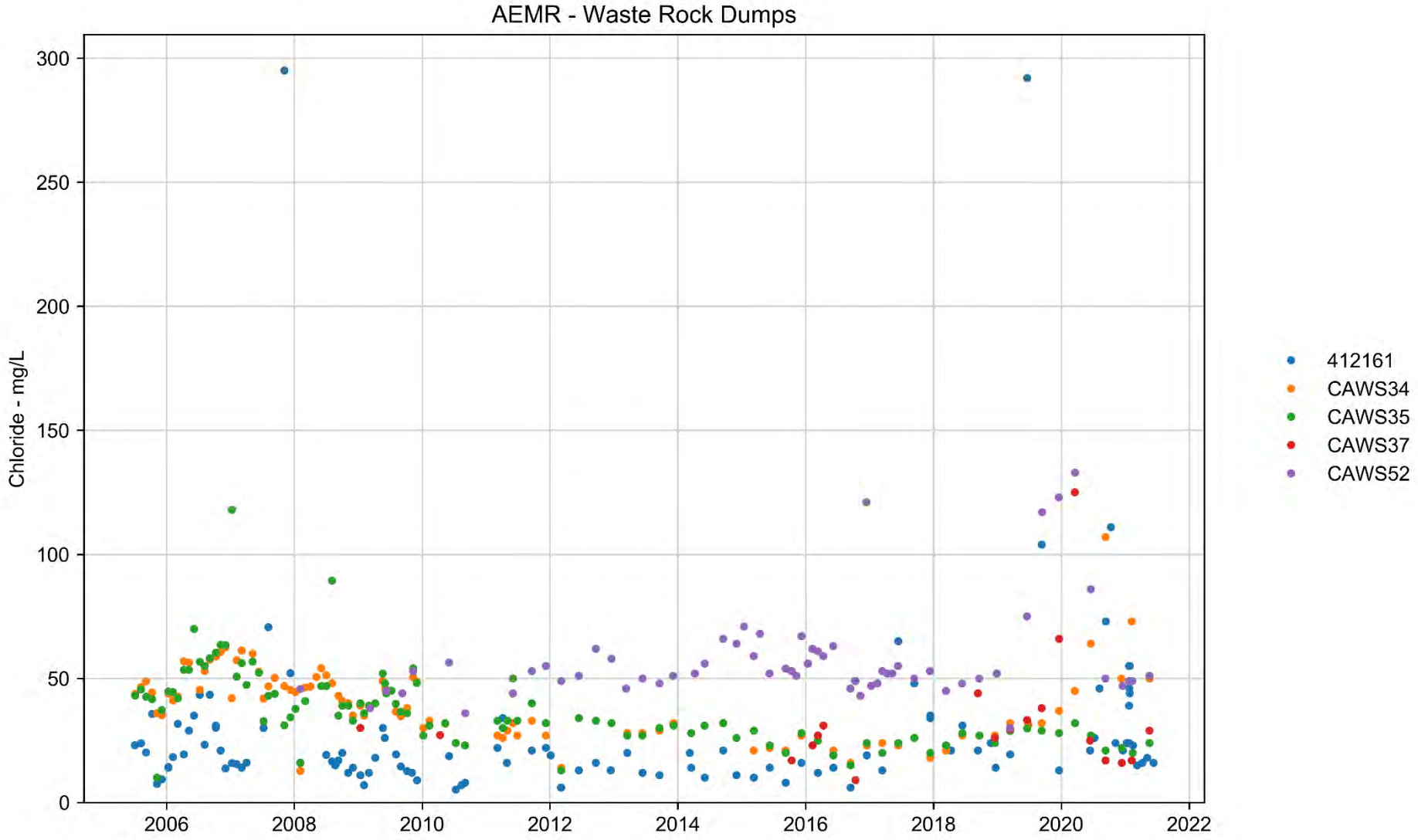
AEMR - Waste Rock Dumps

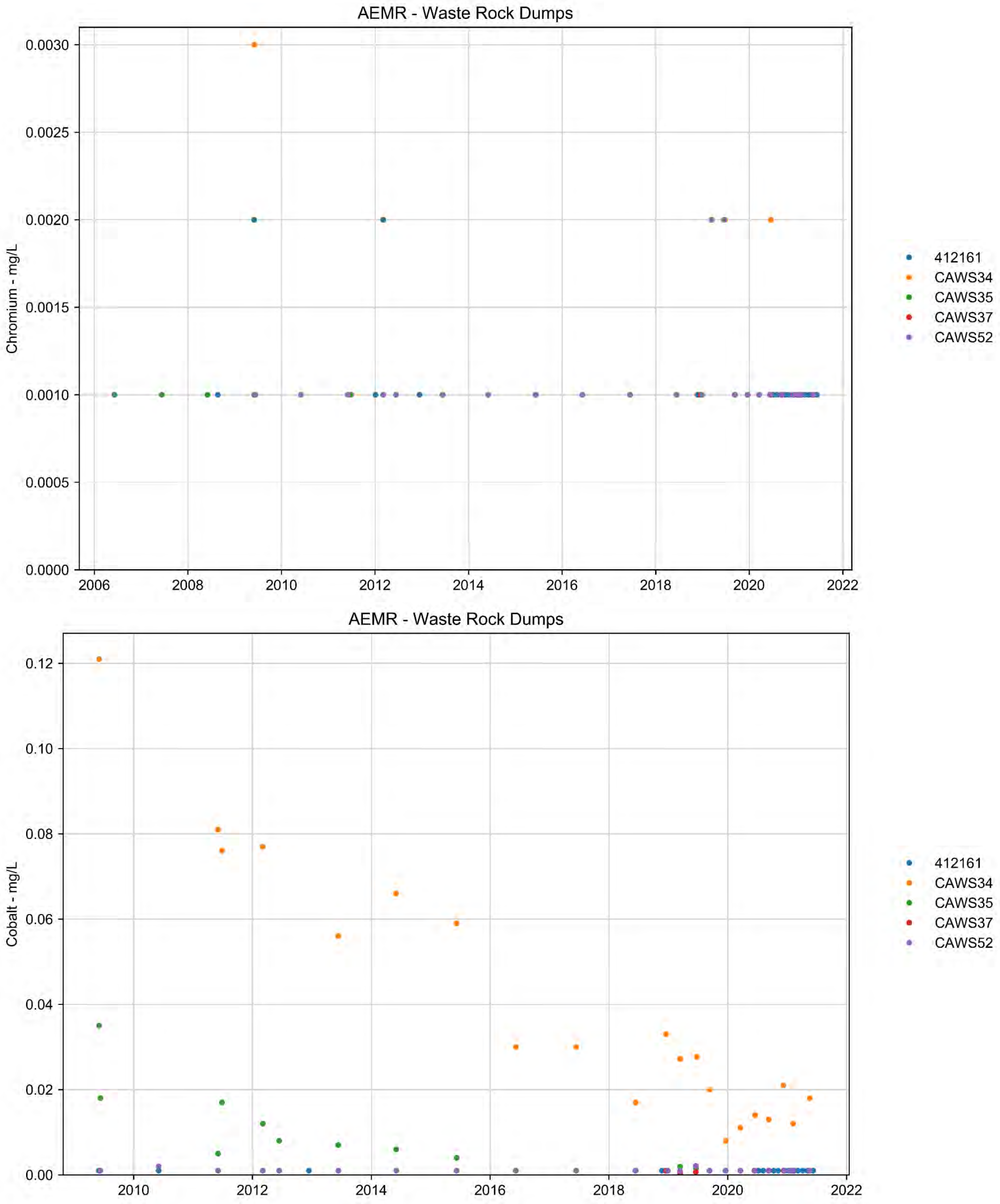


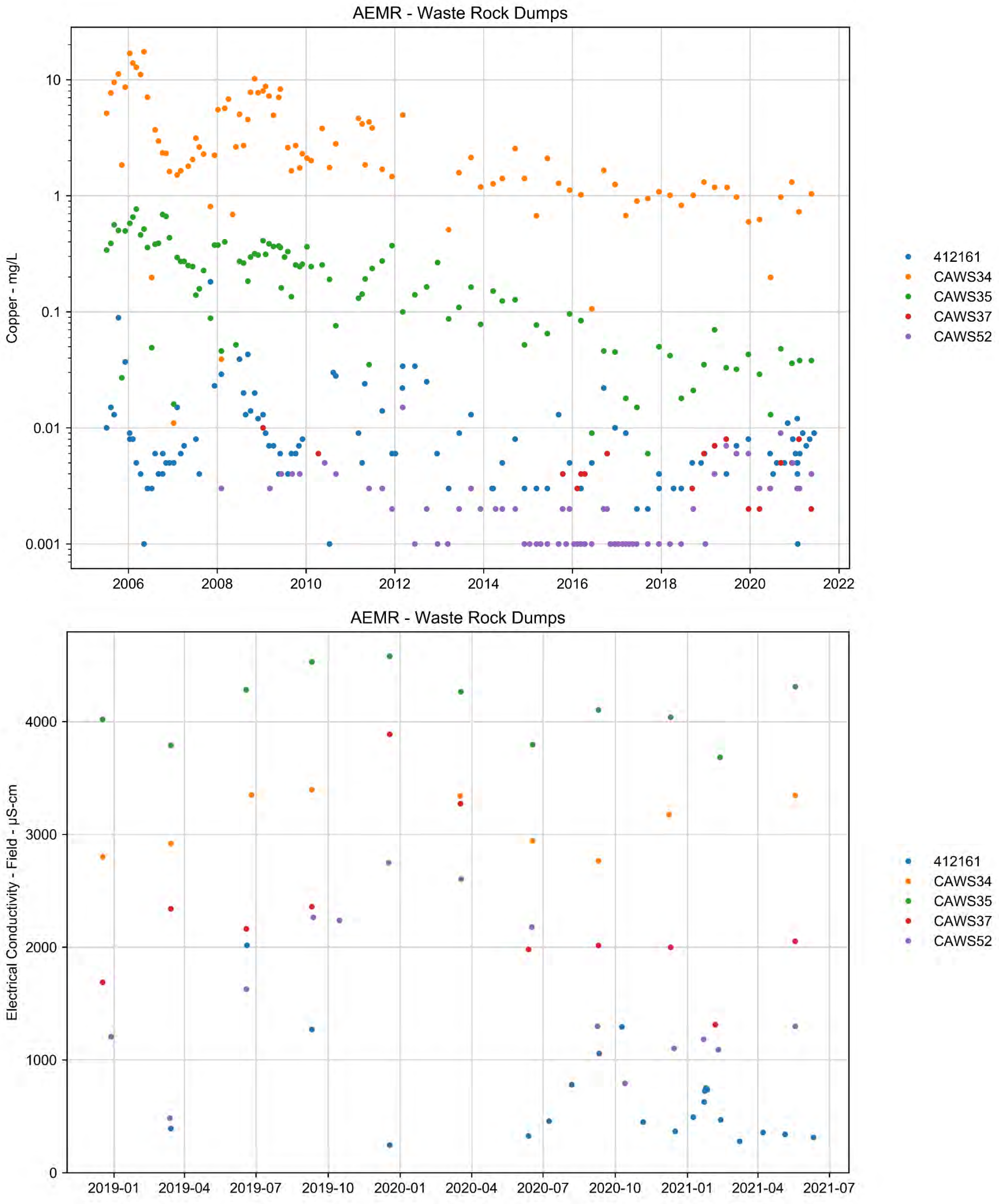
AEMR - Waste Rock Dumps



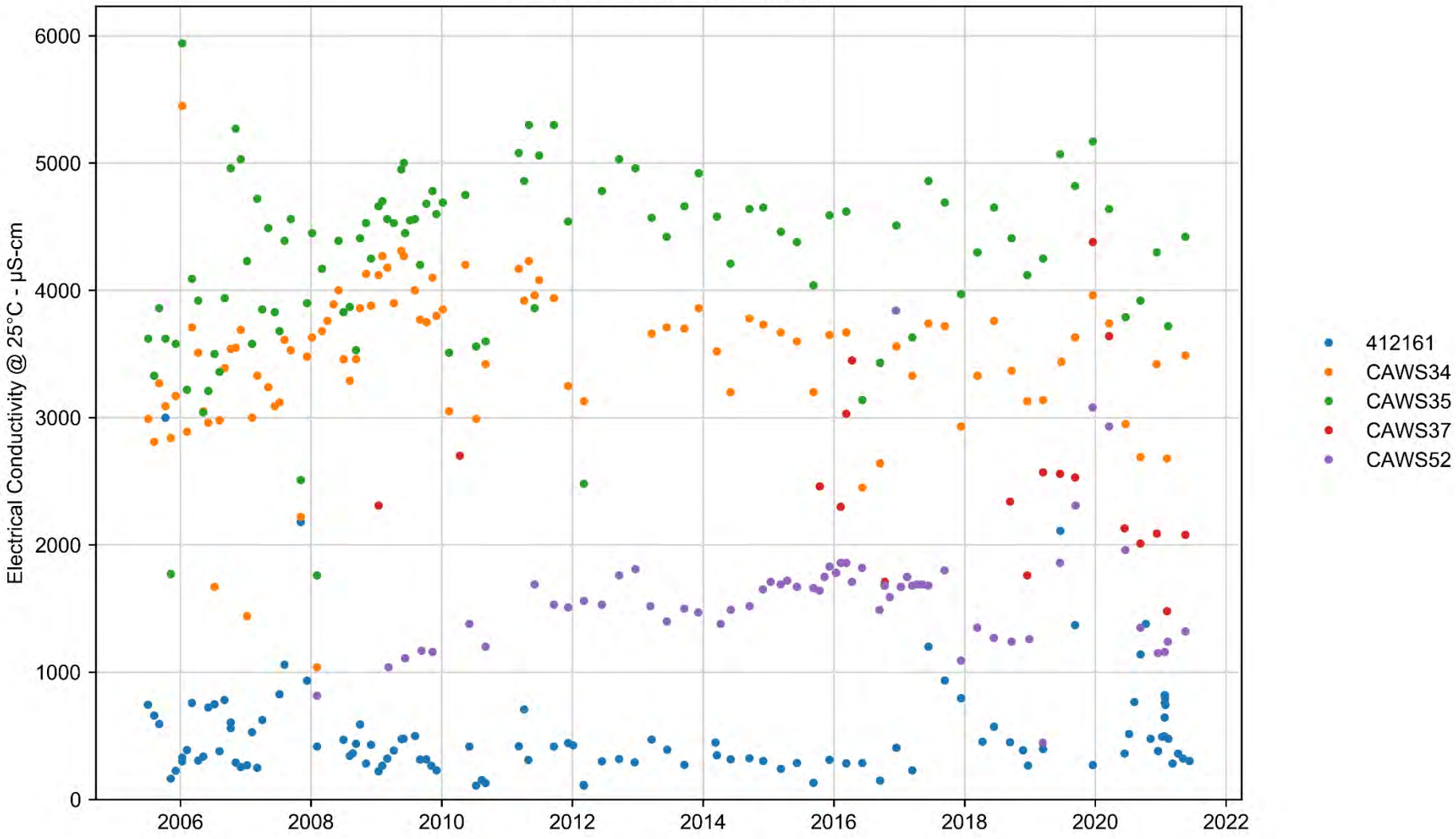
AEMR - Waste Rock Dumps



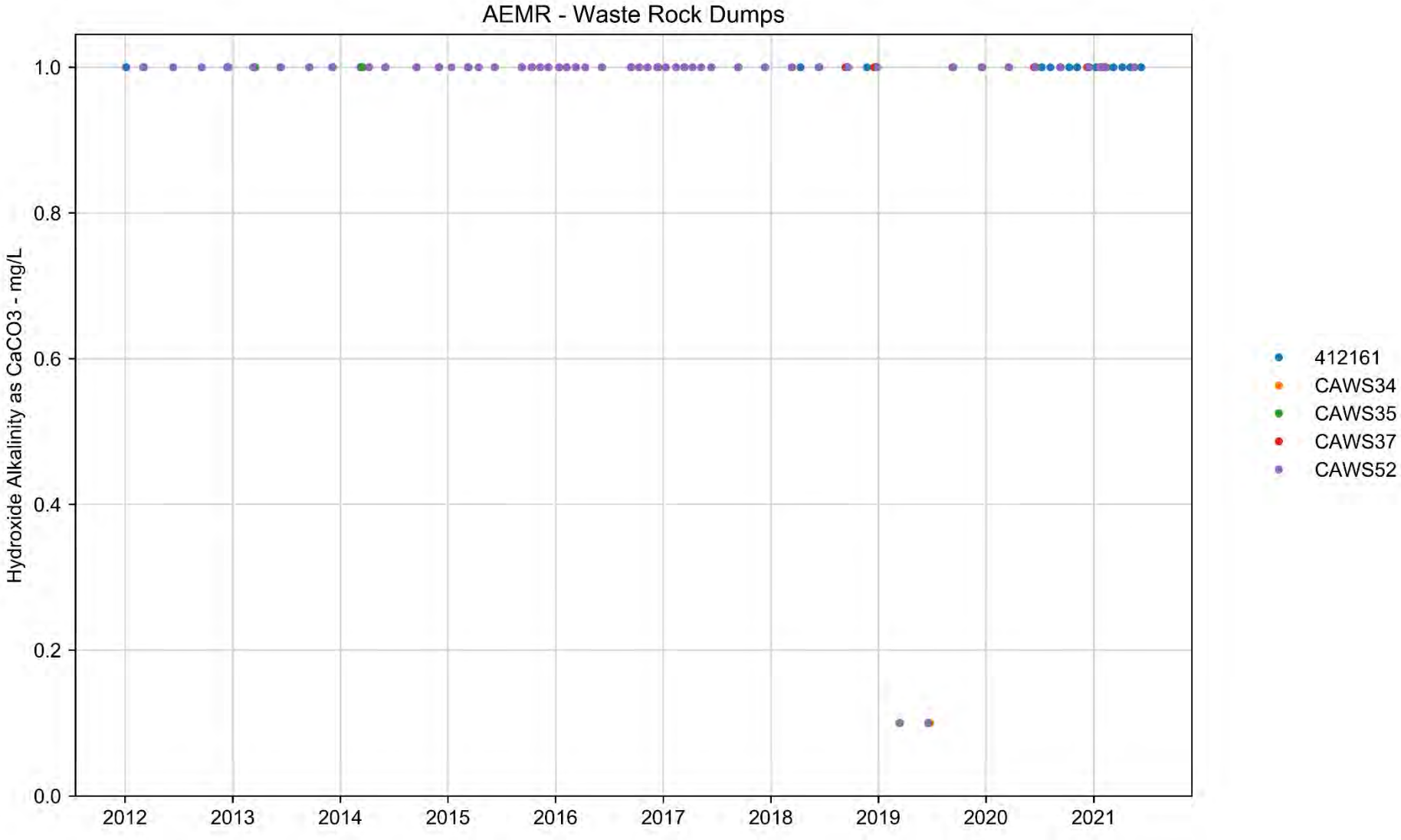

AEMR - Waste Rock Dumps
Chromium - mg/L
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
2006
2008
2010
2012
2014
2016
2018
2020
2022
412161
CAWS34
CAWS35
CAWS37
CAWS52
AEMR - Waste Rock Dumps
Cobalt - mg/L
0.12
0.10
0.08
0.06
0.04
0.02
0.00
2010
2012
2014
2016
2018
2020
2022
412161
CAWS34
CAWS35
CAWS37
CAWS52


AEMR - Waste Rock Dumps
Copper - mg/L
10
1
0.1
0.01
0.001
2006
2008
2010
2012
2014
2016
2018
2020
2022
412161
CAWS34
CAWS35
CAWS37
CAWS52
AEMR - Waste Rock Dumps
Electrical Conductivity - Field - µS-cm
4000
3000
2000
1000
0
2019-01
2019-04
2019-07
2019-10
2020-01
2020-04
2020-07
2020-10
2021-01
2021-04
2021-07
412161
CAWS34
CAWS35
CAWS37
CAWS52

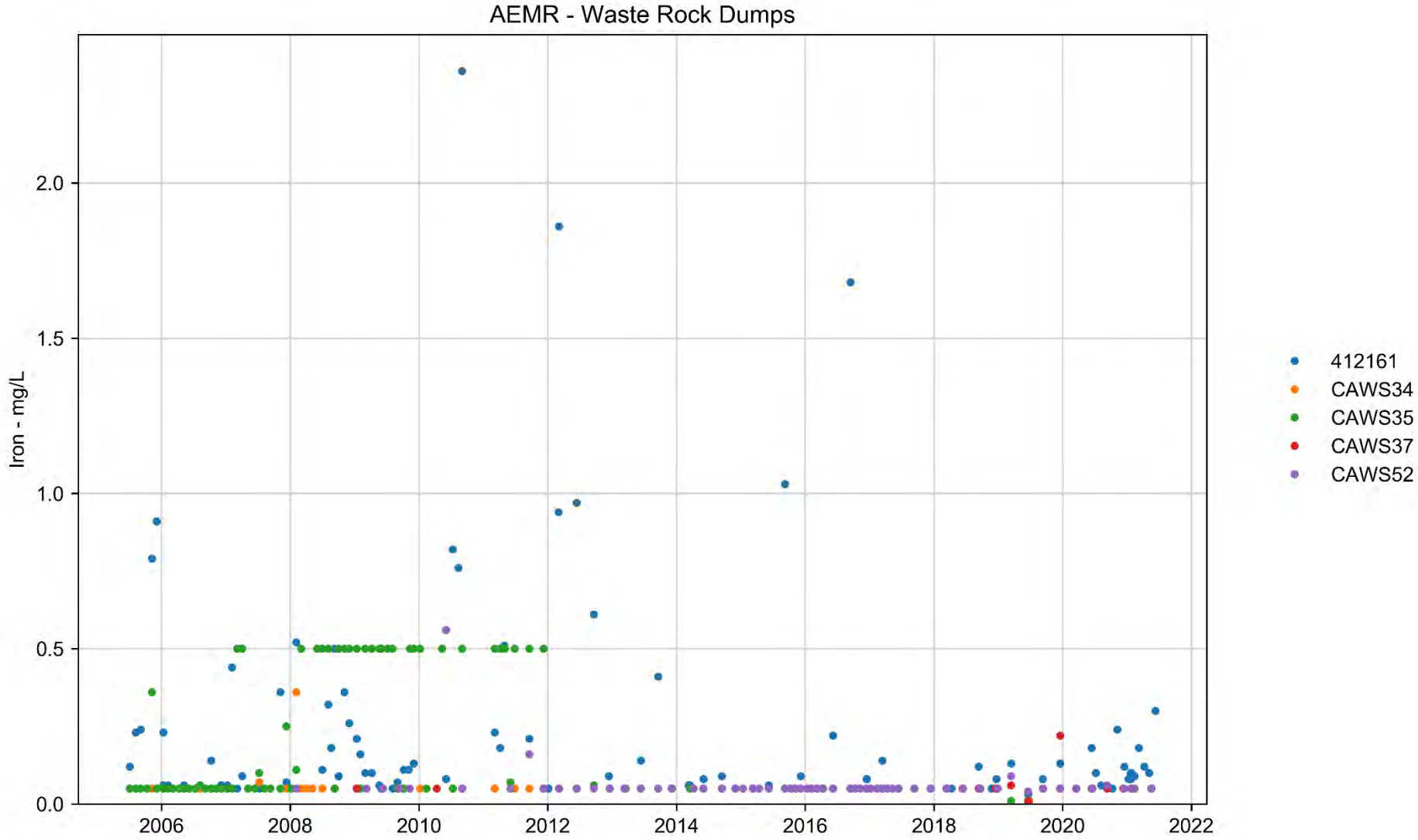
AEMR - Waste Rock Dumps



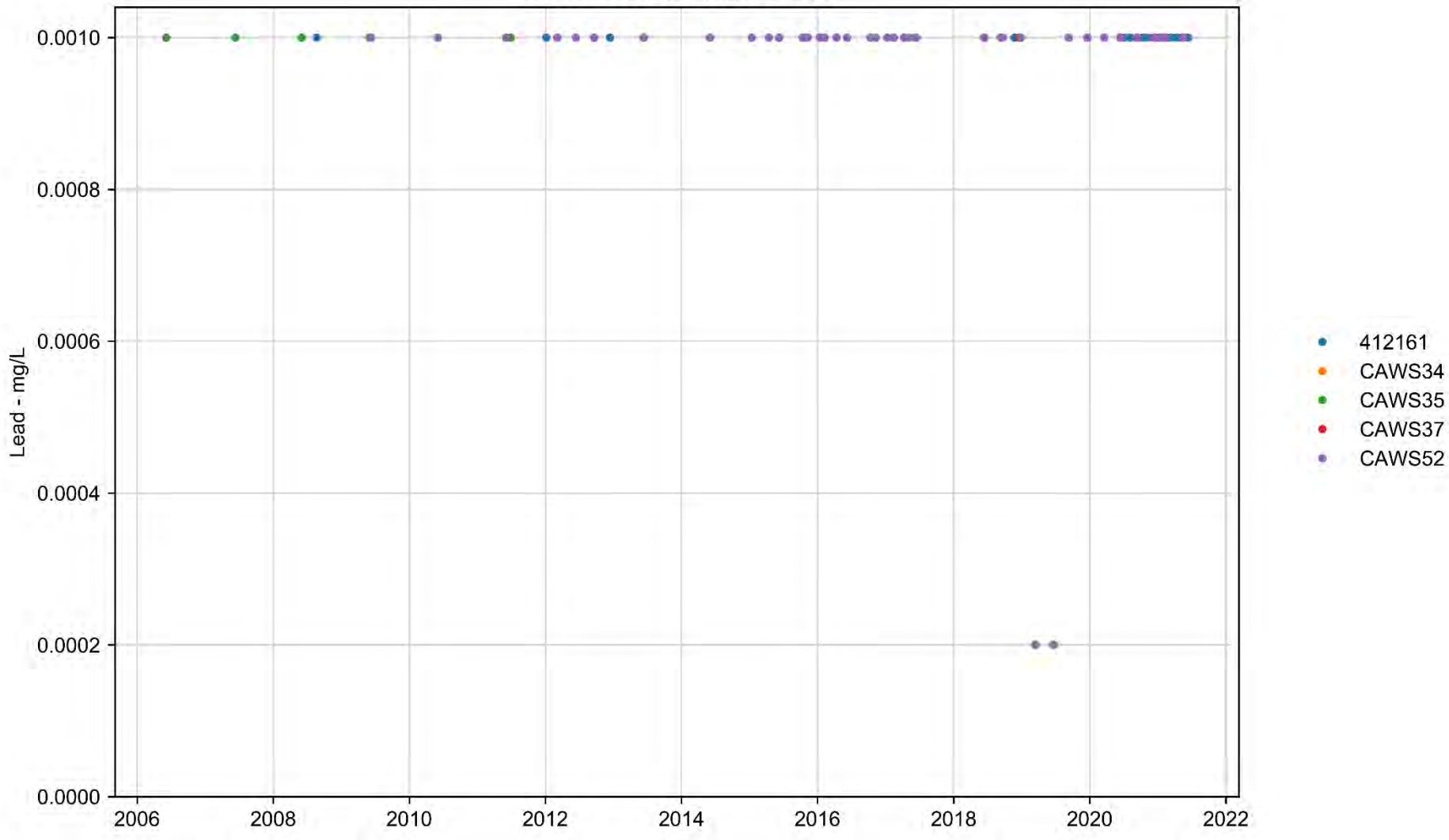
AEMR - Waste Rock Dumps

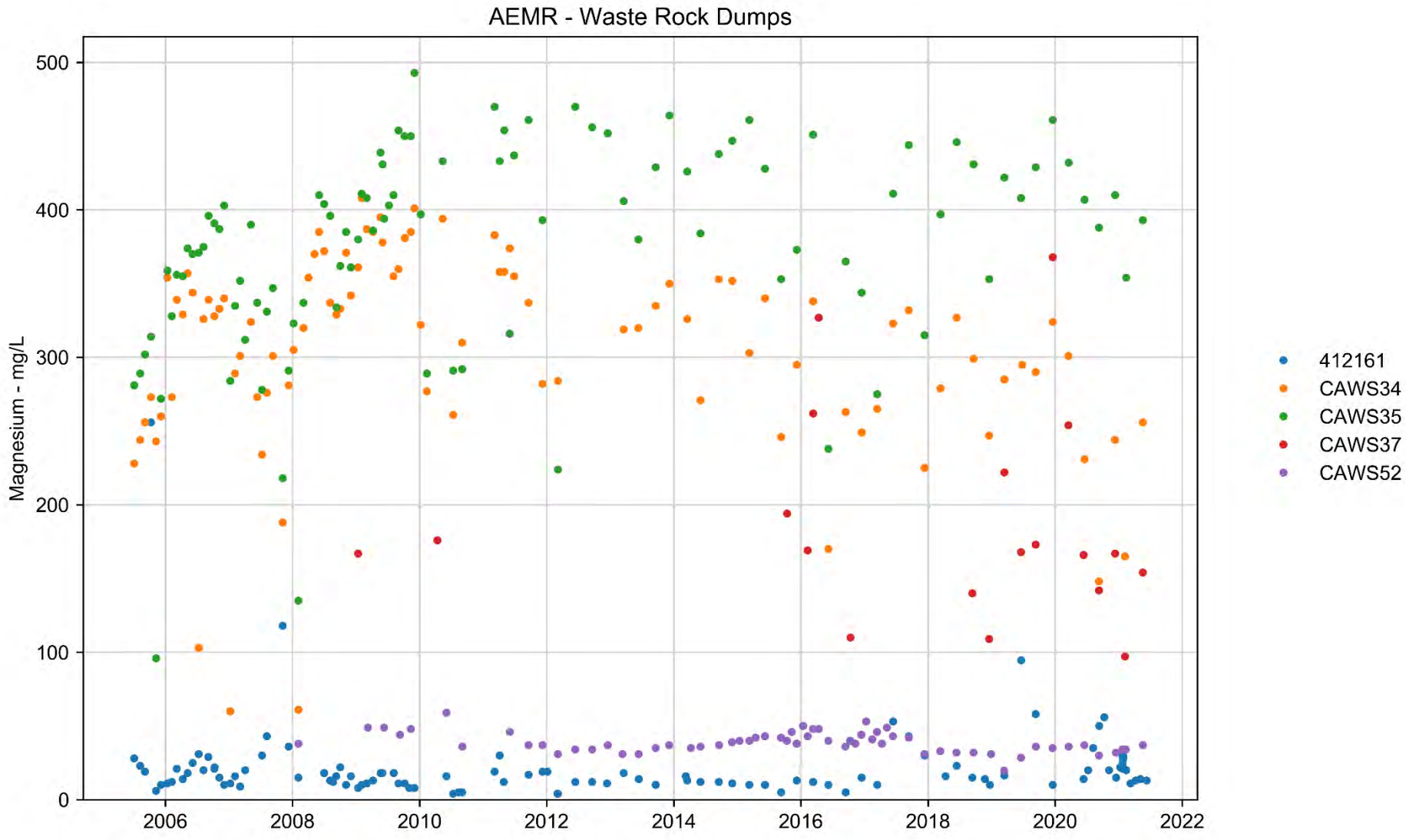


AEMR - Waste Rock Dumps

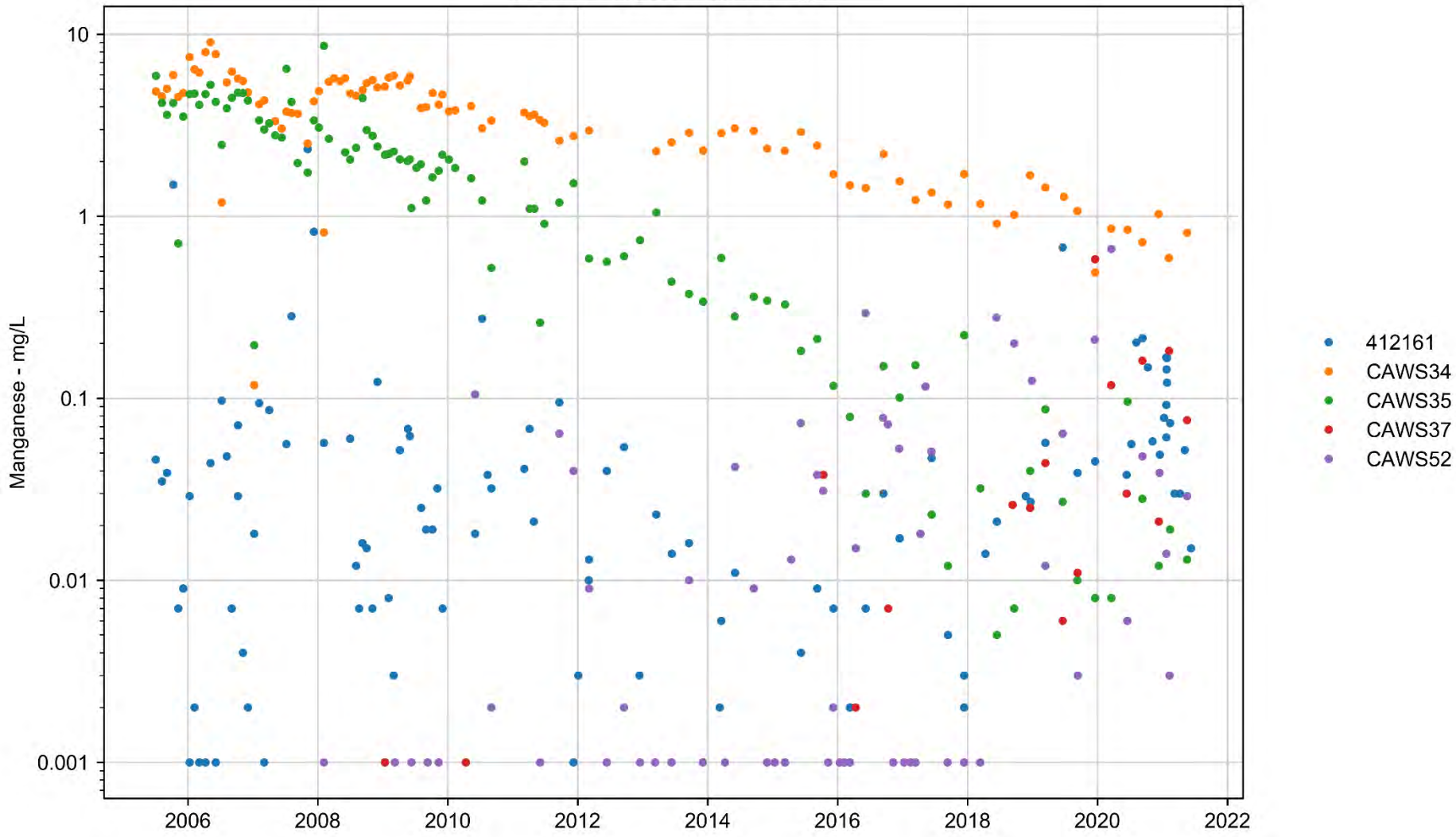


AEMR - Waste Rock Dumps

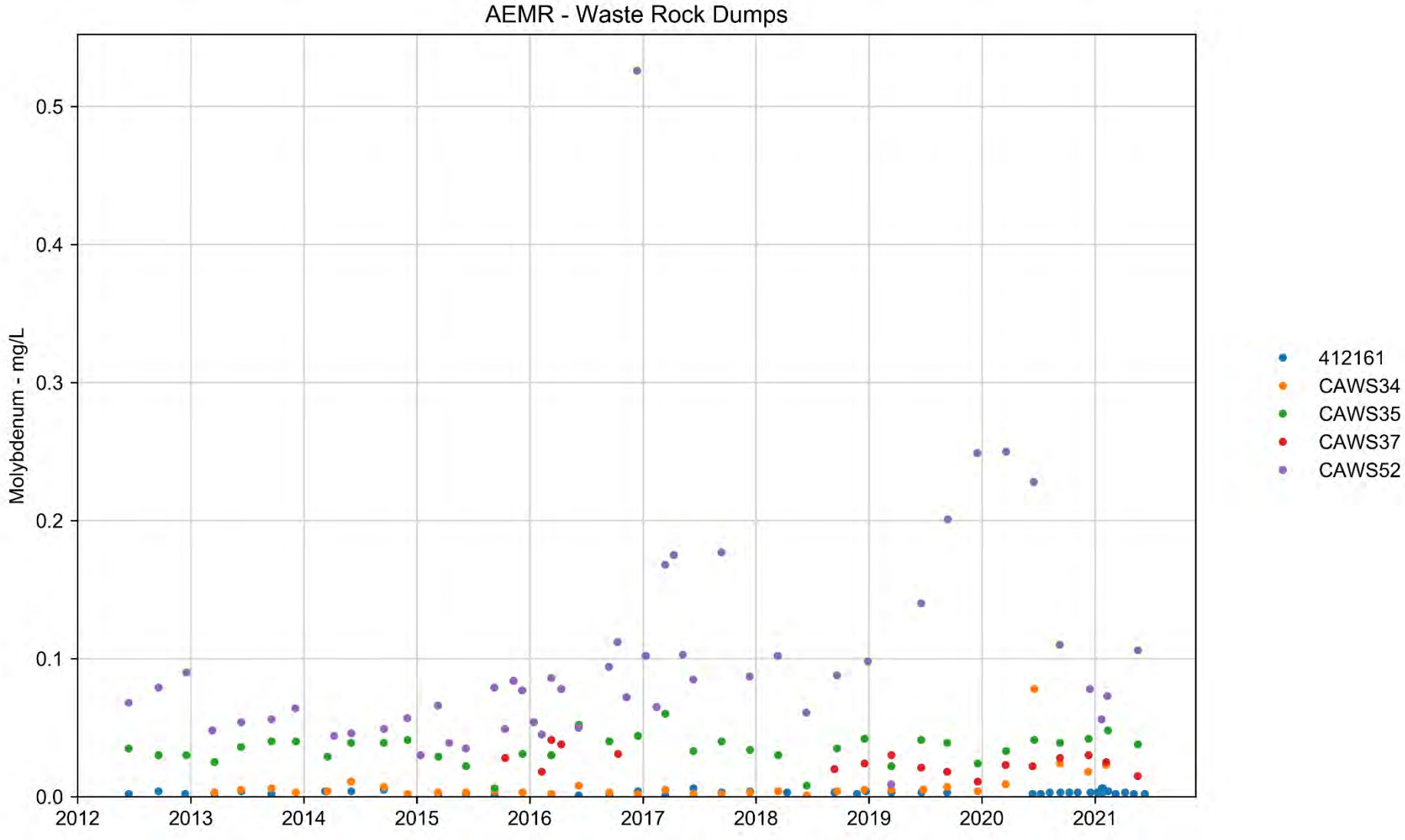


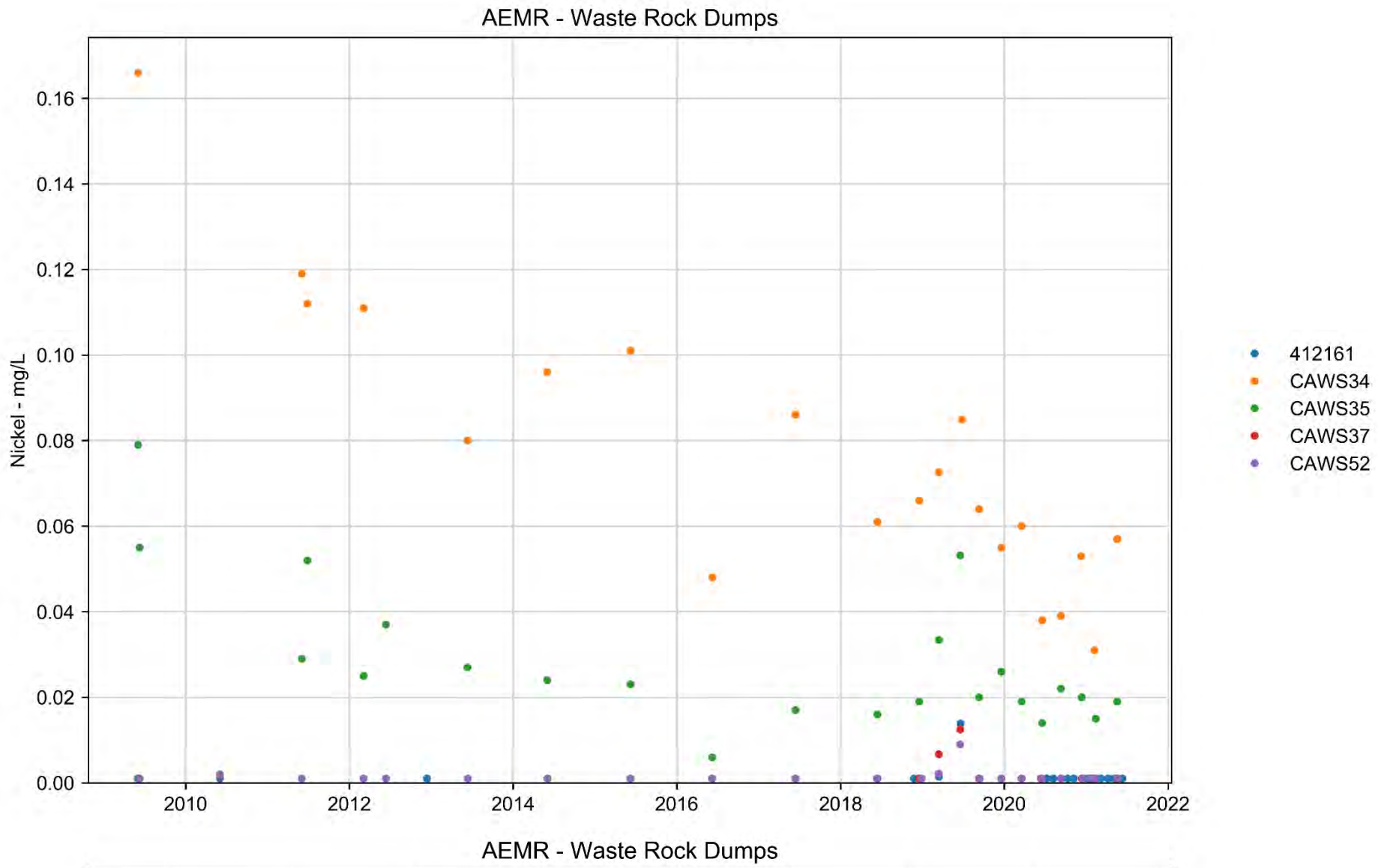

AEMR - Waste Rock Dumps
Magnesium - mg/L
500
400
300
200
100
0
2006
2008
2010
2012
2014
2016
2018
2020
2022
412161
CAWS34
CAWS35
CAWS37
CAWS52

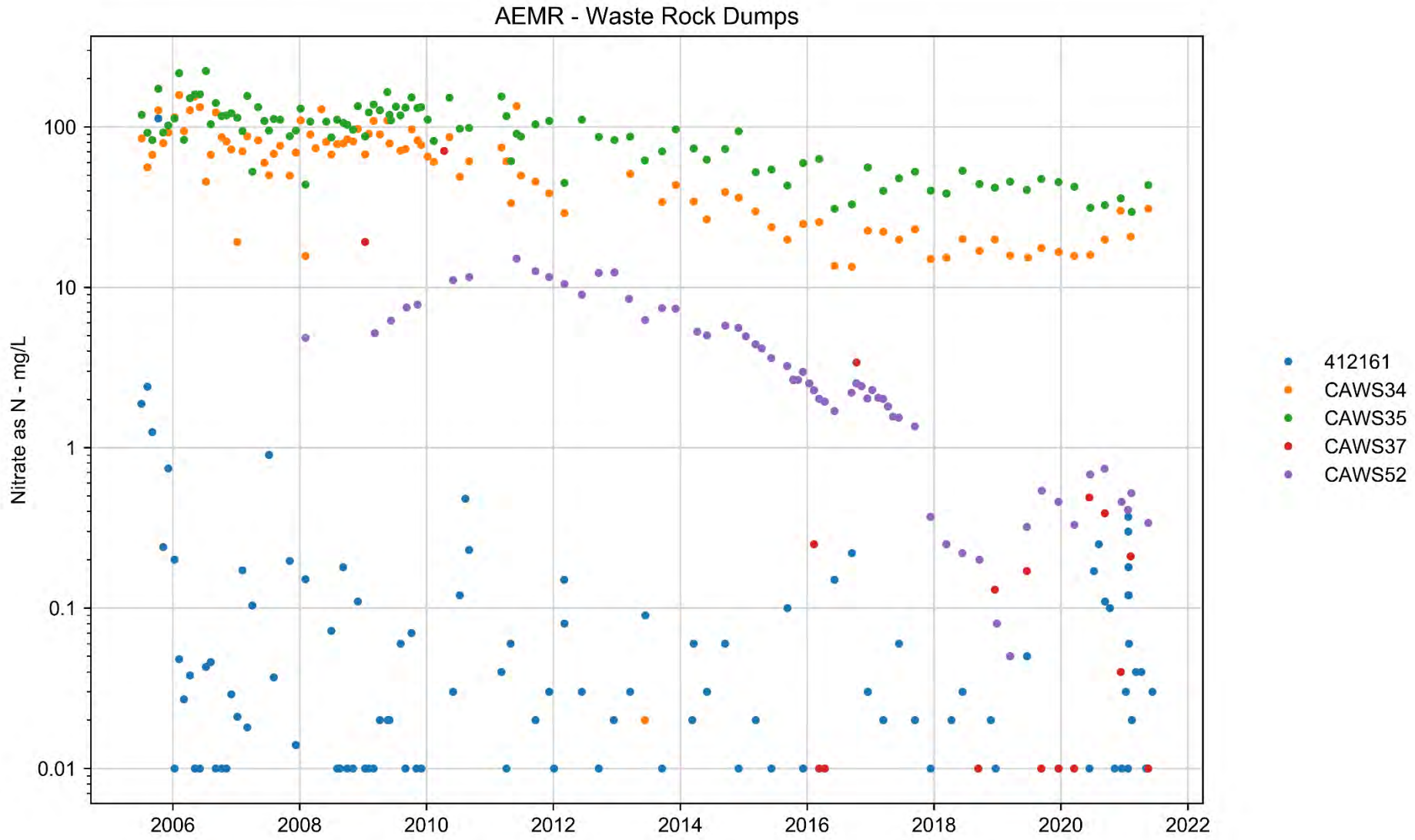
AEMR - Waste Rock Dumps



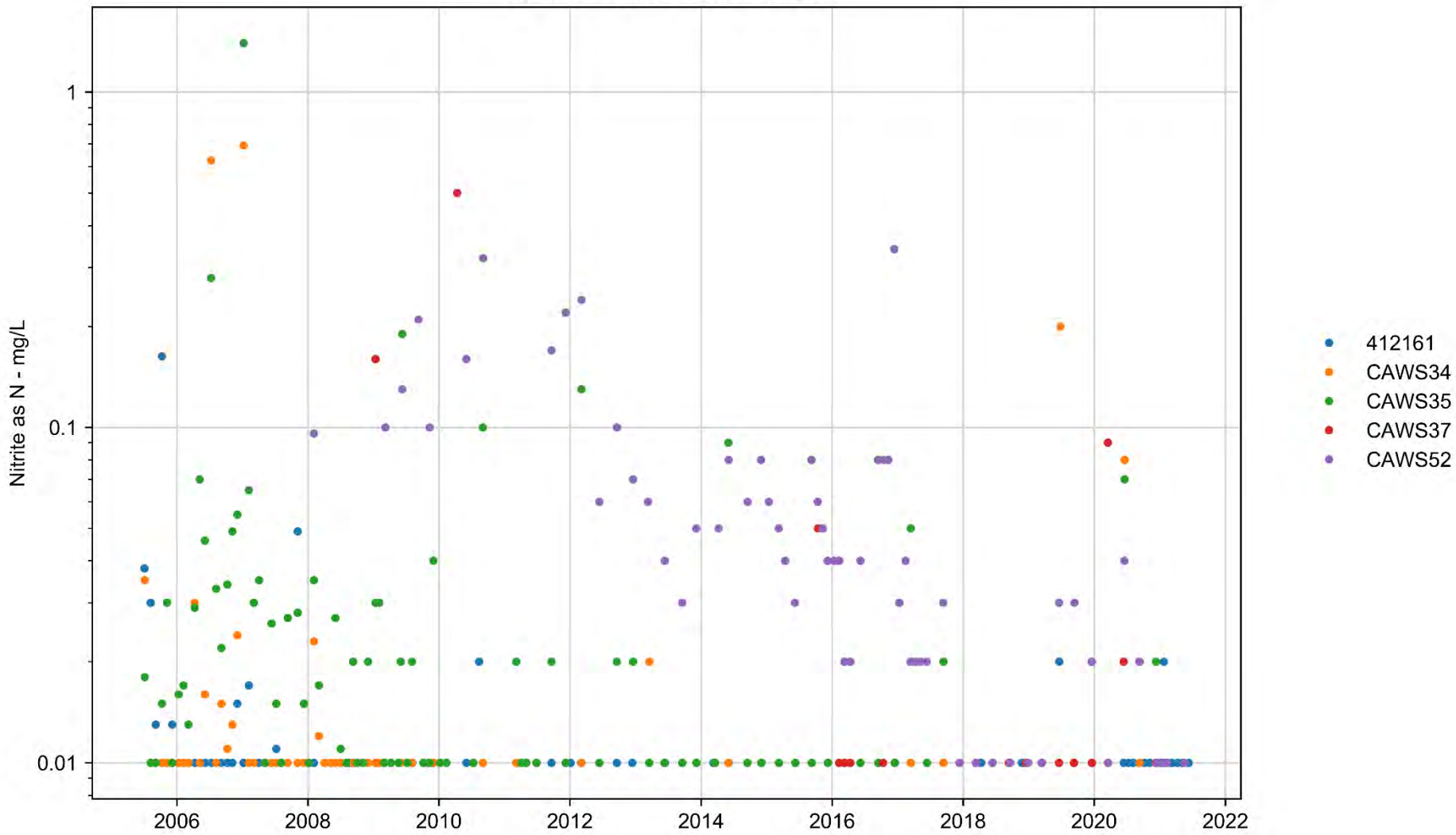
AEMR - Waste Rock Dumps



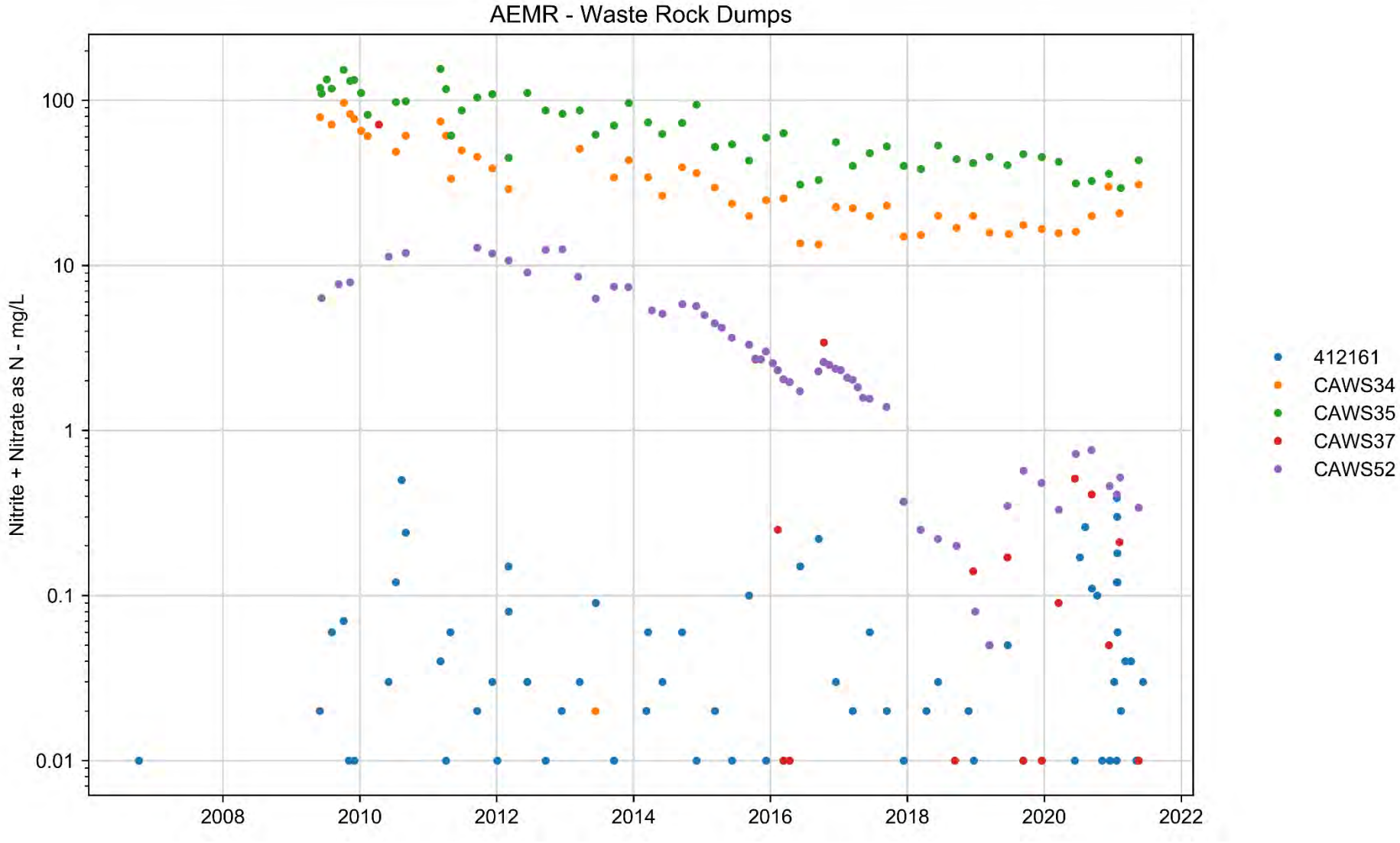

AEMR - Waste Rock Dumps
Nickel - mg/L
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
2010
2012
2014
2016
2018
2020
2022
412161
CAWS34
CAWS35
CAWS37
CAWS52


AEMR - Waste Rock Dumps
Nitrate as N - mg/L
100
10
1
0.1
0.01
2006
2008
2010
2012
2014
2016
2018
2020
2022
412161
CAWS34
CAWS35
CAWS37
CAWS52

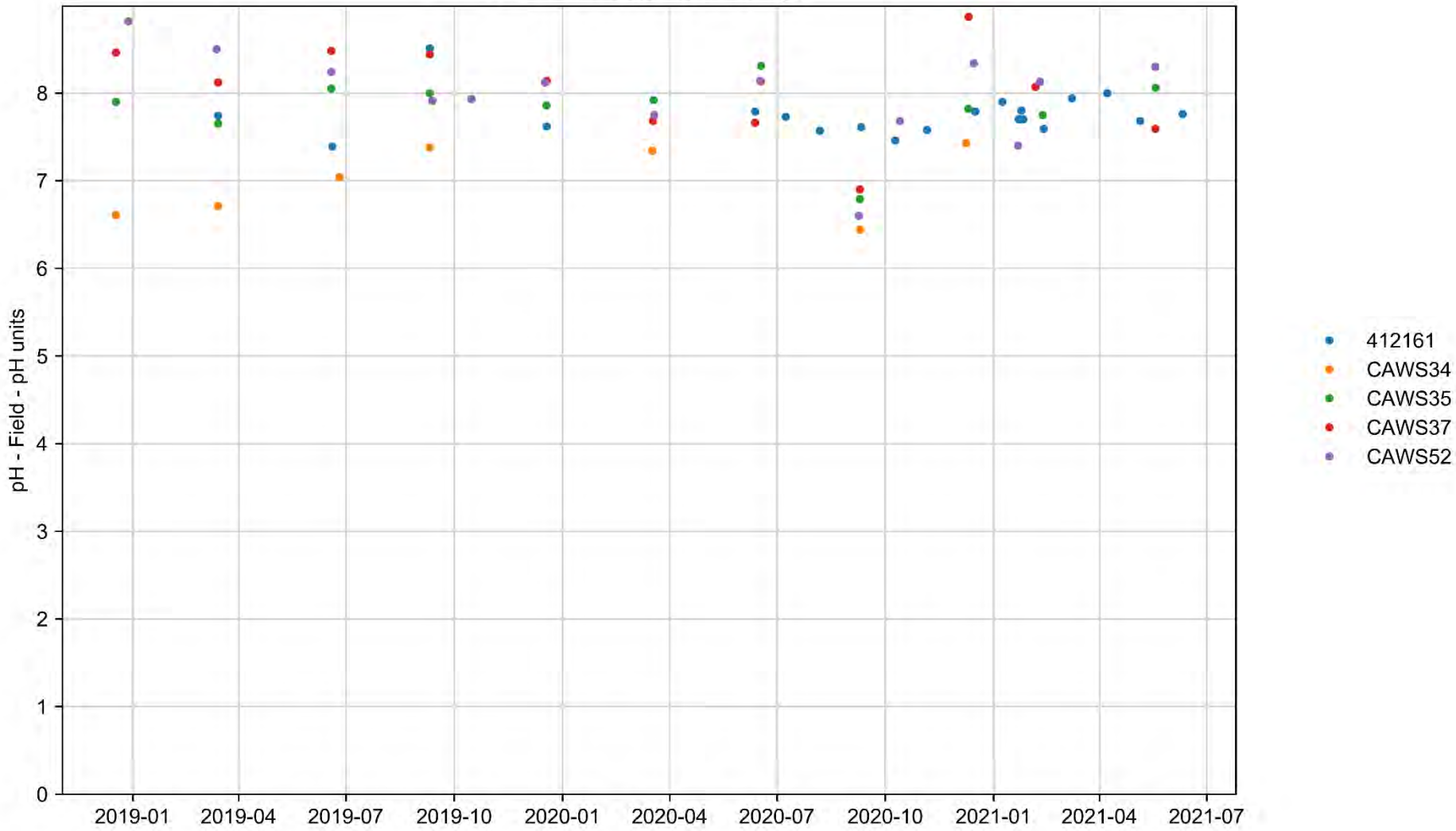
AEMR - Waste Rock Dumps



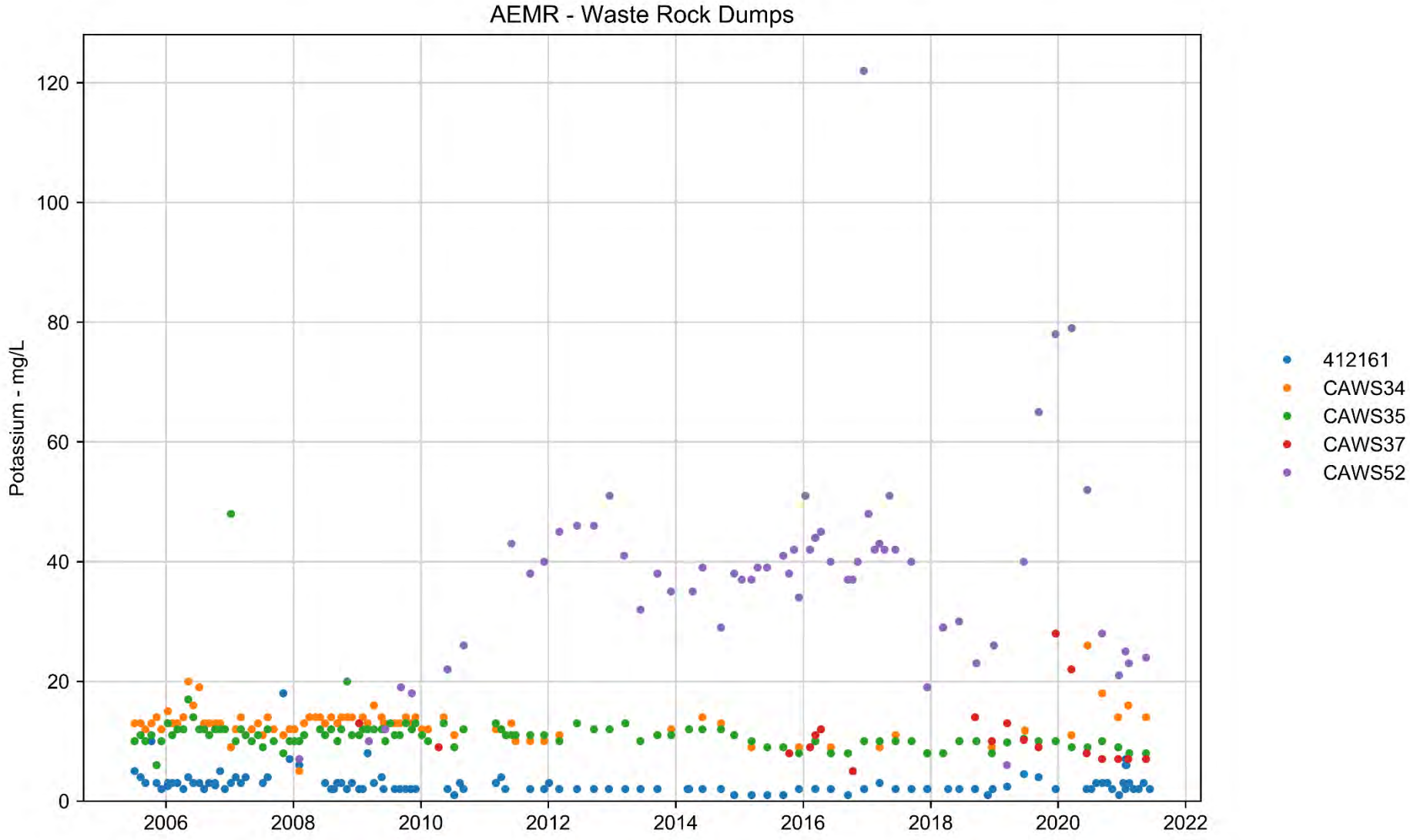
AEMR - Waste Rock Dumps



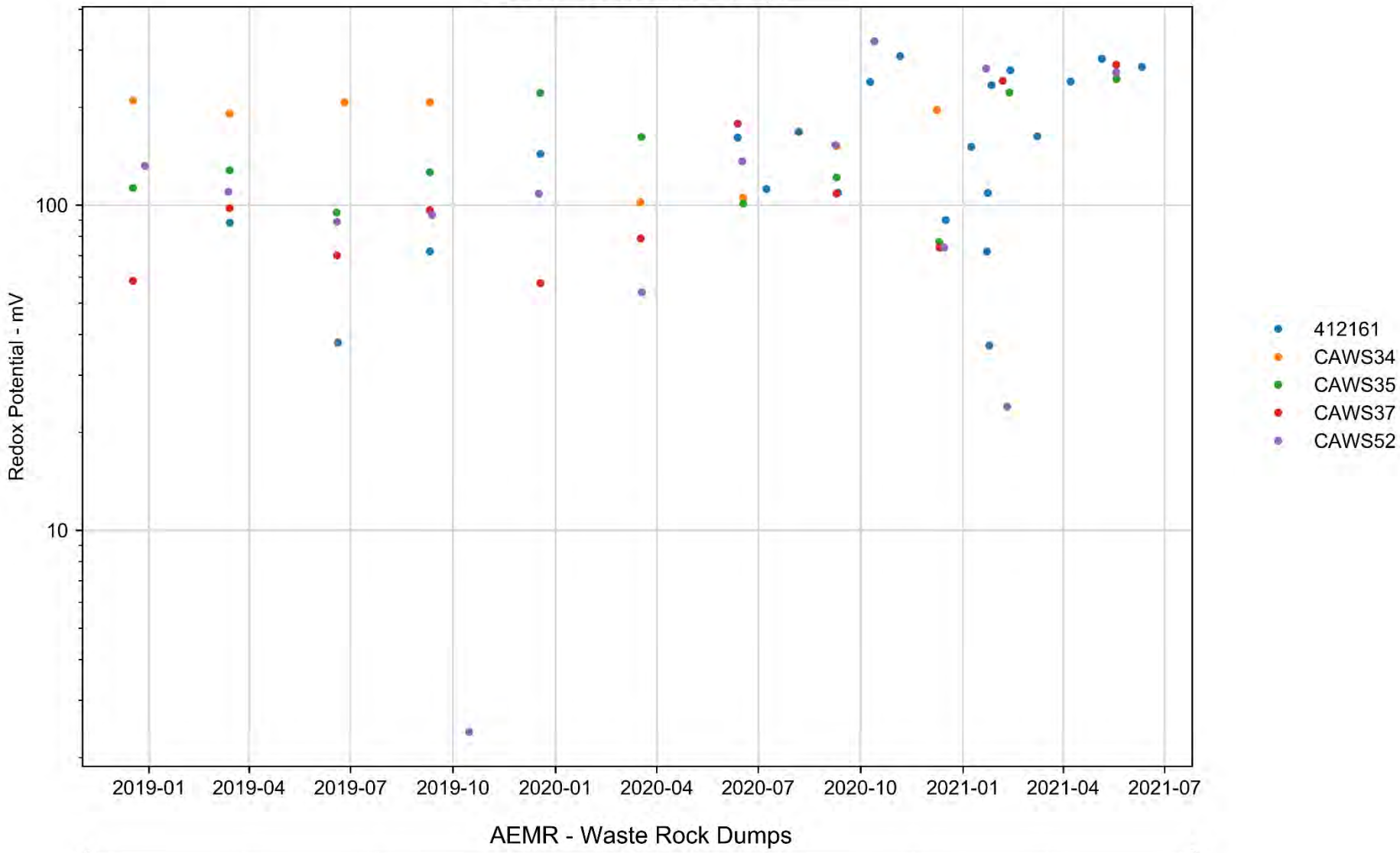
AEMR - Waste Rock Dumps



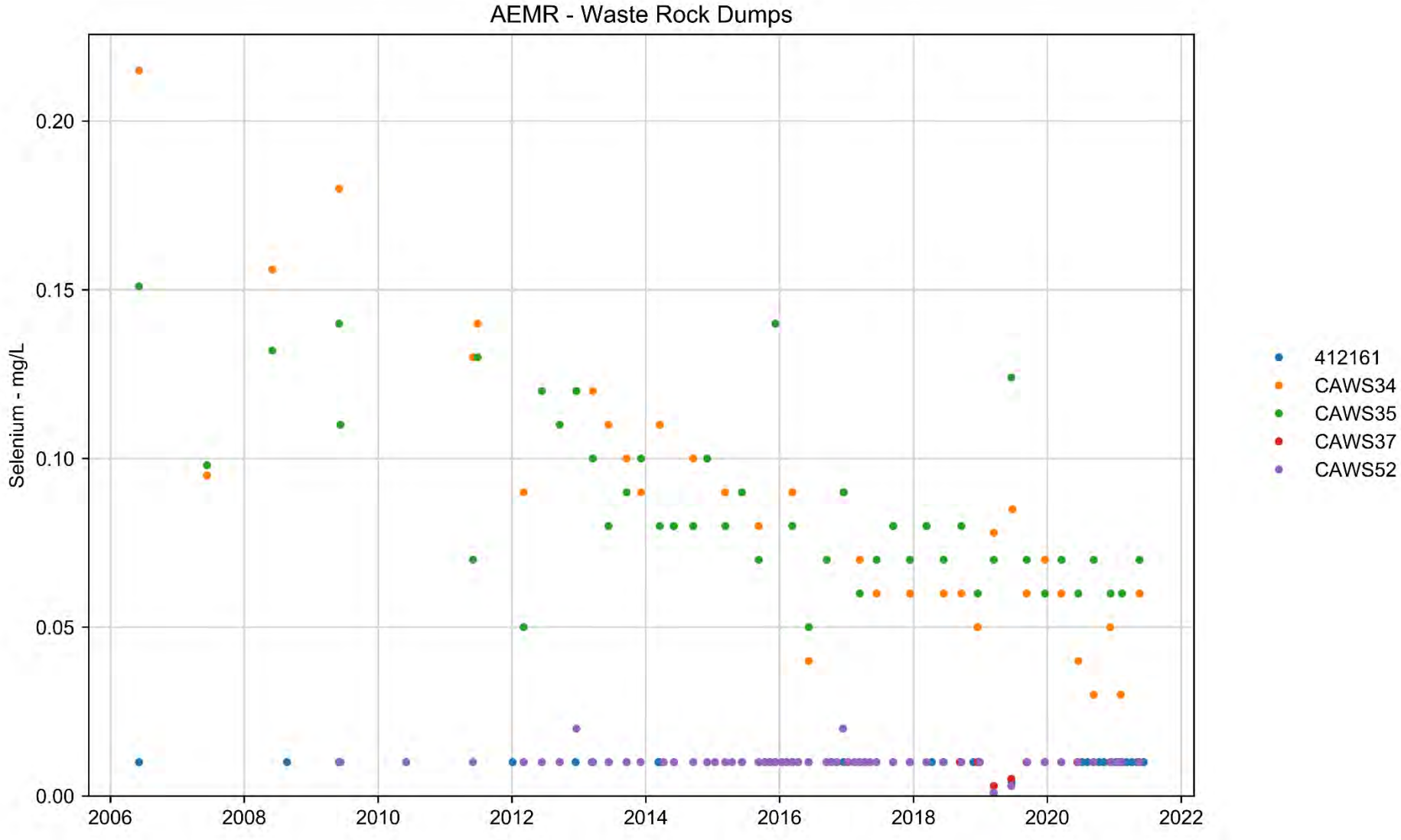
AEMR - Waste Rock Dumps

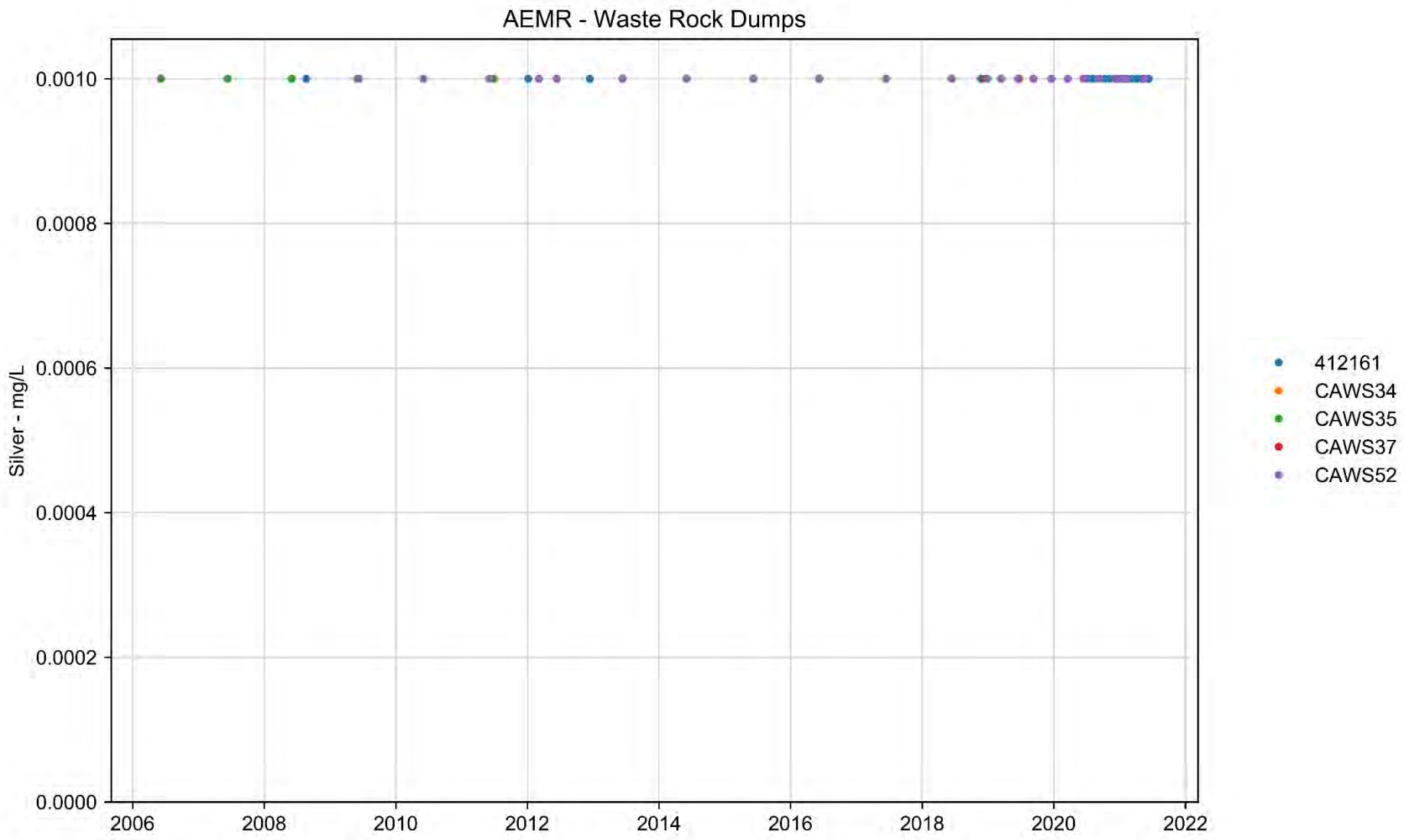


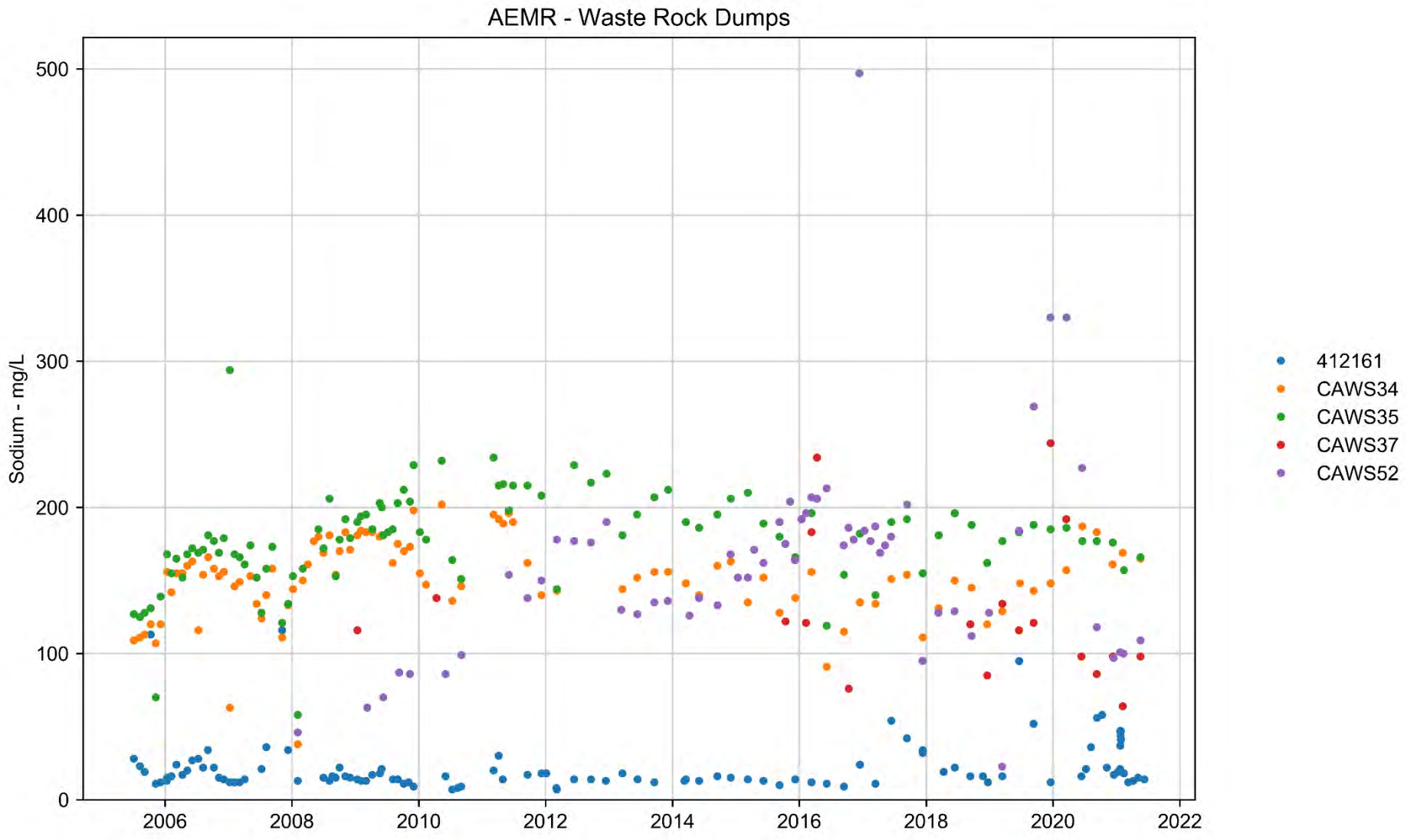
AEMR - Waste Rock Dumps



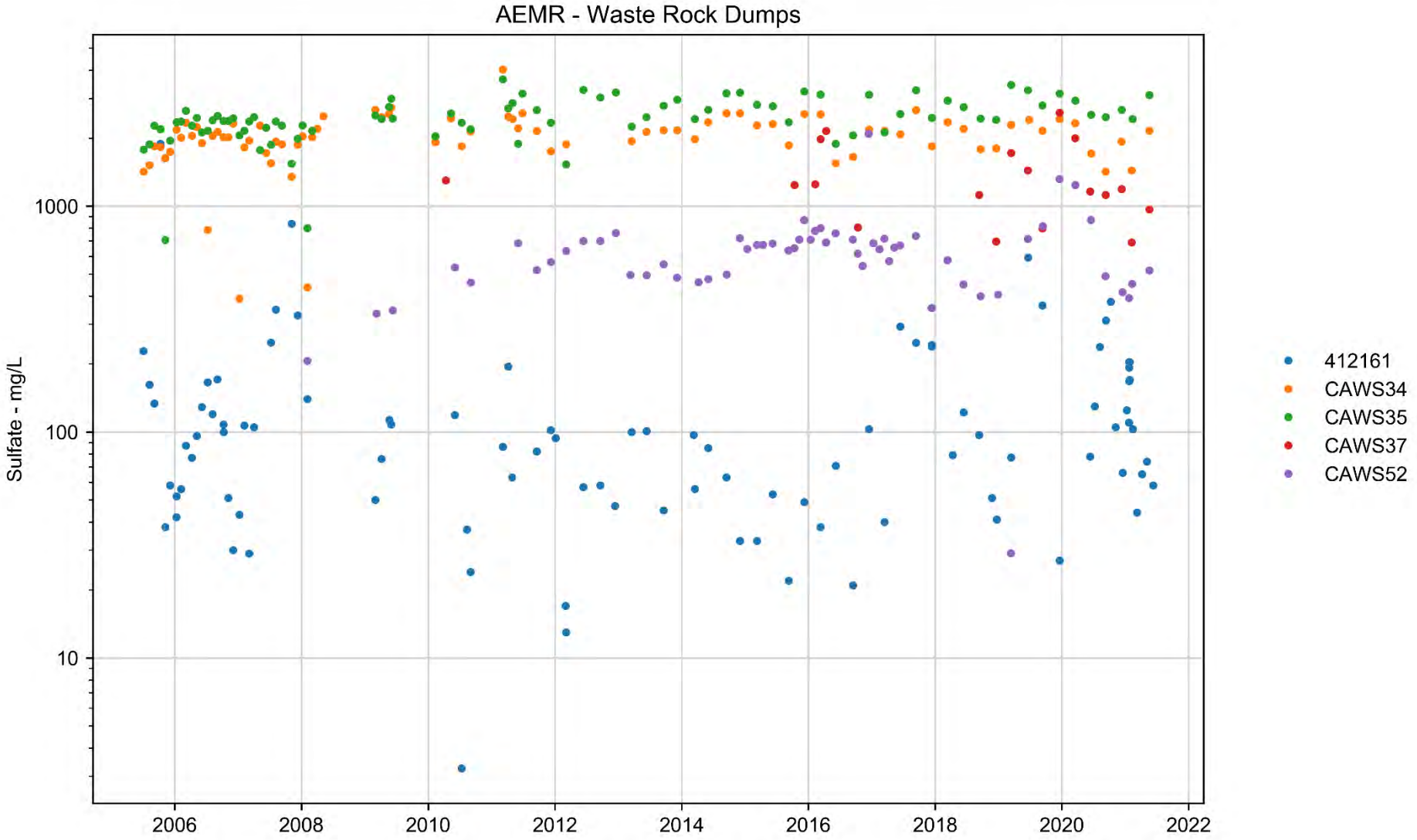
AEMR - Waste Rock Dumps



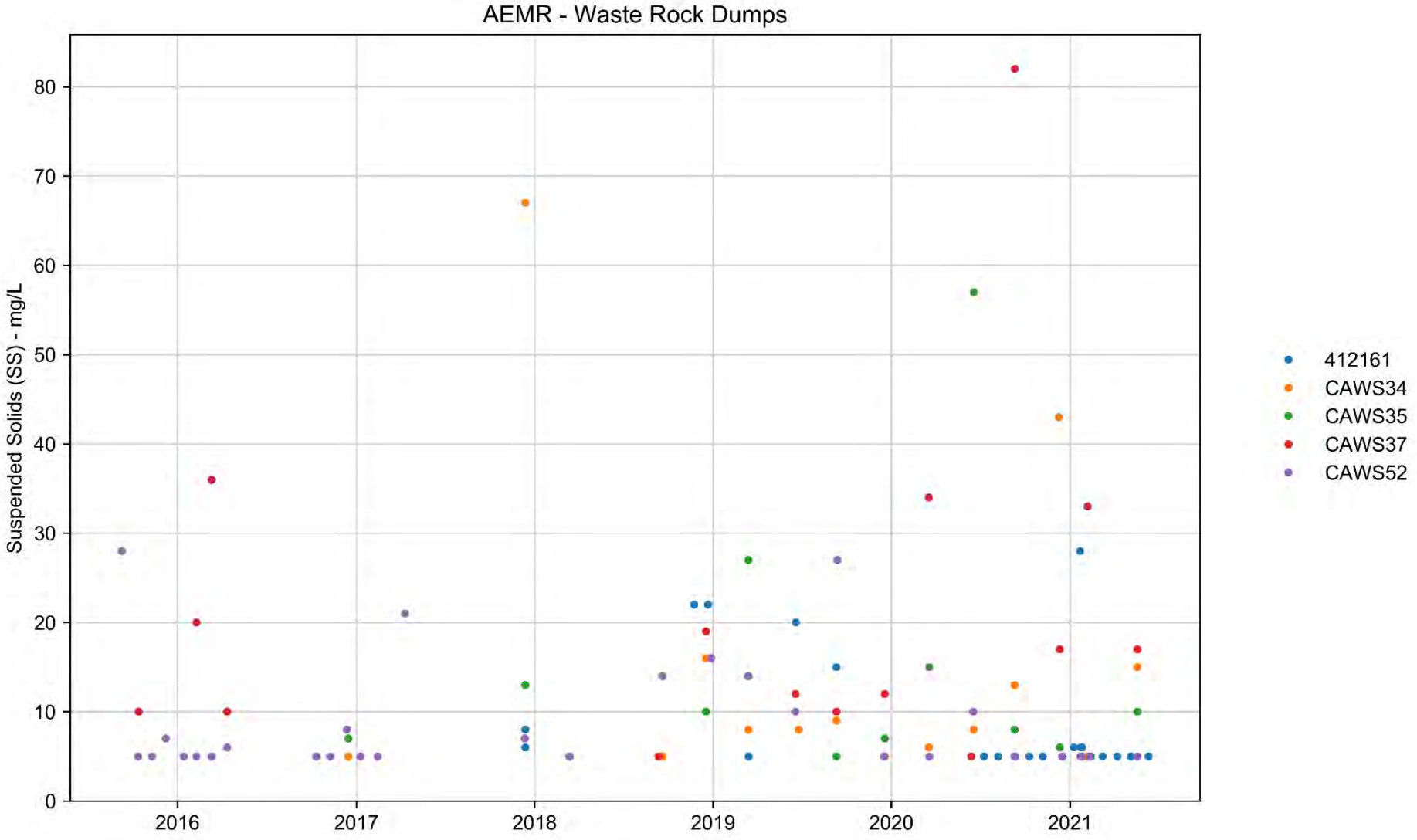

AEMR - Waste Rock Dumps
Silver - mg/L
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
2006
2008
2010
2012
2014
2016
2018
2020
2022
412161
CAWS34
CAWS35
CAWS37
CAWS52


AEMR - Waste Rock Dumps
Sodium - mg/L
500
400
300
200
100
0
2006
2008
2010
2012
2014
2016
2018
2020
2022
412161
CAWS34
CAWS35
CAWS37
CAWS52

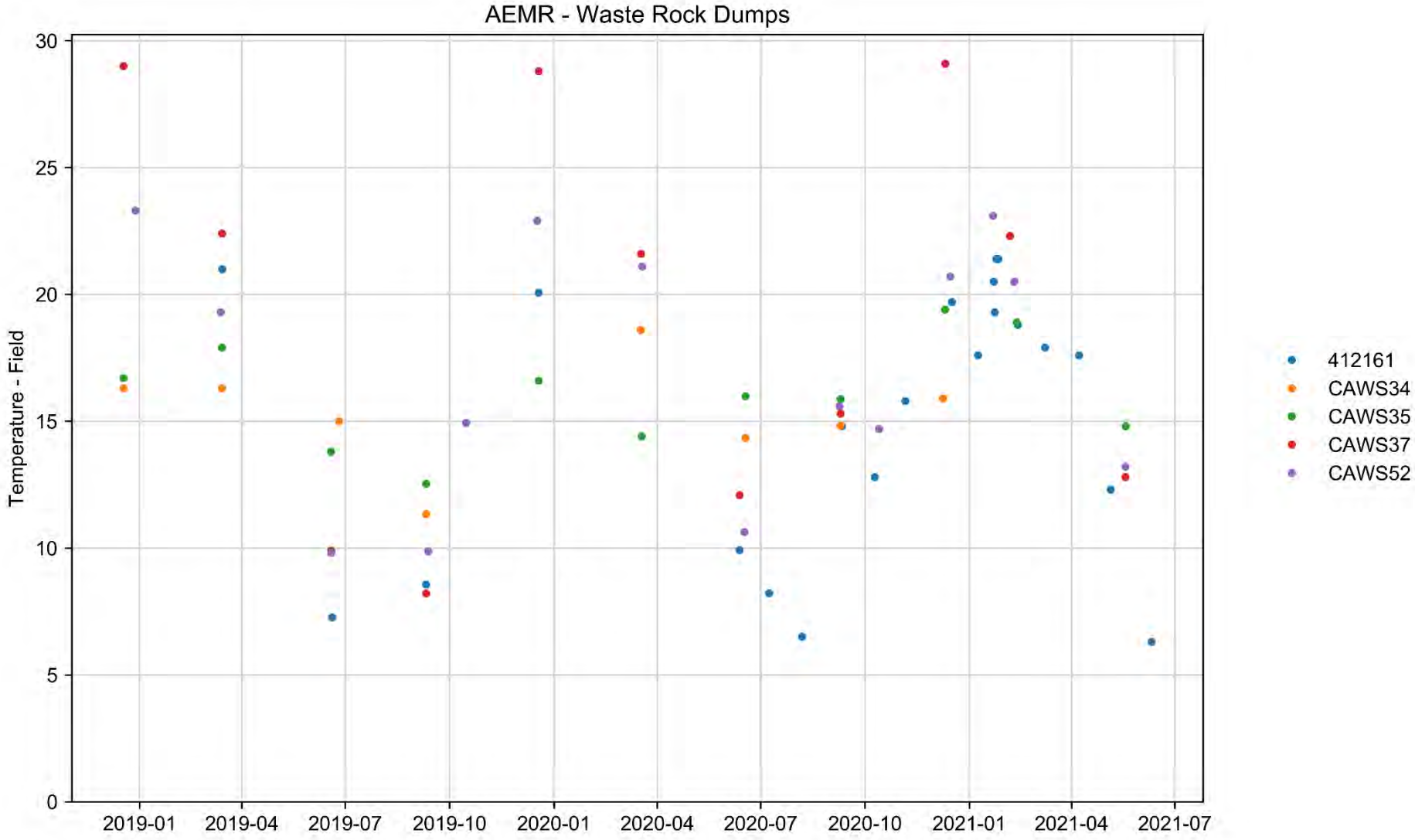
AEMR - Waste Rock Dumps



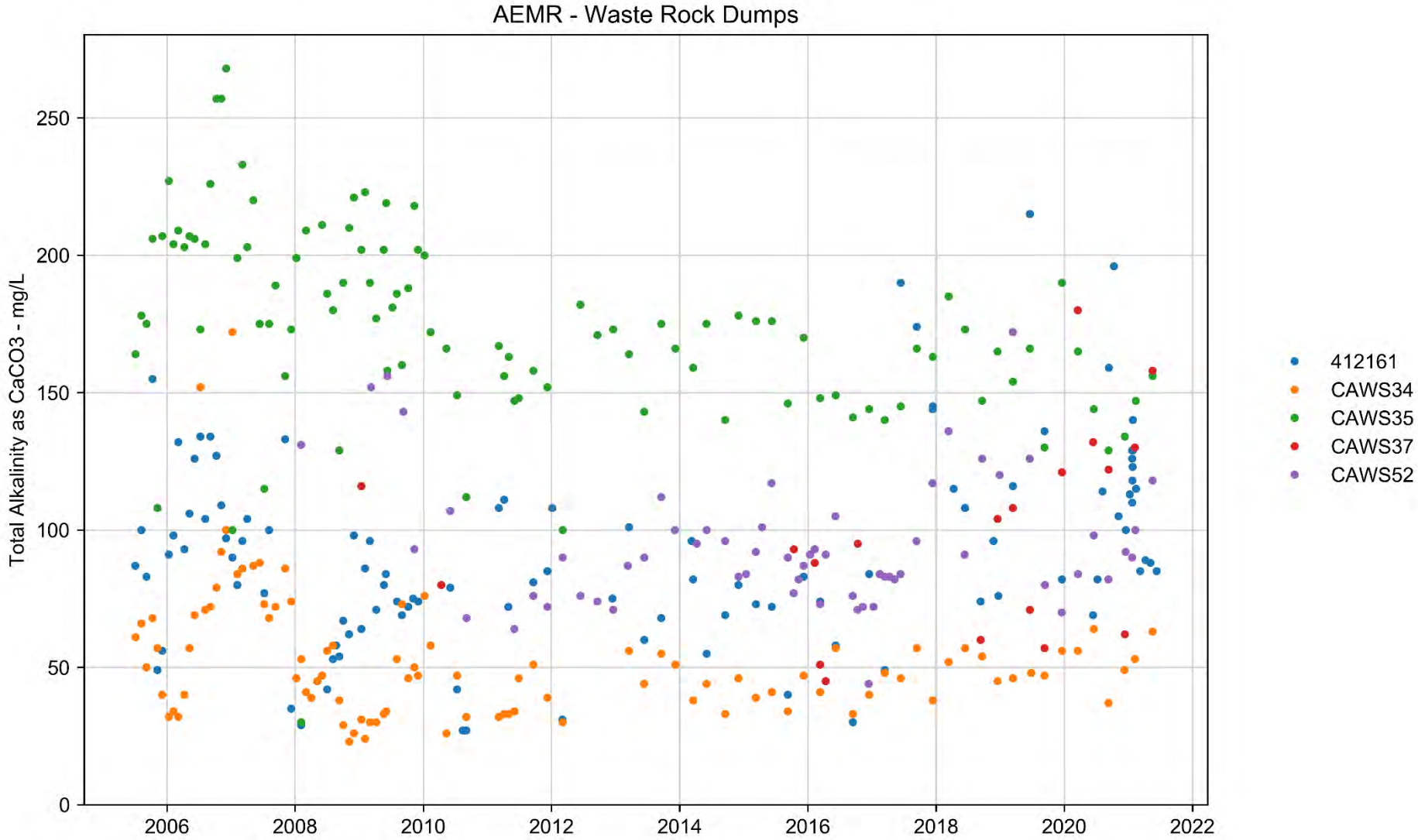
AEMR - Waste Rock Dumps

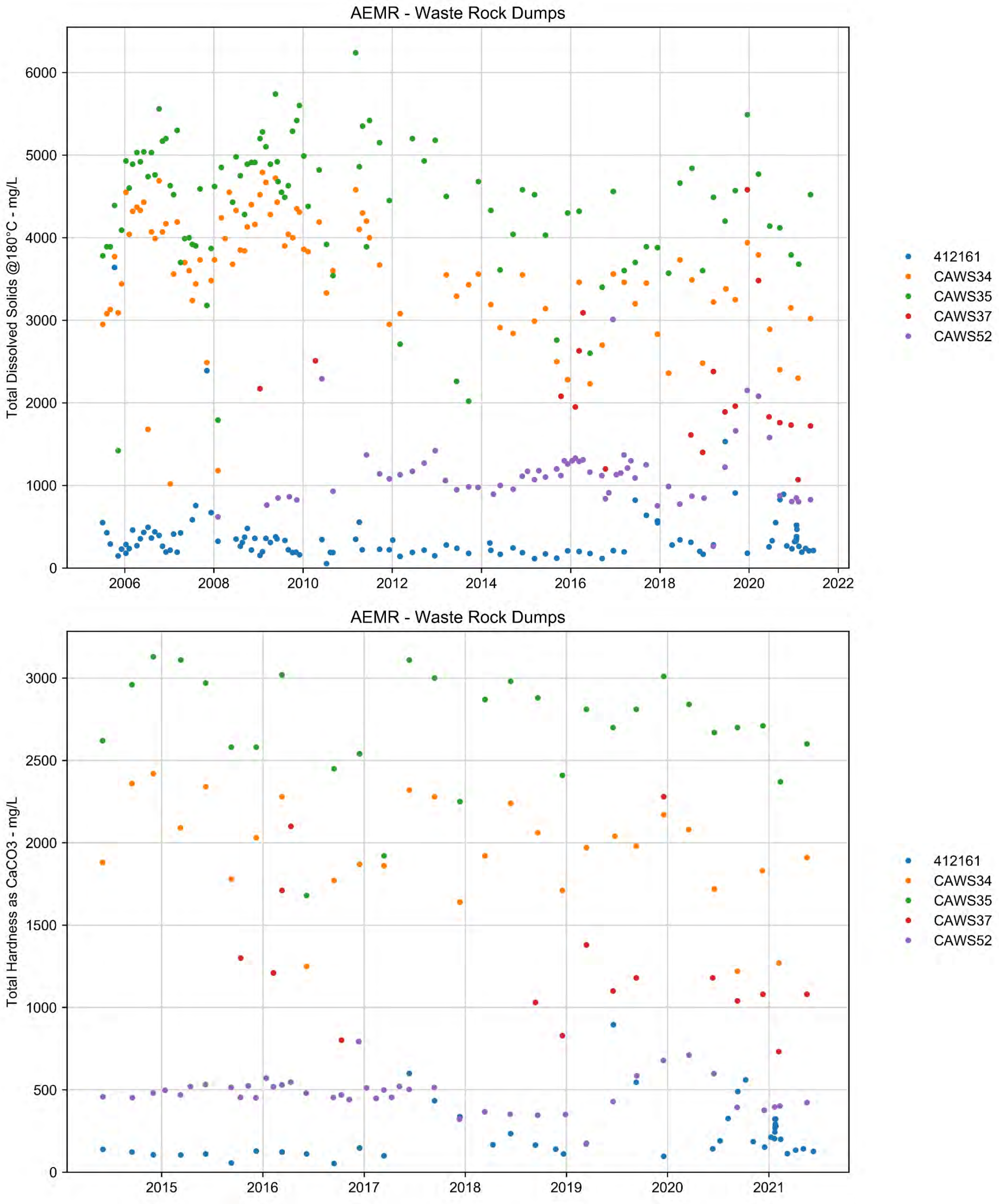


AEMR - Waste Rock Dumps

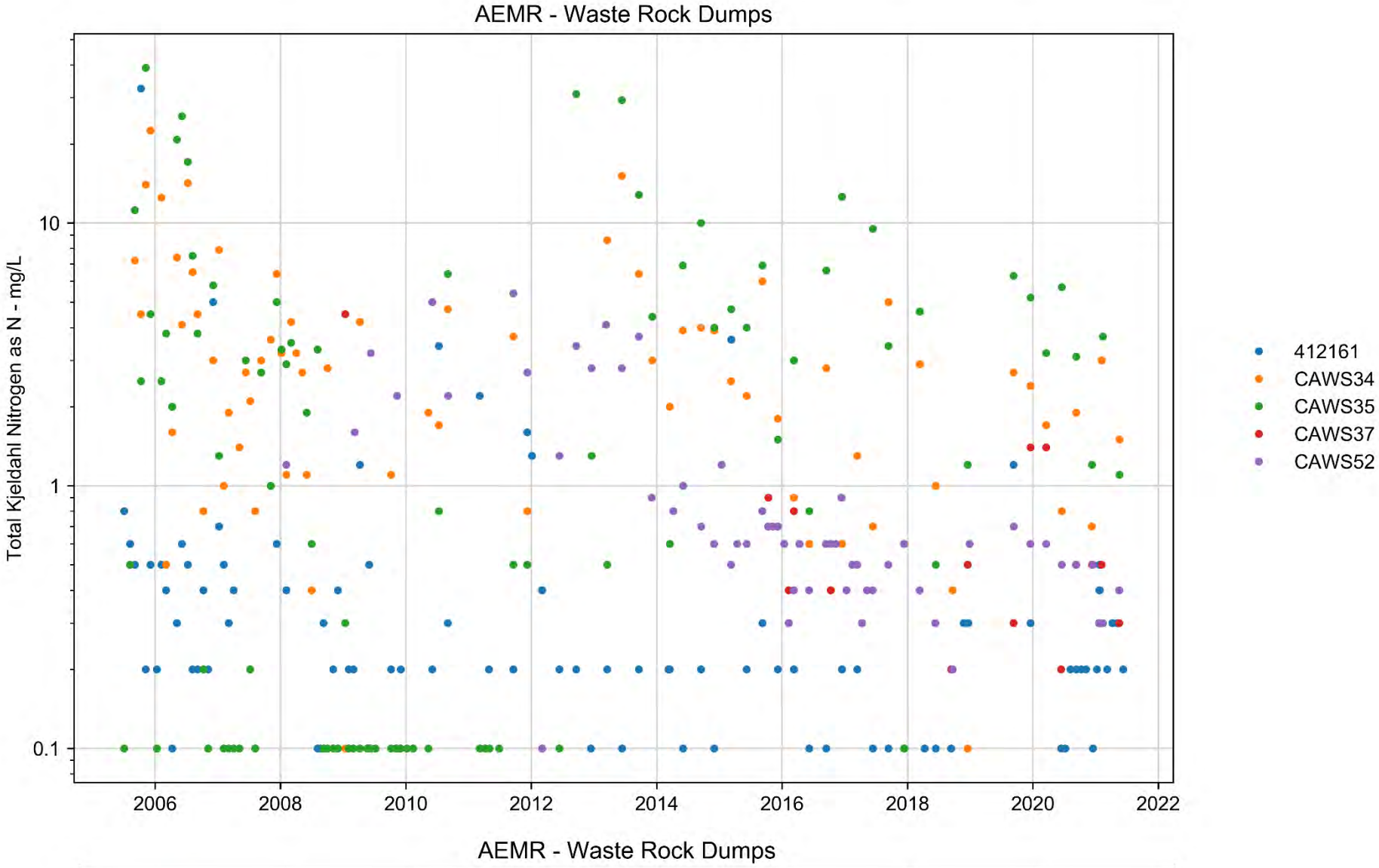


AEMR - Waste Rock Dumps

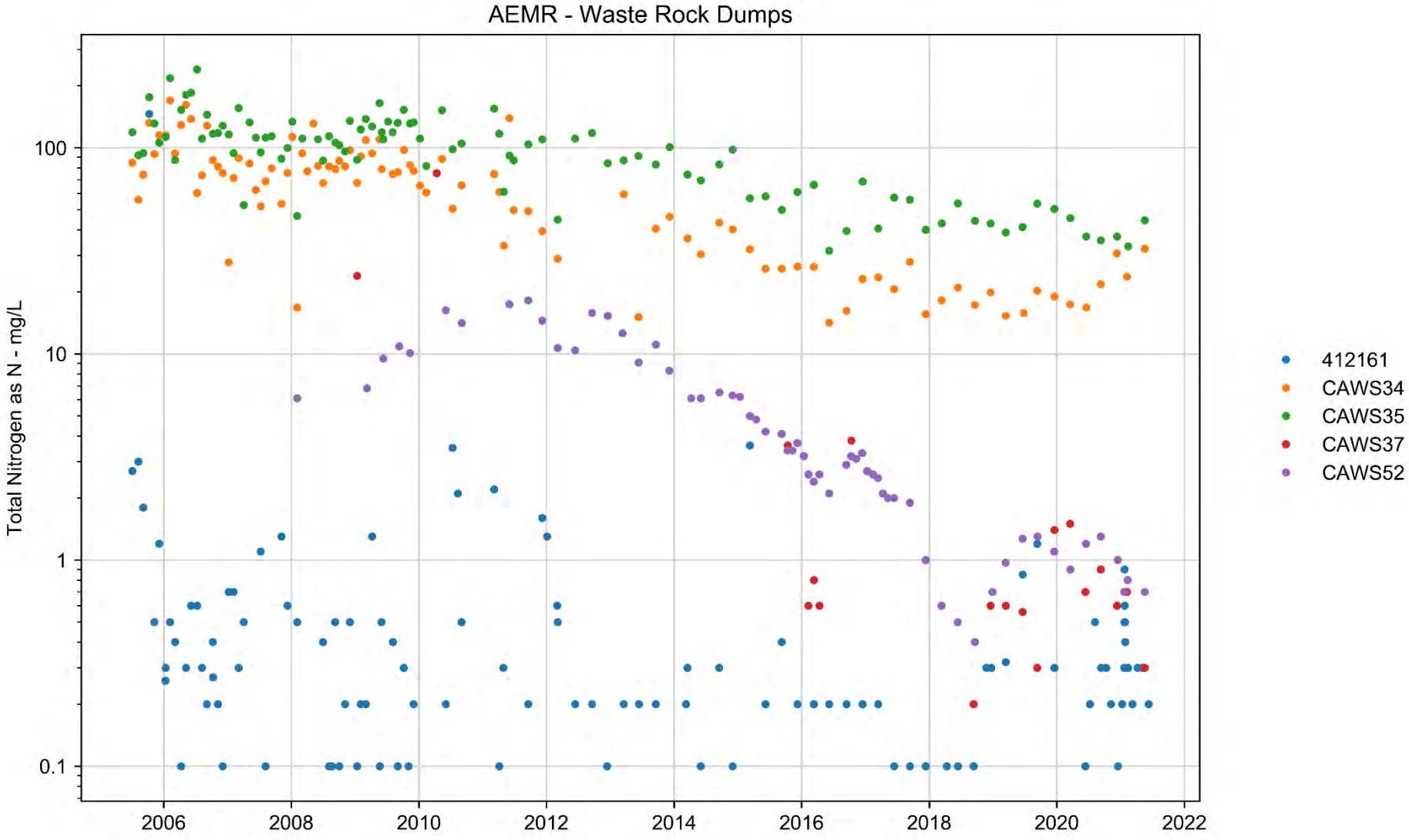



AEMR - Waste Rock Dumps
Total Dissolved Solids @180°C - mg/L
6000
5000
4000
3000
2000
1000
0
2006
2008
2010
2012
2014
2016
2018
2020
2022
412161
CAWS34
CAWS35
CAWS37
CAWS52
AEMR - Waste Rock Dumps
Total Hardness as CaCO3 - mg/L
3000
2500
2000
1500
1000
500
0
2015
2016
2017
2018
2019
2020
2021
412161
CAWS34
CAWS35
CAWS37
CAWS52

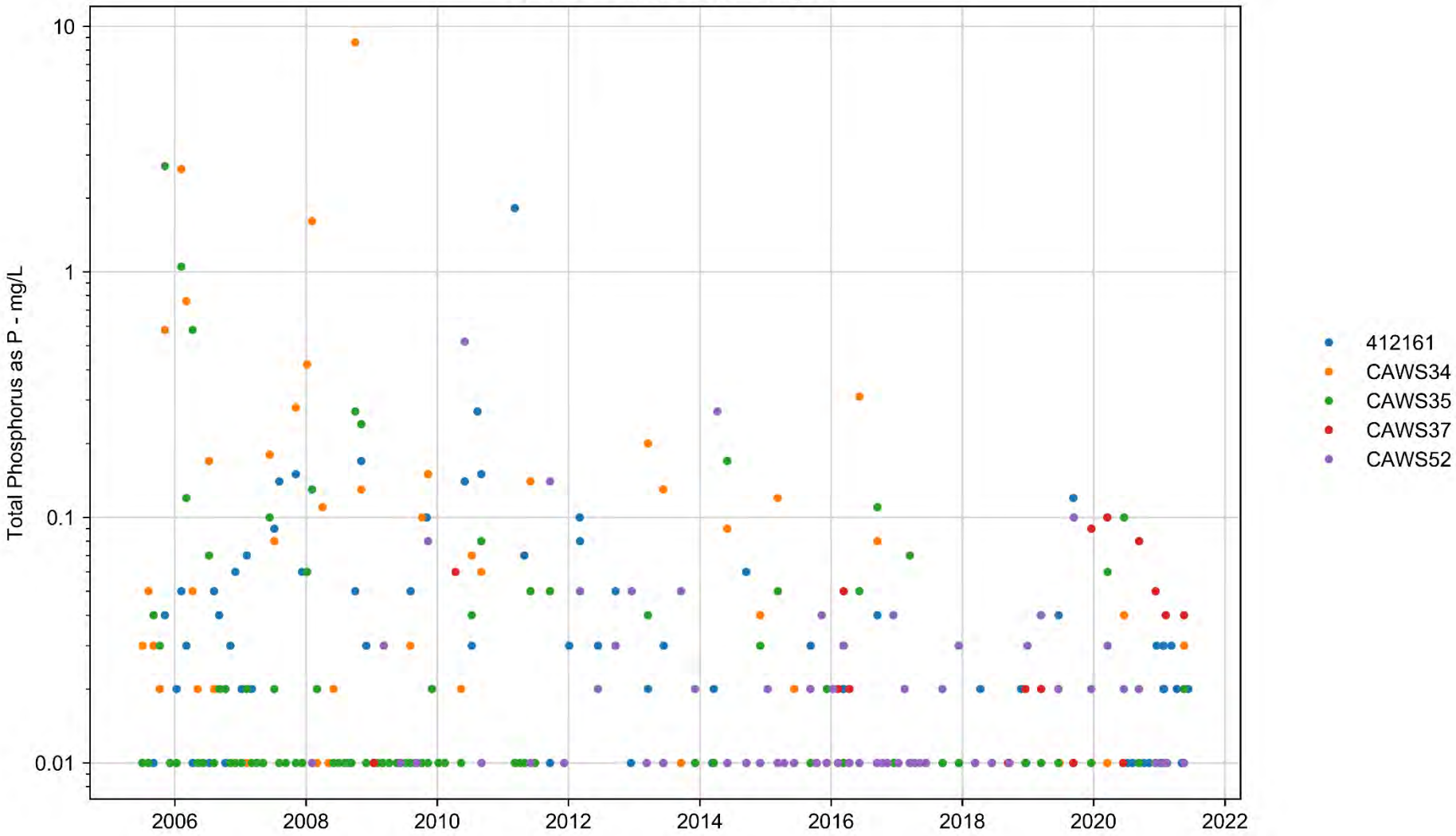
AEMR - Waste Rock Dumps



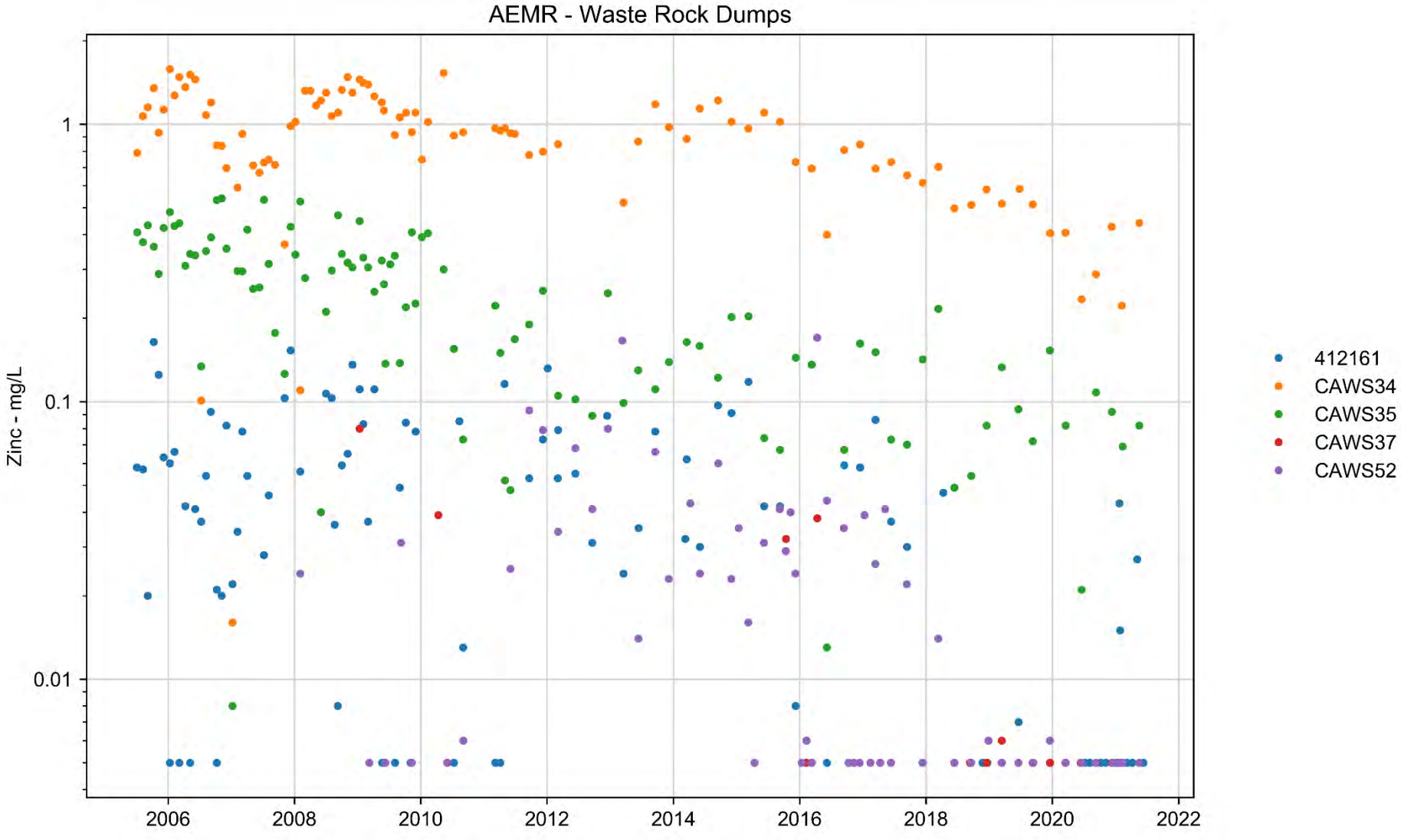
AEMR - Waste Rock Dumps

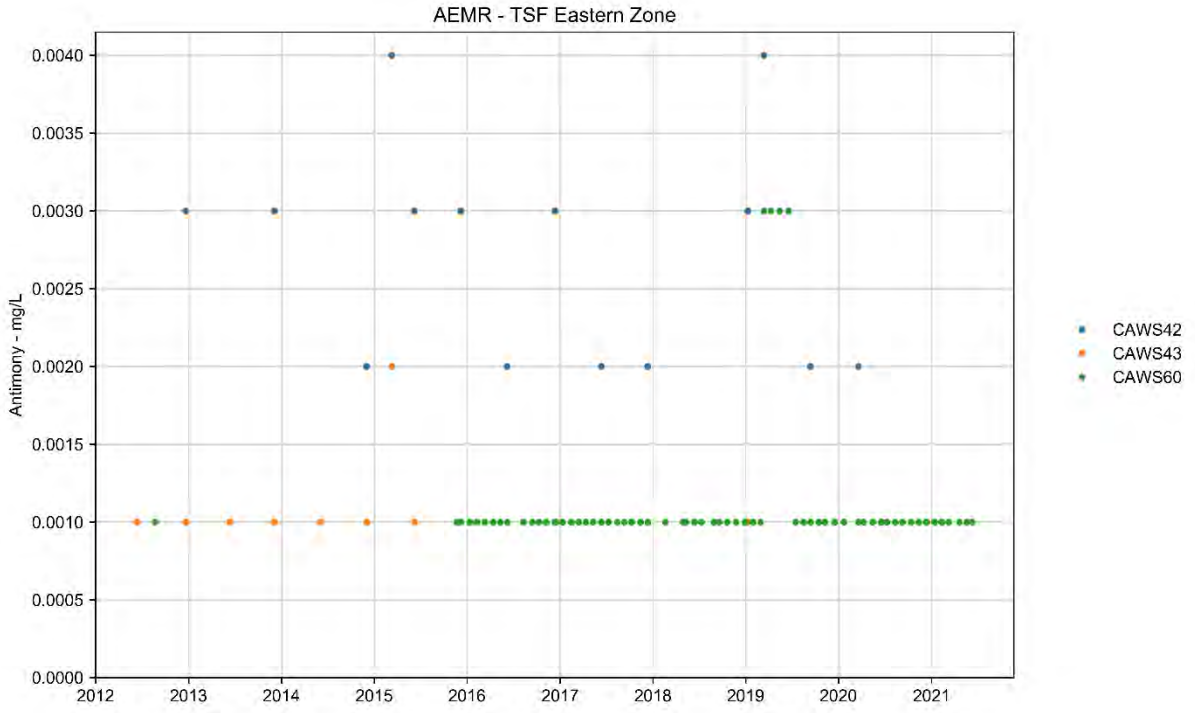


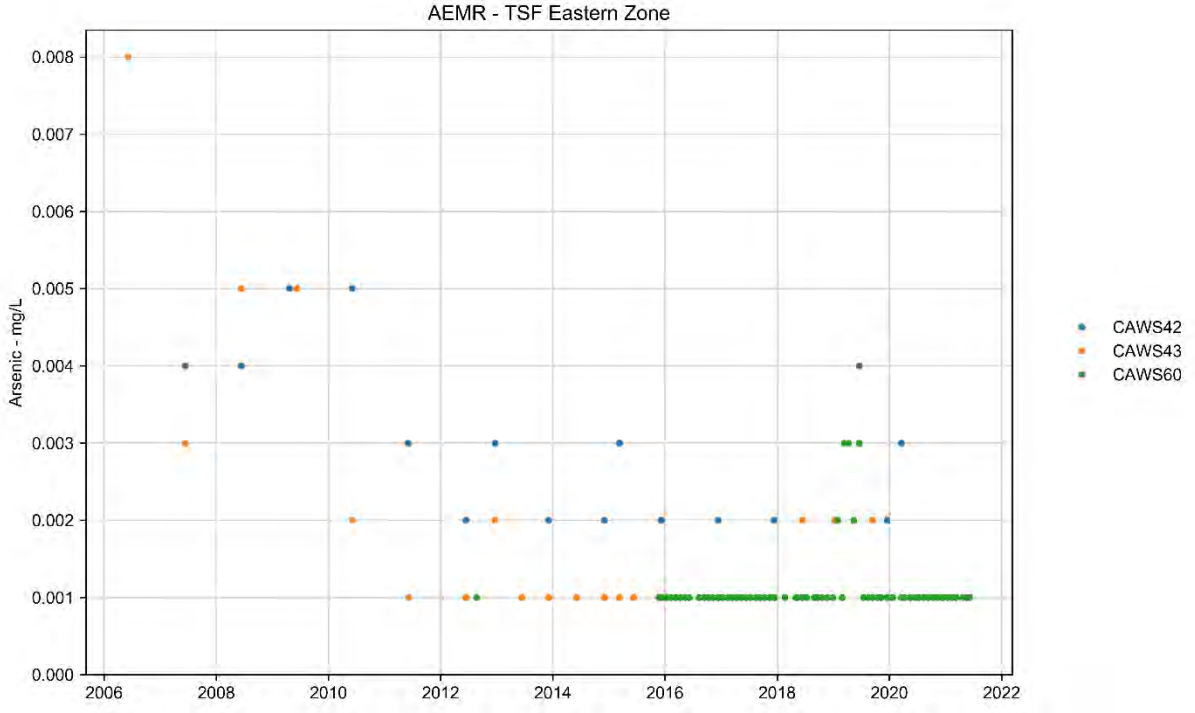
AEMR - Waste Rock Dumps

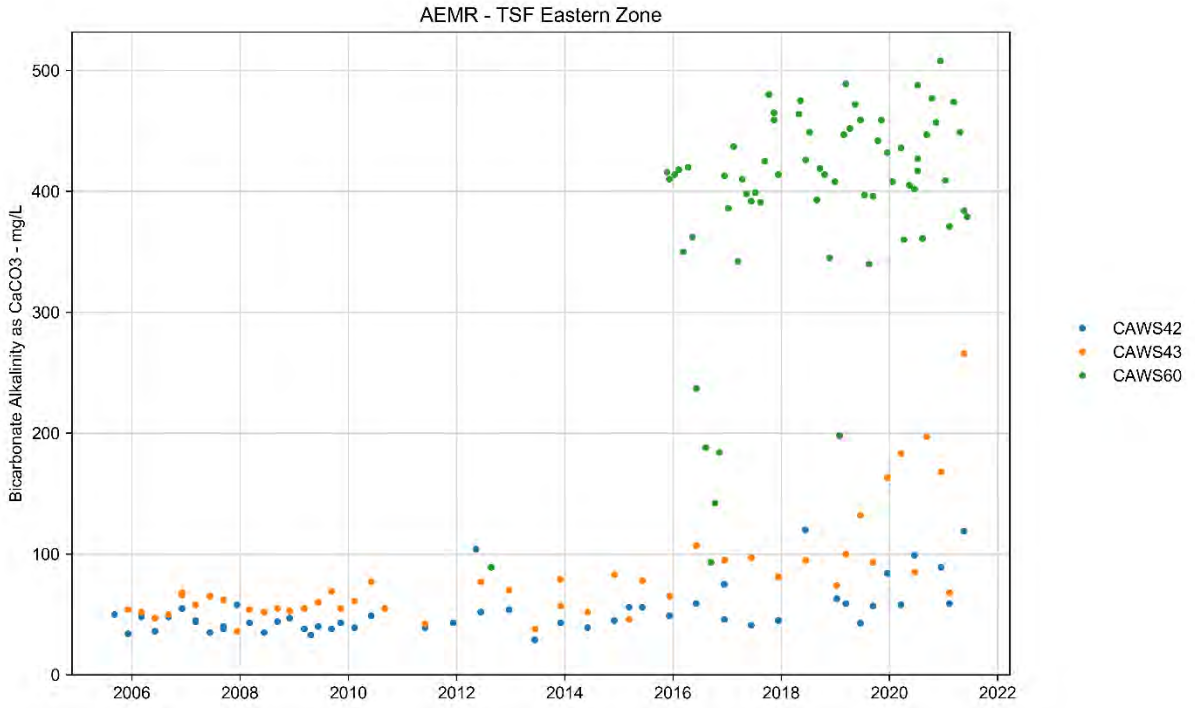


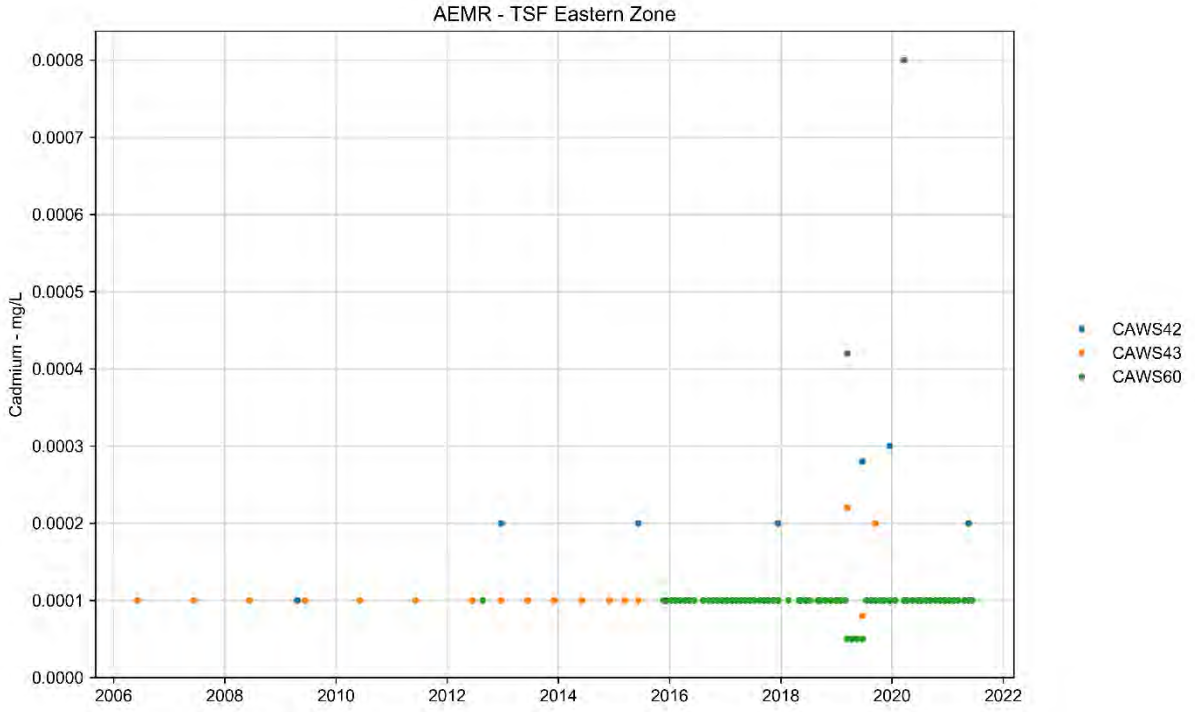
AEMR - Waste Rock Dumps

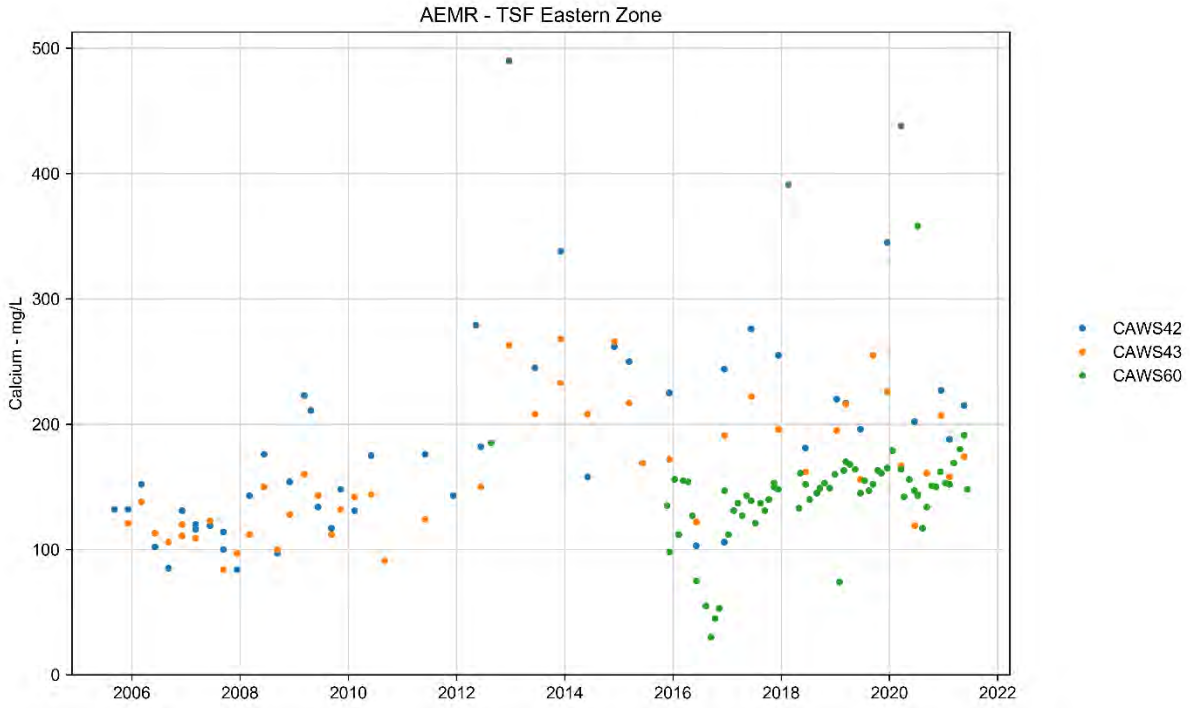


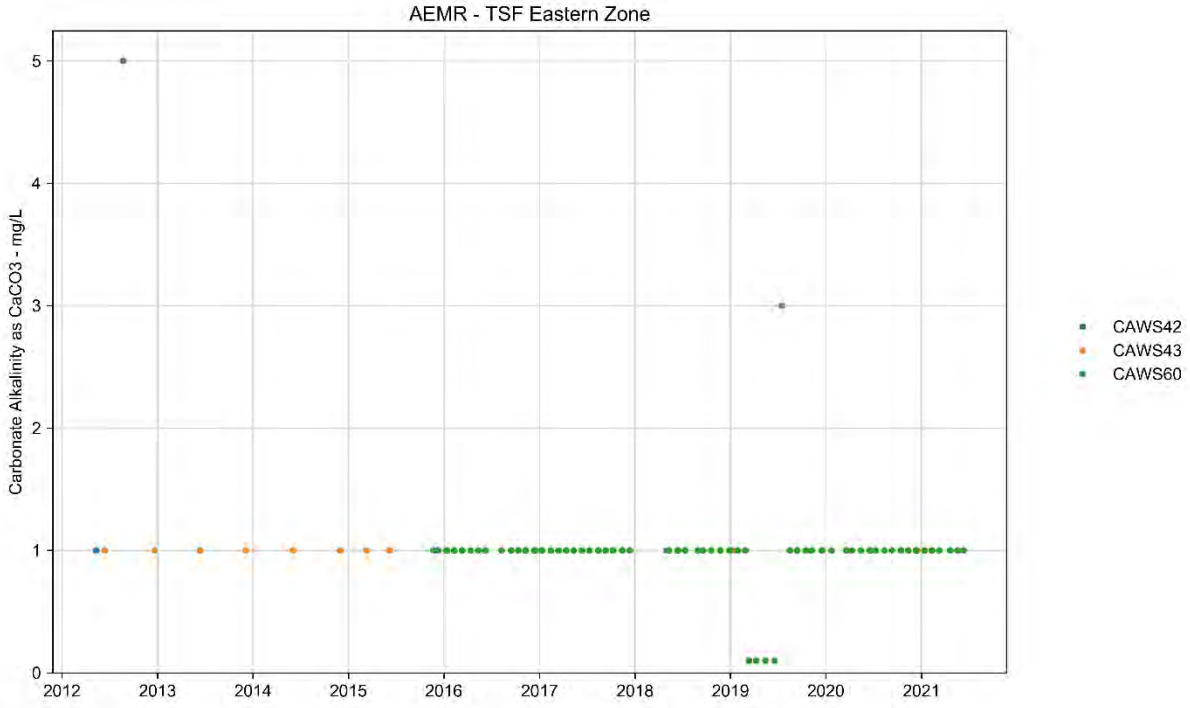

AEMR - TSF Eastern Zone
Antimony - mg/L
0.0040
0.0035
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
CAWS42
CAWS43
CAWS60

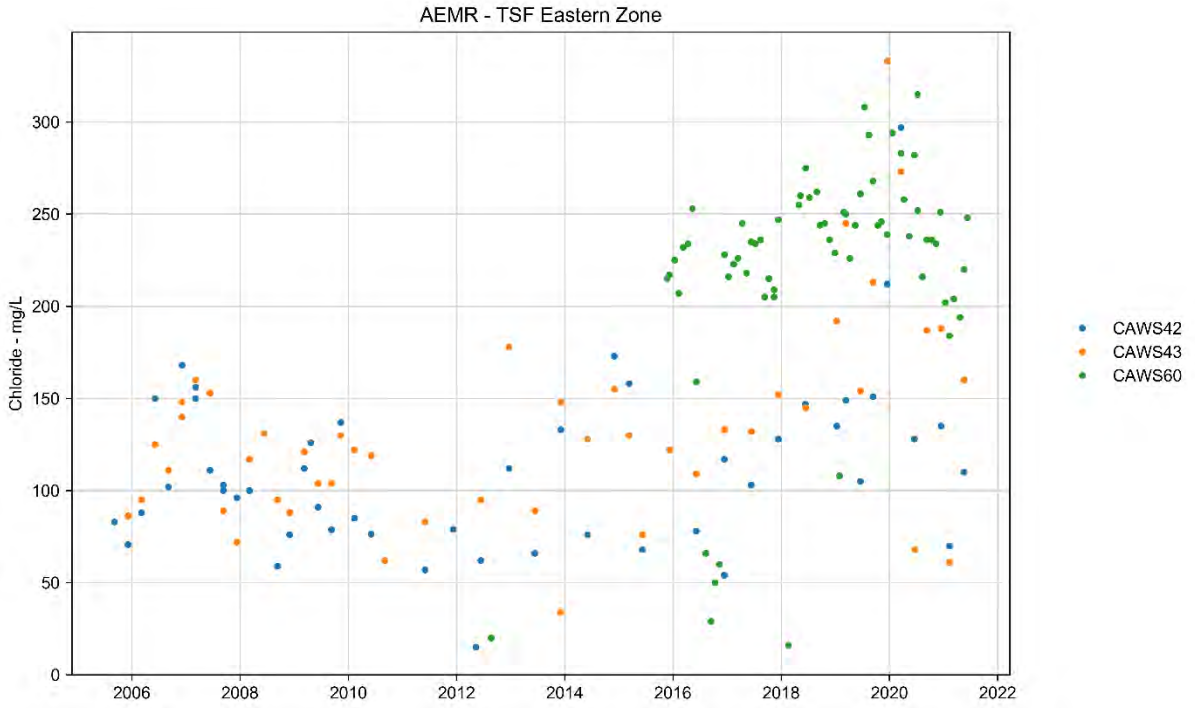

AEMR - TSF Eastern Zone
Arsenic - mg/L
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS42
CAWS43
CAWS60

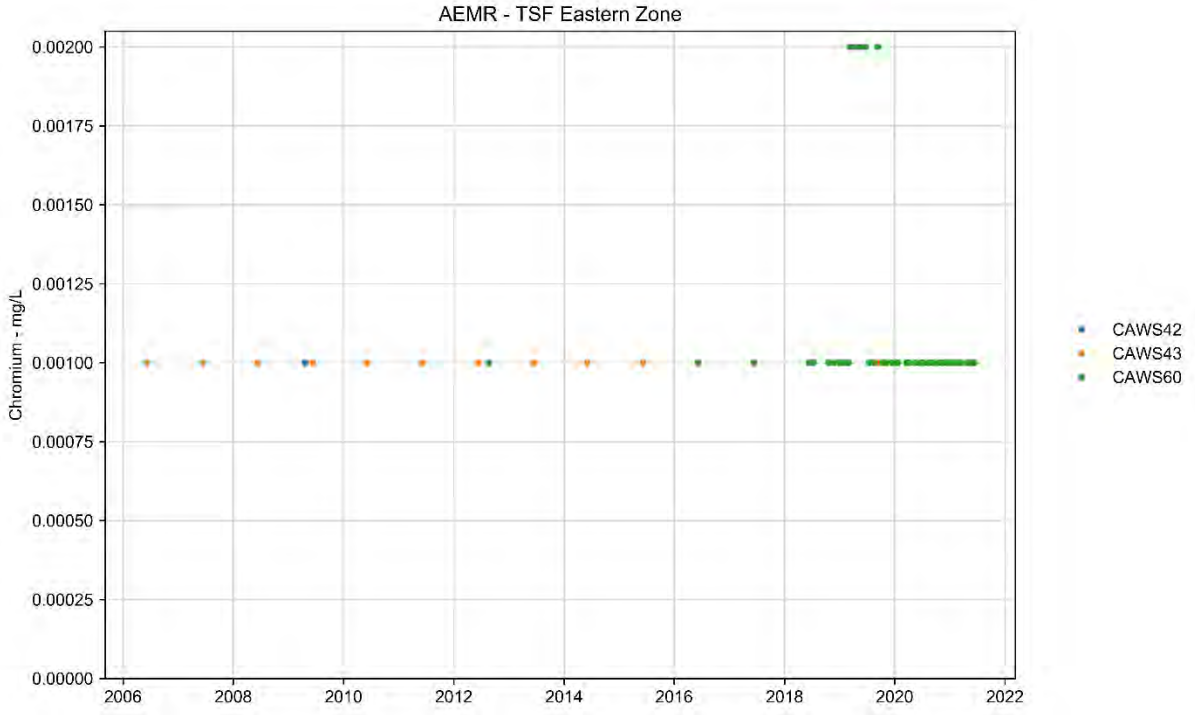

AEMR - TSF Eastern Zone
Bicarbonate Alkalinity as CaCO3 - mg/L
0
100
200
300
400
500
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS42
CAWS43
CAWS60

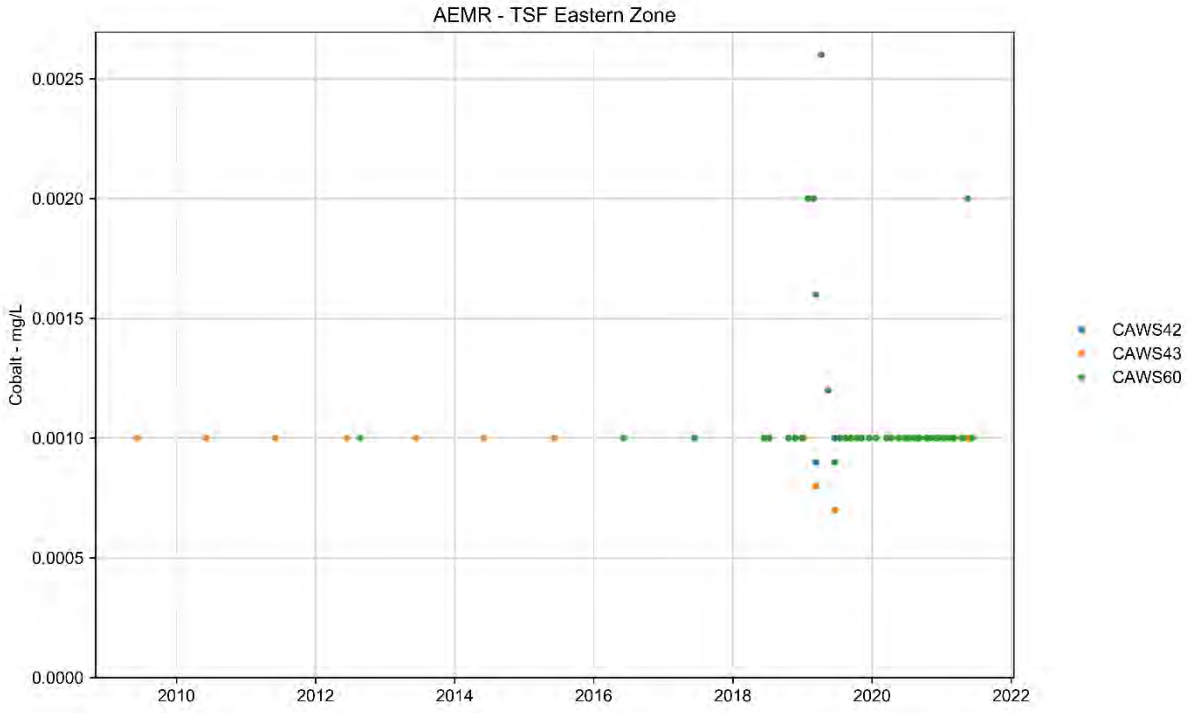

AEMR - TSF Eastern Zone
Cadmium - mg/L
0.0000
0.0001
0.0002
0.0003
0.0004
0.0005
0.0006
0.0007
0.0008
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS42
CAWS43
CAWS60

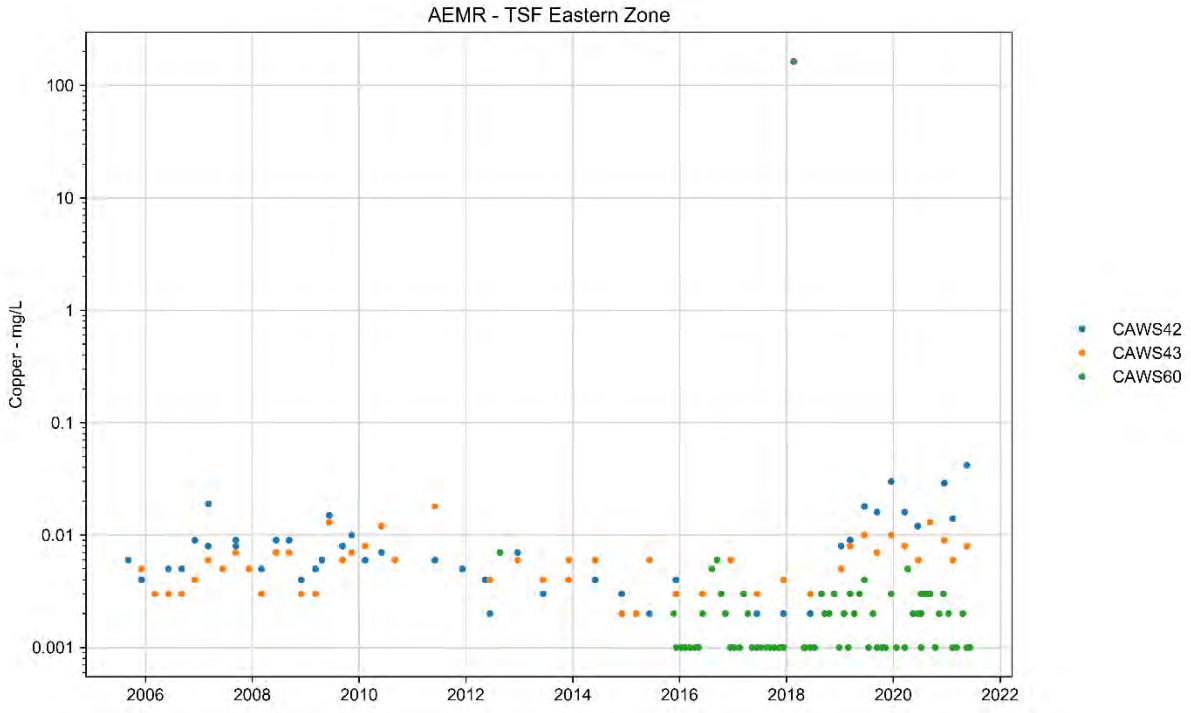

AEMR - TSF Eastern Zone
Calcium - mg/L
0
100
200
300
400
500
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS42
CAWS43
CAWS60

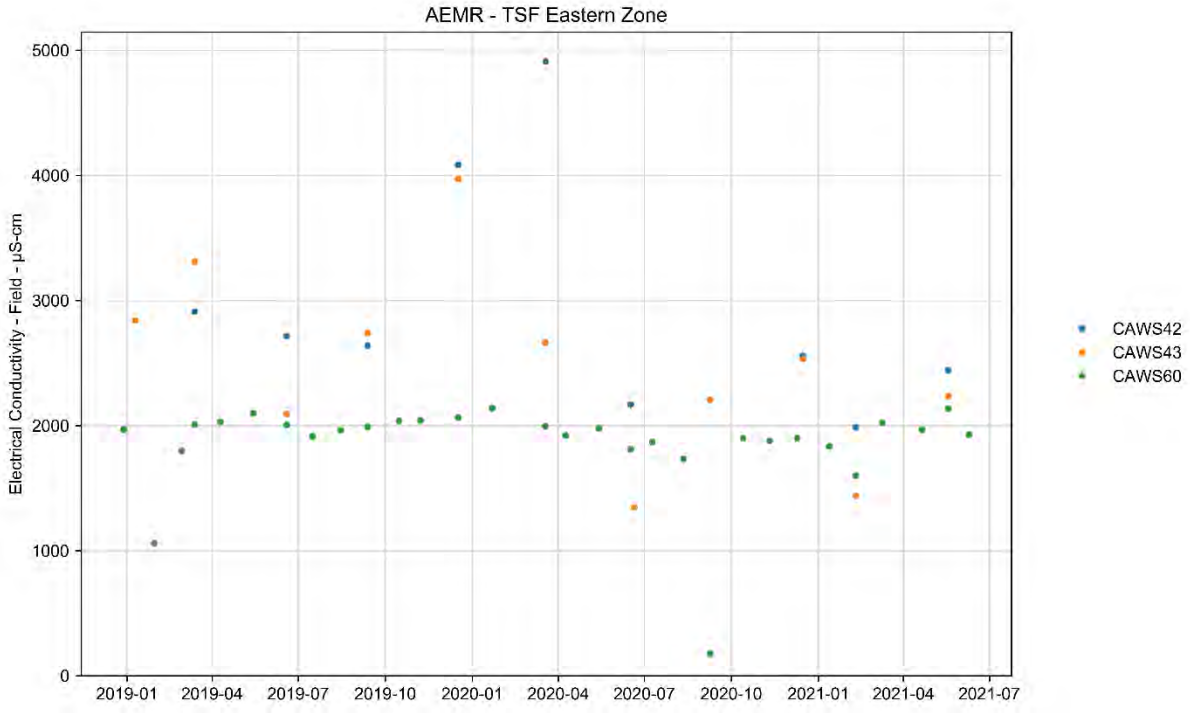

AEMR - TSF Eastern Zone
Carbonate Alkalinity as CaCO3 - mg/L
0
1
2
3
4
5
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
CAWS42
CAWS43
CAWS60

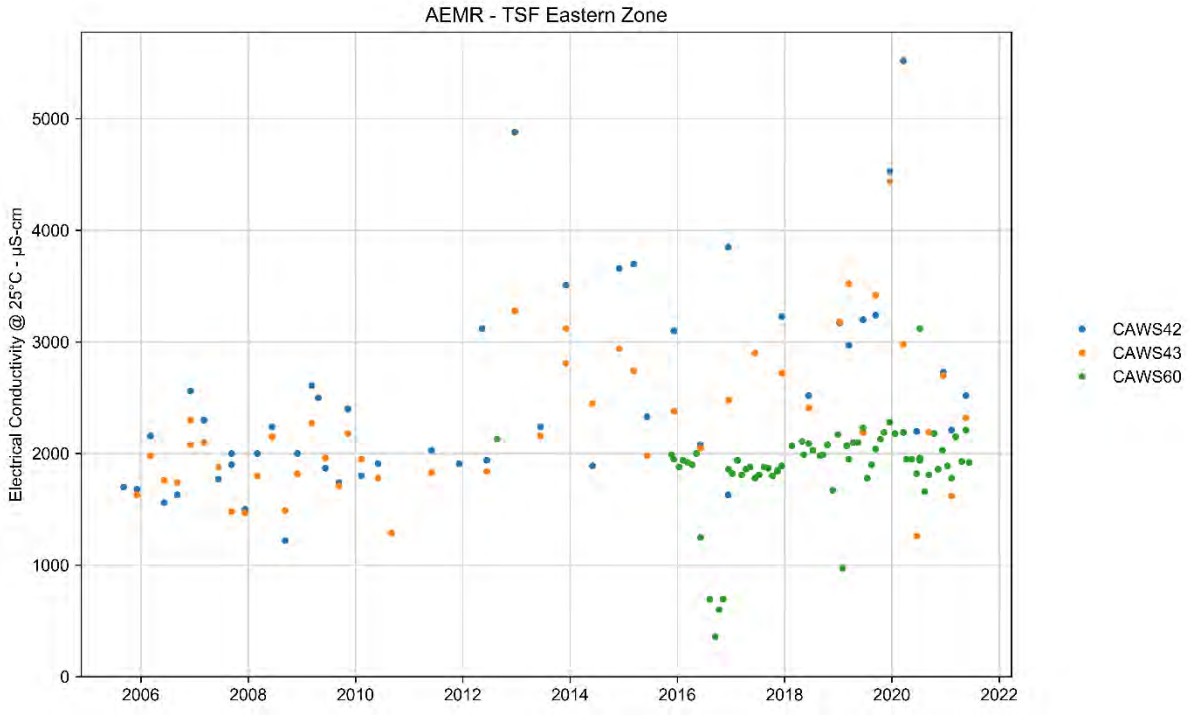

AEMR - TSF Eastern Zone
Chloride - mg/L
0
50
100
150
200
250
300
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS42
CAWS43
CAWS60

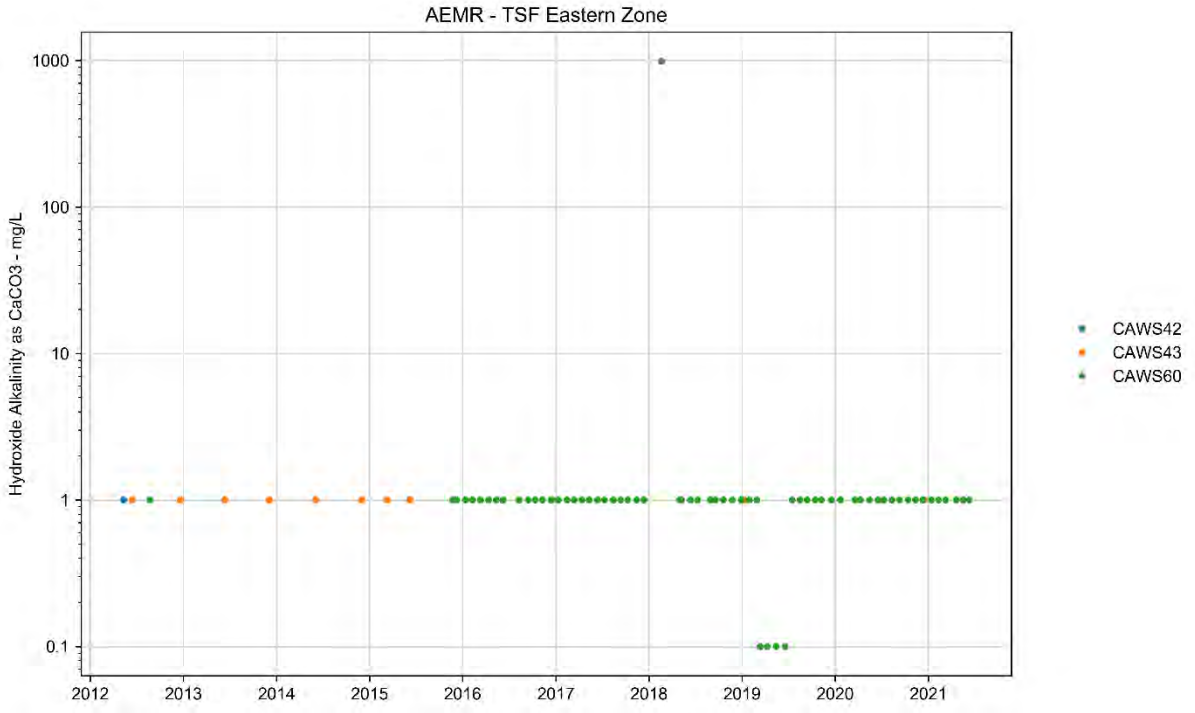

AEMR - TSF Eastern Zone
Chromium - mg/L
0.00000
0.00025
0.00050
0.00075
0.00100
0.00125
0.00150
0.00175
0.00200
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS42
CAWS43
CAWS60

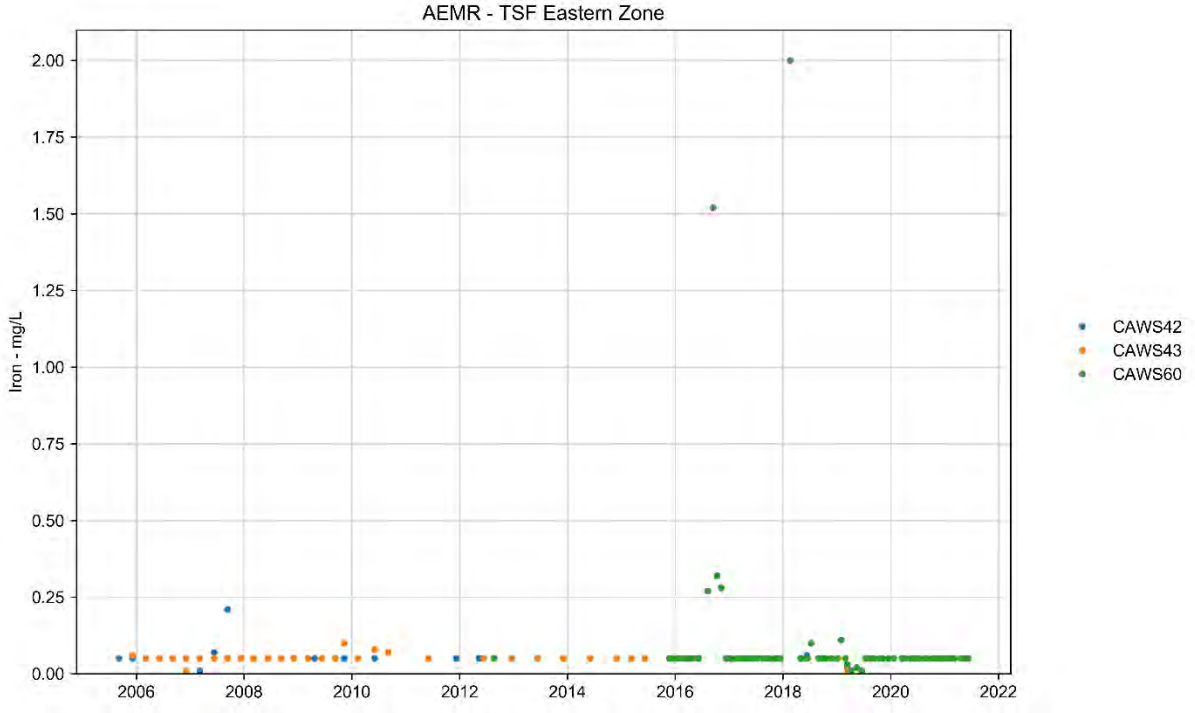

AEMR - TSF Eastern Zone
Cobalt - mg/L
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
2010
2012
2014
2016
2018
2020
2022
CAWS42
CAWS43
CAWS60

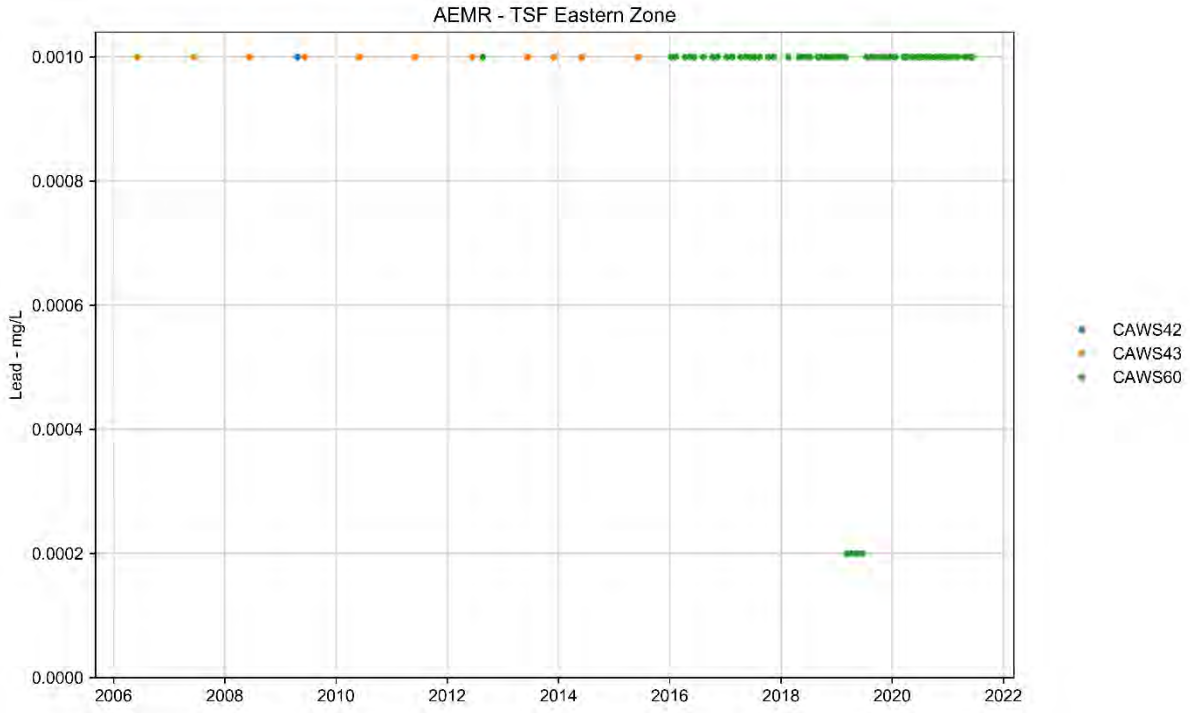

AEMR - TSF Eastern Zone
Copper - mg/L
100
10
1
0.1
0.01
0.001
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS42
CAWS43
CAWS60

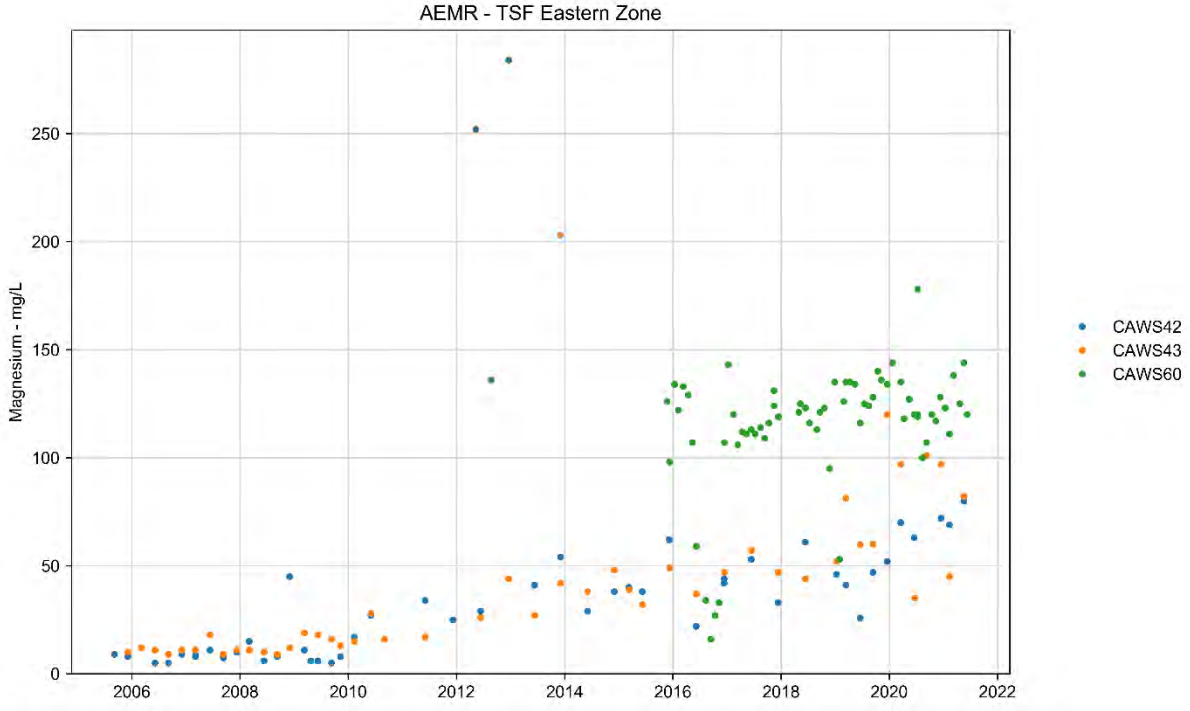

AEMR - TSF Eastern Zone
Electrical Conductivity - Field - µS-cm
5000
4000
3000
2000
1000
0
2019-01
2019-04
2019-07
2019-10
2020-01
2020-04
2020-07
2020-10
2021-01
2021-04
2021-07
CAWS42
CAWS43
CAWS60

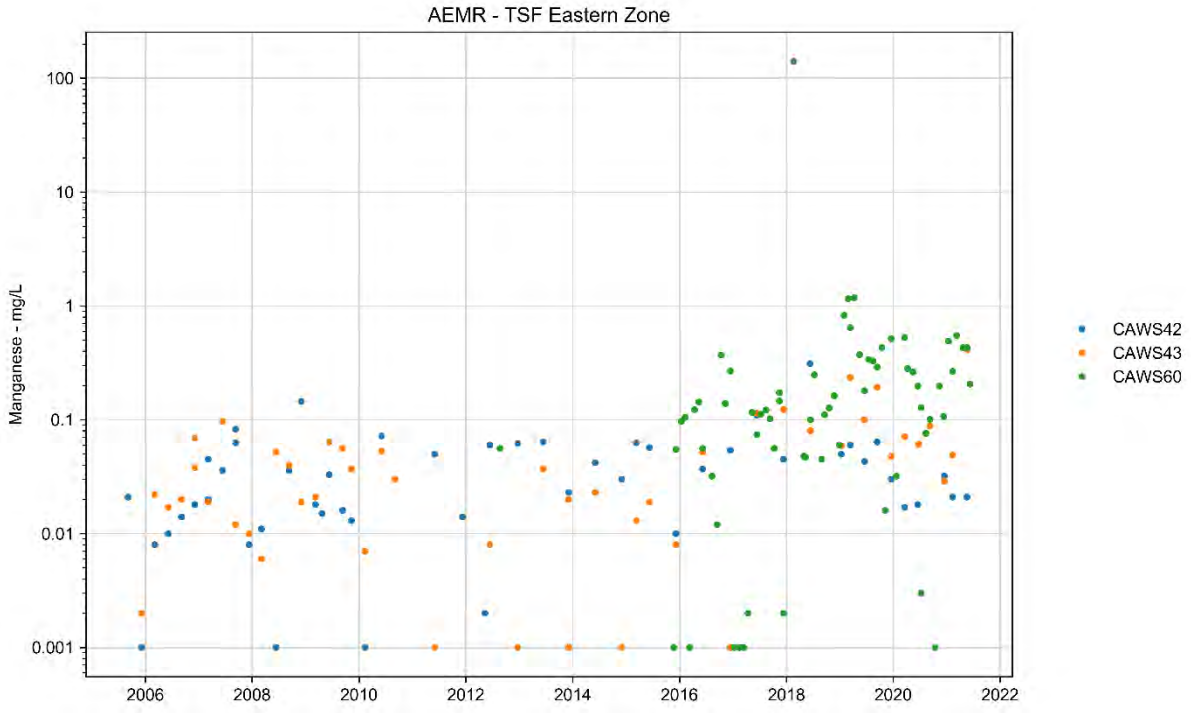

AEMR - TSF Eastern Zone
Electrical Conductivity @ 25°C - µS-cm
5000
4000
3000
2000
1000
0
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS42
CAWS43
CAWS60

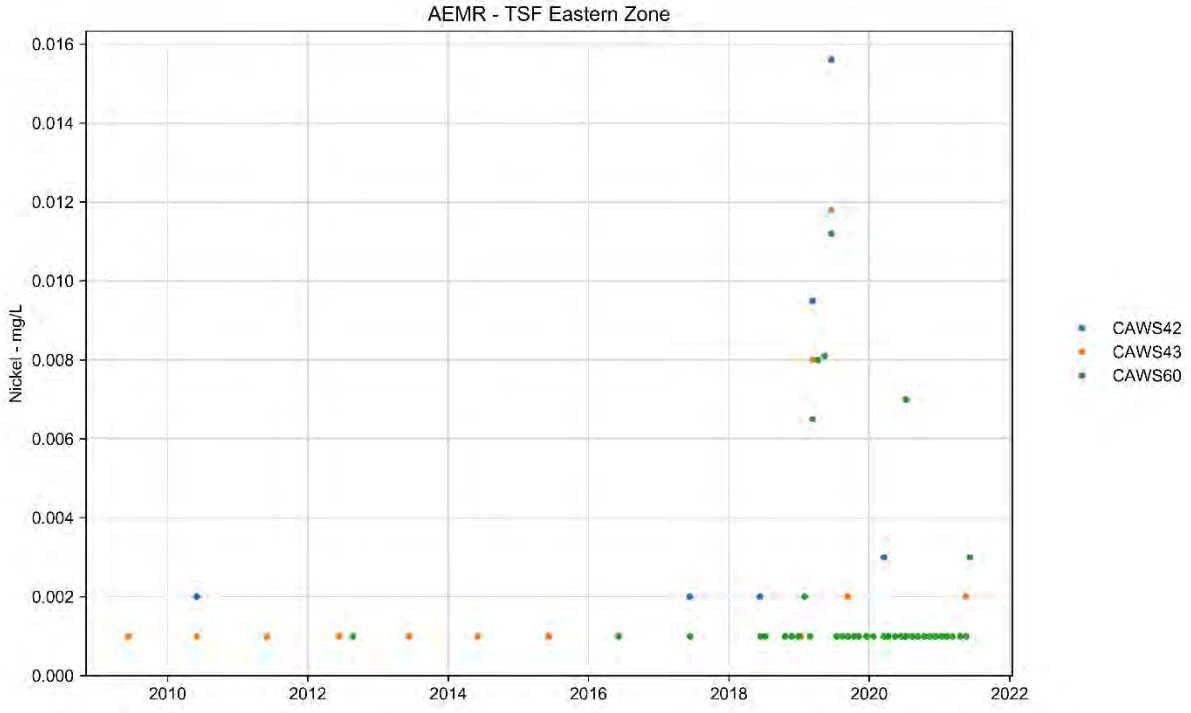

AEMR - TSF Eastern Zone
Hydroxide Alkalinity as CaCO3 - mg/L
1000
100
10
1
0.1
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
CAWS42
CAWS43
CAWS60

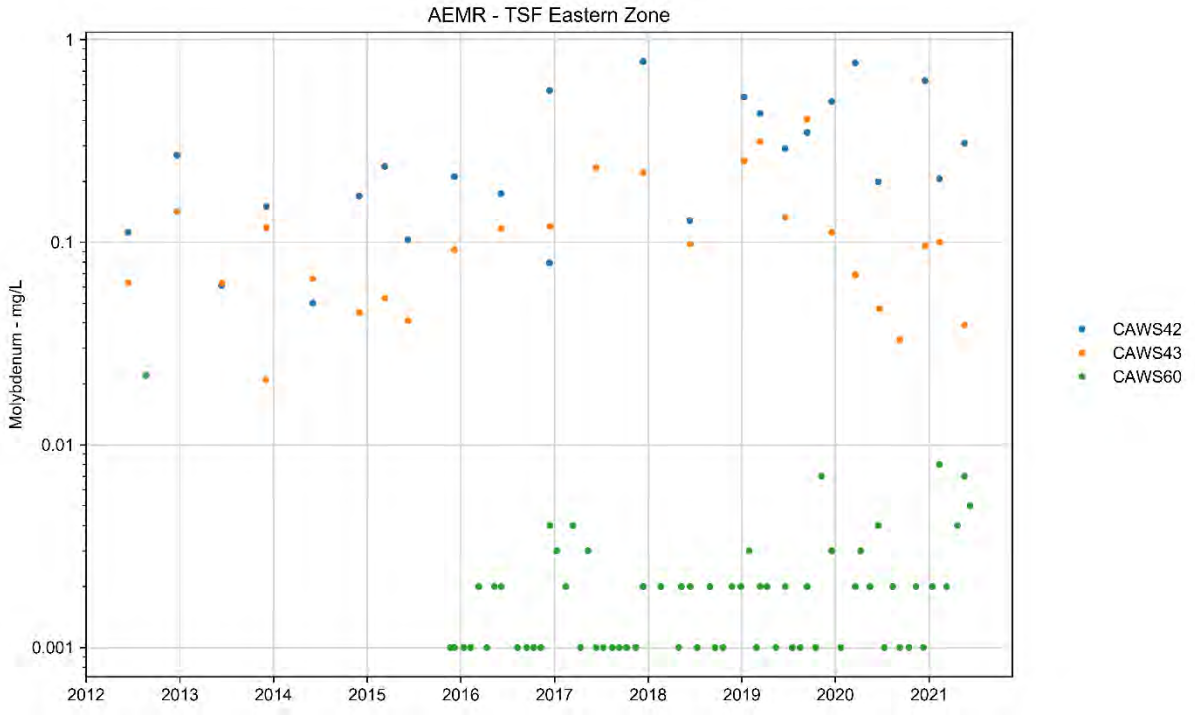

AEMR - TSF Eastern Zone
Iron - mg/L
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS42
CAWS43
CAWS60

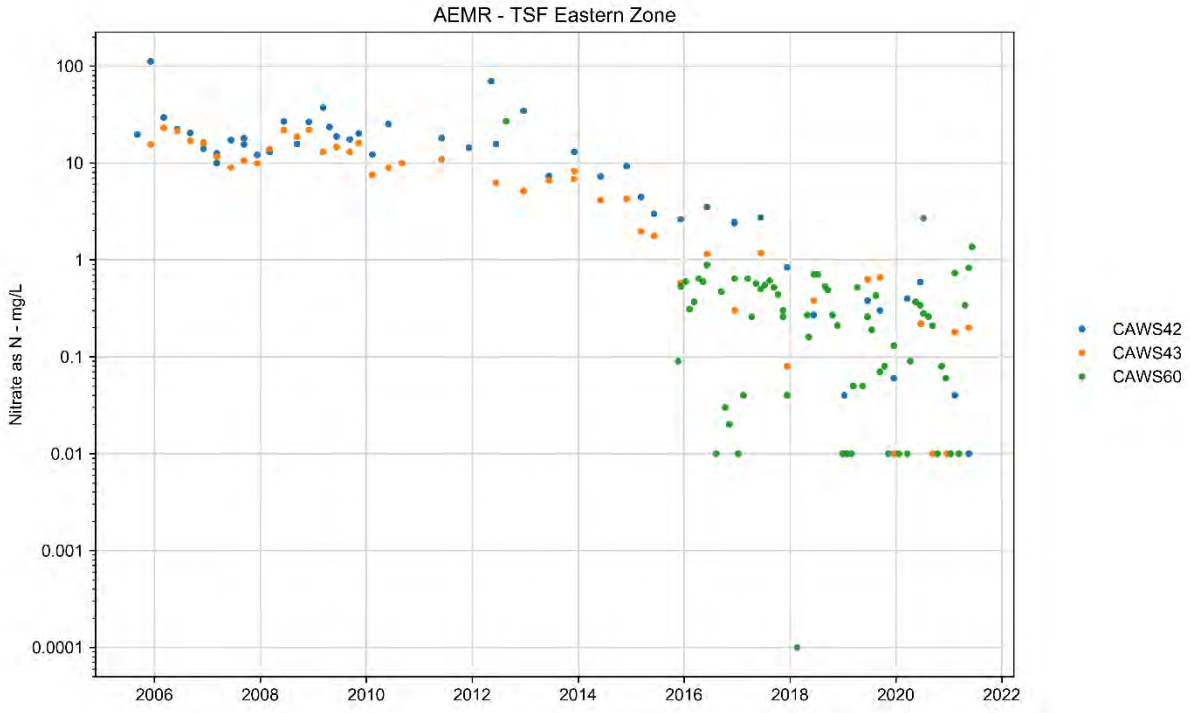

AEMR - TSF Eastern Zone
Lead - mg/L
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS42
CAWS43
CAWS60

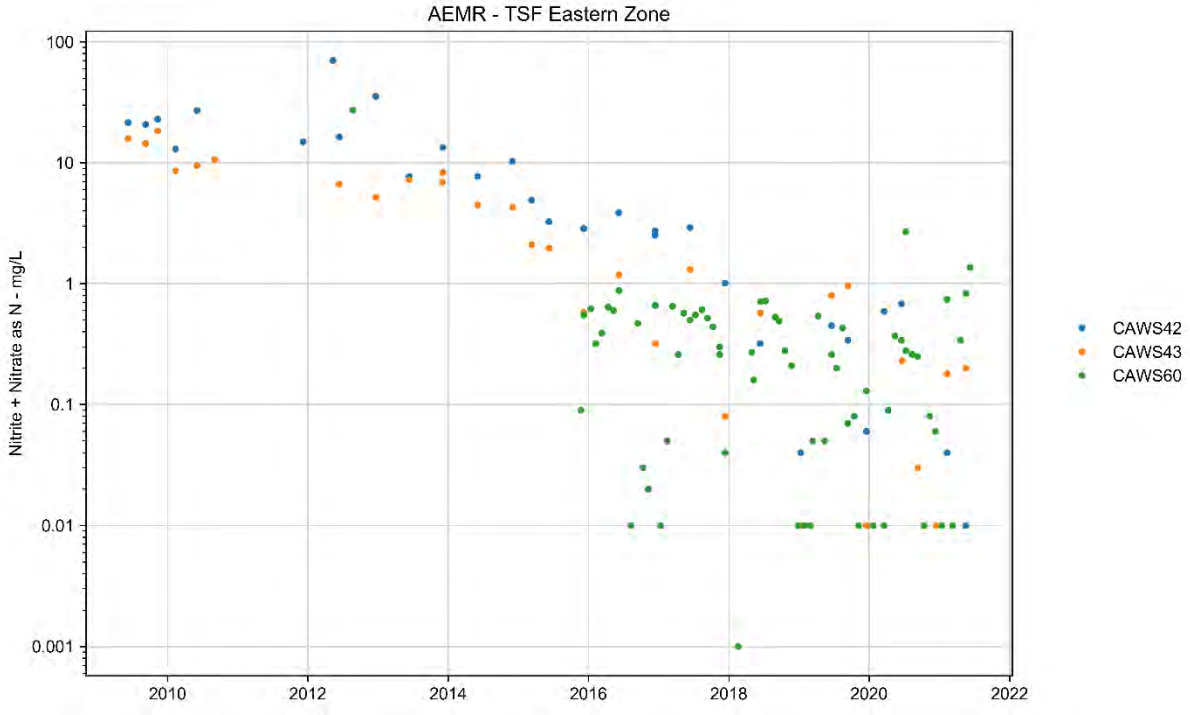

AEMR - TSF Eastern Zone
Magnesium - mg/L
250
200
150
100
50
0
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS42
CAWS43
CAWS60

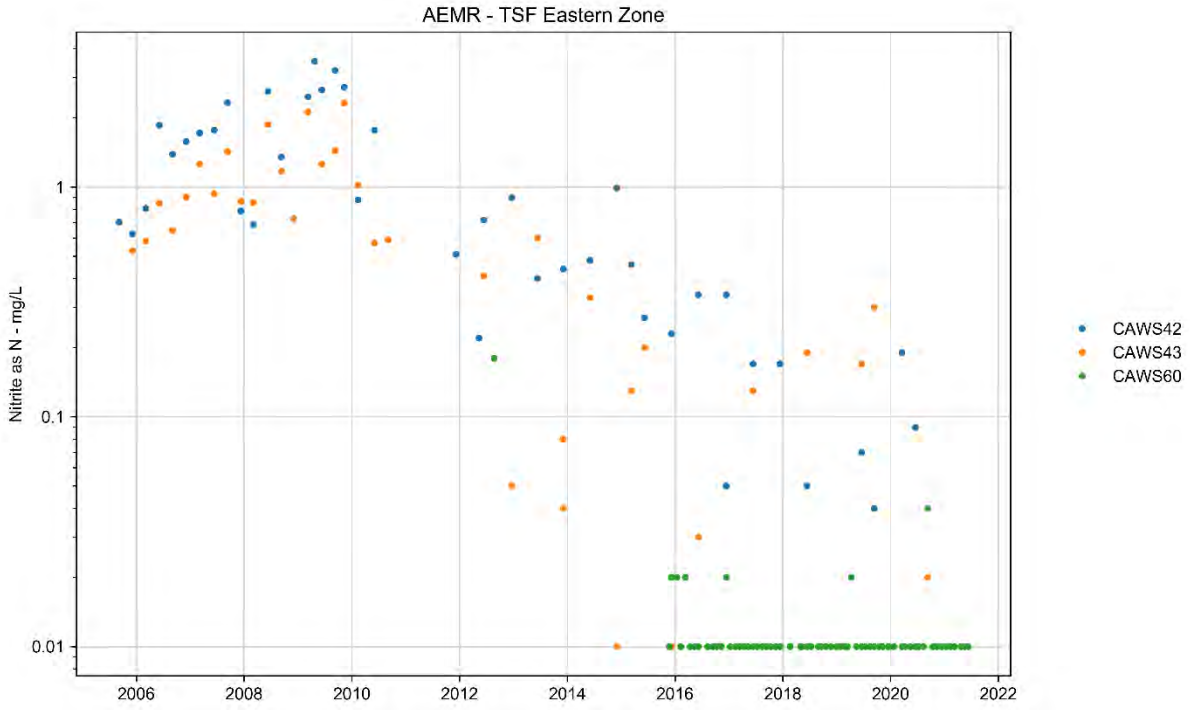

AEMR - TSF Eastern Zone
Manganese - mg/L
100
10
1
0.1
0.01
0.001
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS42
CAWS43
CAWS60

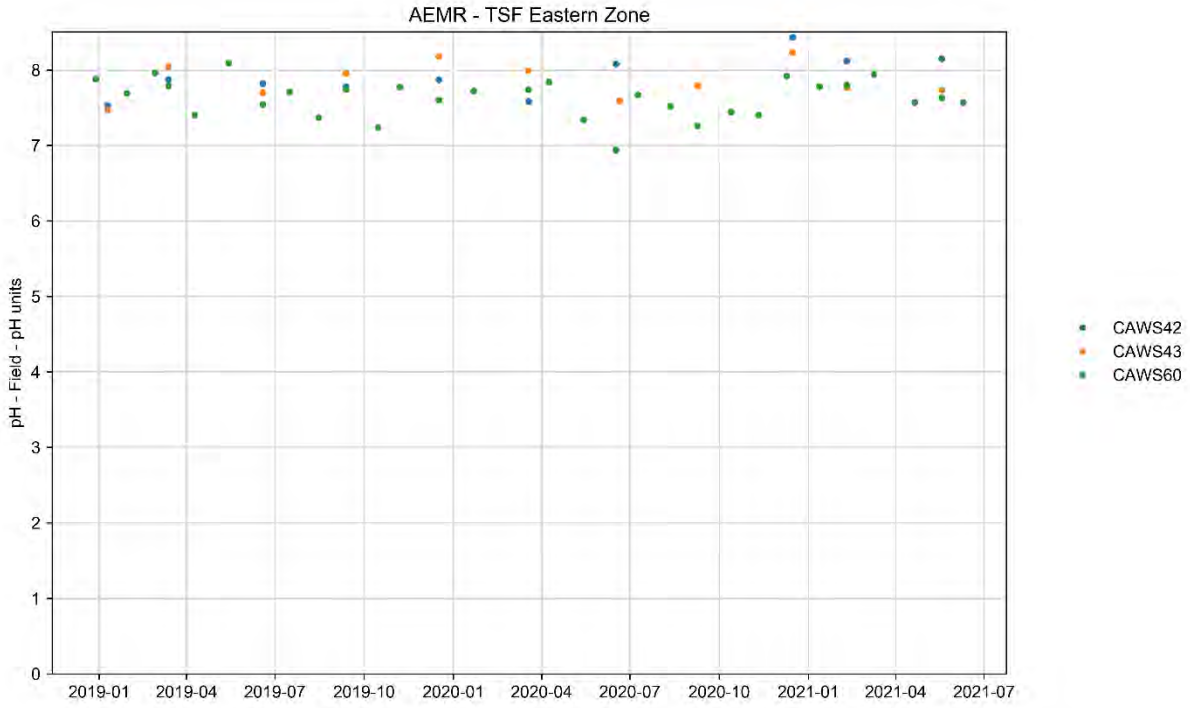

AEMR - TSF Eastern Zone
Nickel - mg/L
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
2010
2012
2014
2016
2018
2020
2022
CAWS42
CAWS43
CAWS60

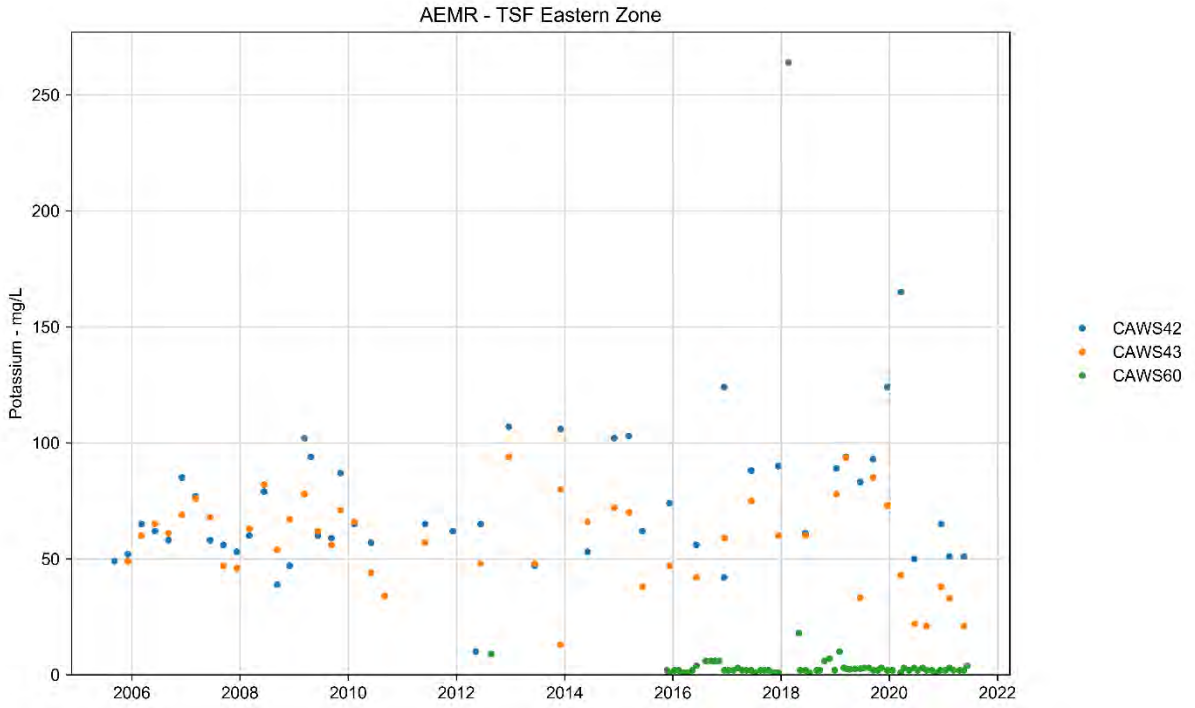

AEMR - TSF Eastern Zone
Molybdenum - mg/L
1
0.1
0.01
0.001
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
CAWS42
CAWS43
CAWS60

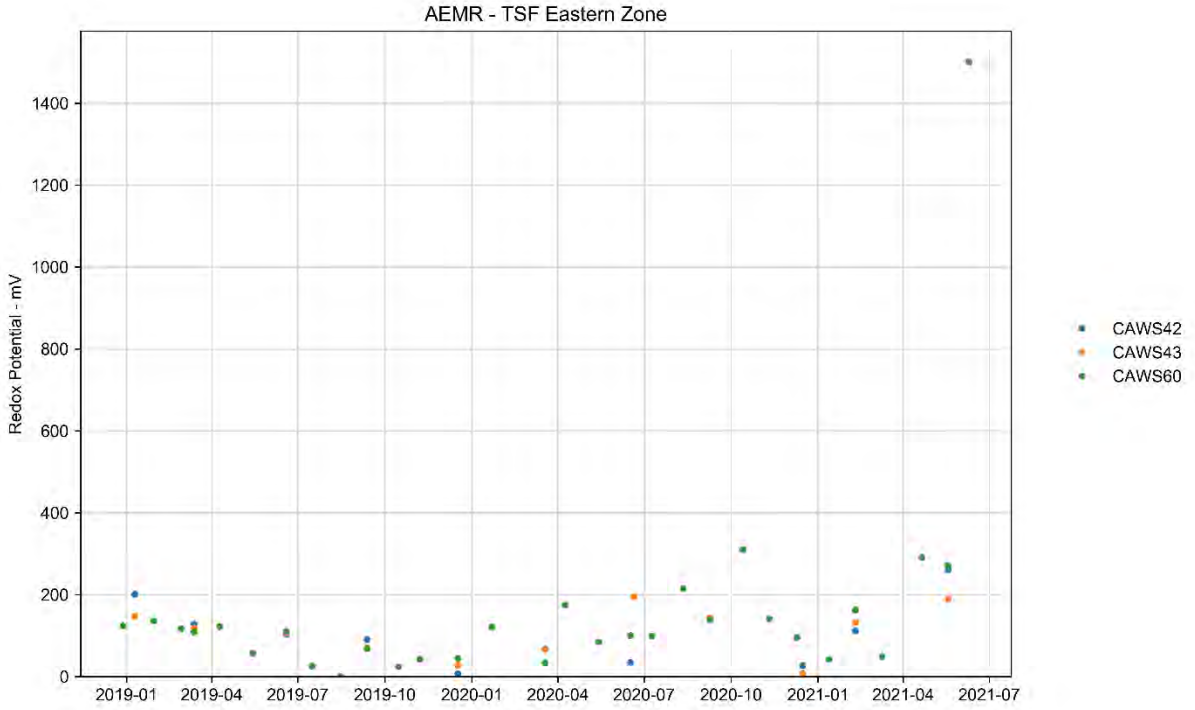

AEMR - TSF Eastern Zone
Nitrate as N - mg/L
100
10
1
0.1
0.01
0.001
0.0001
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS42
CAWS43
CAWS60

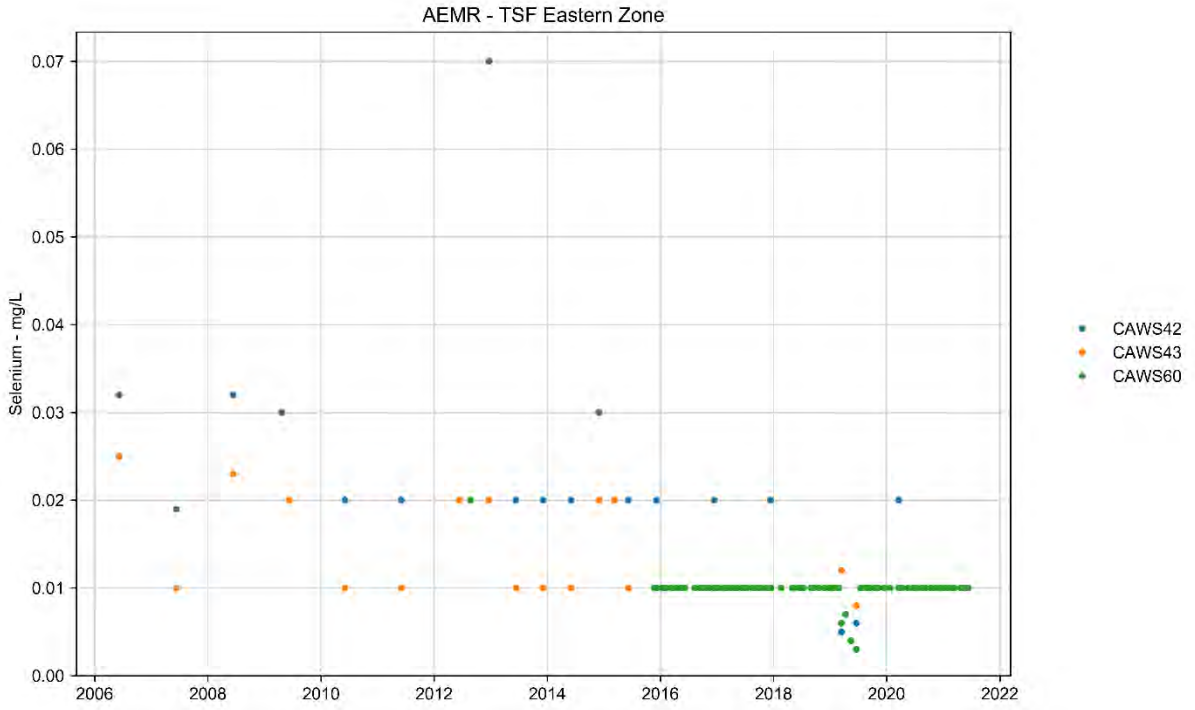

AEMR - TSF Eastern Zone
Nitrite + Nitrate as N - mg/L
100
10
1
0.1
0.01
0.001
2010
2012
2014
2016
2018
2020
2022
CAWS42
CAWS43
CAWS60

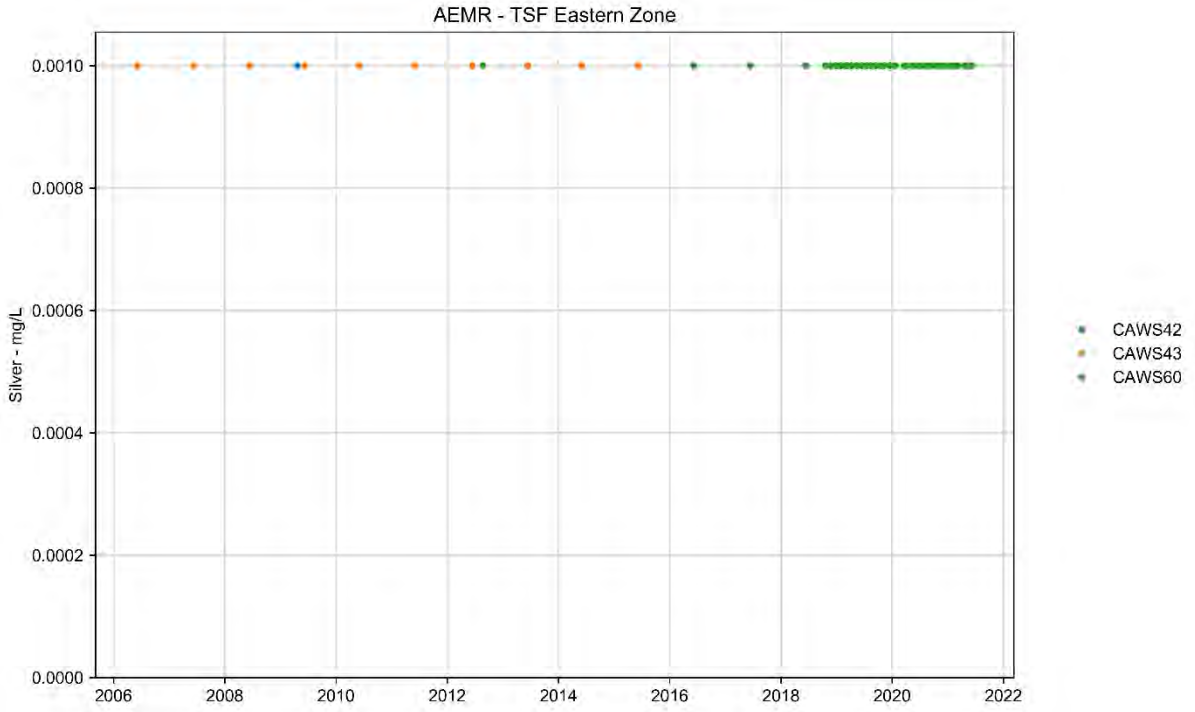

AEMR - TSF Eastern Zone
Nitrite as N - mg/L
1
0.1
0.01
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS42
CAWS43
CAWS60

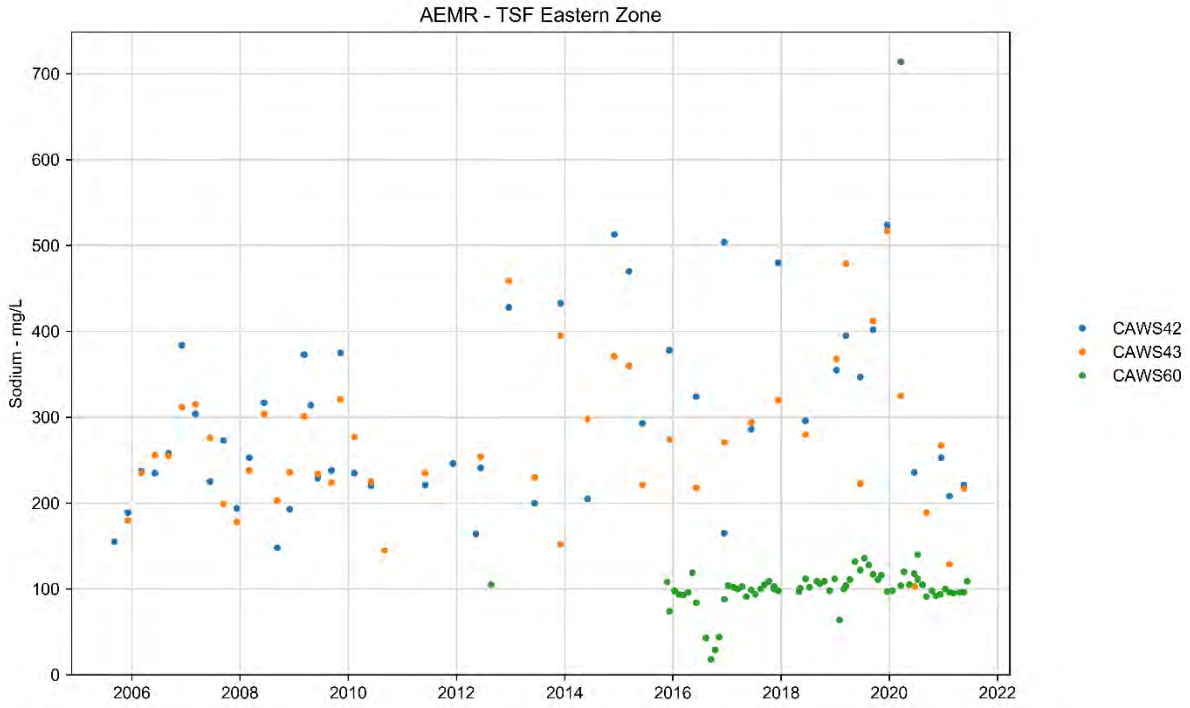

AEMR - TSF Eastern Zone
pH - Field - pH units
0
1
2
3
4
5
6
7
8
2019-01
2019-04
2019-07
2019-10
2020-01
2020-04
2020-07
2020-10
2021-01
2021-04
2021-07
CAWS42
CAWS43
CAWS60

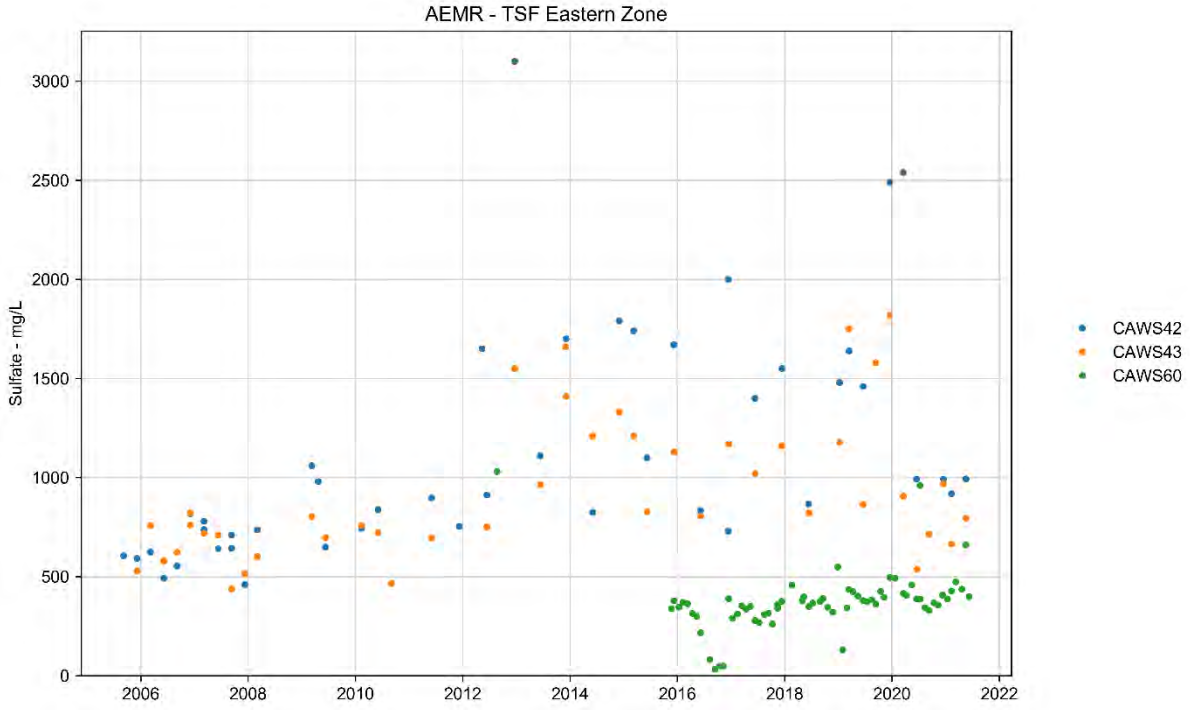

AEMR - TSF Eastern Zone
Potassium - mg/L
0
50
100
150
200
250
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS42
CAWS43
CAWS60

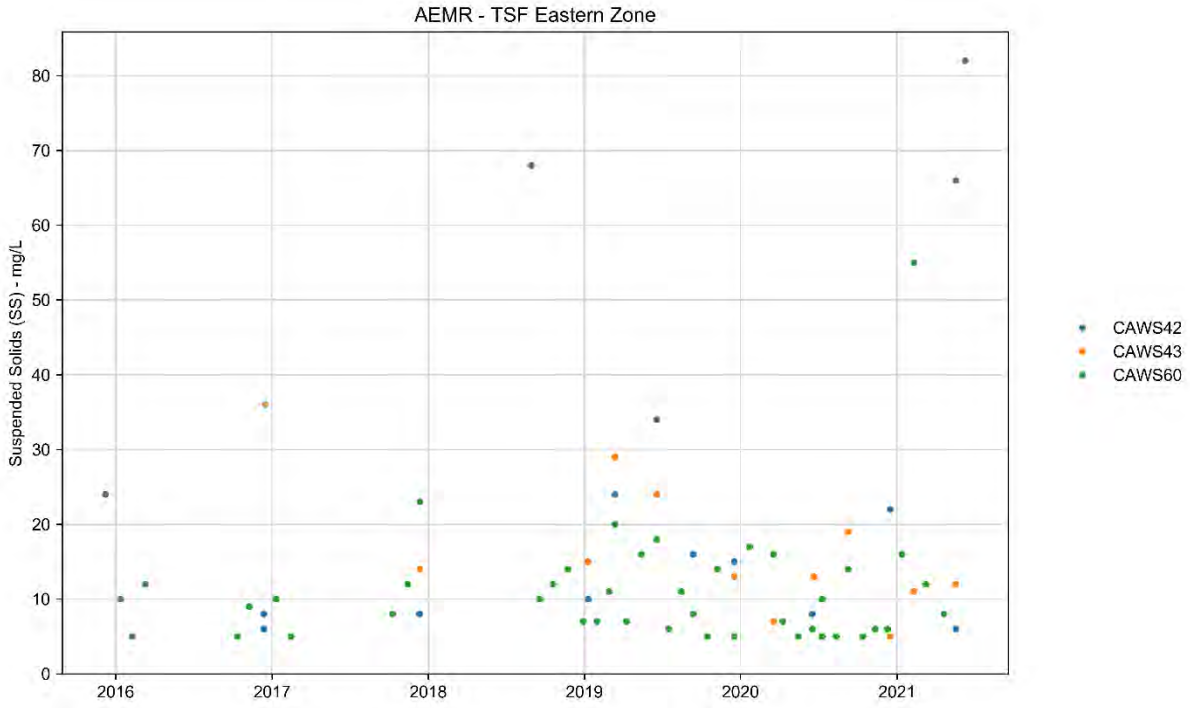

AEMR - TSF Eastern Zone
Redox Potential - mV
0
200
400
600
800
1000
1200
1400
2019-01
2019-04
2019-07
2019-10
2020-01
2020-04
2020-07
2020-10
2021-01
2021-04
2021-07
CAWS42
CAWS43
CAWS60

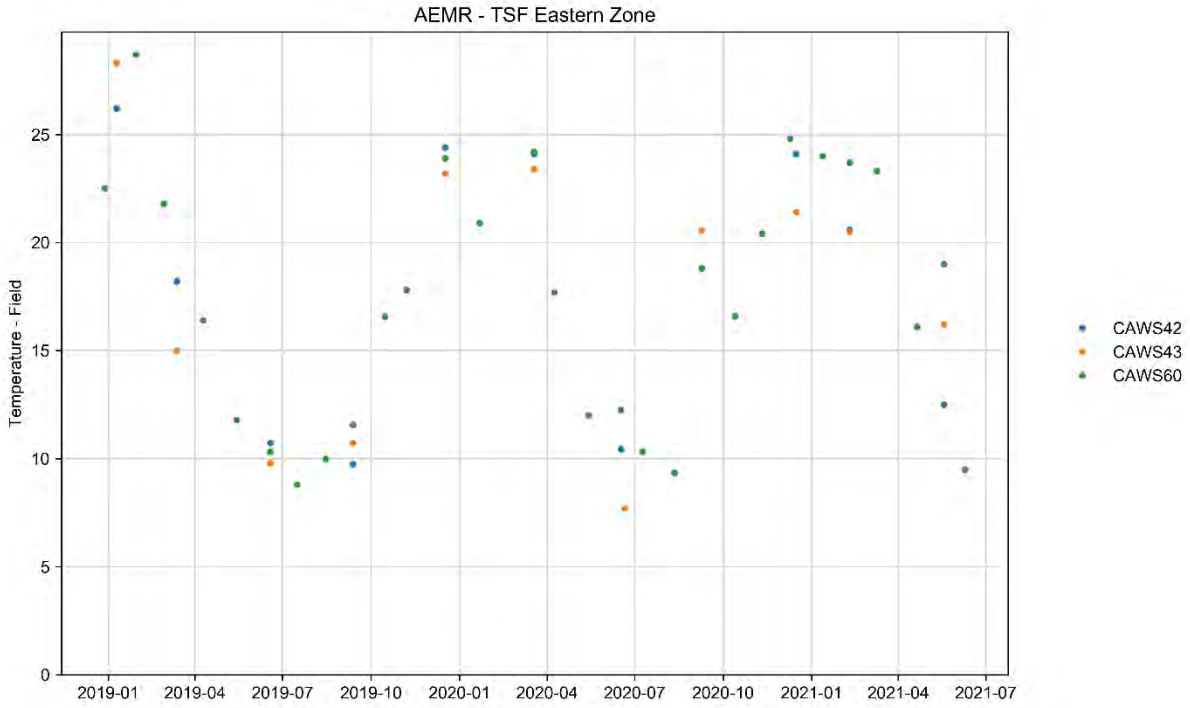

AEMR - TSF Eastern Zone
Selenium - mg/L
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS42
CAWS43
CAWS60

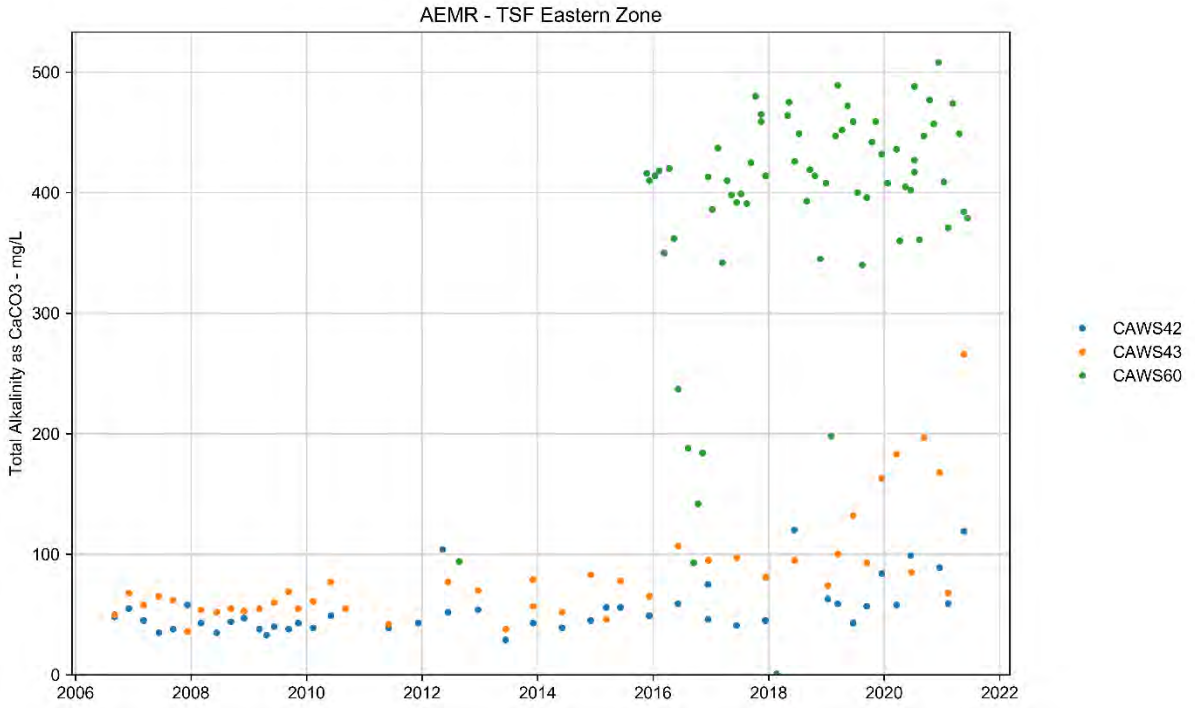

AEMR - TSF Eastern Zone
Silver - mg/L
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS42
CAWS43
CAWS60

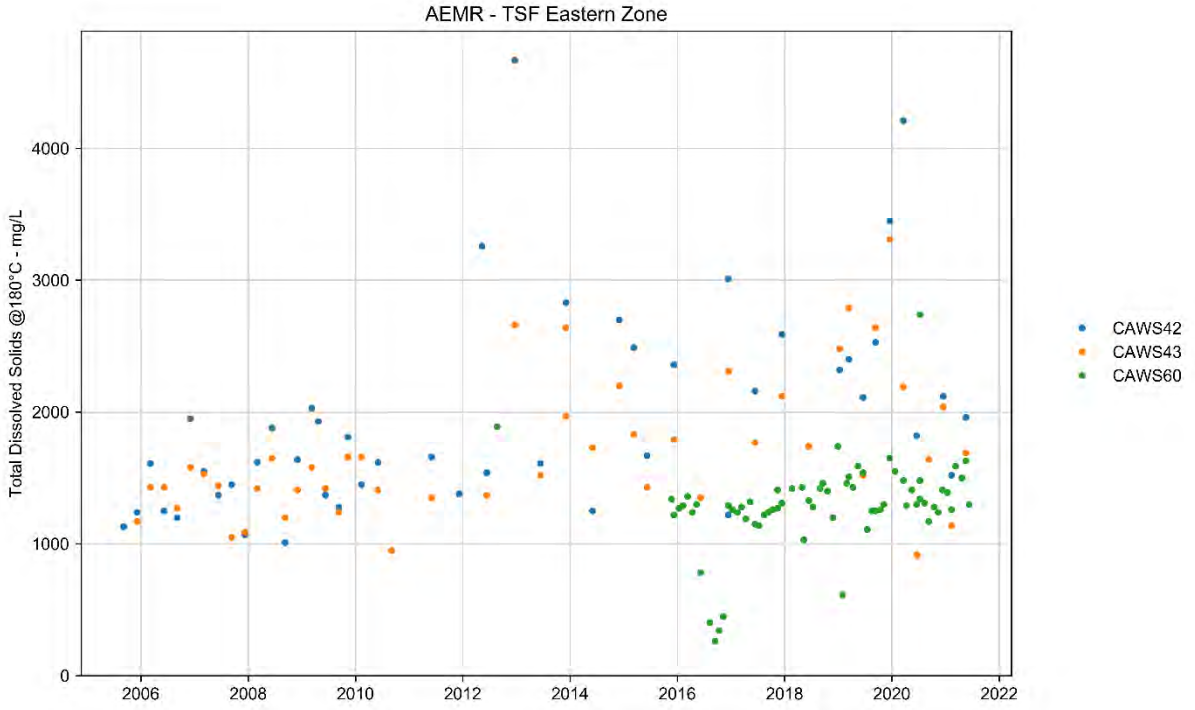

AEMR - TSF Eastern Zone
Sodium - mg/L
0
100
200
300
400
500
600
700
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS42
CAWS43
CAWS60

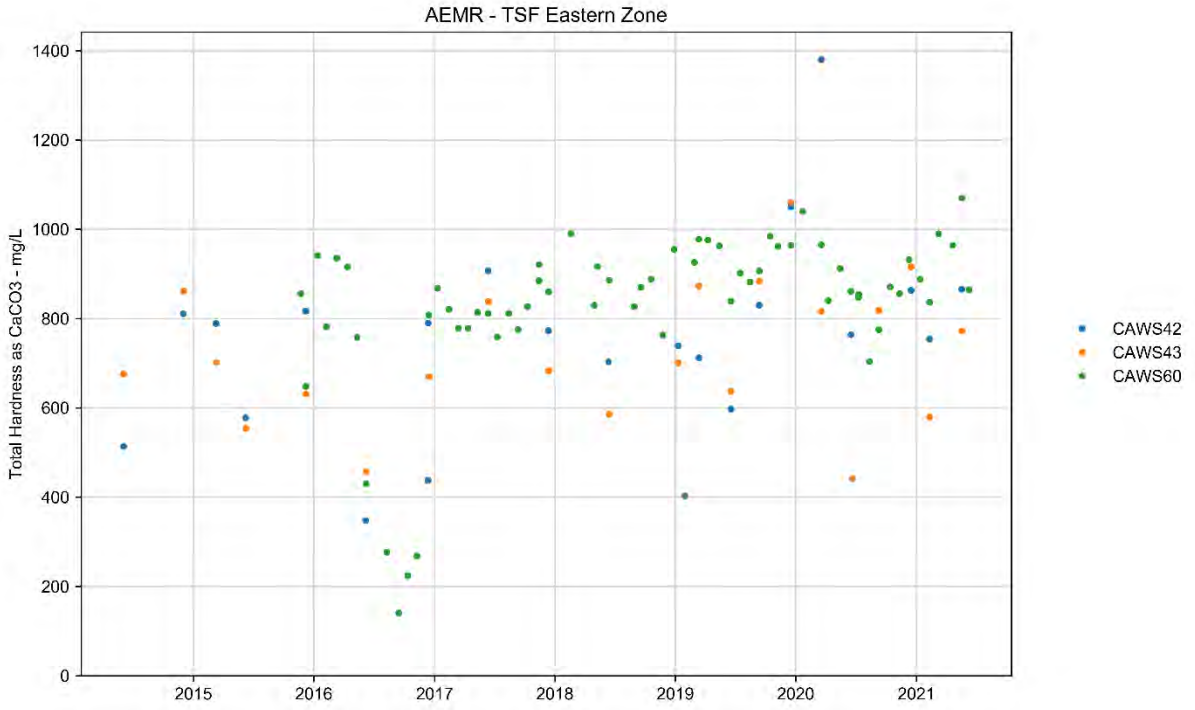

AEMR - TSF Eastern Zone
Sulfate - mg/L
0
500
1000
1500
2000
2500
3000
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS42
CAWS43
CAWS60

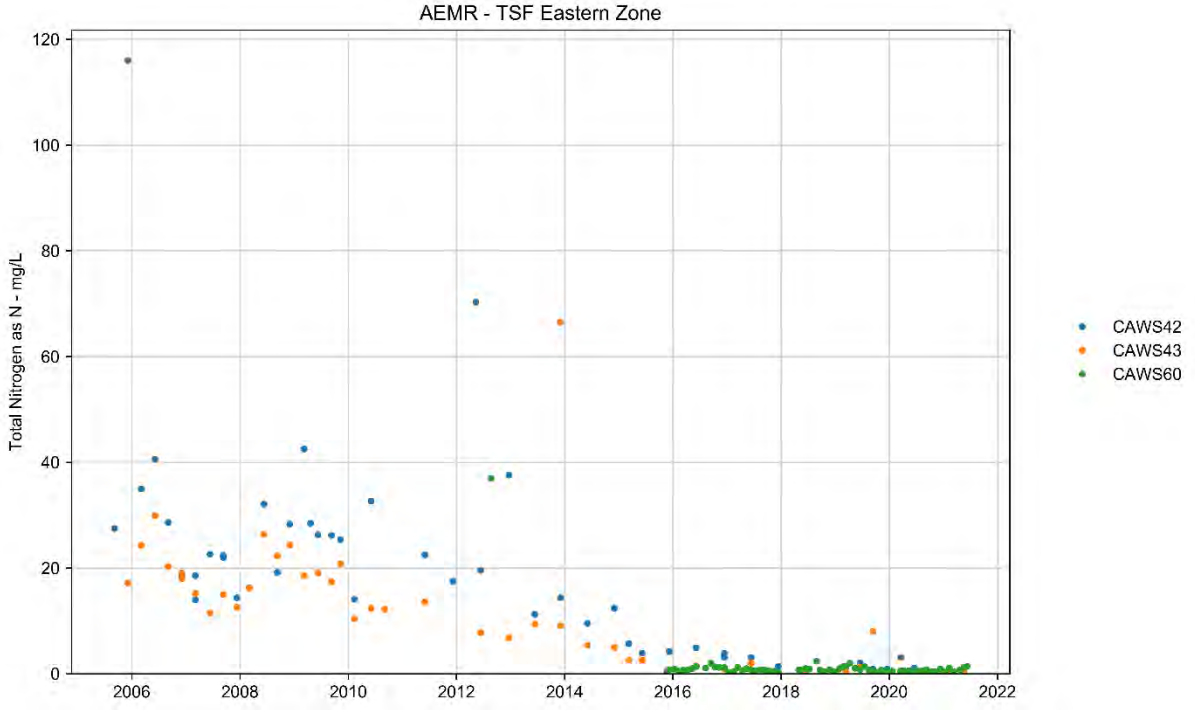

AEMR - TSF Eastern Zone
Suspended Solids (SS) - mg/L
0
10
20
30
40
50
60
70
80
2016
2017
2018
2019
2020
2021
CAWS42
CAWS43
CAWS60

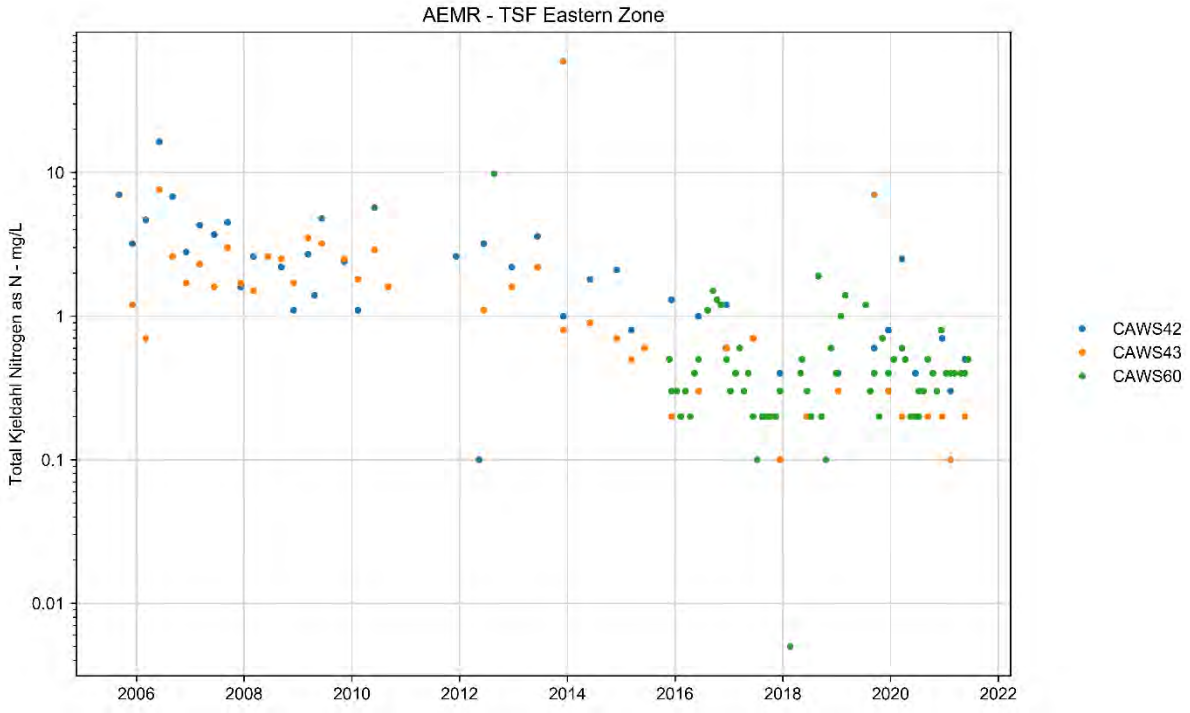

AEMR - TSF Eastern Zone
Temperature - Field
0
5
10
15
20
25
2019-01
2019-04
2019-07
2019-10
2020-01
2020-04
2020-07
2020-10
2021-01
2021-04
2021-07
CAWS42
CAWS43
CAWS60

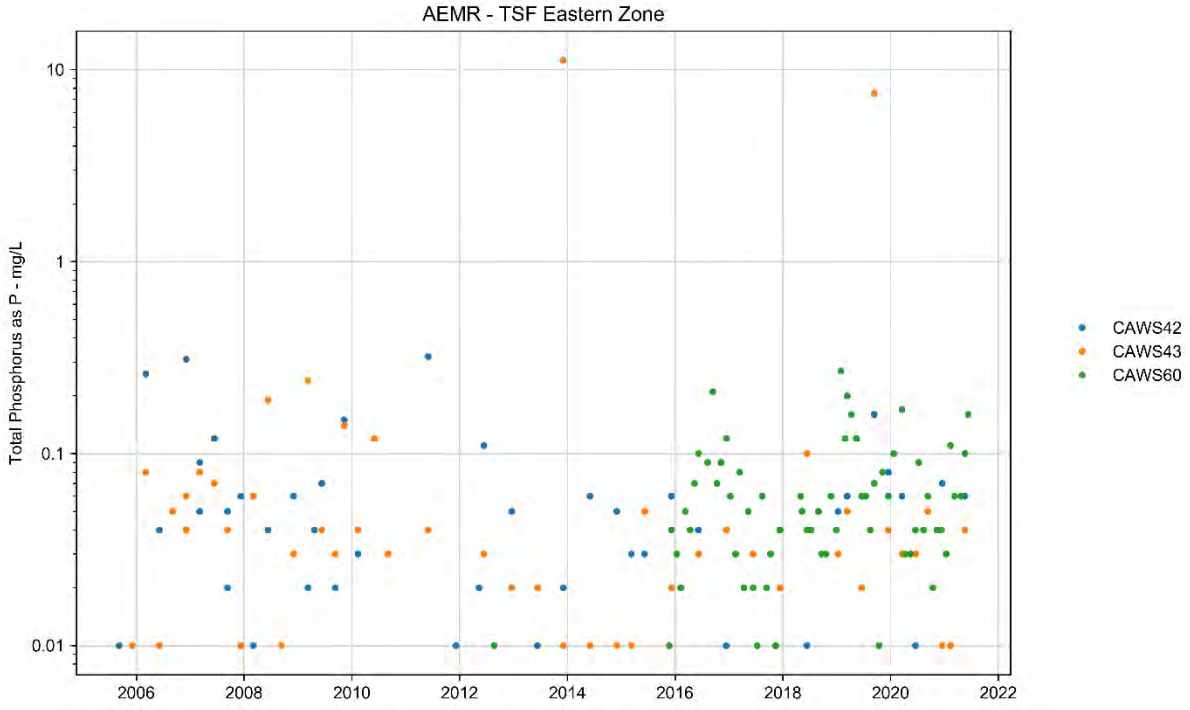

AEMR - TSF Eastern Zone
Total Alkalinity as CaCO3 - mg/L
0
100
200
300
400
500
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS42
CAWS43
CAWS60

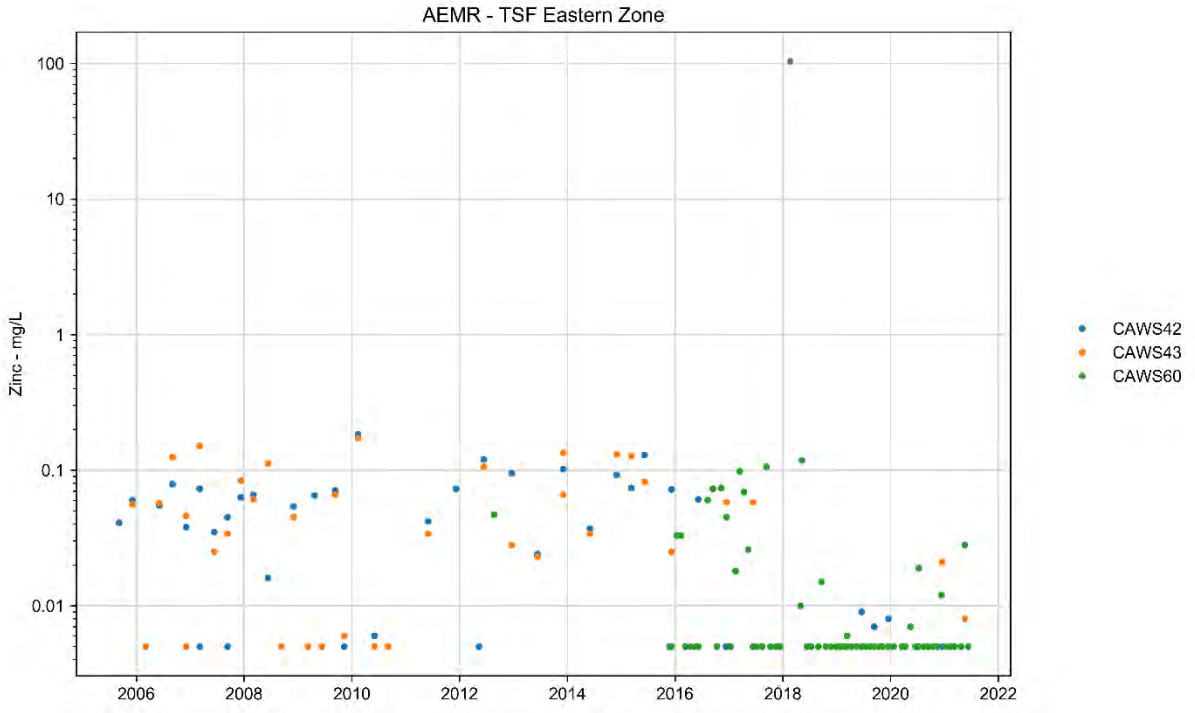

AEMR - TSF Eastern Zone
Total Dissolved Solids @180°C - mg/L
0
1000
2000
3000
4000
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS42
CAWS43
CAWS60

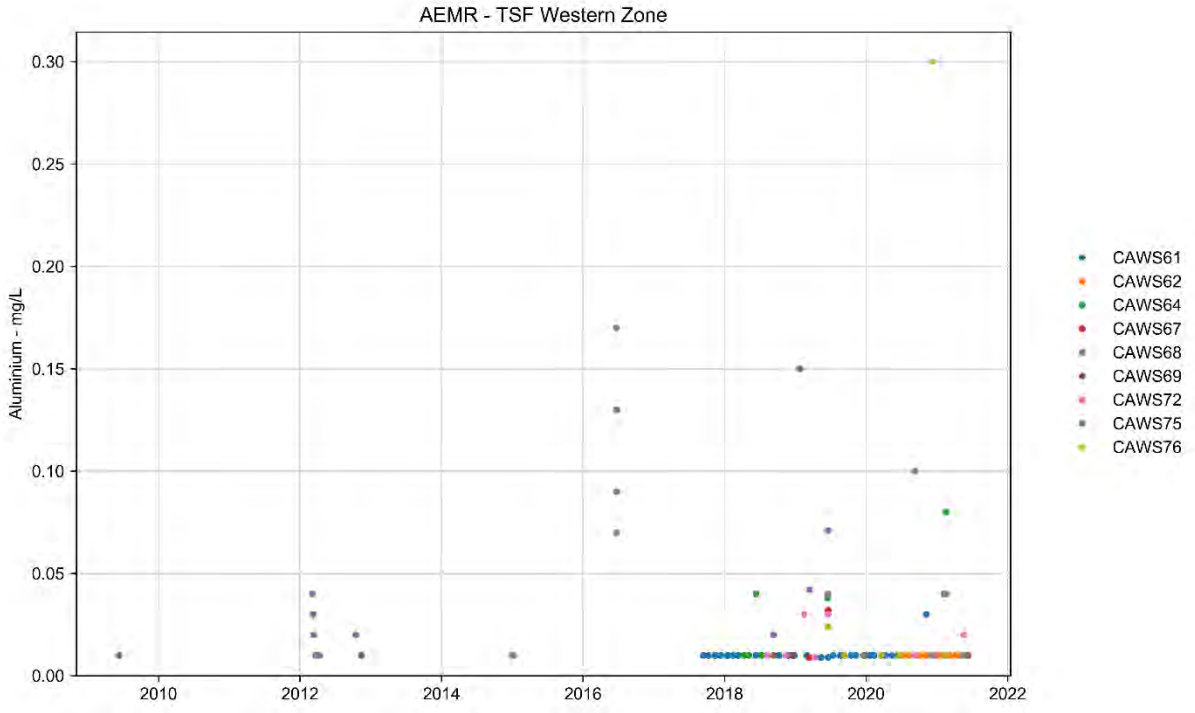

AEMR - TSF Eastern Zone
Total Hardness as CaCO3 - mg/L
0
200
400
600
800
1000
1200
1400
2015
2016
2017
2018
2019
2020
2021
CAWS42
CAWS43
CAWS60


AEMR - TSF Eastern Zone
Total Nitrogen as N - mg/L
0
20
40
60
80
100
120
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS42
CAWS43
CAWS60

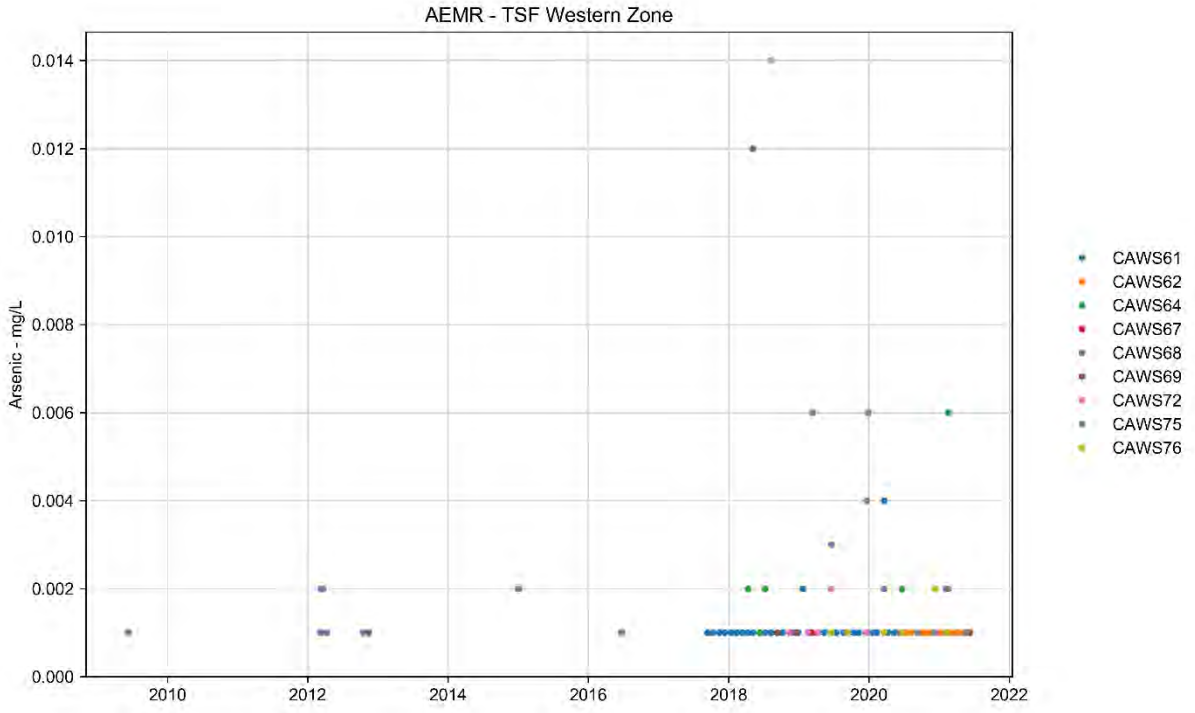

AEMR - TSF Eastern Zone
Total Kjeldahl Nitrogen as N - mg/L
10
1
0.1
0.01
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS42
CAWS43
CAWS60

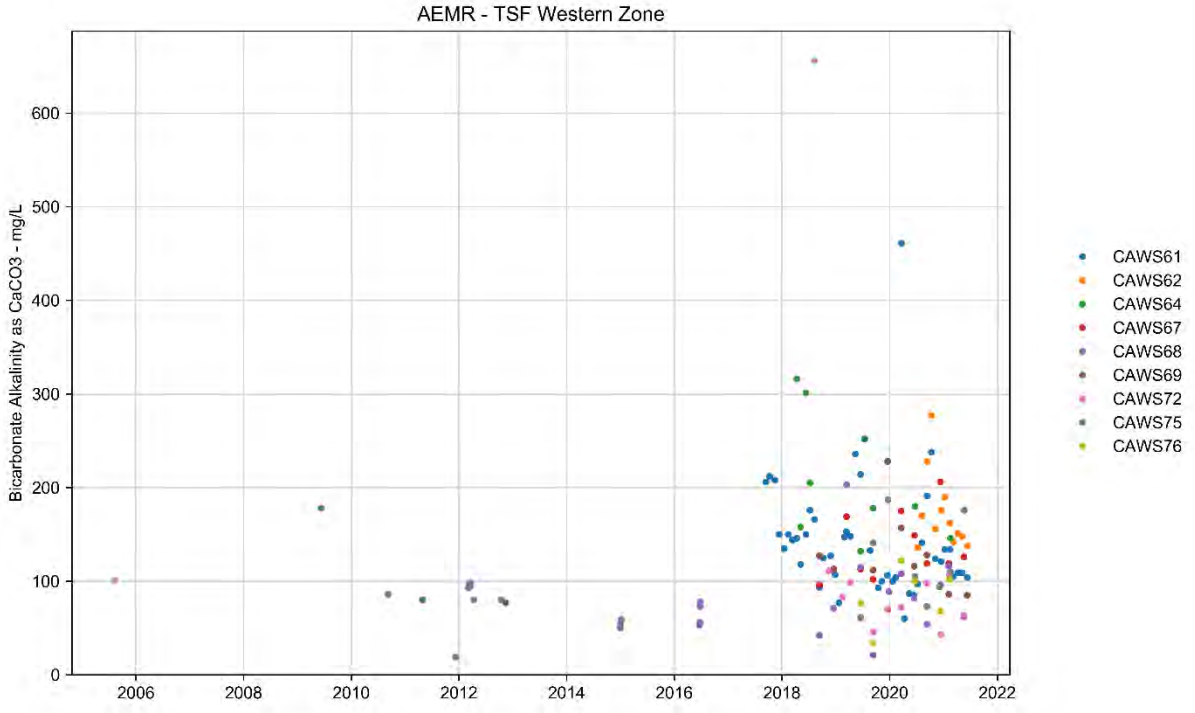

AEMR - TSF Eastern Zone
Total Phosphorus as P - mg/L
10
1
0.1
0.01
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS42
CAWS43
CAWS60

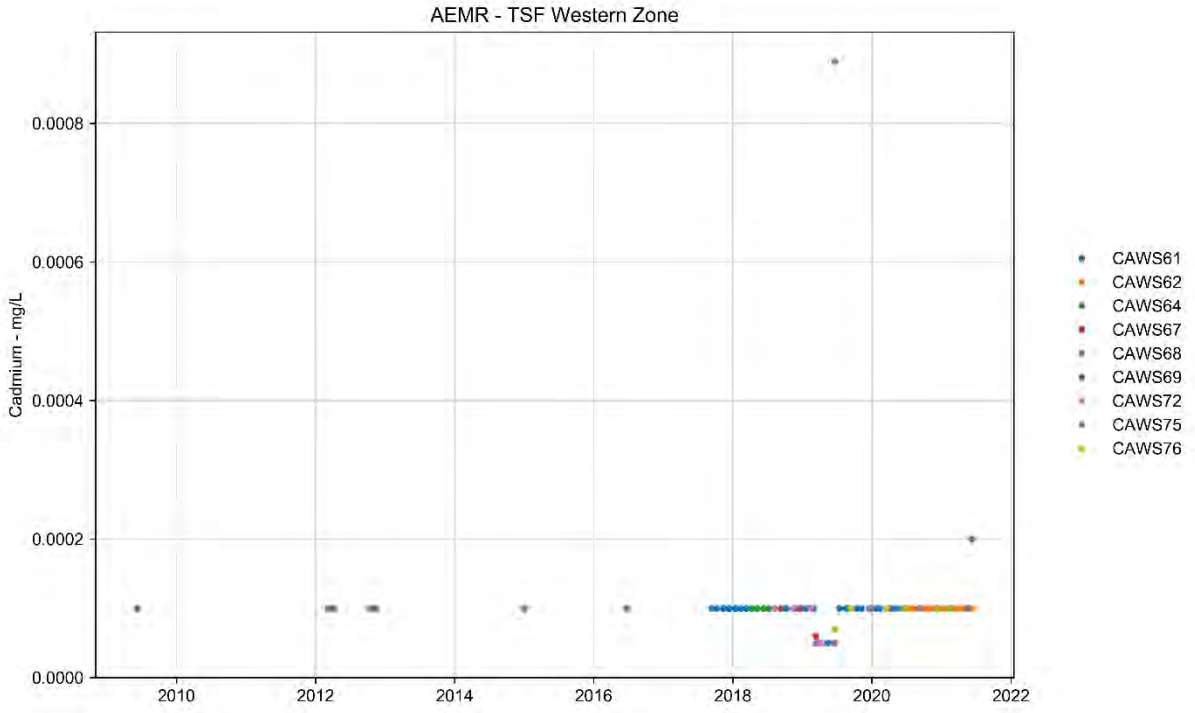

AEMR - TSF Eastern Zone
Zinc - mg/L
100
10
1
0.1
0.01
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS42
CAWS43
CAWS60

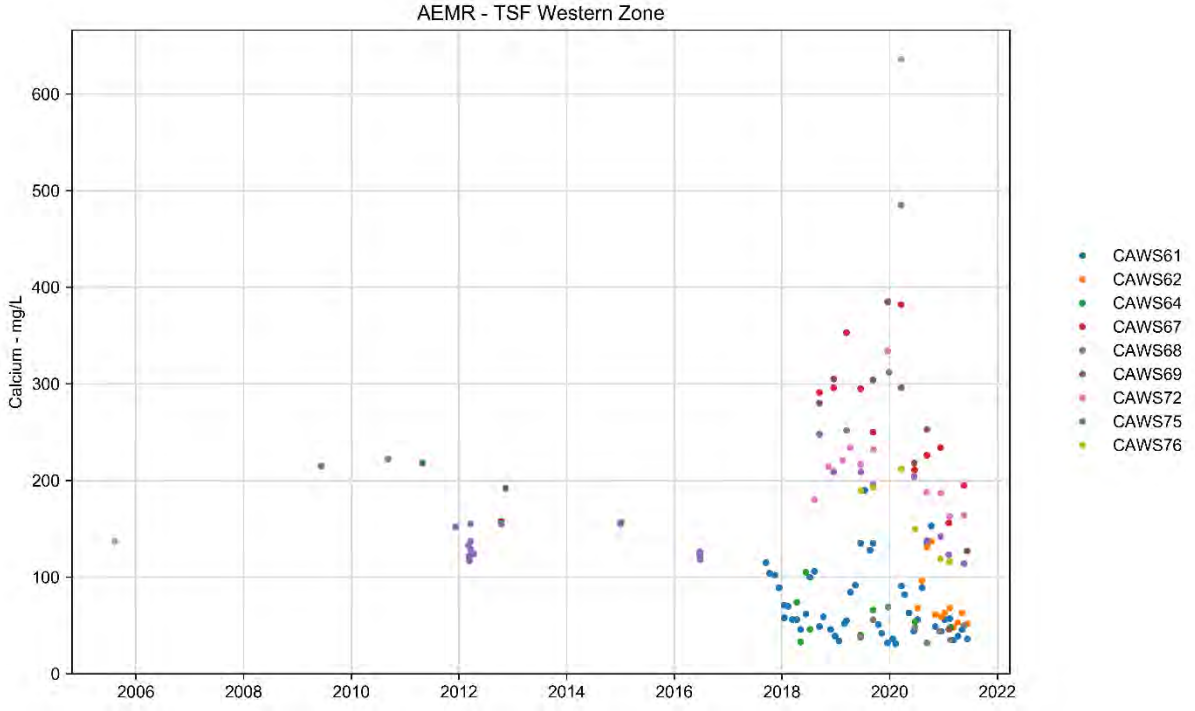

AEMR - TSF Western Zone
Aluminium - mg/L
0.30
0.25
0.20
0.15
0.10
0.05
0.00
2010
2012
2014
2016
2018
2020
2022
CAWS61
CAWS62
CAWS64
CAWS67
CAWS68
CAWS69
CAWS72
CAWS75
CAWS76

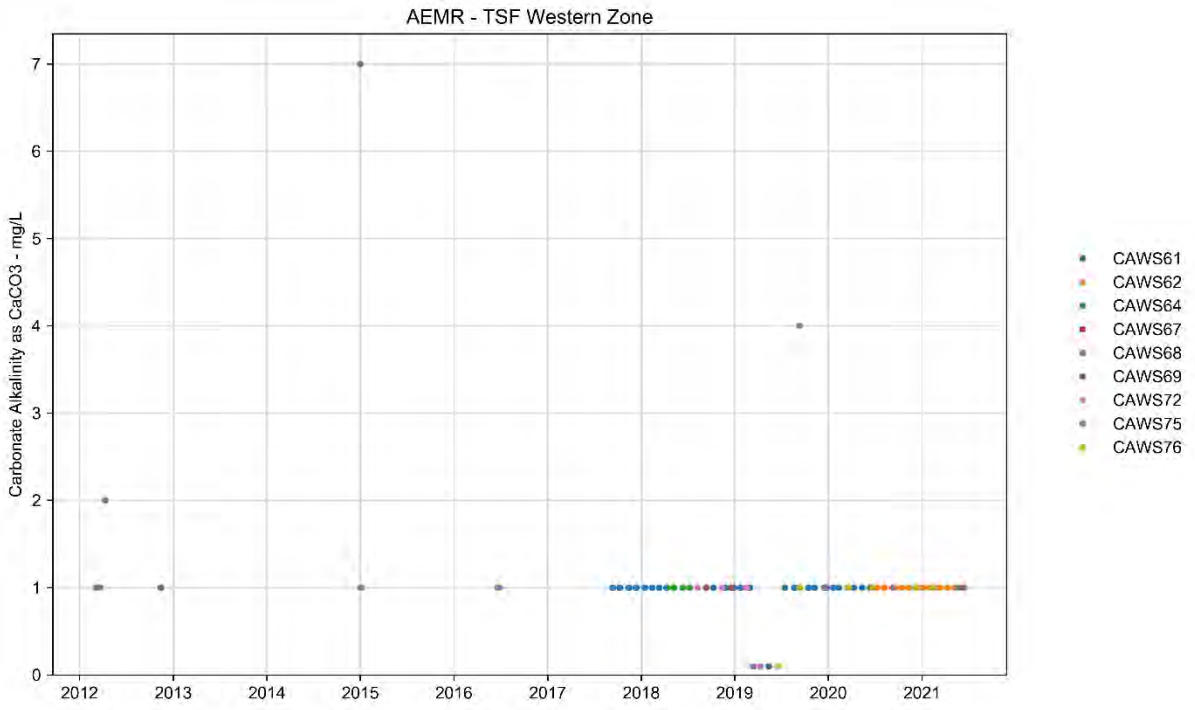
AEMR - TSF Western Zone
Antimony - mg/L
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
2013
2014
2015
2016
2017
2018
2019
2020
2021
CAWS61
CAWS62
CAWS64
CAWS67
CAWS68
CAWS69
CAWS72
CAWS75
CAWS76

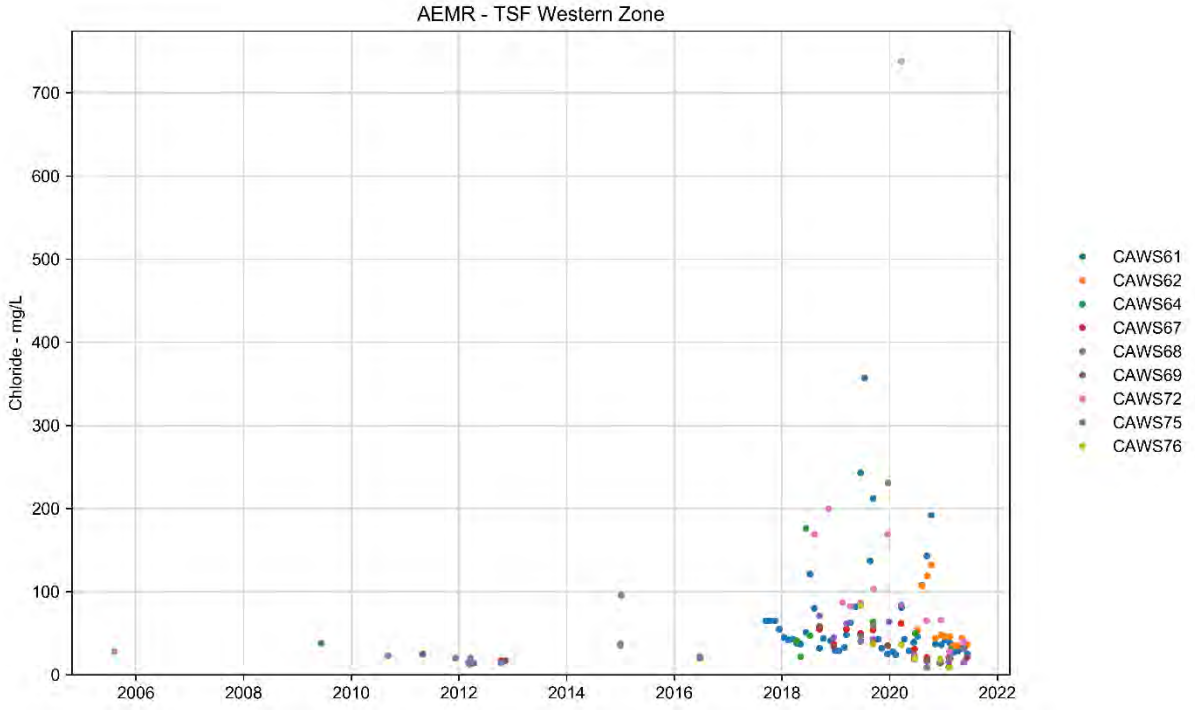

AEMR - TSF Western Zone
Arsenic - mg/L
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
2010
2012
2014
2016
2018
2020
2022
CAWS61
CAWS62
CAWS64
CAWS67
CAWS68
CAWS69
CAWS72
CAWS75
CAWS76

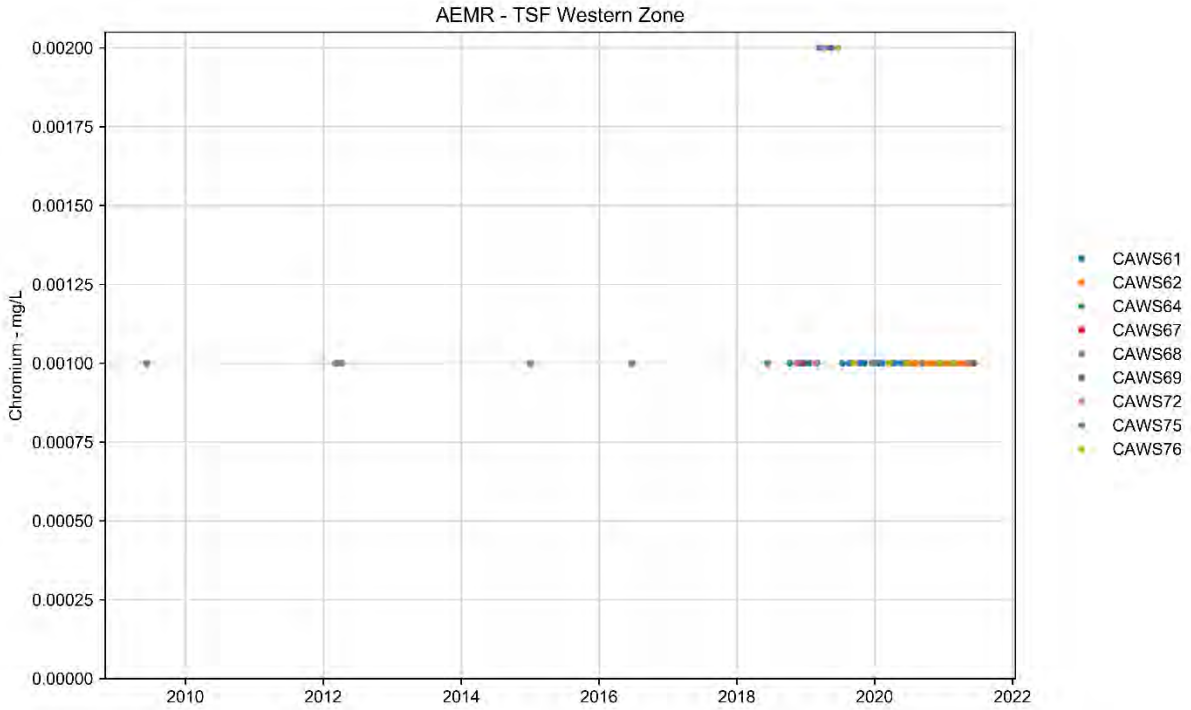

AEMR - TSF Western Zone
Bicarbonate Alkalinity as CaCO3 - mg/L
600
500
400
300
200
100
0
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS61
CAWS62
CAWS64
CAWS67
CAWS68
CAWS69
CAWS72
CAWS75
CAWS76

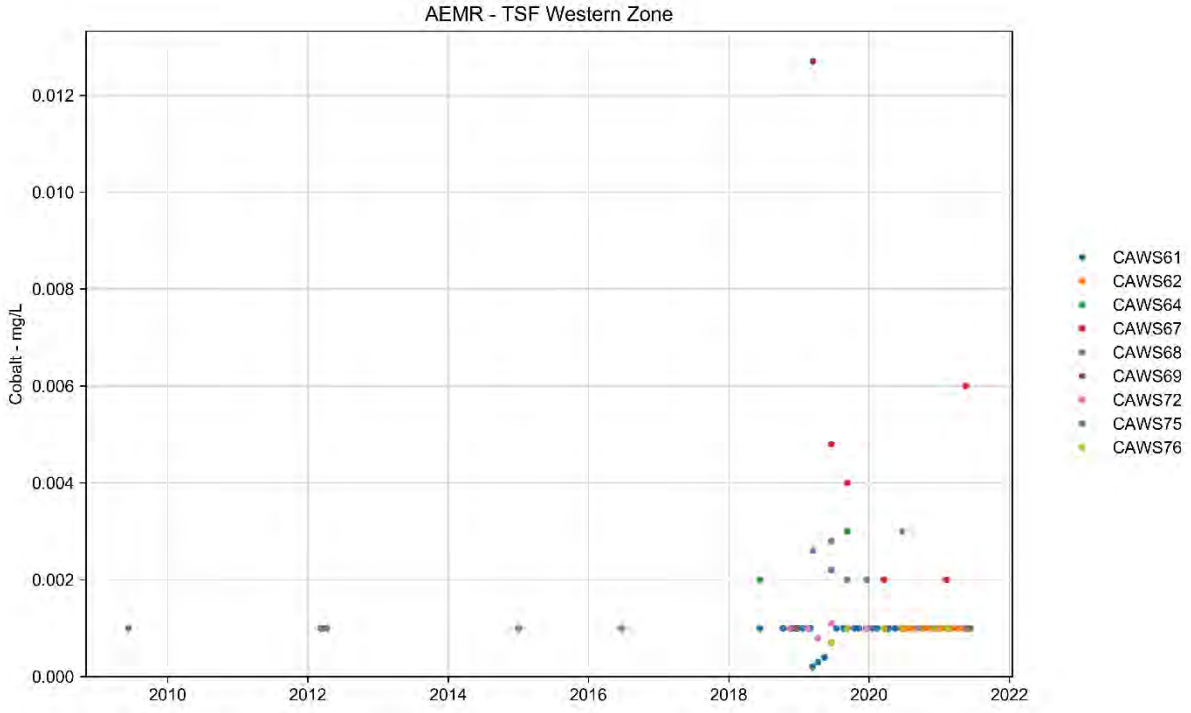

AEMR - TSF Western Zone
Cadmium - mg/L
0.0008
0.0006
0.0004
0.0002
0.0000
2010
2012
2014
2016
2018
2020
2022
CAWS61
CAWS62
CAWS64
CAWS67
CAWS68
CAWS69
CAWS72
CAWS75
CAWS76

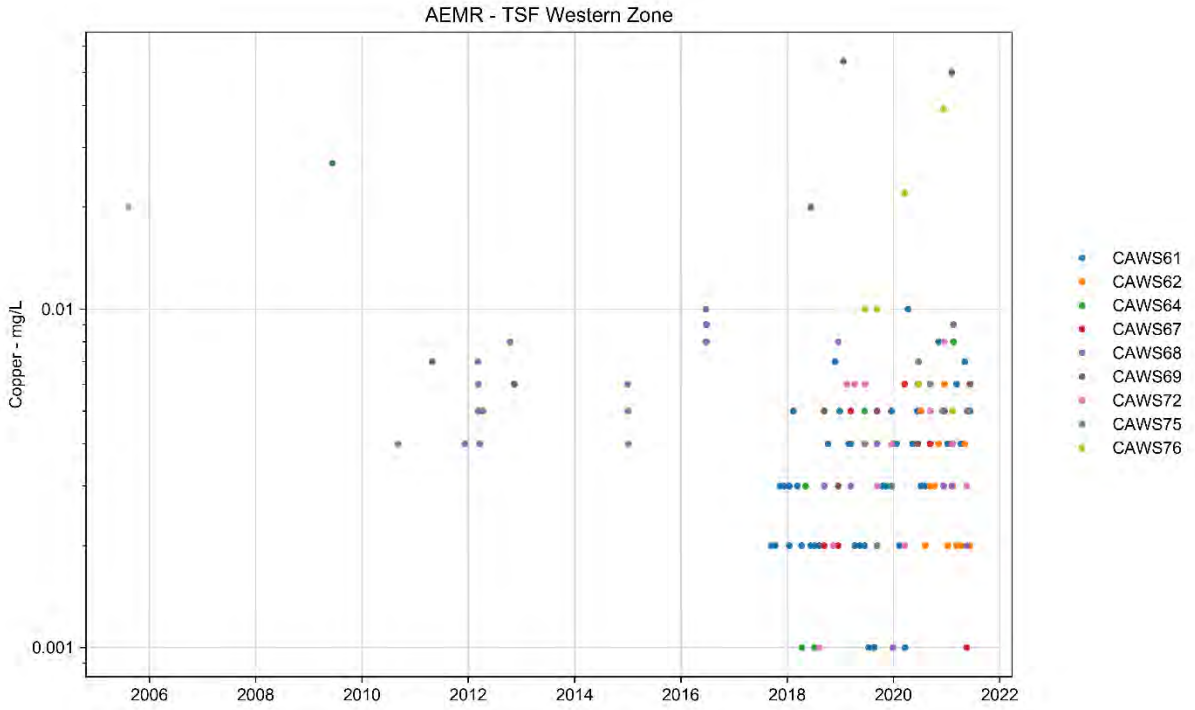

AEMR - TSF Western Zone
Calcium - mg/L
600
500
400
300
200
100
0
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS61
CAWS62
CAWS64
CAWS67
CAWS68
CAWS69
CAWS72
CAWS75
CAWS76

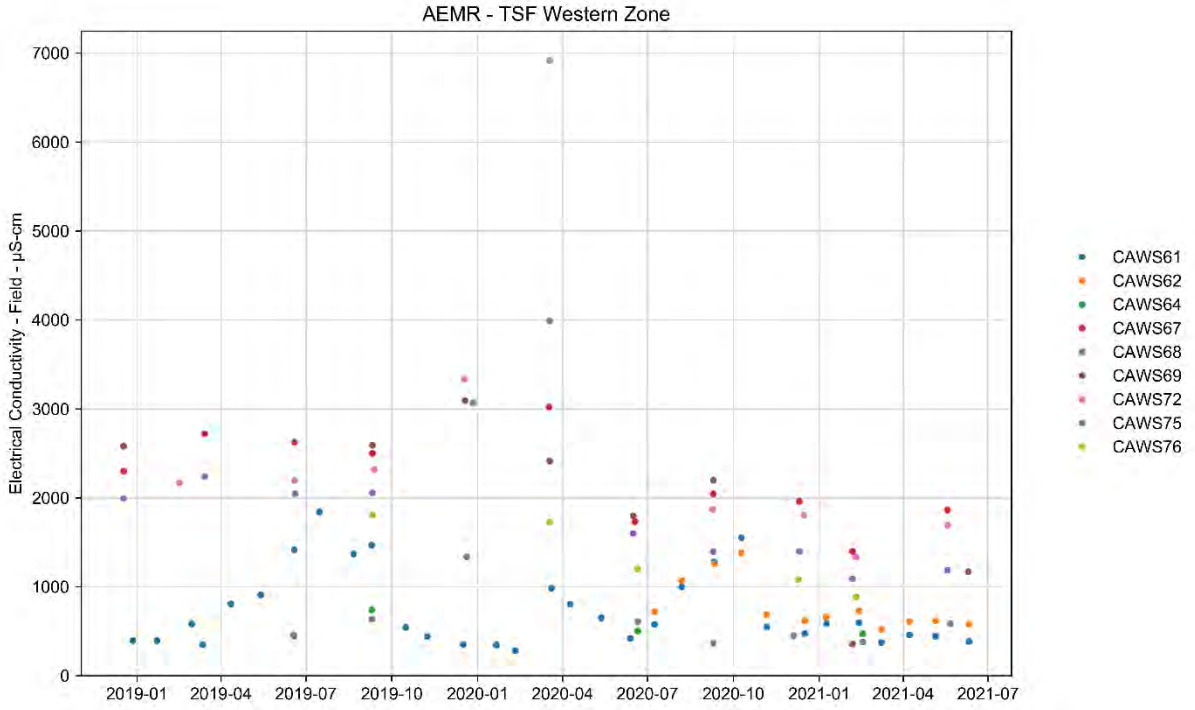

AEMR - TSF Western Zone
Carbonate Alkalinity as CaCO3 - mg/L
0
1
2
3
4
5
6
7
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
CAWS61
CAWS62
CAWS64
CAWS67
CAWS68
CAWS69
CAWS72
CAWS75
CAWS76

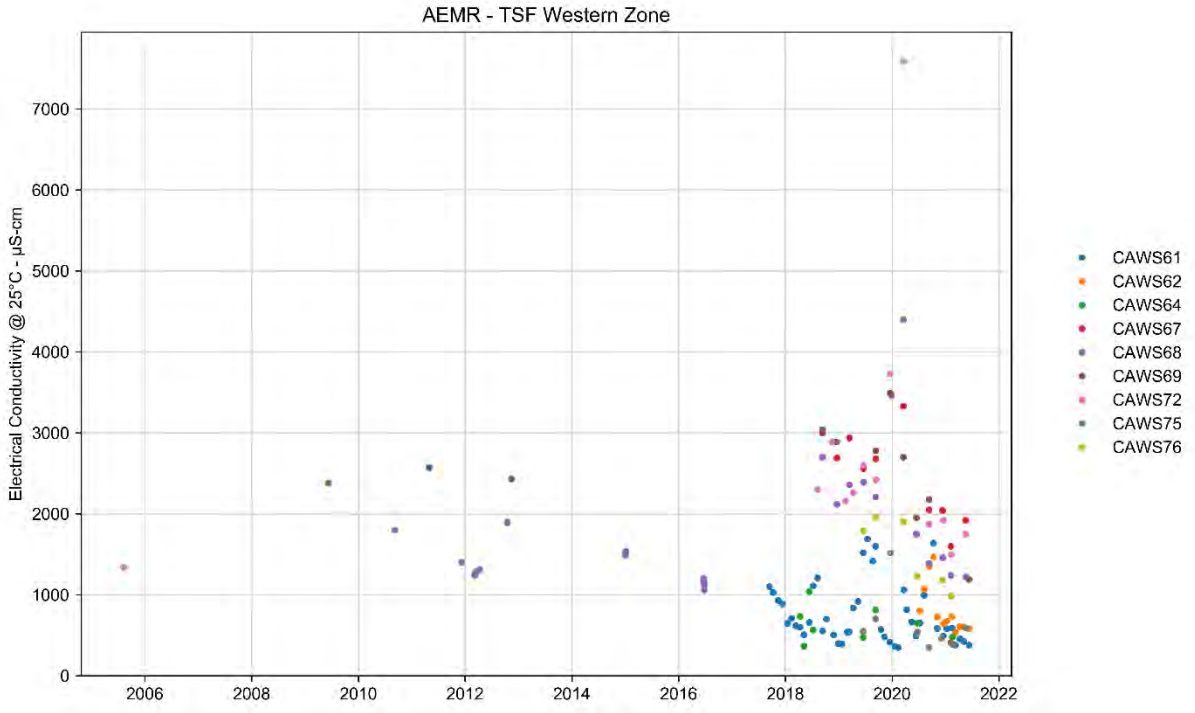

AEMR - TSF Western Zone
Chloride - mg/L
0
100
200
300
400
500
600
700
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS61
CAWS62
CAWS64
CAWS67
CAWS68
CAWS69
CAWS72
CAWS75
CAWS76

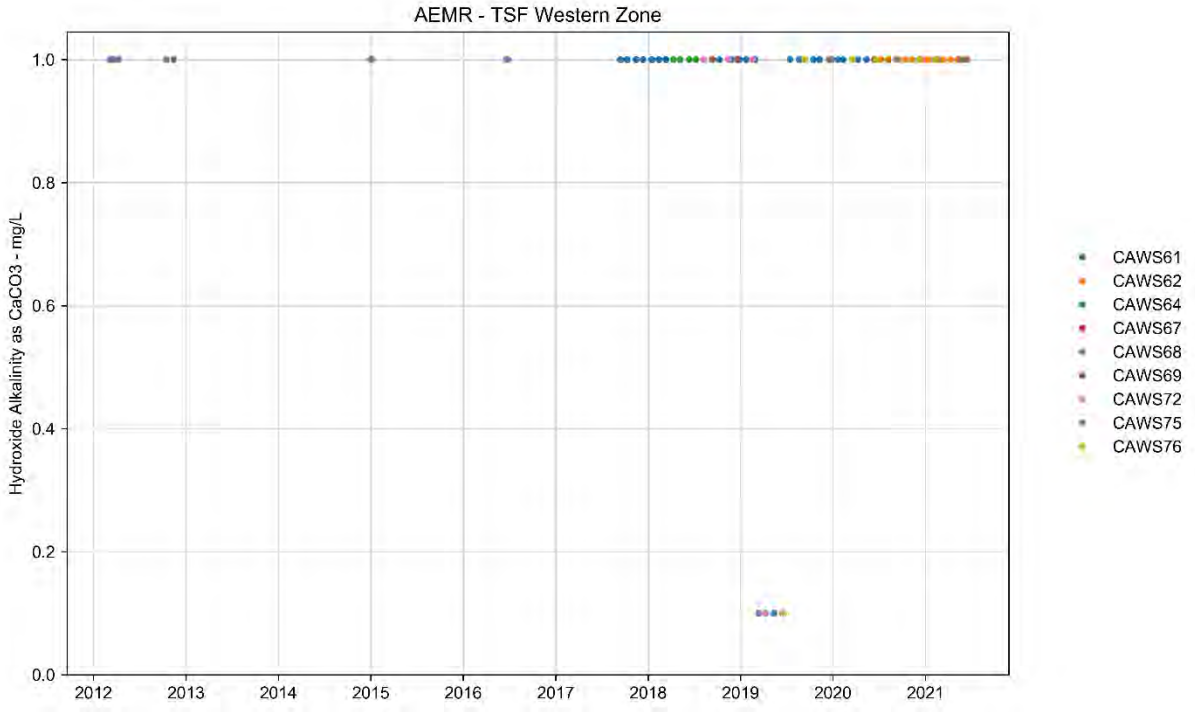

AEMR - TSF Western Zone
Chromium - mg/L
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
2010
2012
2014
2016
2018
2020
2022
CAWS61
CAWS62
CAWS64
CAWS67
CAWS68
CAWS69
CAWS72
CAWS75
CAWS76

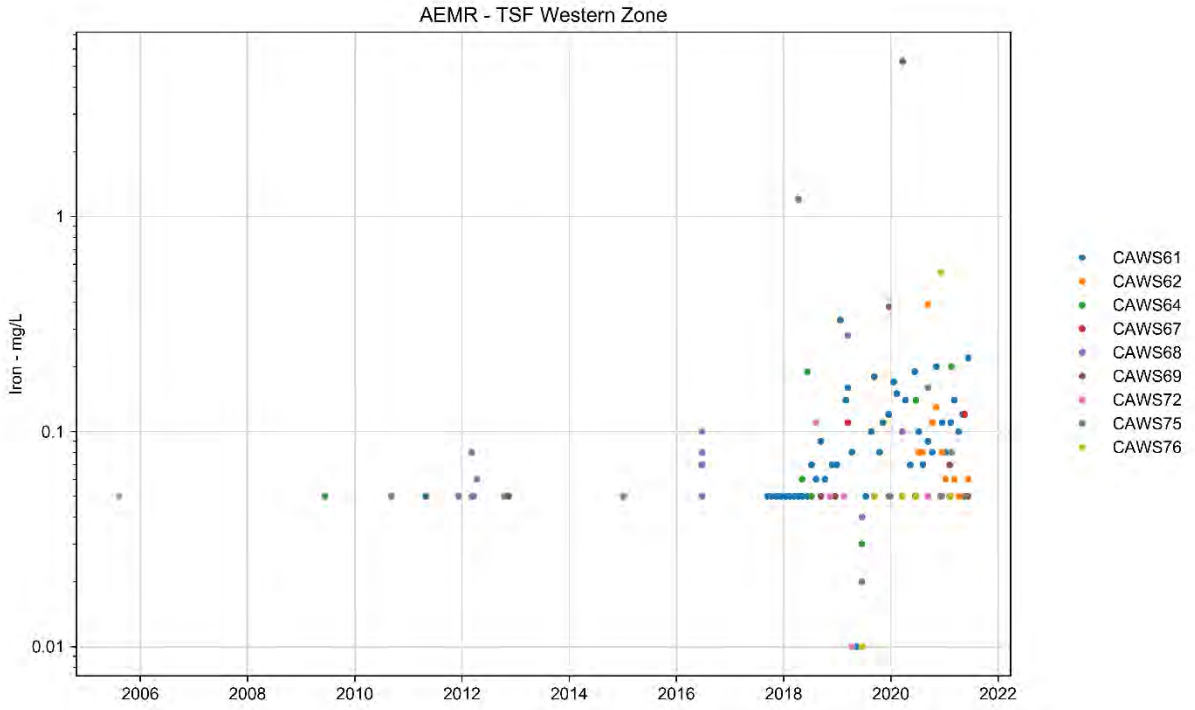

AEMR - TSF Western Zone
Cobalt - mg/L
0.012
0.010
0.008
0.006
0.004
0.002
0.000
2010
2012
2014
2016
2018
2020
2022
CAWS61
CAWS62
CAWS64
CAWS67
CAWS68
CAWS69
CAWS72
CAWS75
CAWS76

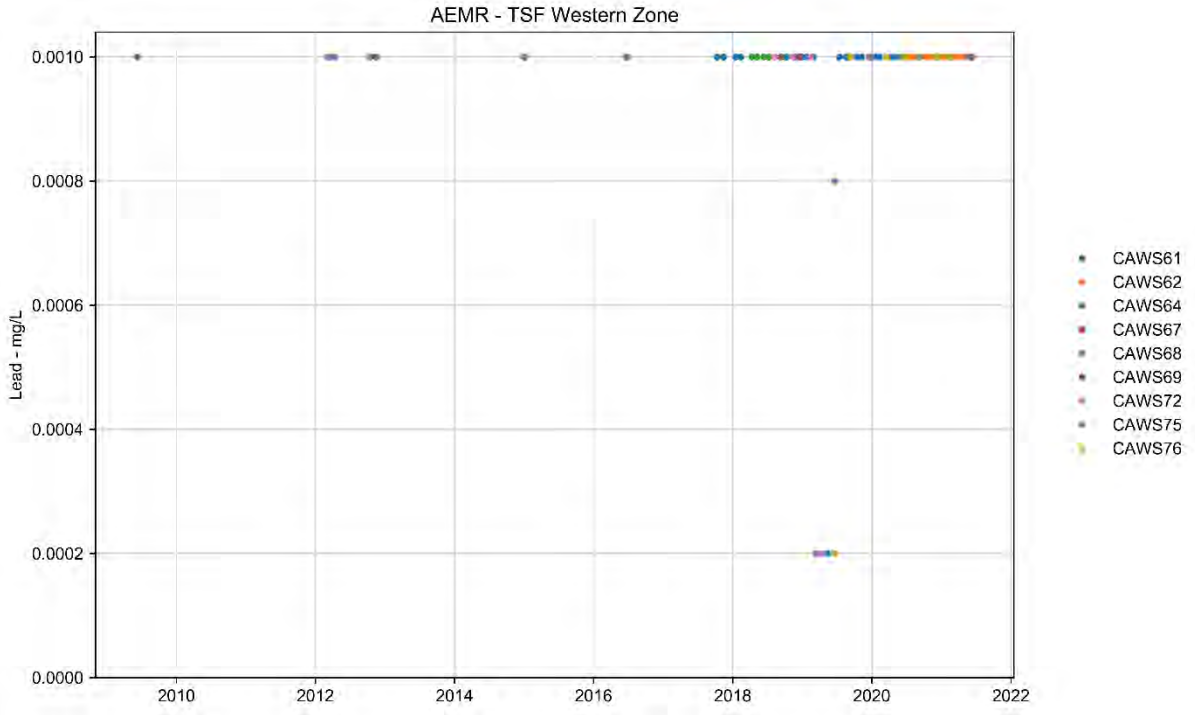

AEMR - TSF Western Zone
Copper - mg/L
0.01
0.001
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS61
CAWS62
CAWS64
CAWS67
CAWS68
CAWS69
CAWS72
CAWS75
CAWS76

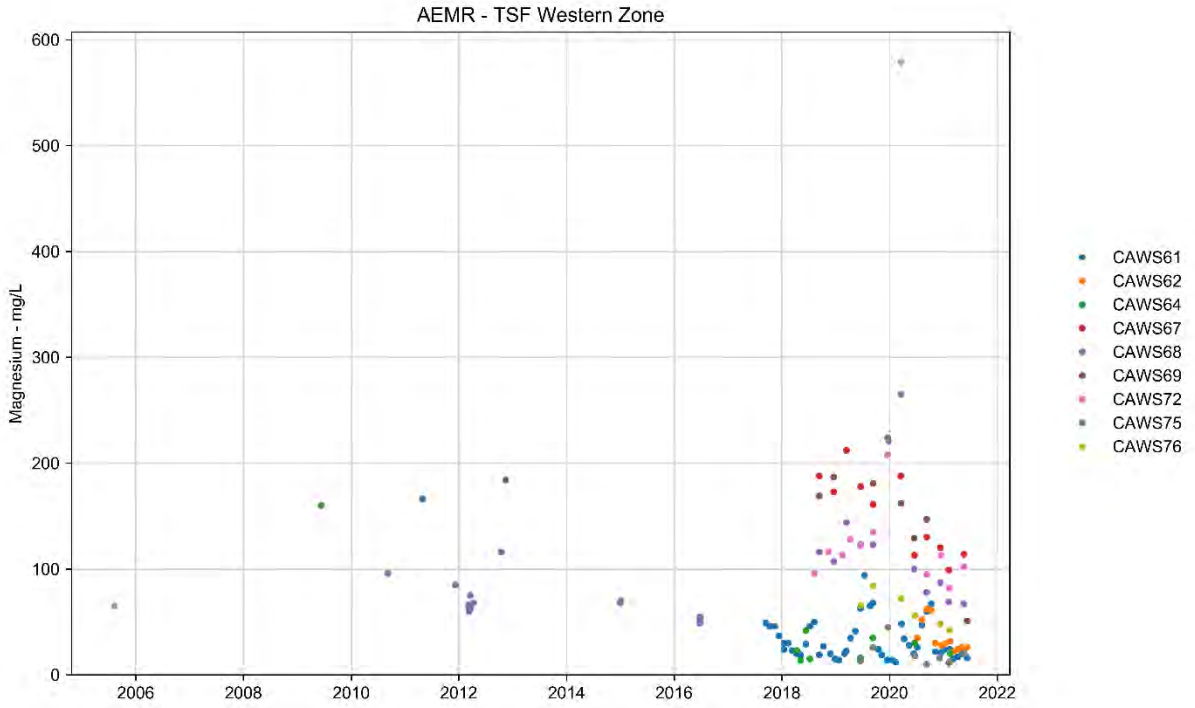

AEMR - TSF Western Zone
Electrical Conductivity - Field - µS-cm
7000
6000
5000
4000
3000
2000
1000
0
2019-01
2019-04
2019-07
2019-10
2020-01
2020-04
2020-07
2020-10
2021-01
2021-04
2021-07
CAWS61
CAWS62
CAWS64
CAWS67
CAWS68
CAWS69
CAWS72
CAWS75
CAWS76

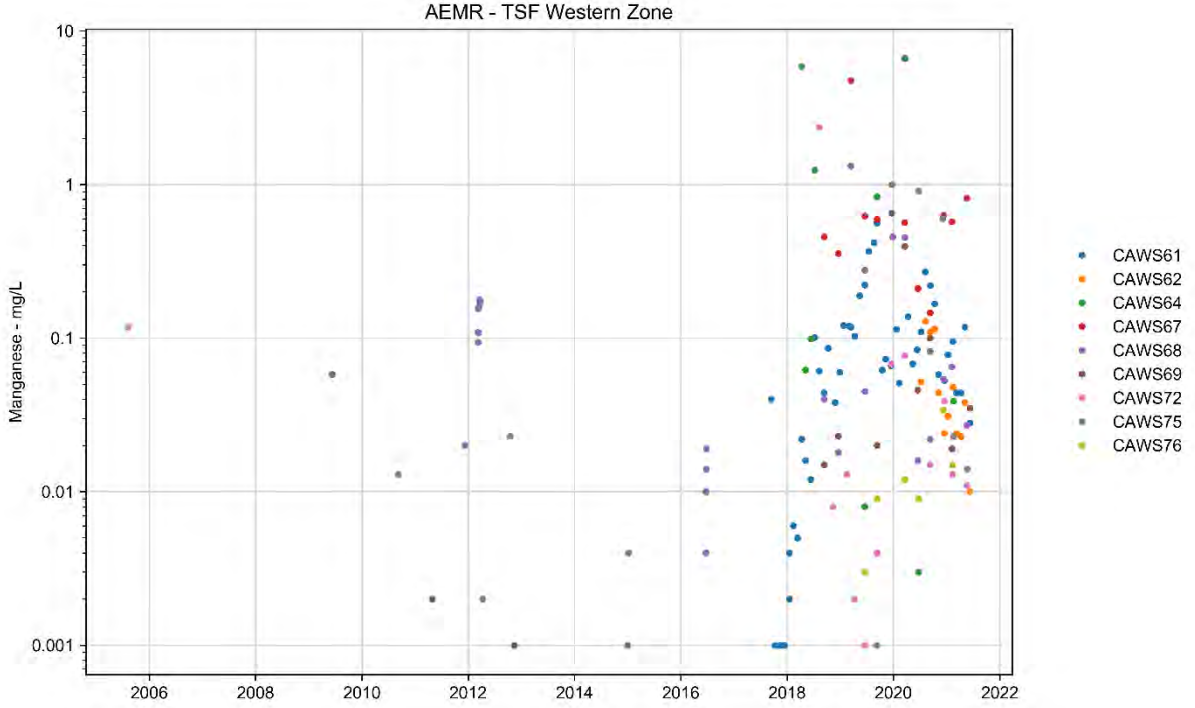

AEMR - TSF Western Zone
Electrical Conductivity @ 25°C - µS-cm
0
1000
2000
3000
4000
5000
6000
7000
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS61
CAWS62
CAWS64
CAWS67
CAWS68
CAWS69
CAWS72
CAWS75
CAWS76

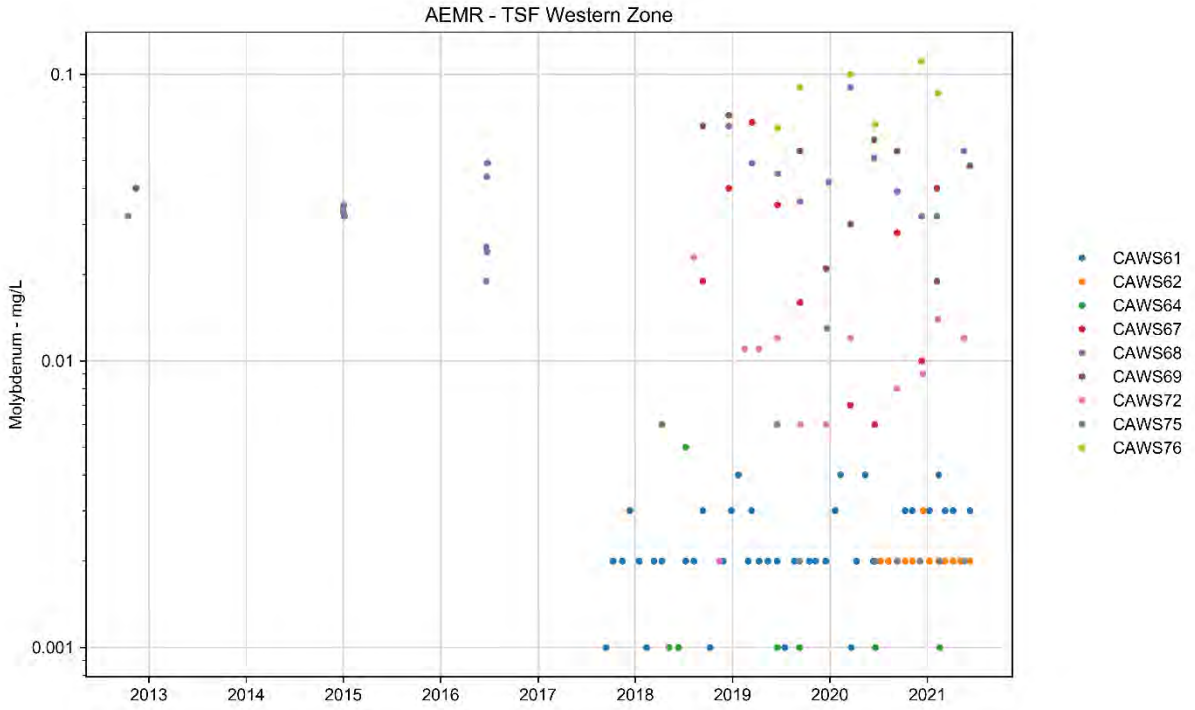

AEMR - TSF Western Zone
Hydroxide Alkalinity as CaCO3 - mg/L
0.0
0.2
0.4
0.6
0.8
1.0
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
CAWS61
CAWS62
CAWS64
CAWS67
CAWS68
CAWS69
CAWS72
CAWS75
CAWS76

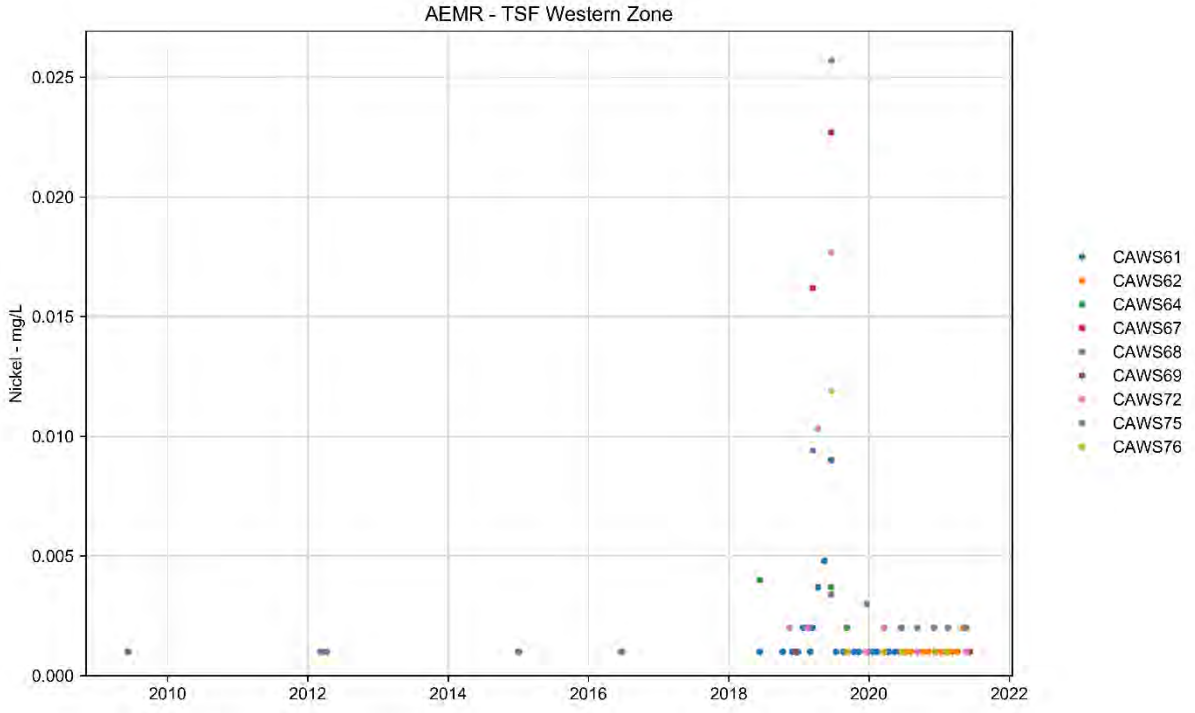

AEMR - TSF Western Zone
Iron - mg/L
1
0.1
0.01
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS61
CAWS62
CAWS64
CAWS67
CAWS68
CAWS69
CAWS72
CAWS75
CAWS76

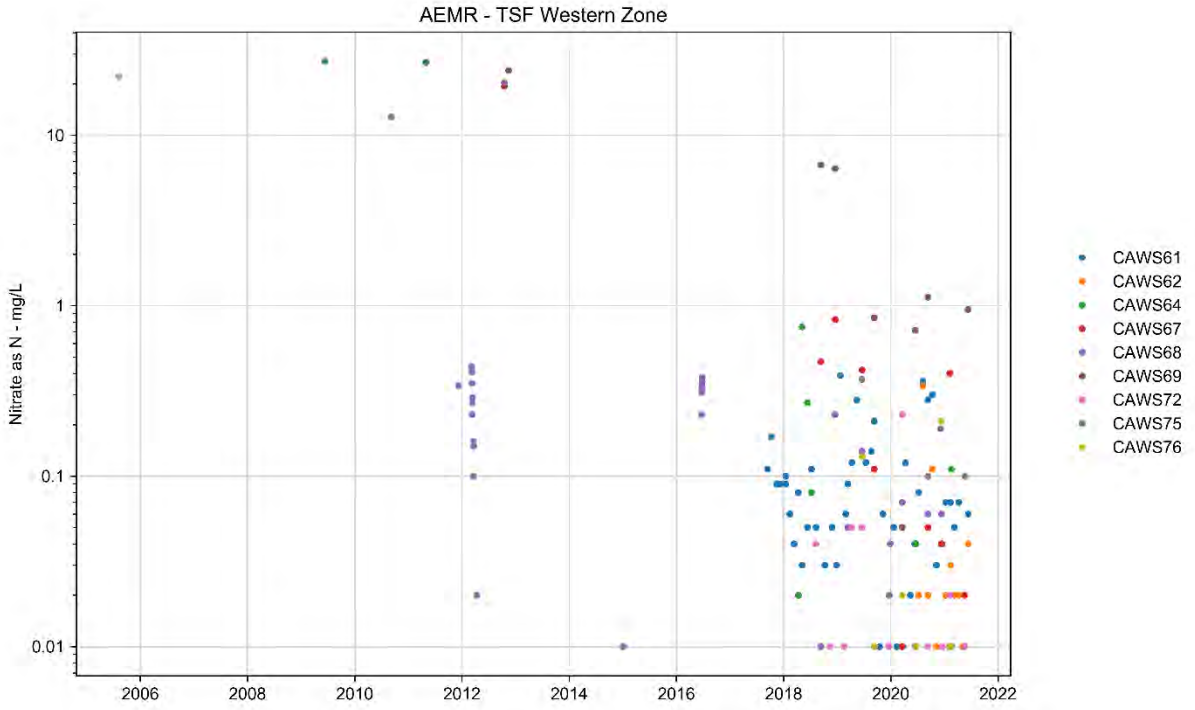

AEMR - TSF Western Zone
Lead - mg/L
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
2010
2012
2014
2016
2018
2020
2022
CAWS61
CAWS62
CAWS64
CAWS67
CAWS68
CAWS69
CAWS72
CAWS75
CAWS76

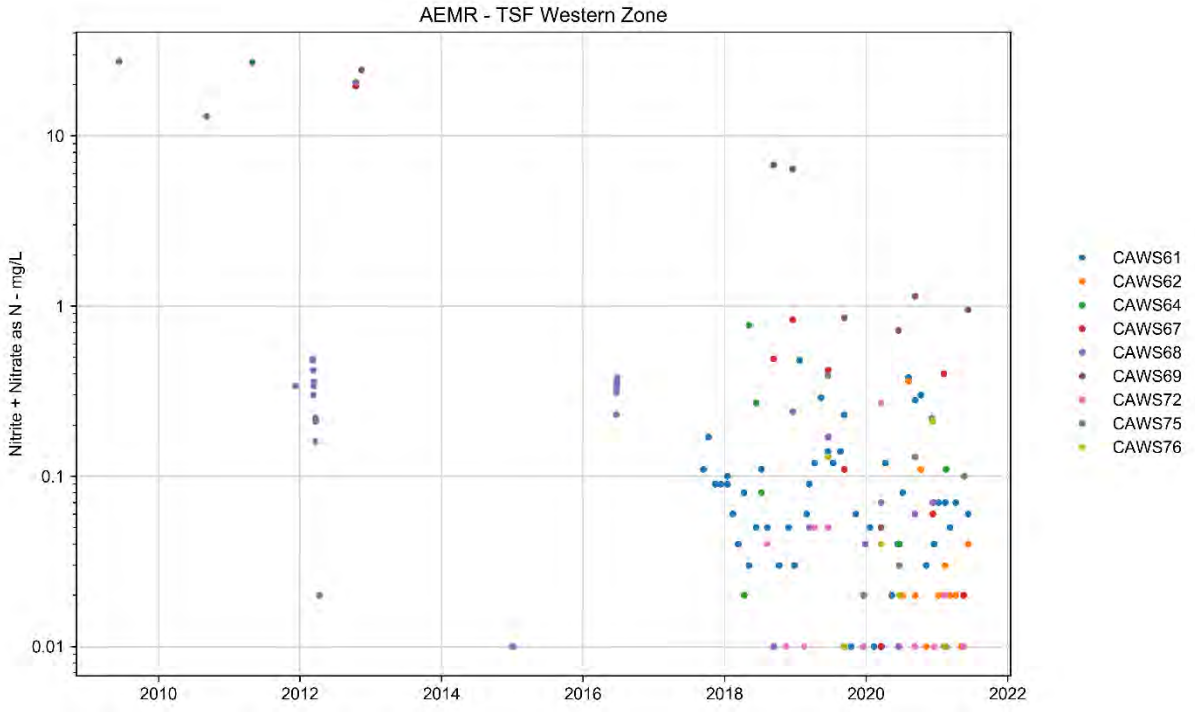

AEMR - TSF Western Zone
Magnesium - mg/L
600
500
400
300
200
100
0
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS61
CAWS62
CAWS64
CAWS67
CAWS68
CAWS69
CAWS72
CAWS75
CAWS76

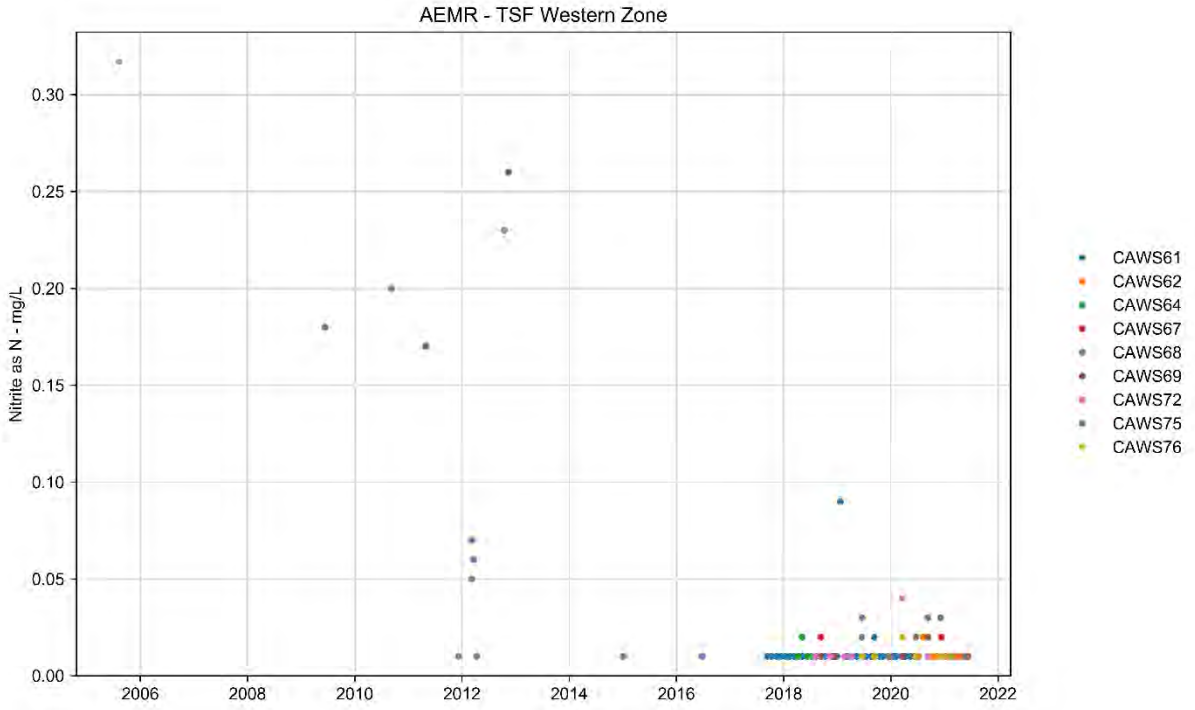

AEMR - TSF Western Zone
Manganese - mg/L
10
1
0.1
0.01
0.001
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS61
CAWS62
CAWS64
CAWS67
CAWS68
CAWS69
CAWS72
CAWS75
CAWS76

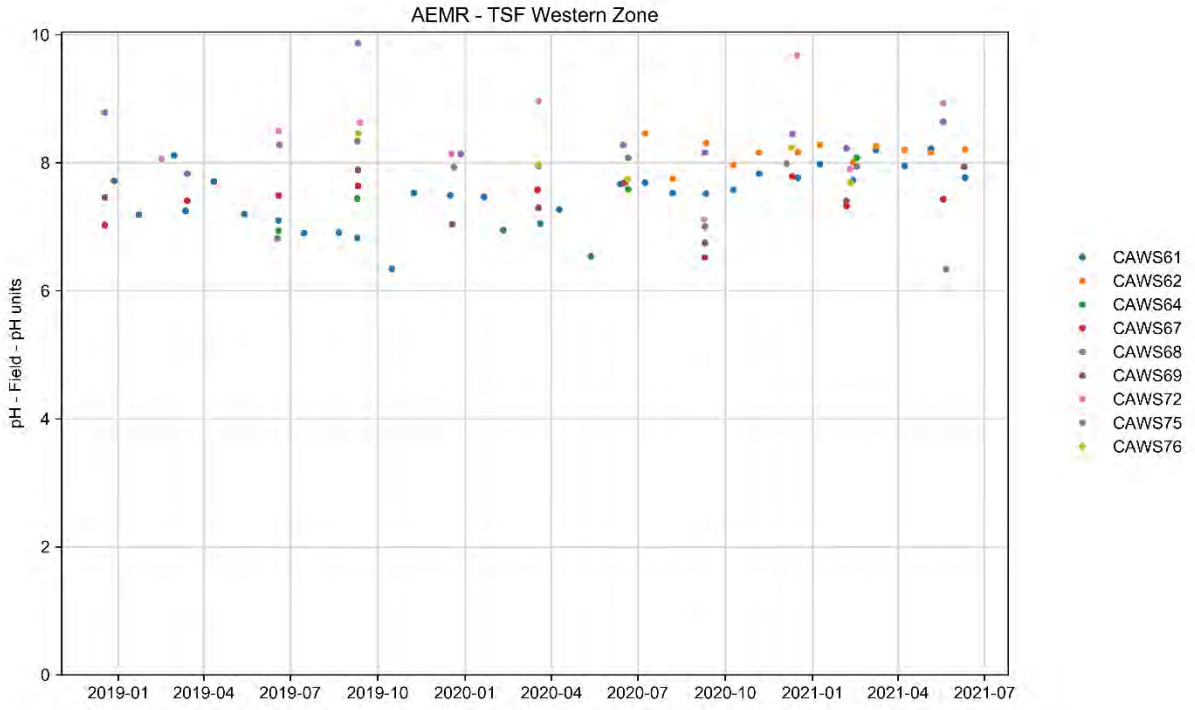

AEMR - TSF Western Zone
Molybdenum - mg/L
0.1
0.01
0.001
2013
2014
2015
2016
2017
2018
2019
2020
2021
CAWS61
CAWS62
CAWS64
CAWS67
CAWS68
CAWS69
CAWS72
CAWS75
CAWS76

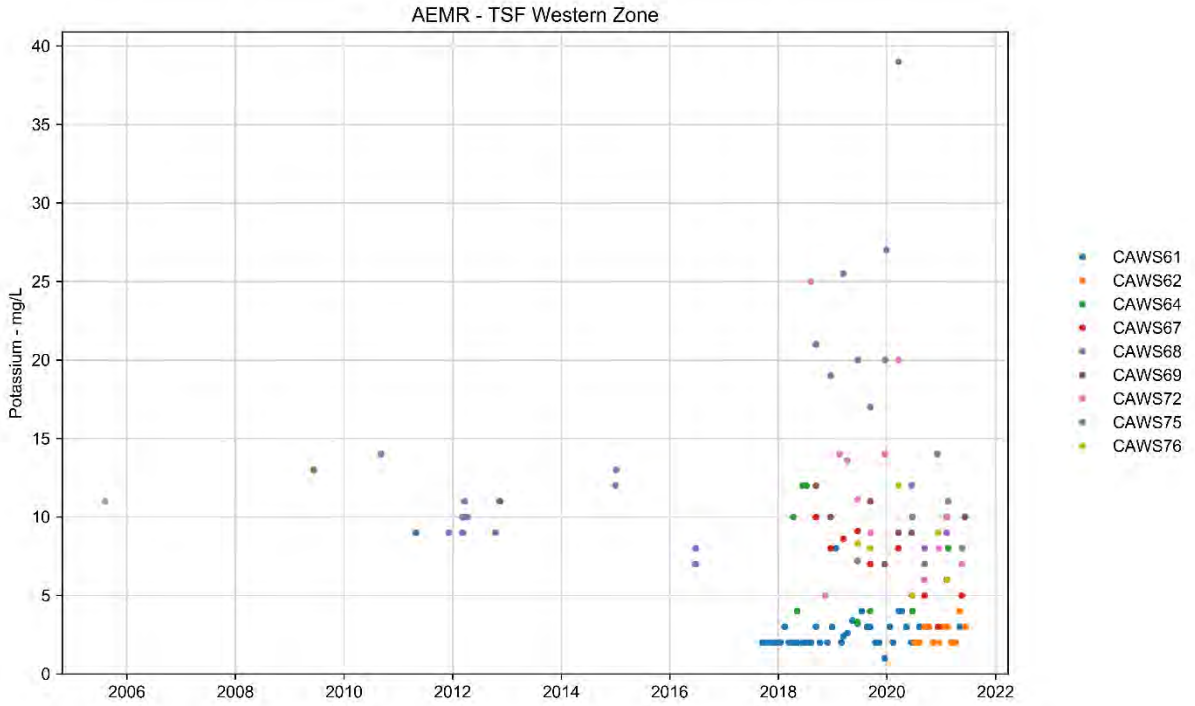

AEMR - TSF Western Zone
Nickel - mg/L
0.025
0.020
0.015
0.010
0.005
0.000
2010
2012
2014
2016
2018
2020
2022
CAWS61
CAWS62
CAWS64
CAWS67
CAWS68
CAWS69
CAWS72
CAWS75
CAWS76

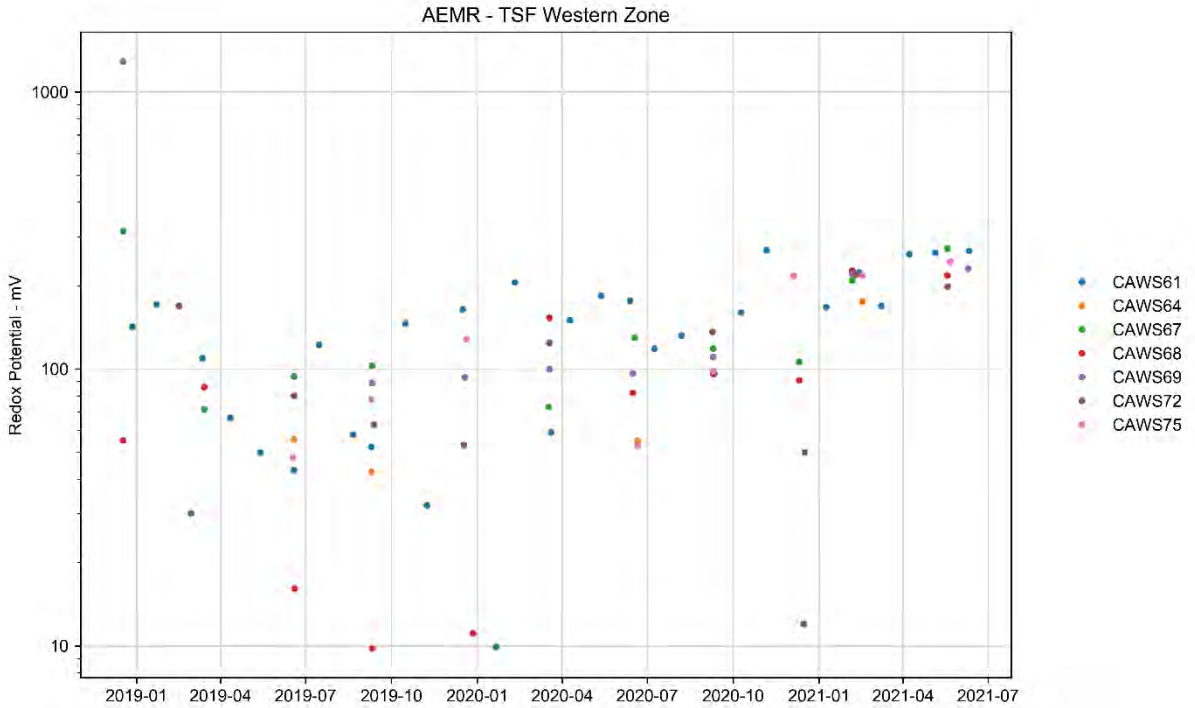

AEMR - TSF Western Zone
Nitrate as N - mg/L
10
1
0.1
0.01
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS61
CAWS62
CAWS64
CAWS67
CAWS68
CAWS69
CAWS72
CAWS75
CAWS76

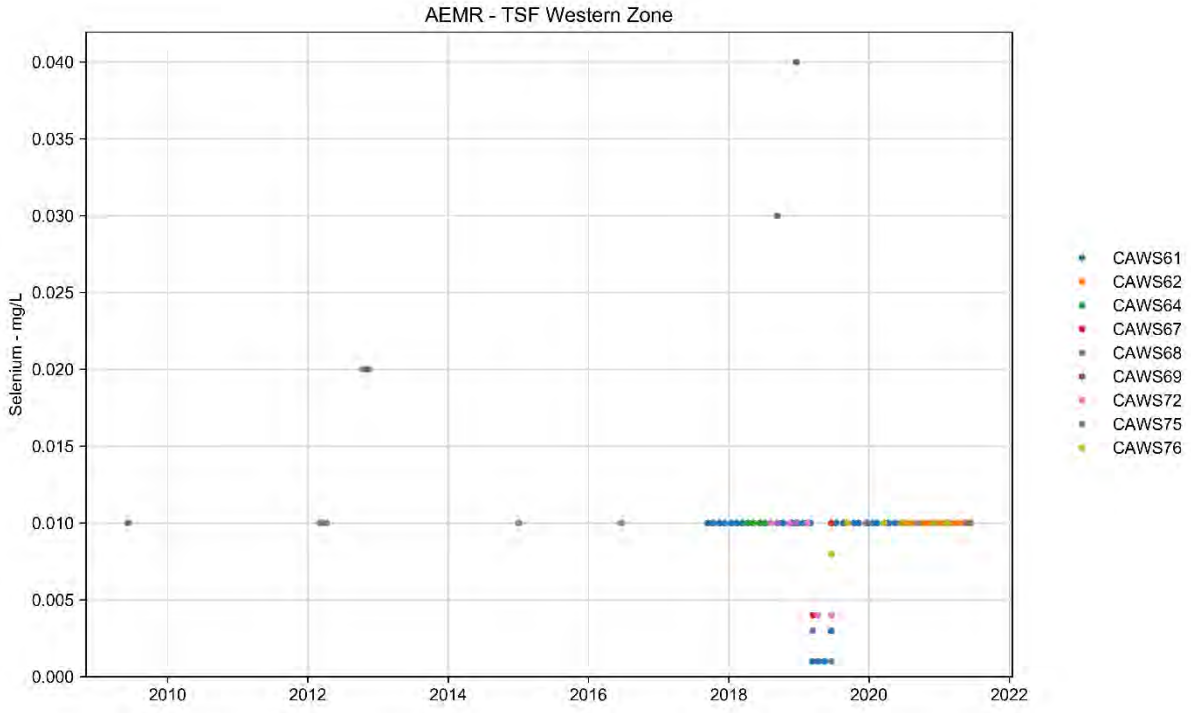

AEMR - TSF Western Zone
Nitrite + Nitrate as N - mg/L
10
1
0.1
0.01
2010
2012
2014
2016
2018
2020
2022
CAWS61
CAWS62
CAWS64
CAWS67
CAWS68
CAWS69
CAWS72
CAWS75
CAWS76

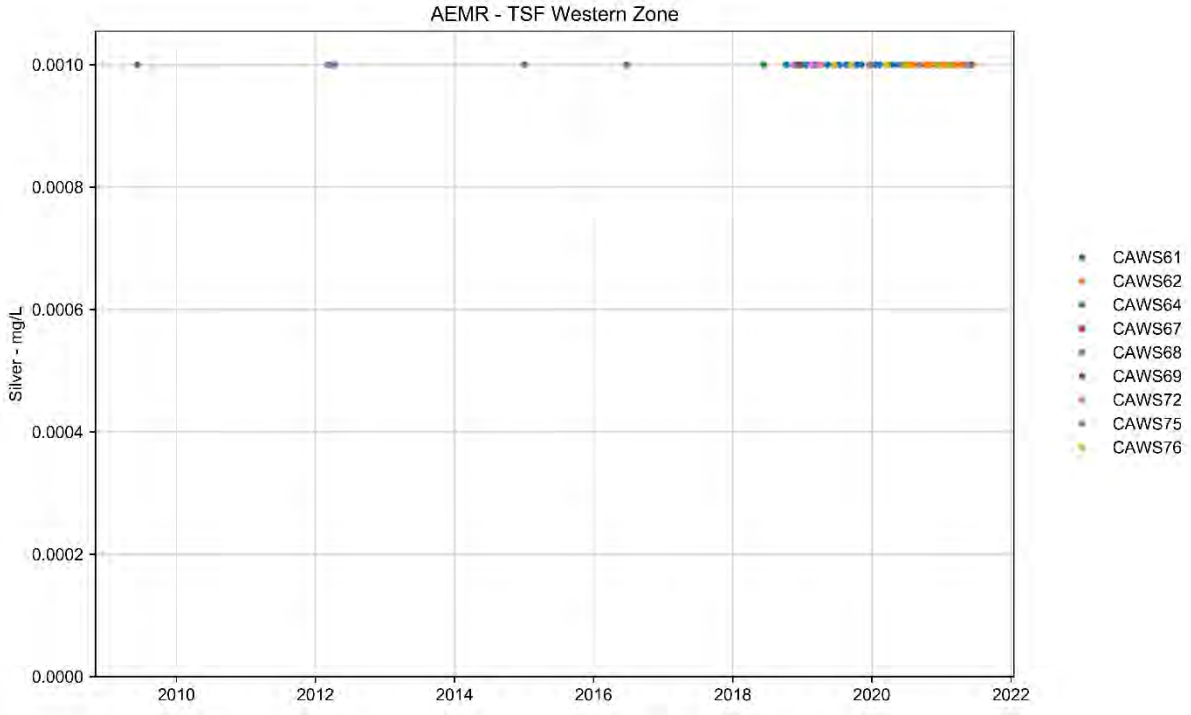

AEMR - TSF Western Zone
Nitrite as N - mg/L
0.00
0.05
0.10
0.15
0.20
0.25
0.30
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS61
CAWS62
CAWS64
CAWS67
CAWS68
CAWS69
CAWS72
CAWS75
CAWS76

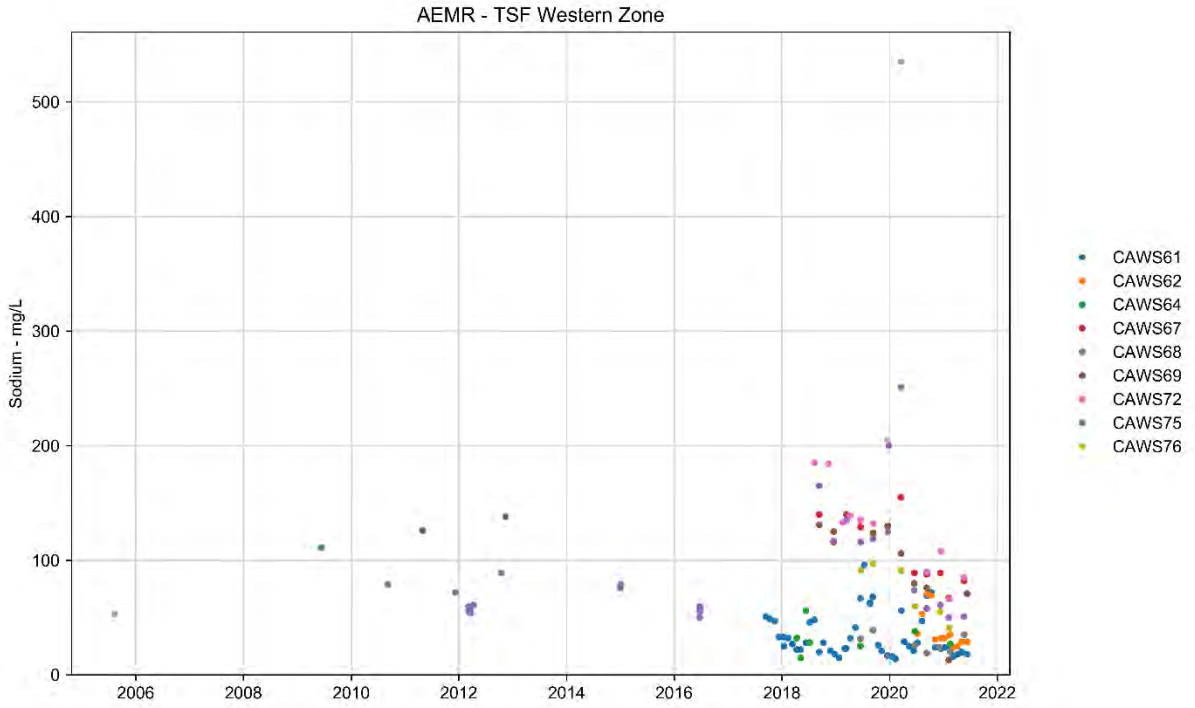

AEMR - TSF Western Zone
pH - Field - pH units
0
2
4
6
8
10
2019-01
2019-04
2019-07
2019-10
2020-01
2020-04
2020-07
2020-10
2021-01
2021-04
2021-07
CAWS61
CAWS62
CAWS64
CAWS67
CAWS68
CAWS69
CAWS72
CAWS75
CAWS76

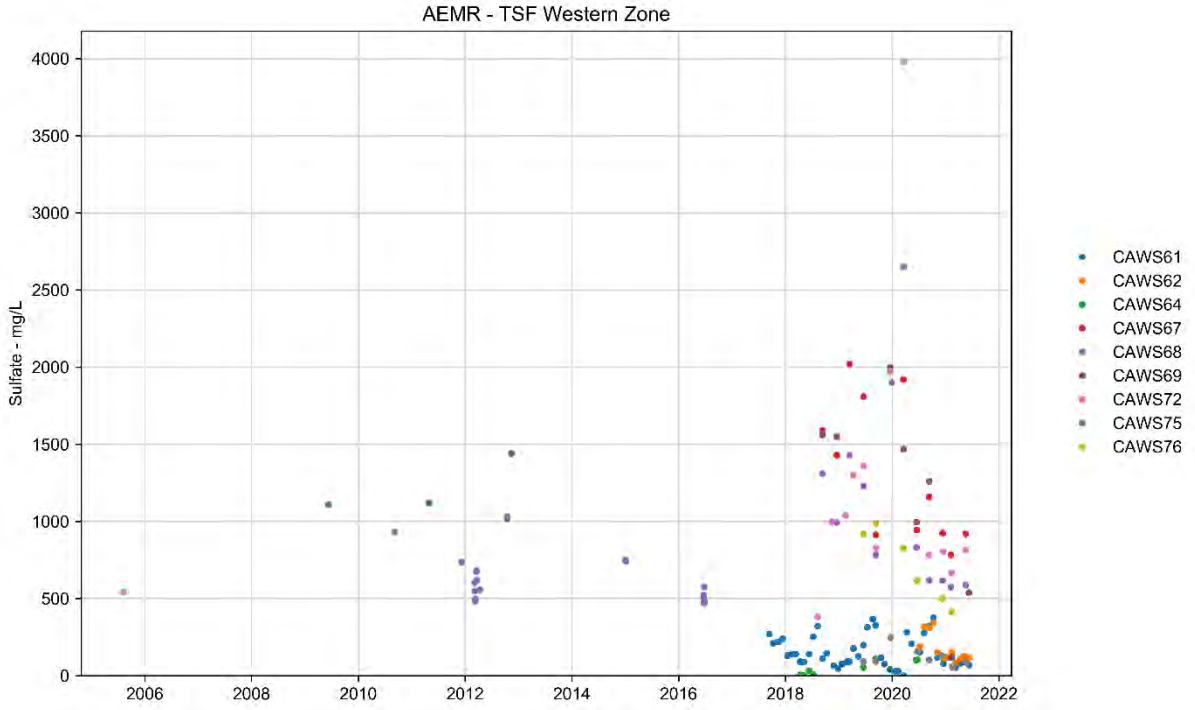

AEMR - TSF Western Zone
Potassium - mg/L
0
5
10
15
20
25
30
35
40
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS61
CAWS62
CAWS64
CAWS67
CAWS68
CAWS69
CAWS72
CAWS75
CAWS76

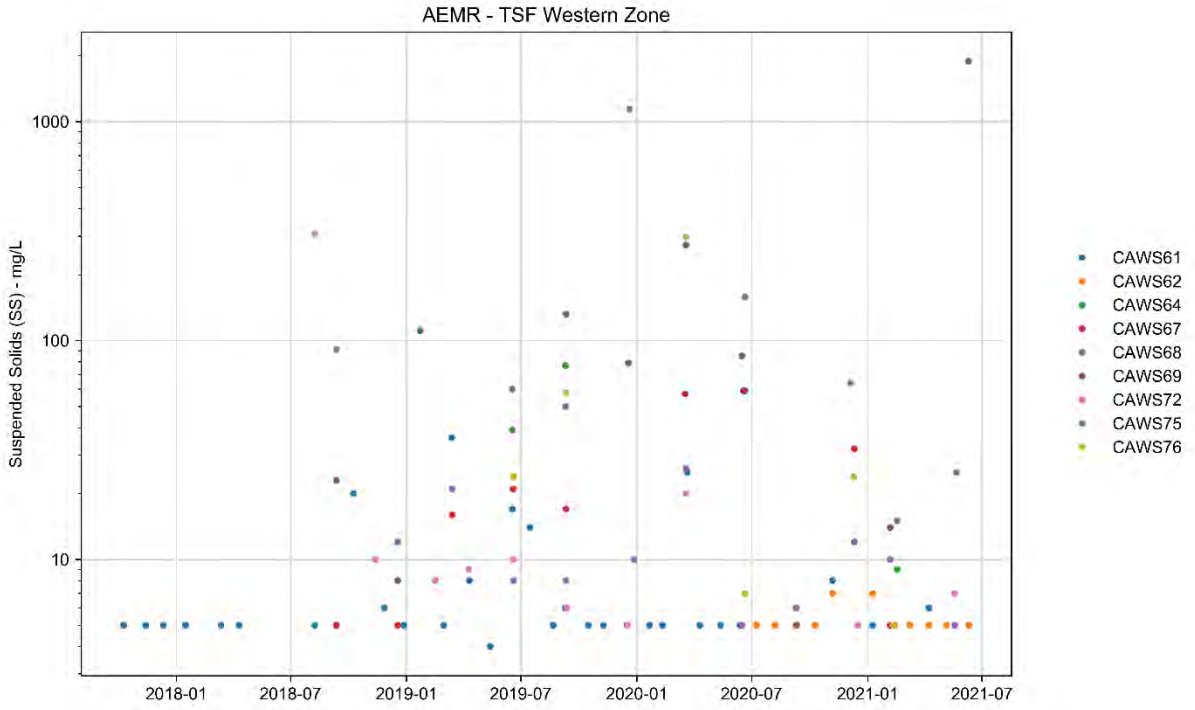

AEMR - TSF Western Zone
Redox Potential - mV
1000
100
10
2019-01
2019-04
2019-07
2019-10
2020-01
2020-04
2020-07
2020-10
2021-01
2021-04
2021-07
CAWS61
CAWS64
CAWS67
CAWS68
CAWS69
CAWS72
CAWS75

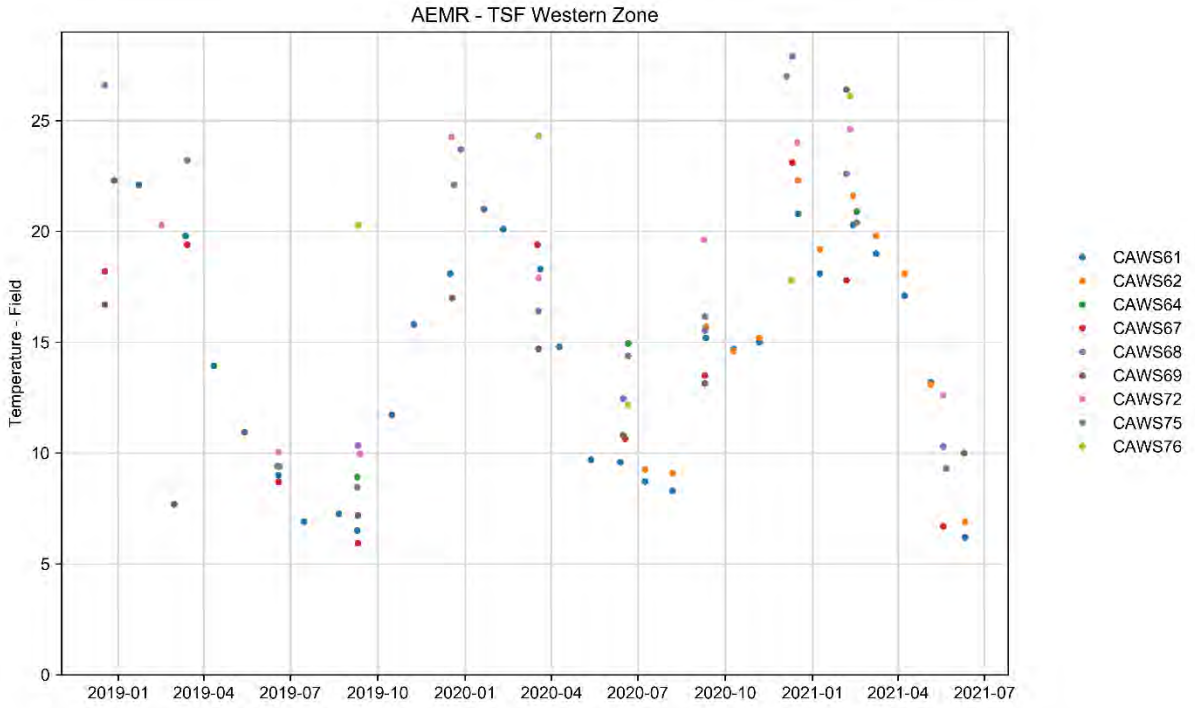

AEMR - TSF Western Zone
Selenium - mg/L
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2010
2012
2014
2016
2018
2020
2022
CAWS61
CAWS62
CAWS64
CAWS67
CAWS68
CAWS69
CAWS72
CAWS75
CAWS76

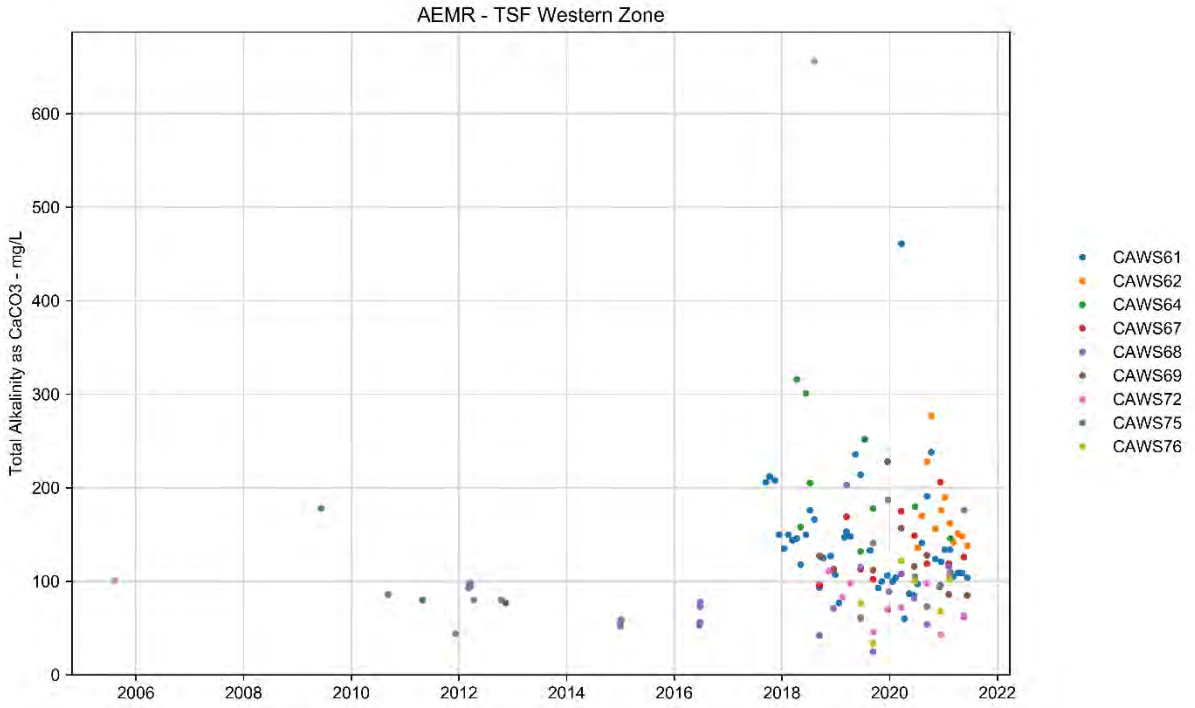

AEMR - TSF Western Zone
Silver - mg/L
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
2010
2012
2014
2016
2018
2020
2022
CAWS61
CAWS62
CAWS64
CAWS67
CAWS68
CAWS69
CAWS72
CAWS75
CAWS76

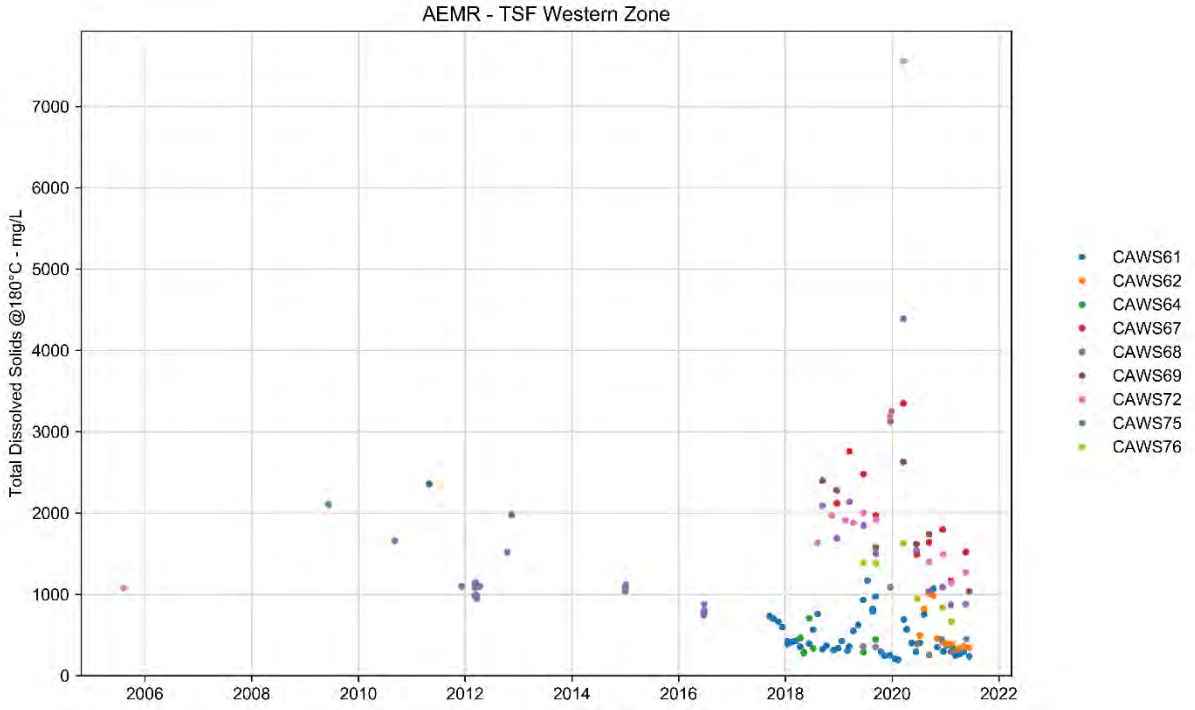

AEMR - TSF Western Zone
Sodium - mg/L
0
100
200
300
400
500
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS61
CAWS62
CAWS64
CAWS67
CAWS68
CAWS69
CAWS72
CAWS75
CAWS76

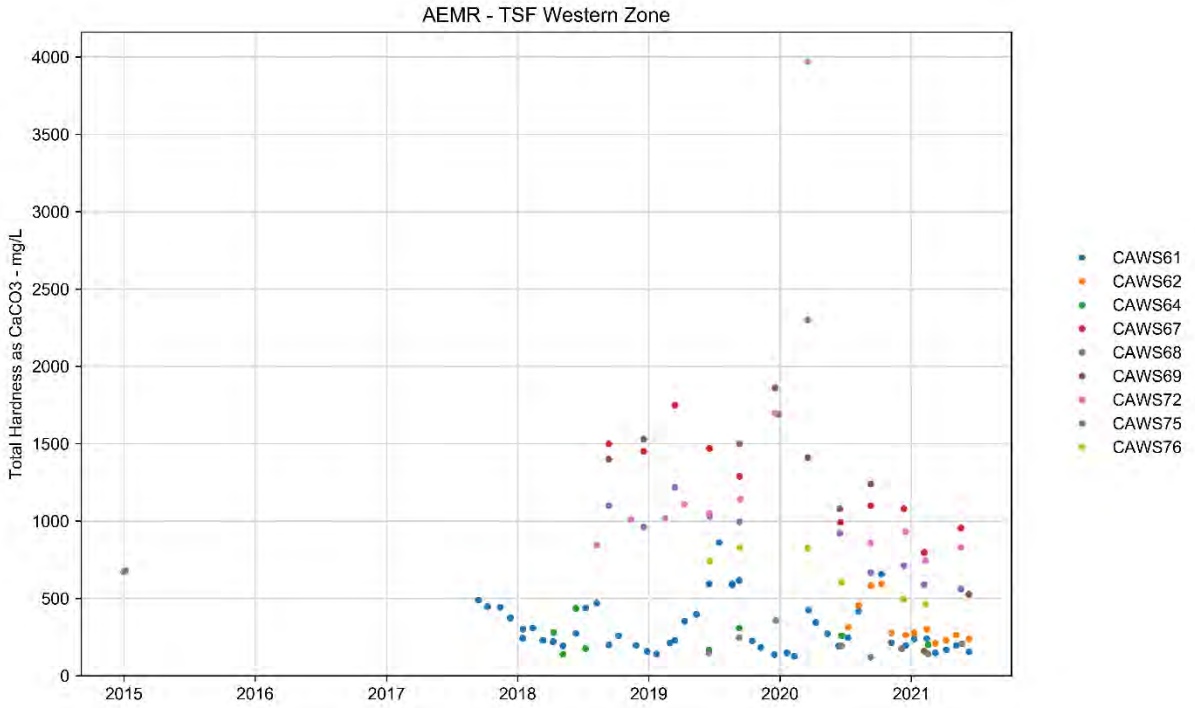

AEMR - TSF Western Zone
Sulfate - mg/L
0
500
1000
1500
2000
2500
3000
3500
4000
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS61
CAWS62
CAWS64
CAWS67
CAWS68
CAWS69
CAWS72
CAWS75
CAWS76

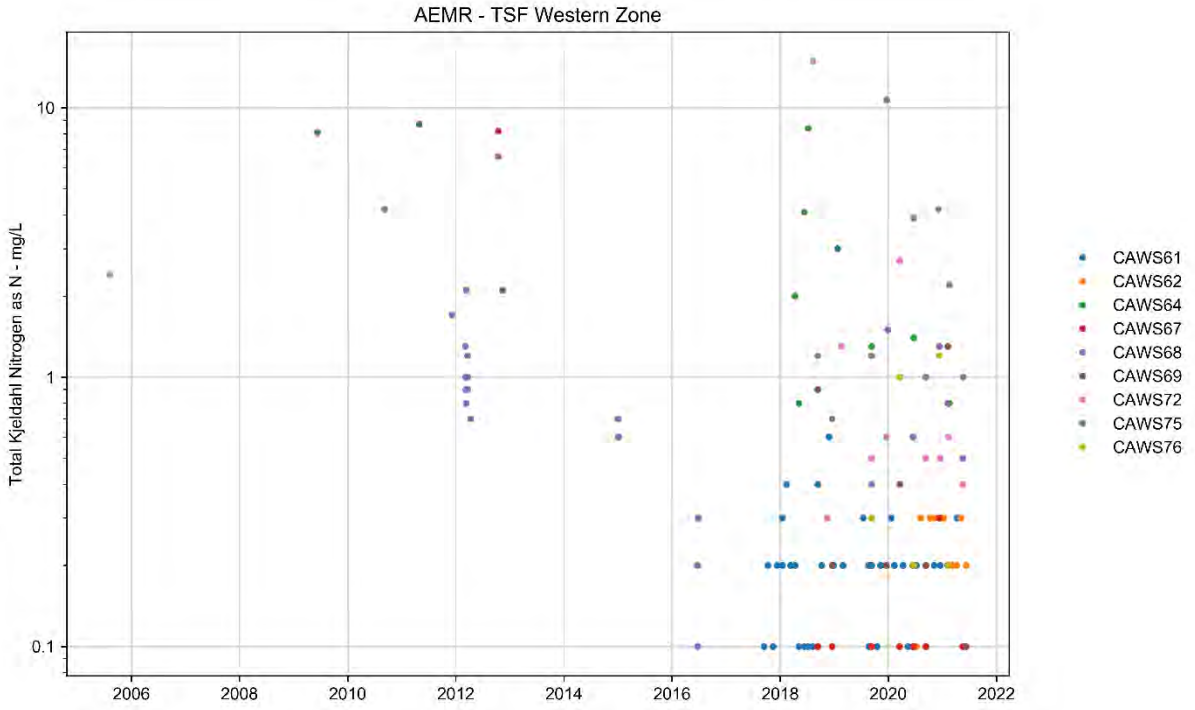

AEMR - TSF Western Zone
Suspended Solids (SS) - mg/L
1000
100
10
2018-01
2018-07
2019-01
2019-07
2020-01
2020-07
2021-01
2021-07
CAWS61
CAWS62
CAWS64
CAWS67
CAWS68
CAWS69
CAWS72
CAWS75
CAWS76

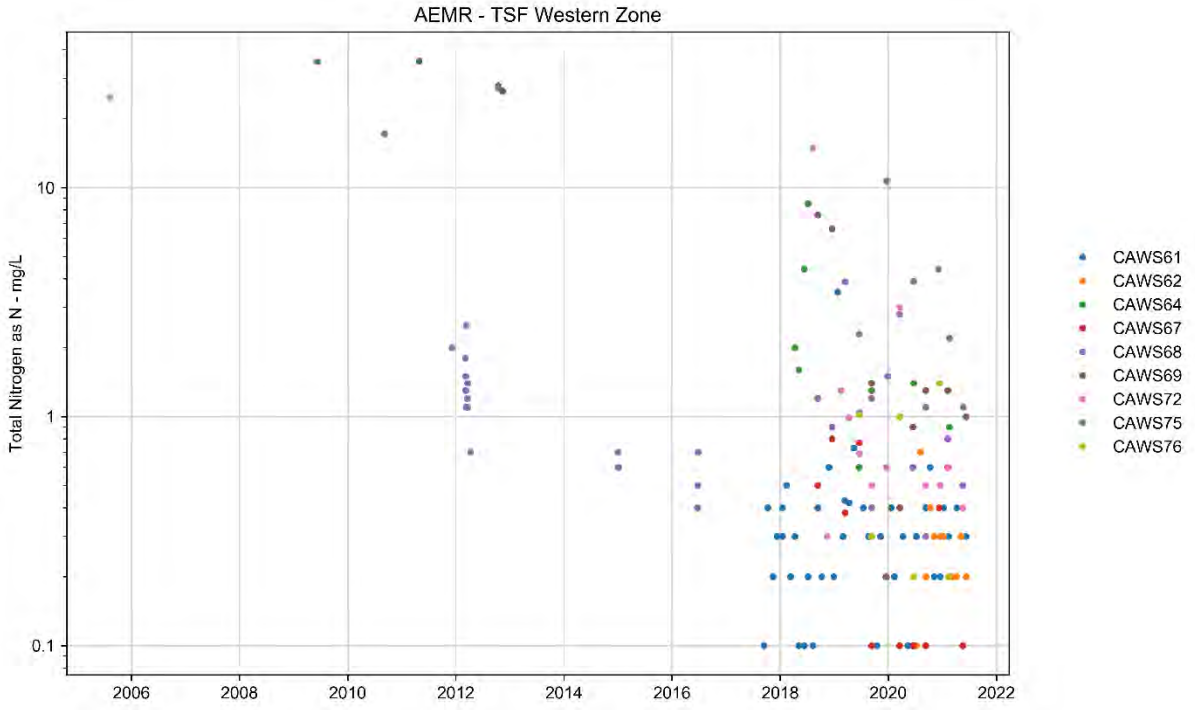

AEMR - TSF Western Zone
Temperature - Field
25
20
15
10
5
0
2019-01
2019-04
2019-07
2019-10
2020-01
2020-04
2020-07
2020-10
2021-01
2021-04
2021-07
CAWS61
CAWS62
CAWS64
CAWS67
CAWS68
CAWS69
CAWS72
CAWS75
CAWS76

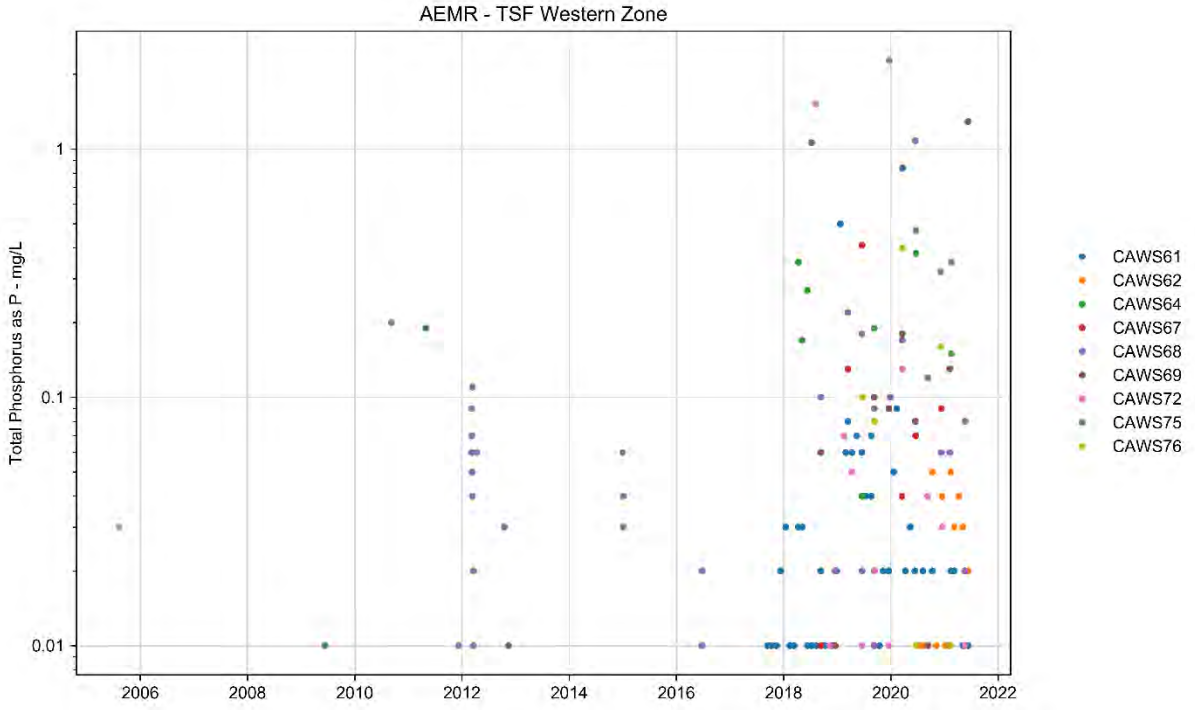

AEMR - TSF Western Zone
Total Alkalinity as CaCO3 - mg/L
0
100
200
300
400
500
600
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS61
CAWS62
CAWS64
CAWS67
CAWS68
CAWS69
CAWS72
CAWS75
CAWS76

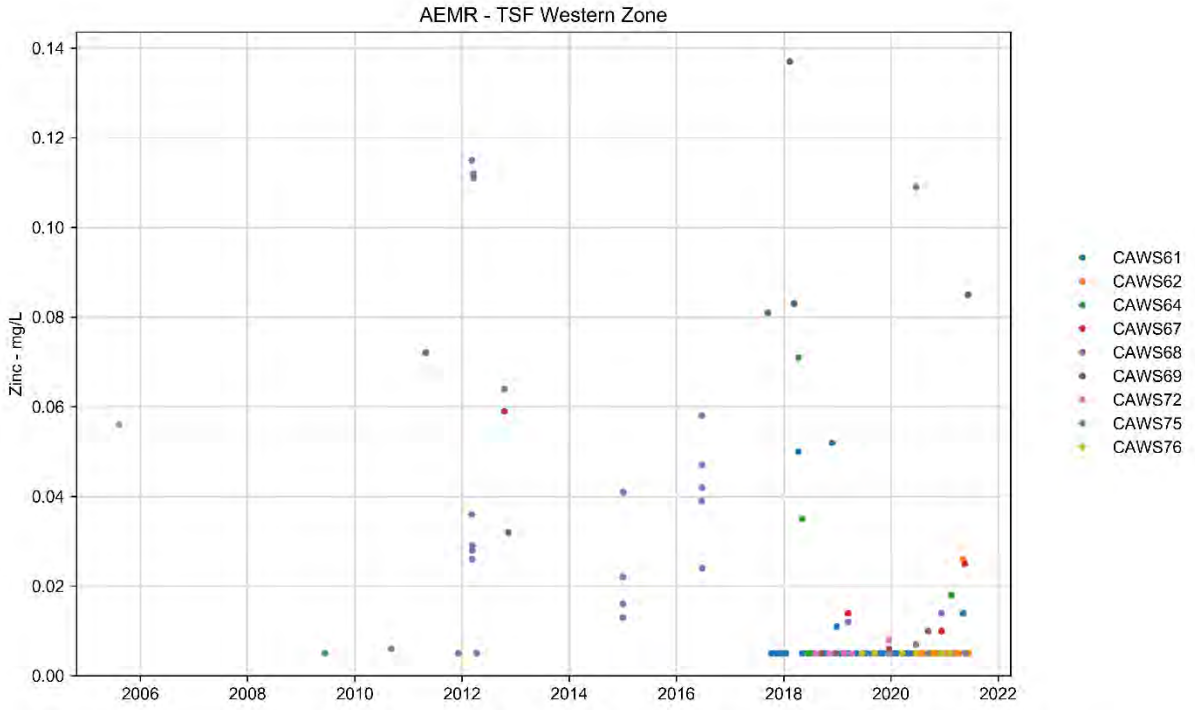

AEMR - TSF Western Zone
Total Dissolved Solids @180°C - mg/L
0
1000
2000
3000
4000
5000
6000
7000
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS61
CAWS62
CAWS64
CAWS67
CAWS68
CAWS69
CAWS72
CAWS75
CAWS76

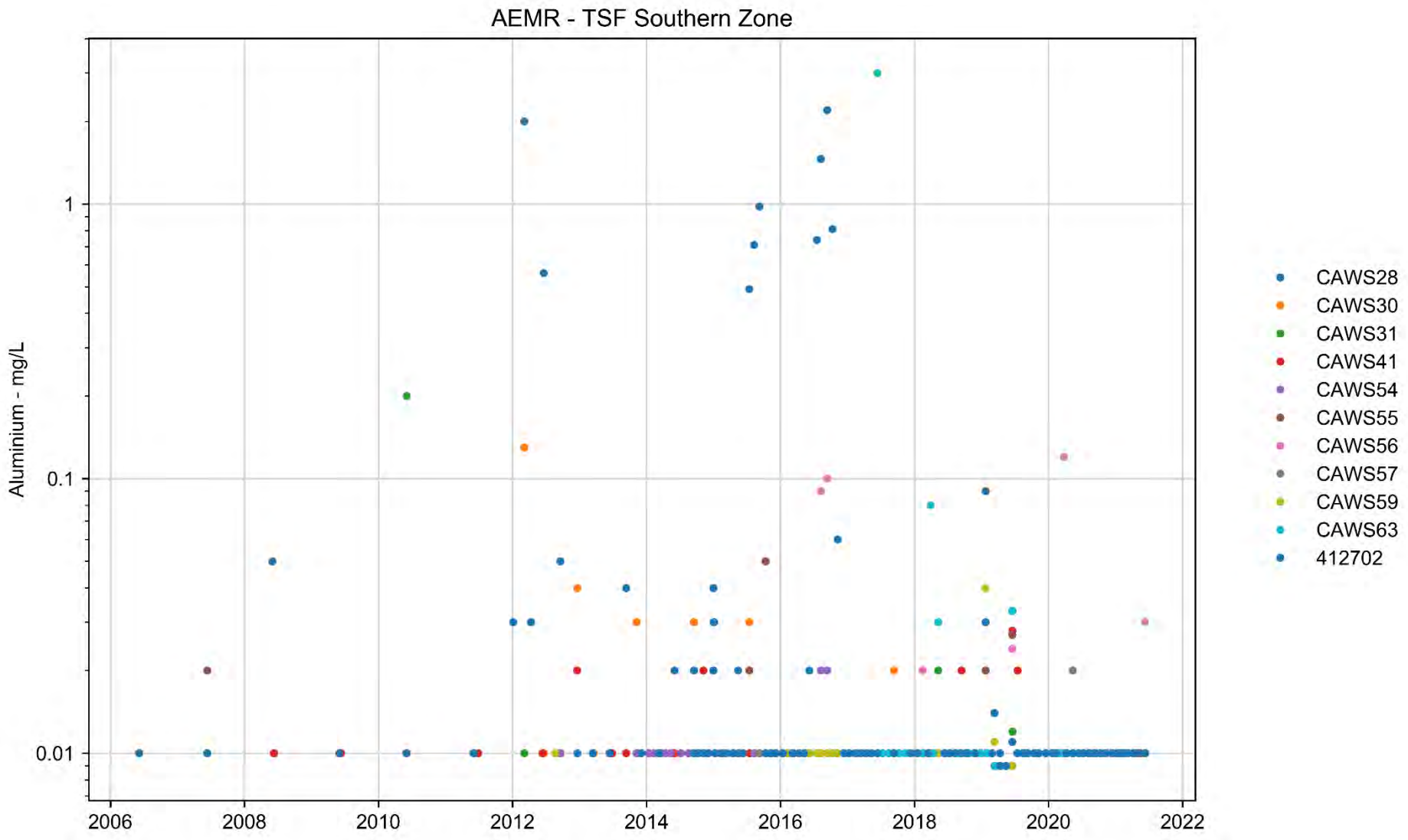

AEMR - TSF Western Zone
Total Hardness as CaCO3 - mg/L
4000
3500
3000
2500
2000
1500
1000
500
0
2015
2016
2017
2018
2019
2020
2021
CAWS61
CAWS62
CAWS64
CAWS67
CAWS68
CAWS69
CAWS72
CAWS75
CAWS76

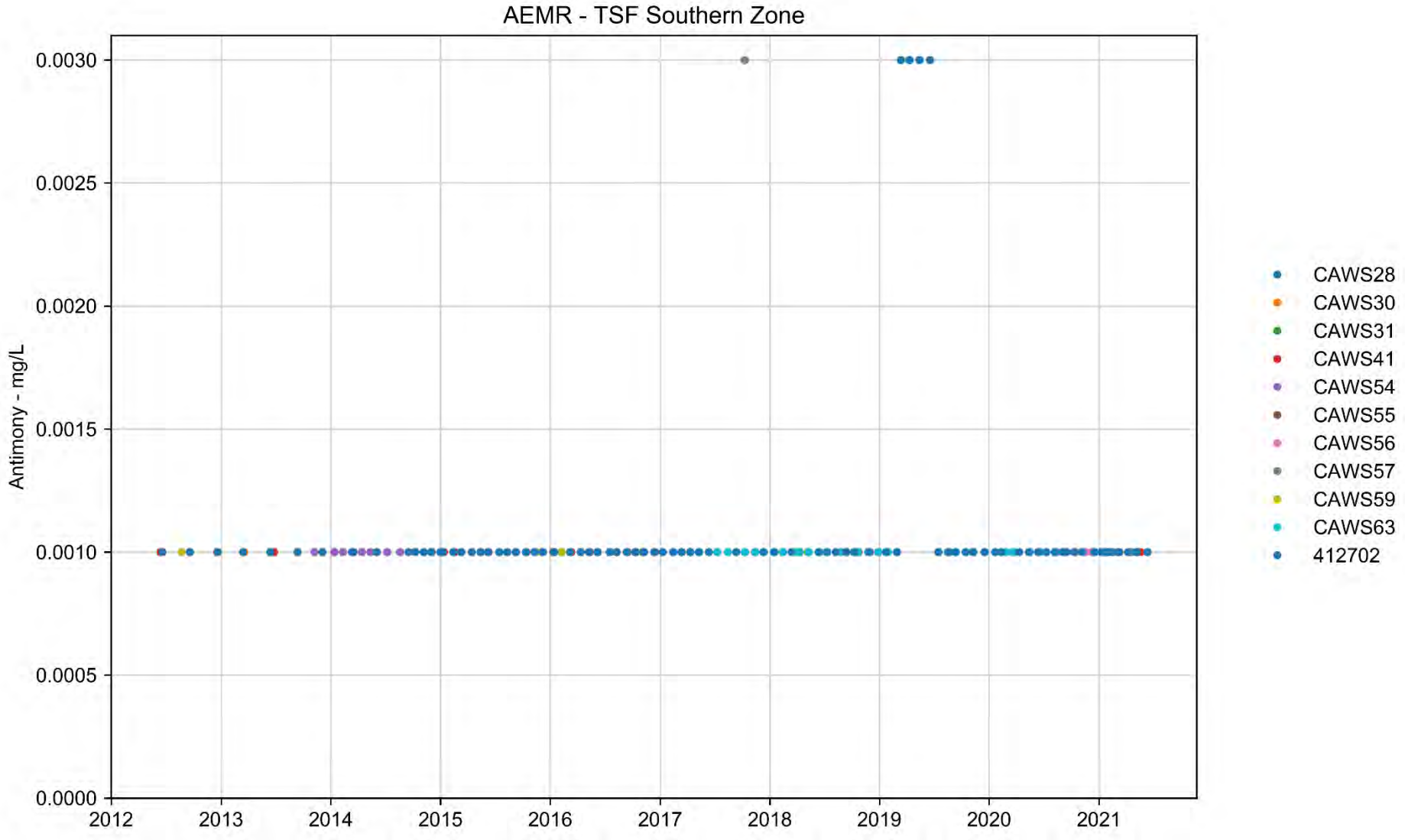

AEMR - TSF Western Zone
Total Kjeldahl Nitrogen as N - mg/L
10
1
0.1
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS61
CAWS62
CAWS64
CAWS67
CAWS68
CAWS69
CAWS72
CAWS75
CAWS76

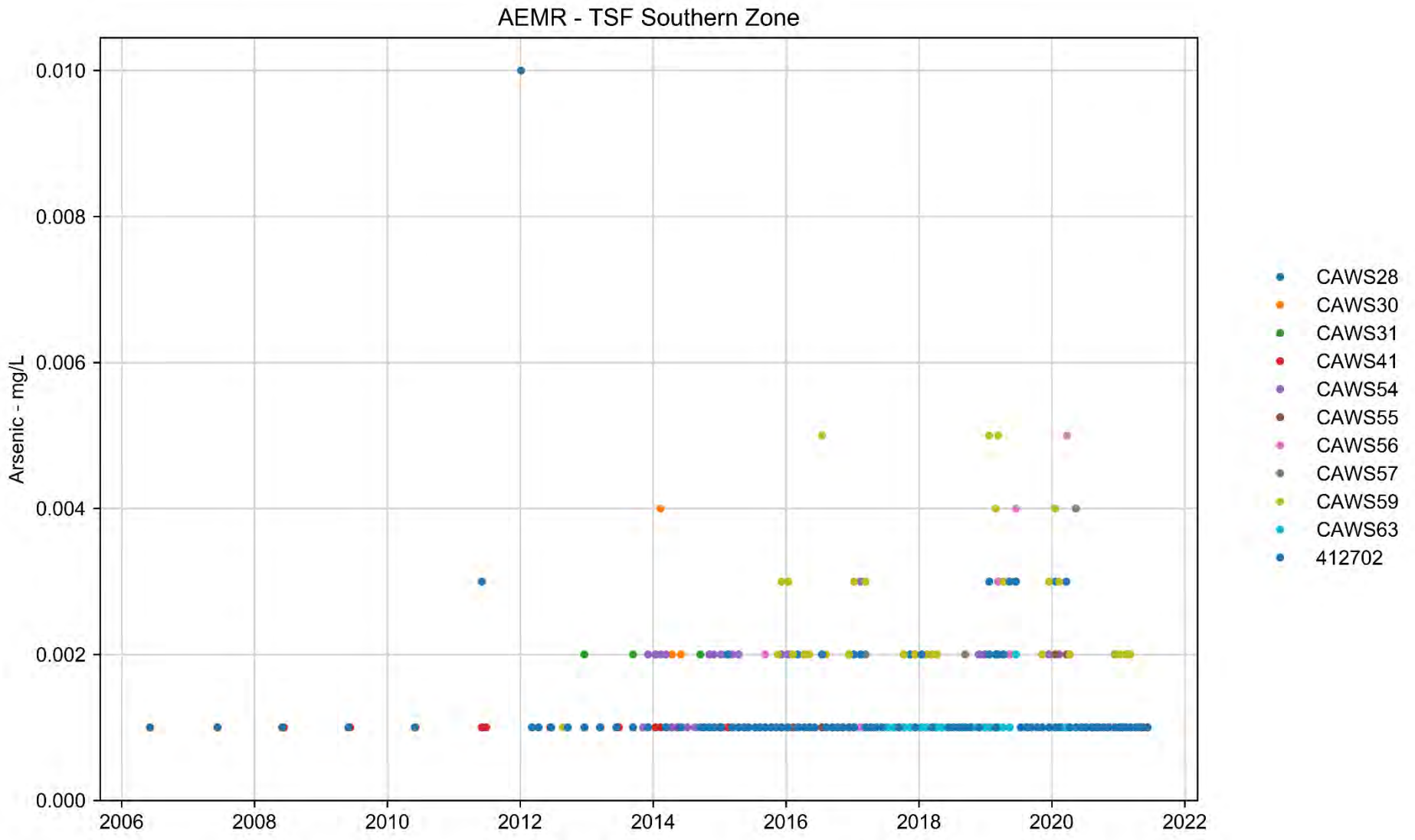

AEMR - TSF Western Zone
Total Nitrogen as N - mg/L
10
1
0.1
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS61
CAWS62
CAWS64
CAWS67
CAWS68
CAWS69
CAWS72
CAWS75
CAWS76


AEMR - TSF Western Zone
Total Phosphorus as P - mg/L
1
0.1
0.01
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS61
CAWS62
CAWS64
CAWS67
CAWS68
CAWS69
CAWS72
CAWS75
CAWS76

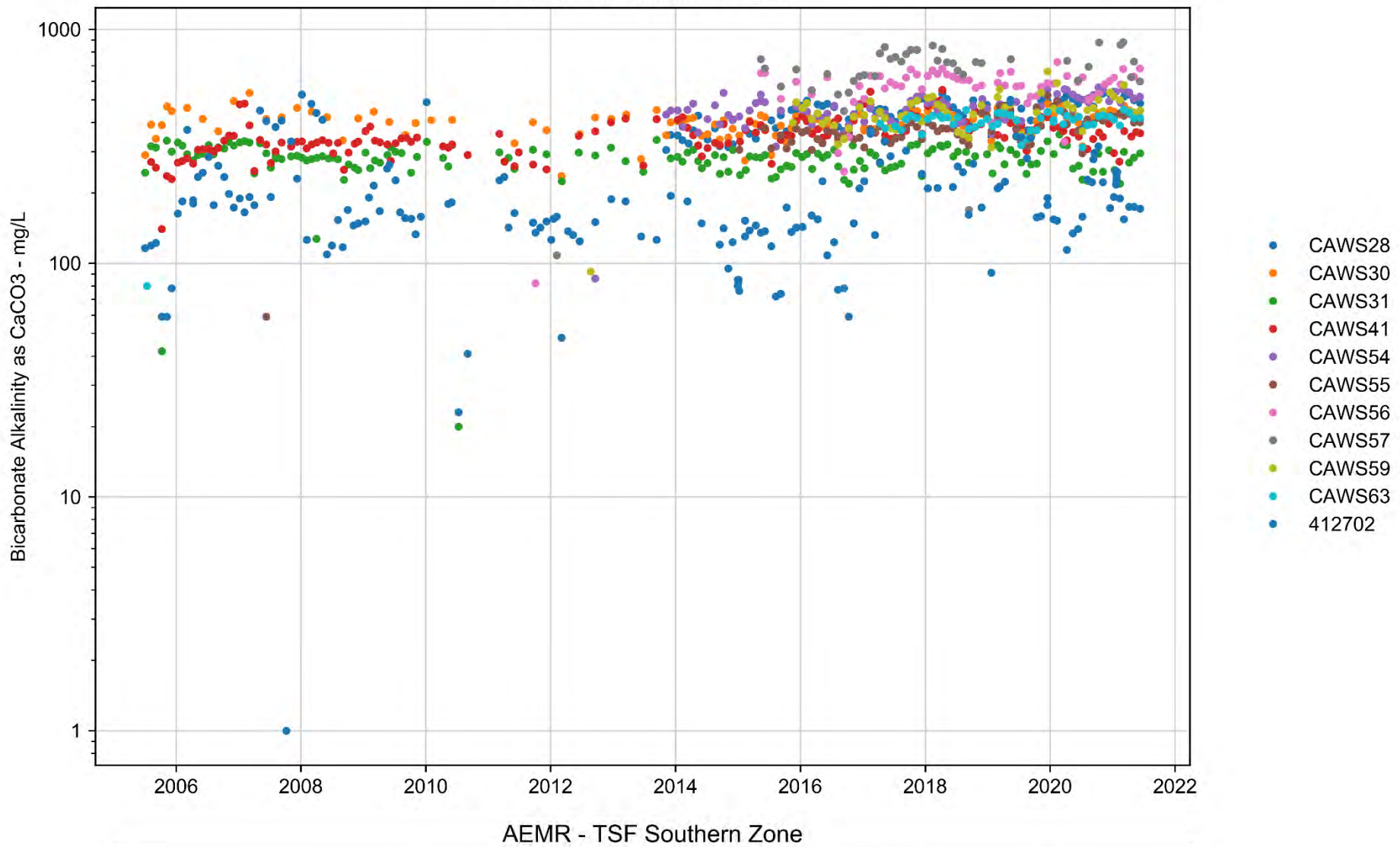

AEMR - TSF Western Zone
Zinc - mg/L
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS61
CAWS62
CAWS64
CAWS67
CAWS68
CAWS69
CAWS72
CAWS75
CAWS76


AEMR - TSF Southern Zone
Aluminium - mg/L
1
0.1
0.01
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS28
CAWS30
CAWS31
CAWS41
CAWS54
CAWS55
CAWS56
CAWS57
CAWS59
CAWS63
412702

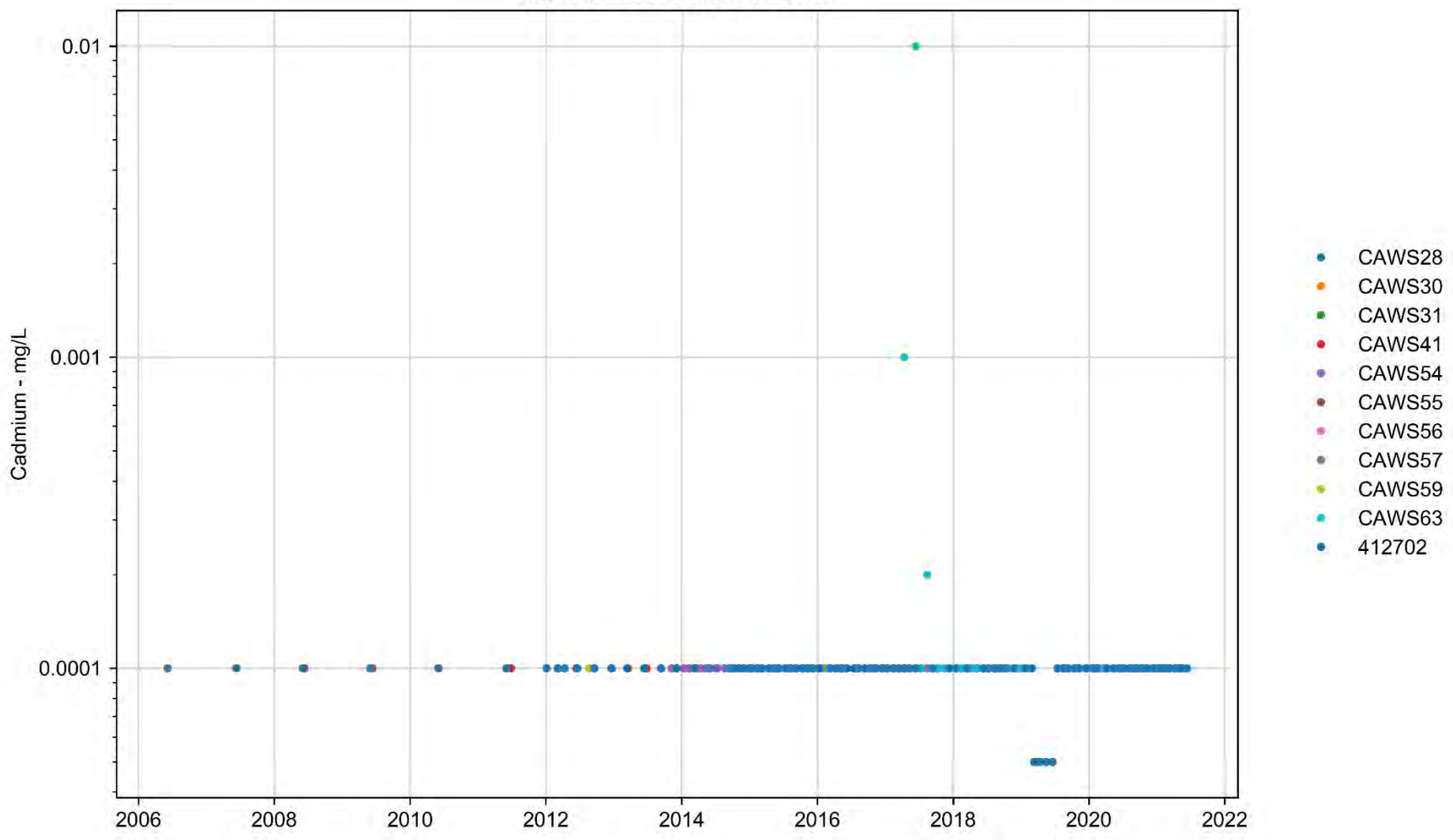

AEMR - TSF Southern Zone
Antimony - mg/L
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
CAWS28
CAWS30
CAWS31
CAWS41
CAWS54
CAWS55
CAWS56
CAWS57
CAWS59
CAWS63
412702


AEMR - TSF Southern Zone
Arsenic - mg/L
0.010
0.008
0.006
0.004
0.002
0.000
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS28
CAWS30
CAWS31
CAWS41
CAWS54
CAWS55
CAWS56
CAWS57
CAWS59
CAWS63
412702

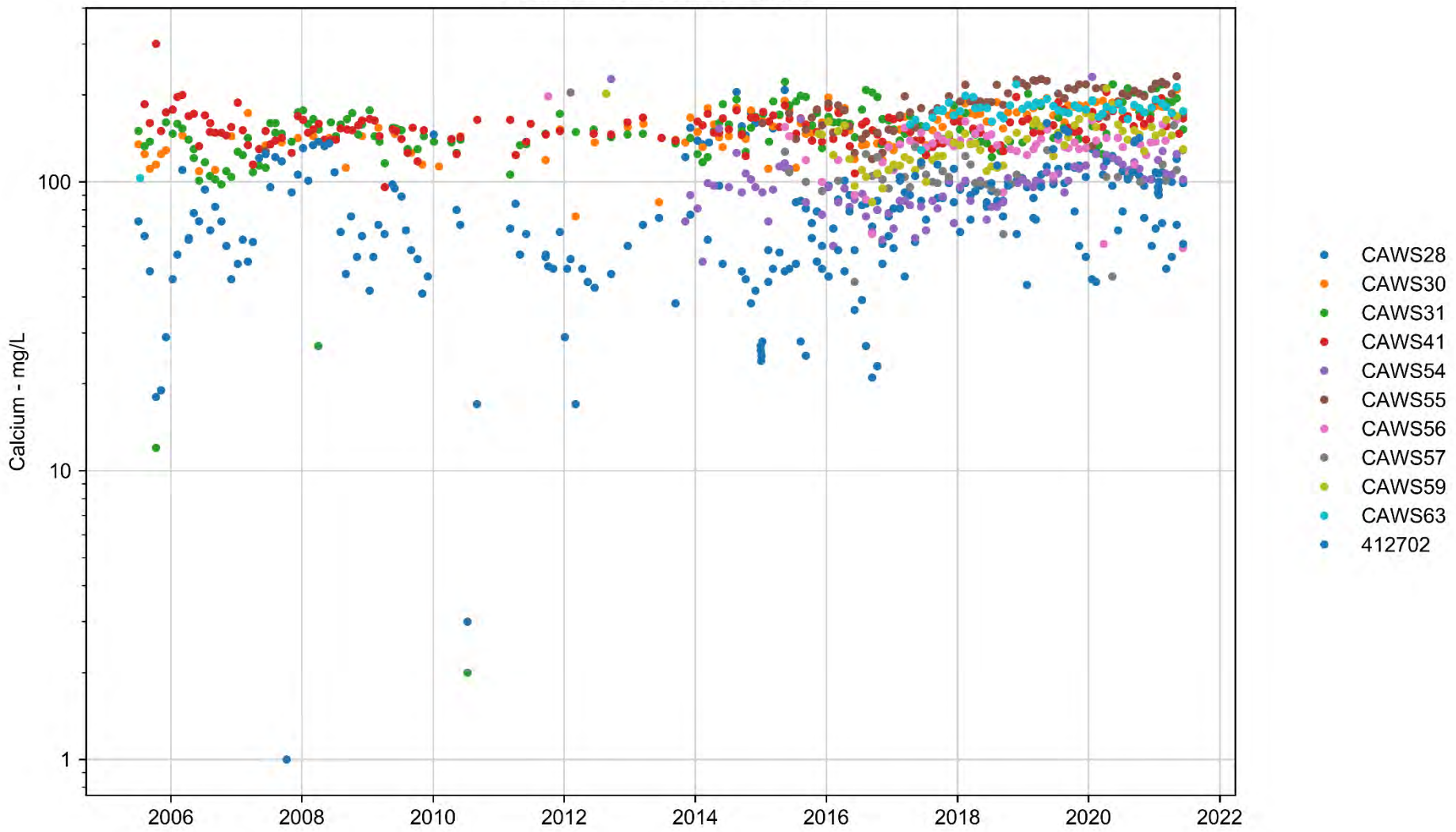
AEMR - TSF Southern Zone



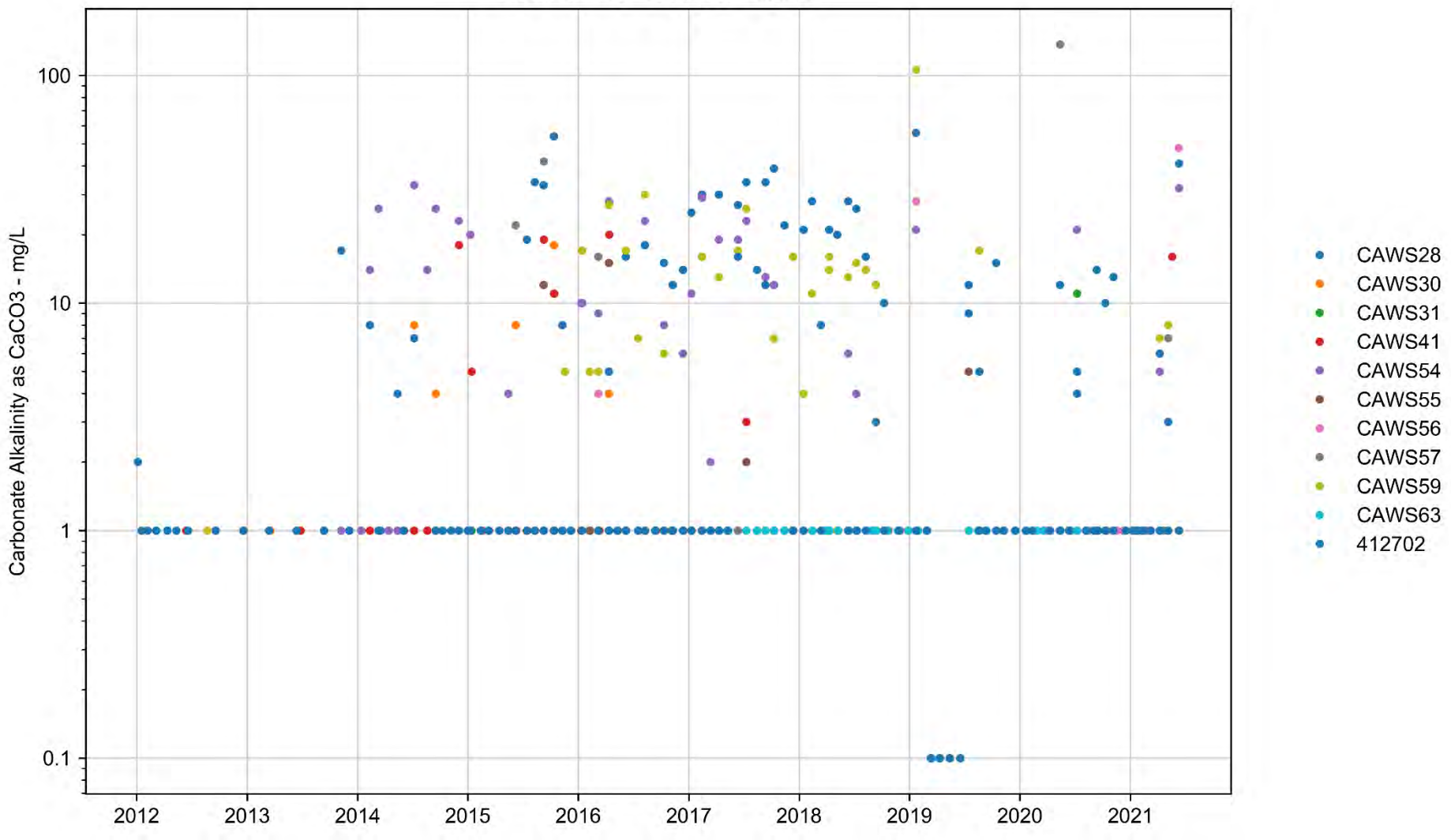
AEMR - TSF Southern Zone



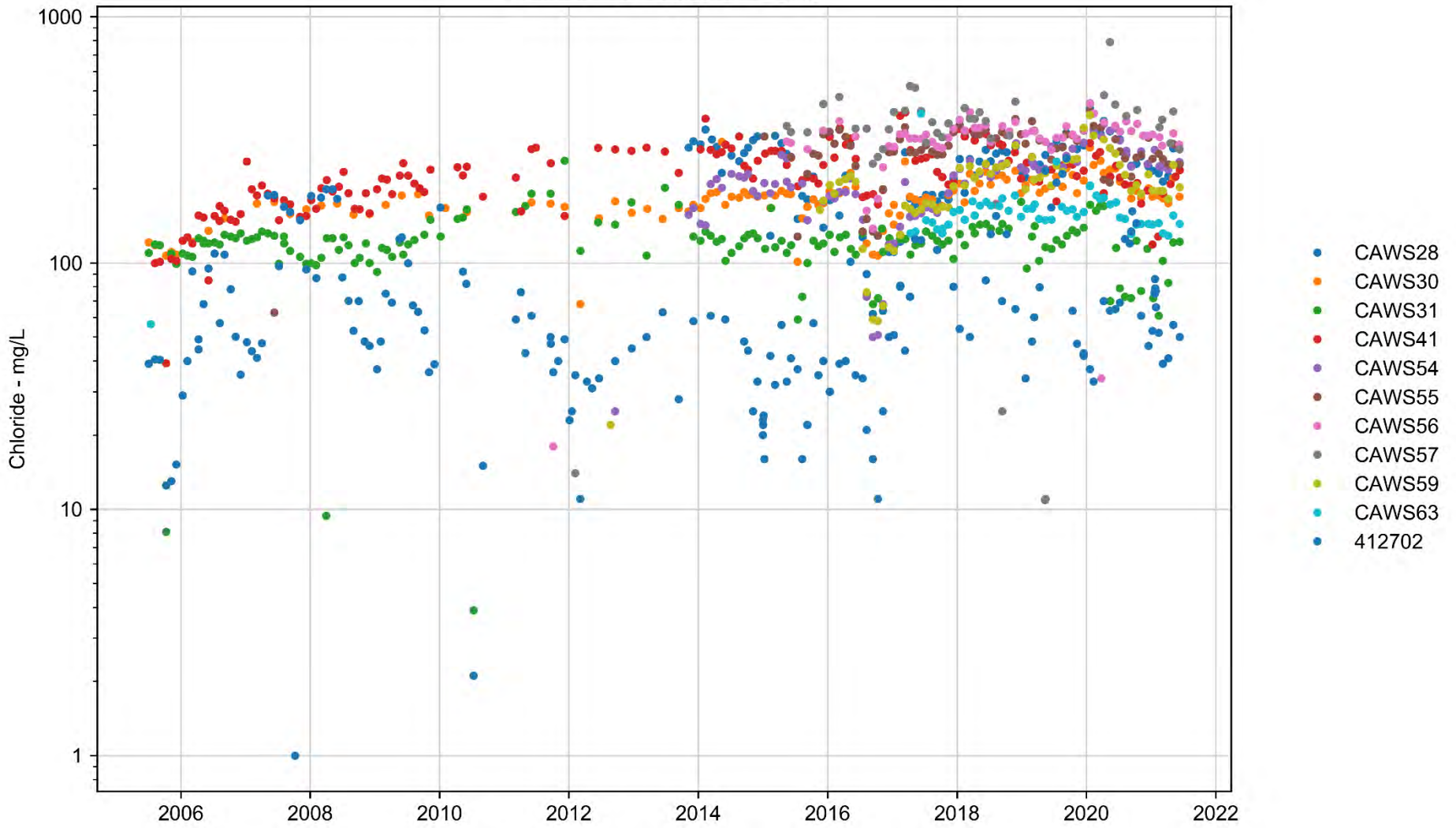
AEMR - TSF Southern Zone



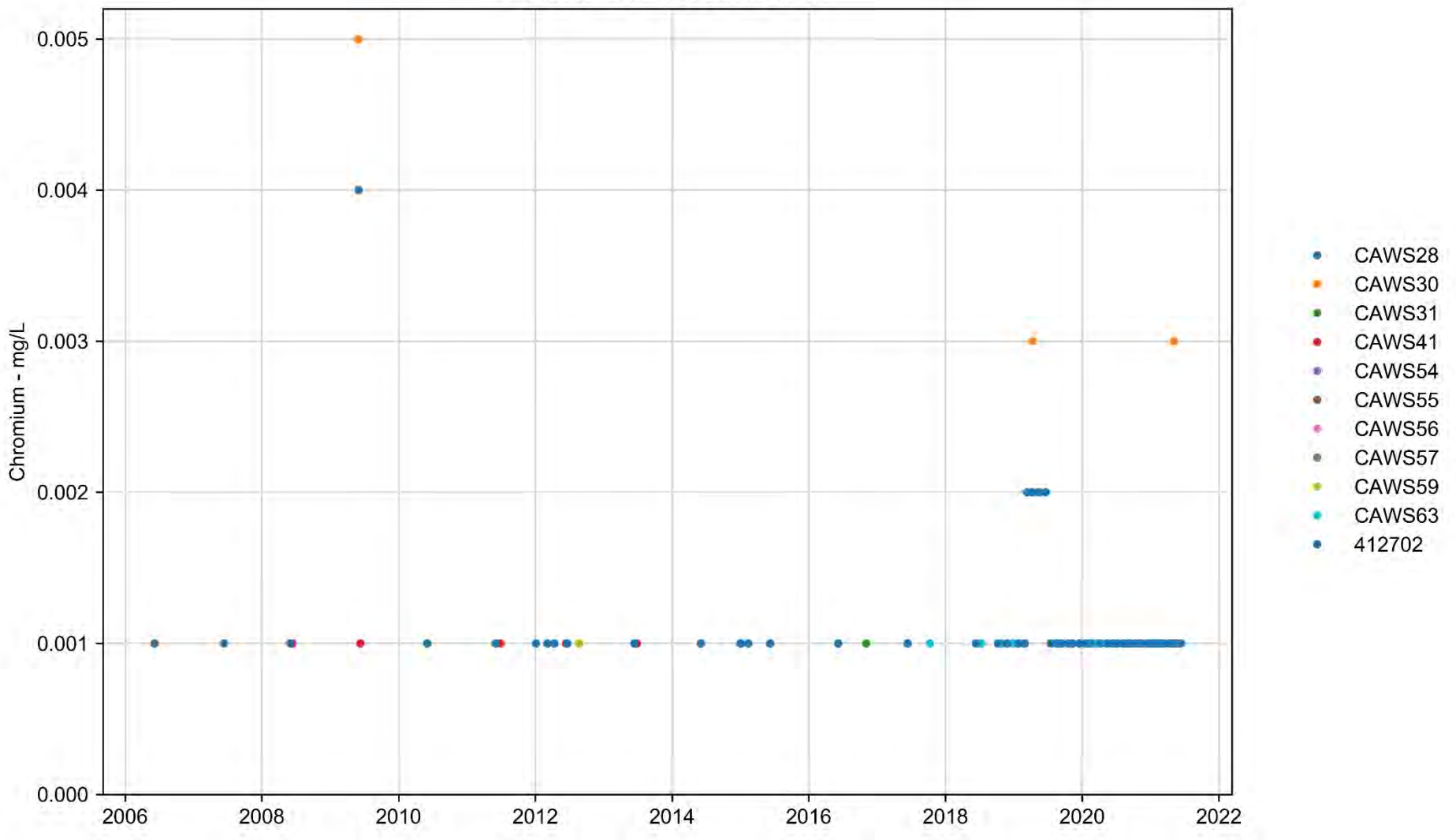
AEMR - TSF Southern Zone



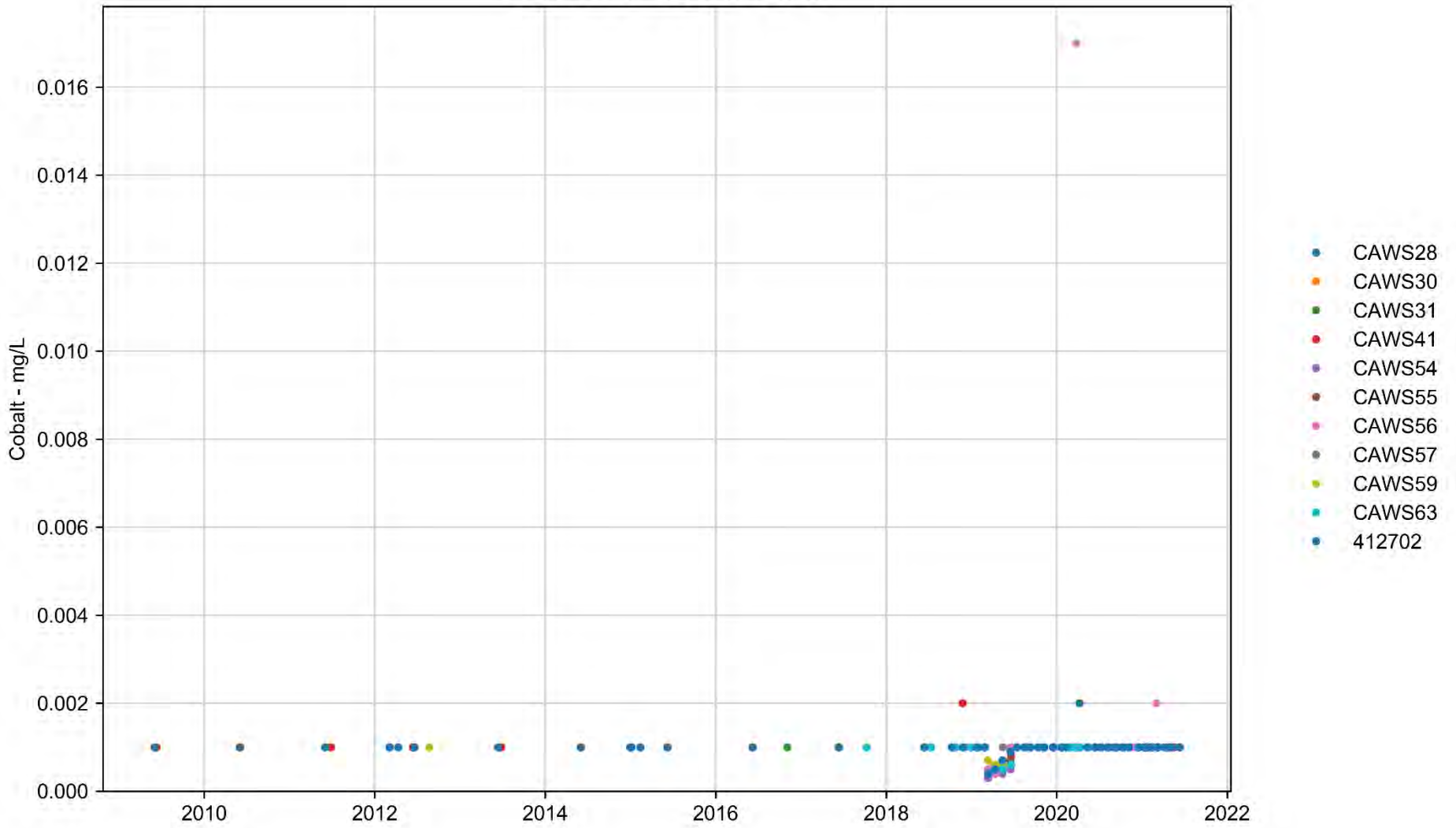
AEMR - TSF Southern Zone



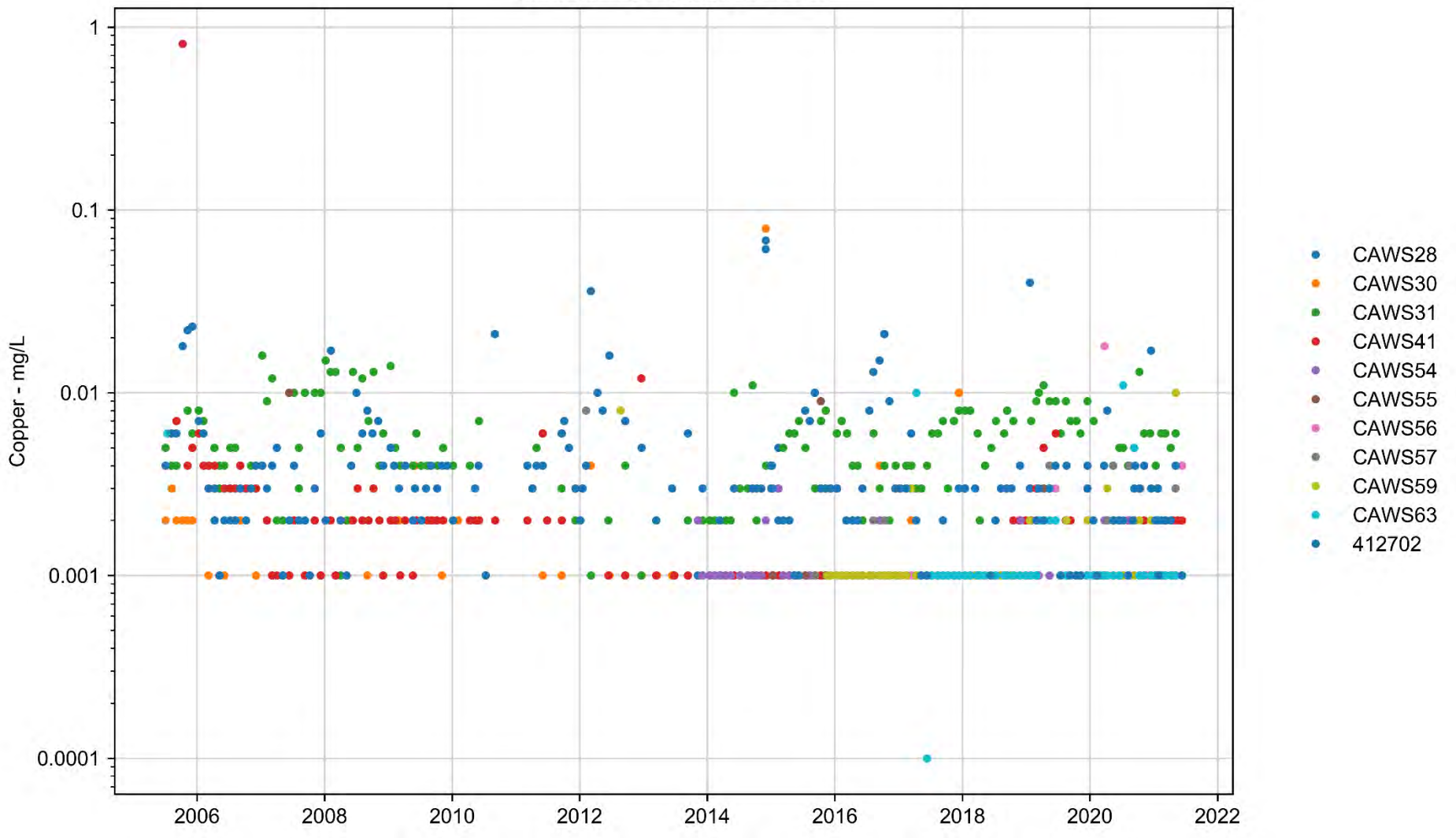
AEMR - TSF Southern Zone



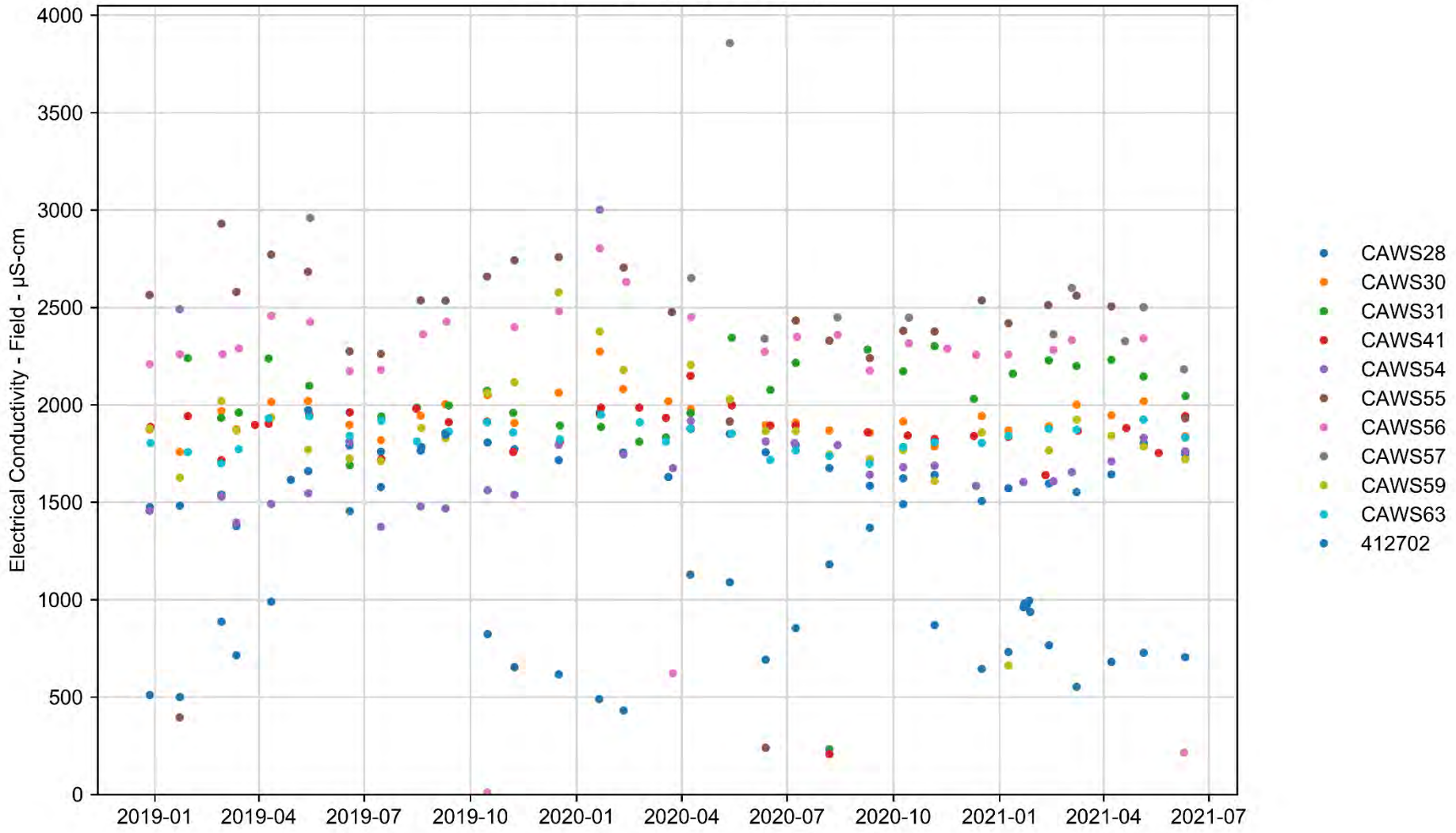
AEMR - TSF Southern Zone



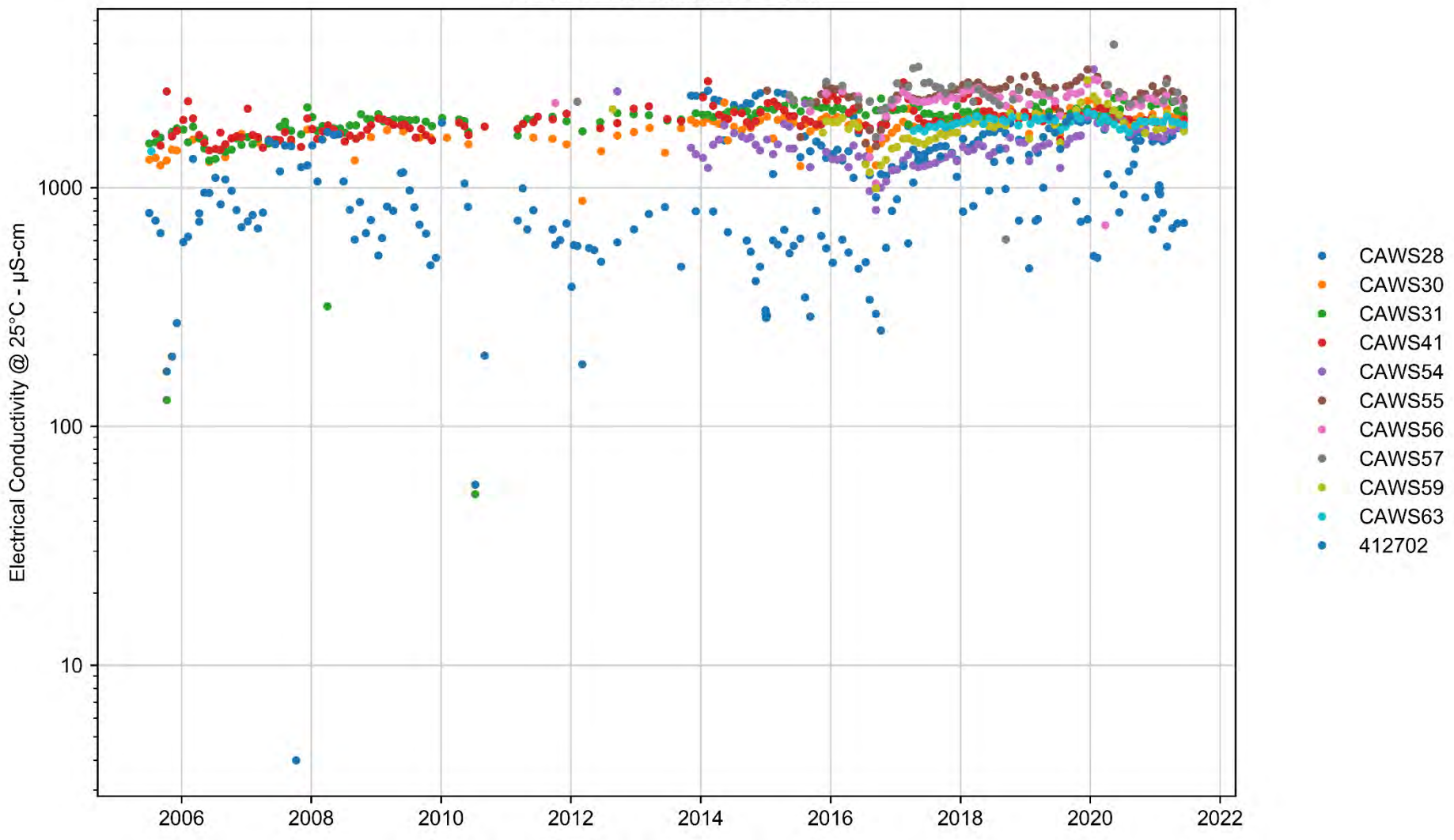
AEMR - TSF Southern Zone



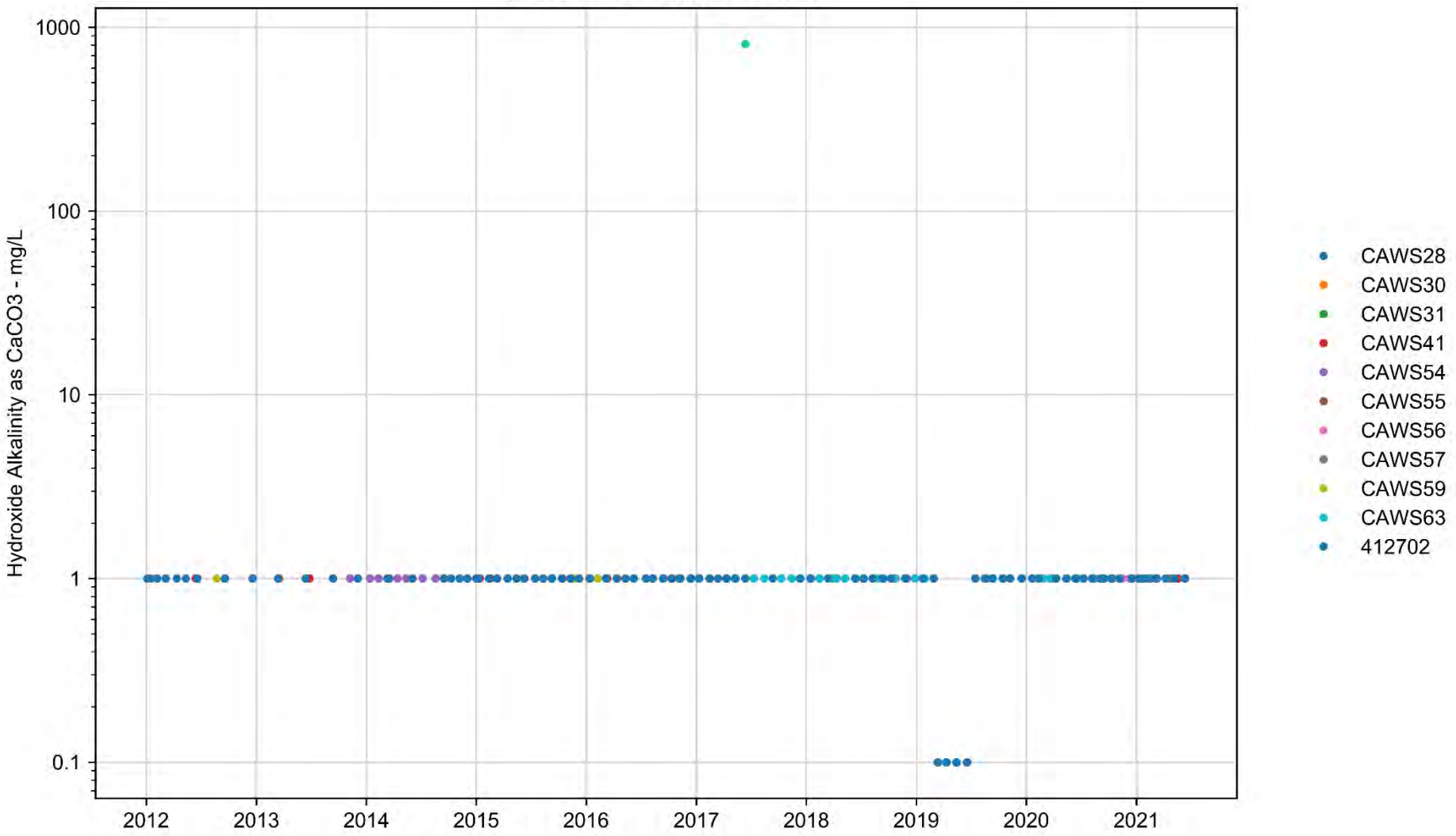
AEMR - TSF Southern Zone



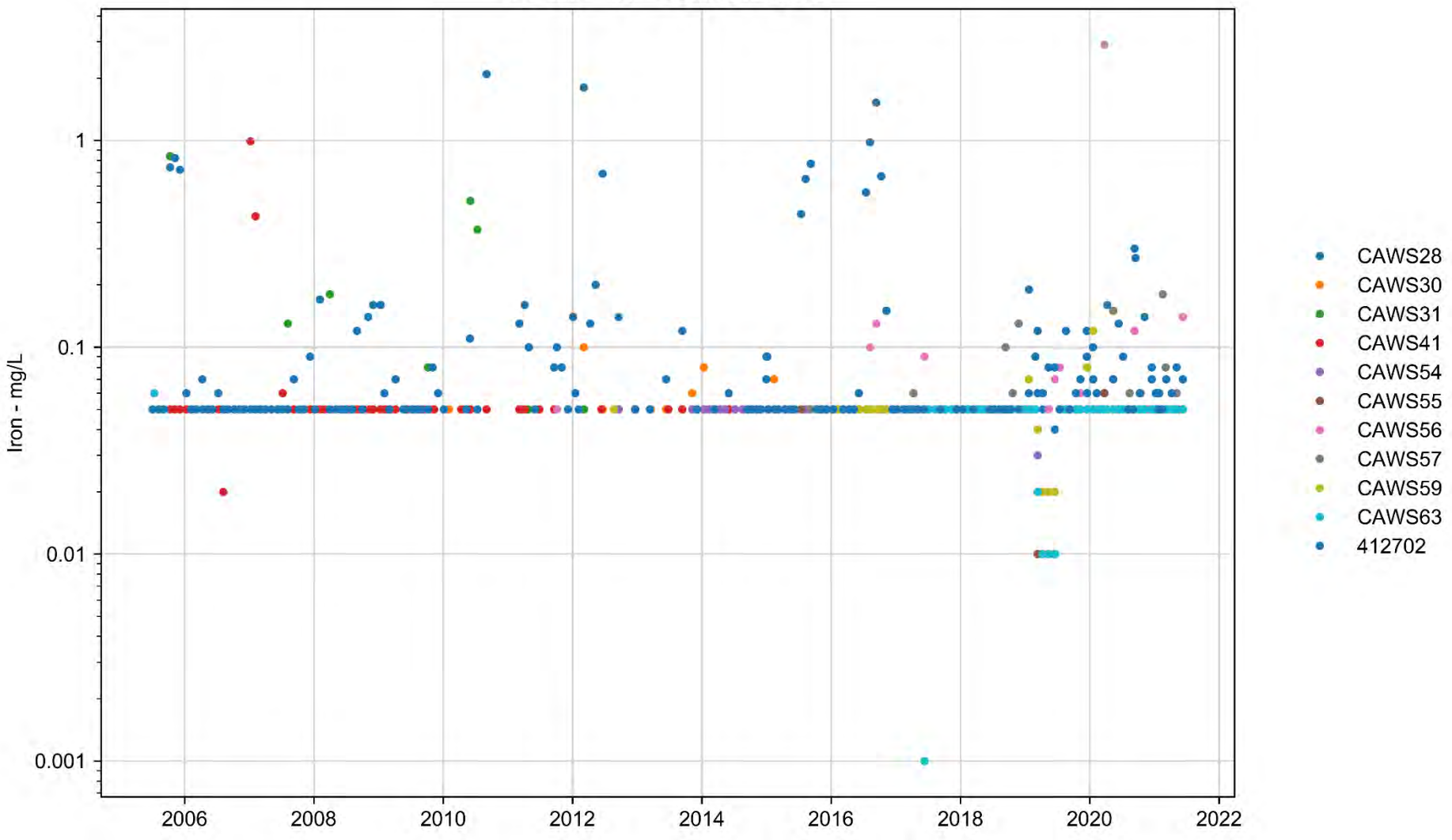
AEMR - TSF Southern Zone

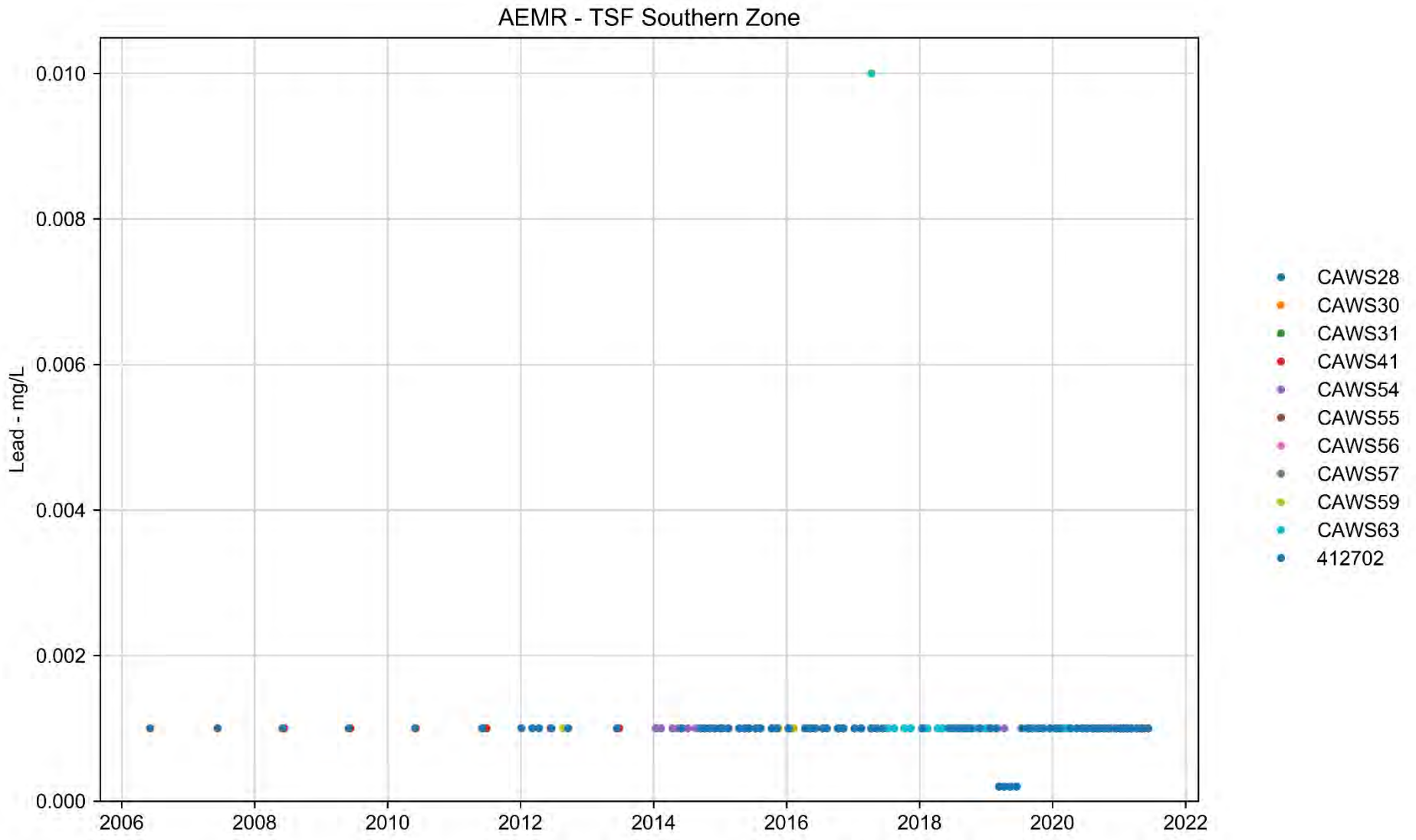


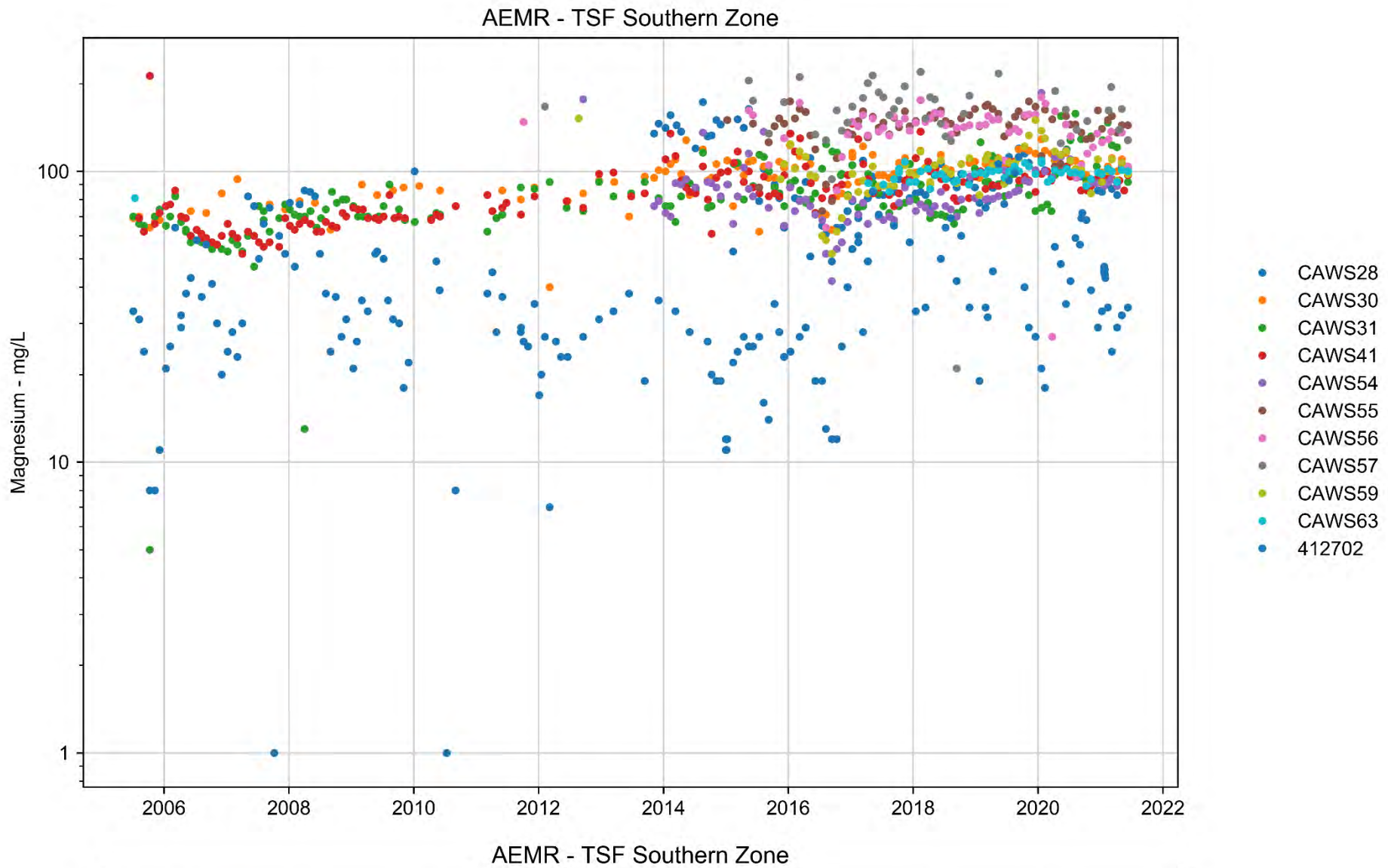
AEMR - TSF Southern Zone

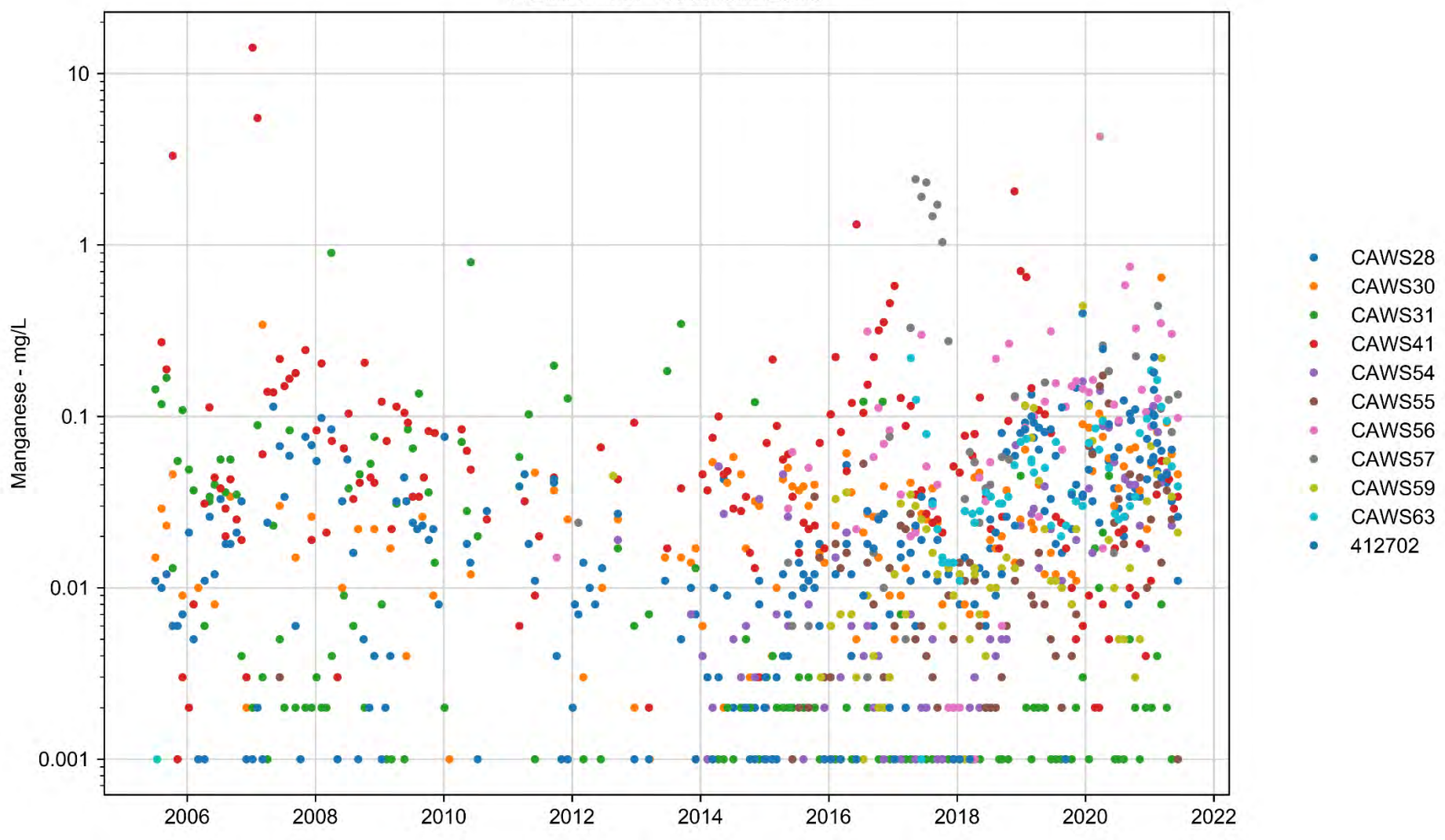


AEMR - TSF Southern Zone

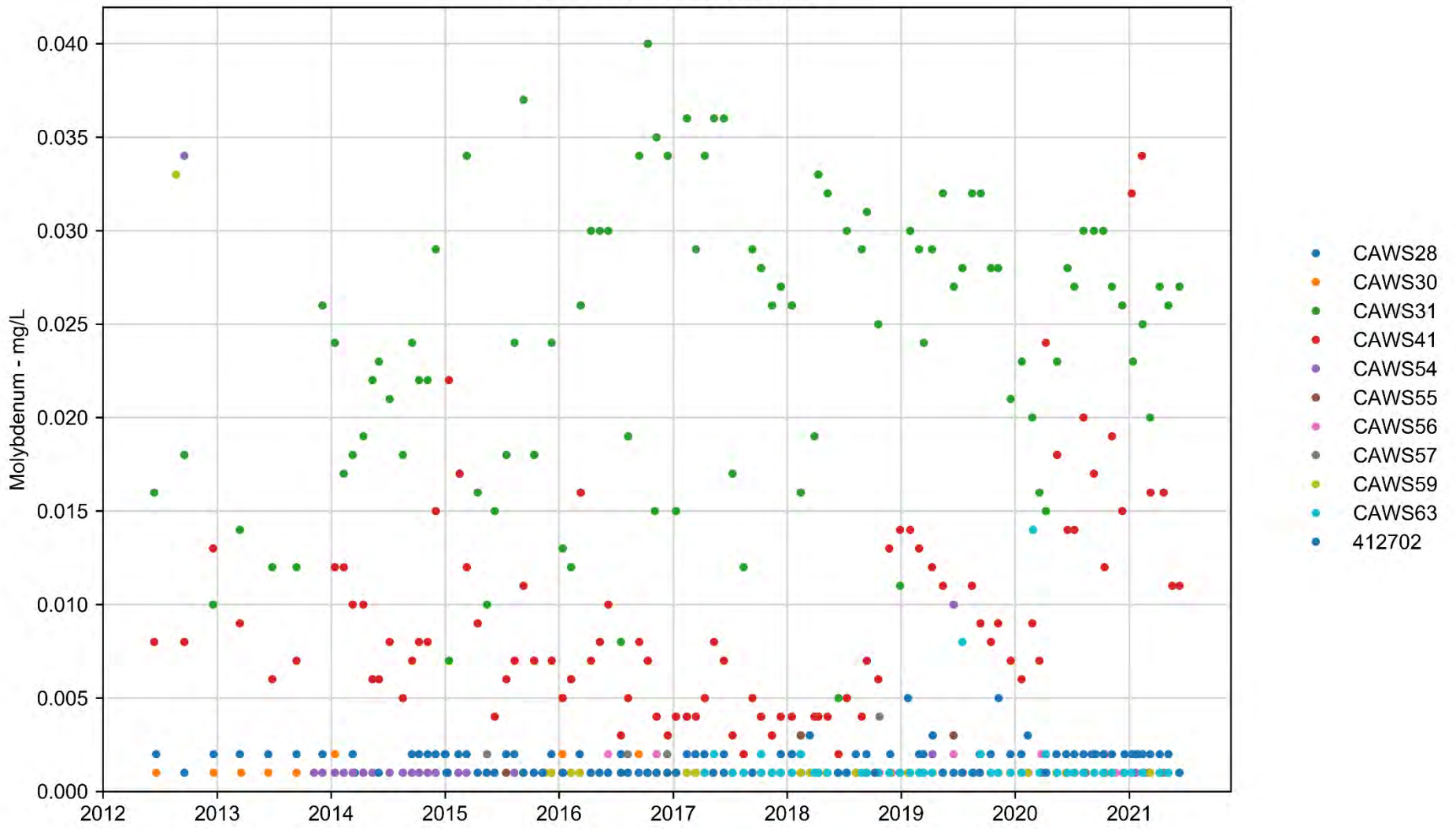



AEMR - TSF Southern Zone
Lead - mg/L
0.010
0.008
0.006
0.004
0.002
0.000
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS28
CAWS30
CAWS31
CAWS41
CAWS54
CAWS55
CAWS56
CAWS57
CAWS59
CAWS63
412702

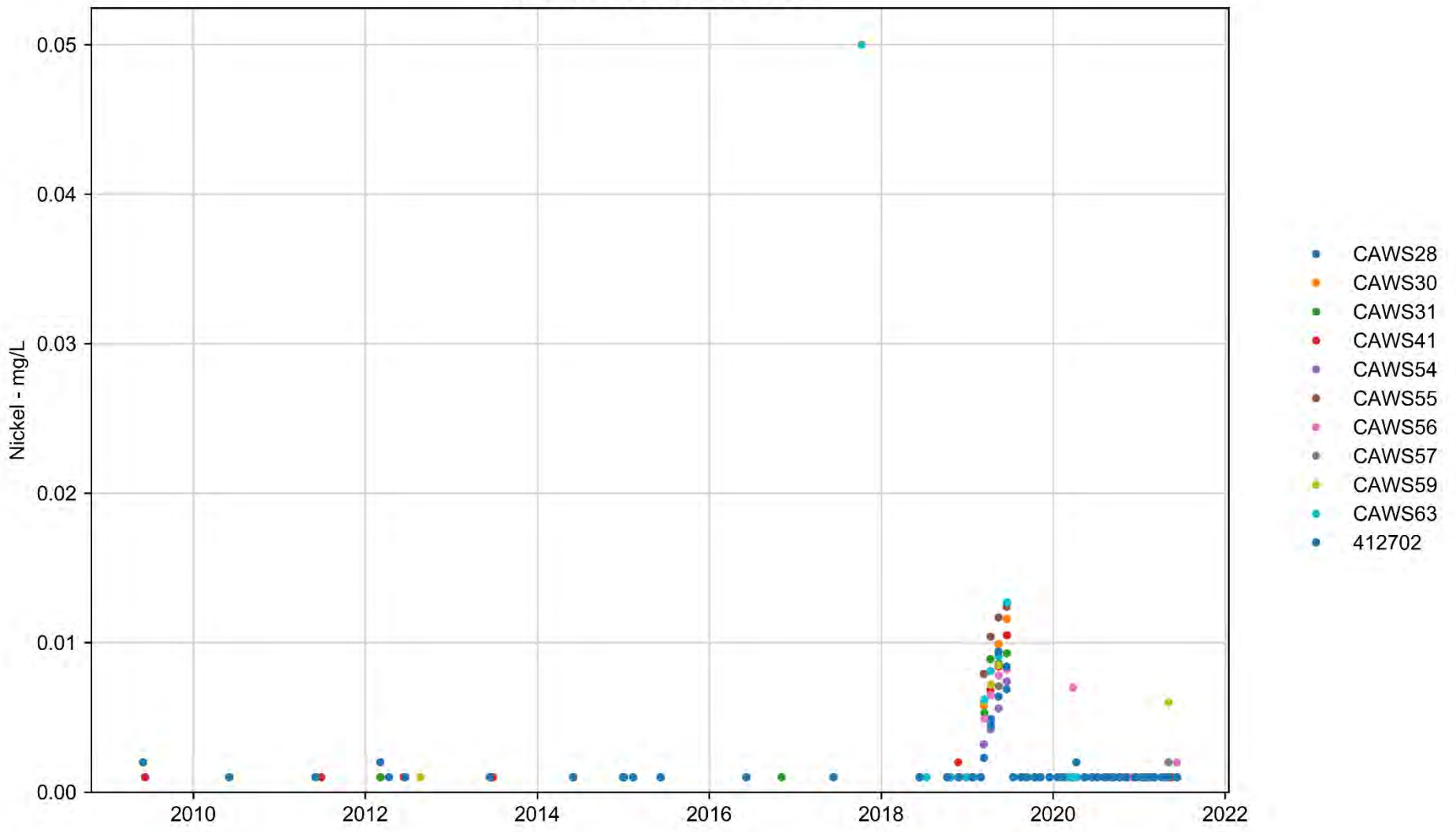

AEMR - TSF Southern Zone
Magnesium - mg/L
100
10
1
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS28
CAWS30
CAWS31
CAWS41
CAWS54
CAWS55
CAWS56
CAWS57
CAWS59
CAWS63
412702

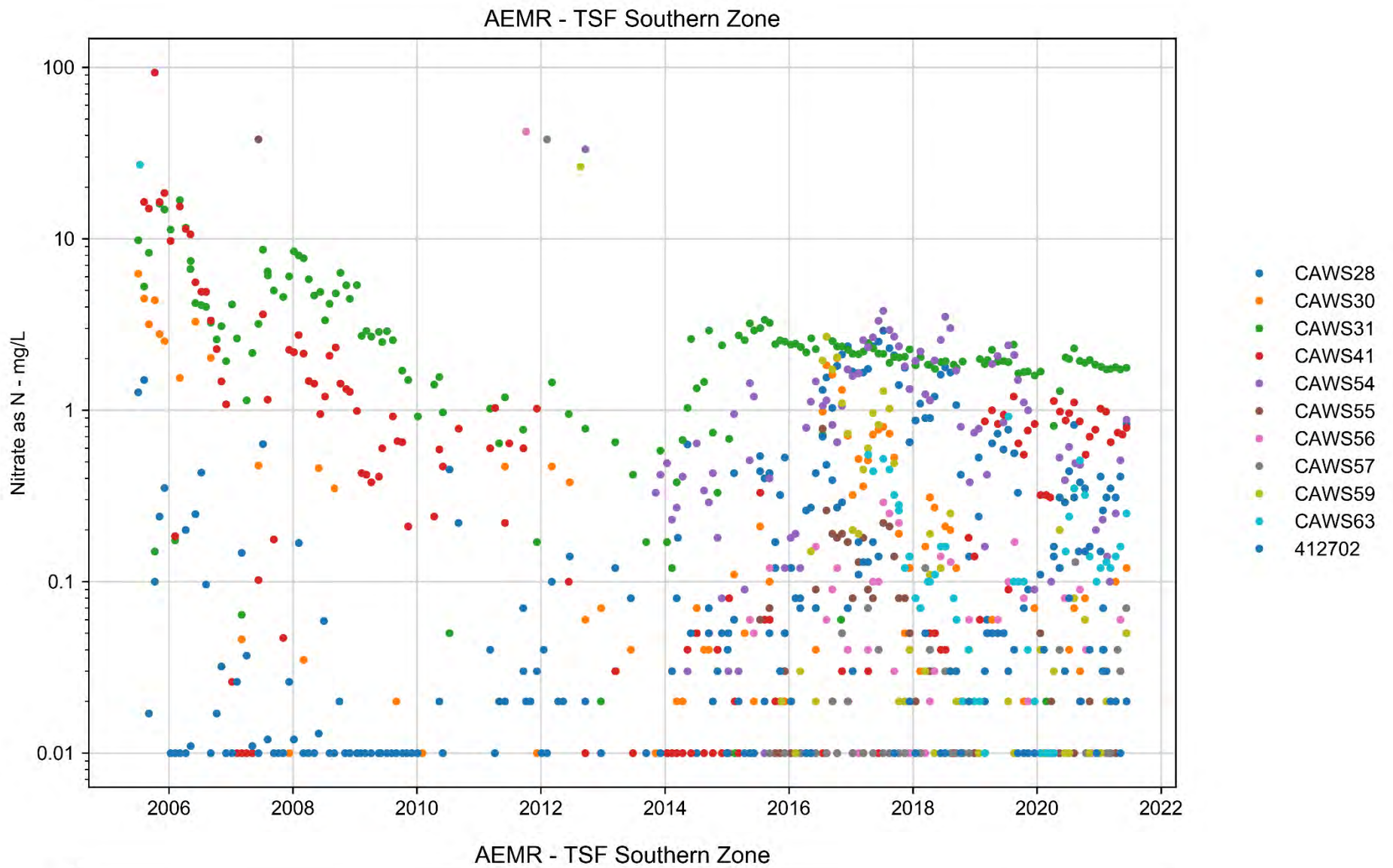

AEMR - TSF Southern Zone
Manganese - mg/L
10
1
0.1
0.01
0.001
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS28
CAWS30
CAWS31
CAWS41
CAWS54
CAWS55
CAWS56
CAWS57
CAWS59
CAWS63
412702

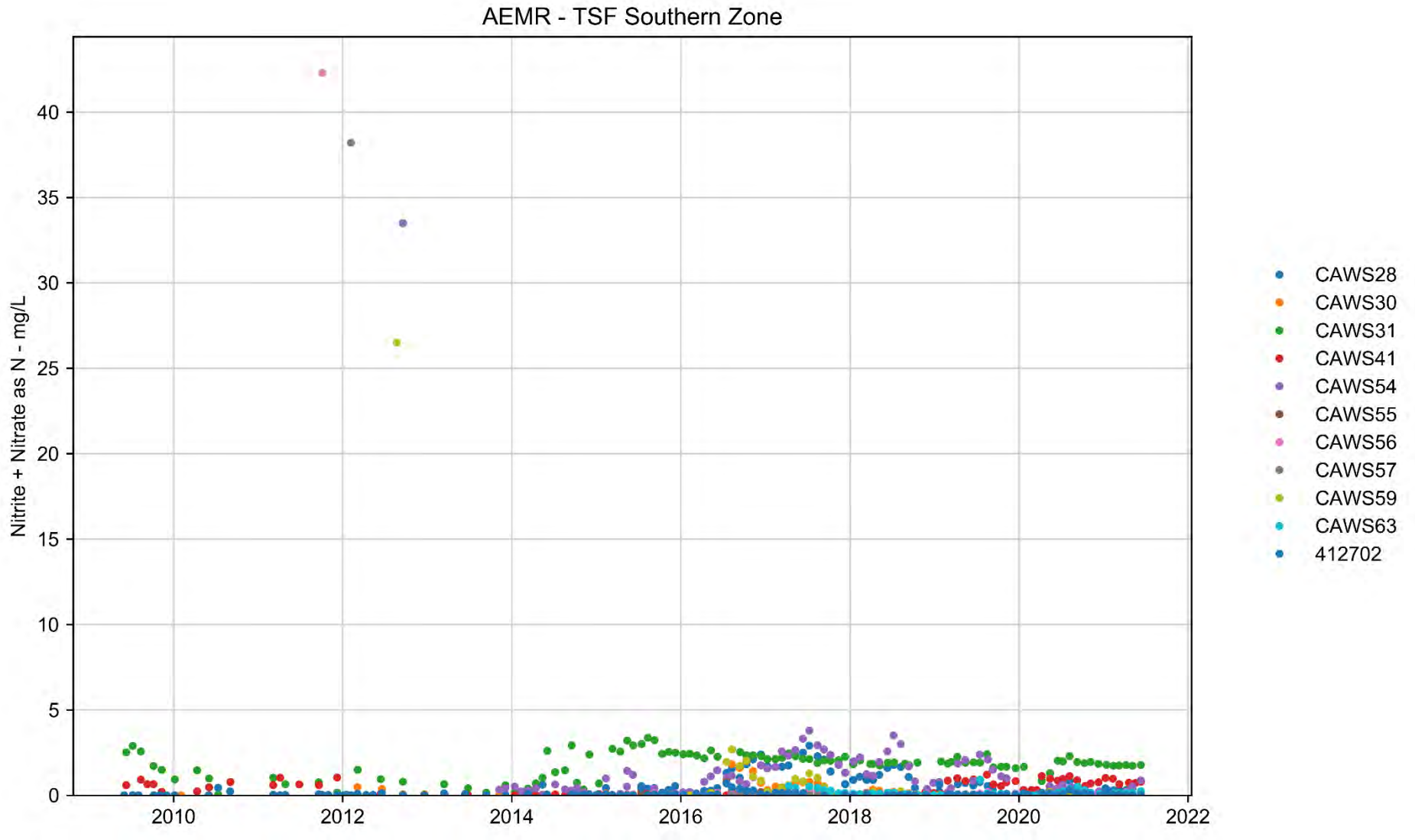
AEMR - TSF Southern Zone



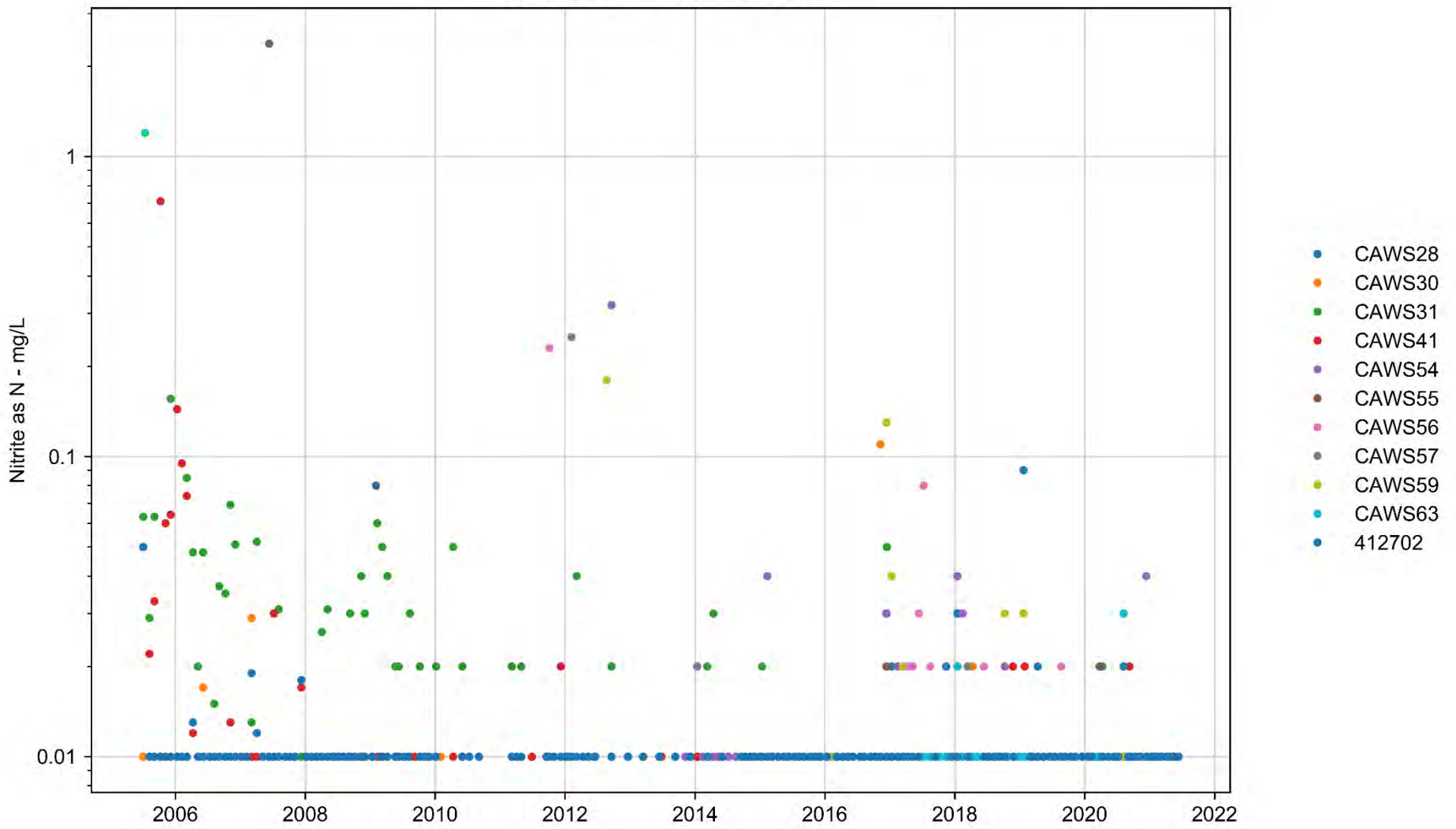
AEMR - TSF Southern Zone



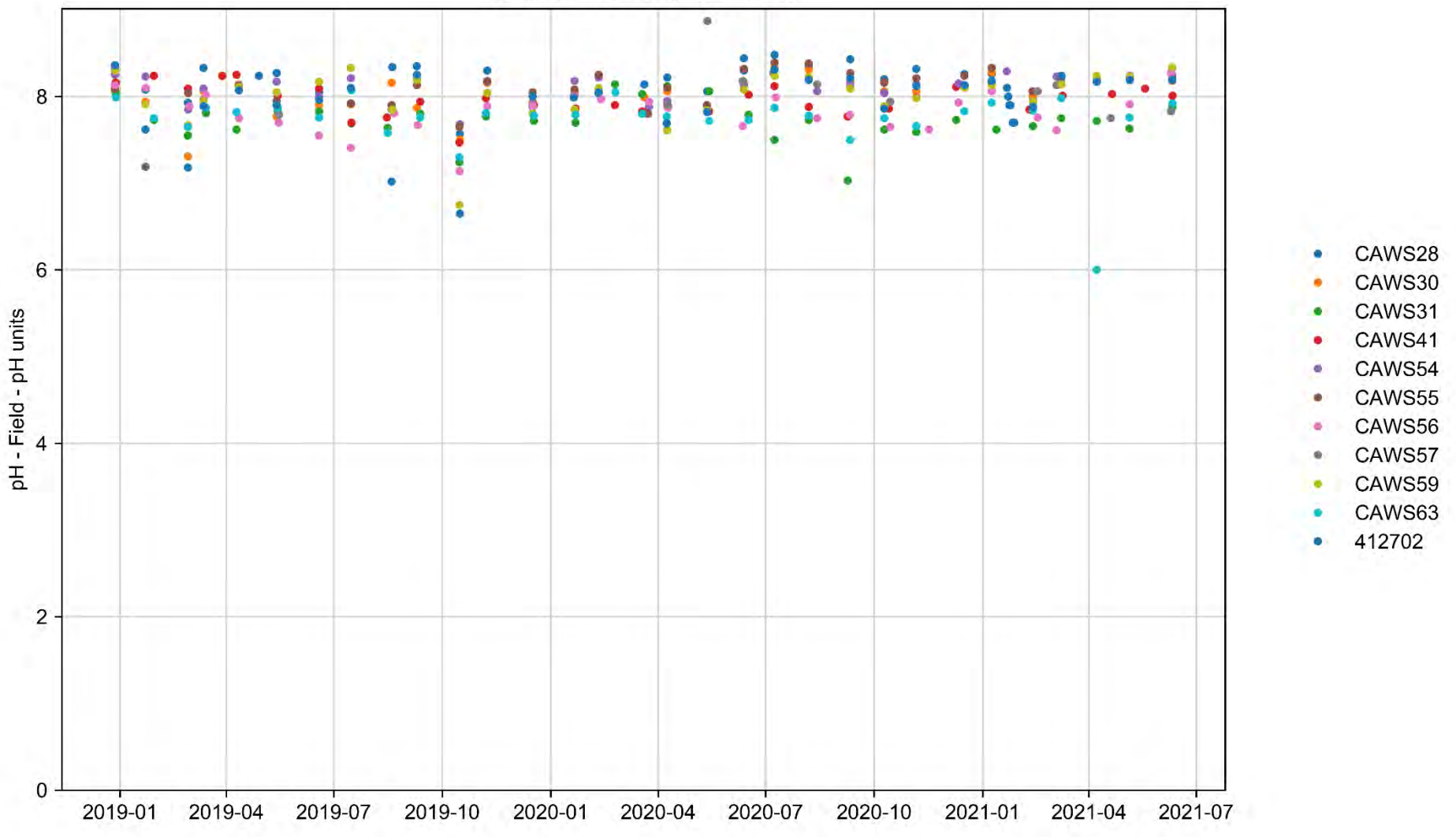

AEMR - TSF Southern Zone
Nitrate as N - mg/L
100
10
1
0.1
0.01
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS28
CAWS30
CAWS31
CAWS41
CAWS54
CAWS55
CAWS56
CAWS57
CAWS59
CAWS63
412702


AEMR - TSF Southern Zone
Nitrite + Nitrate as N - mg/L
40
35
30
25
20
15
10
5
0
2010
2012
2014
2016
2018
2020
2022
CAWS28
CAWS30
CAWS31
CAWS41
CAWS54
CAWS55
CAWS56
CAWS57
CAWS59
CAWS63
412702

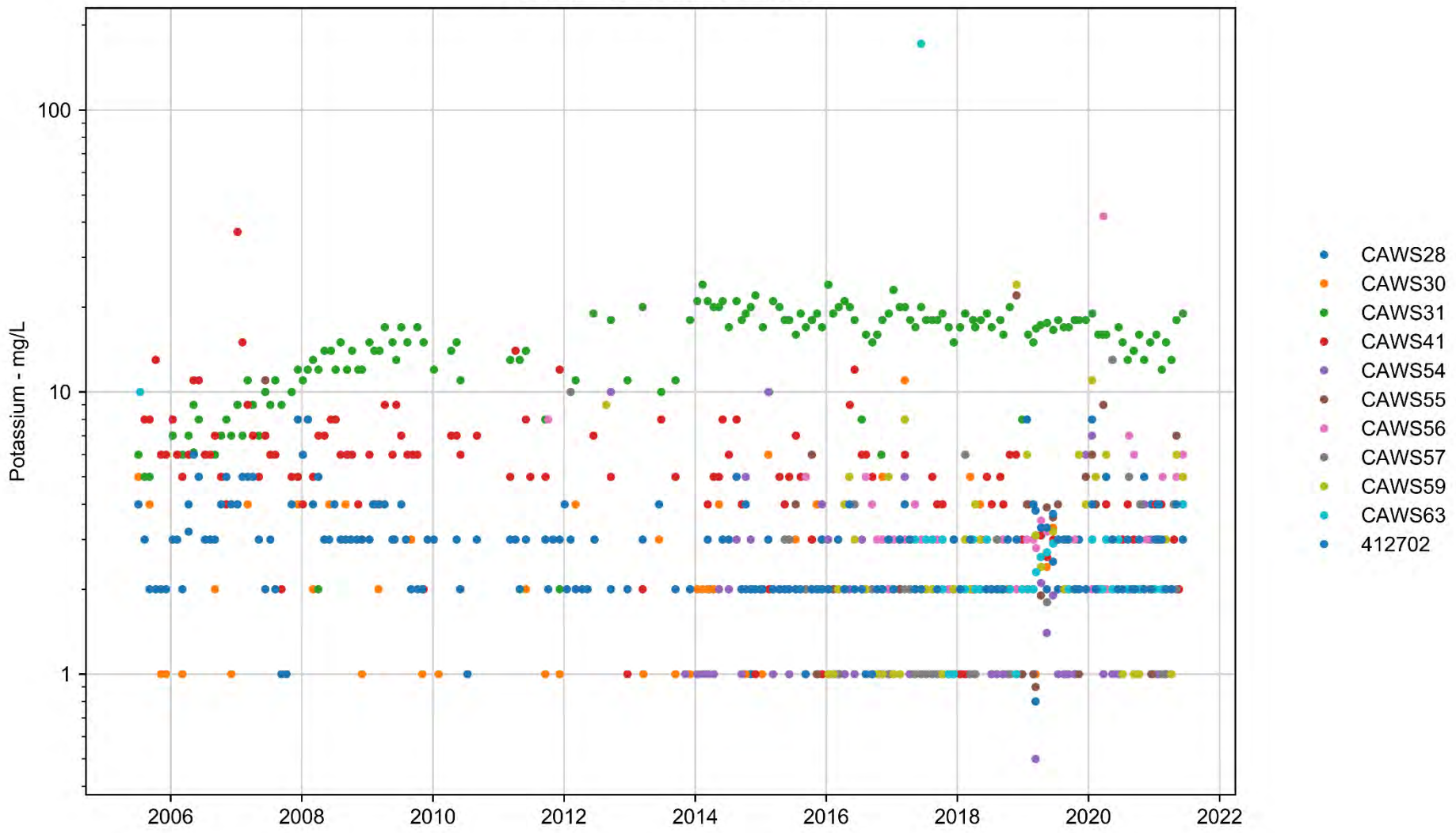
AEMR - TSF Southern Zone



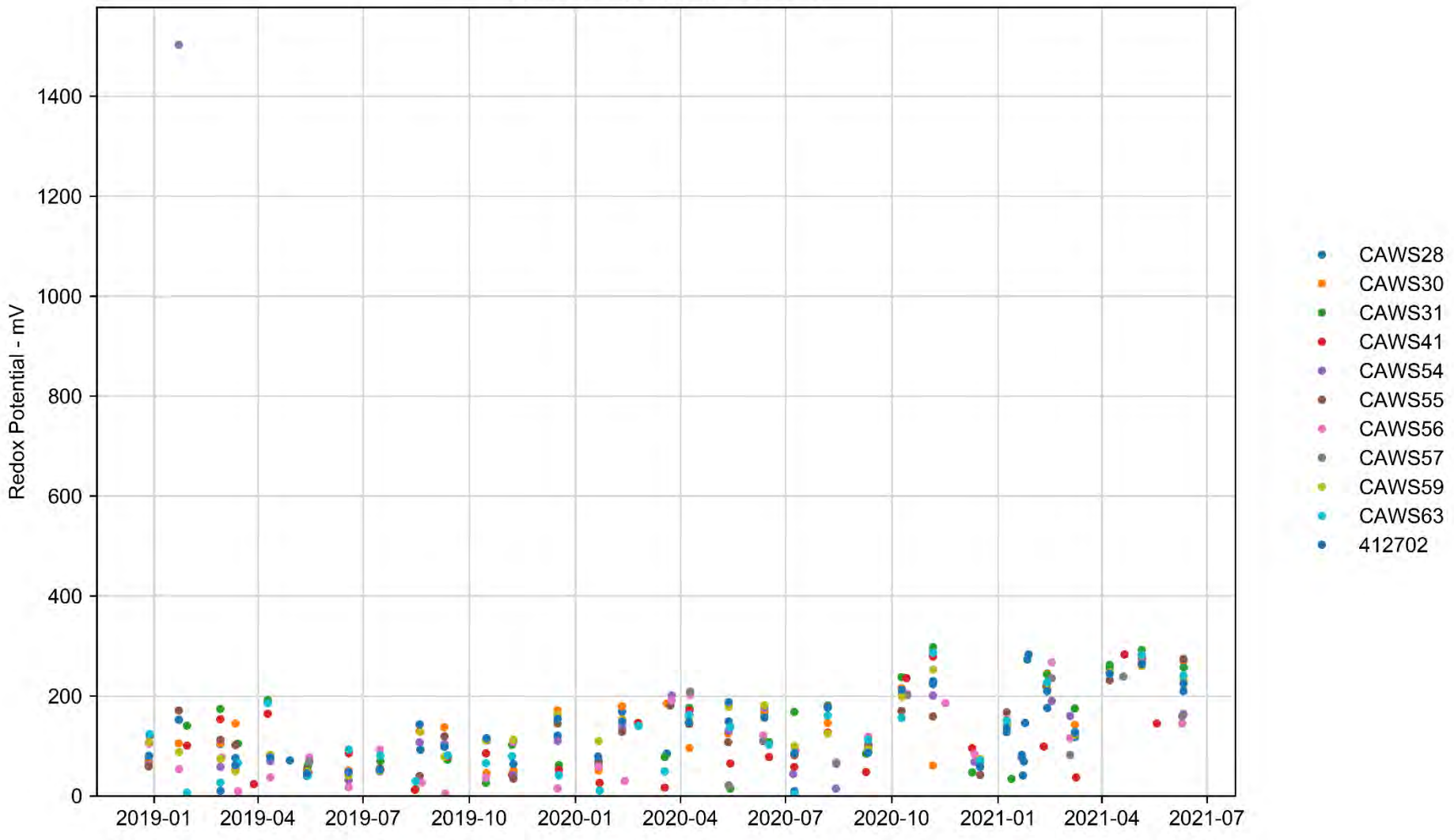
AEMR - TSF Southern Zone

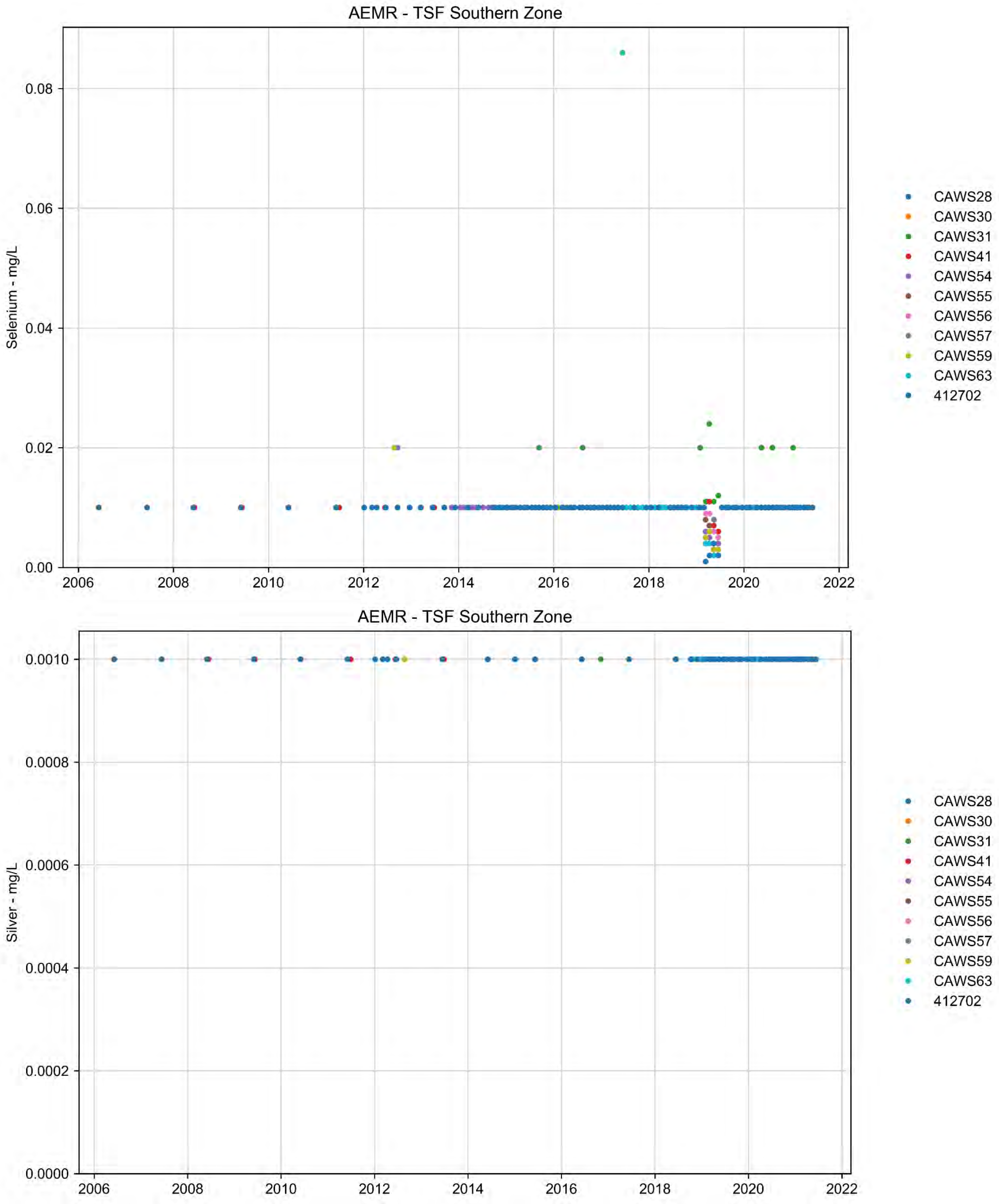


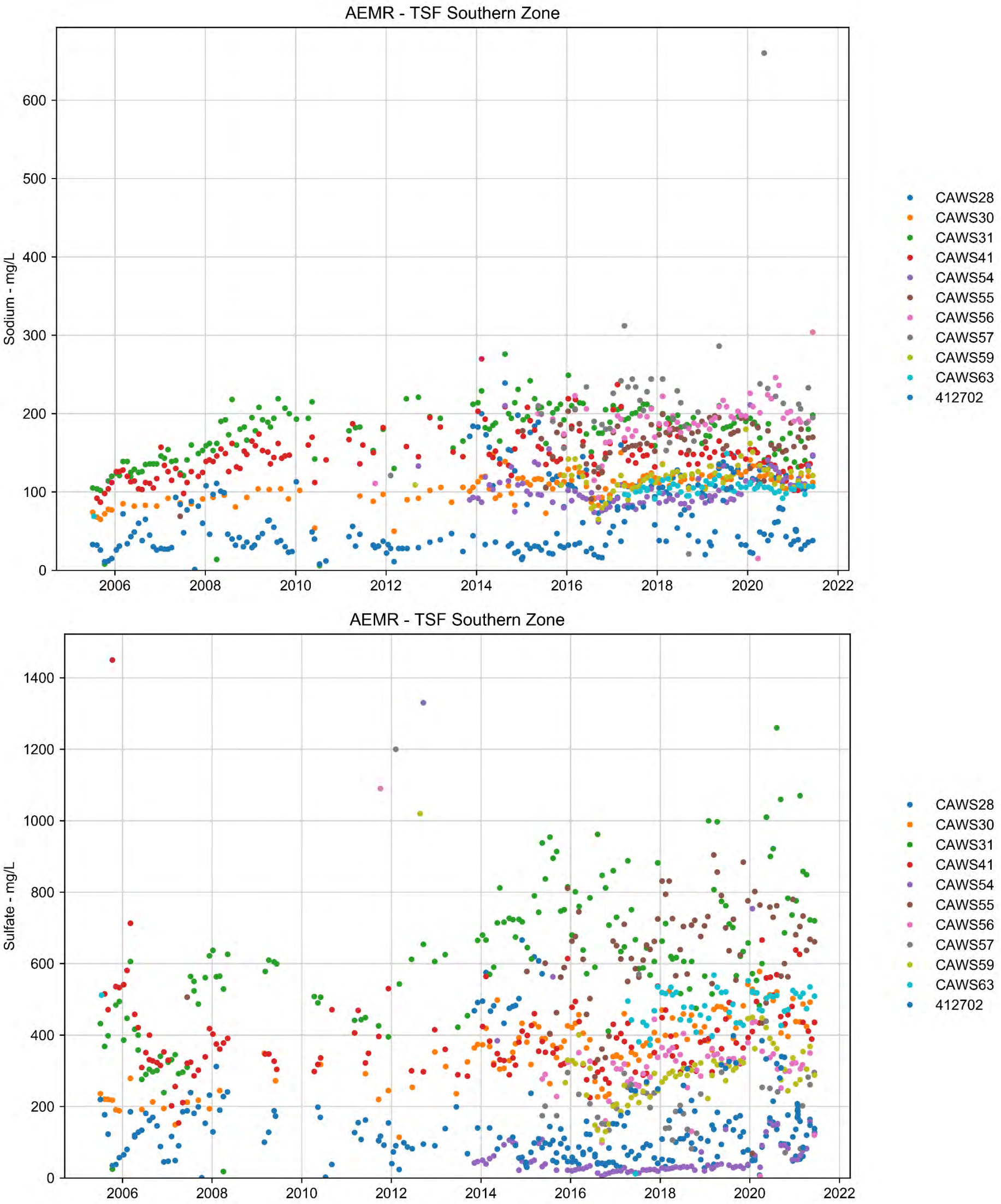
AEMR - TSF Southern Zone

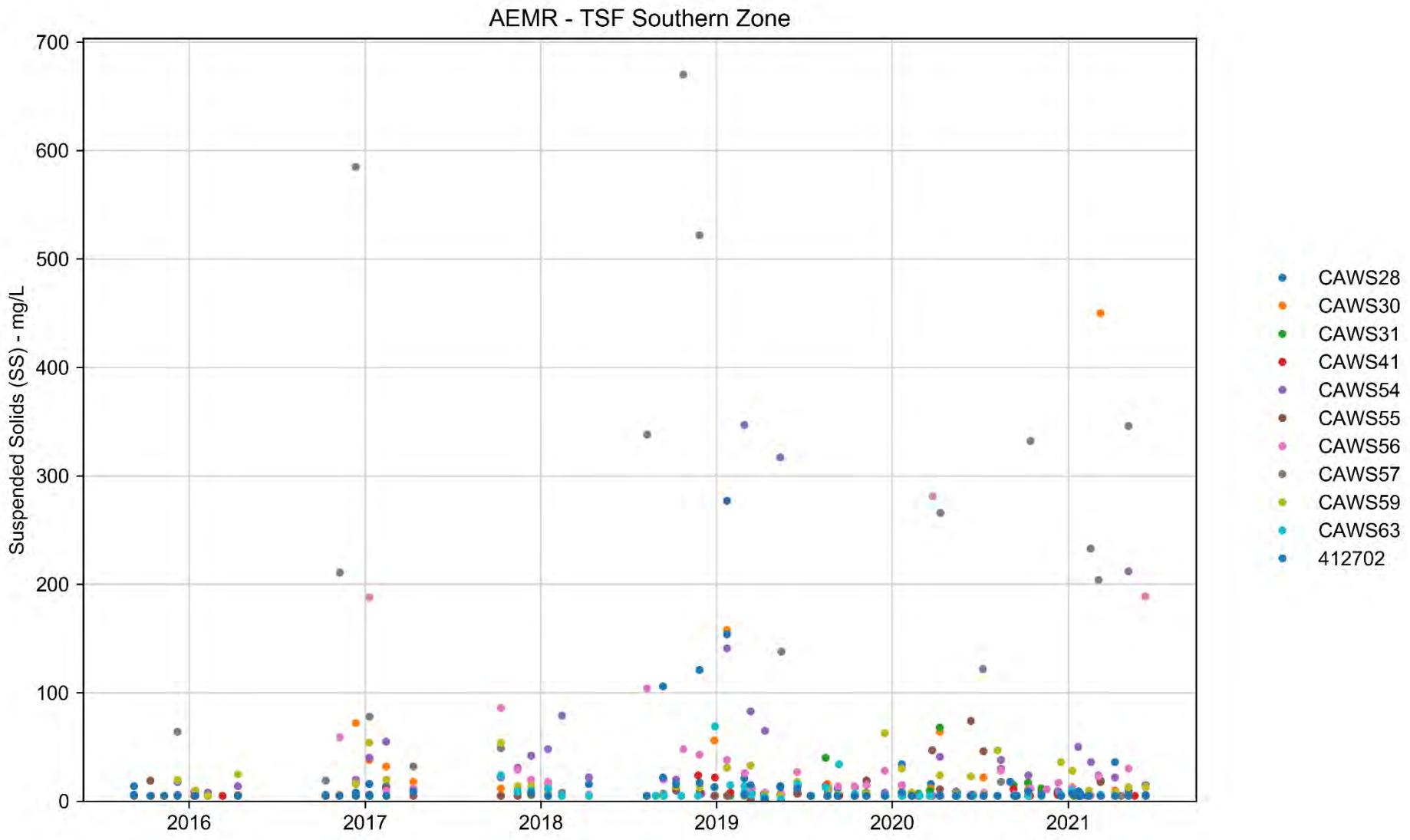


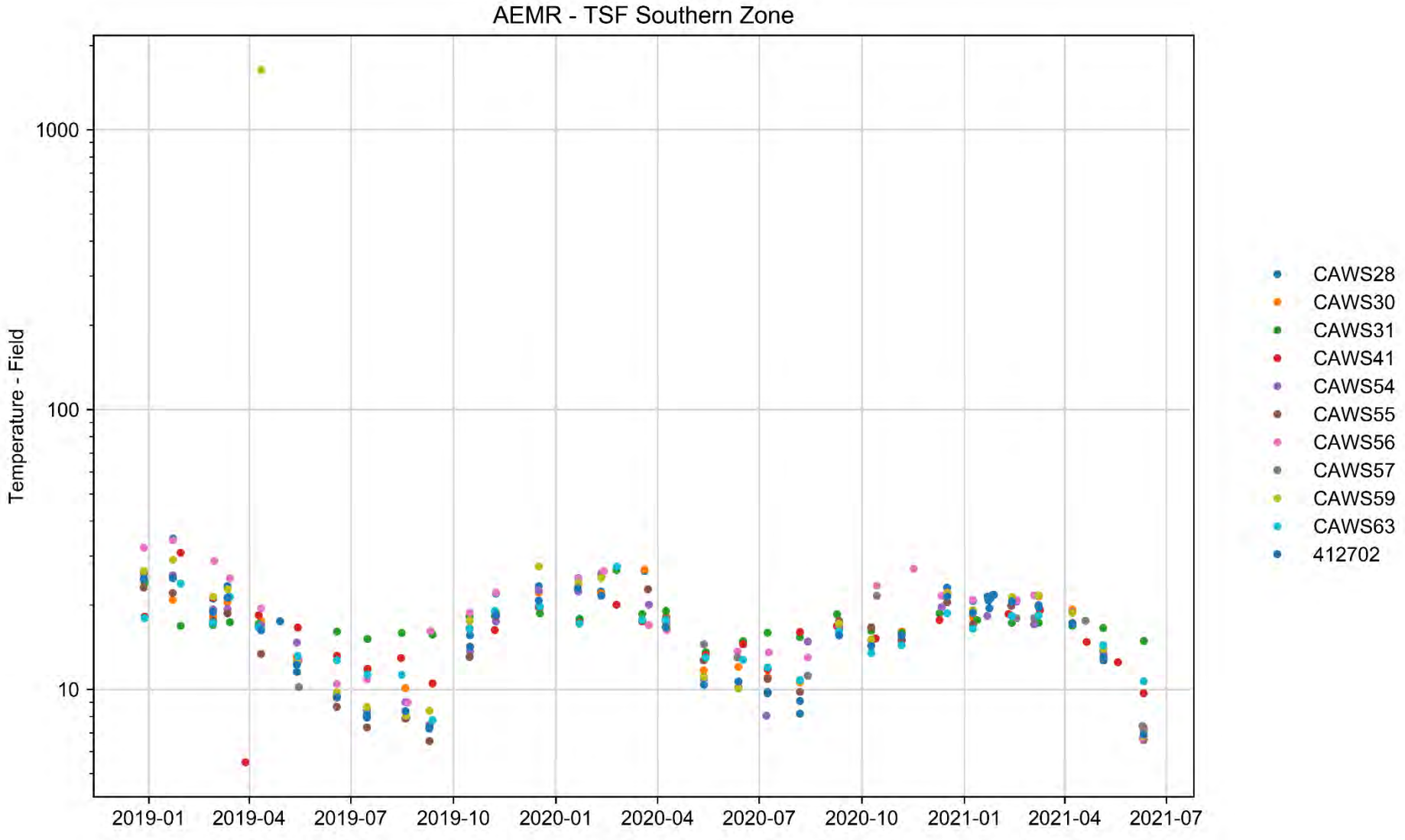
AEMR - TSF Southern Zone



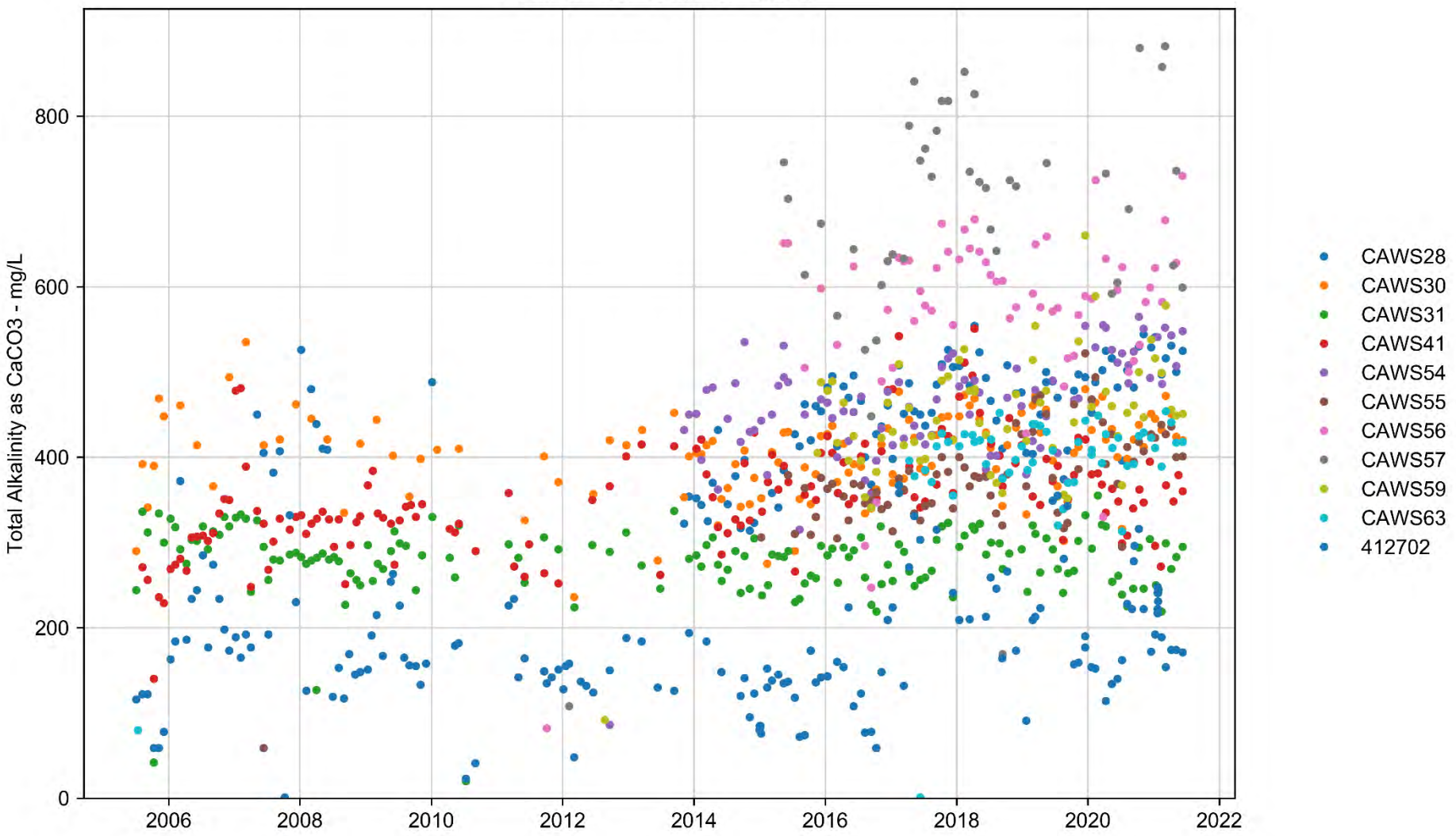

AEMR - TSF Southern Zone
Selenium - mg/L
0.08
0.06
0.04
0.02
0.00
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS28
CAWS30
CAWS31
CAWS41
CAWS54
CAWS55
CAWS56
CAWS57
CAWS59
CAWS63
412702
AEMR - TSF Southern Zone
Silver - mg/L
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS28
CAWS30
CAWS31
CAWS41
CAWS54
CAWS55
CAWS56
CAWS57
CAWS59
CAWS63
412702


AEMR - TSF Southern Zone
Sodium - mg/L
0
100
200
300
400
500
600
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS28
CAWS30
CAWS31
CAWS41
CAWS54
CAWS55
CAWS56
CAWS57
CAWS59
CAWS63
412702
AEMR - TSF Southern Zone
Sulfate - mg/L
0
200
400
600
800
1000
1200
1400
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS28
CAWS30
CAWS31
CAWS41
CAWS54
CAWS55
CAWS56
CAWS57
CAWS59
CAWS63
412702

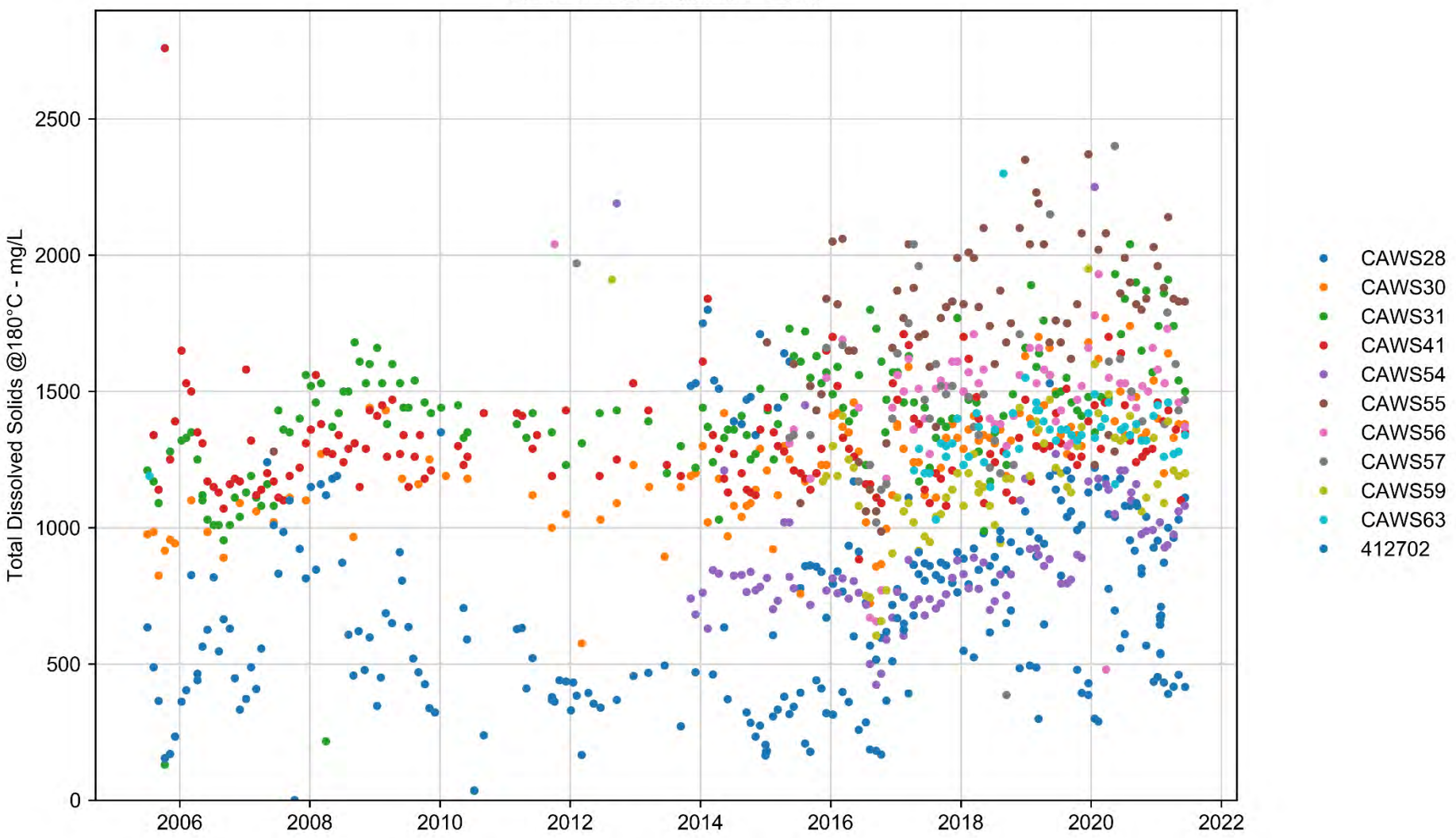

AEMR - TSF Southern Zone
Suspended Solids (SS) - mg/L
700
600
500
400
300
200
100
0
2016
2017
2018
2019
2020
2021
CAWS28
CAWS30
CAWS31
CAWS41
CAWS54
CAWS55
CAWS56
CAWS57
CAWS59
CAWS63
412702

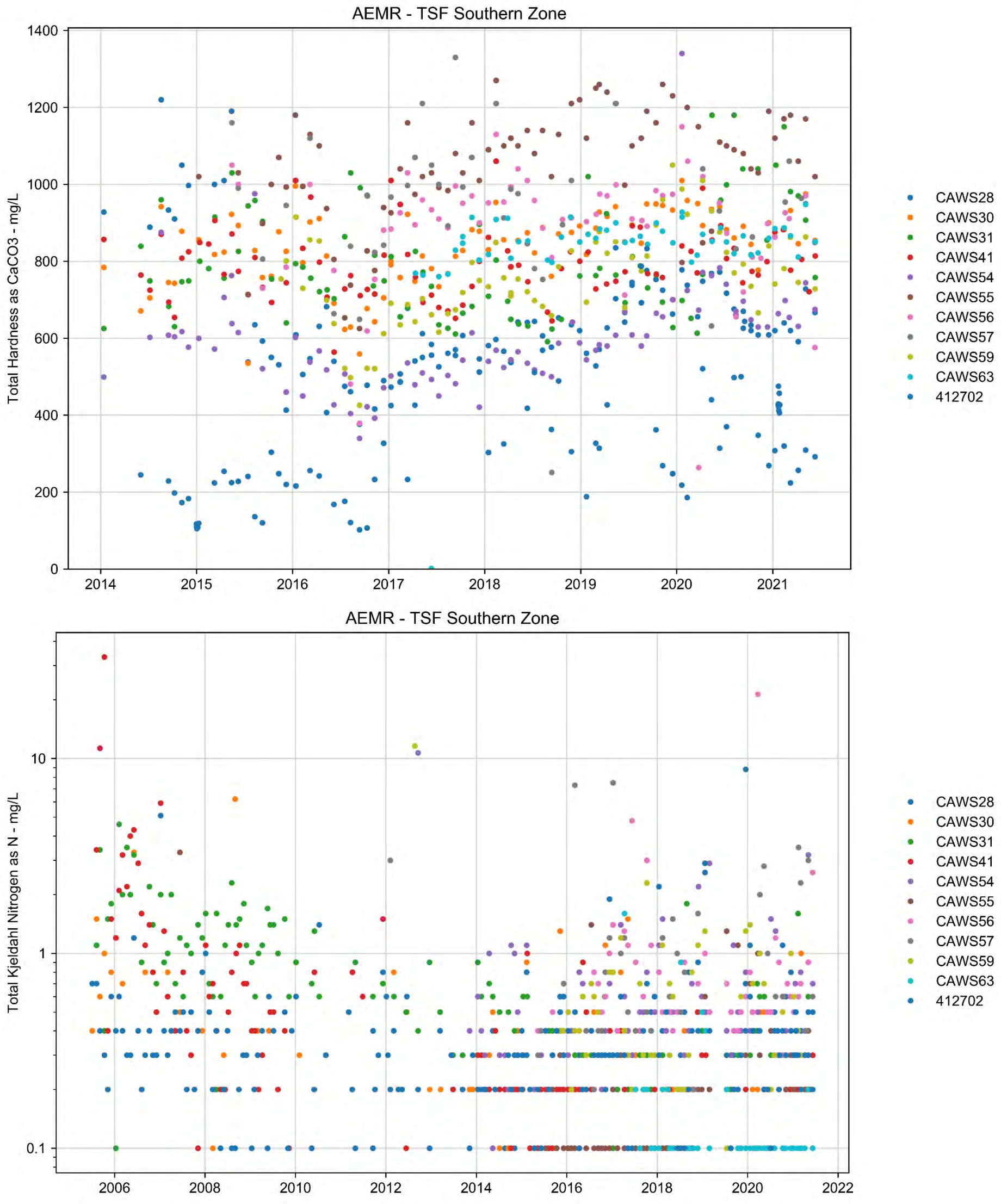

AEMR - TSF Southern Zone
Temperature - Field
1000
100
10
2019-01
2019-04
2019-07
2019-10
2020-01
2020-04
2020-07
2020-10
2021-01
2021-04
2021-07
CAWS28
CAWS30
CAWS31
CAWS41
CAWS54
CAWS55
CAWS56
CAWS57
CAWS59
CAWS63
412702

AEMR - TSF Southern Zone

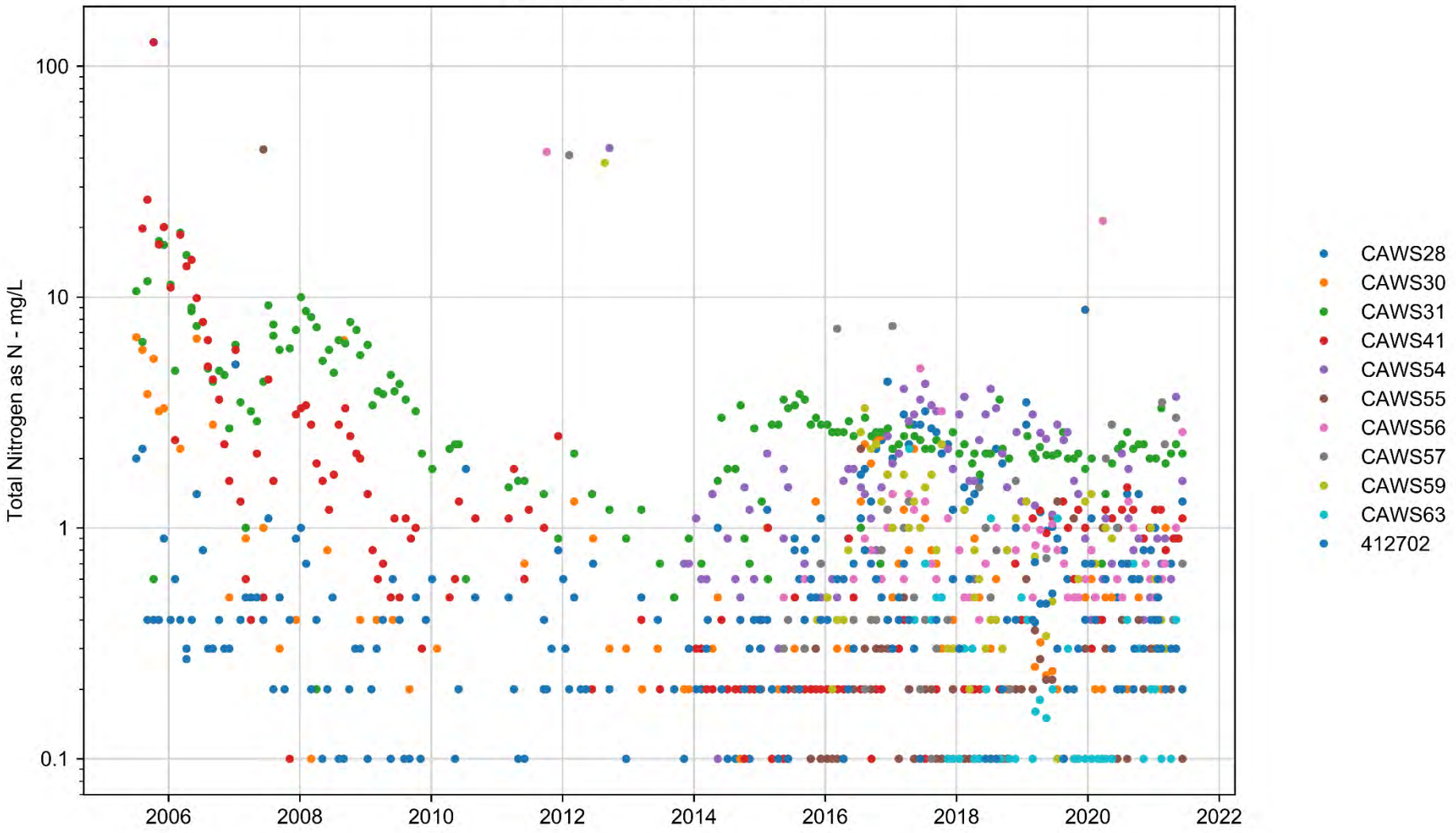


AEMR - TSF Southern Zone

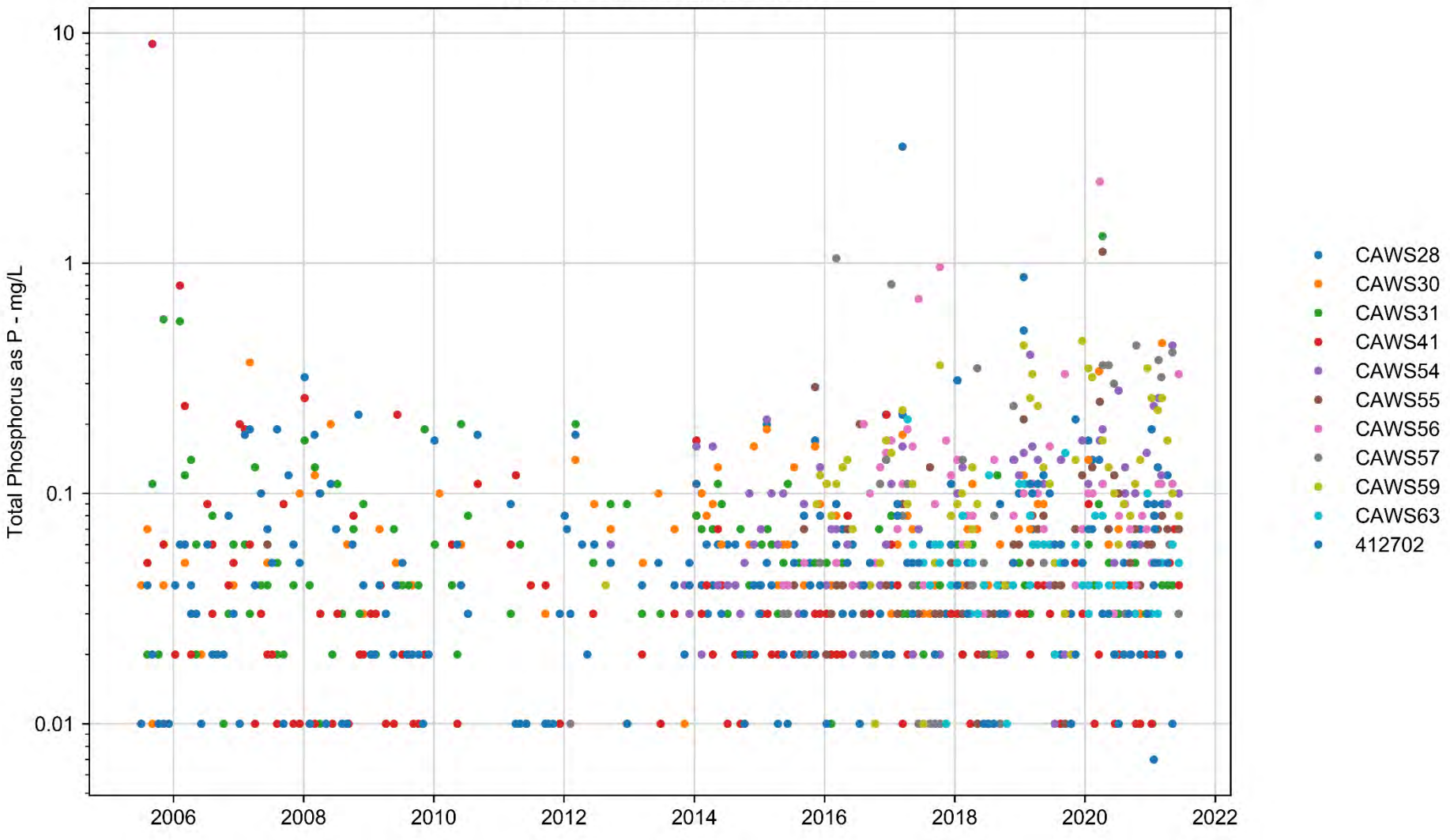


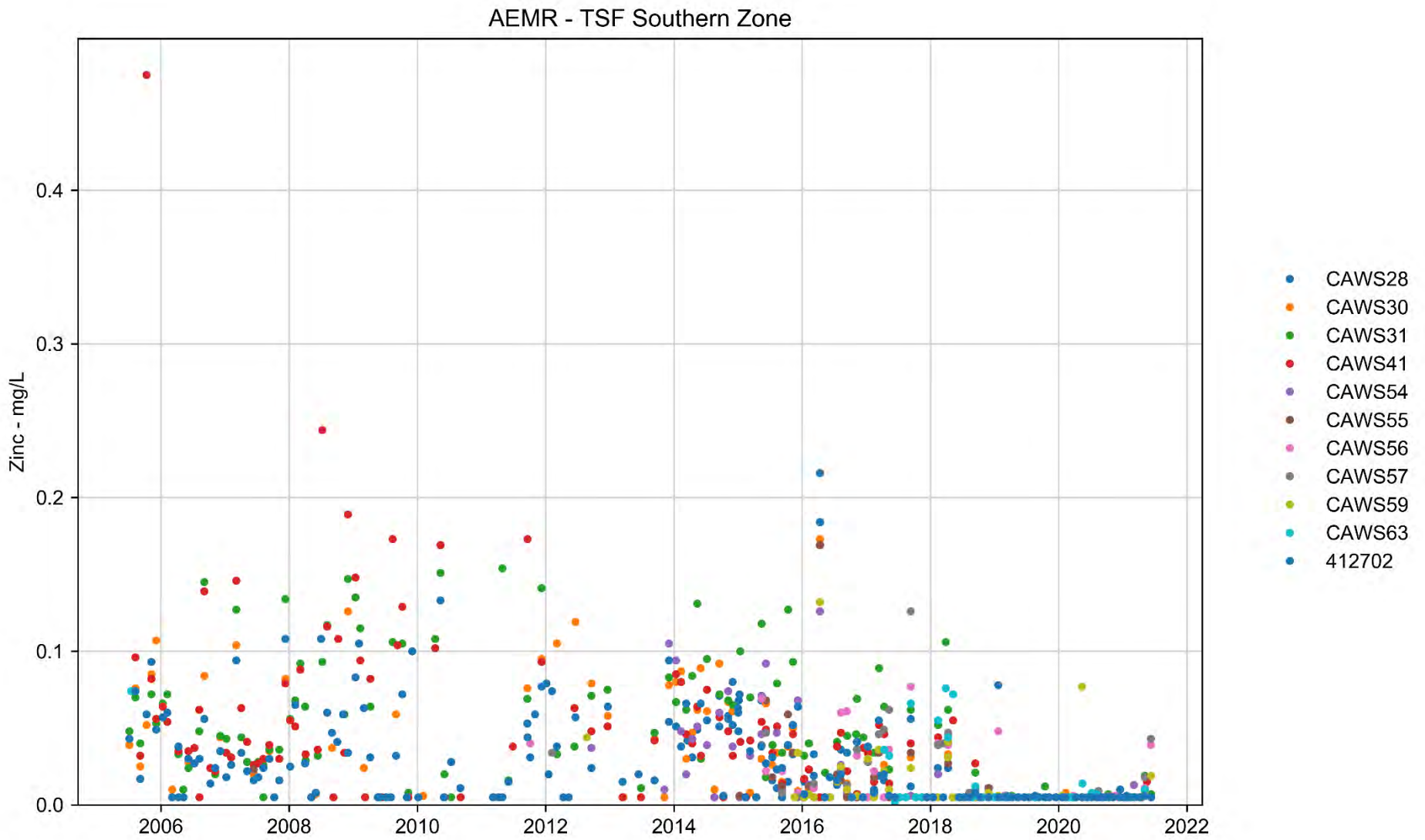

AEMR - TSF Southern Zone
Total Hardness as CaCO3 - mg/L
1400
1200
1000
800
600
400
200
0
2014
2015
2016
2017
2018
2019
2020
2021
CAWS28
CAWS30
CAWS31
CAWS41
CAWS54
CAWS55
CAWS56
CAWS57
CAWS59
CAWS63
412702
AEMR - TSF Southern Zone
Total Kjeldahl Nitrogen as N - mg/L
10
1
0.1
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS28
CAWS30
CAWS31
CAWS41
CAWS54
CAWS55
CAWS56
CAWS57
CAWS59
CAWS63
412702

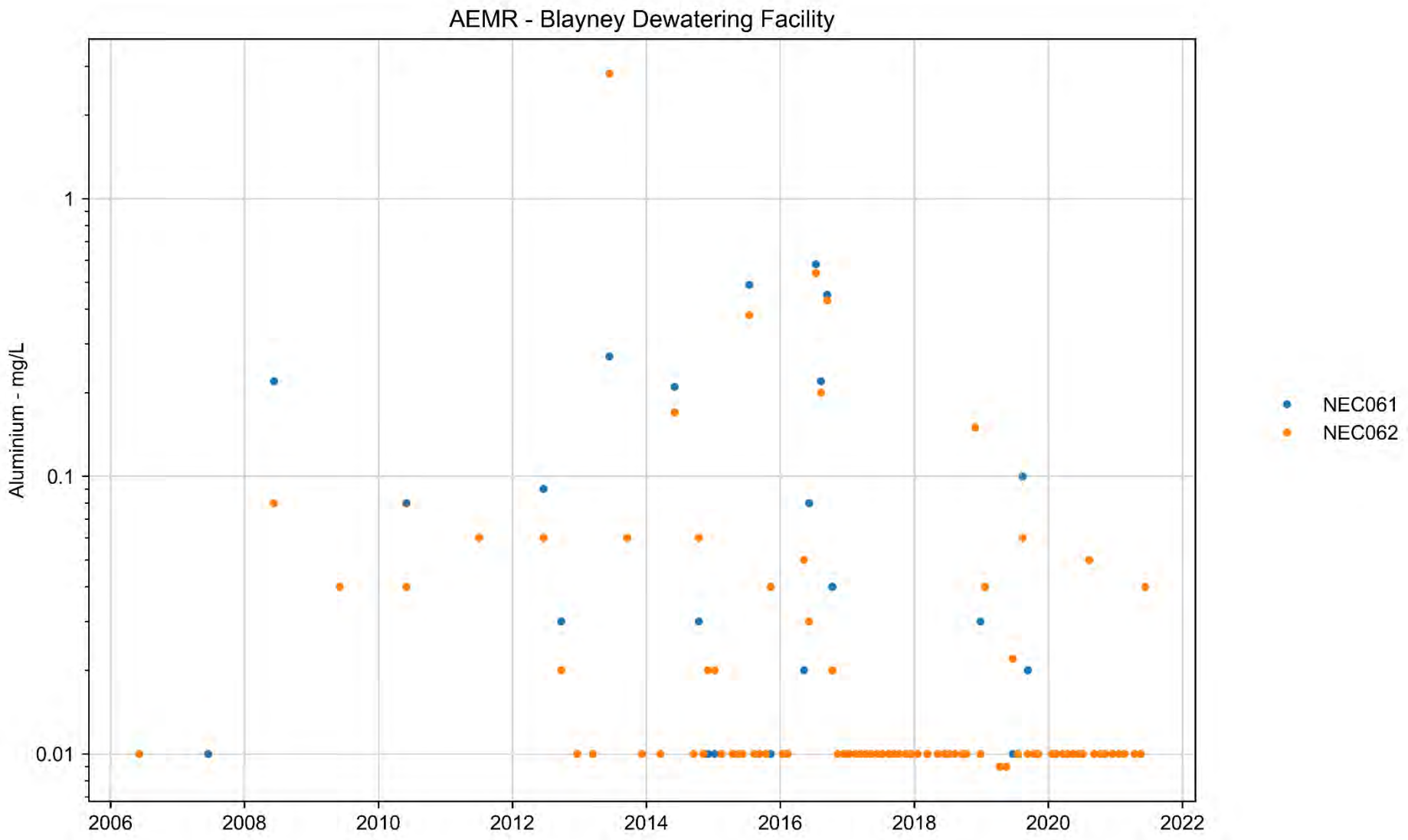
AEMR - TSF Southern Zone

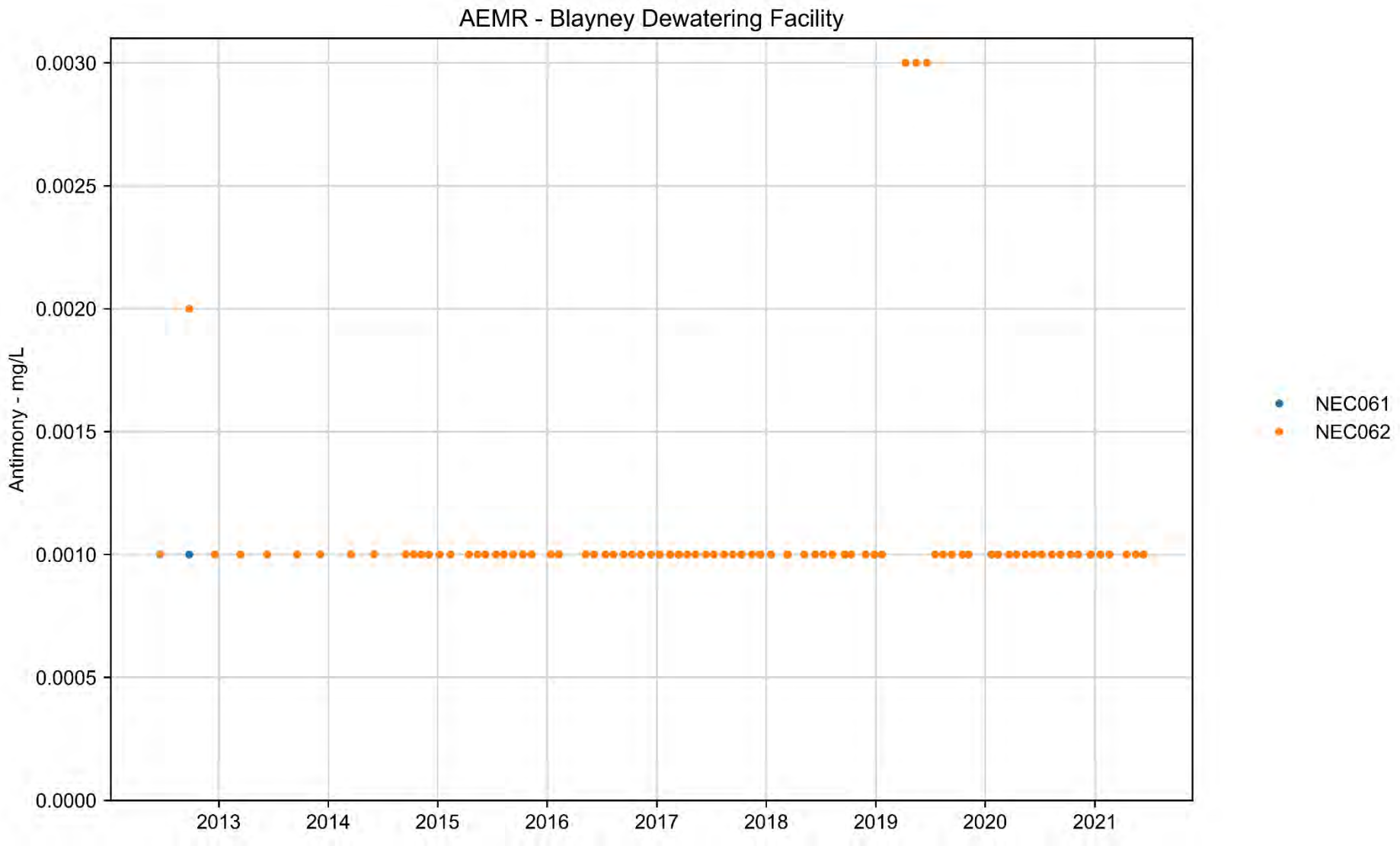


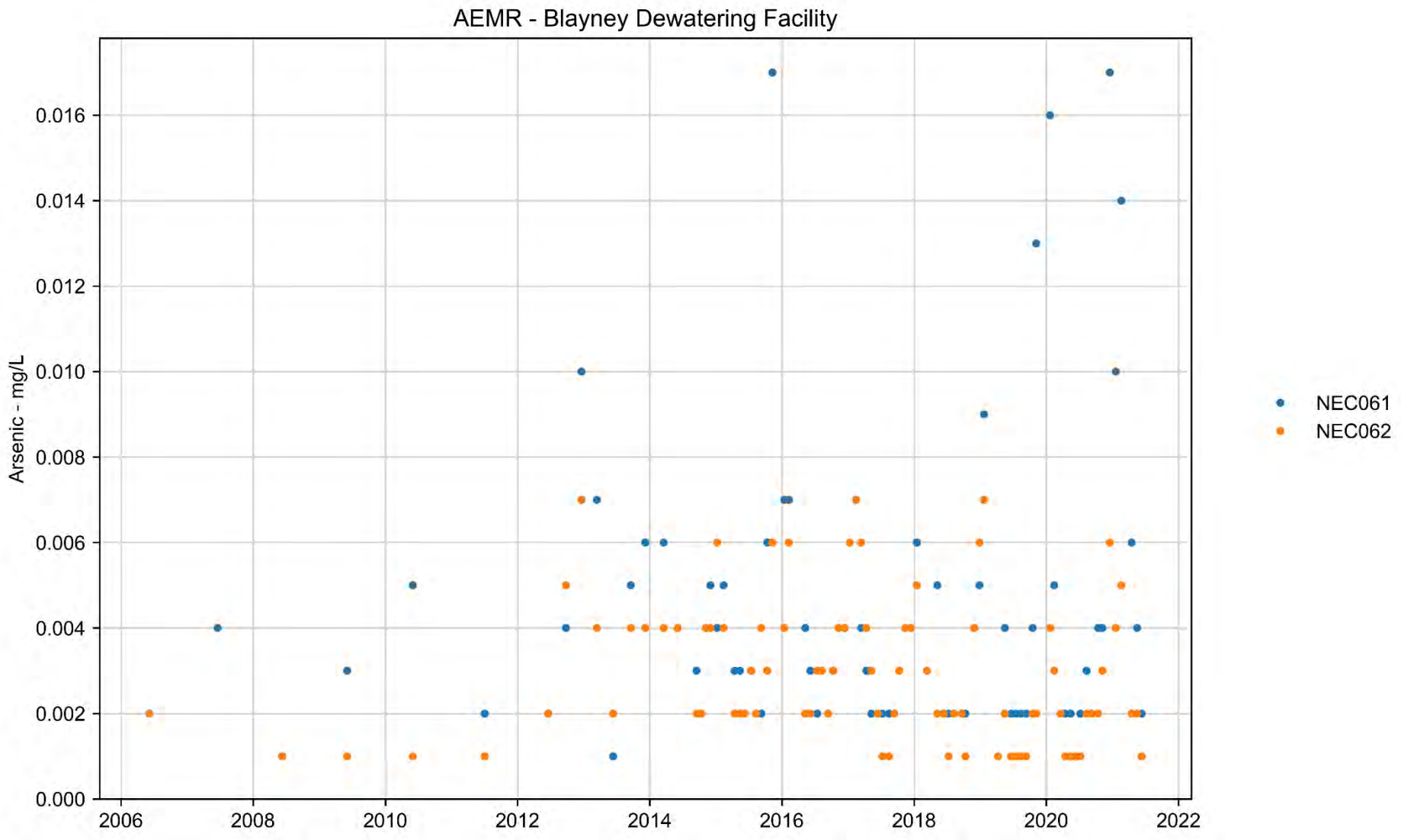
AEMR - TSF Southern Zone



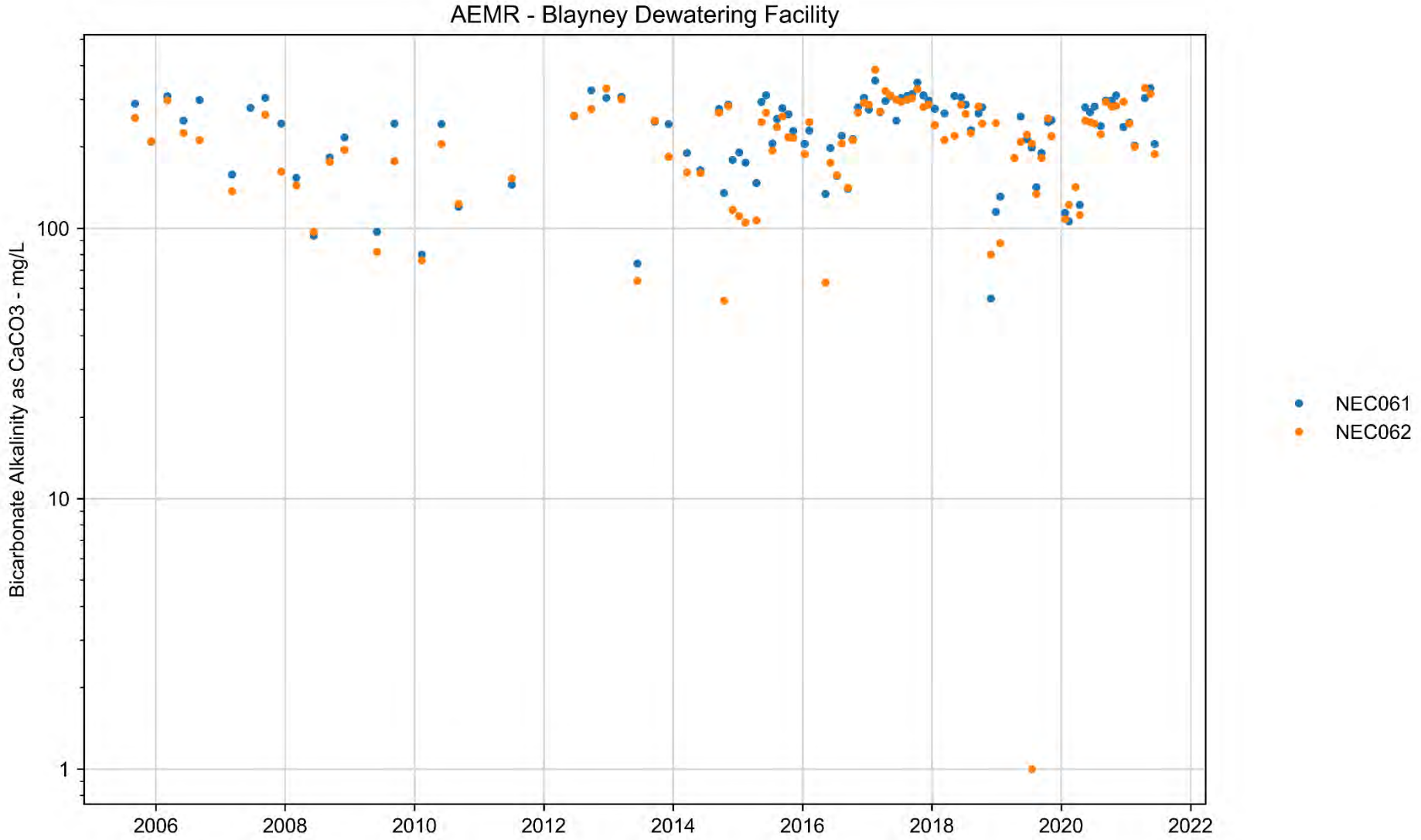

AEMR - TSF Southern Zone
Zinc - mg/L
0.4
0.3
0.2
0.1
0.0
2006
2008
2010
2012
2014
2016
2018
2020
2022
CAWS28
CAWS30
CAWS31
CAWS41
CAWS54
CAWS55
CAWS56
CAWS57
CAWS59
CAWS63
412702


AEMR - Blayney Dewatering Facility
Aluminium - mg/L
1
0.1
0.01
2006
2008
2010
2012
2014
2016
2018
2020
2022
NEC061
NEC062

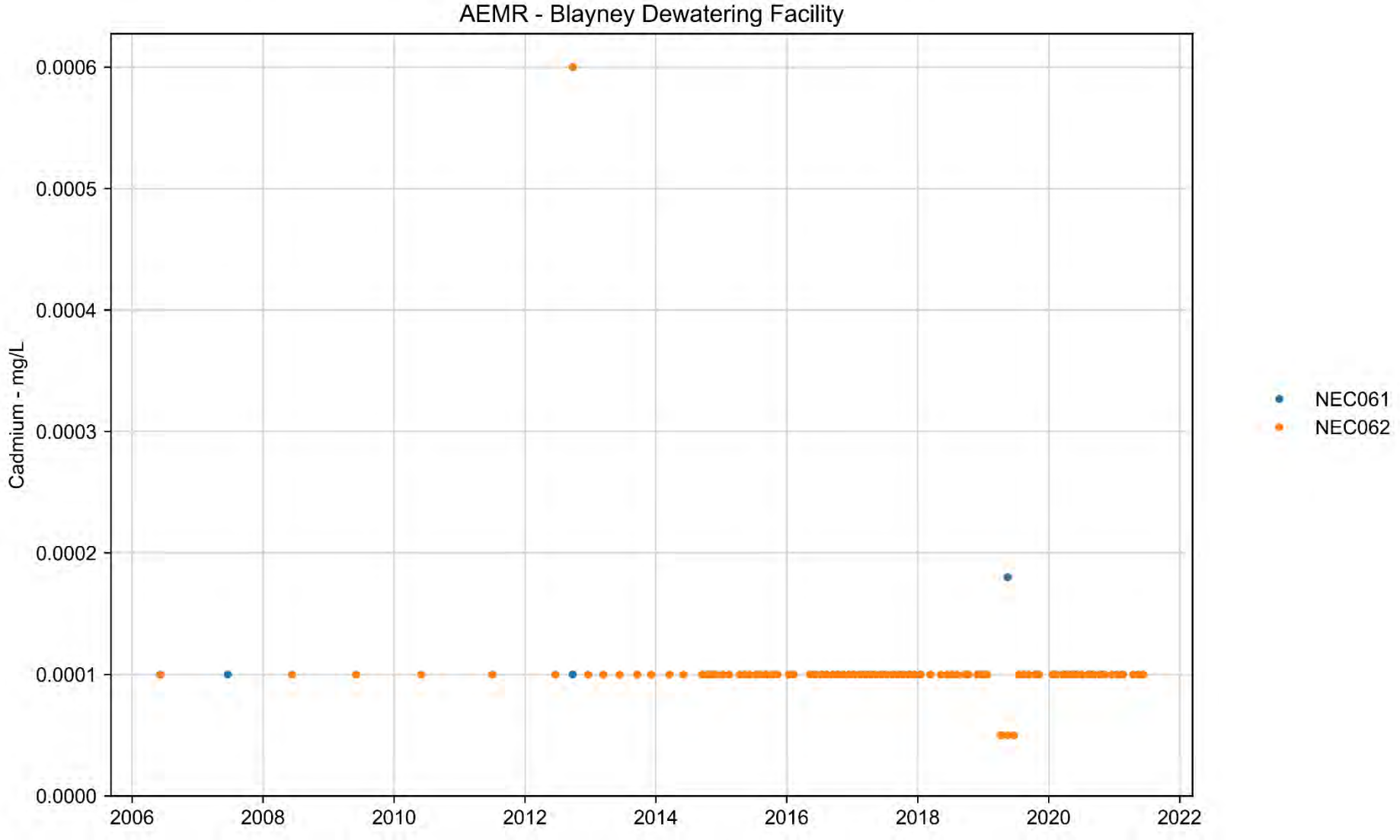

AEMR - Blayney Dewatering Facility
Antimony - mg/L
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
2013
2014
2015
2016
2017
2018
2019
2020
2021
NEC061
NEC062

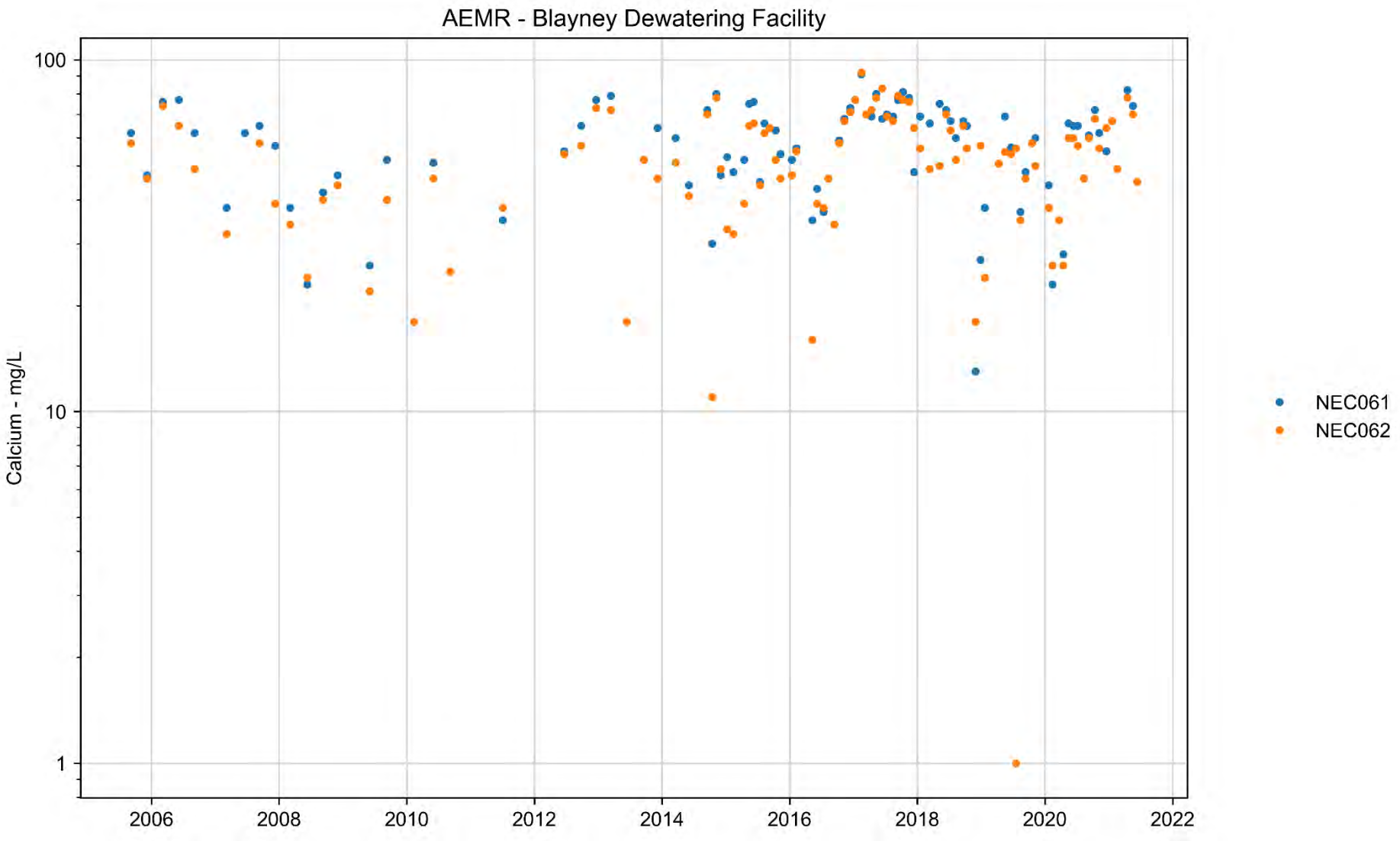

AEMR - Blayney Dewatering Facility
Arsenic - mg/L
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
2006
2008
2010
2012
2014
2016
2018
2020
2022
NEC061
NEC062

AEMR - Blayney Dewatering Facility

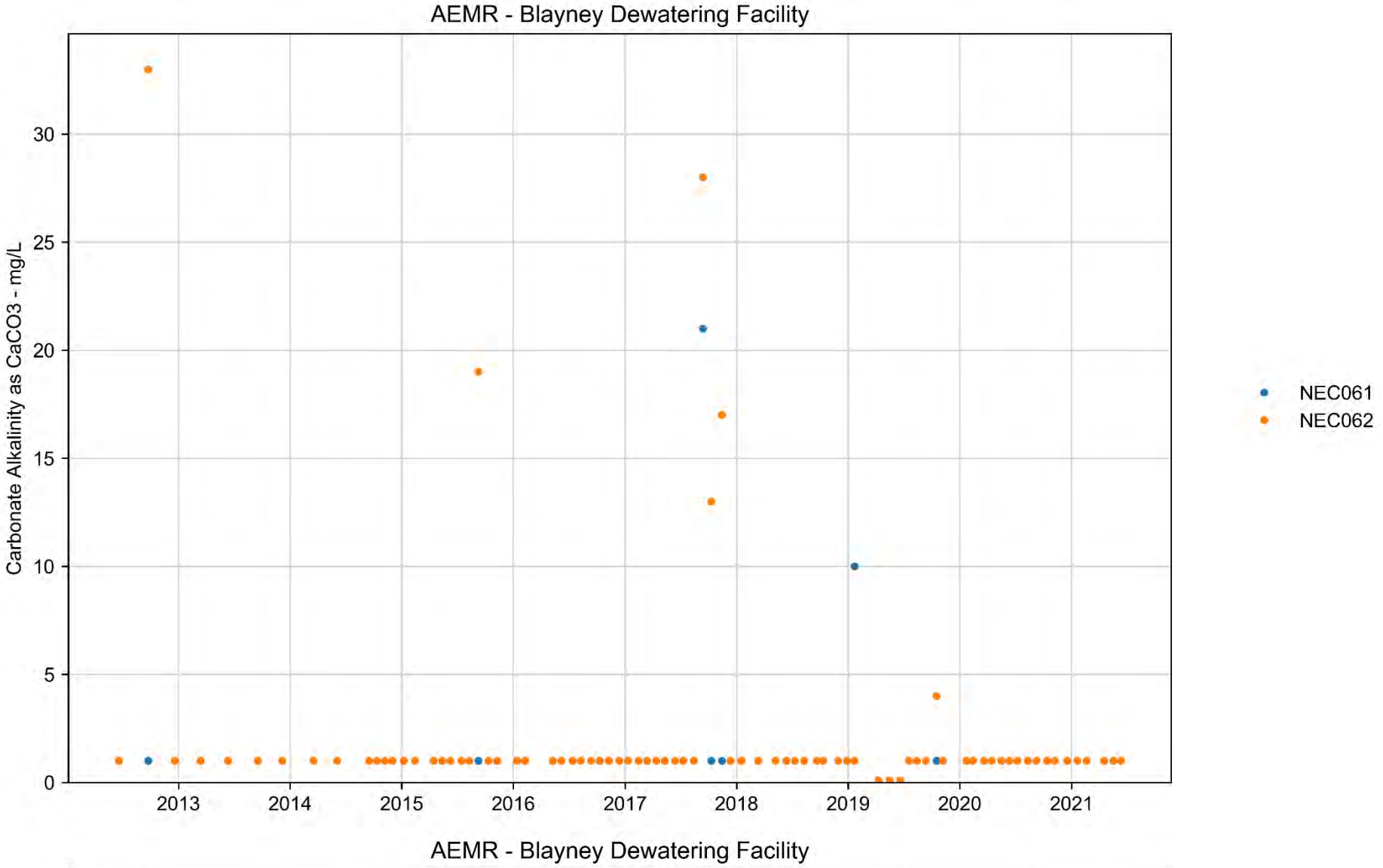


AEMR - Blayney Dewatering Facility

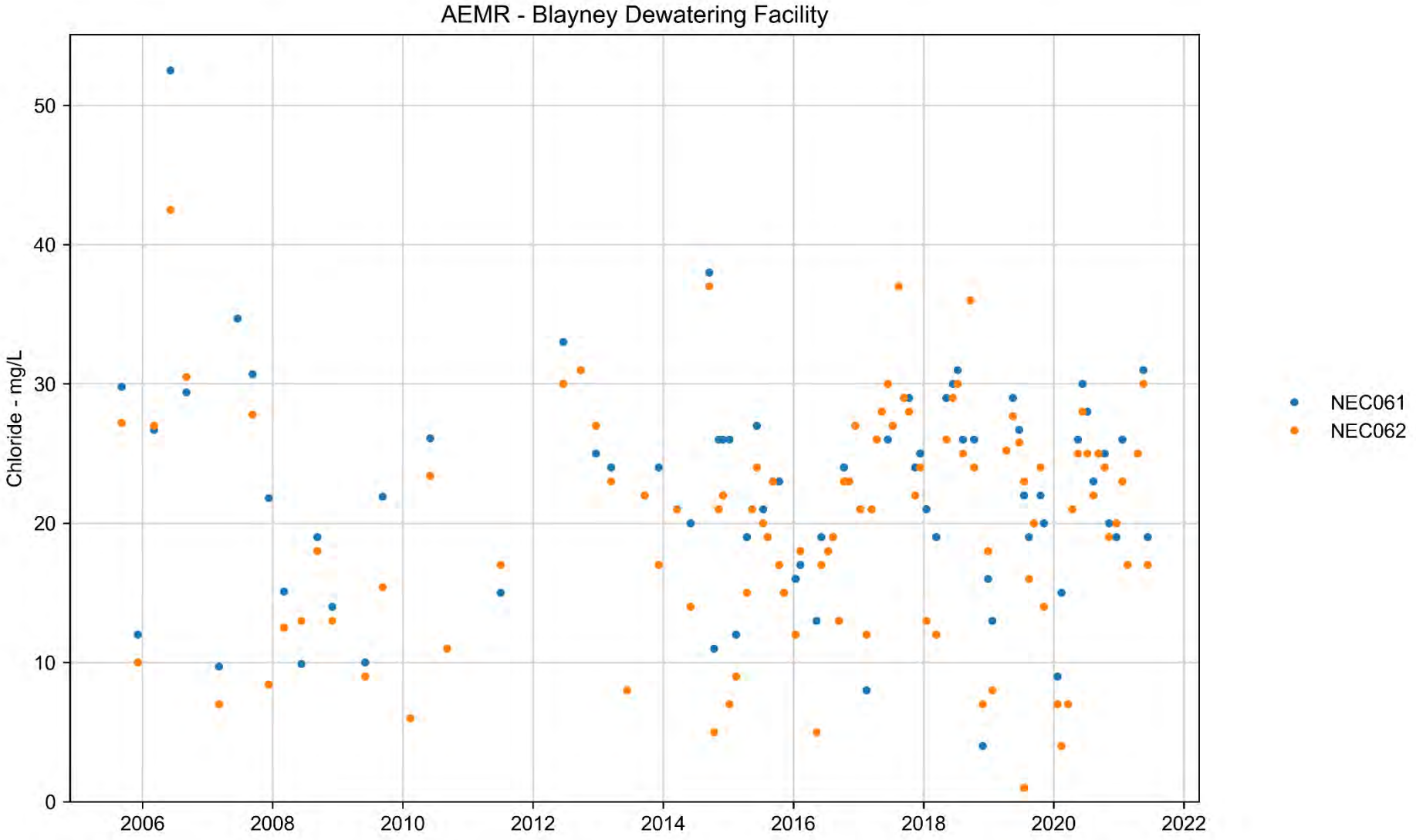


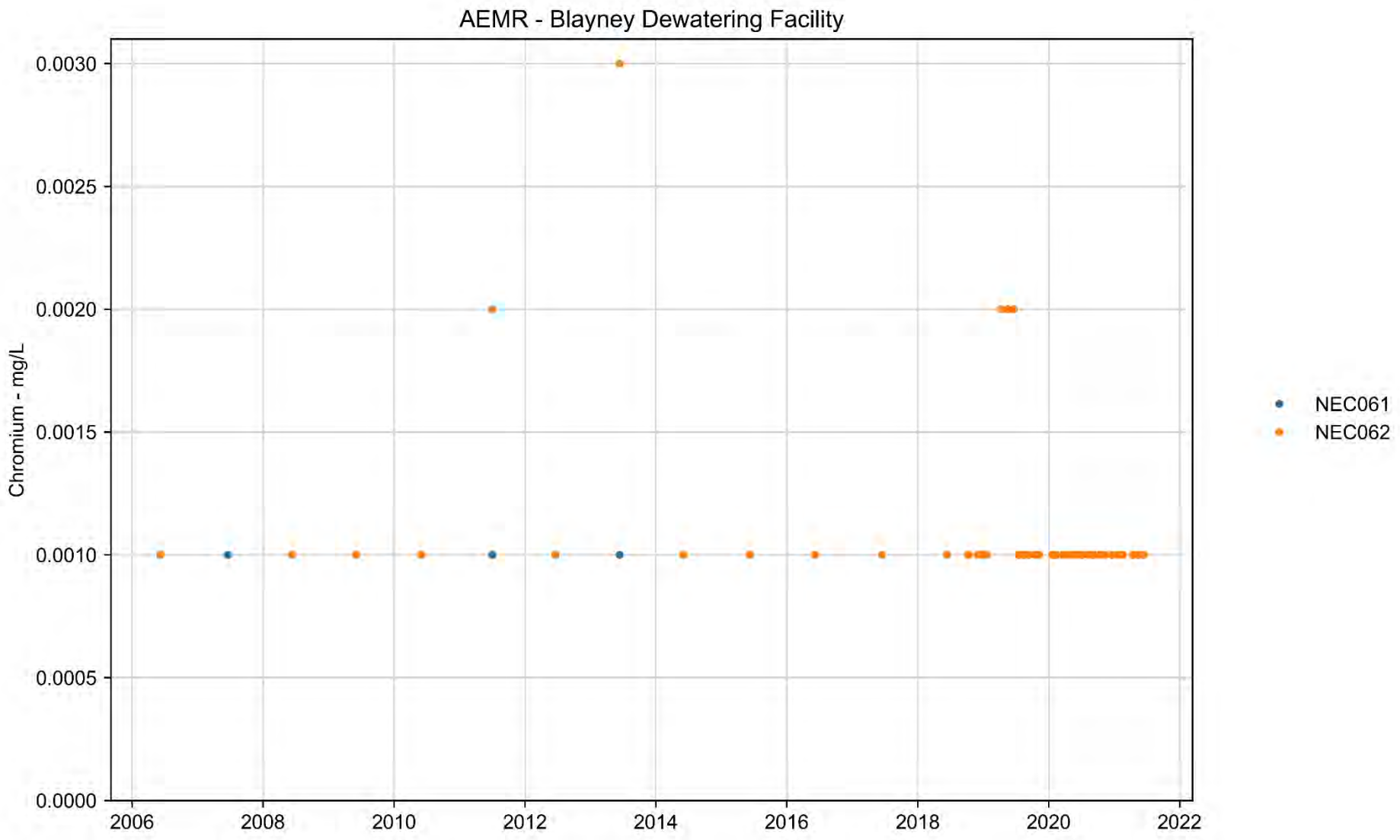

AEMR - Blayney Dewatering Facility
Calcium - mg/L
100
10
1
2006
2008
2010
2012
2014
2016
2018
2020
2022
NEC061
NEC062

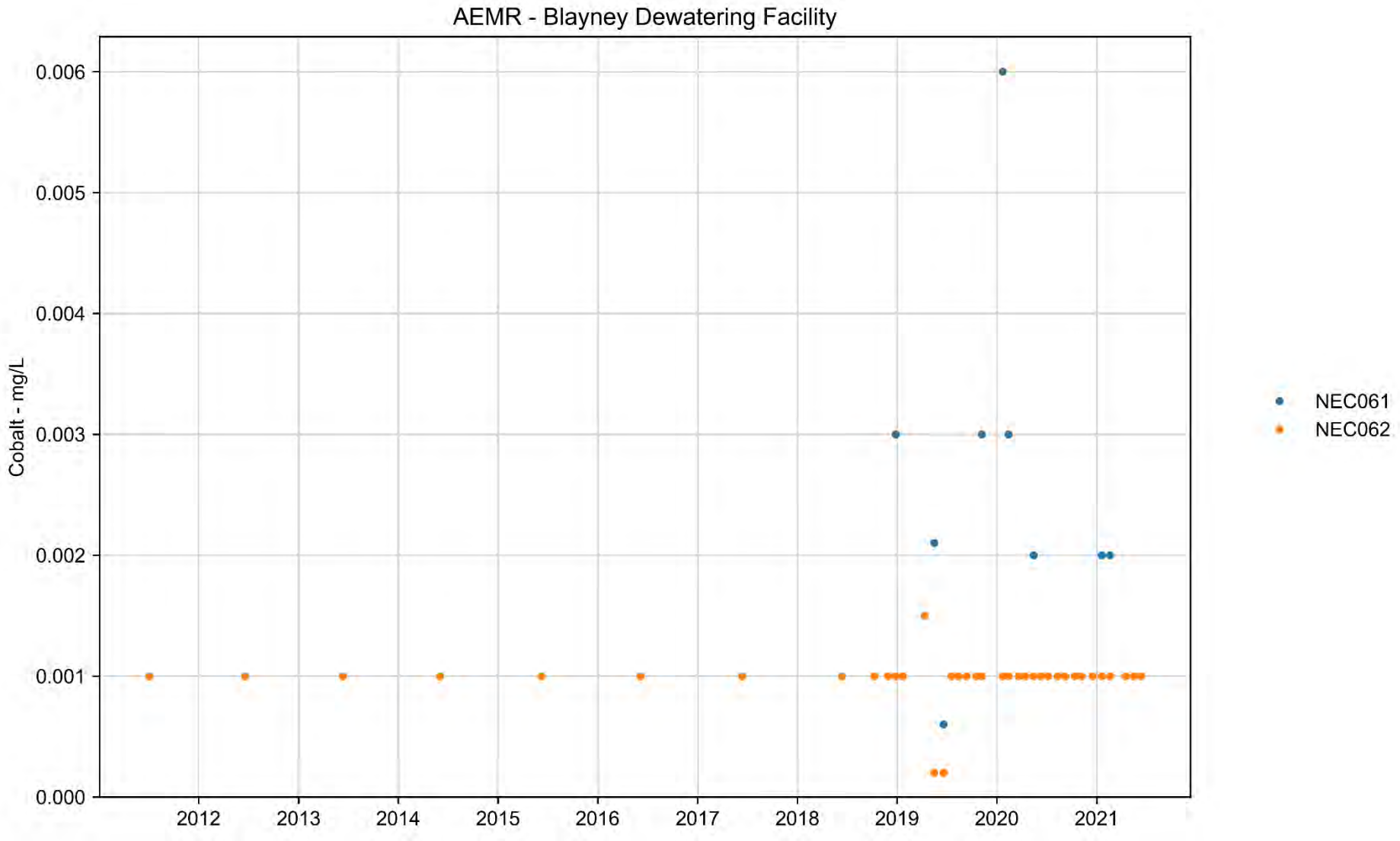
AEMR - Blayney Dewatering Facility

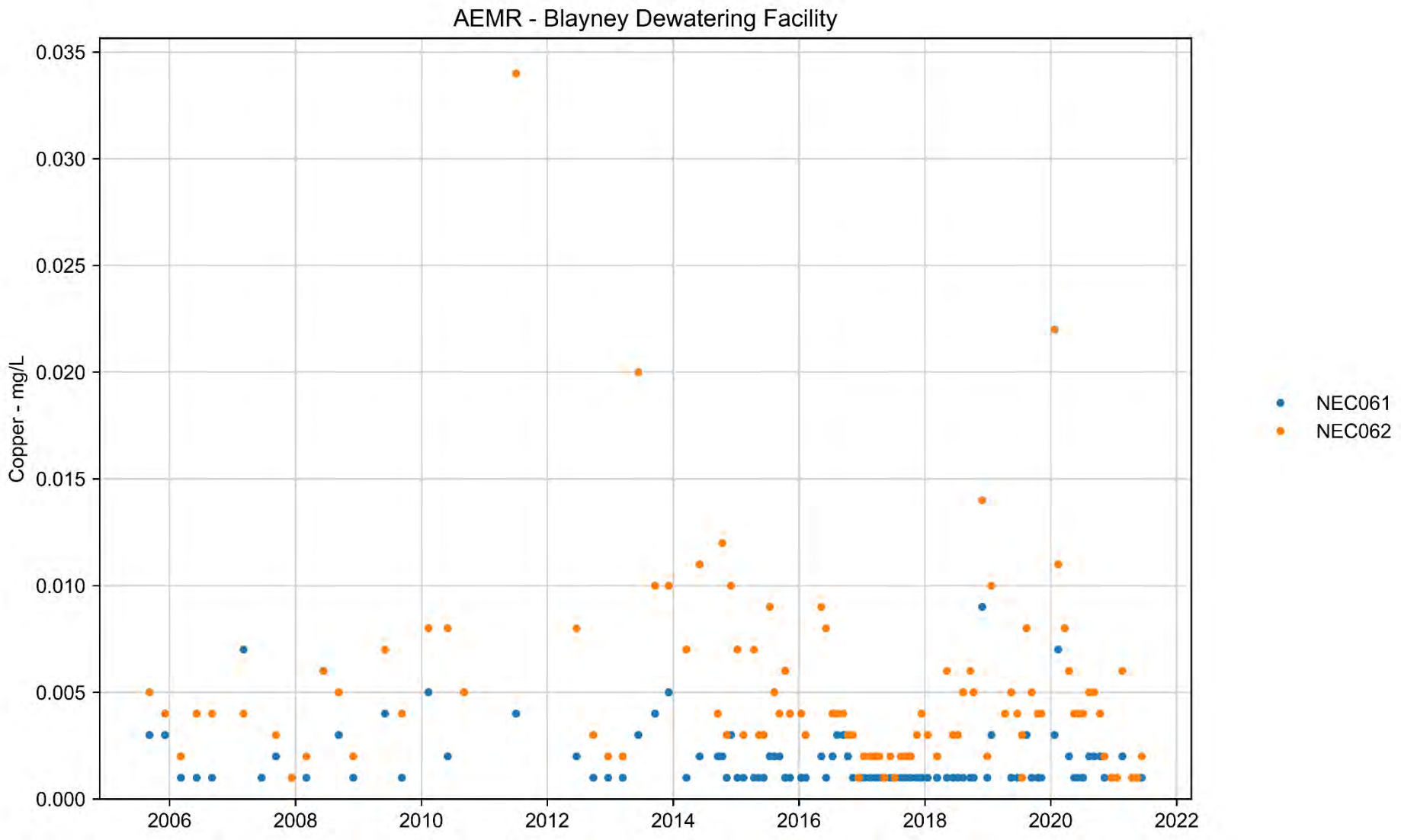


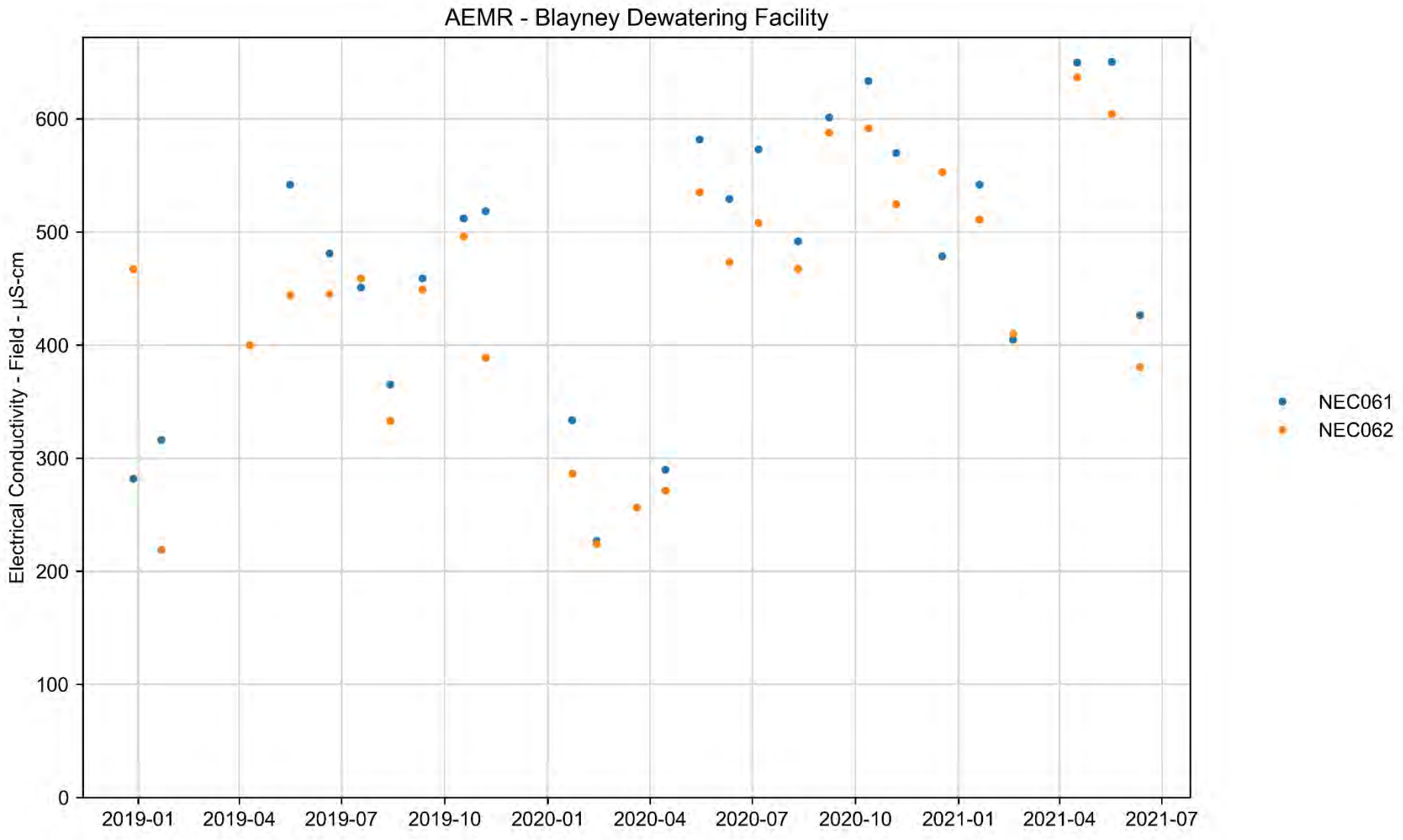
AEMR - Blayney Dewatering Facility



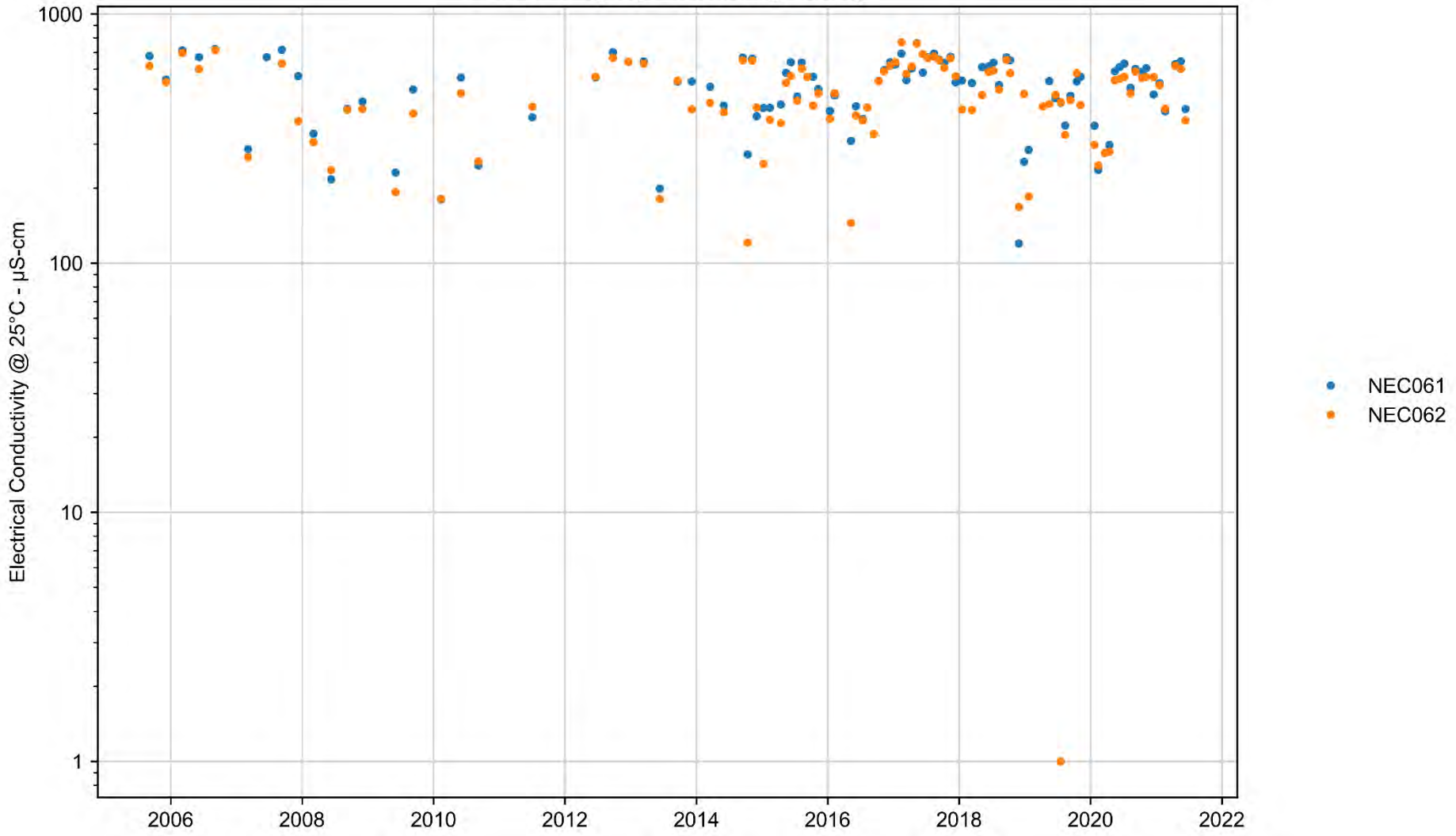

AEMR - Blayney Dewatering Facility
Chromium - mg/L
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
2006
2008
2010
2012
2014
2016
2018
2020
2022
NEC061
NEC062


AEMR - Blayney Dewatering Facility
Cobalt - mg/L
0.006
0.005
0.004
0.003
0.002
0.001
0.000
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
NEC061
NEC062

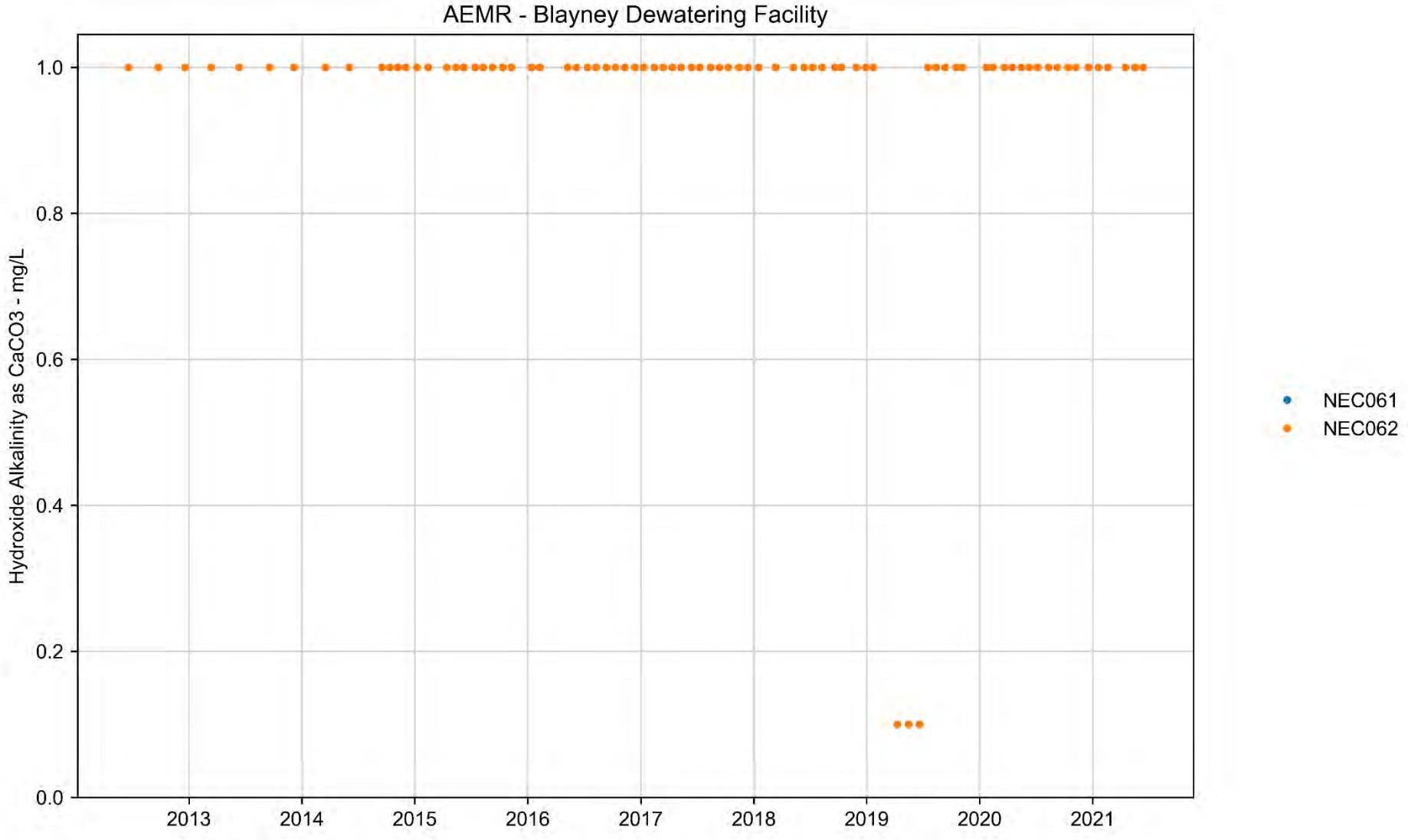

AEMR - Blayney Dewatering Facility
Copper - mg/L
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2006
2008
2010
2012
2014
2016
2018
2020
2022
NEC061
NEC062

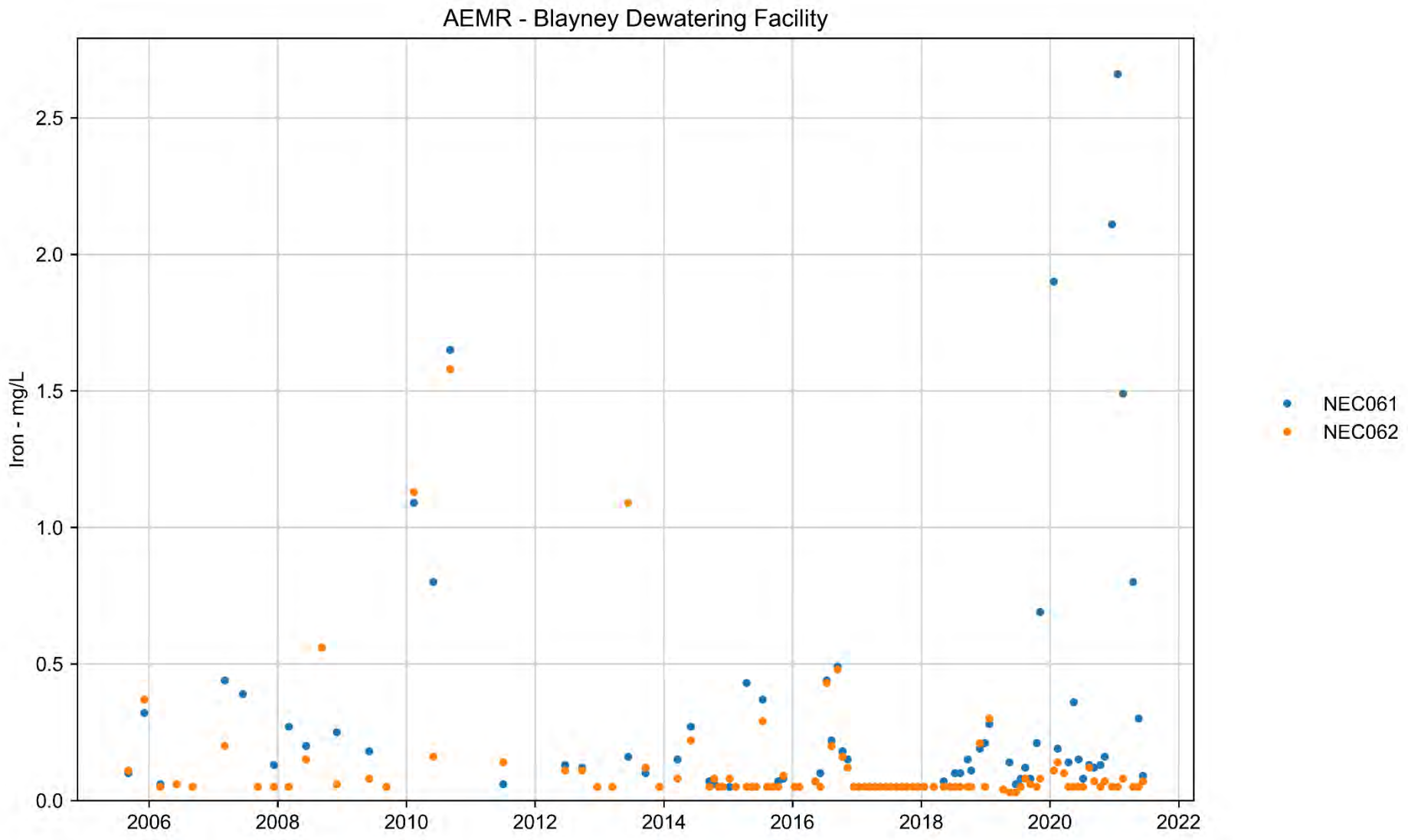

AEMR - Blayney Dewatering Facility
Electrical Conductivity - Field - µS-cm
600
500
400
300
200
100
0
2019-01
2019-04
2019-07
2019-10
2020-01
2020-04
2020-07
2020-10
2021-01
2021-04
2021-07
NEC061
NEC062

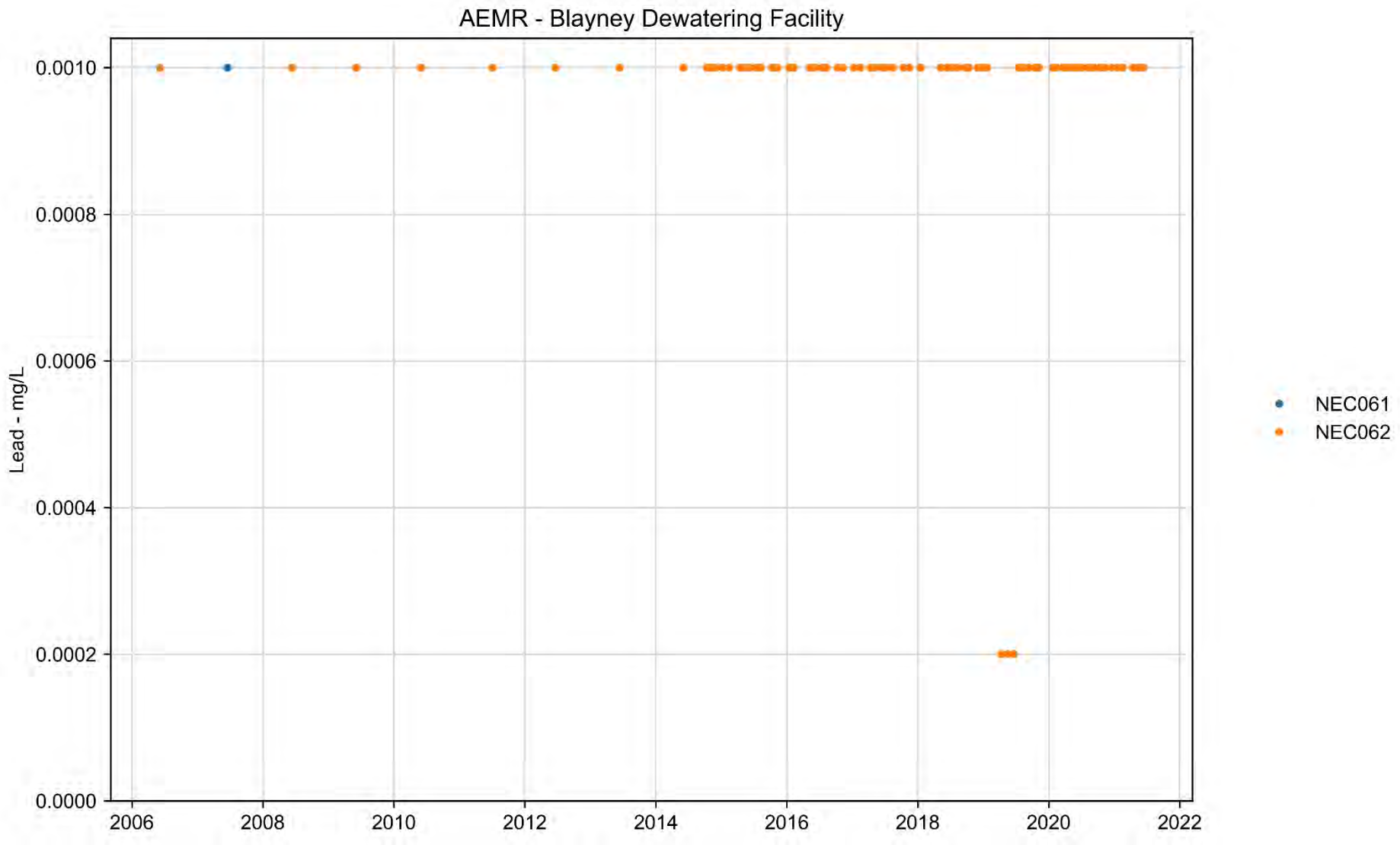
AEMR - Blayney Dewatering Facility

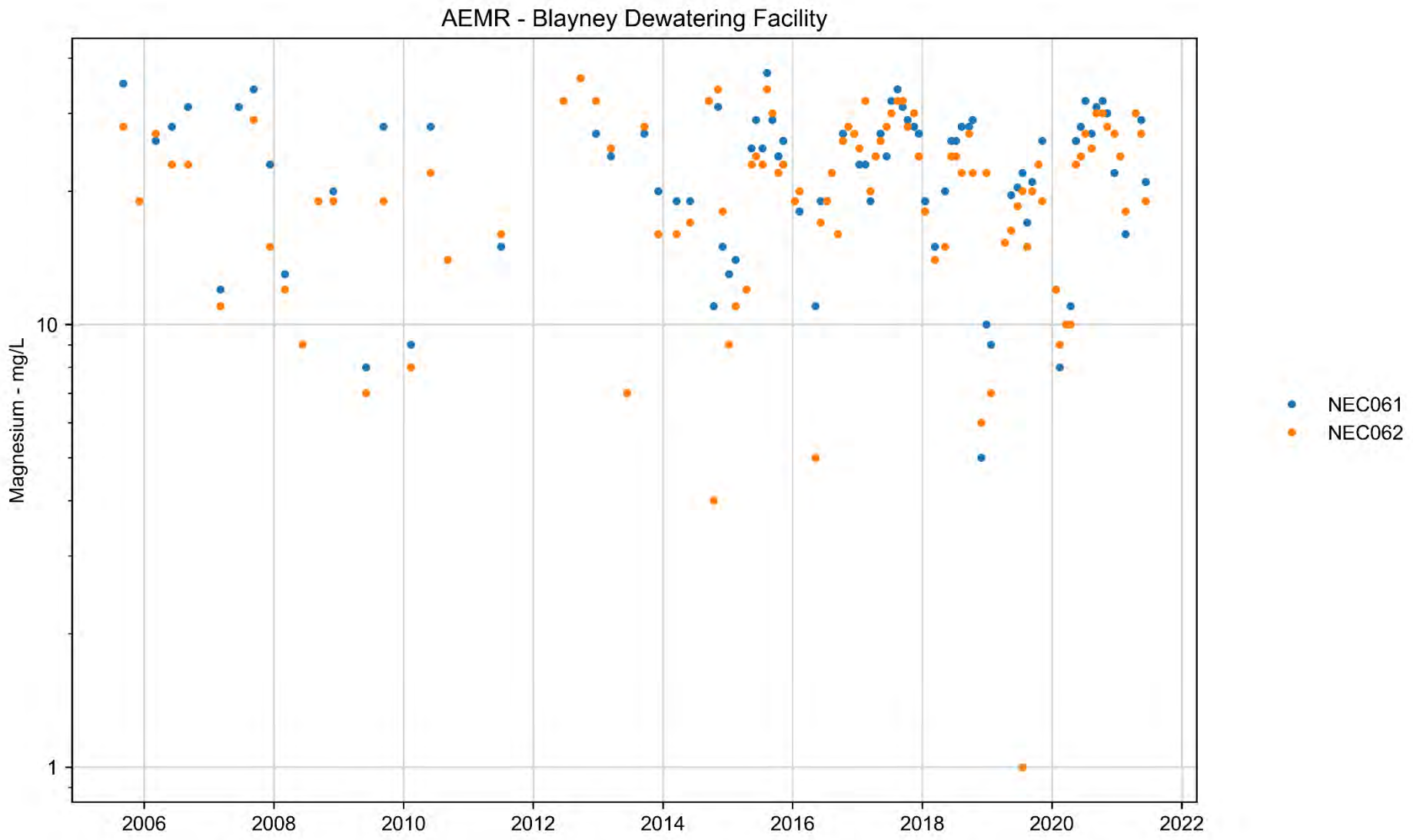


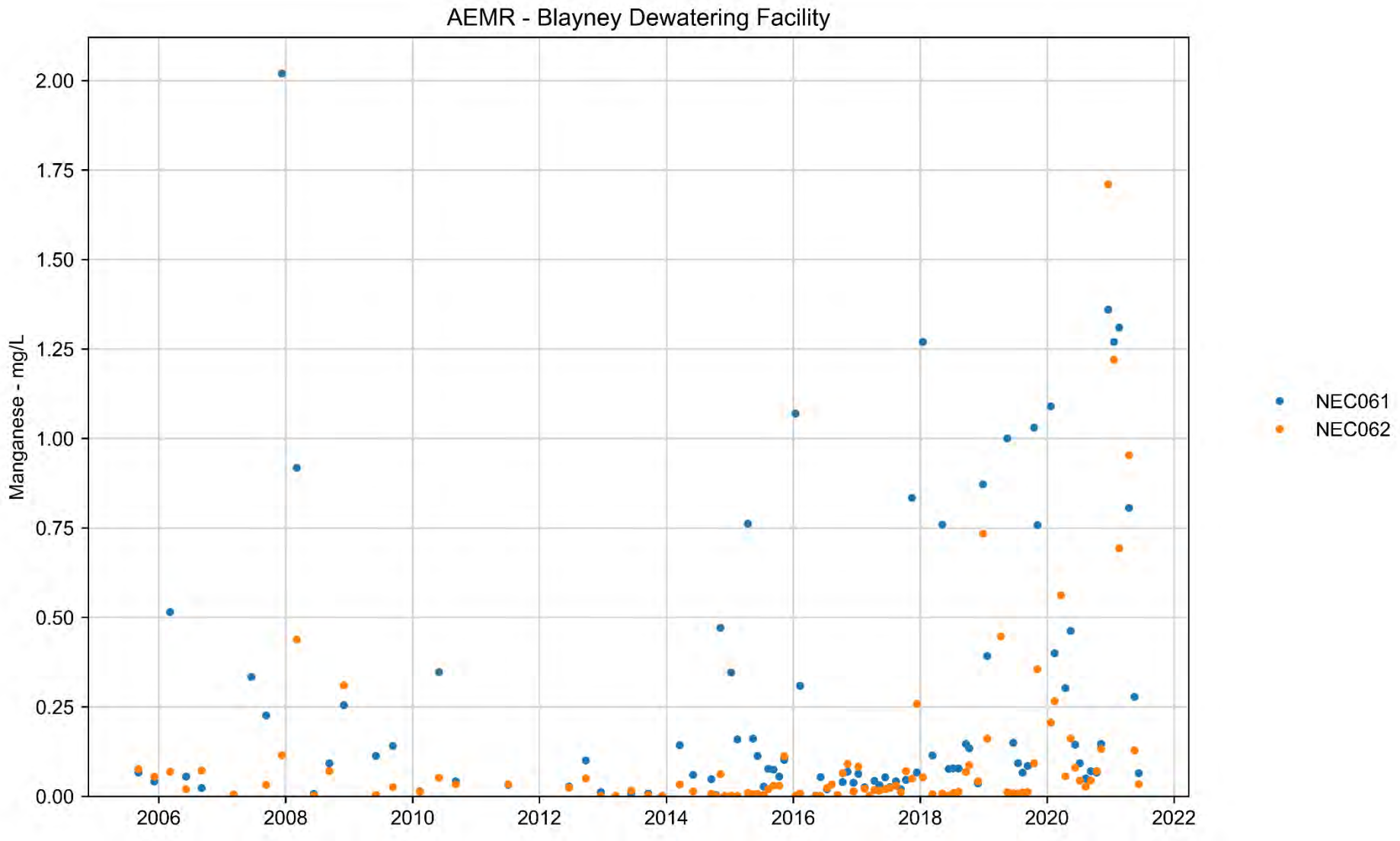
AEMR - Blayney Dewatering Facility

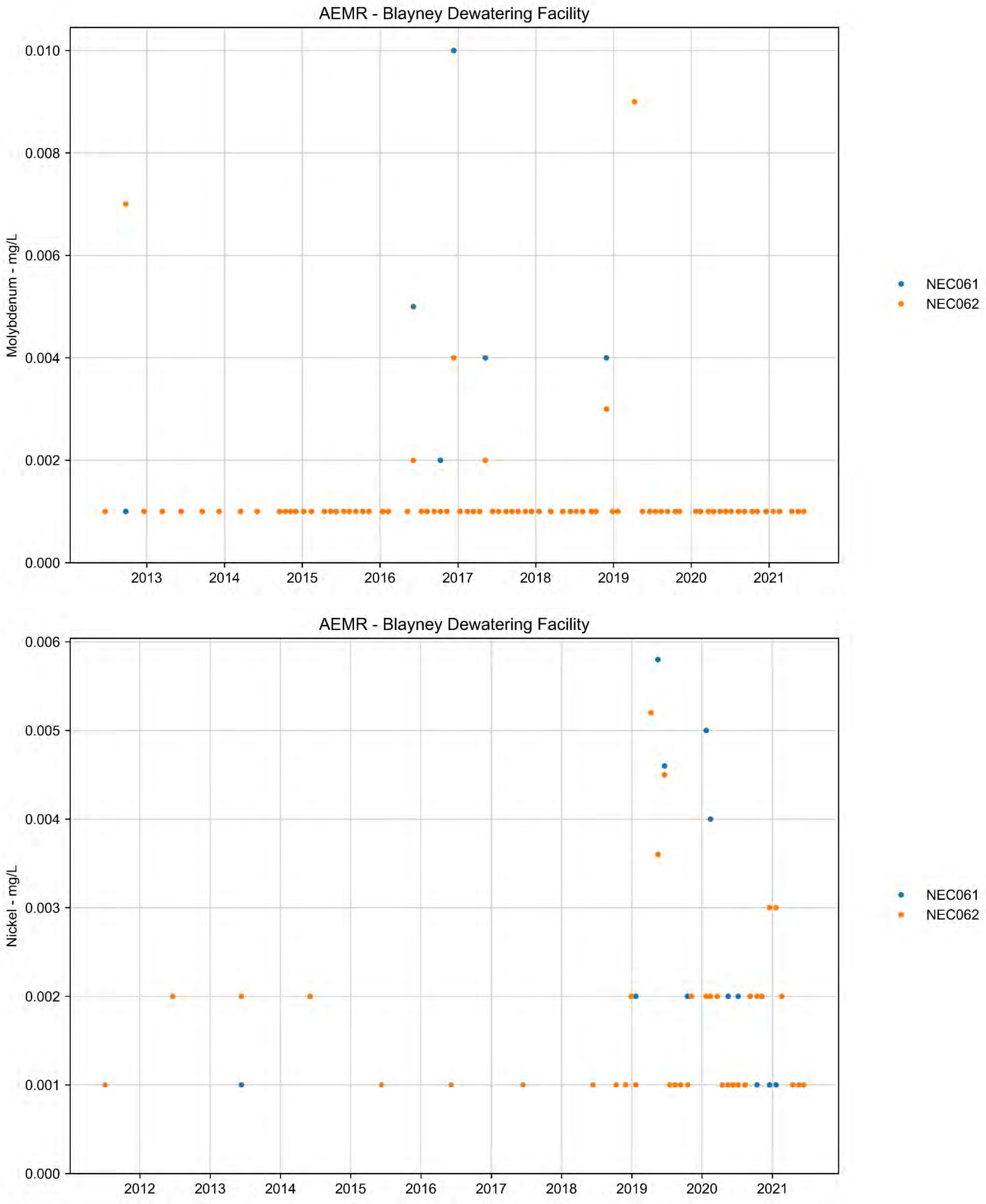


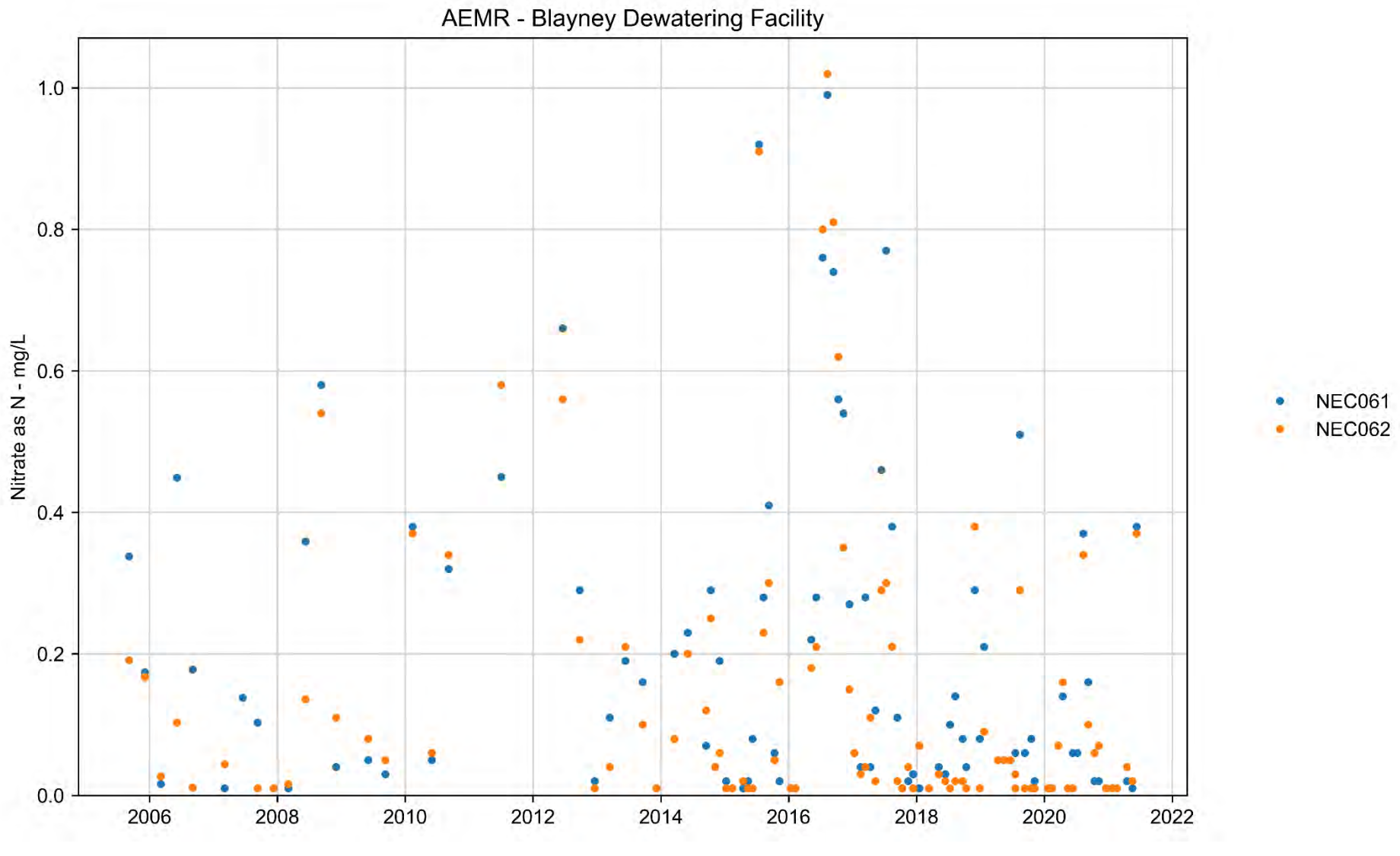

AEMR - Blayney Dewatering Facility
Iron - mg/L
2.5
2.0
1.5
1.0
0.5
0.0
2006
2008
2010
2012
2014
2016
2018
2020
2022
NEC061
NEC062

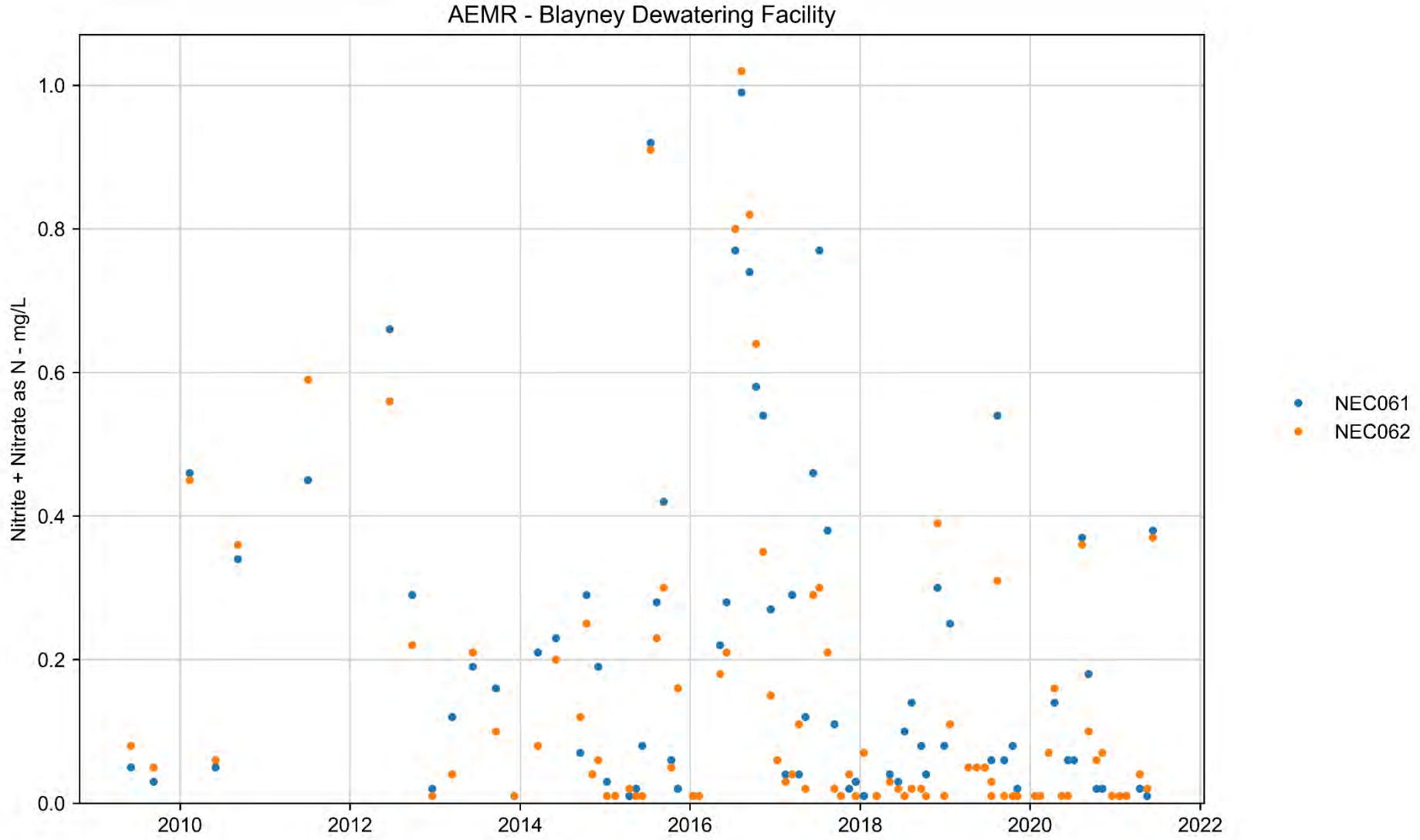

AEMR - Blayney Dewatering Facility
Lead - mg/L
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
2006
2008
2010
2012
2014
2016
2018
2020
2022
NEC061
NEC062

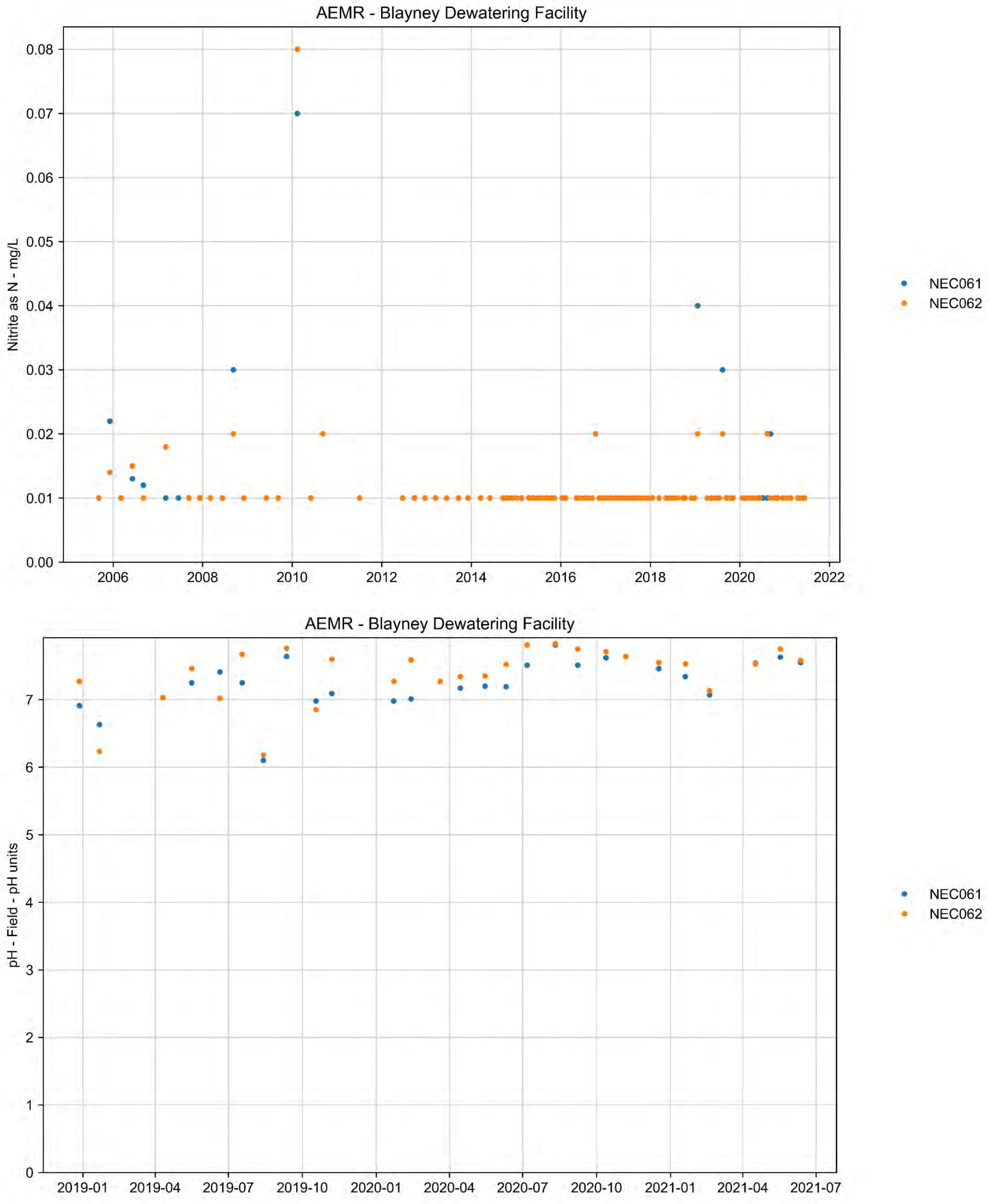

AEMR - Blayney Dewatering Facility
Magnesium - mg/L
10
1
2006
2008
2010
2012
2014
2016
2018
2020
2022
NEC061
NEC062

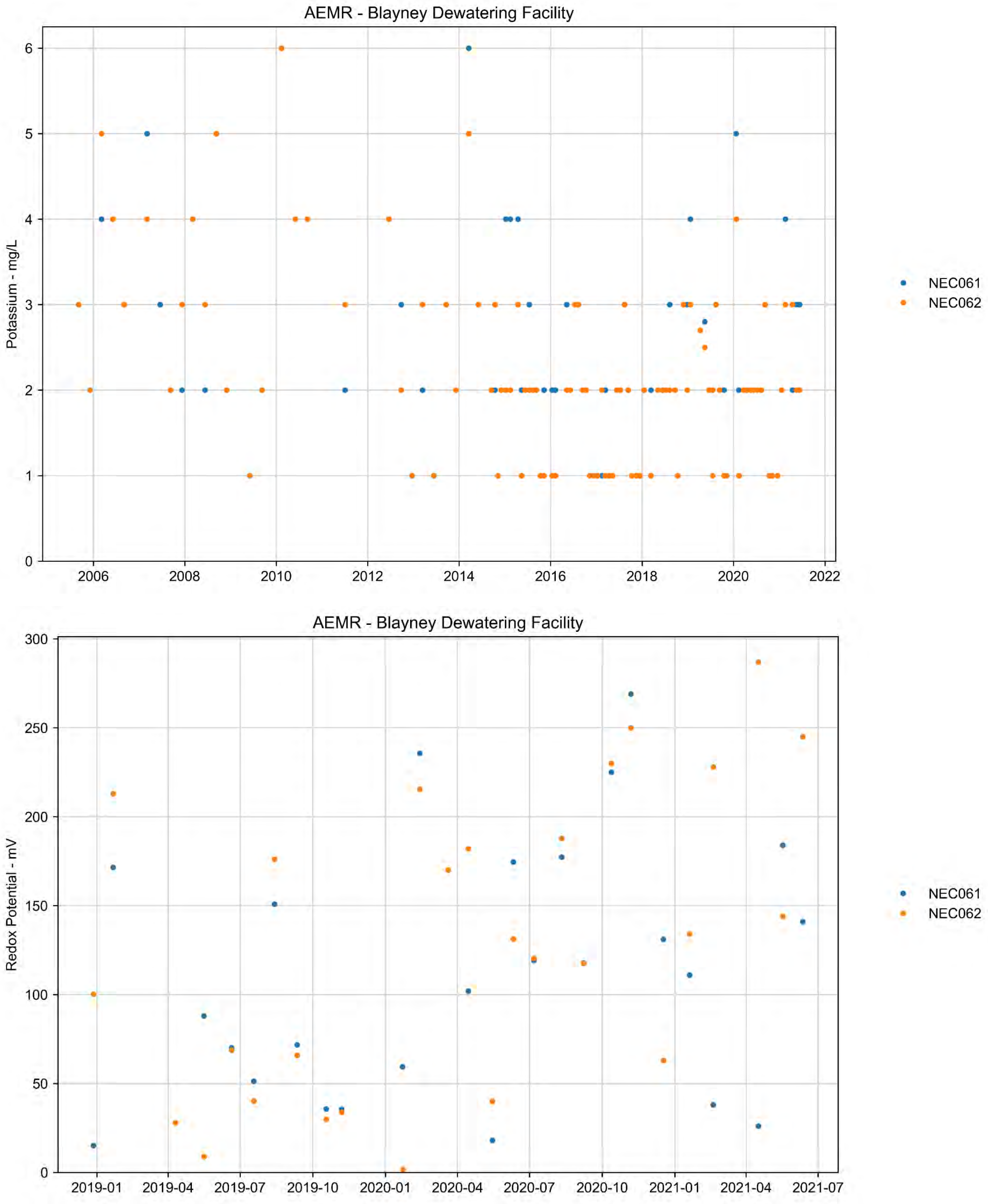

AEMR - Blayney Dewatering Facility
Manganese - mg/L
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
2006
2008
2010
2012
2014
2016
2018
2020
2022
NEC061
NEC062

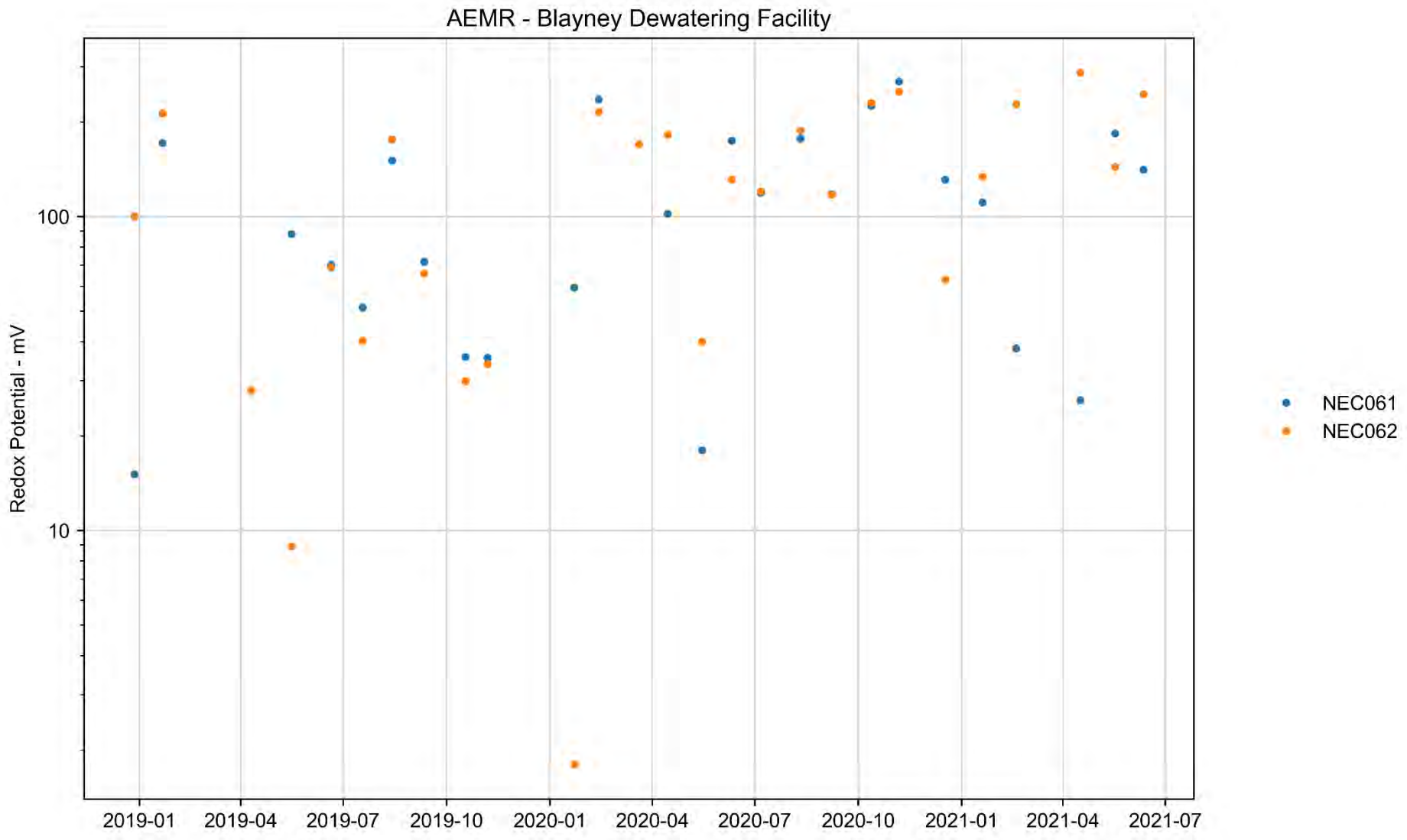

AEMR - Blayney Dewatering Facility
Molybdenum - mg/L
0.010
0.008
0.006
0.004
0.002
0.000
2013
2014
2015
2016
2017
2018
2019
2020
2021
NEC061
NEC062
AEMR - Blayney Dewatering Facility
Nickel - mg/L
0.006
0.005
0.004
0.003
0.002
0.001
0.000
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
NEC061
NEC062

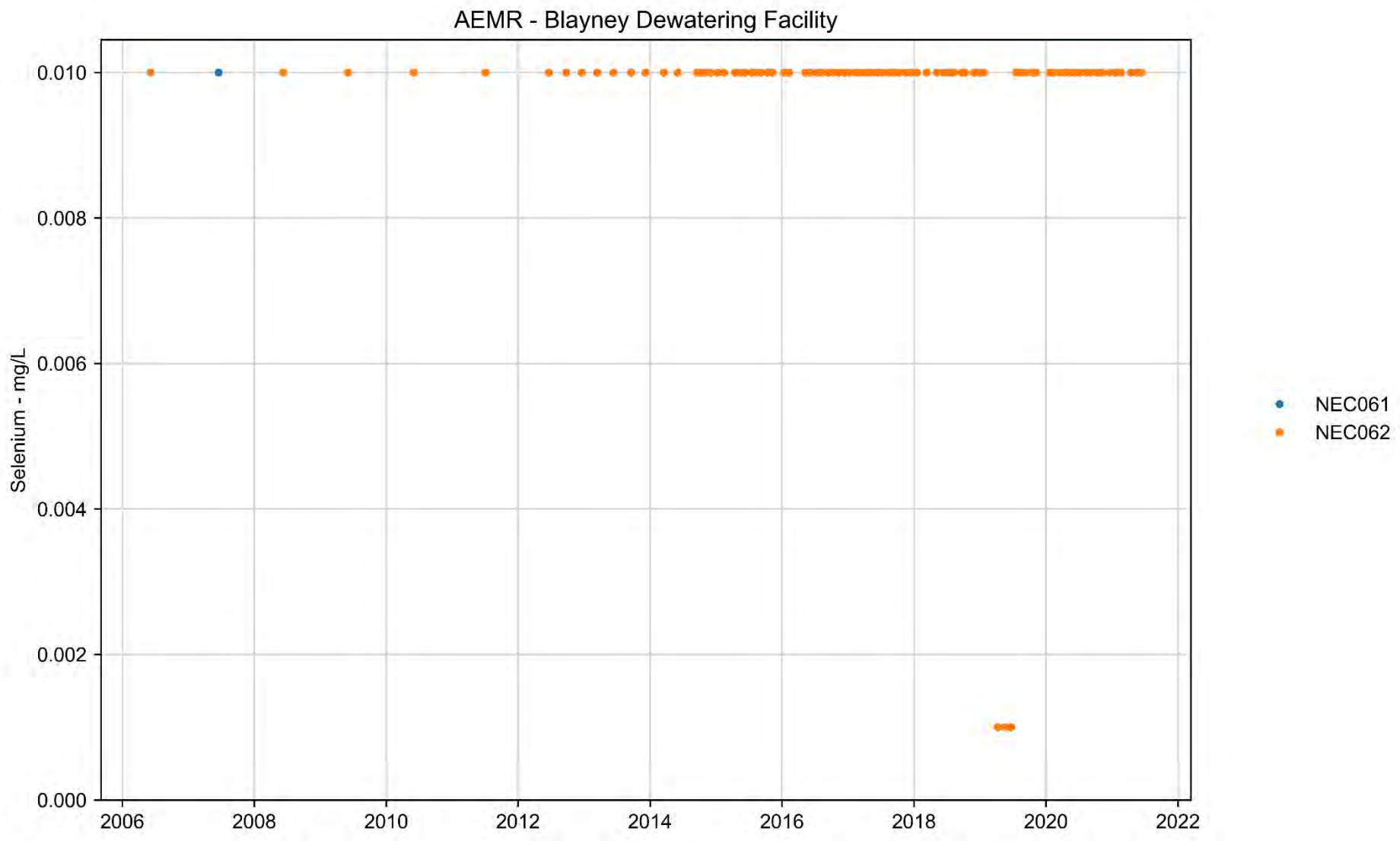

AEMR - Blayney Dewatering Facility
Nitrate as N - mg/L
1.0
0.8
0.6
0.4
0.2
0.0
2006
2008
2010
2012
2014
2016
2018
2020
2022
NEC061
NEC062

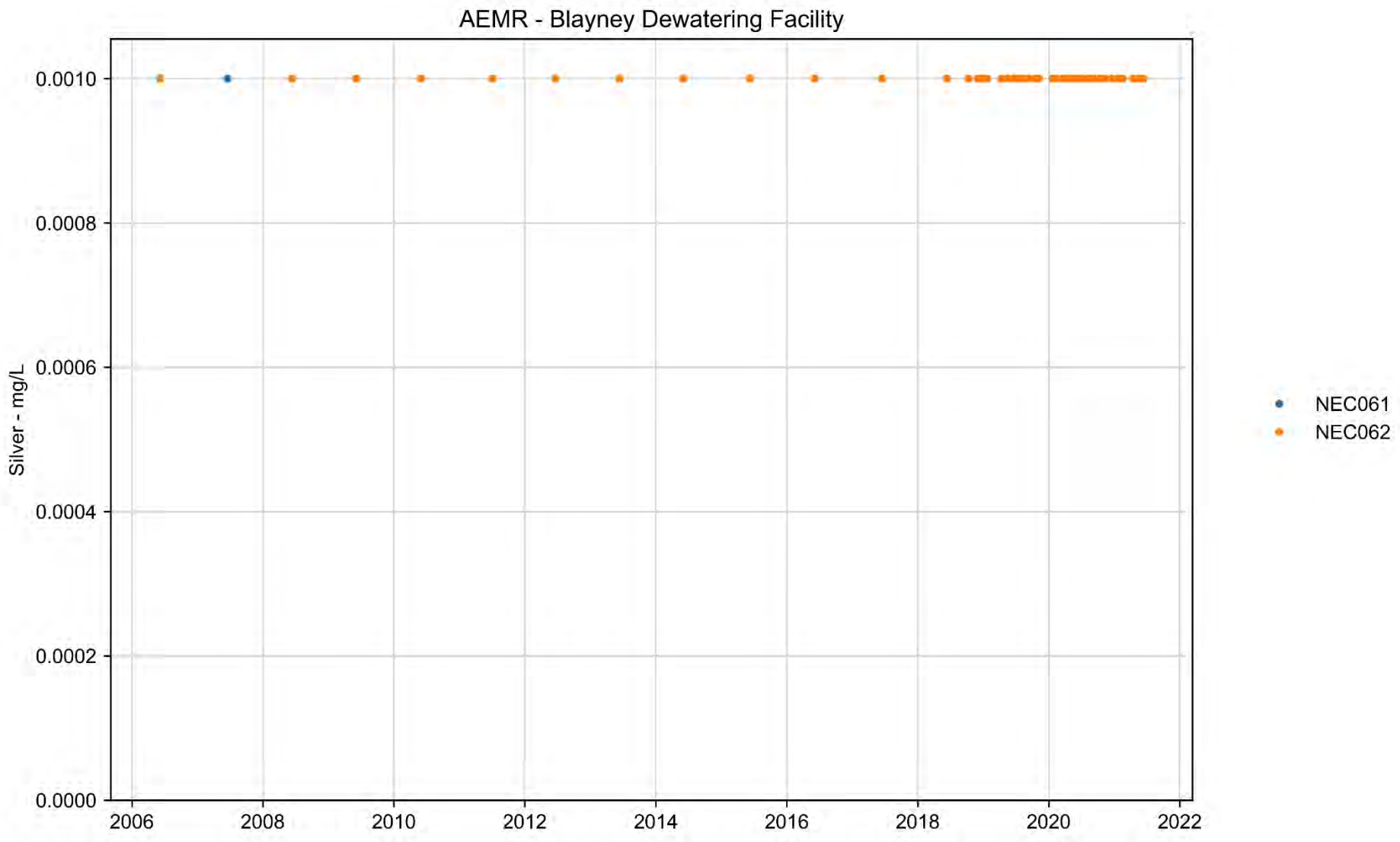

AEMR - Blayney Dewatering Facility
Nitrite + Nitrate as N - mg/L
1.0
0.8
0.6
0.4
0.2
0.0
2010
2012
2014
2016
2018
2020
2022
NEC061
NEC062

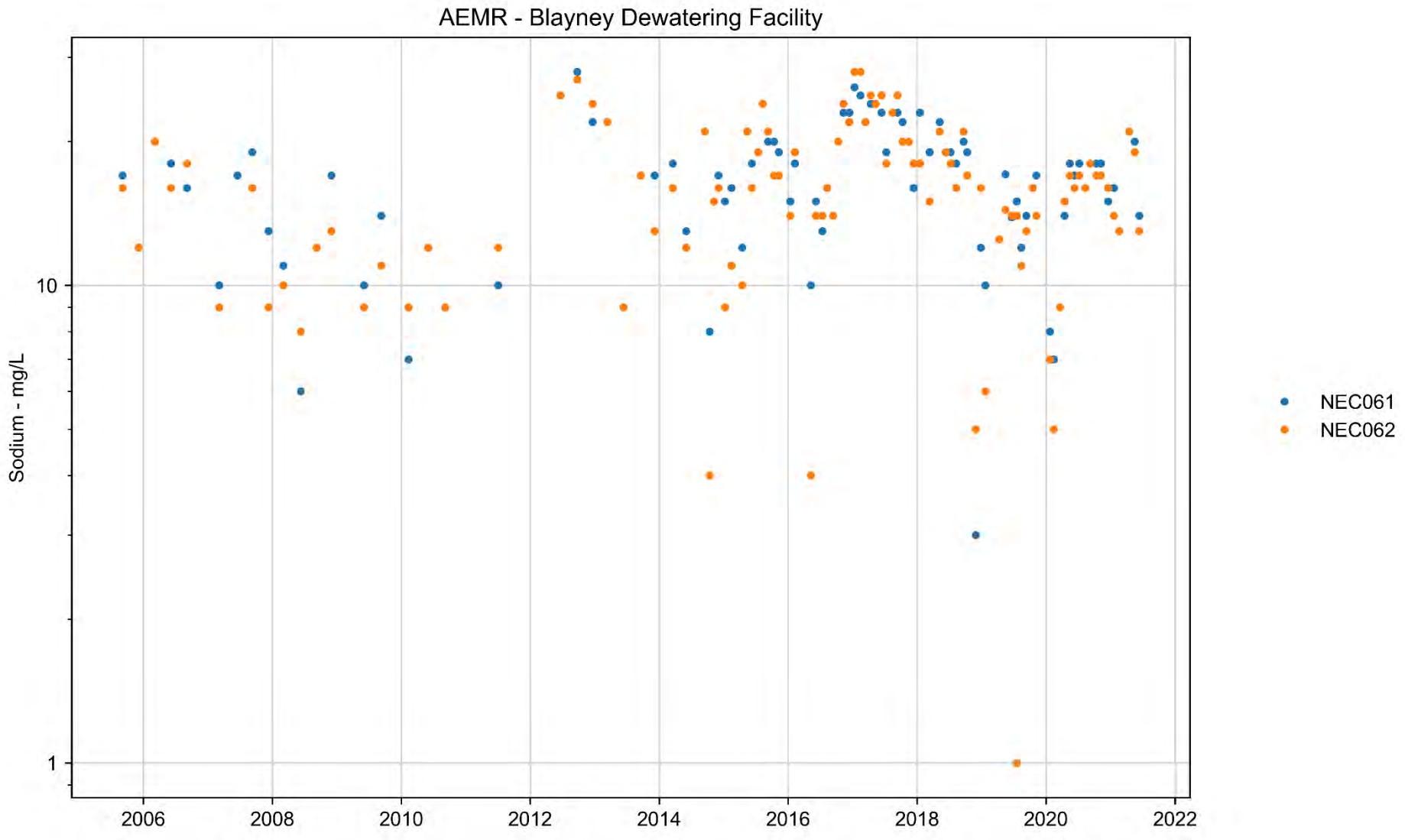

AEMR - Blayney Dewatering Facility
Nitrite as N - mg/L
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
2006
2008
2010
2012
2014
2016
2018
2020
2022
NEC061
NEC062
AEMR - Blayney Dewatering Facility
pH - Field - pH units
7
6
5
4
3
2
1
0
2019-01
2019-04
2019-07
2019-10
2020-01
2020-04
2020-07
2020-10
2021-01
2021-04
2021-07
NEC061
NEC062

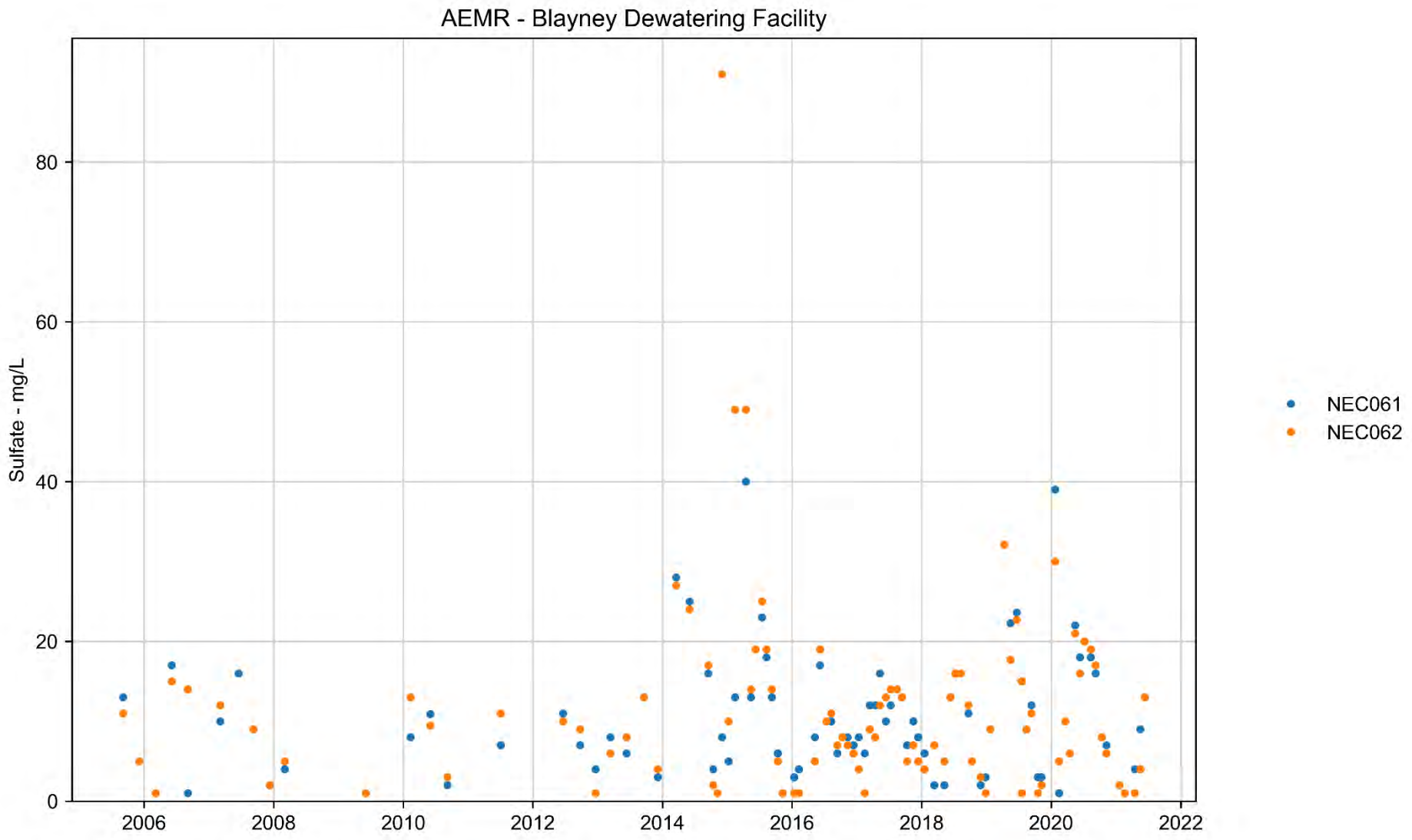

AEMR - Blayney Dewatering Facility
Potassium - mg/L
0
1
2
3
4
5
6
2006
2008
2010
2012
2014
2016
2018
2020
2022
NEC061
NEC062
AEMR - Blayney Dewatering Facility
Redox Potential - mV
0
50
100
150
200
250
300
2019-01
2019-04
2019-07
2019-10
2020-01
2020-04
2020-07
2020-10
2021-01
2021-04
2021-07
NEC061
NEC062

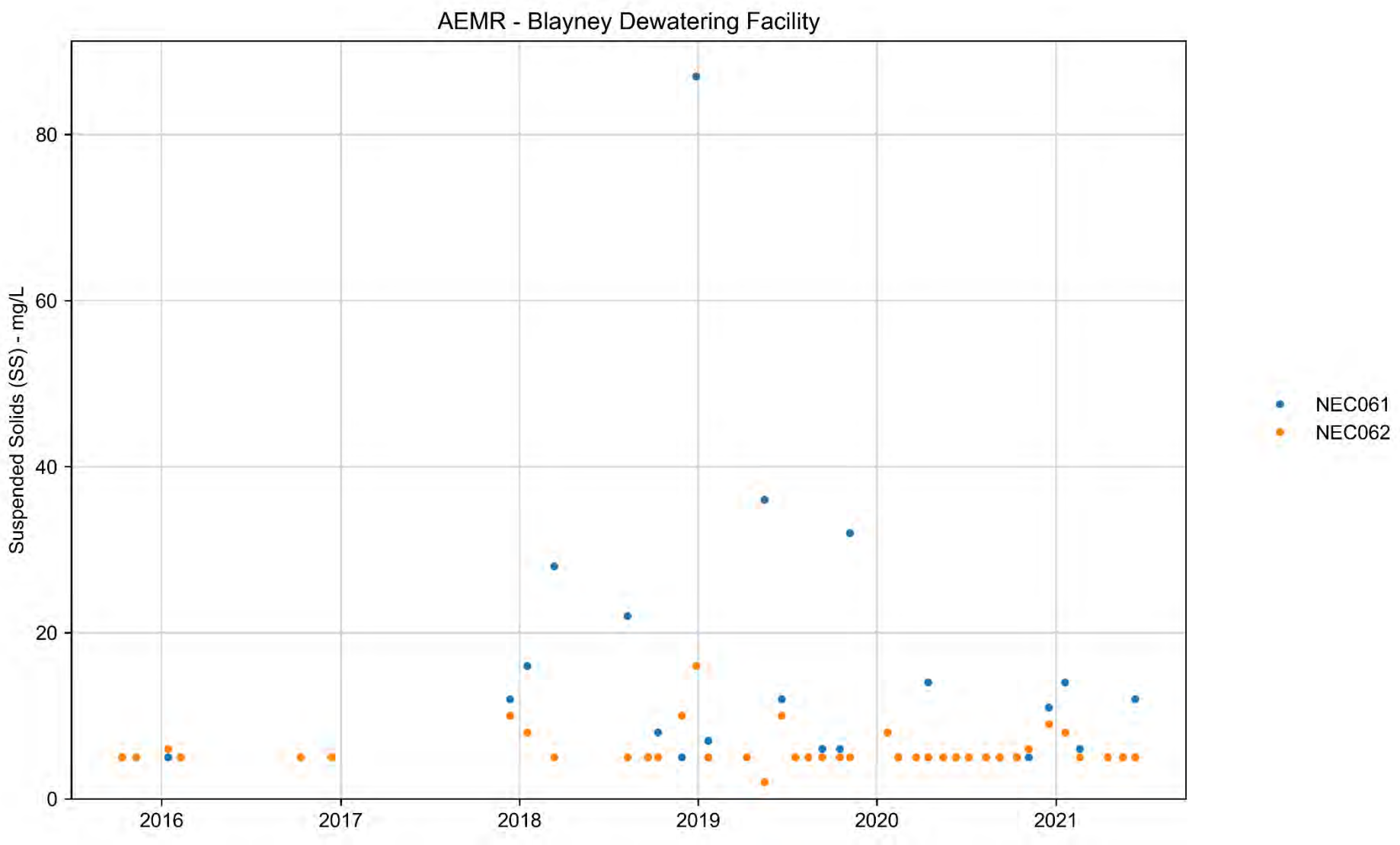

AEMR - Blayney Dewatering Facility
Redox Potential - mV
100
10
2019-01
2019-04
2019-07
2019-10
2020-01
2020-04
2020-07
2020-10
2021-01
2021-04
2021-07
NEC061
NEC062


AEMR - Blayney Dewatering Facility
Selenium - mg/L
0.010
0.008
0.006
0.004
0.002
0.000
2006
2008
2010
2012
2014
2016
2018
2020
2022
NEC061
NEC062

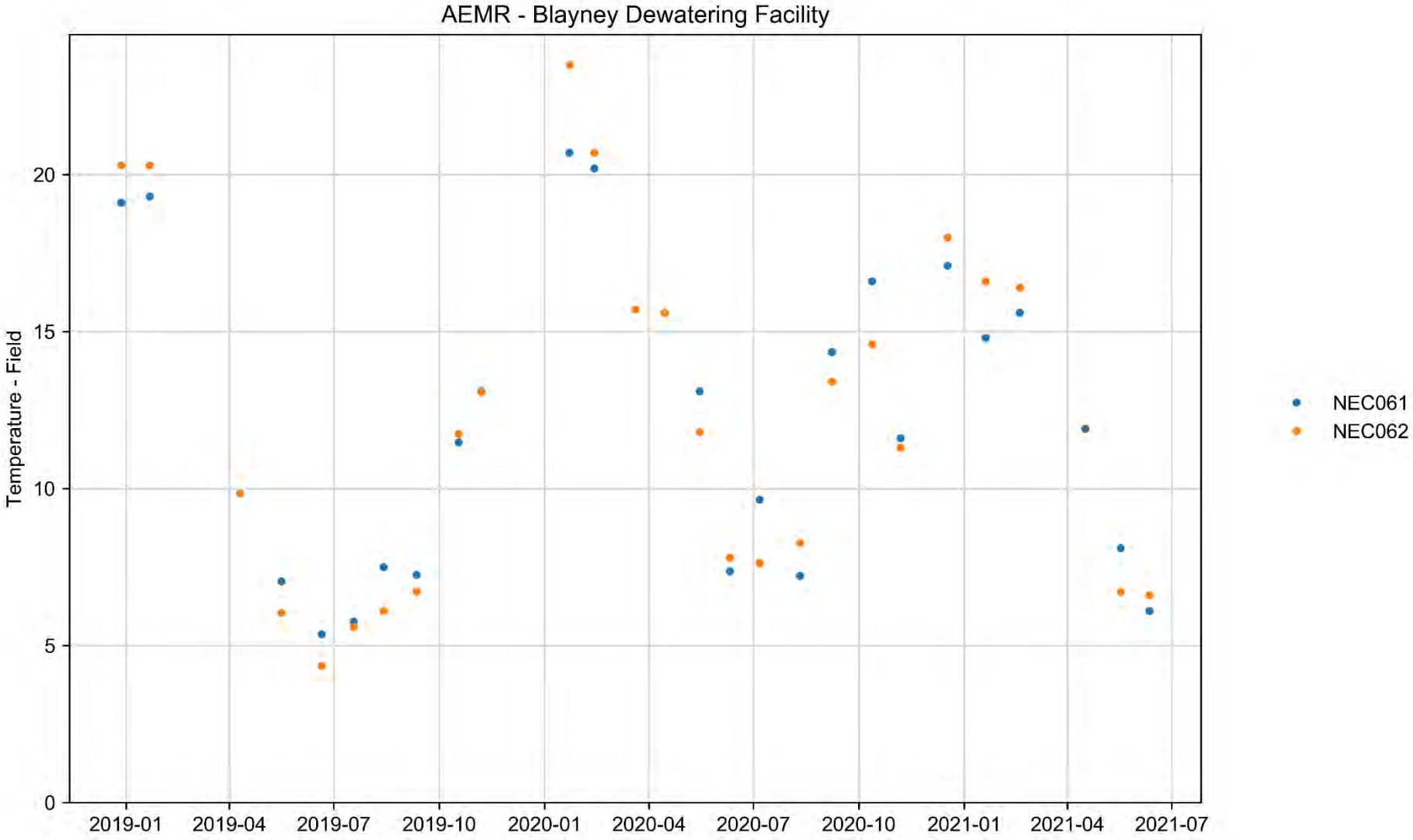

AEMR - Blayney Dewatering Facility
Silver - mg/L
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
2006
2008
2010
2012
2014
2016
2018
2020
2022
NEC061
NEC062


AEMR - Blayney Dewatering Facility
Sodium - mg/L
10
1
2006
2008
2010
2012
2014
2016
2018
2020
2022
NEC061
NEC062

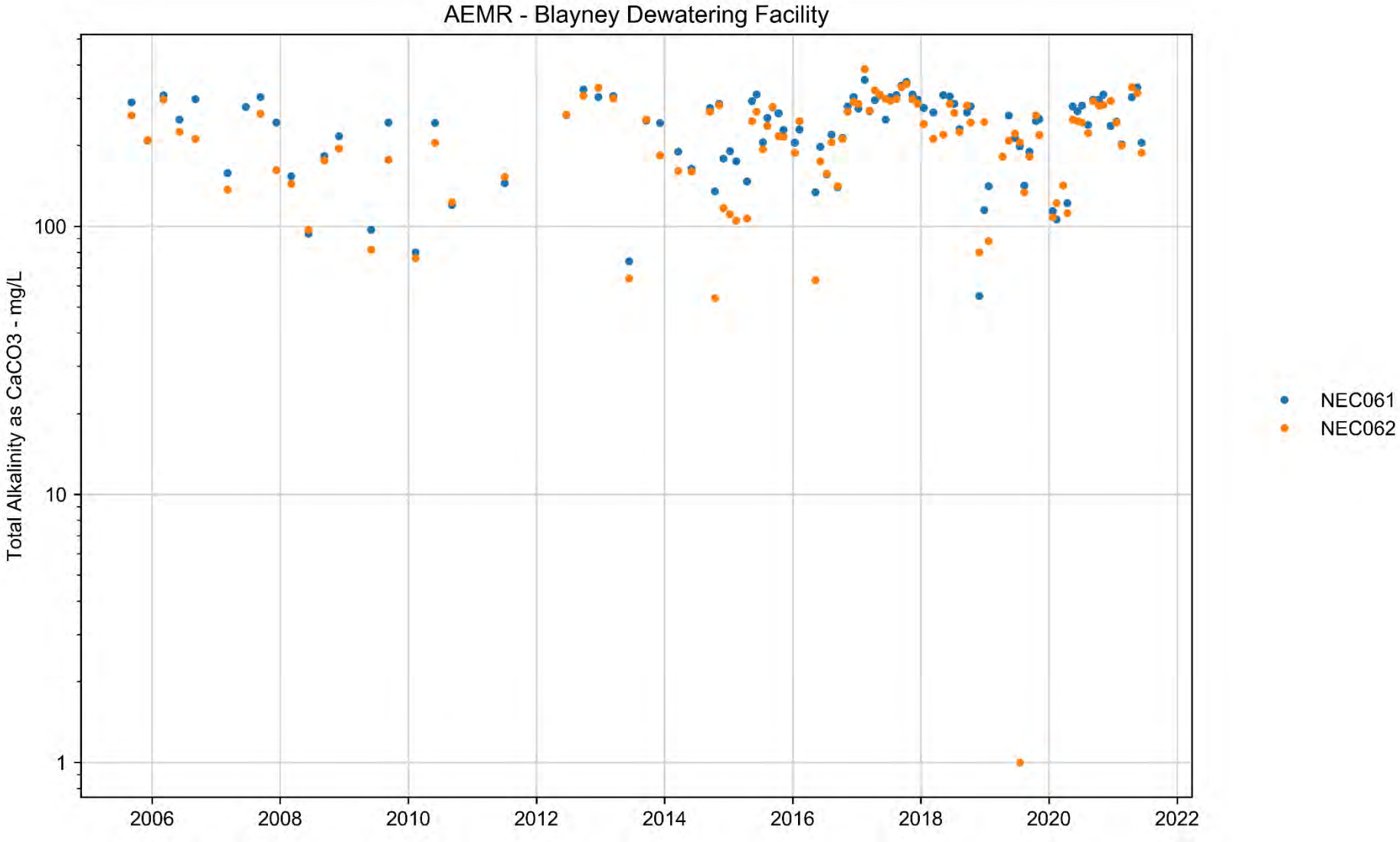

AEMR - Blayney Dewatering Facility
Sulfate - mg/L
0
20
40
60
80
2006
2008
2010
2012
2014
2016
2018
2020
2022
NEC061
NEC062

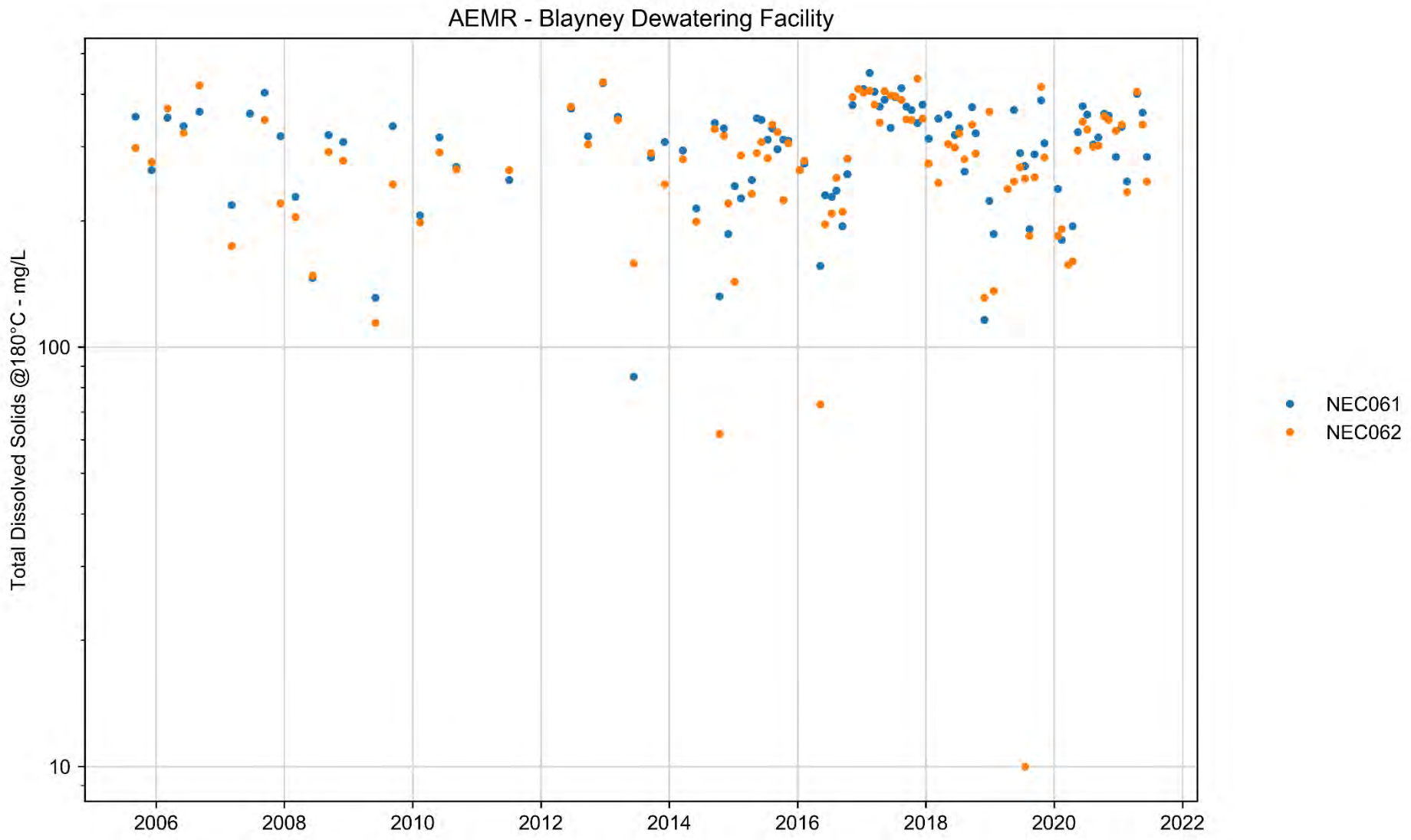

AEMR - Blayney Dewatering Facility
Suspended Solids (SS) - mg/L
0
20
40
60
80
2016
2017
2018
2019
2020
2021
NEC061
NEC062

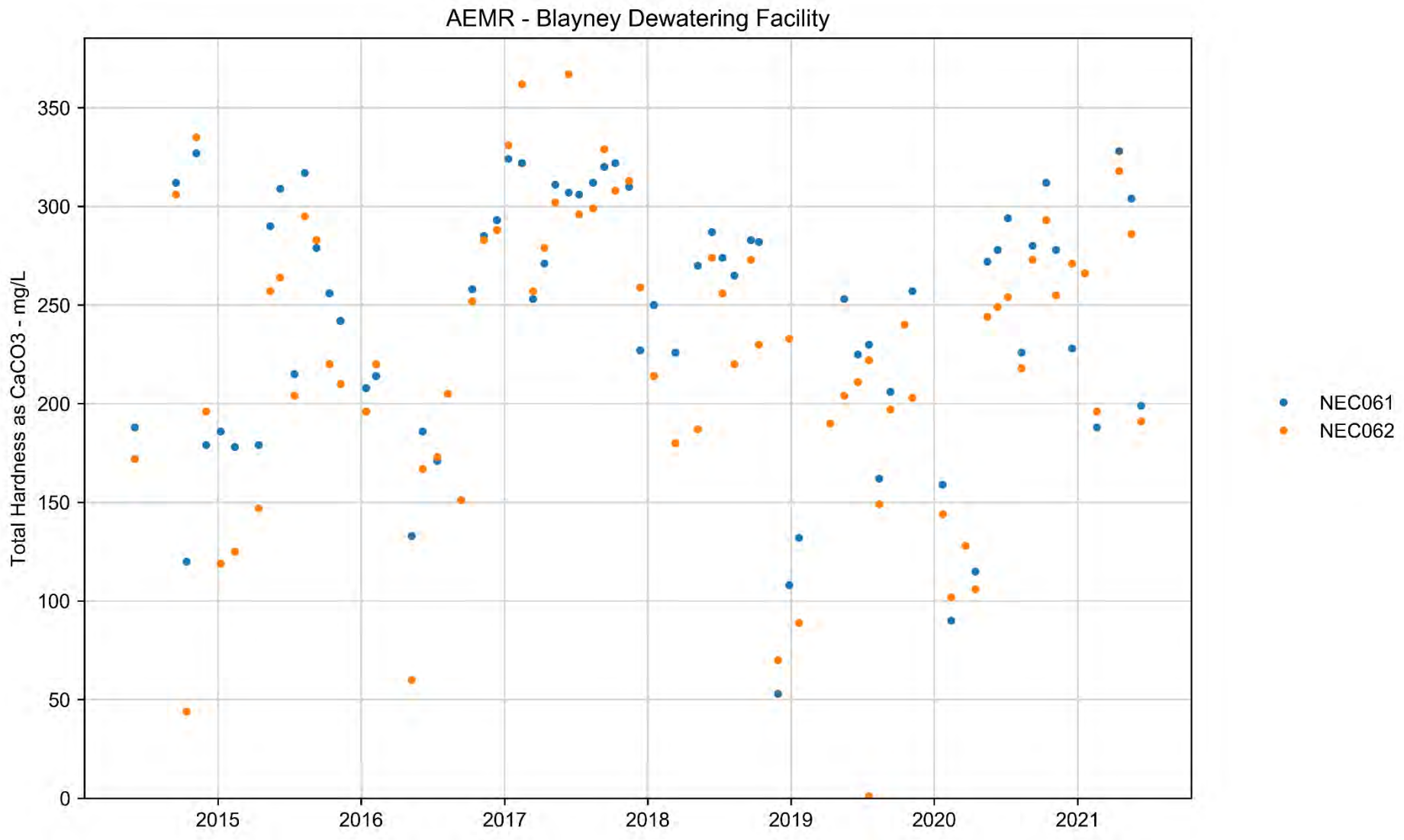
AEMR - Blayney Dewatering Facility

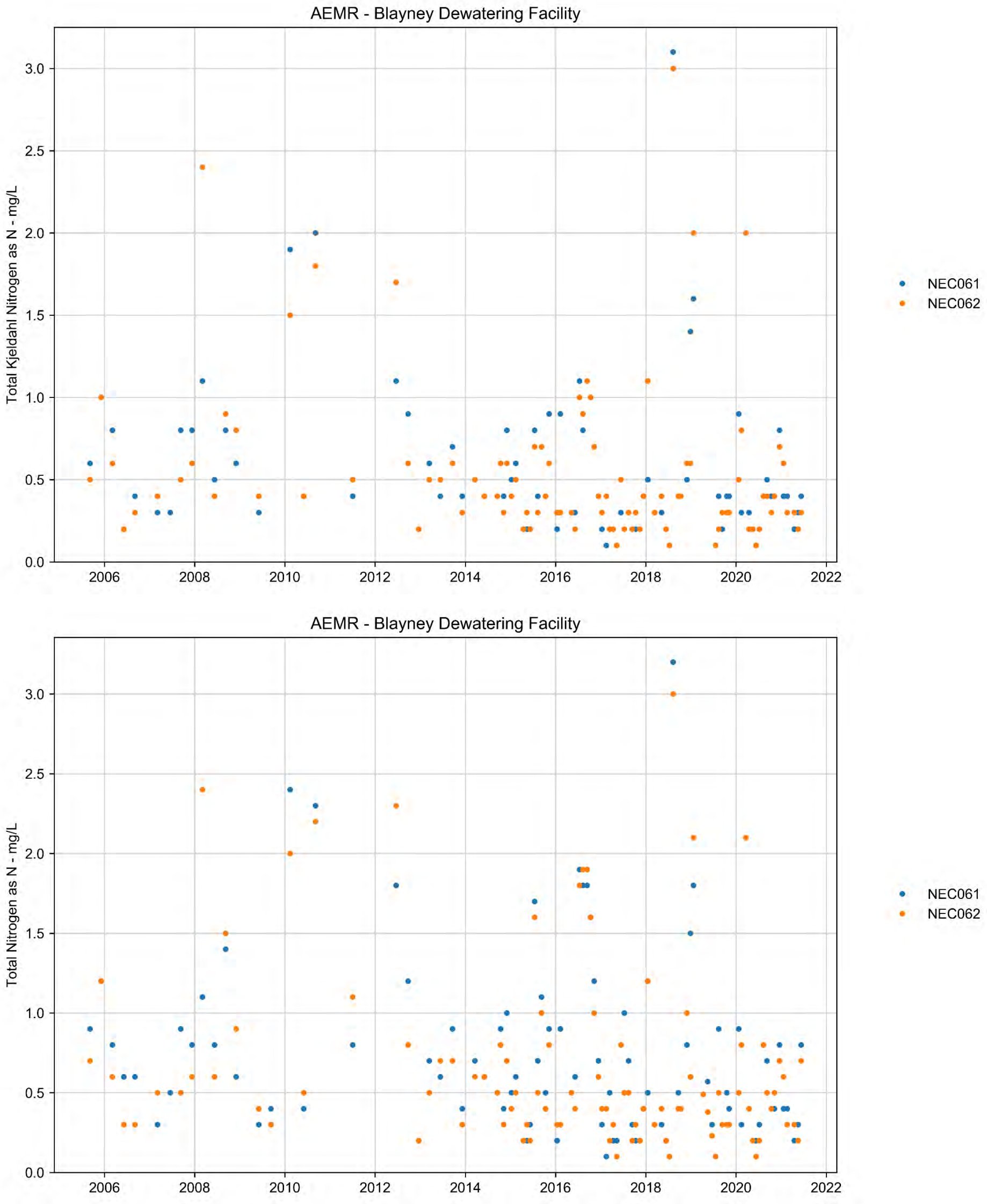


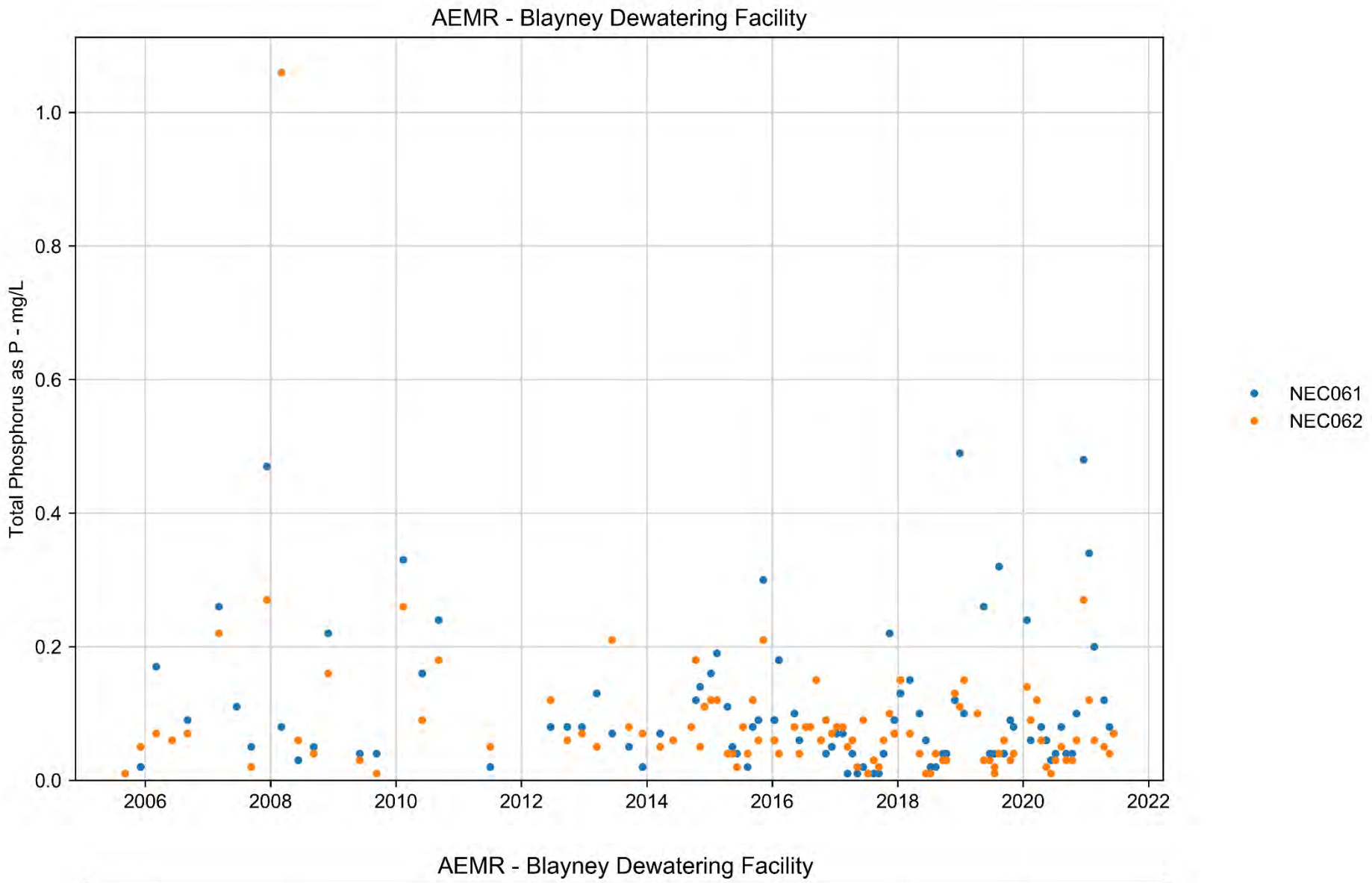
AEMR - Blayney Dewatering Facility

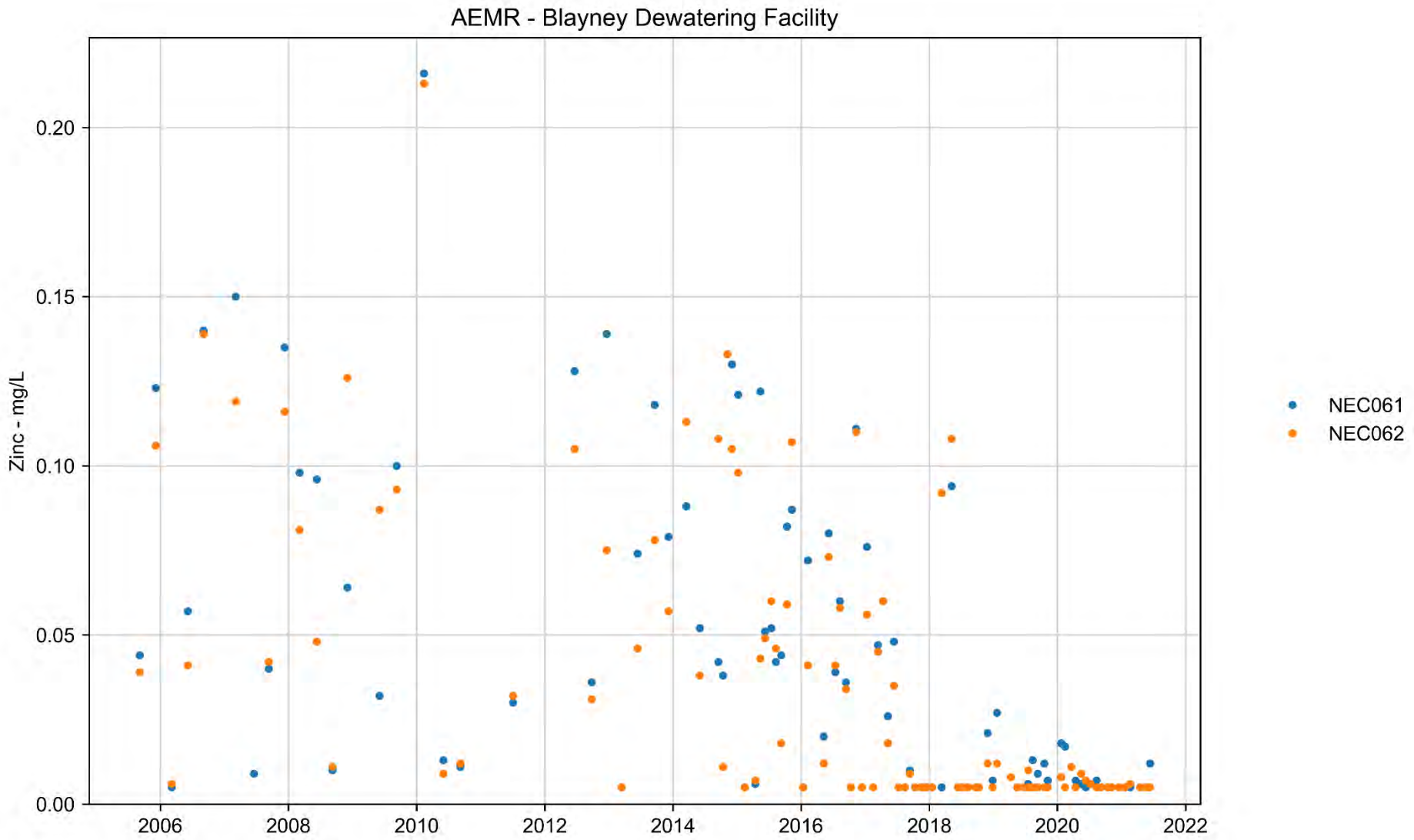


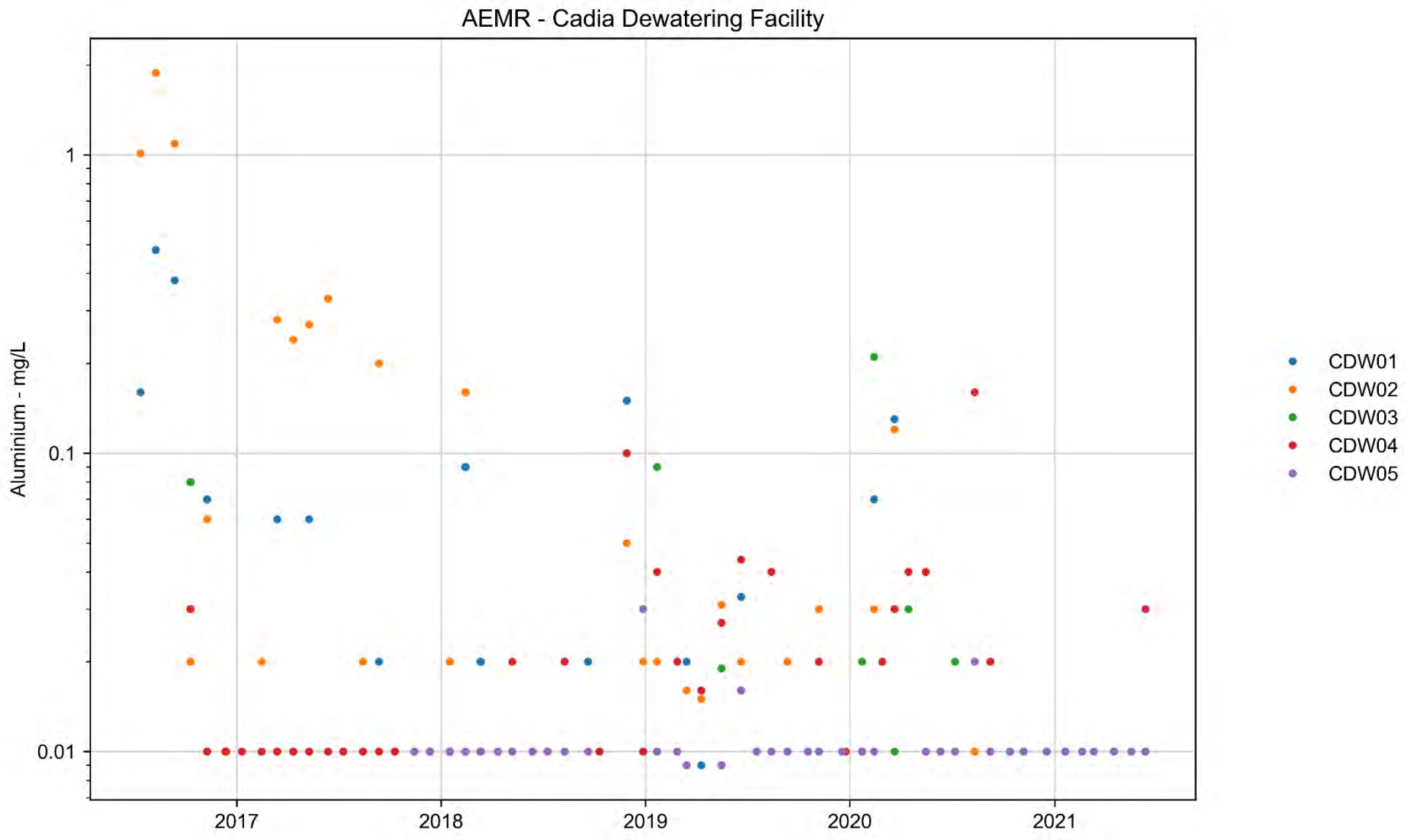

AEMR - Blayney Dewatering Facility
Total Dissolved Solids @180°C - mg/L
100
10
2006
2008
2010
2012
2014
2016
2018
2020
2022
NEC061
NEC062

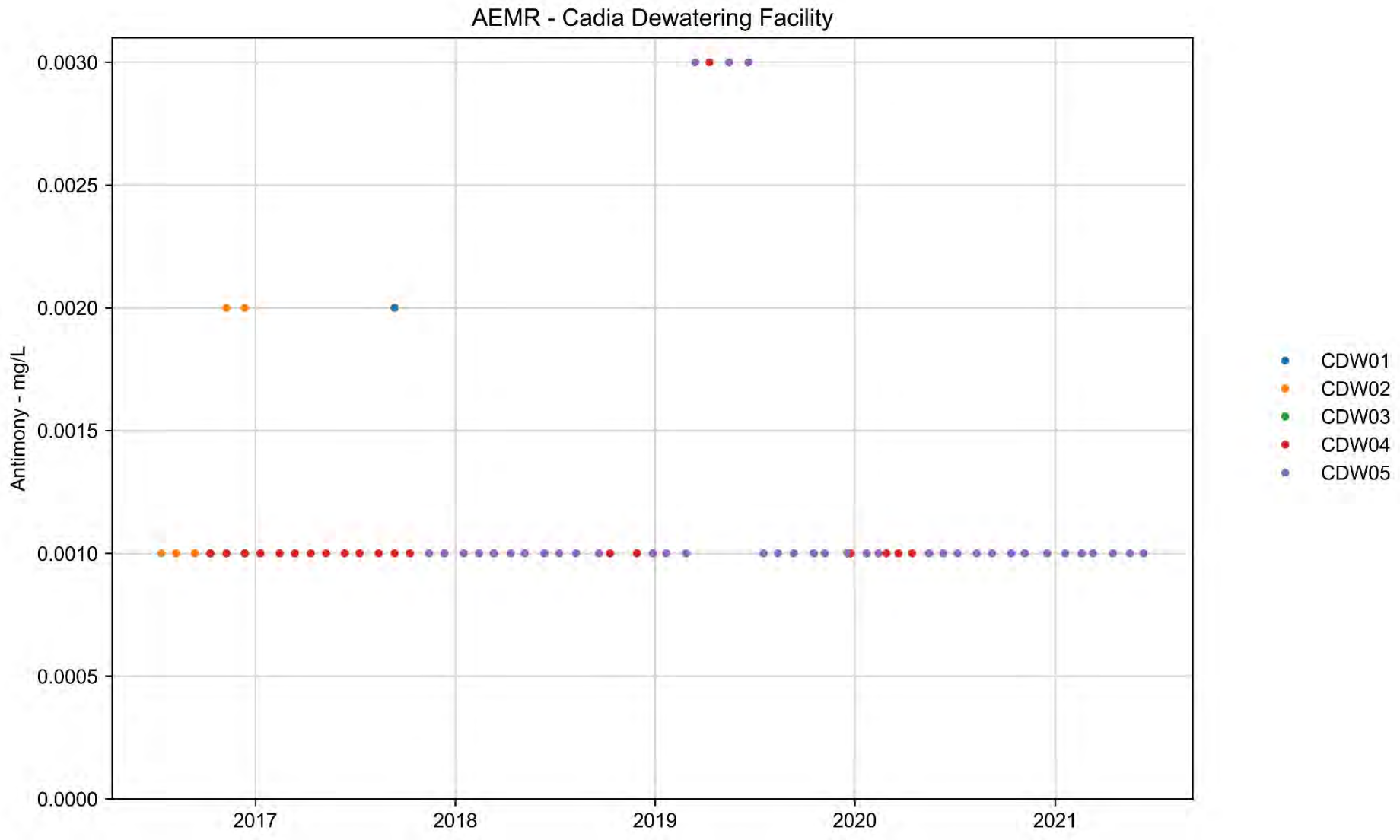

AEMR - Blayney Dewatering Facility
Total Hardness as CaCO3 - mg/L
350
300
250
200
150
100
50
0
2015
2016
2017
2018
2019
2020
2021
NEC061
NEC062


AEMR - Blayney Dewatering Facility
Total Kjeldahl Nitrogen as N - mg/L
3.0
2.5
2.0
1.5
1.0
0.5
0.0
2006
2008
2010
2012
2014
2016
2018
2020
2022
NEC061
NEC062
AEMR - Blayney Dewatering Facility
Total Nitrogen as N - mg/L
3.0
2.5
2.0
1.5
1.0
0.5
0.0
2006
2008
2010
2012
2014
2016
2018
2020
2022
NEC061
NEC062

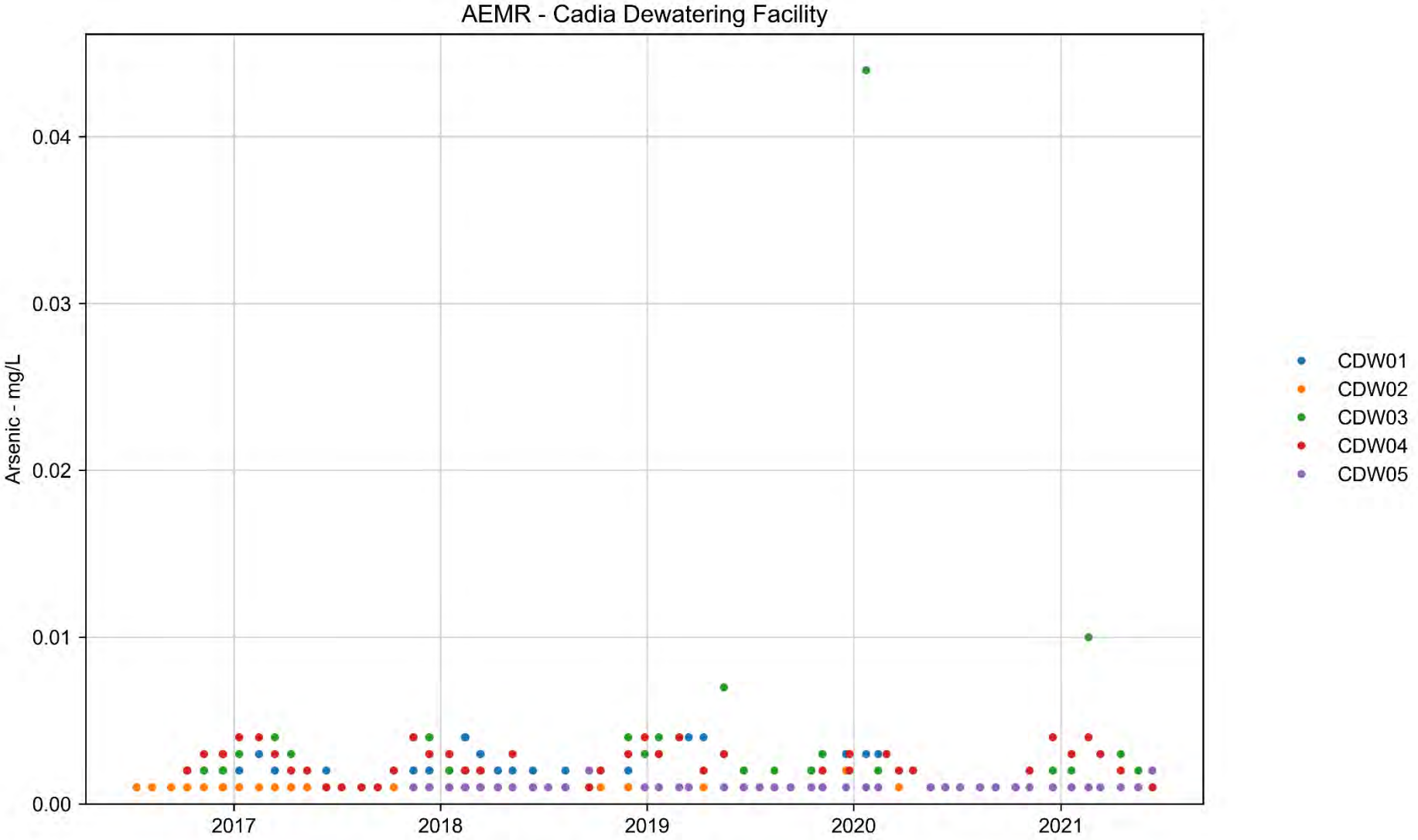

AEMR - Blayney Dewatering Facility
Total Phosphorus as P - mg/L
1.0
0.8
0.6
0.4
0.2
0.0
2006
2008
2010
2012
2014
2016
2018
2020
2022
NEC061
NEC062


AEMR - Blayney Dewatering Facility
Zinc - mg/L
0.20
0.15
0.10
0.05
0.00
2006
2008
2010
2012
2014
2016
2018
2020
2022
NEC061
NEC062

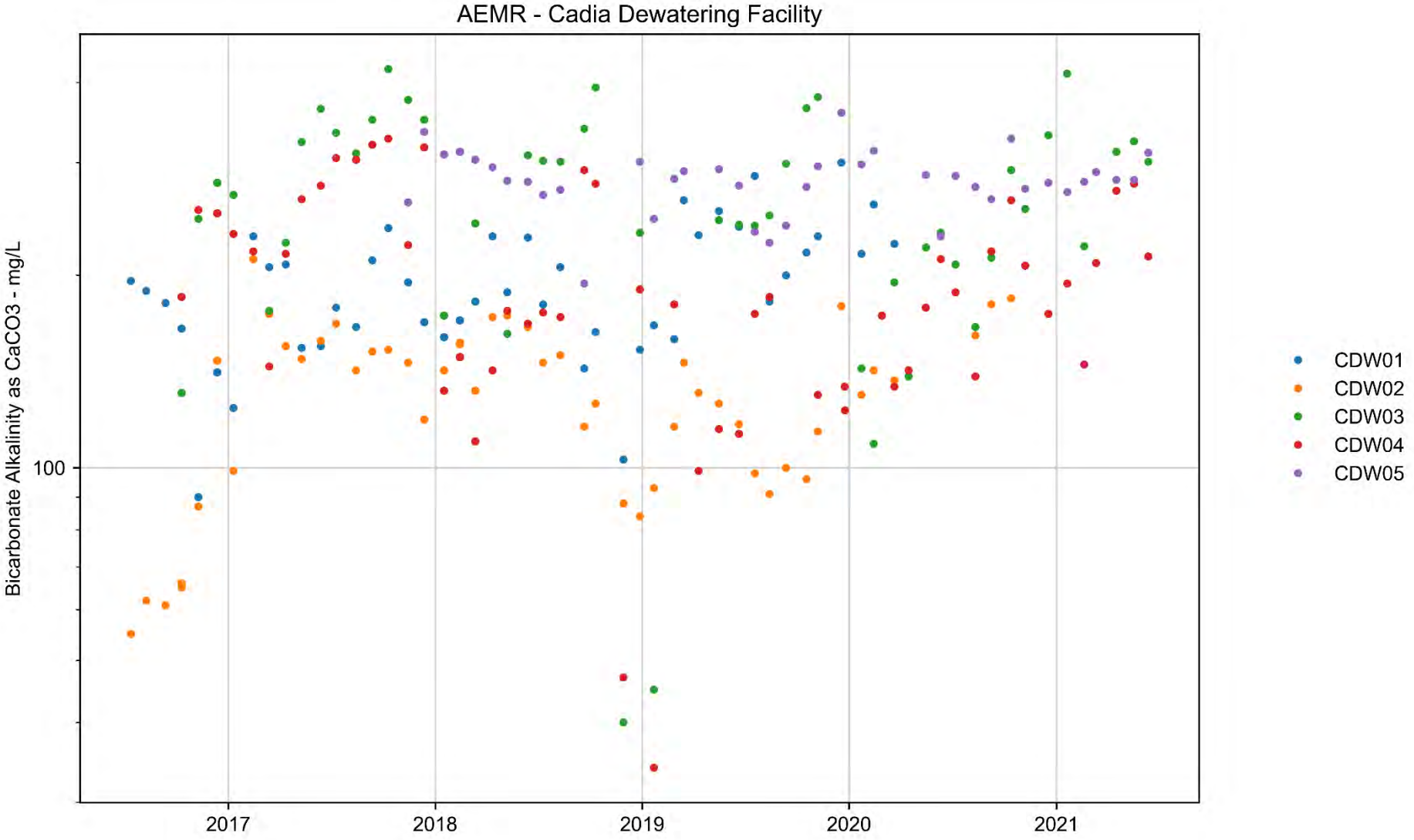

AEMR - Cadia Dewatering Facility
Aluminium - mg/L
1
0.1
0.01
2017
2018
2019
2020
2021
CDW01
CDW02
CDW03
CDW04
CDW05


AEMR - Cadia Dewatering Facility
Antimony - mg/L
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
2017
2018
2019
2020
2021
CDW01
CDW02
CDW03
CDW04
CDW05

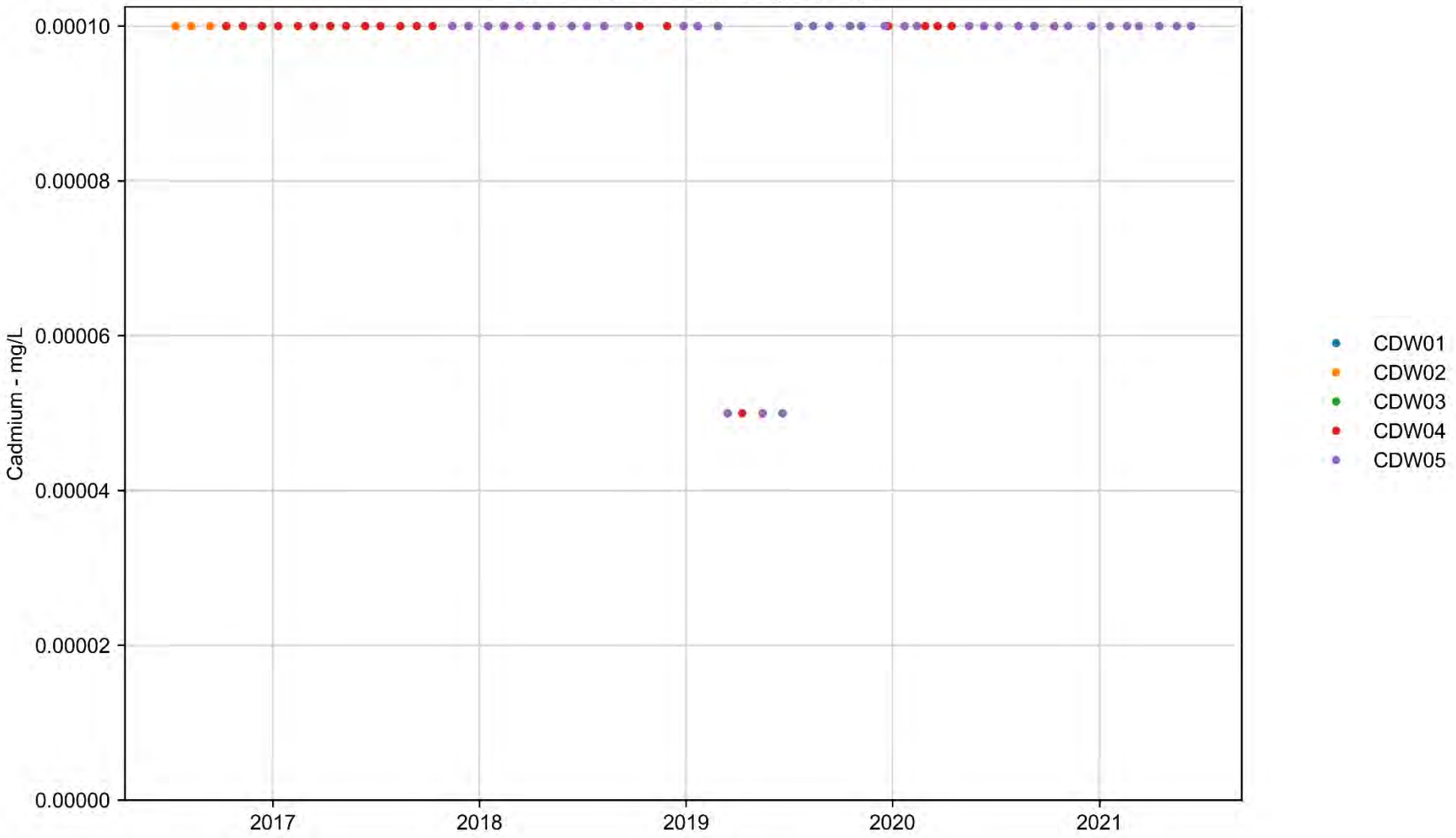
AEMR - Cadia Dewatering Facility



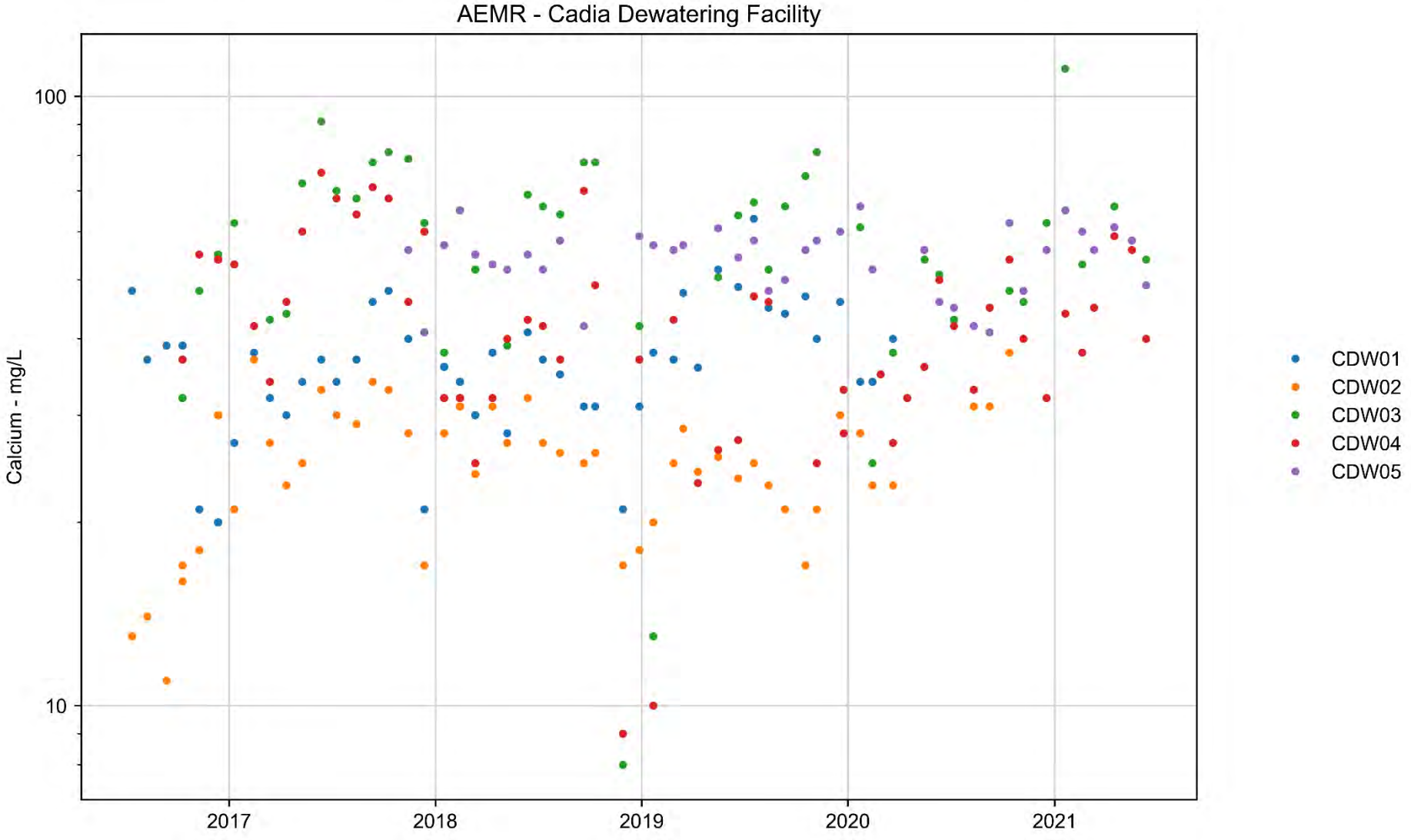
AEMR - Cadia Dewatering Facility

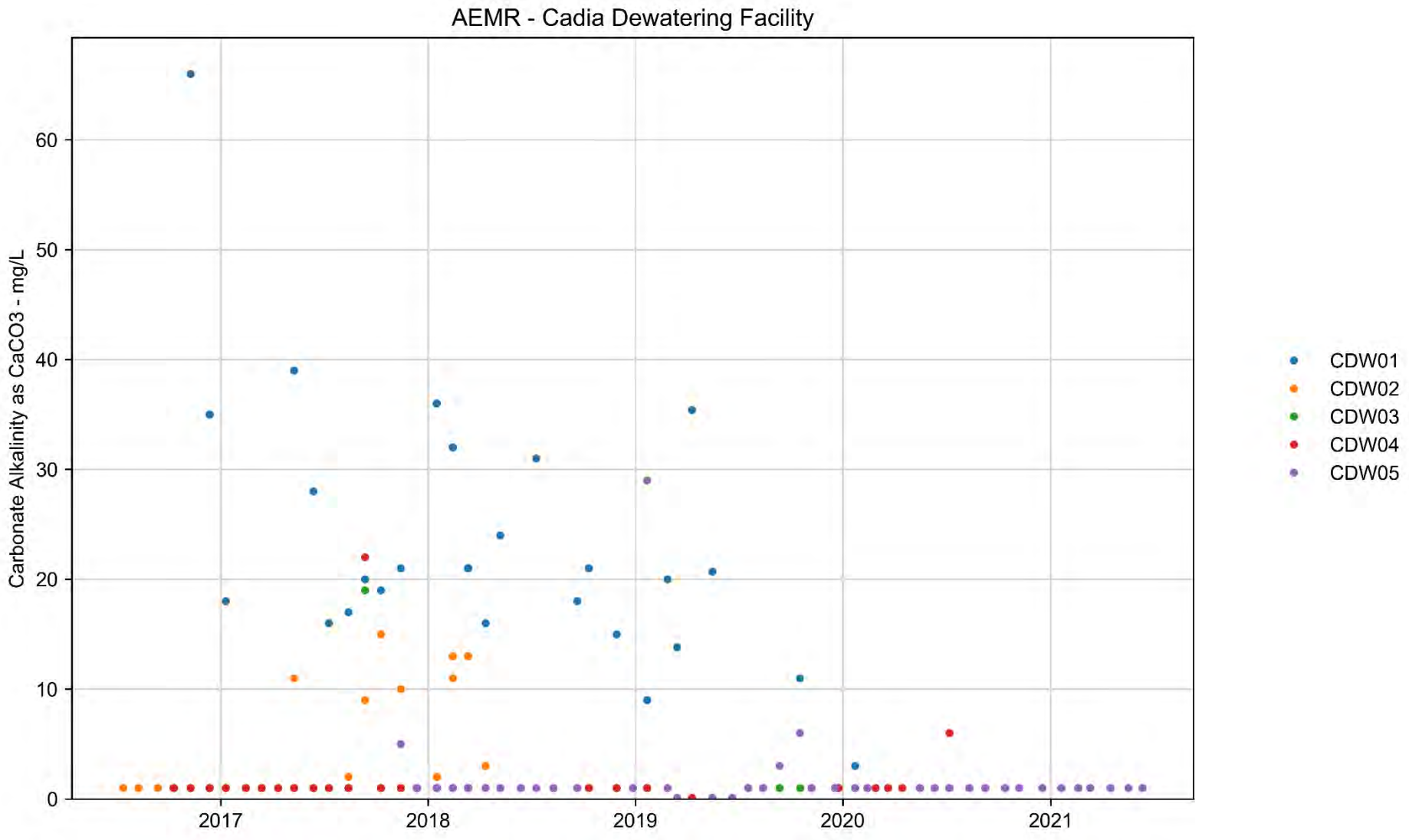


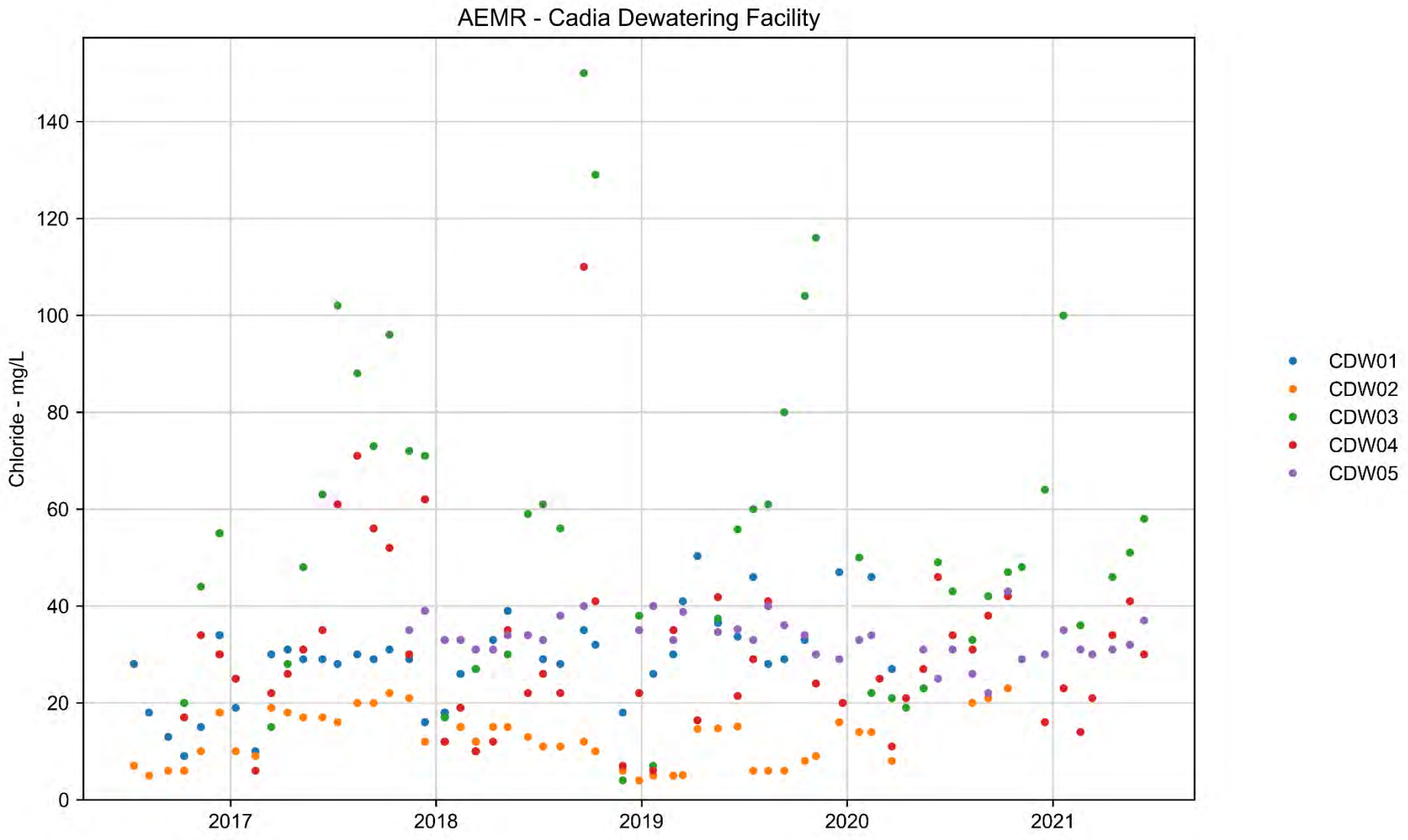
AEMR - Cadia Dewatering Facility

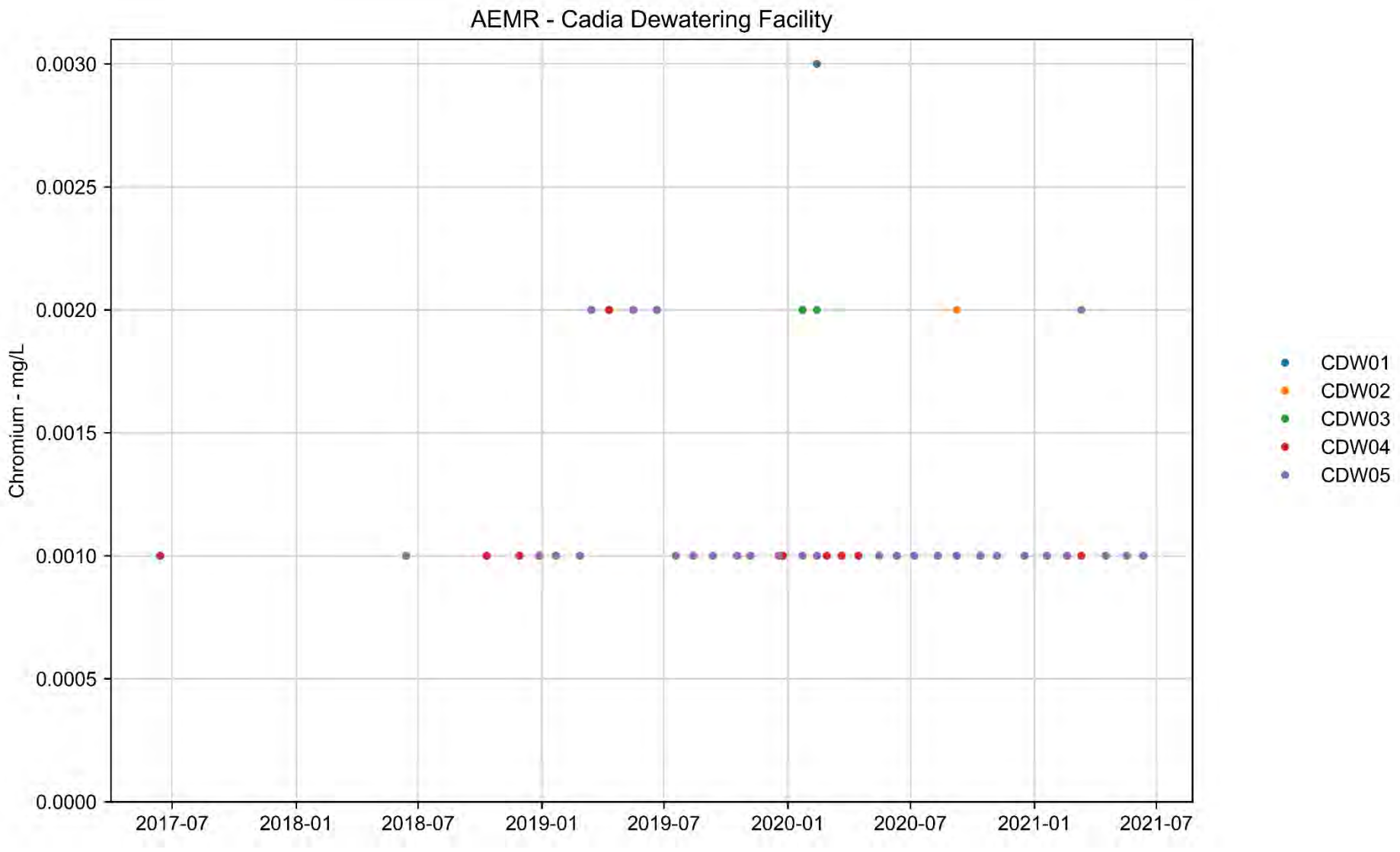


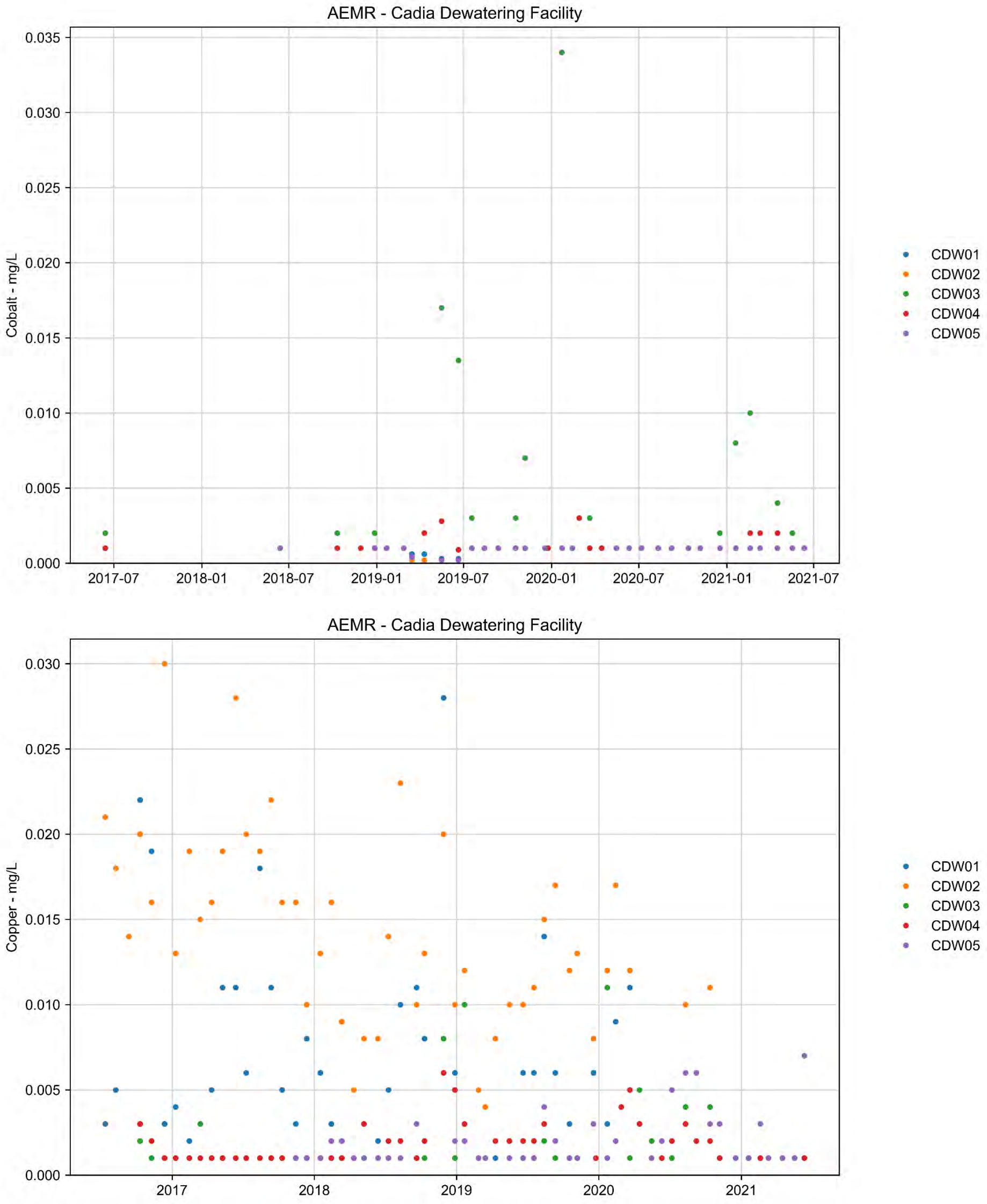
AEMR - Cadia Dewatering Facility

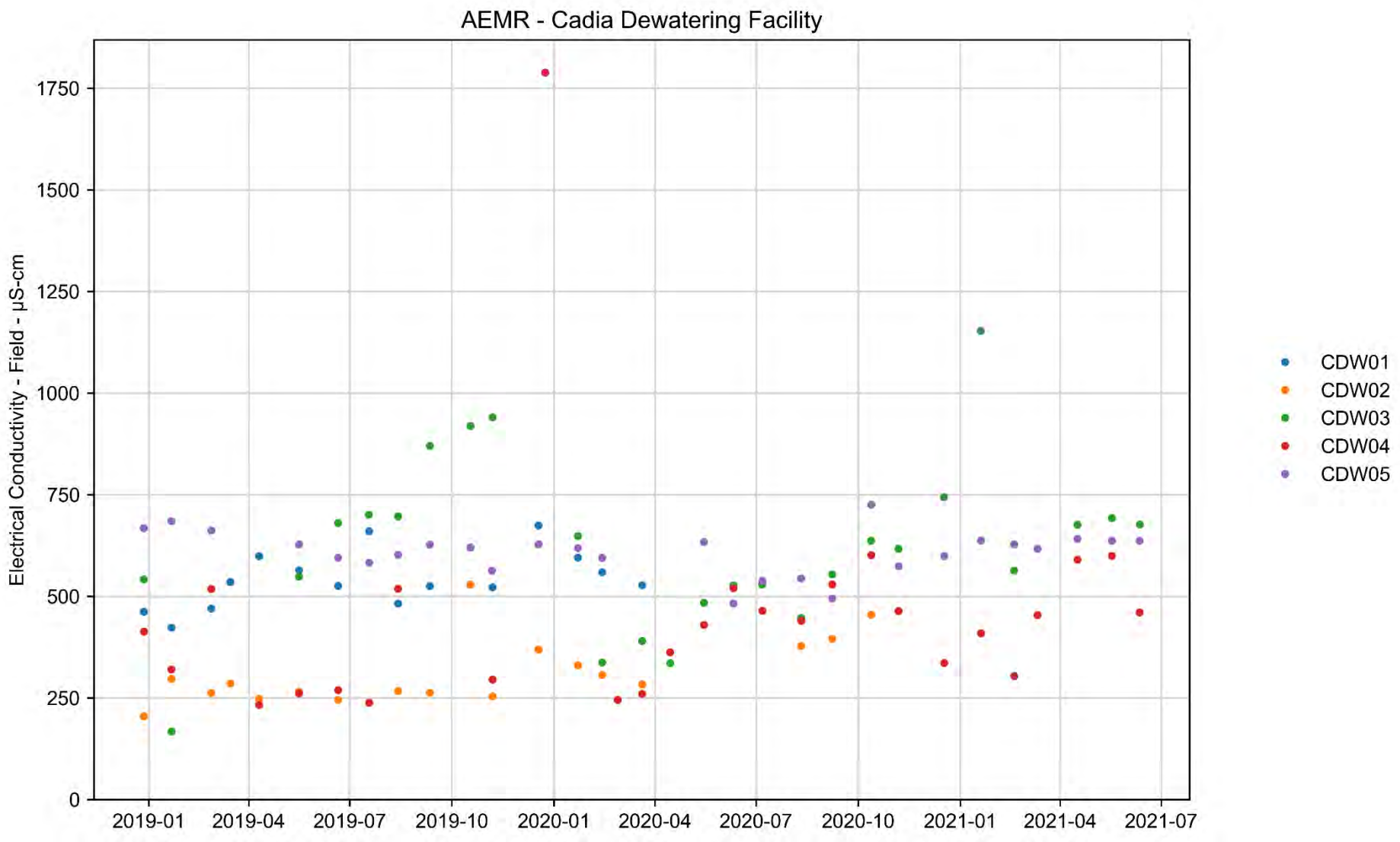



AEMR - Cadia Dewatering Facility
Carbonate Alkalinity as CaCO3 - mg/L
60
50
40
30
20
10
0
2017
2018
2019
2020
2021
CDW01
CDW02
CDW03
CDW04
CDW05

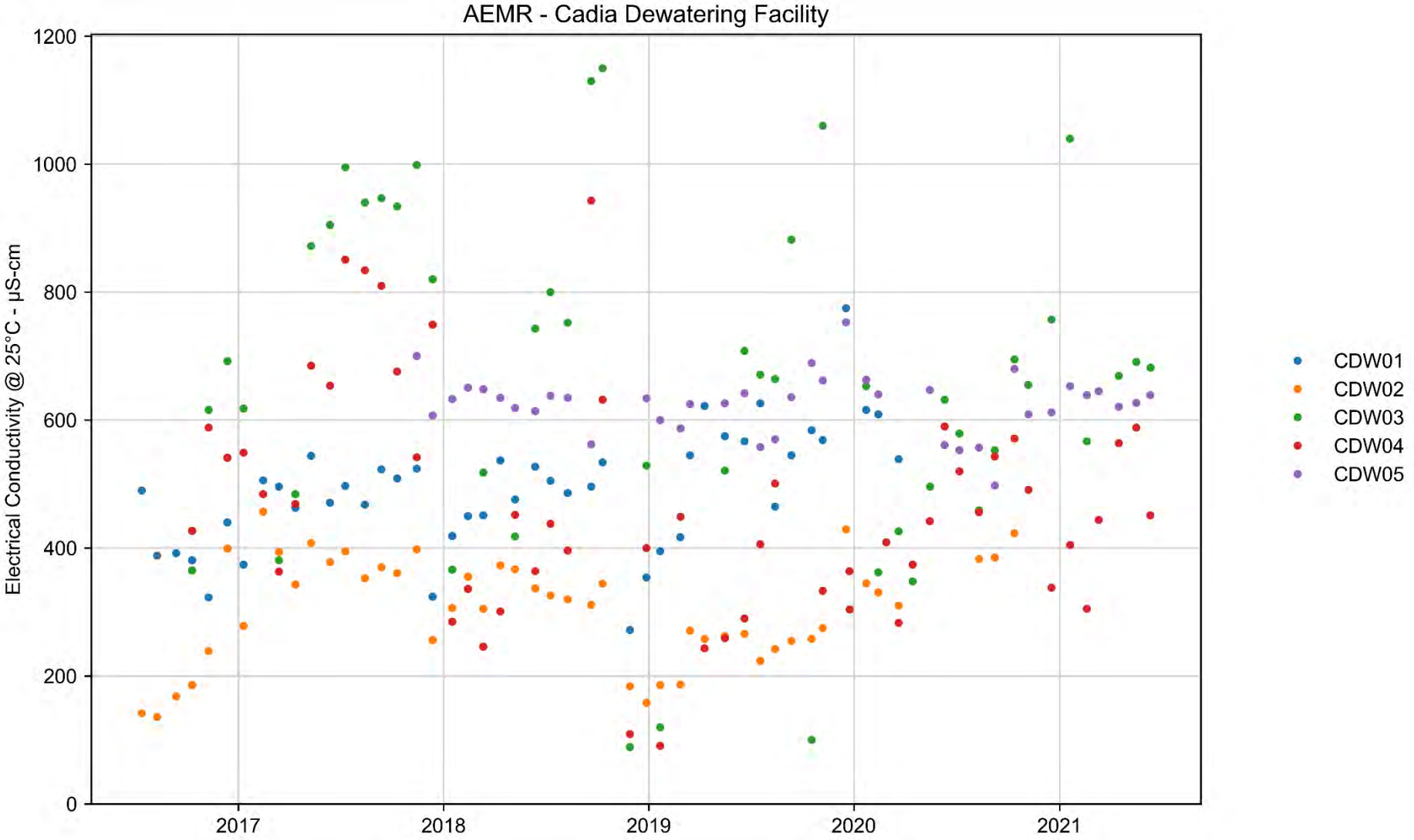

AEMR - Cadia Dewatering Facility
Chloride - mg/L
140
120
100
80
60
40
20
0
2017
2018
2019
2020
2021
CDW01
CDW02
CDW03
CDW04
CDW05


AEMR - Cadia Dewatering Facility
Chromium - mg/L
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
2017-07
2018-01
2018-07
2019-01
2019-07
2020-01
2020-07
2021-01
2021-07
CDW01
CDW02
CDW03
CDW04
CDW05

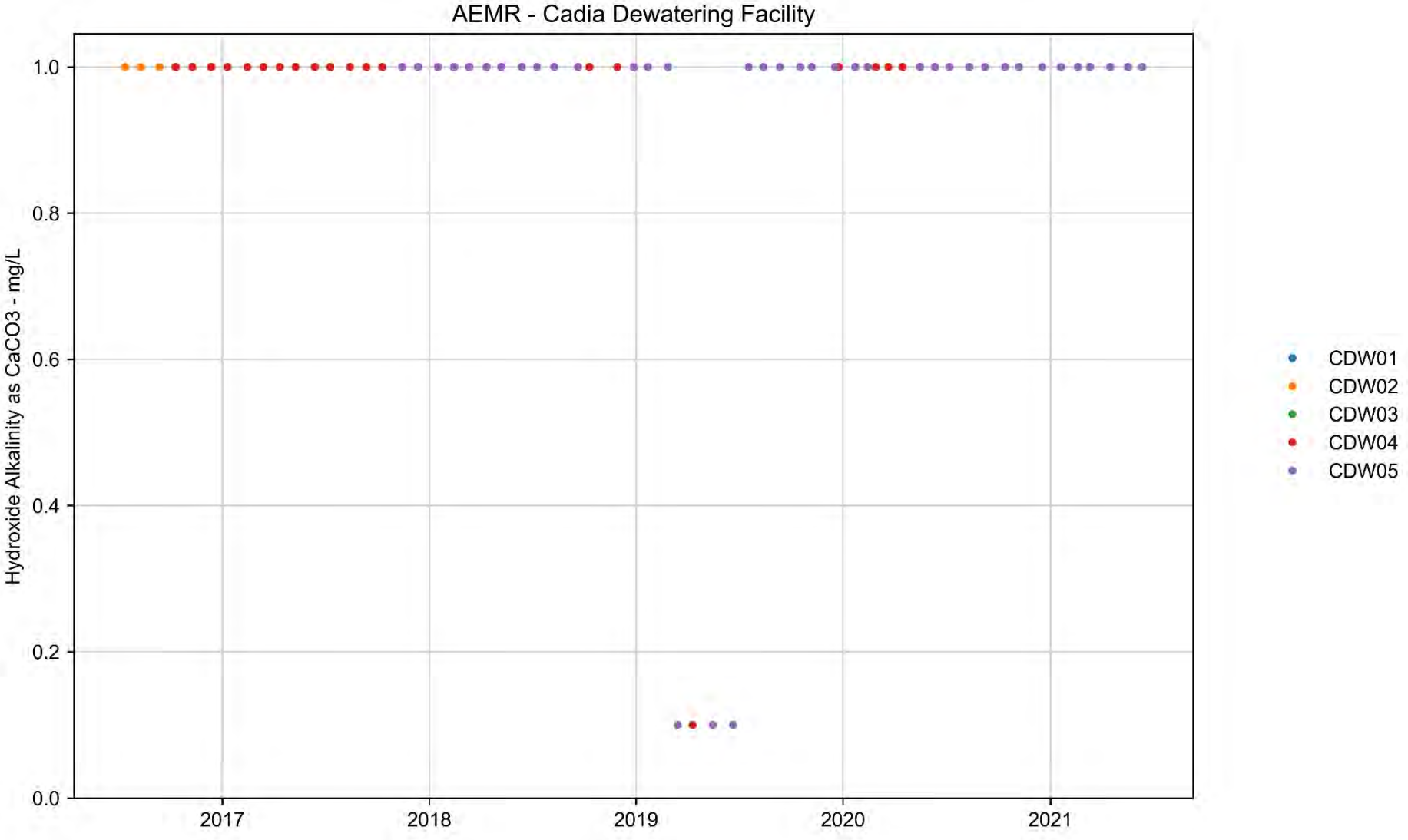

AEMR - Cadia Dewatering Facility
Cobalt - mg/L
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2017-07
2018-01
2018-07
2019-01
2019-07
2020-01
2020-07
2021-01
2021-07
CDW01
CDW02
CDW03
CDW04
CDW05
AEMR - Cadia Dewatering Facility
Copper - mg/L
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2017
2018
2019
2020
2021
CDW01
CDW02
CDW03
CDW04
CDW05

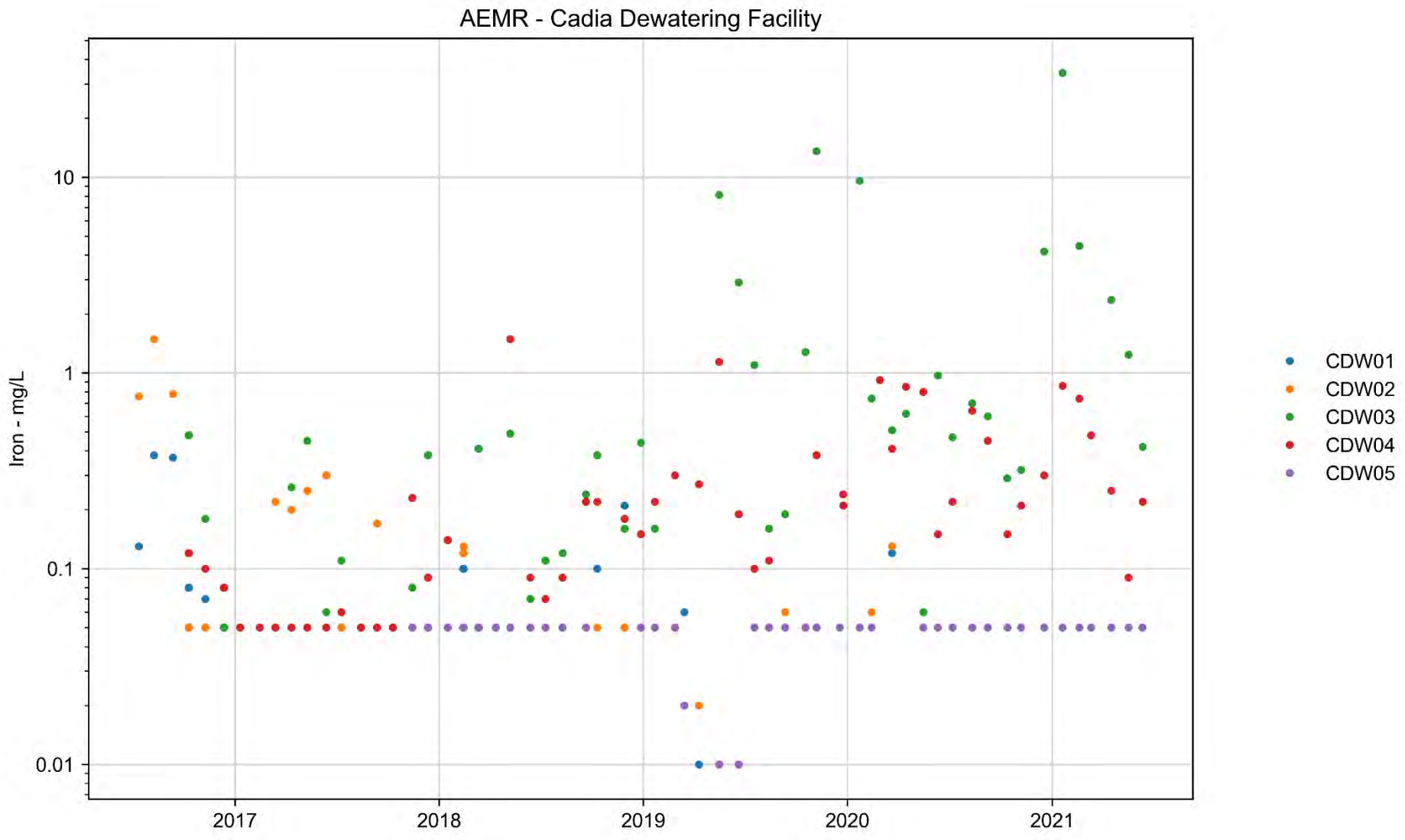

AEMR - Cadia Dewatering Facility
Electrical Conductivity - Field - µS-cm
1750
1500
1250
1000
750
500
250
0
2019-01
2019-04
2019-07
2019-10
2020-01
2020-04
2020-07
2020-10
2021-01
2021-04
2021-07
CDW01
CDW02
CDW03
CDW04
CDW05

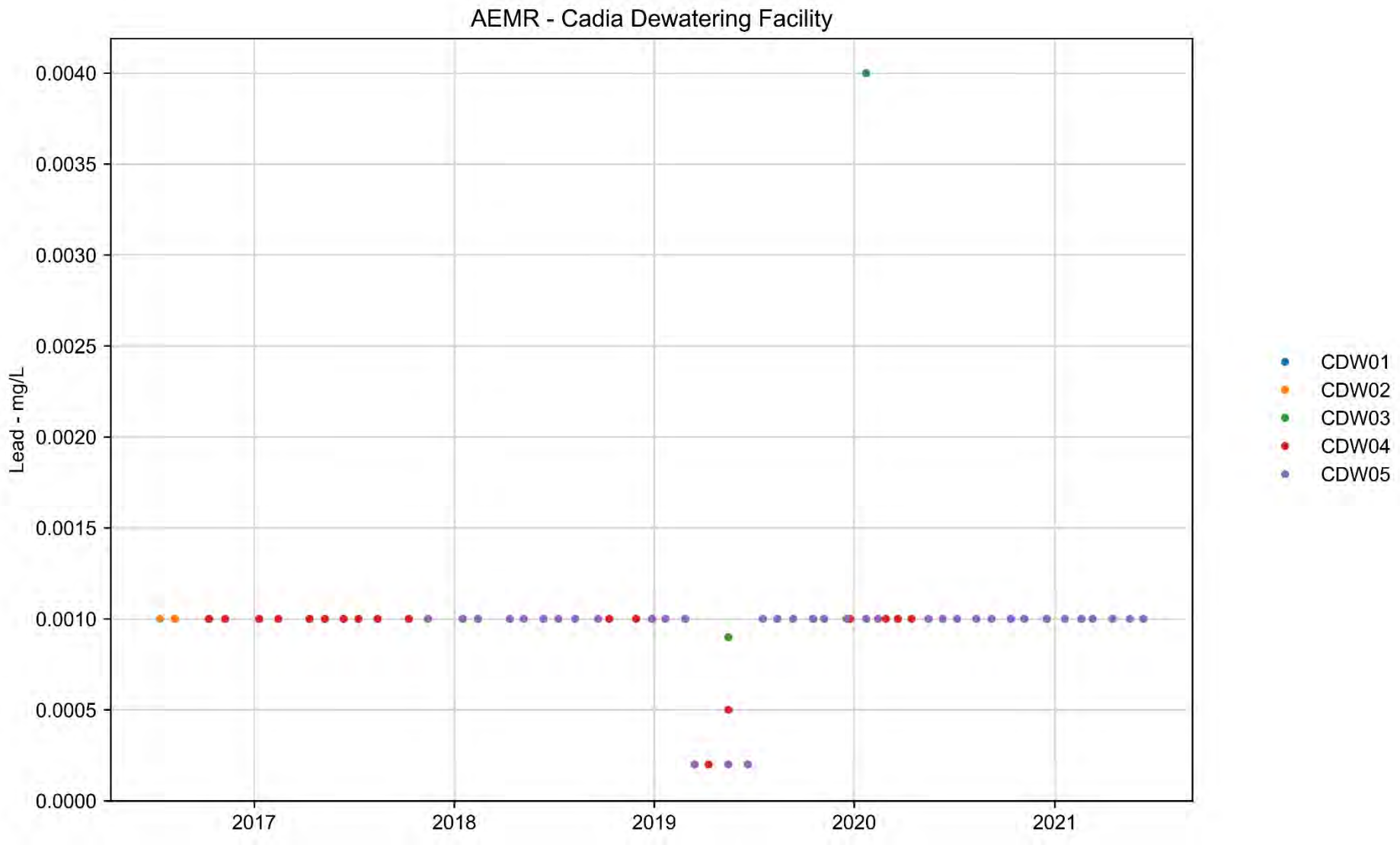
AEMR - Cadia Dewatering Facility

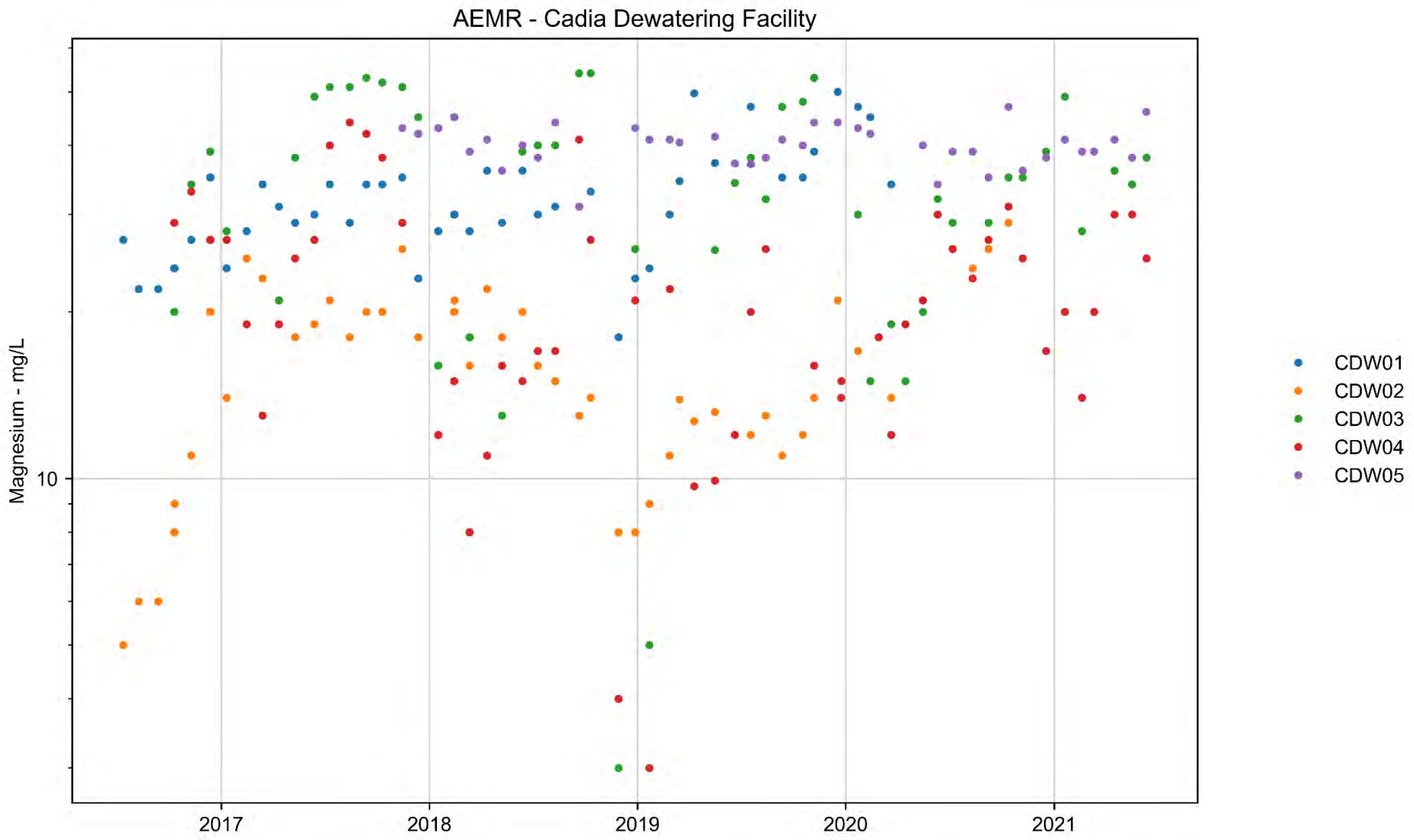


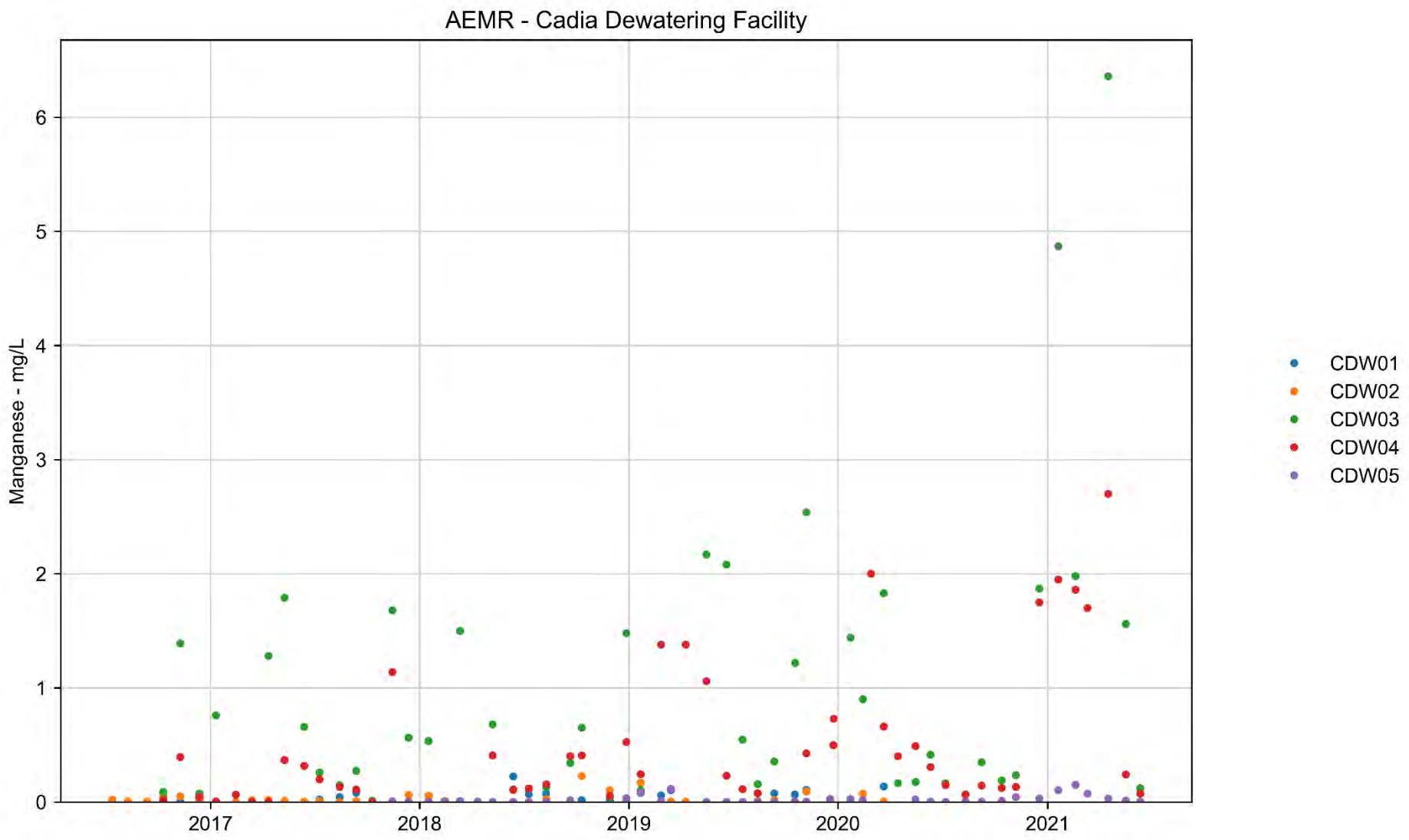
AEMR - Cadia Dewatering Facility

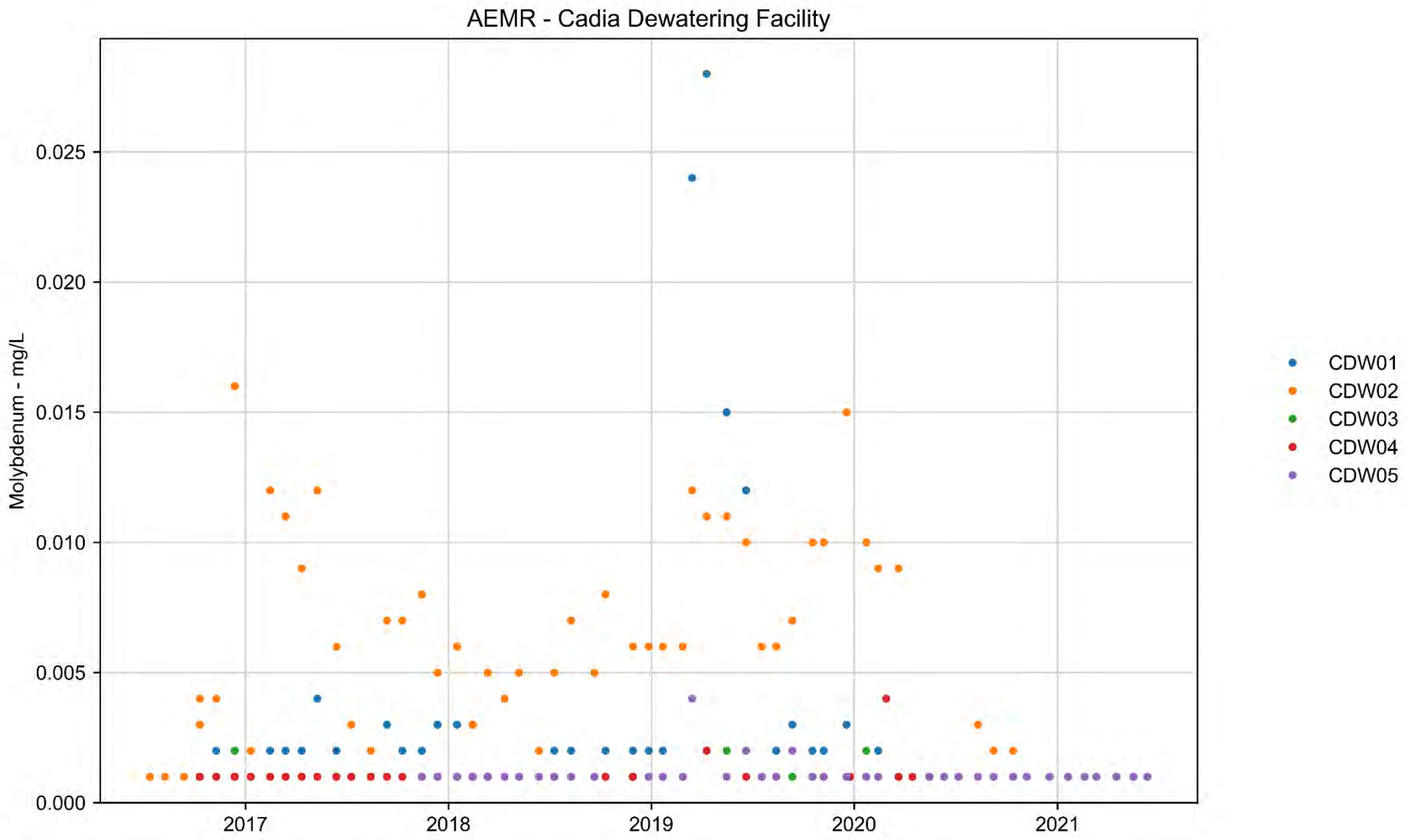


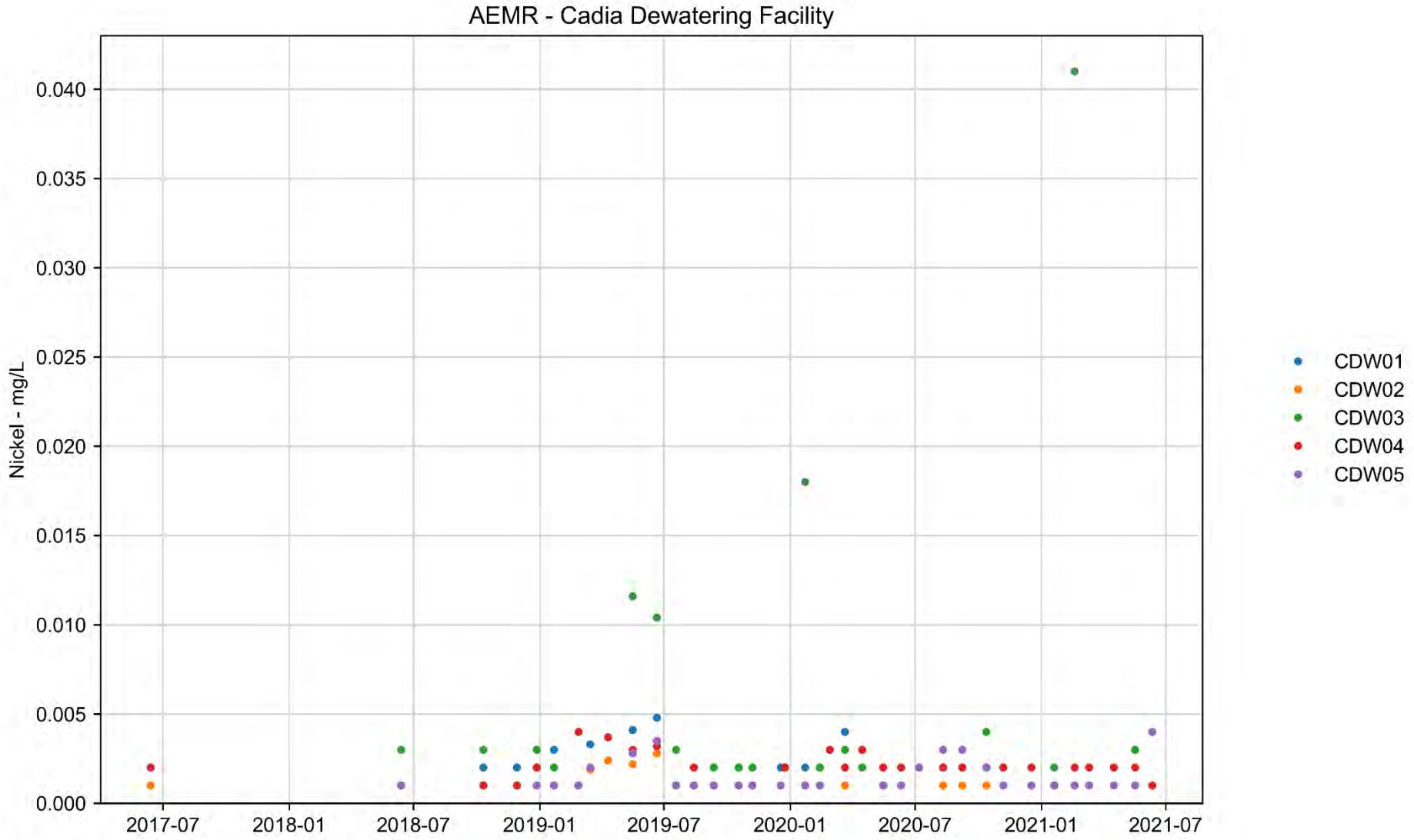

AEMR - Cadia Dewatering Facility
Iron - mg/L
10
1
0.1
0.01
2017
2018
2019
2020
2021
CDW01
CDW02
CDW03
CDW04
CDW05

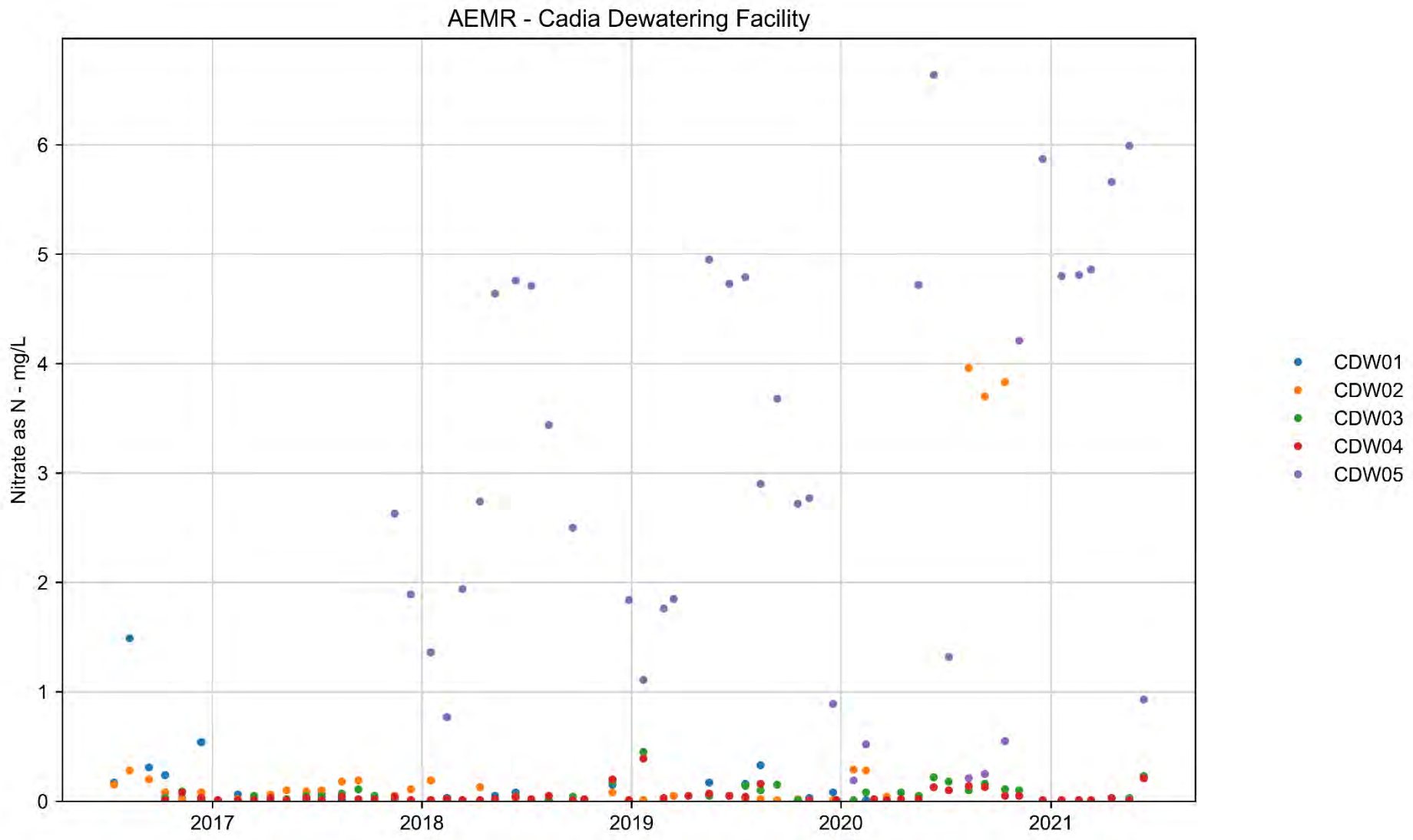

AEMR - Cadia Dewatering Facility
Lead - mg/L
0.0040
0.0035
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
2017
2018
2019
2020
2021
CDW01
CDW02
CDW03
CDW04
CDW05

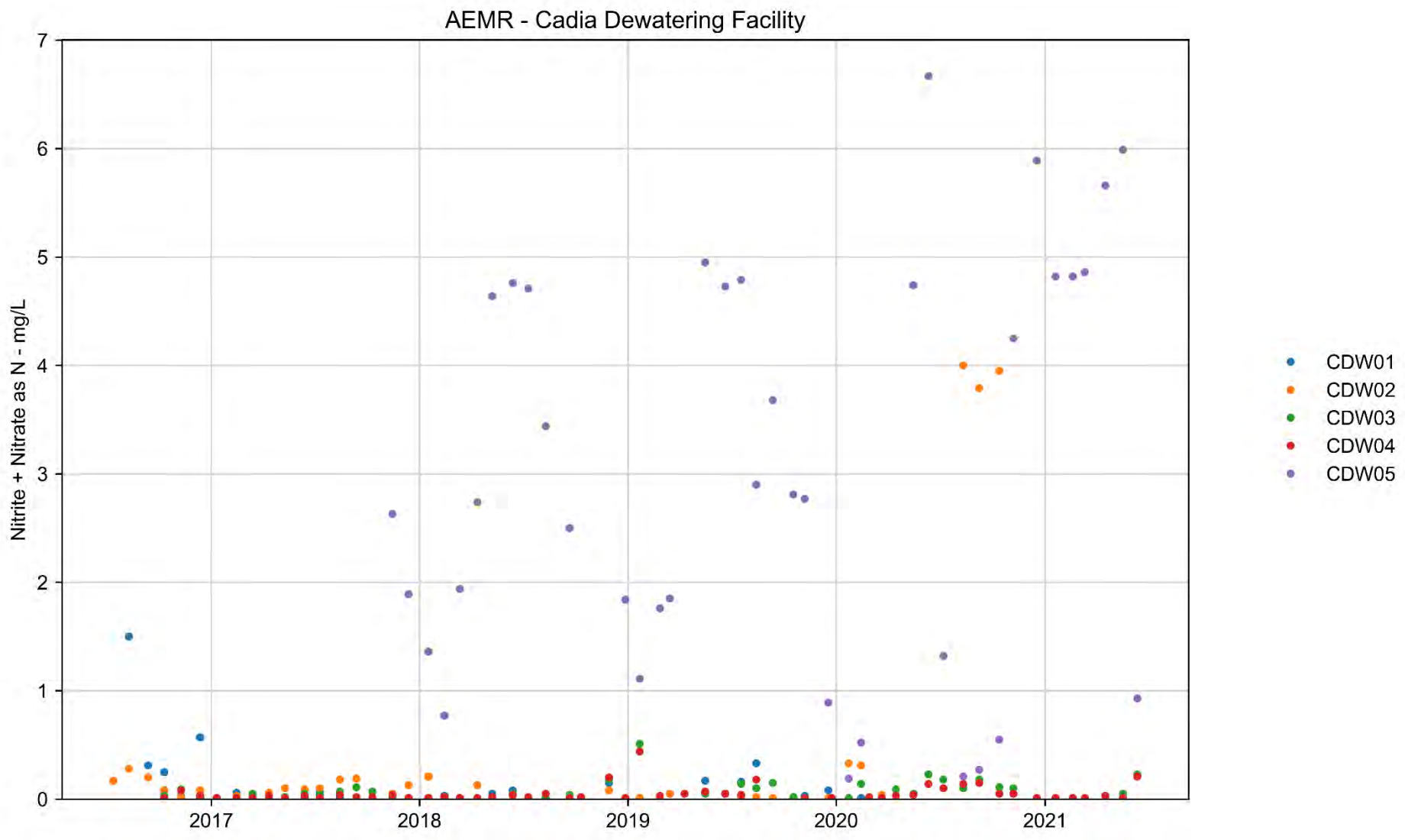

AEMR - Cadia Dewatering Facility
Magnesium - mg/L
10
2017
2018
2019
2020
2021
CDW01
CDW02
CDW03
CDW04
CDW05


AEMR - Cadia Dewatering Facility
Manganese - mg/L
6
5
4
3
2
1
0
2017
2018
2019
2020
2021
CDW01
CDW02
CDW03
CDW04
CDW05

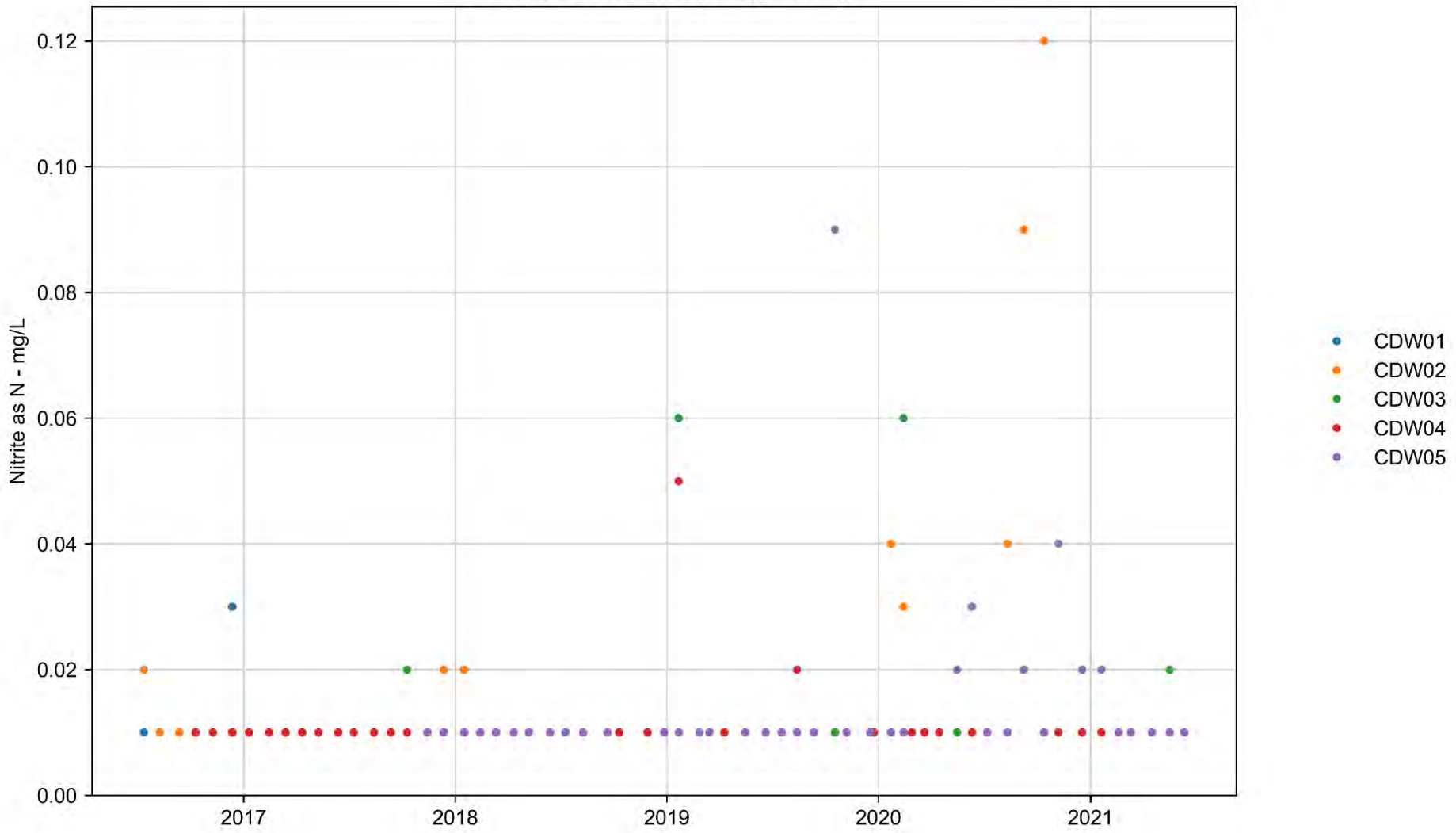

AEMR - Cadia Dewatering Facility
Molybdenum - mg/L
0.025
0.020
0.015
0.010
0.005
0.000
2017
2018
2019
2020
2021
CDW01
CDW02
CDW03
CDW04
CDW05


AEMR - Cadia Dewatering Facility
Nickel - mg/L
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2017-07
2018-01
2018-07
2019-01
2019-07
2020-01
2020-07
2021-01
2021-07
CDW01
CDW02
CDW03
CDW04
CDW05

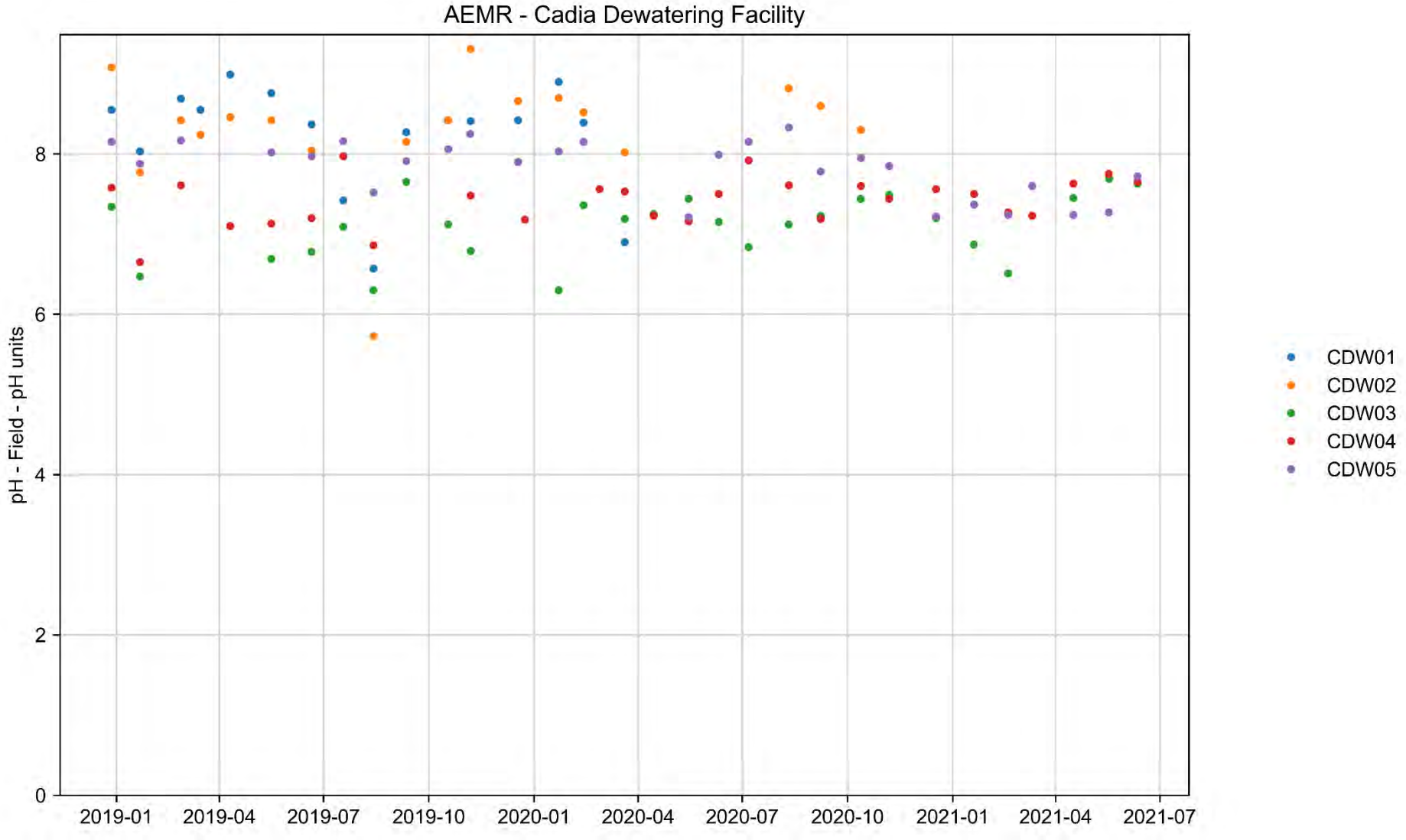

AEMR - Cadia Dewatering Facility
Nitrate as N - mg/L
0
1
2
3
4
5
6
2017
2018
2019
2020
2021
CDW01
CDW02
CDW03
CDW04
CDW05

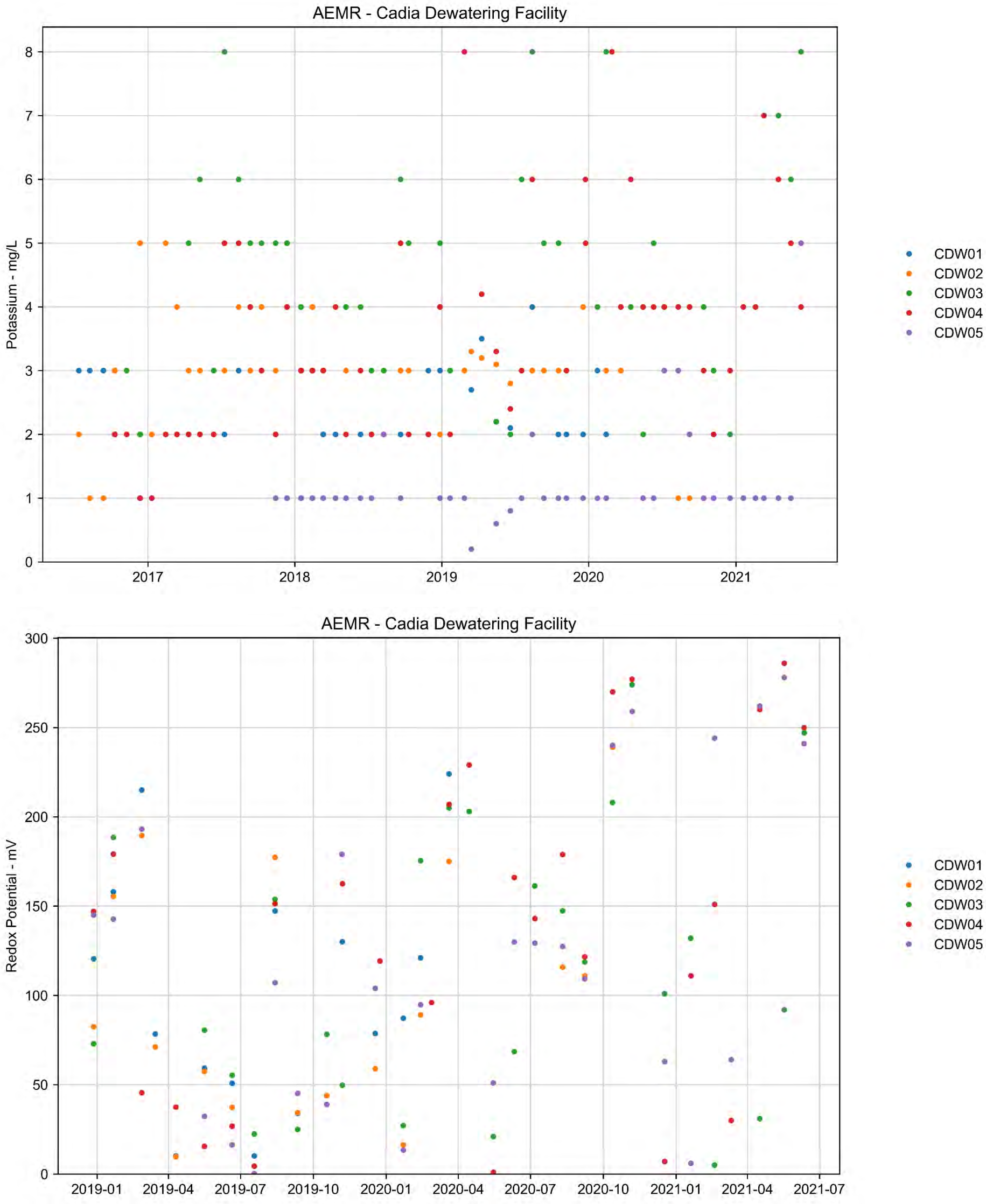

AEMR - Cadia Dewatering Facility
Nitrite + Nitrate as N - mg/L
0
1
2
3
4
5
6
7
2017
2018
2019
2020
2021
CDW01
CDW02
CDW03
CDW04
CDW05

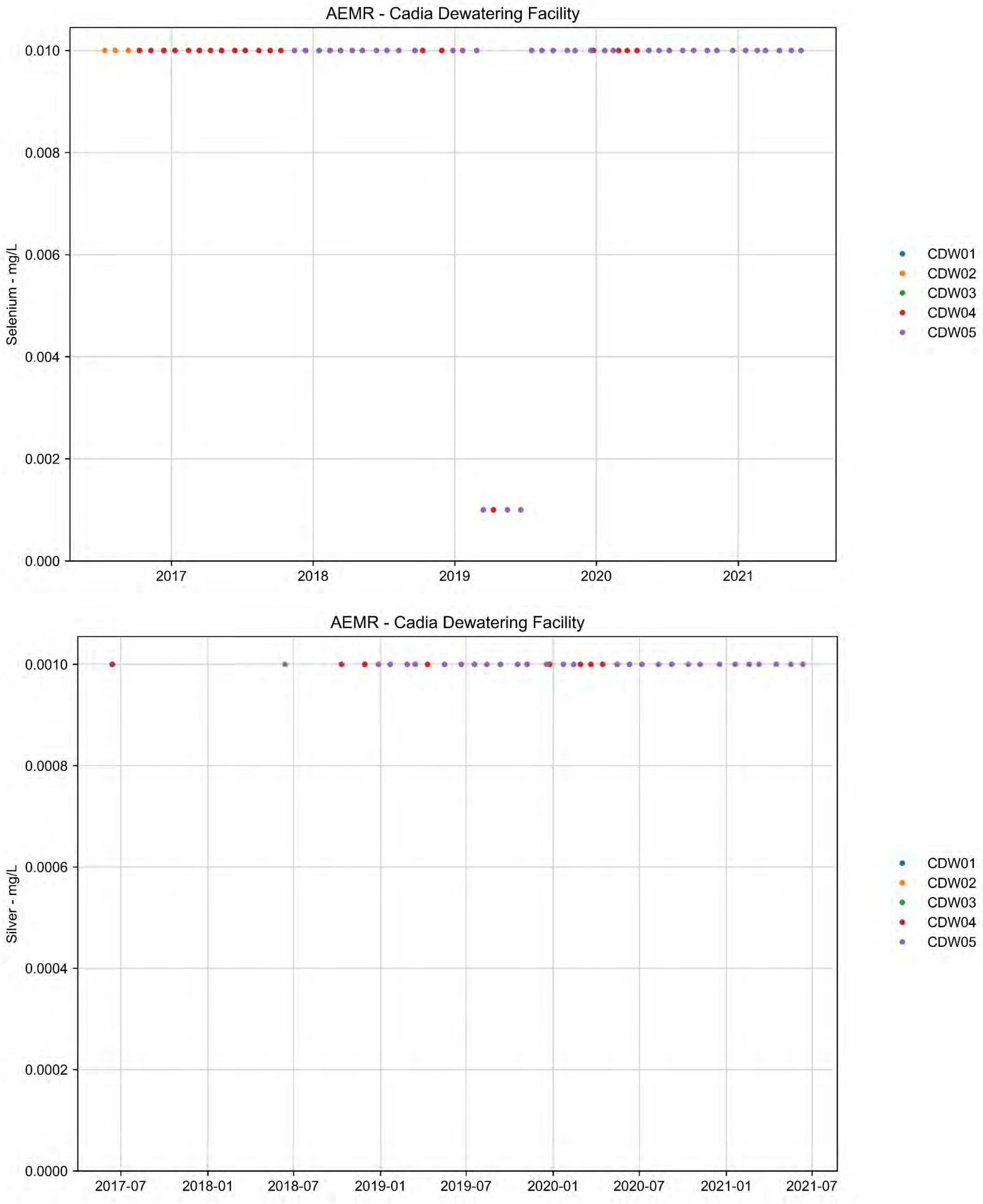
AEMR - Cadia Dewatering Facility

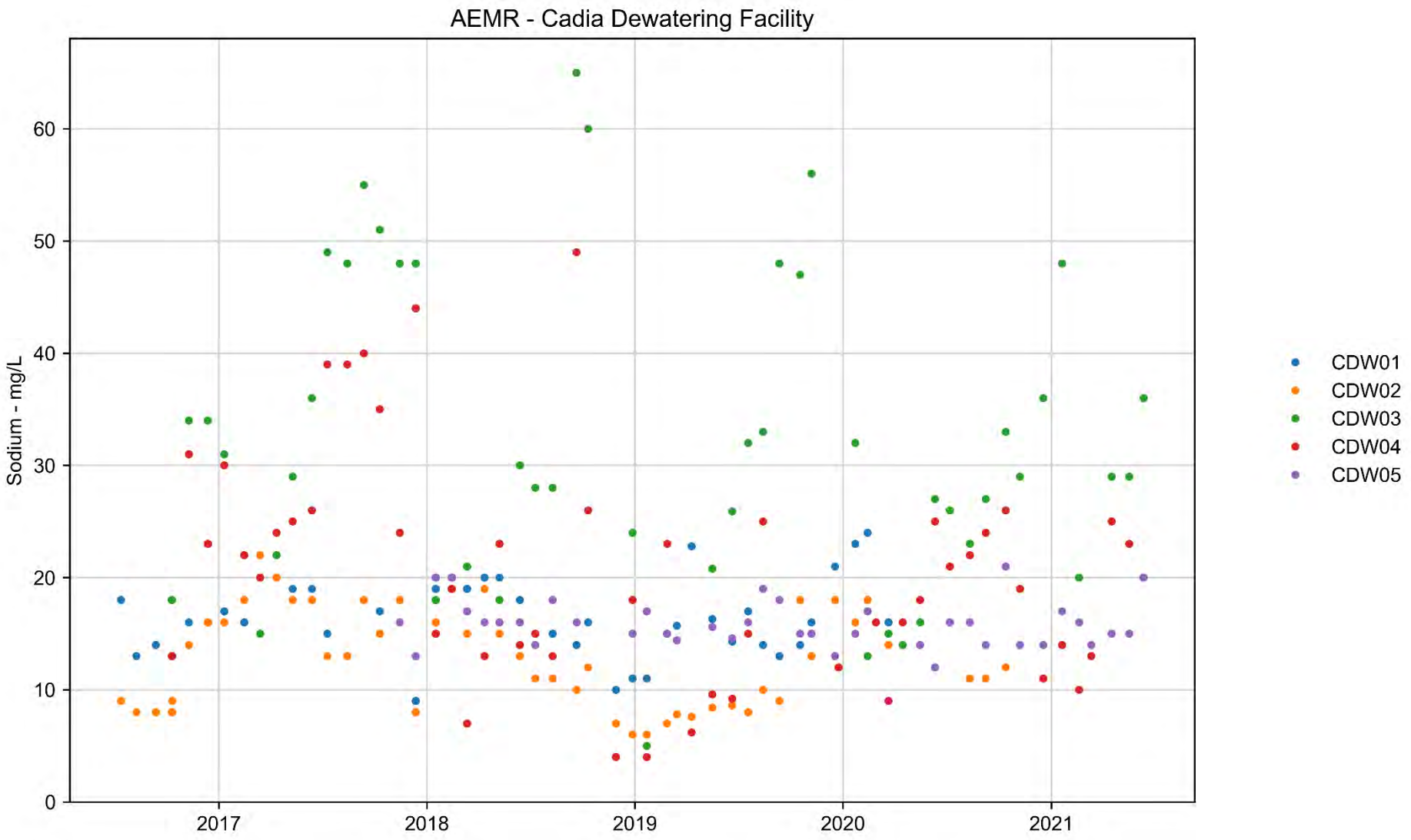


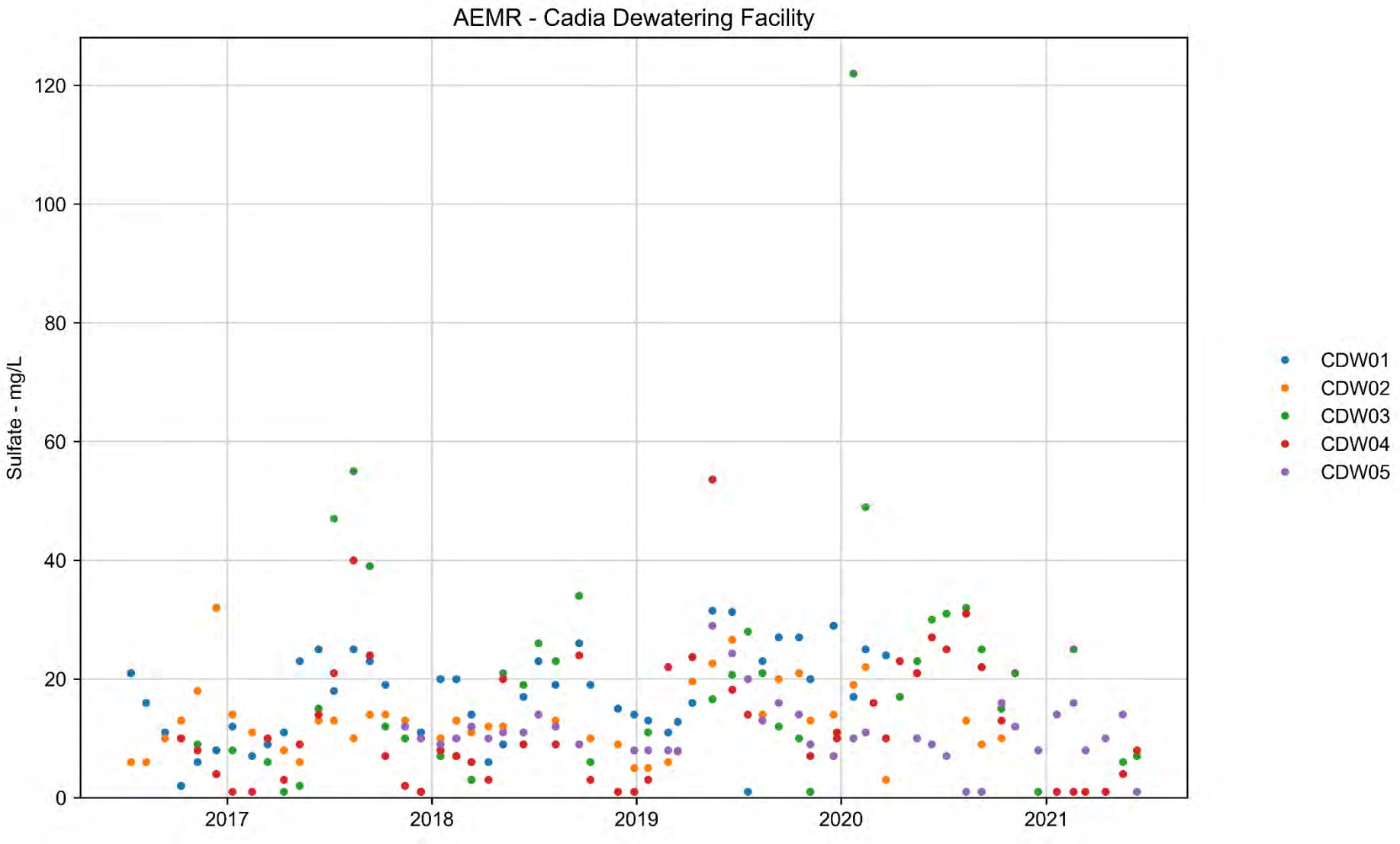
AEMR - Cadia Dewatering Facility



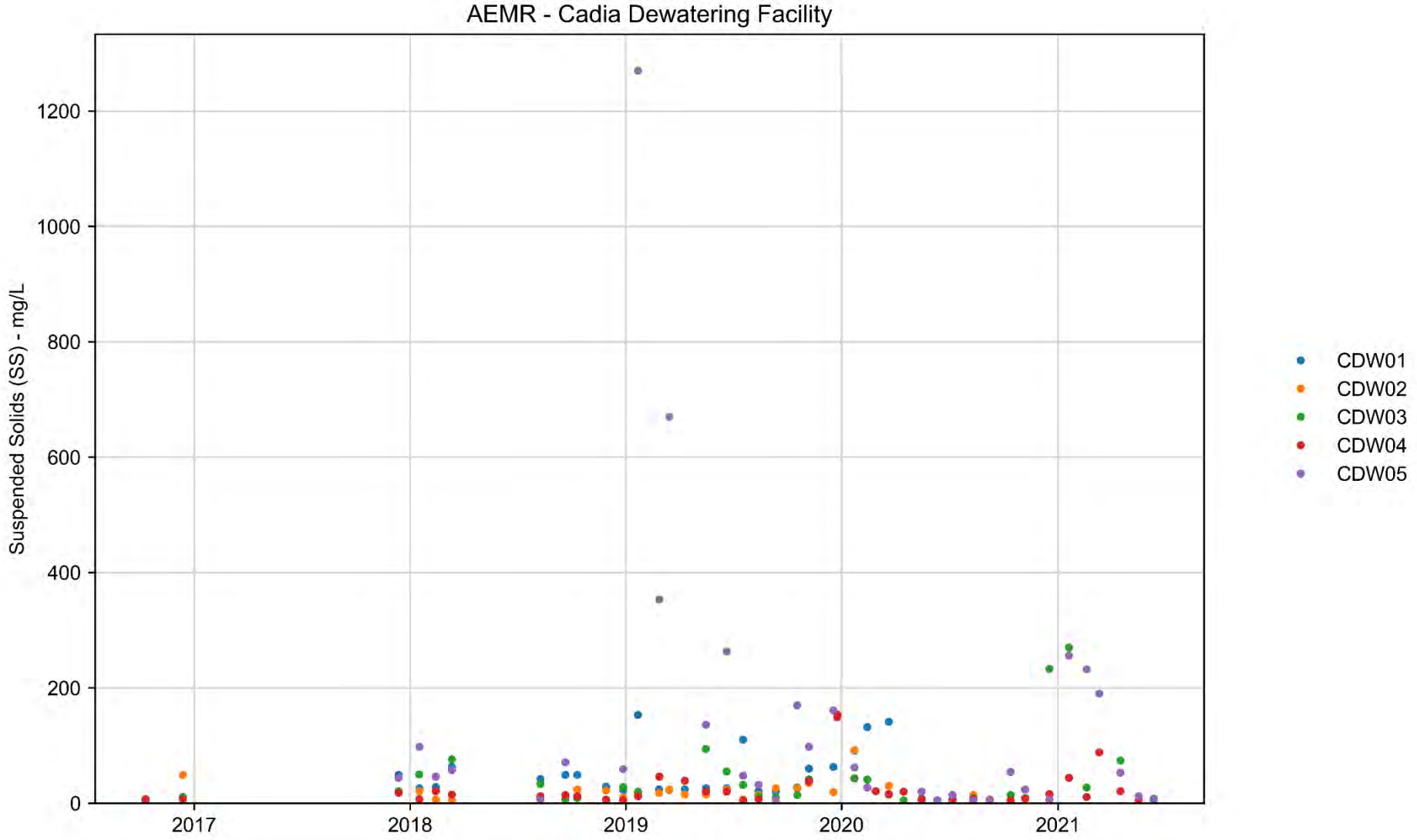

AEMR - Cadia Dewatering Facility
Potassium - mg/L
0
1
2
3
4
5
6
7
8
2017
2018
2019
2020
2021
CDW01
CDW02
CDW03
CDW04
CDW05
AEMR - Cadia Dewatering Facility
Redox Potential - mV
0
50
100
150
200
250
300
2019-01
2019-04
2019-07
2019-10
2020-01
2020-04
2020-07
2020-10
2021-01
2021-04
2021-07
CDW01
CDW02
CDW03
CDW04
CDW05


AEMR - Cadia Dewatering Facility
Selenium - mg/L
0.010
0.008
0.006
0.004
0.002
0.000
2017
2018
2019
2020
2021
CDW01
CDW02
CDW03
CDW04
CDW05
AEMR - Cadia Dewatering Facility
Silver - mg/L
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
2017-07
2018-01
2018-07
2019-01
2019-07
2020-01
2020-07
2021-01
2021-07
CDW01
CDW02
CDW03
CDW04
CDW05

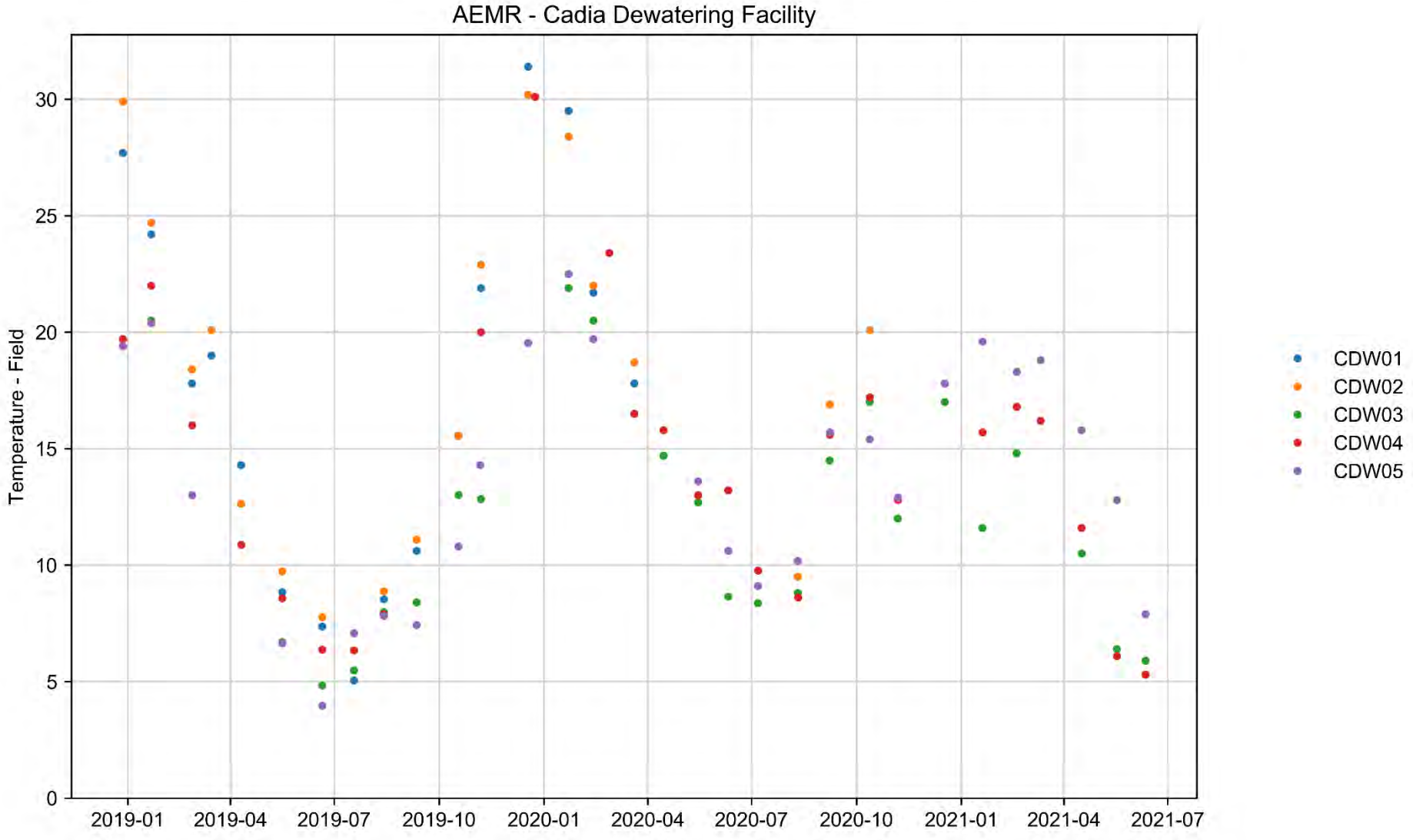

AEMR - Cadia Dewatering Facility
Sodium - mg/L
0
10
20
30
40
50
60
2017
2018
2019
2020
2021
CDW01
CDW02
CDW03
CDW04
CDW05


AEMR - Cadia Dewatering Facility
Sulfate - mg/L
0
20
40
60
80
100
120
2017
2018
2019
2020
2021
CDW01
CDW02
CDW03
CDW04
CDW05

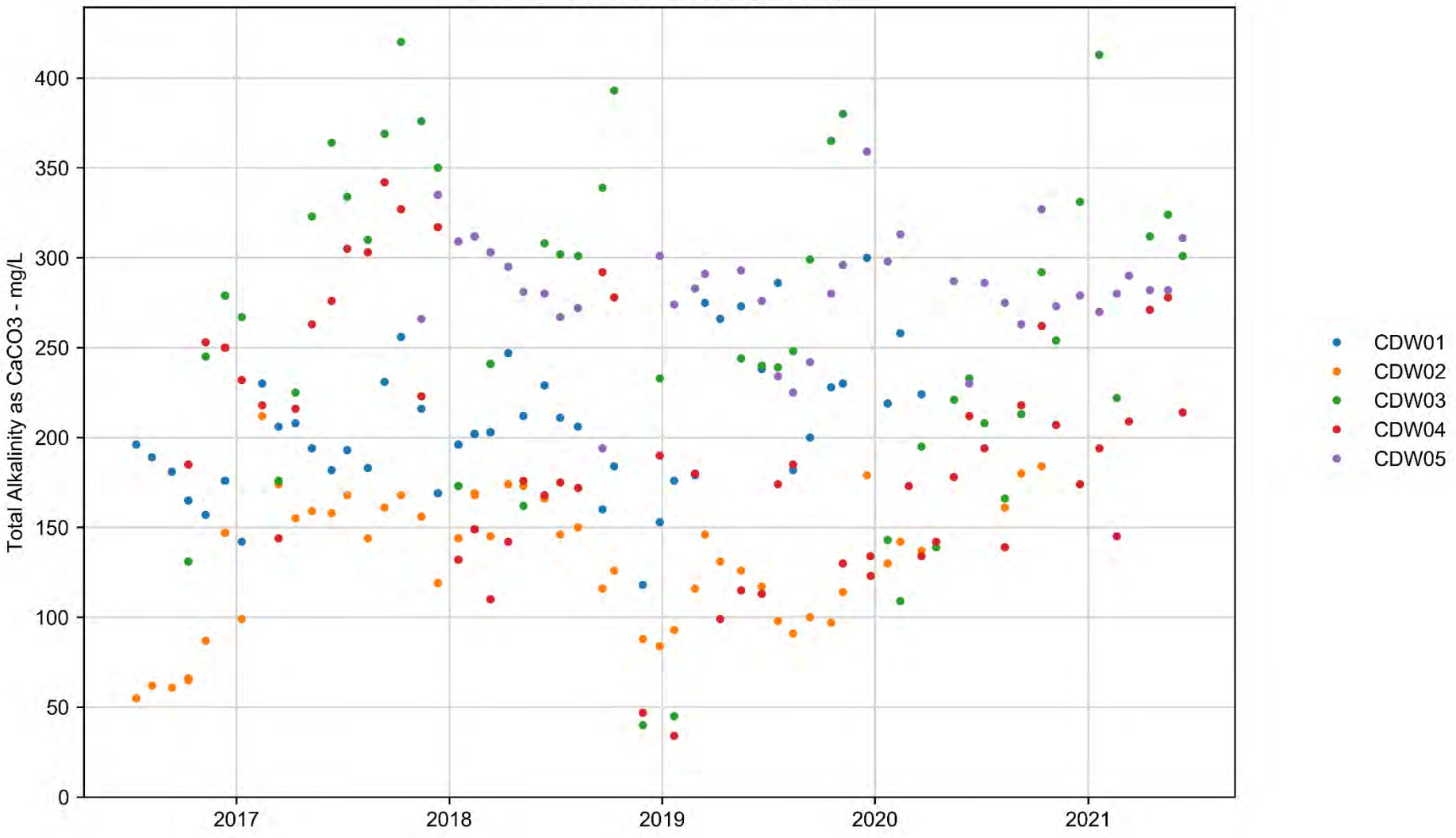
AEMR - Cadia Dewatering Facility



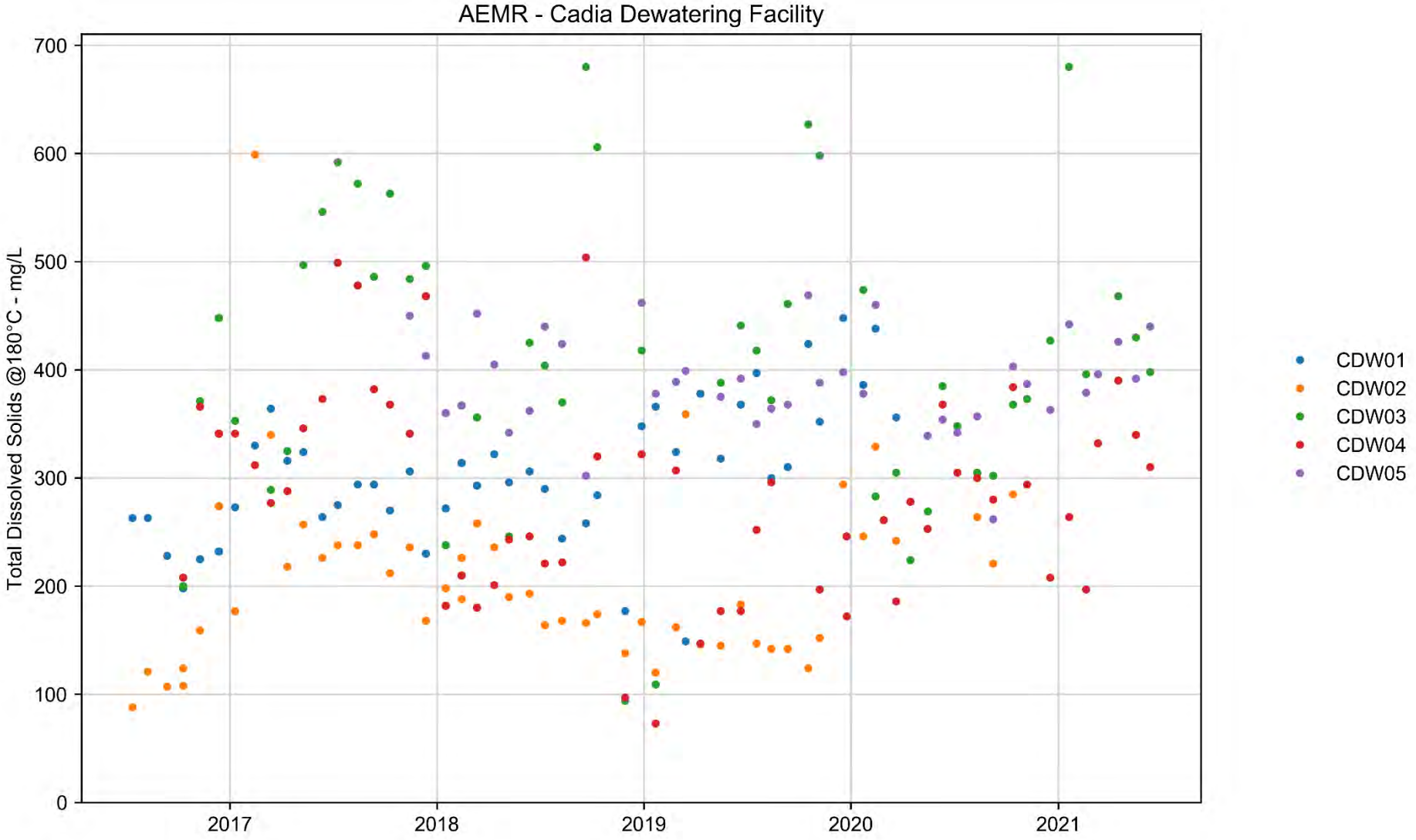
AEMR - Cadia Dewatering Facility

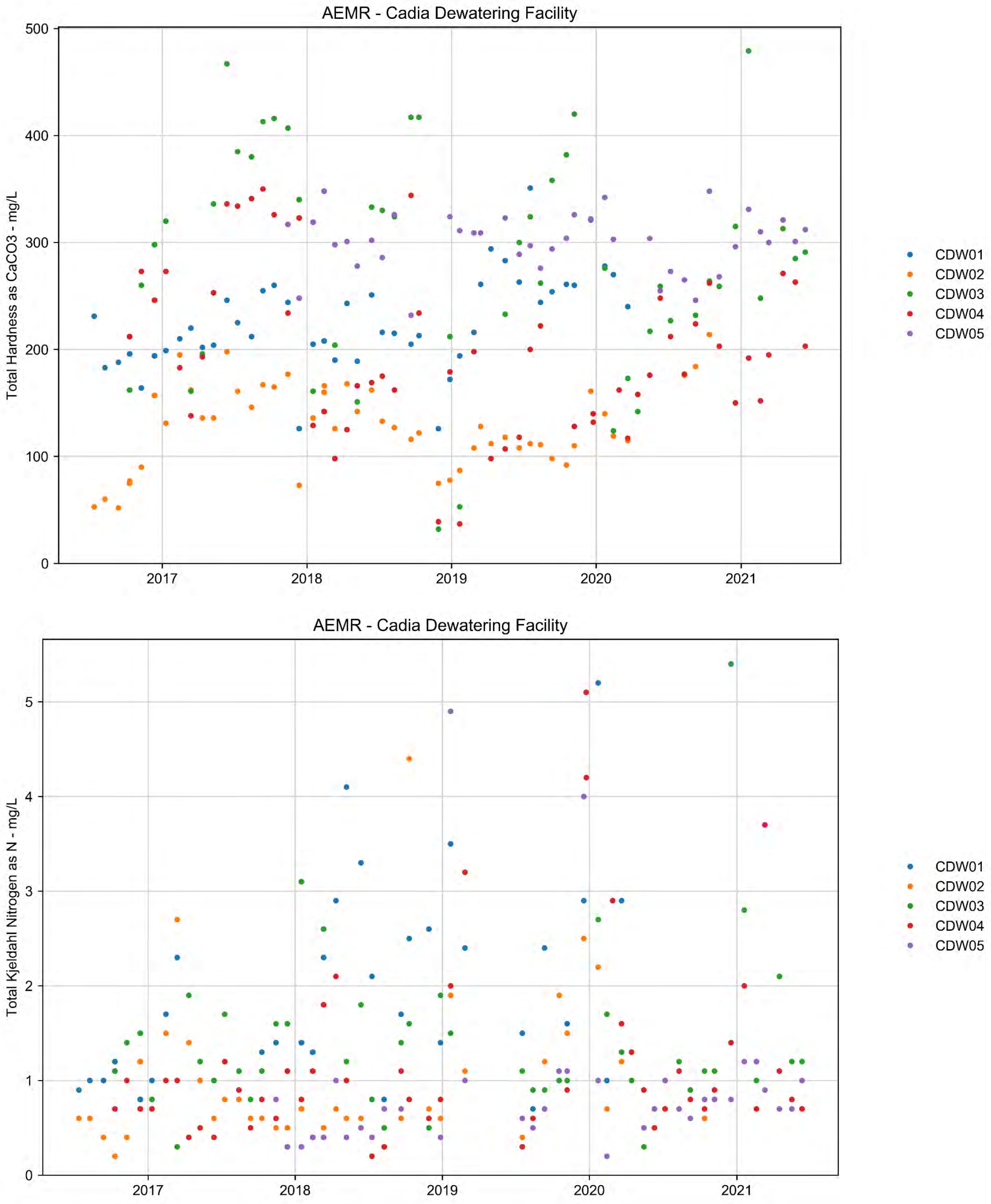


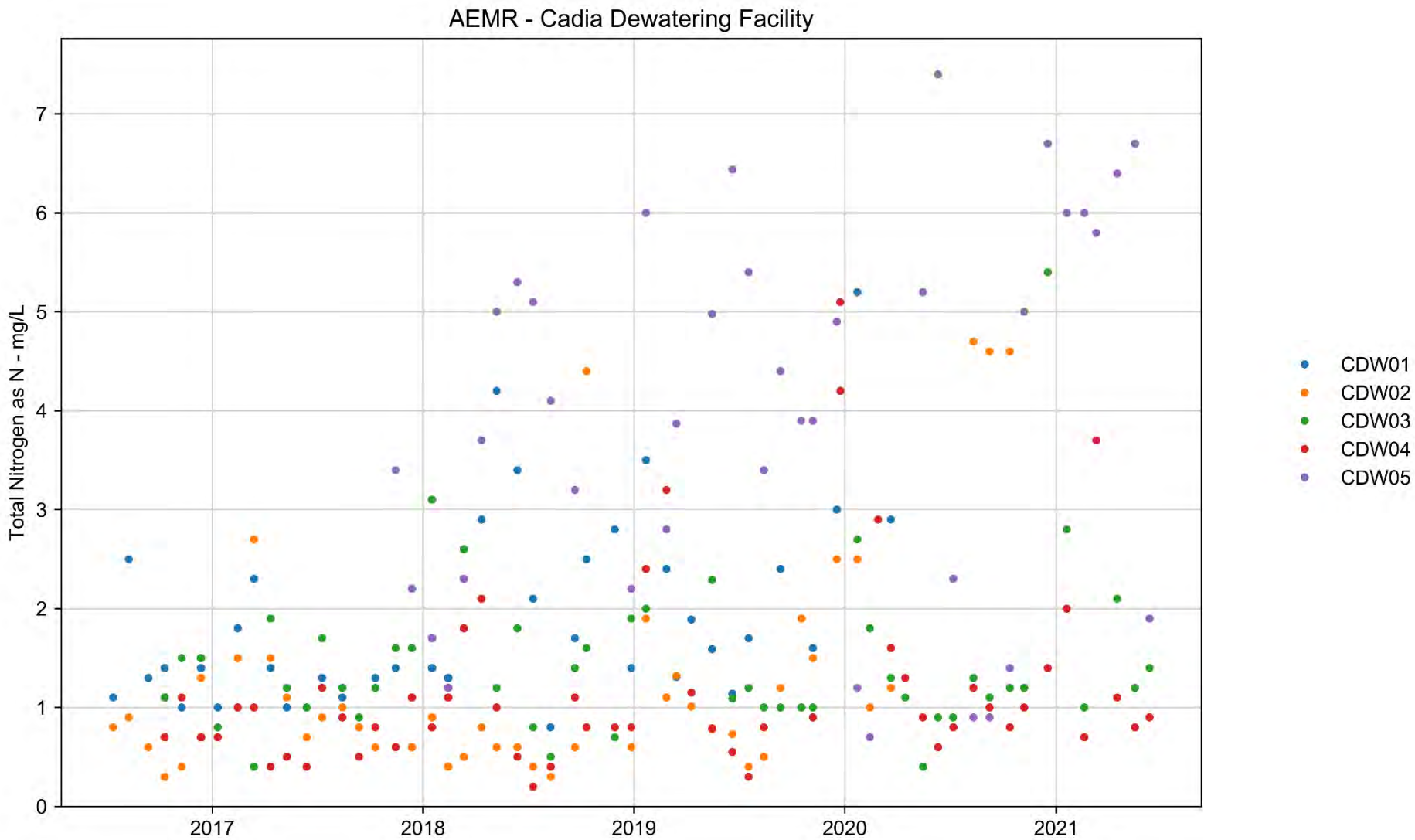
AEMR - Cadia Dewatering Facility

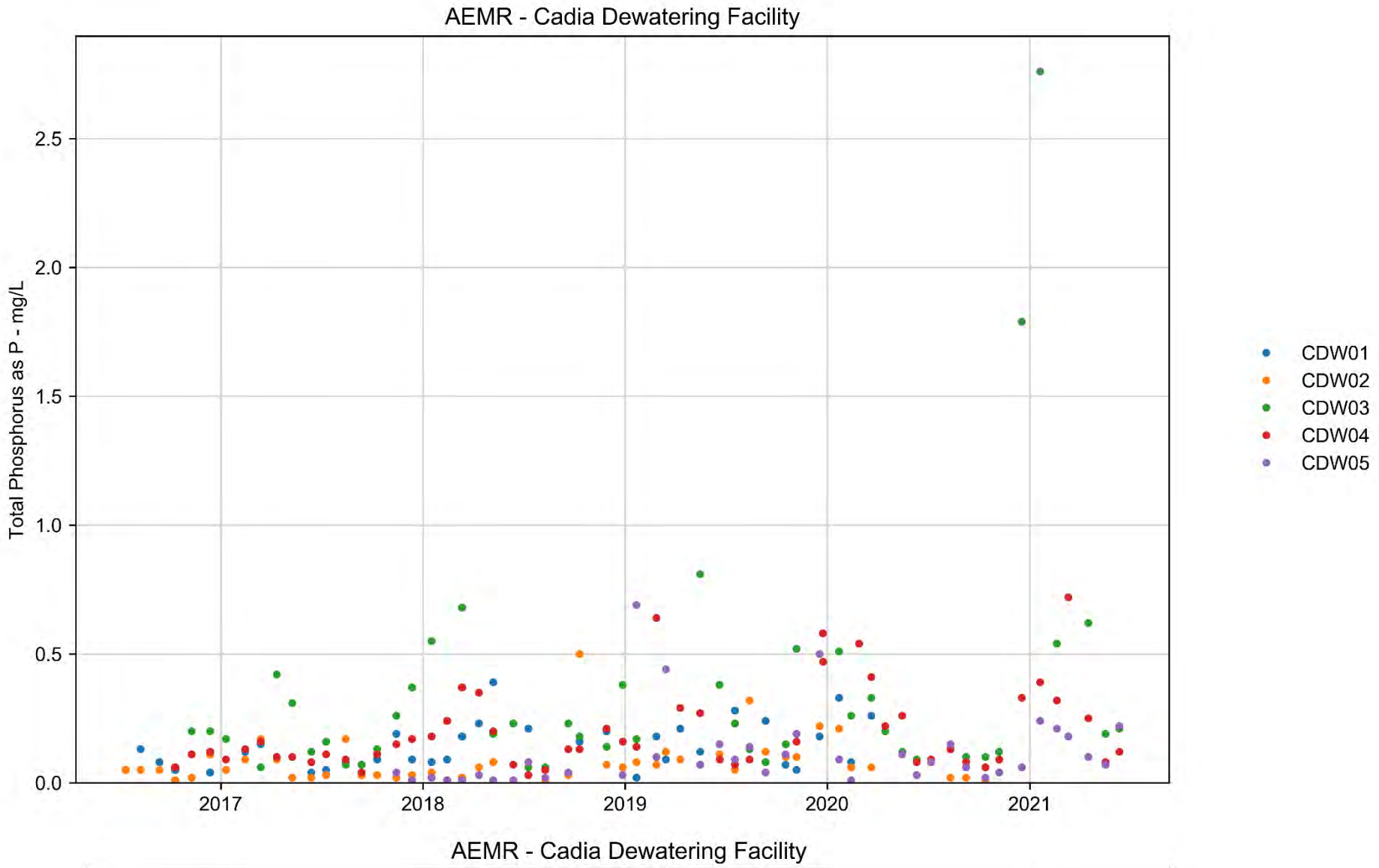


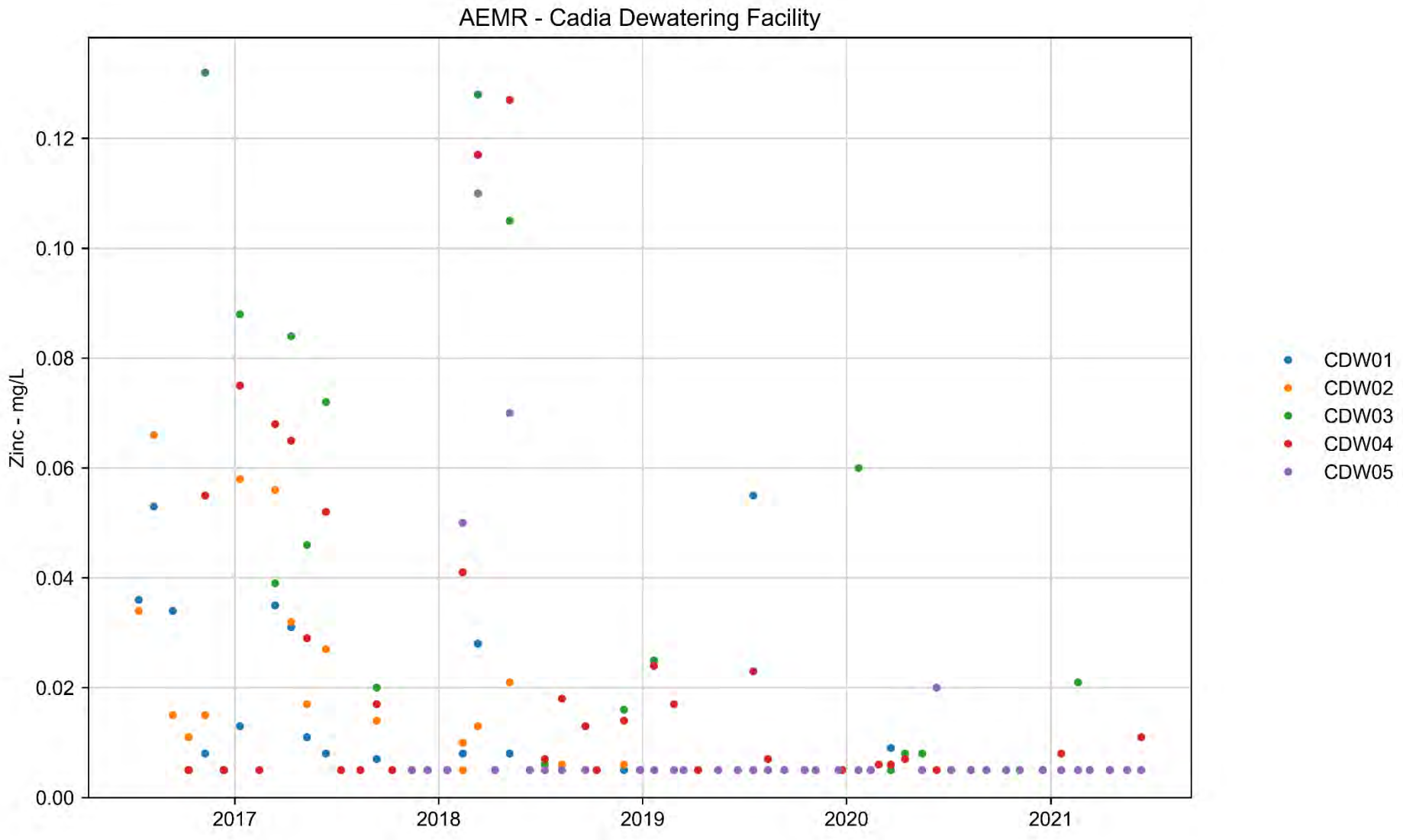
AEMR - Cadia Dewatering Facility

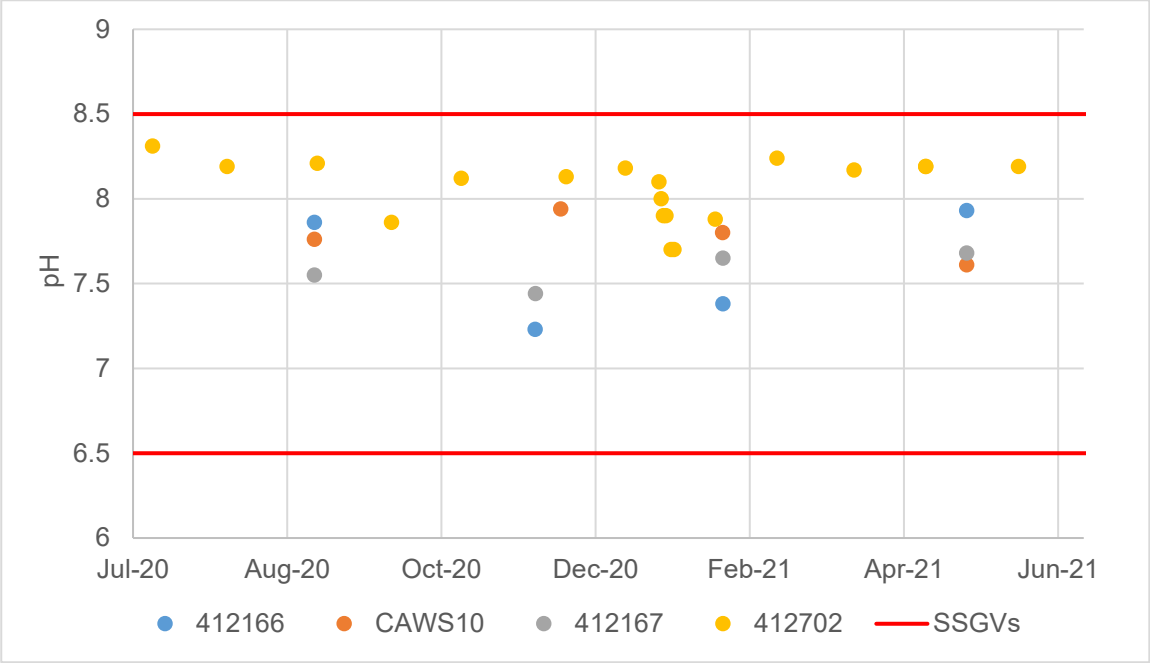


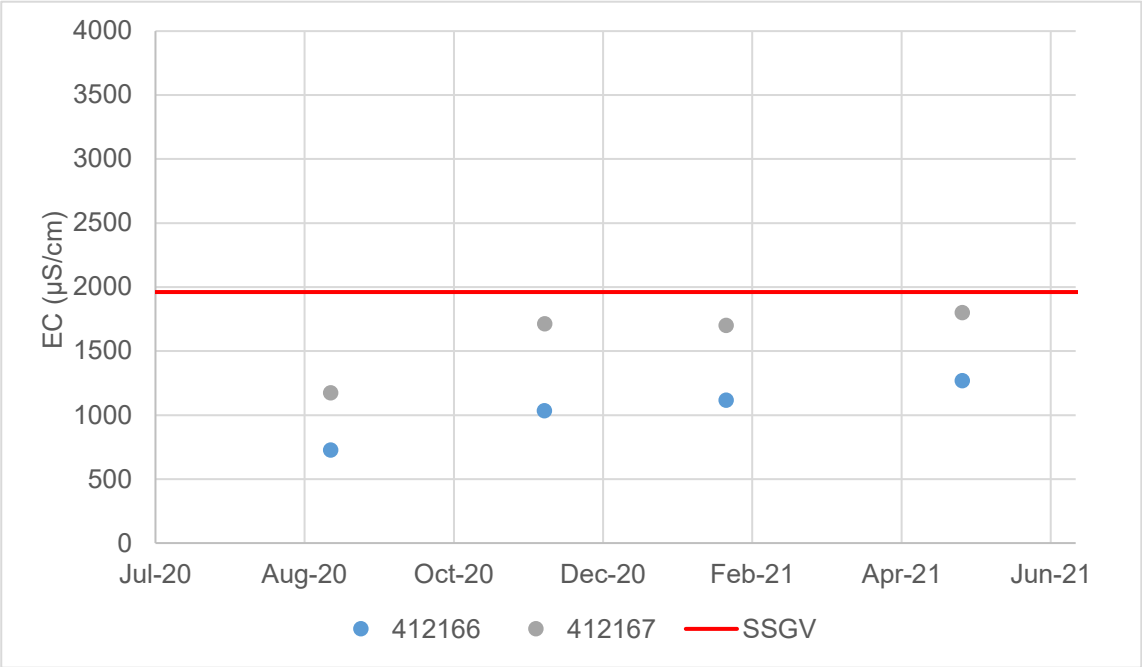

AEMR - Cadia Dewatering Facility
Total Hardness as CaCO3 - mg/L
500
400
300
200
100
0
2017
2018
2019
2020
2021
CDW01
CDW02
CDW03
CDW04
CDW05
AEMR - Cadia Dewatering Facility
Total Kjeldahl Nitrogen as N - mg/L
5
4
3
2
1
0
2017
2018
2019
2020
2021
CDW01
CDW02
CDW03
CDW04
CDW05

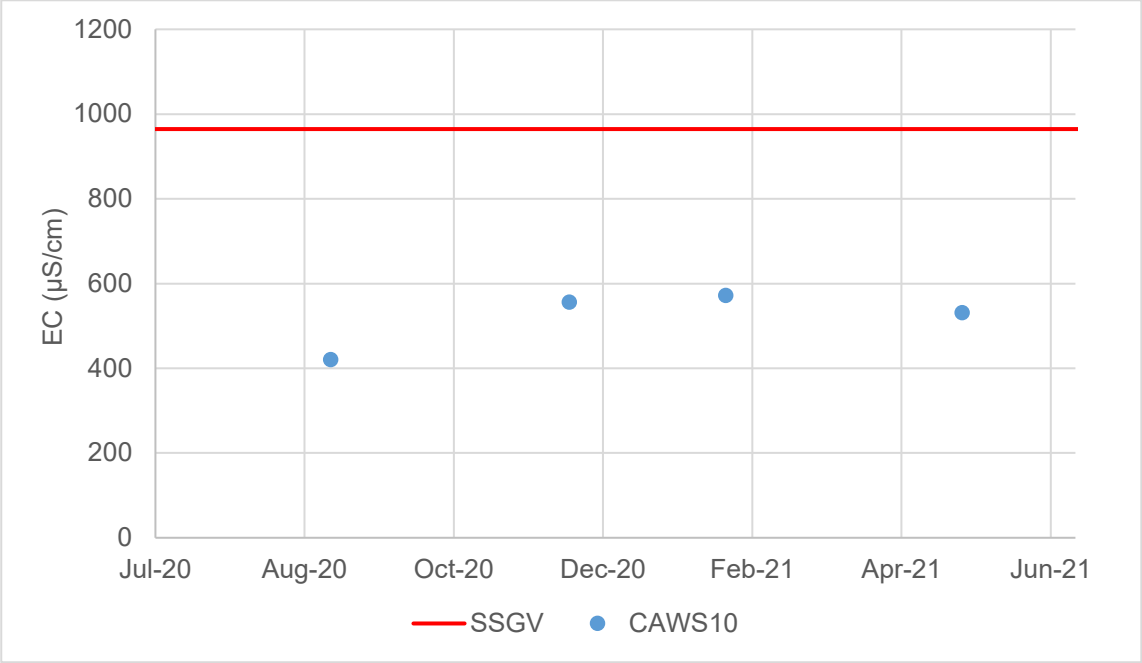

AEMR - Cadia Dewatering Facility
Total Nitrogen as N - mg/L
0
1
2
3
4
5
6
7
2017
2018
2019
2020
2021
CDW01
CDW02
CDW03
CDW04
CDW05

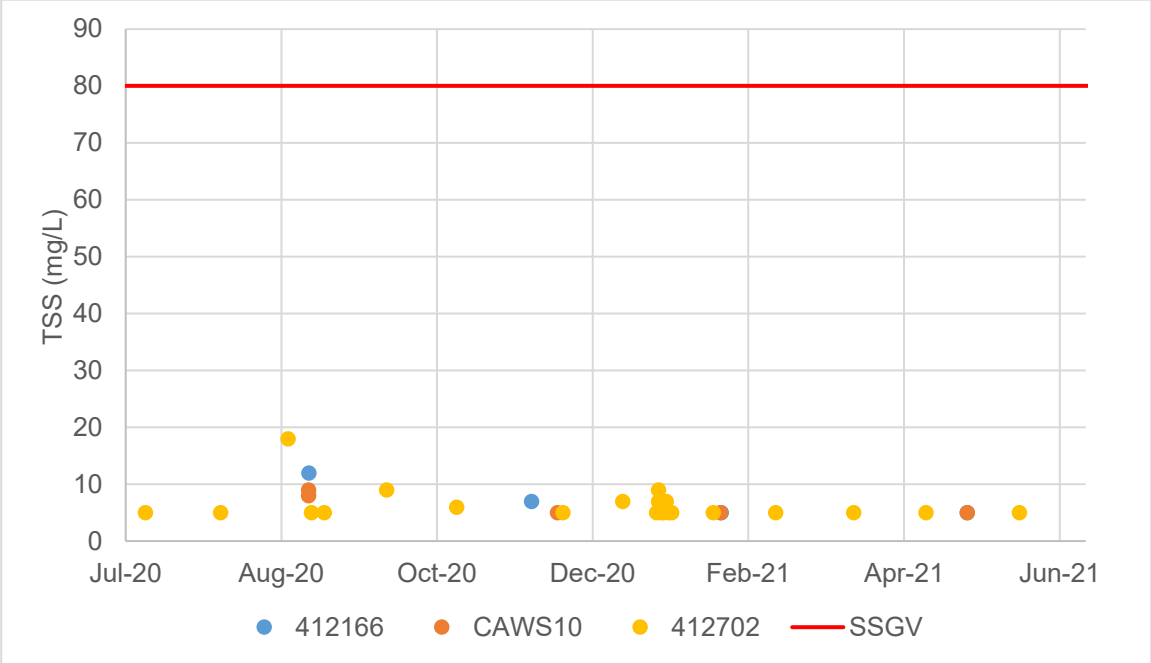

AEMR - Cadia Dewatering Facility
Total Phosphorus as P - mg/L
2.5
2.0
1.5
1.0
0.5
0.0
2017
2018
2019
2020
2021
CDW01
CDW02
CDW03
CDW04
CDW05

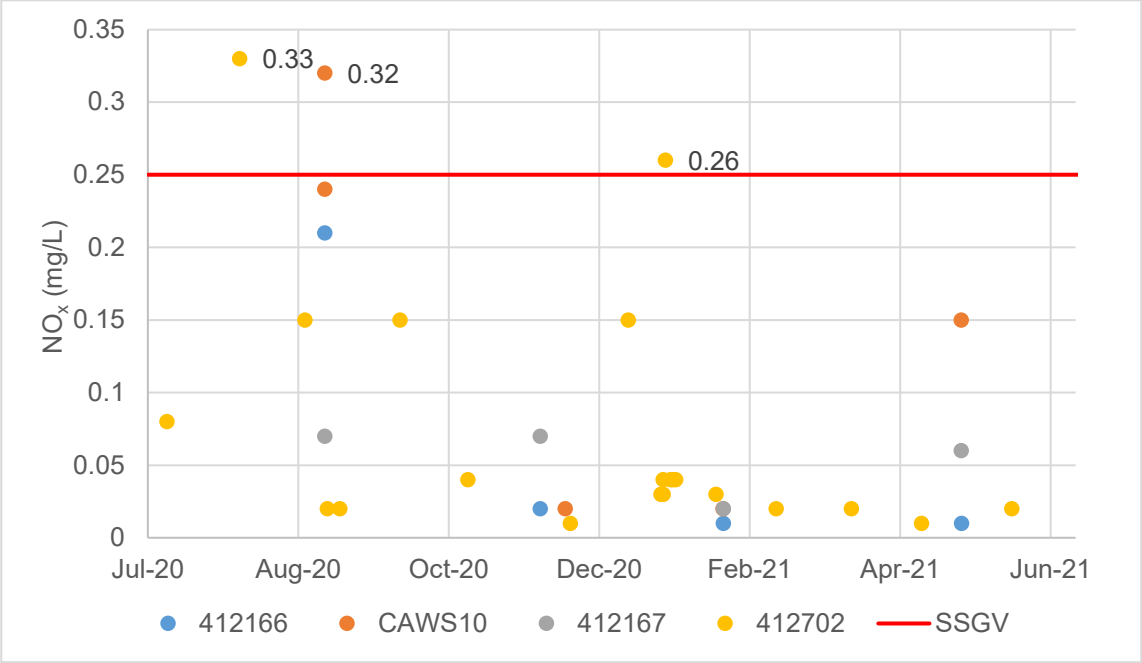

AEMR - Cadia Dewatering Facility
Zinc - mg/L
0.12
0.10
0.08
0.06
0.04
0.02
0.00
2017
2018
2019
2020
2021
CDW01
CDW02
CDW03
CDW04
CDW05

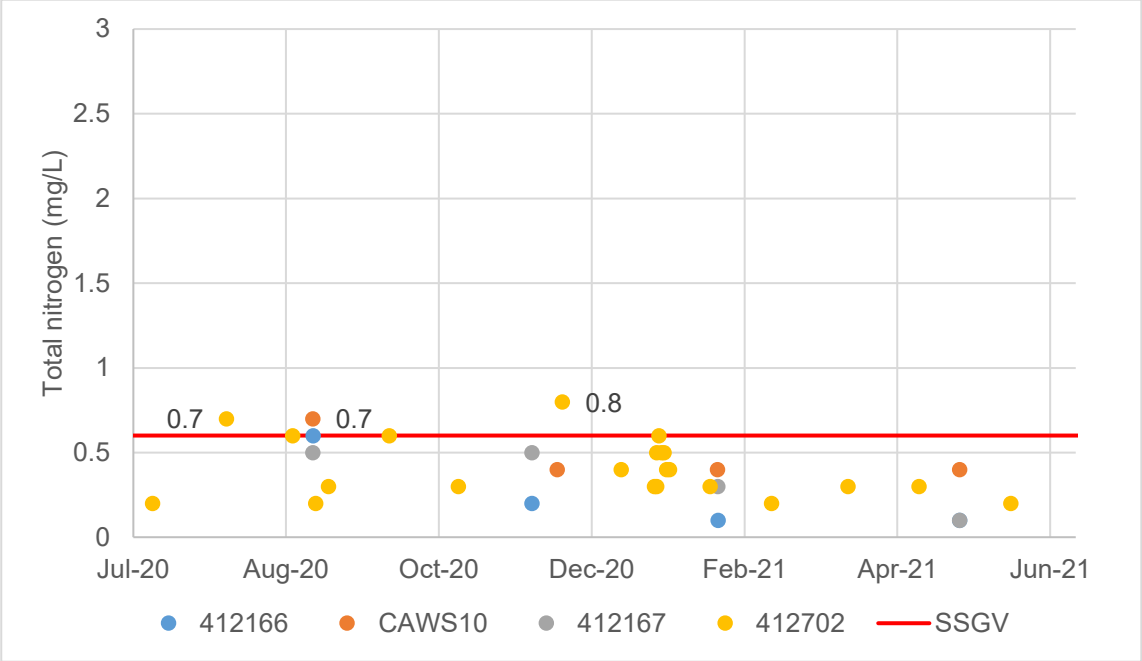

9
8.5
8
7.5
7
6.5
6
pH
Jul-20
Aug-20
Oct-20
Dec-20
Feb-21
Apr-21
Jun-21
412166
CAWS10
412167
412702
SSGVs

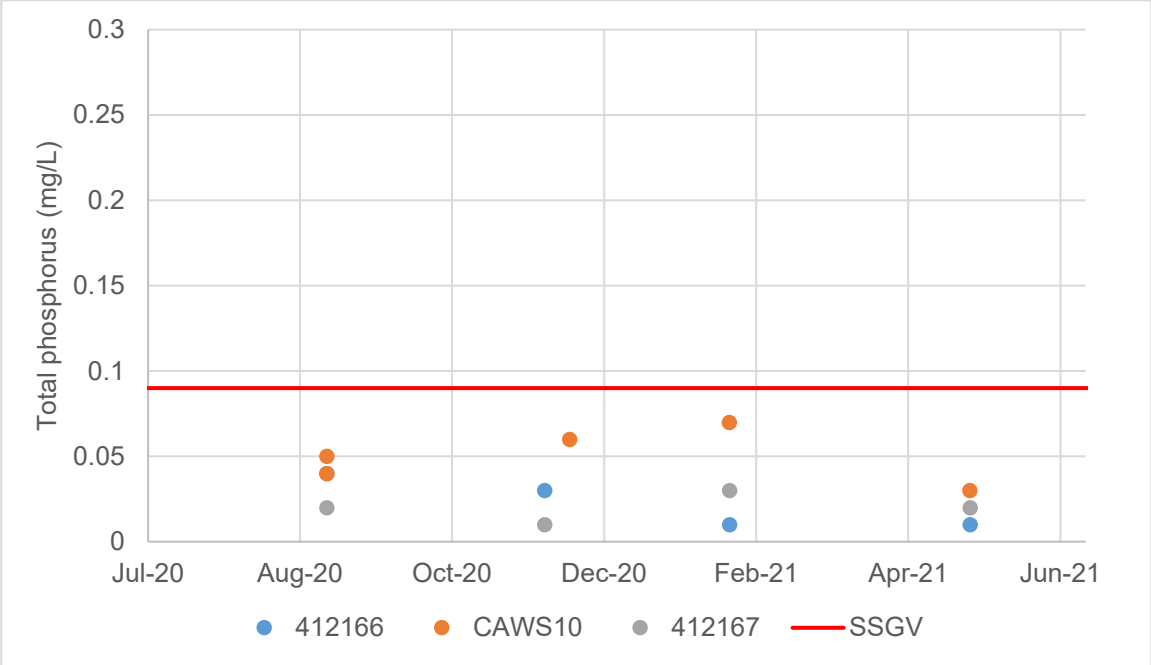

4000
3500
3000
2500
2000
1500
1000
500
0
EC (µS/cm)
Jul-20
Aug-20
Oct-20
Dec-20
Feb-21
Apr-21
Jun-21
412166
412167
SSGV

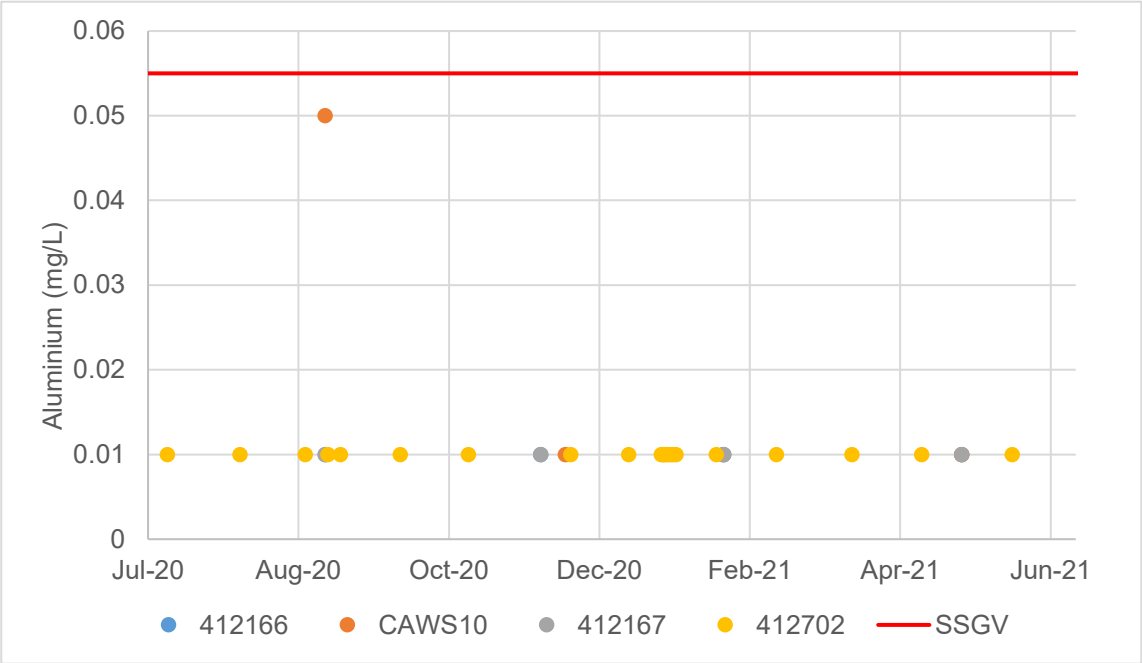

1200
1000
800
600
400
200
0
EC (µS/cm)
Jul-20
Aug-20
Oct-20
Dec-20
Feb-21
Apr-21
Jun-21
SSGV
CAWS10

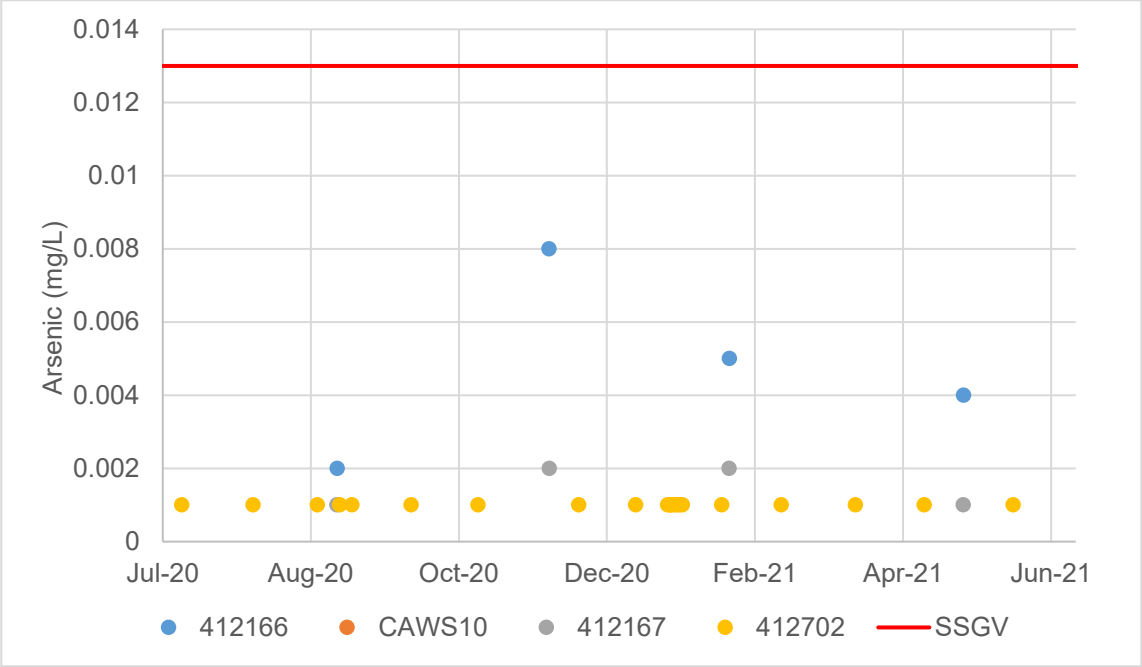

90
80
70
60
50
40
30
20
10
0
TSS (mg/L)
Jul-20
Aug-20
Oct-20
Dec-20
Feb-21
Apr-21
Jun-21
412166
CAWS10
412702
SSGV

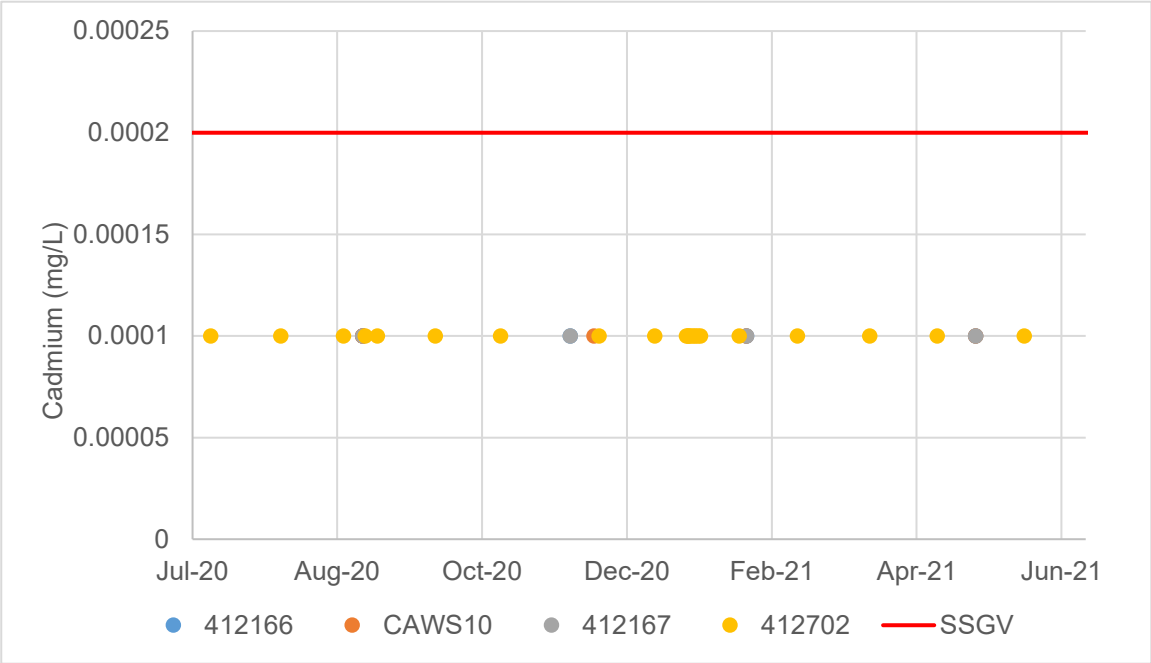

0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
NOx (mg/L)
0.33
0.32
0.26
Jul-20
Aug-20
Oct-20
Dec-20
Feb-21
Apr-21
Jun-21
412166
CAWS10
412167
412702
SSGV

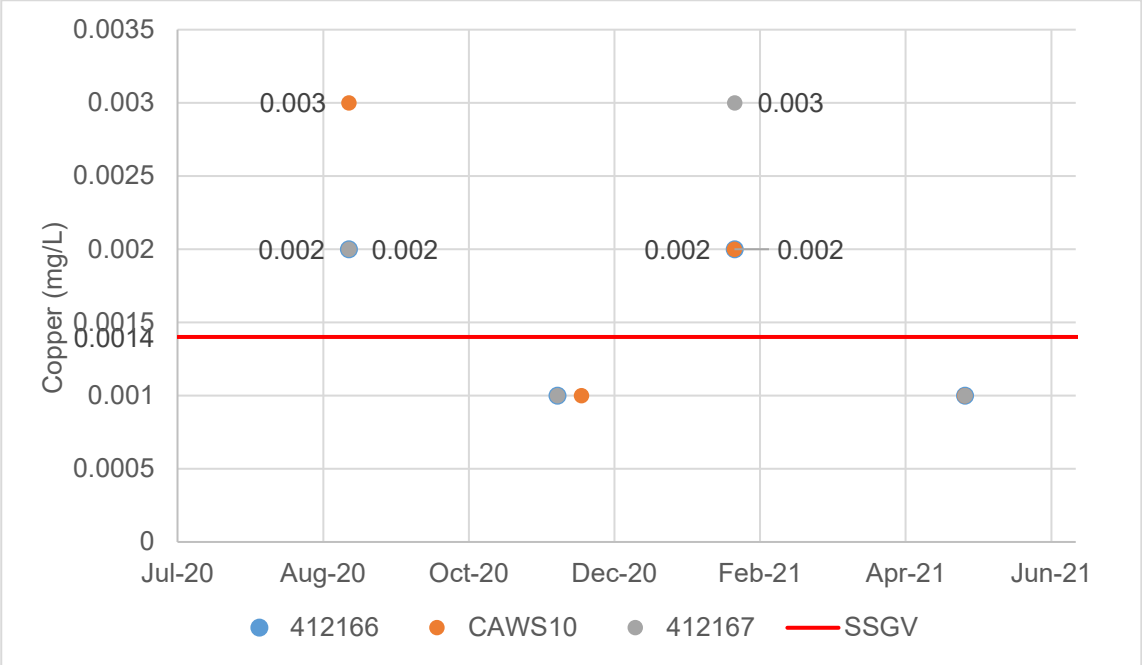

3
2.5
2
1.5
1
0.5
0
Total nitrogen (mg/L)
0.7
0.7
0.8
Jul-20
Aug-20
Oct-20
Dec-20
Feb-21
Apr-21
Jun-21
412166
CAWS10
412167
412702
SSGV

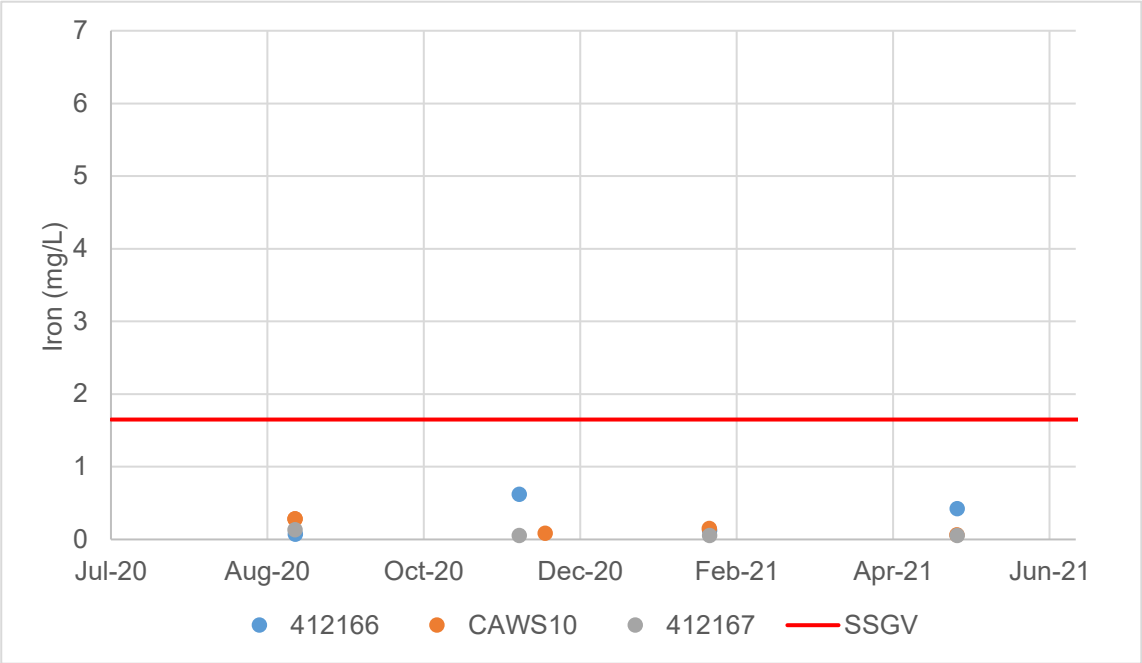

0.3
0.25
0.2
0.15
0.1
0.05
0
Total phosphorus (mg/L)
Jul-20
Aug-20
Oct-20
Dec-20
Feb-21
Apr-21
Jun-21
412166
CAWS10
412167
SSGV

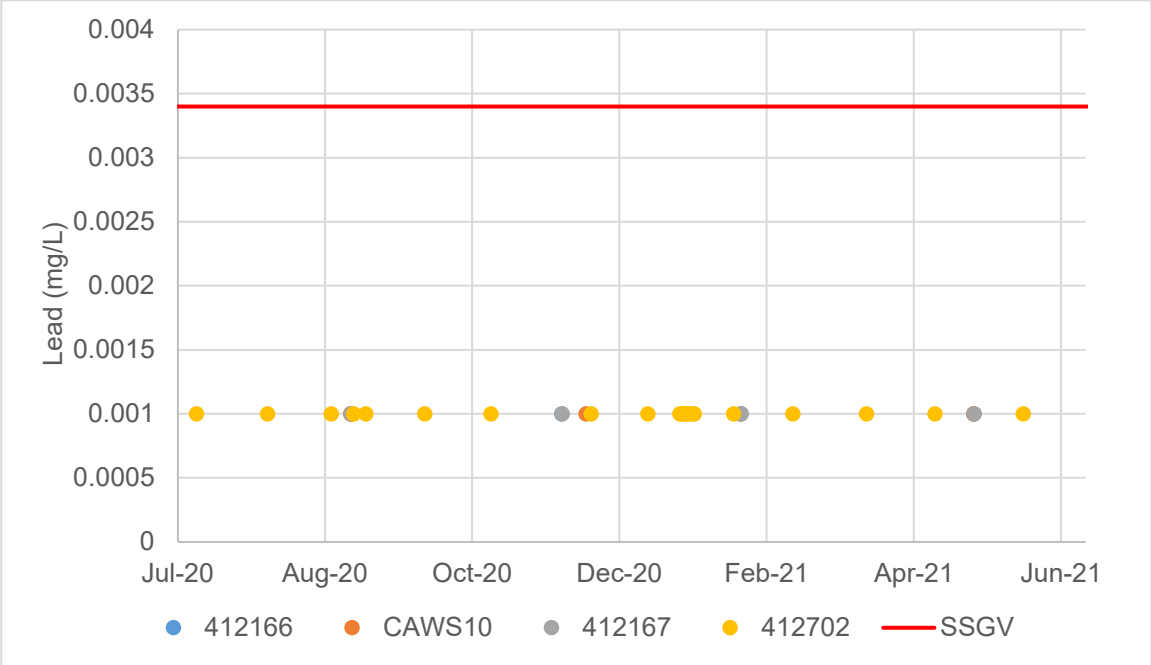

0.06
0.05
0.04
0.03
0.02
0.01
0
Aluminium (mg/L)
Jul-20
Aug-20
Oct-20
Dec-20
Feb-21
Apr-21
Jun-21
412166
CAWS10
412167
412702
SSGV

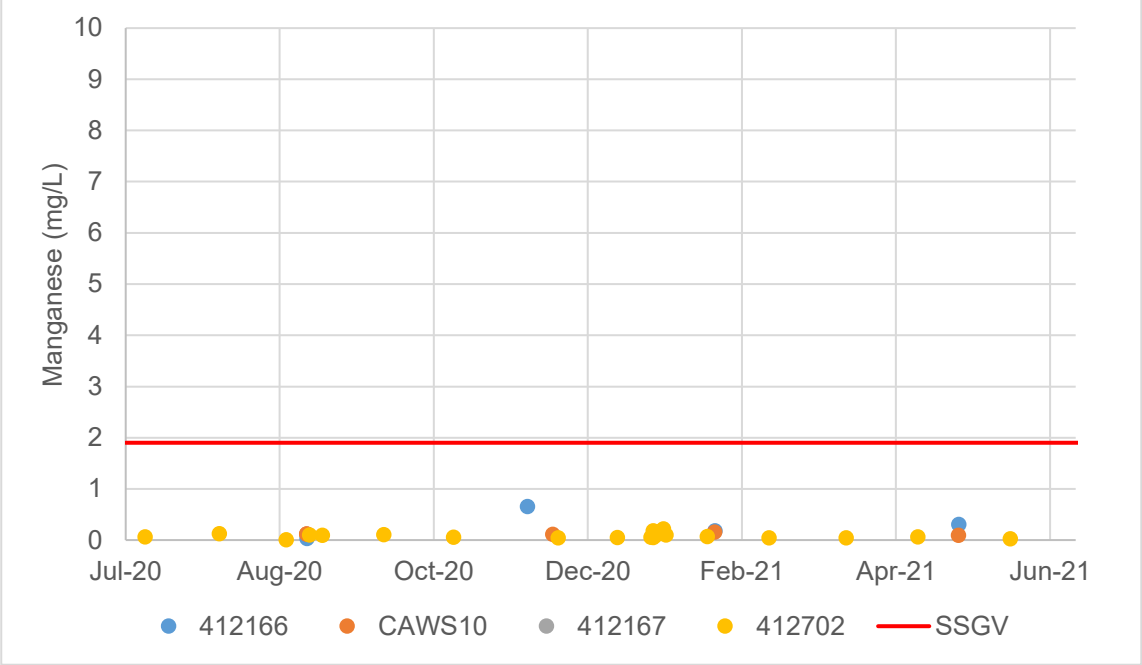

0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
Arsenic (mg/L)
Jul-20
Aug-20
Oct-20
Dec-20
Feb-21
Apr-21
Jun-21
412166
CAWS10
412167
412702
SSGV

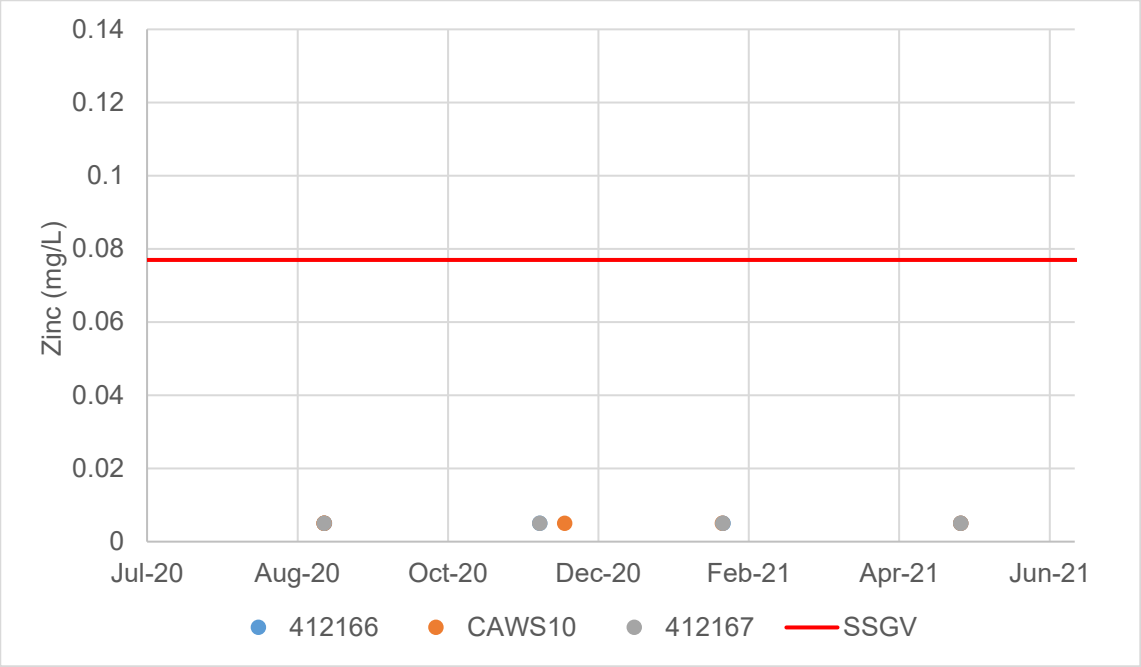

0.00025
0.0002
0.00015
0.0001
0.00005
0
Cadmium (mg/L)
Jul-20
Aug-20
Oct-20
Dec-20
Feb-21
Apr-21
Jun-21
412166
CAWS10
412167
412702
SSGV

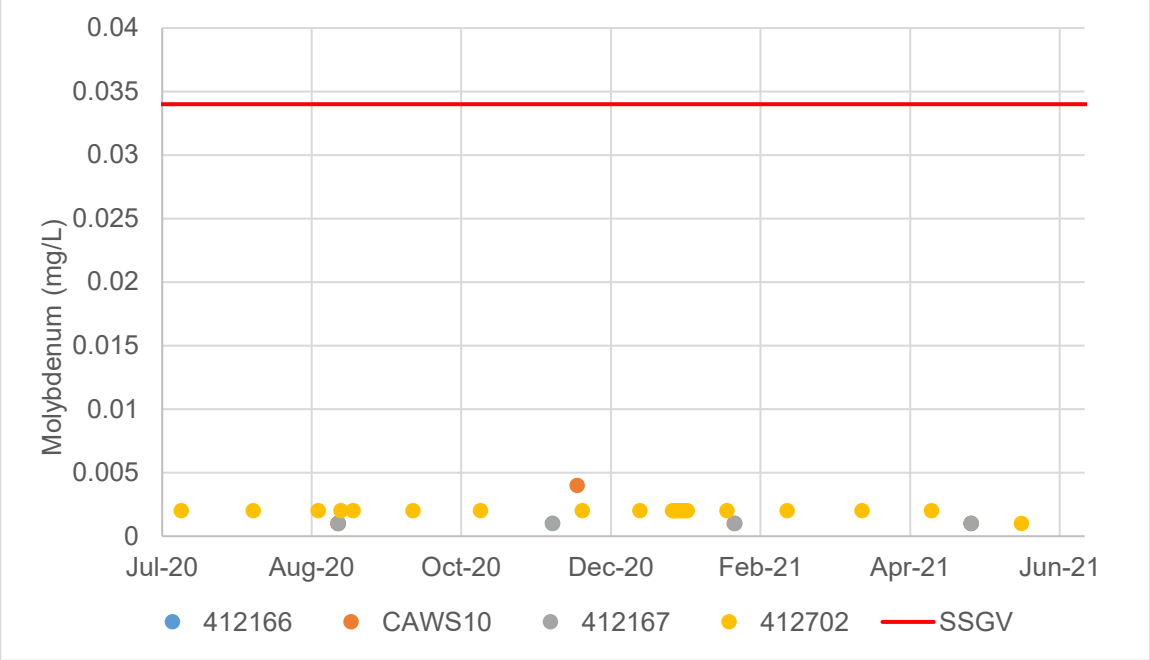

0.0035
0.003
0.0025
0.002
0.0015
0.0014
0.001
0.0005
0
Copper (mg/L)
0.003
0.003
0.002
0.002
0.002
0.002
Jul-20
Aug-20
Oct-20
Dec-20
Feb-21
Apr-21
Jun-21
412166
CAWS10
412167
SSGV

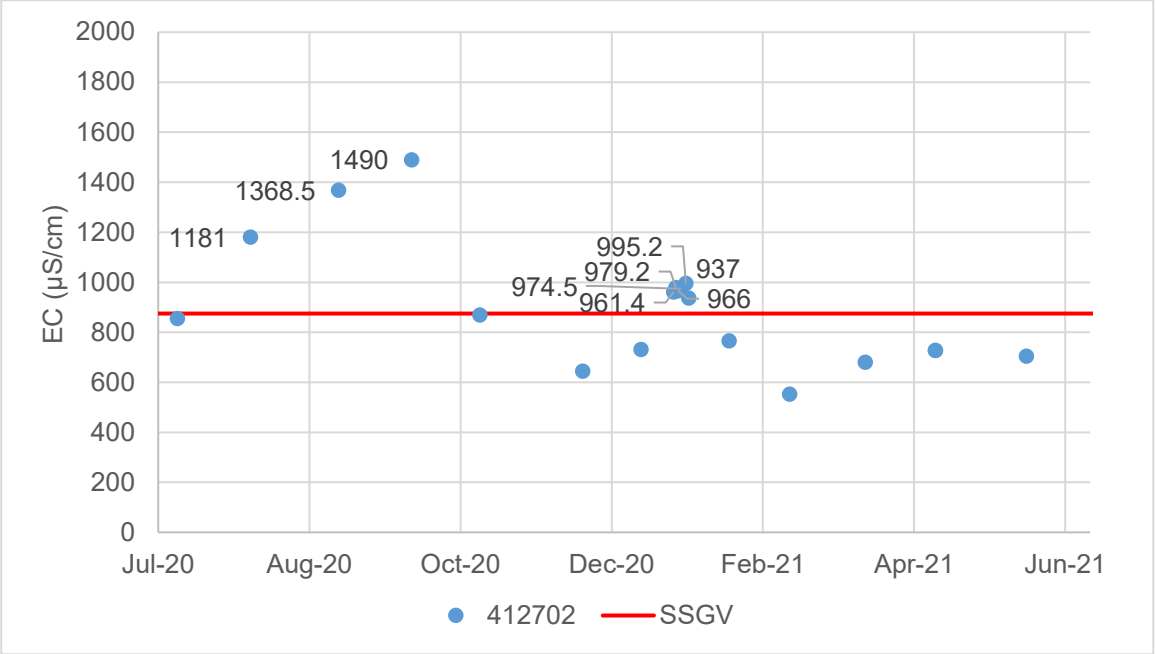

7
6
5
4
3
2
1
0
Iron (mg/L)
Jul-20
Aug-20
Oct-20
Dec-20
Feb-21
Apr-21
Jun-21
412166
CAWS10
412167
SSGV

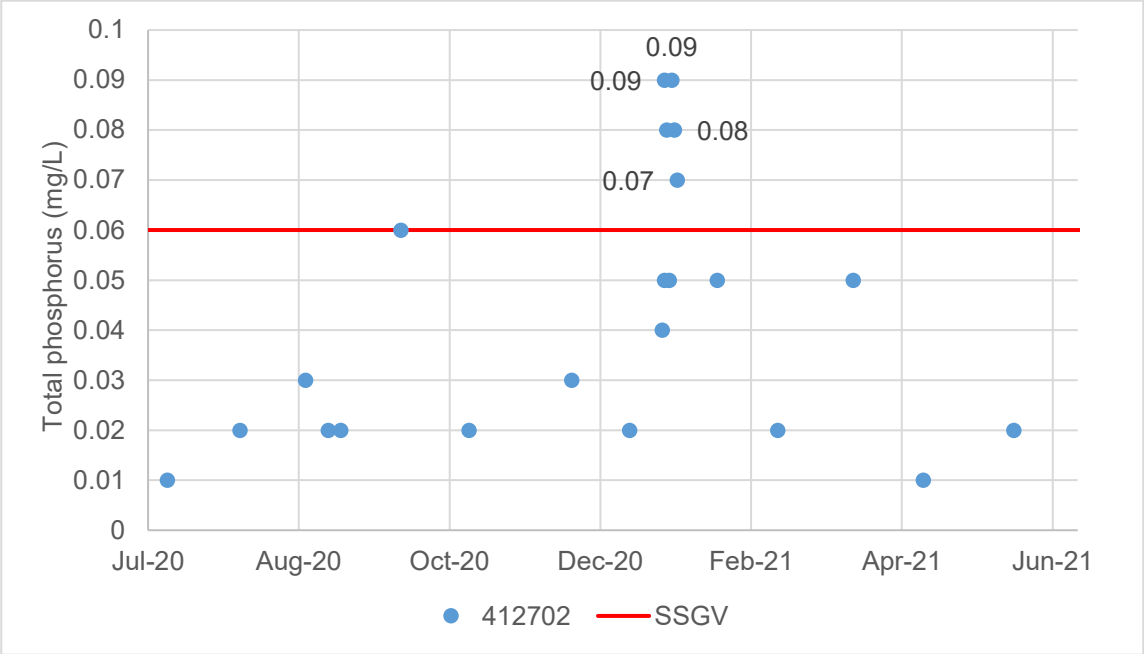

0.004
0.0035
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
Lead (mg/L)
Jul-20
Aug-20
Oct-20
Dec-20
Feb-21
Apr-21
Jun-21
412166
CAWS10
412167
412702
SSGV

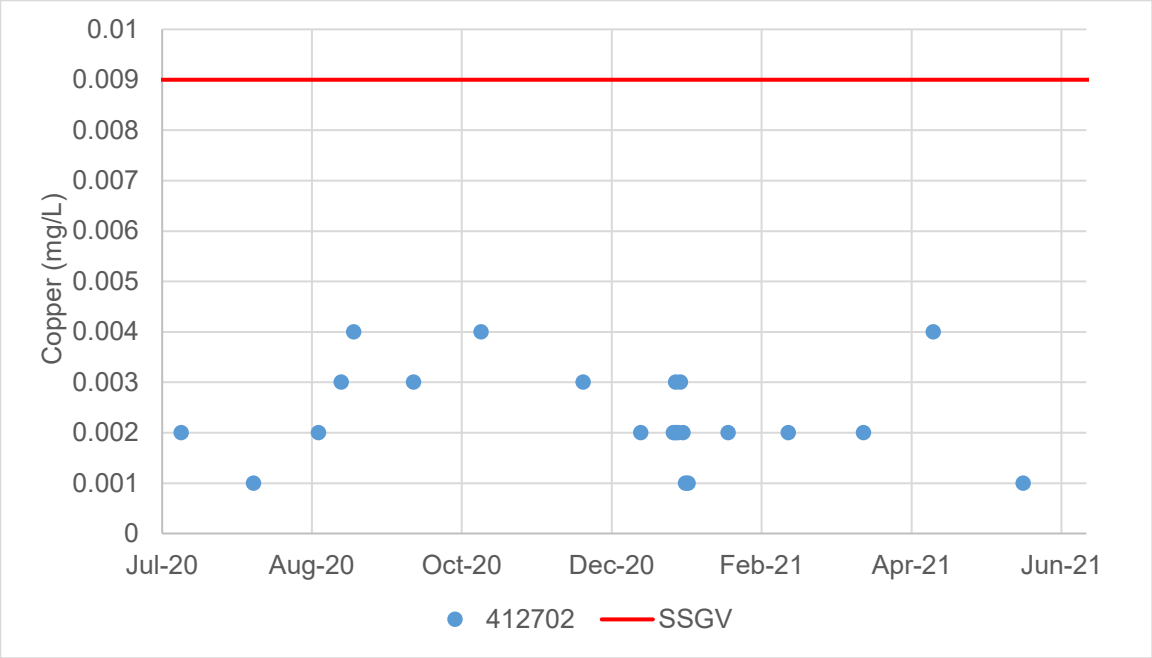

10
9
8
7
6
5
4
3
2
1
0
Manganese (mg/L)
Jul-20
Aug-20
Oct-20
Dec-20
Feb-21
Apr-21
Jun-21
412166
CAWS10
412167
412702
SSGV

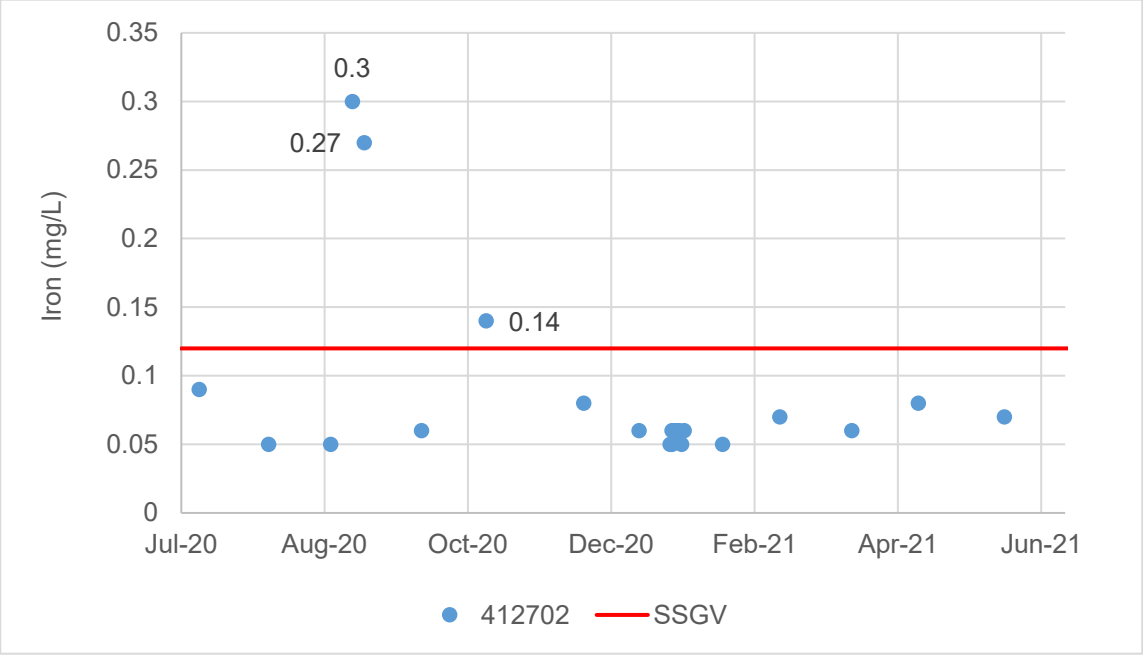

0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Zinc (mg/L)
Jul-20
Aug-20
Oct-20
Dec-20
Feb-21
Apr-21
Jun-21
412166
CAWS10
412167
SSGV


0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
Molybdenum (mg/L)
Jul-20
Aug-20
Oct-20
Dec-20
Feb-21
Apr-21
Jun-21
412166
CAWS10
412167
412702
SSGV


2000
1800
1600
1400
1200
1000
800
600
400
200
0
EC (µS/cm)
1490
1368.5
1181
995.2
979.2
974.5
961.4
937
966
Jul-20
Aug-20
Oct-20
Dec-20
Feb-21
Apr-21
Jun-21
412702
SSGV


0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Total phosphorus (mg/L)
0.09
0.09
0.08
0.07
Jul-20
Aug-20
Oct-20
Dec-20
Feb-21
Apr-21
Jun-21
412702
SSGV


0.01
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
Copper (mg/L)
Jul-20
Aug-20
Oct-20
Dec-20
Feb-21
Apr-21
Jun-21
412702
SSGV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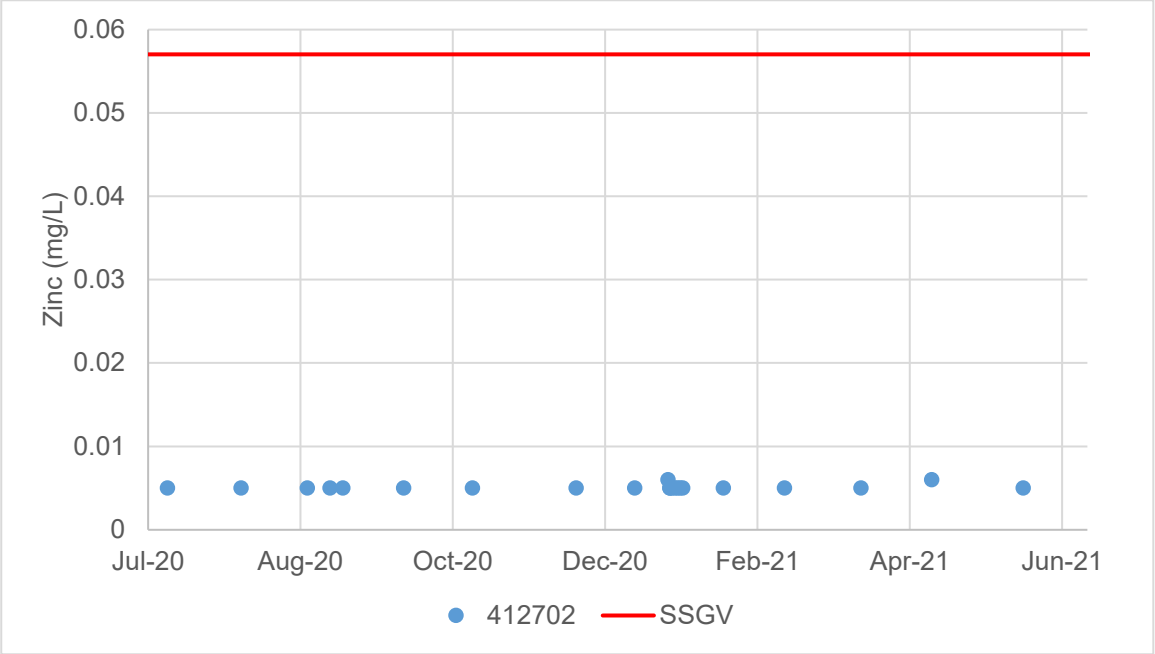
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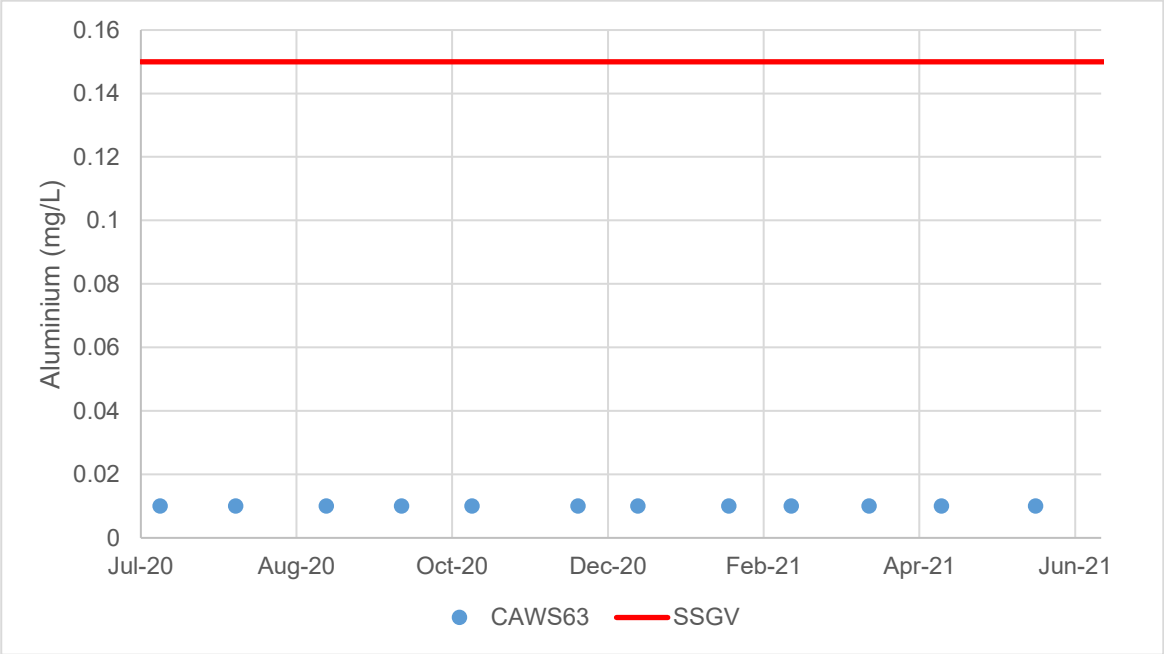
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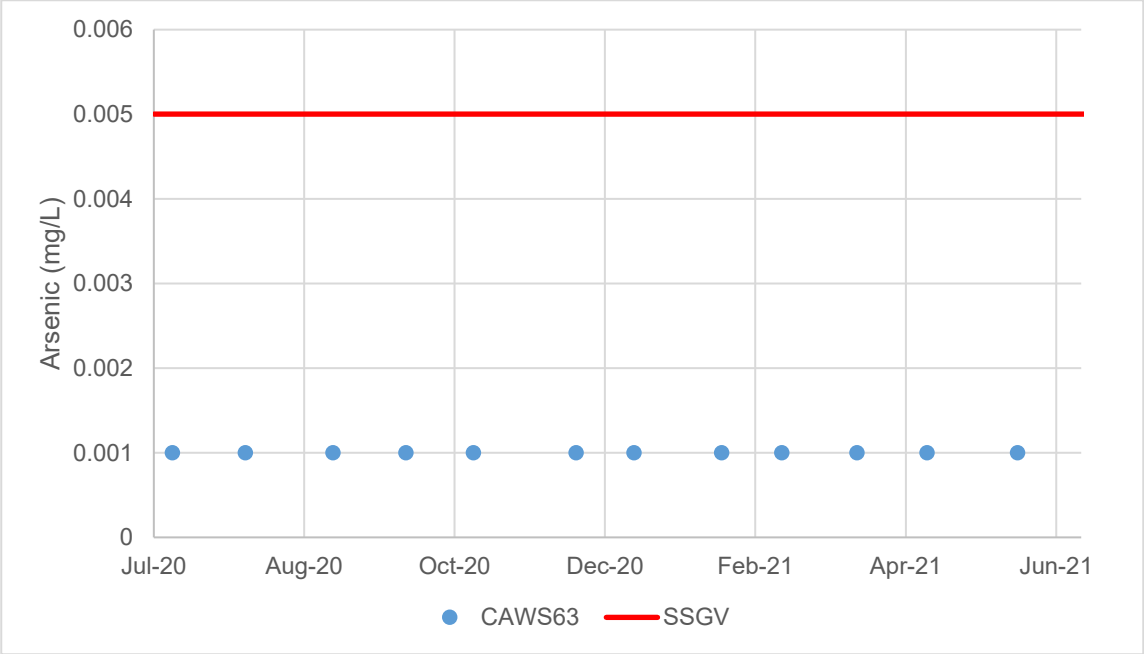
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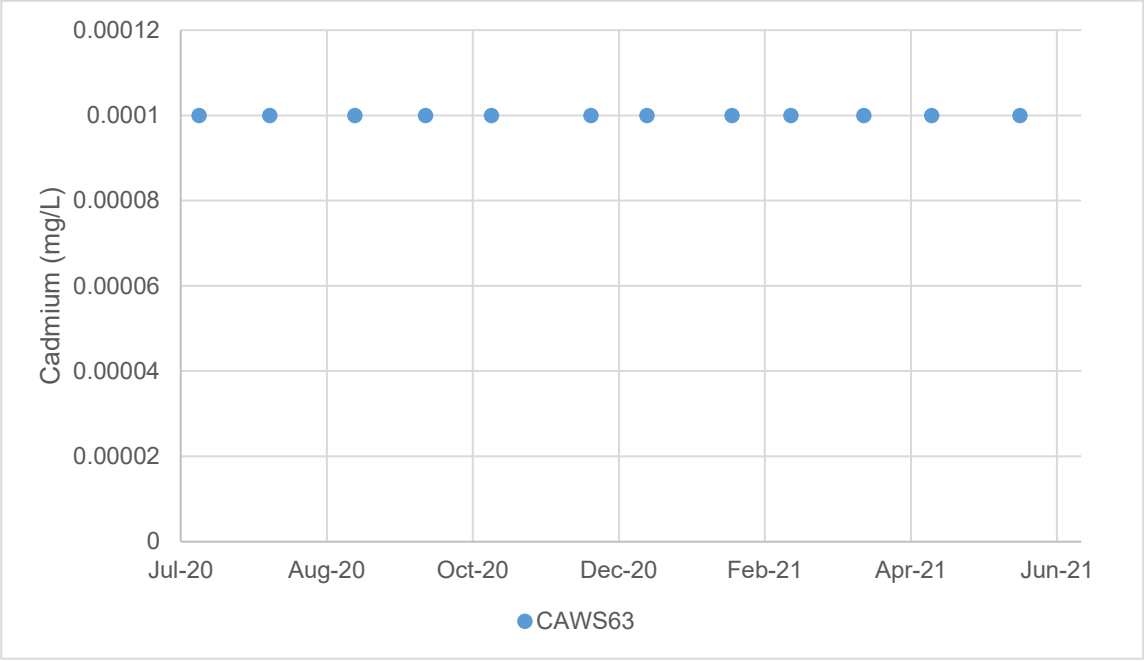
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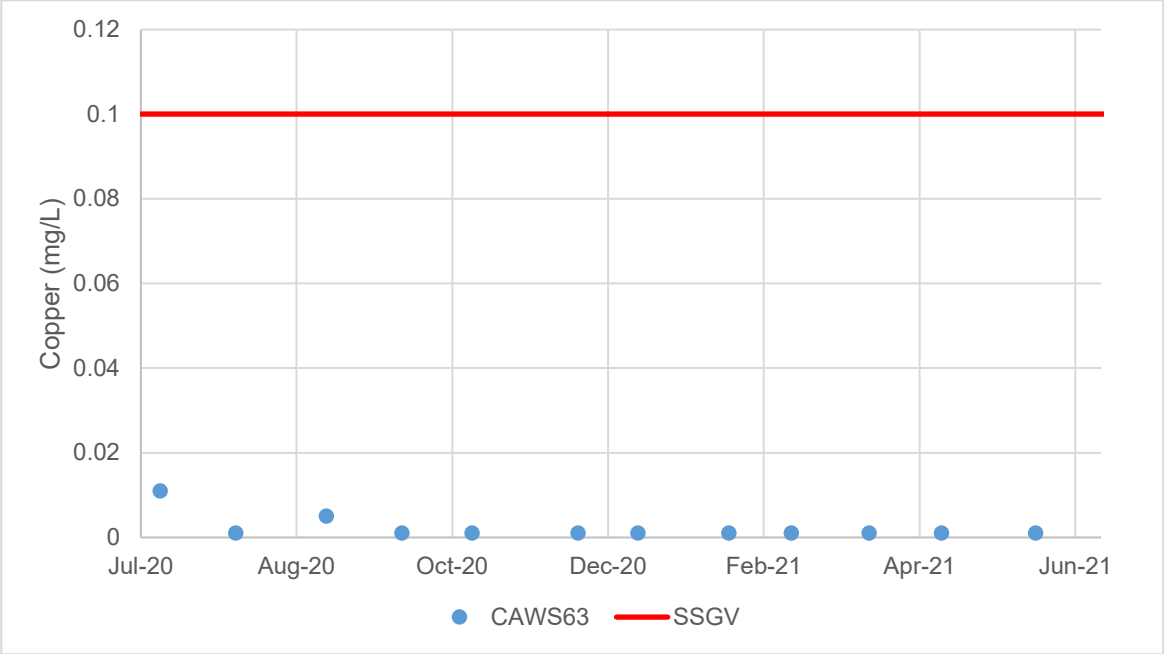
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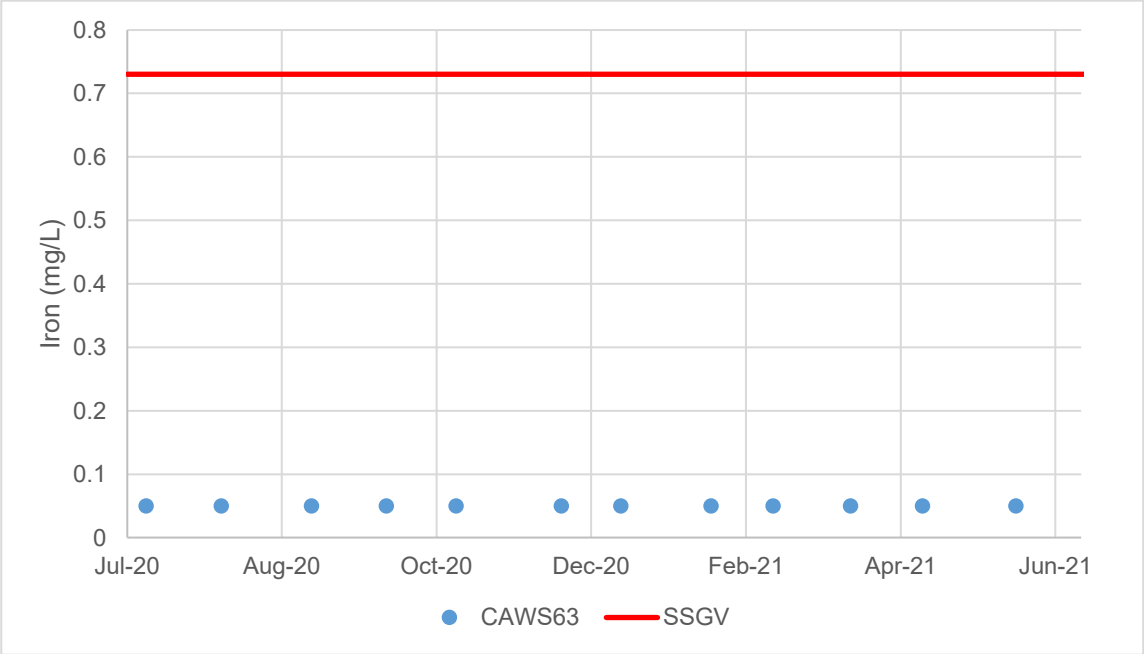
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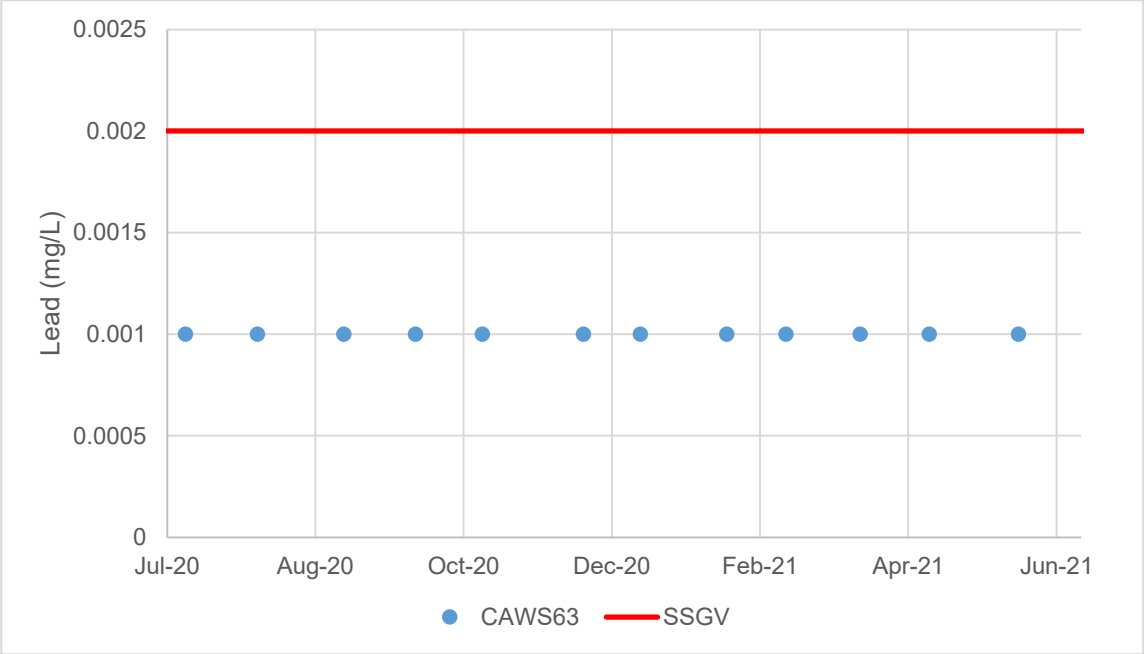
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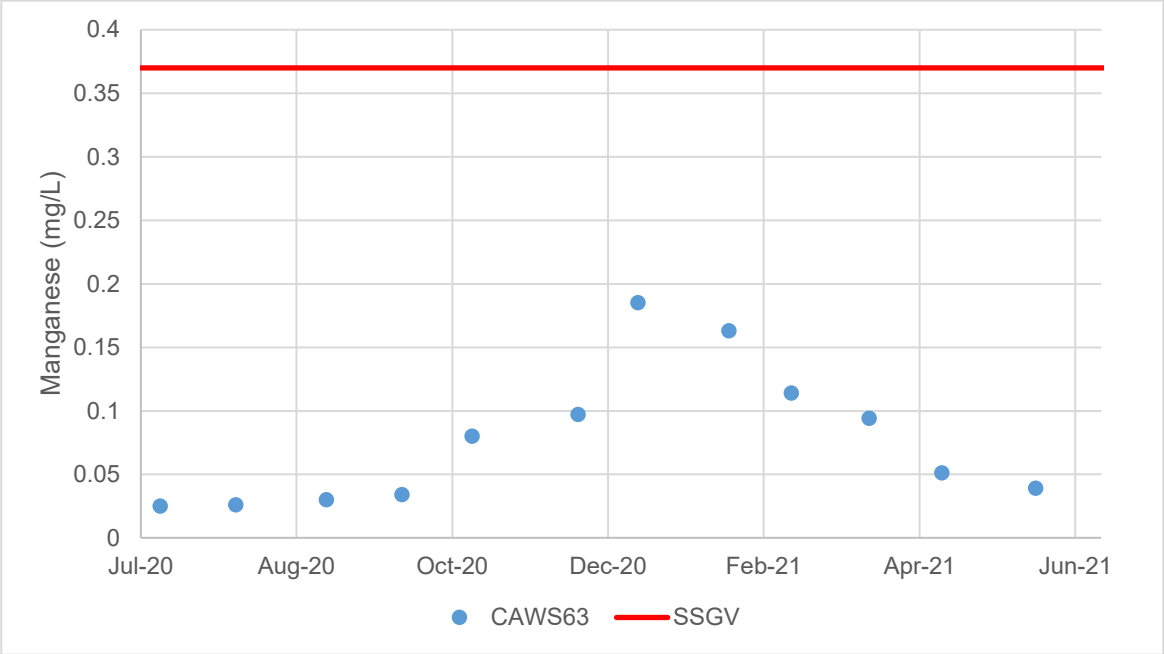
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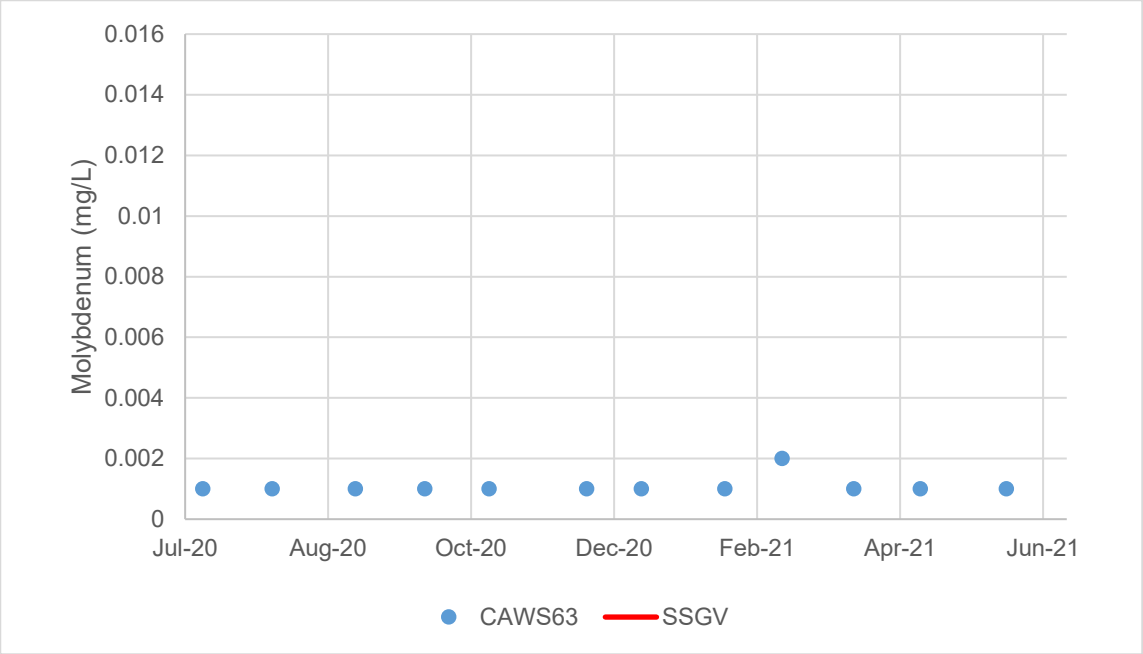
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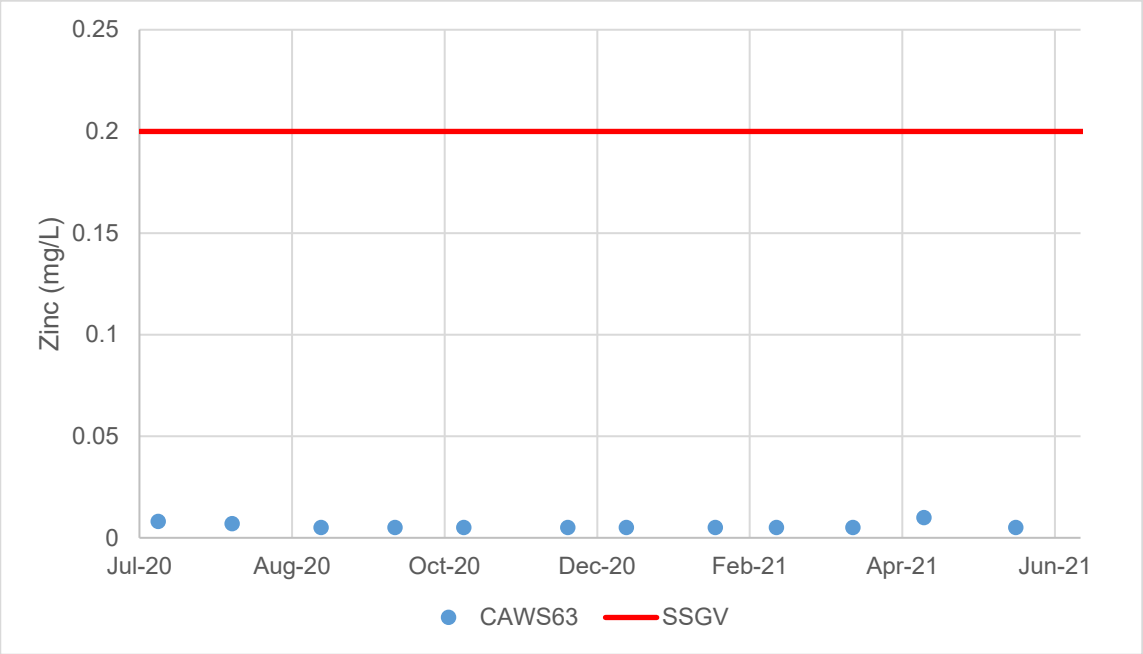
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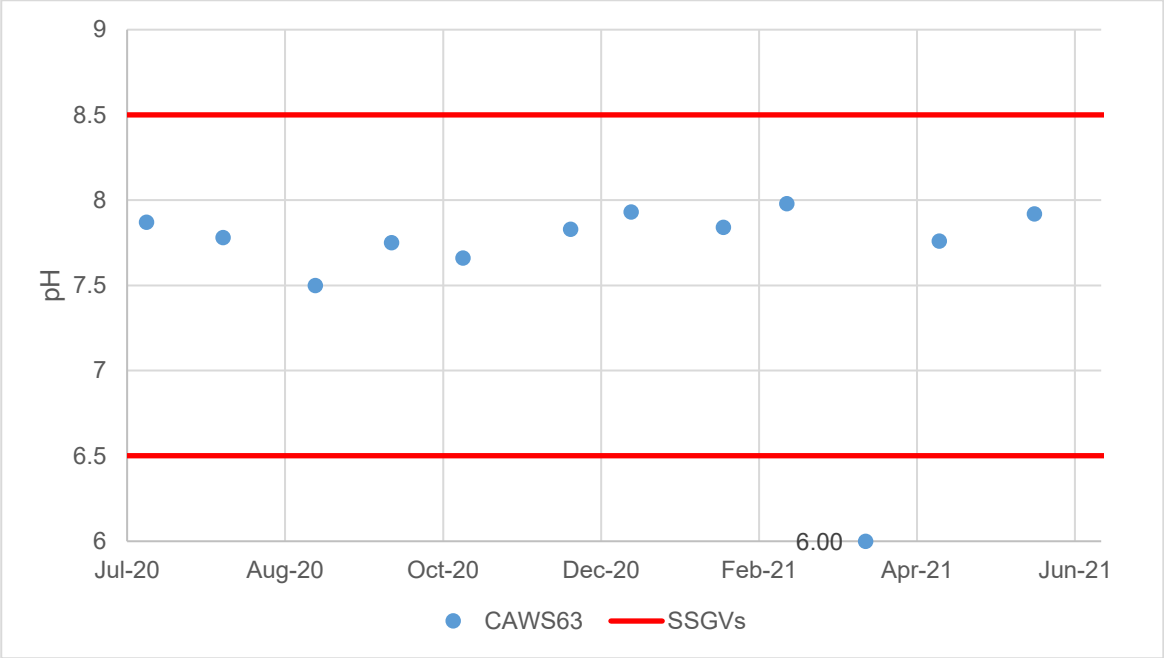
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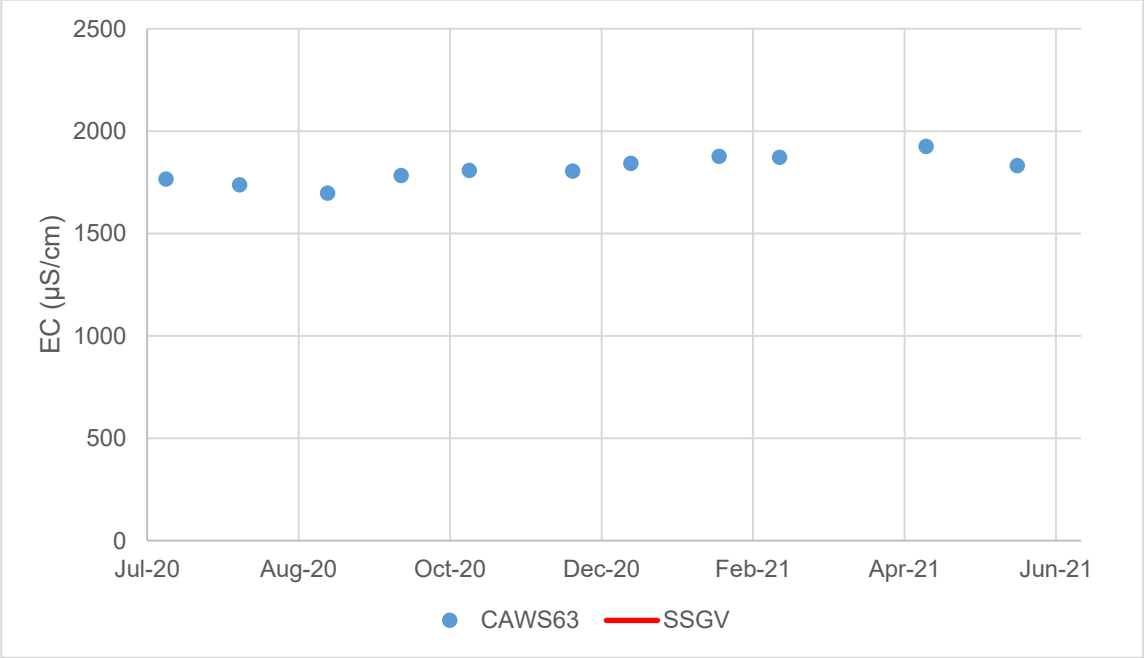
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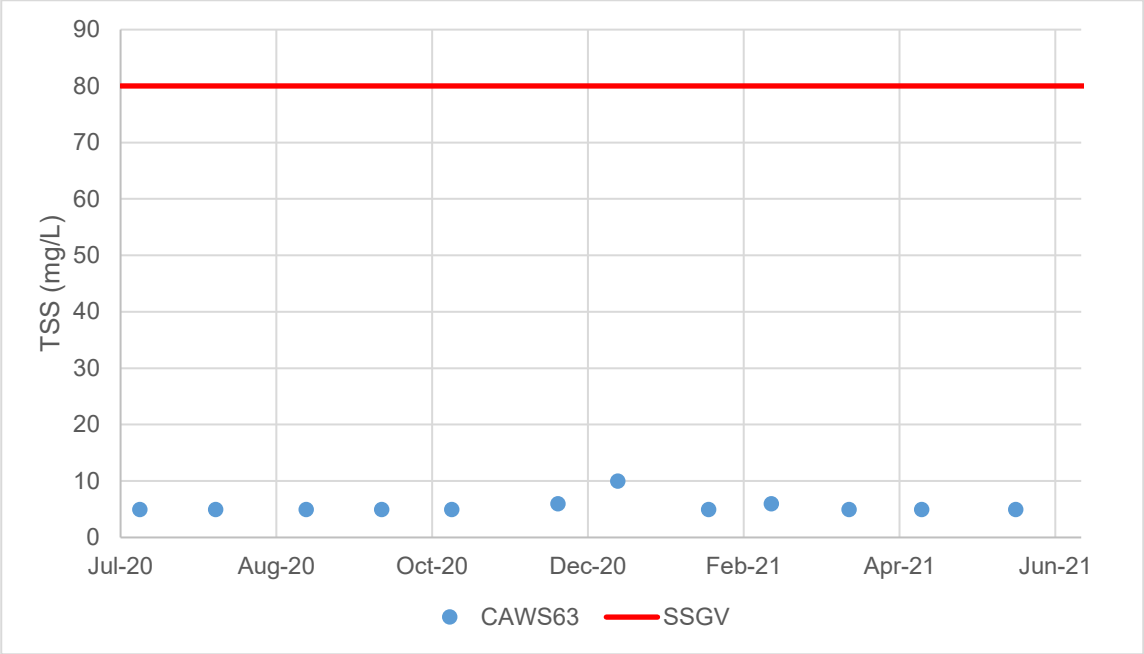
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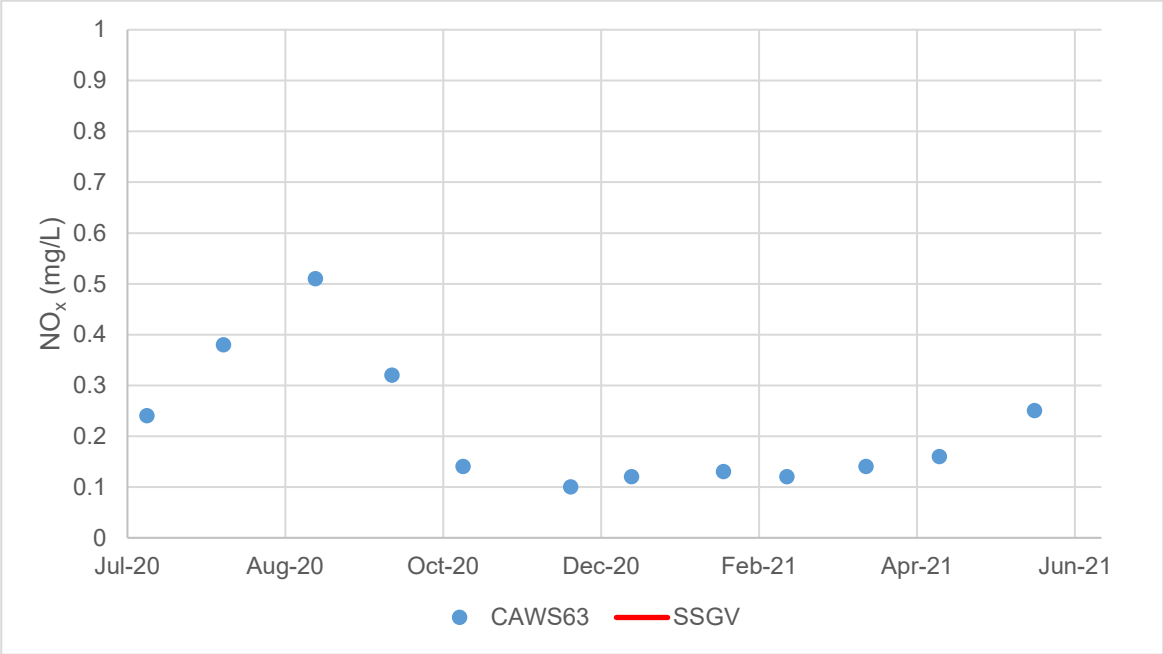
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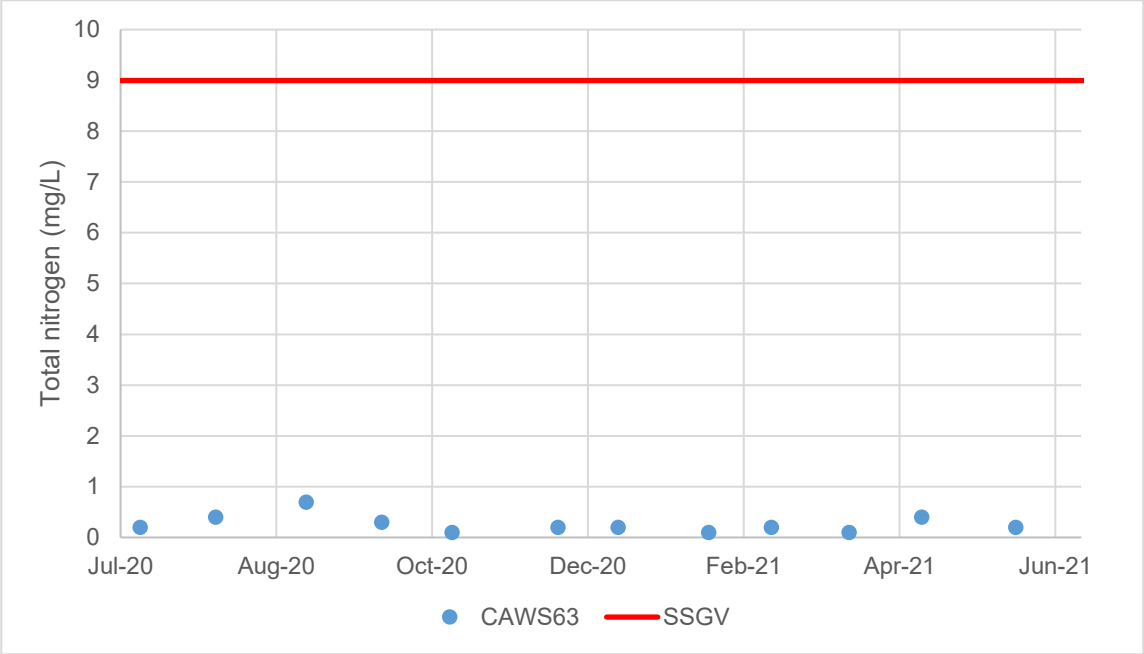
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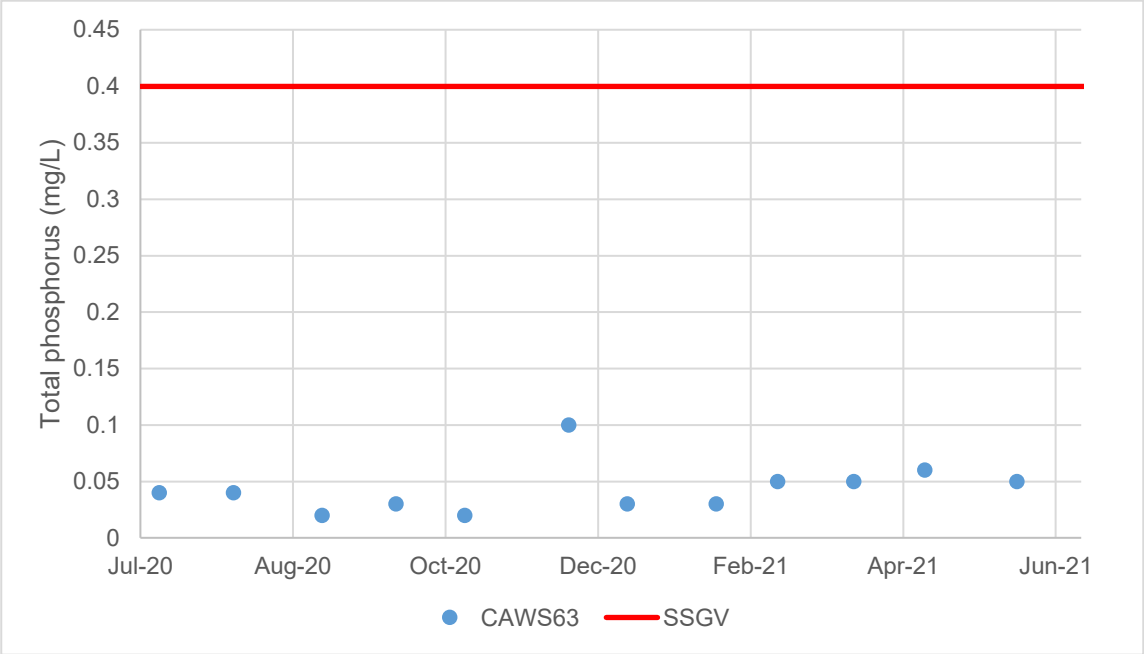
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Jul-20
Aug-20
Oct-20
Dec-20
Feb-21
Apr-21
Jun-21
CAWS63
SSGV

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→ The Power of Commitment

Australasian Groundwater & Environmental Consultants

Report on

Cadia Annual Groundwater Monitoring Review 2020/2021 Water Year

Prepared for
Cadia Holdings Pty Limited

Project No. CAD1383AA.0
August 2021

ageconsultants.com.au

ABN 64 080 238 642

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Australasian Groundwater and Environmental Consultants Pty Ltd

Brisbane Head Office
Level 2/15 Mallon Street
Bowen Hills QLD 4006
t: (07) 3257 2055

Newcastle
4 Hudson Street
Hamilton NSW 2303
t: (02) 4962 2091

Townsville
3/10 Cummins Street
Hyde Park QLD 4812
t: (07) 4413 2020

brisbane@ageconsultants.com.au
ageconsultants.com.au

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Cadia Annual Groundwater Monitoring Review 2020/2021Water Year

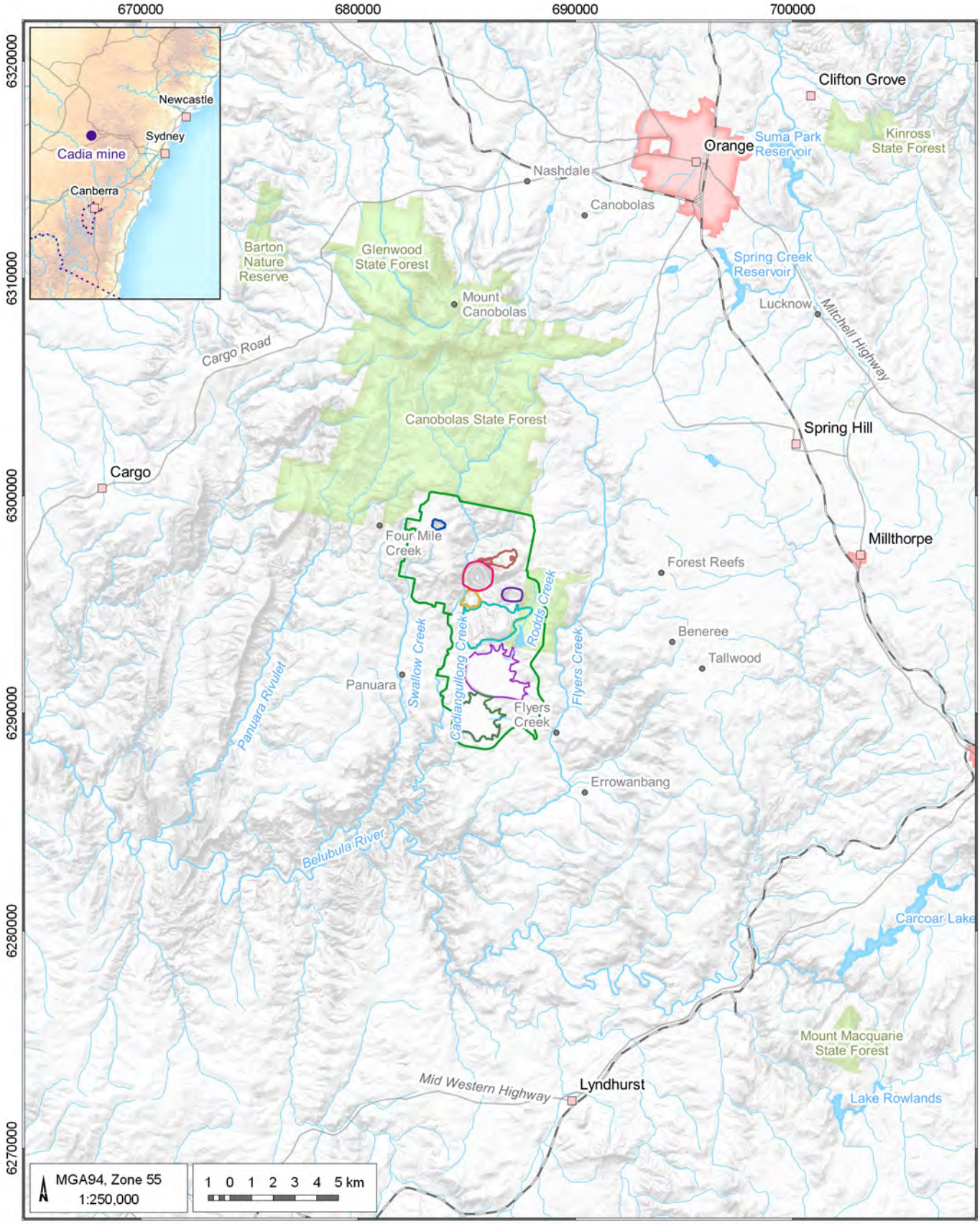
1 Introduction

Cadia Holdings Pty Limited (CHPL) own and operate the gold/copper Cadia Valley Operations (CVO), which is a wholly owned subsidiary of Newcrest Mining Limited (Newcrest). CVO comprises two underground mines, a defunct pit, and processing/waste storage infrastructure. The operations are located approximately 25 km southwest of the city of Orange in central west NSW and about 250 km west of Sydney (Figure 1.1). CHPL operates on six Mining Leases (ML): ML1405, ML1449, ML1472, ML1481, ML1689, and ML1690.

CHPL have engaged Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) to undertake an assessment of groundwater levels and quality at CVO to meet internal and annual reporting requirements as part of project approvals (06_0295) for the 2020/2021 water year. This report presents a review of groundwater monitoring data from the existing groundwater monitoring network to assess for potential impacts to the environment and stakeholders. Historical data is also reviewed to identify long term trends. AGE has prepared this report on the basis of information provided by Newcrest.

As CVO has multiple activities occurring onsite, which have different influences on the groundwater regime, the site has been separated into different operational areas for assessment. These areas include the:

- Cadia Hill Pit, which is currently used for tailings disposal;
- Ridgeway Mine, which has been placed into care and maintenance since March 2016;
- Cadia East Mine, where works are still ongoing and are approved to extract approximately 450 million tonnes (Mt) of ore over a period of 21 years;
- northern and southern tailings storage facilities (NTSF and STSF, respectively);
- southern waste rock dump (SWRD); and
- other areas, which include the ore processing area and regional monitoring bores.



LEGEND

- Cadia Hill Pit
- Cadia East subsidence zone
- Ridgeway cave mine subsidence zone
- Mining lease
- North Waste Rock Dump
- South Waste Rock Dump
- Ore Processing Facilities
- Northern Tailings Storage Facility
- Southern Tailings Storage Facility
- Populated place
- Place name
- Major road
- Rail
- Major drainage
- Minor drainage
- Built up area
- Water area
- Reserve

Cadia AGMR 2020/2021 (G1383AA)

Location of Cadia Valley Operations

AGE

DATE 10/08/2021

FIGURE No: **1.1**

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G:\Projects\G1383AA.Cadia regular data reviews\3_GIS\Workspaces\001_Deliverable1\01.01_G1383AA_Location of Cadia Valley Operations.qgs

2 Approval conditions

2.1 Applicable approval conditions and water management plan

The annual groundwater monitoring review is a requirement of the Project Approval (PA 06_0295) and is specified within CVO's water management plan (Newcrest, 2019). Applicable conditions within PA 06_0295 are:

- Condition 2 of Schedule 5. The annual groundwater monitoring review forms part of the annual environmental management report produced by Cadia Valley Operations.
- Condition 34 in Schedule. Requirement for implementation of a groundwater monitoring program within the site water management plan, as well as a requirement for reporting of the monitoring program results (Condition 34(e)).

Condition 2 of Schedule 5 states the following:

- *'By the end of 2010, and annually thereafter, the Proponent shall review the environmental performance of the project to the satisfaction of the Secretary. This review must:*
  - *describe the works that were carried out in the past year, and the works that are proposed to be carried out* over the next year;
  - include a comprehensive review of the monitoring results and complaints records of the project over the past year, which includes a comparison of these results against the
    - *a) the relevant statutory requirements, limits or performance measures/criteria;*
    - *b) the monitoring results of previous years; and*
    - *c) the relevant predictions in the EA and previous EAs;*
    - *d) identify any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance;*
    - *e) identify any trends in the monitoring data over the life of the project;*
    - *f) identify any discrepancies between the predicted and actual impacts of the project, and analyse the potential cause of any significant discrepancies; and*
    - *g) describe what measures will be implemented over the next year to improve the environmental performance of the project.'*

Schedule 5 Conditions 2 (a),(b), (c), (d), (e), and (f) are discussed in this report.

Condition 34 of the project approval states the following:

- *'The Groundwater Monitoring Program must include:*
  - *a) detailed baseline data, based on sound statistical analysis, to benchmark the pre-mining natural variation in groundwater levels, yield and quality (including privately-owned bores within the maximum predicted 1 metre groundwater drawdown contour, as indicated on the plans in Appendix 5);*
  - *b) groundwater impact assessment criteria (including for monitoring bores and privately-owned bores);*
  - *c) a program to monitor:*
    - impacts on the groundwater supply of potentially affected landowners;
    - impacts on springs and groundwater dependent ecosystems;
    - the volume of groundwater seeping into open pit and underground mine workings;
    - regional groundwater levels and quality in all potentially affected aquifers;
    - potential acid rock drainage;
    - the hydraulic gradient and groundwater quality around the base of the Cadia Hill pit;
    - a program for the ongoing verification and refinement of the groundwater model; and
    - reporting procedures for the results of the monitoring program and model verification.'

It should be noted with respect to Condition 34 (a), that the plans in Appendix 5 presenting modelled groundwater drawdown predictions are currently superseded by more recent numerical modelling (AGE, 2021). These updated modelled plans are discussed further in Section 3.6.6.

The assessment of groundwater monitoring data was undertaken in accordance with the site Water Management Plan (WMP) (Cadia, 2019).

2.2 WMP impact assessment criteria

Impact assessment criteria are used to identify changes in groundwater quality and level, which may indicate potential adverse impacts on the environment because of mining operations. Impact assessment criteria are adopted as site-specific guideline values (SSGVs) which trigger further monitoring, investigations, and if required remedial action.

2.2.1 Groundwater levels

Groundwater levels guidelines from the 2019 WMP (Cadia, 2019) are provided for different operational areas and are presented below in Table 2.1, Table 2.2, and Table 2.3.

Table 2.1 Groundwater level guidelines – Ridgeway area (Table 6-5 of WMP)

Bore	Guideline level	
	Depth to water (m)	Water level (mAHD)
RO6A	36	866
RO6B	70	832
RO7	34	865
RO10A	21	882
RO10B	33	870
RO12	29	893

Table 2.2 Groundwater level guidelines – Cadia East area (table 6-6 of WMP)

Bore ID	Aquifer	Drawdown [1] (m)
RB01	Tertiary Basalt	3
MB43	Silurian Shallow	3
MB44A	Silurian Deep	3
MB44B	Shallow Basalt	3
MB47A	Silurian Limestone	3
MB47B	Silurian Sandstone	3
MB55	Shallow Basalt	3
MB62	Silurian Deep	3
MB71	Deep Basalt	3
MB76	Silurian Deep	3

Note: [1] these Cadia East groundwater level guidelines provide a trigger for drawdown greater than 3 m above what is considered normal climatic variation.

Table 2.3 Groundwater level guidelines – STSF and Western NTSF(Table 6-7 of WMP)

Bore ID	Increase in water level (m) *	Initial water level (mAHD) *	Guideline level (mAHD)
STSF			
MB25	40	679.99	719.99
MB26B	20	631.36	651.36
MB27	5	590.87	595.87
MB28B	40	630.35	670.35
MB29B	10	625.02	635.02
MB77A/B	10	652.70	662.7
MB78	5	653.49	658.49
MB81	10	651.13	661.13
Western NTSF			
MB18	20	698.20	718.2
MB23	40	668.56	708.56
MB24	20	680.83	700.83

Note: * from initial measured level data.

2.2.2 Groundwater quality

Groundwater quality triggers from the 2019 WMP (Cadia, 2019) are provided for different operational areas and are presented below in Table 2.4, Table 2.5, and Table 2.6.

Table 2.4 Cadia East groundwater impact assessment triggers (Table 6-2 of WMP)

Bore	pH (pH units)	TDS (mg/L)	Sulfate (mg/L)	Aluminium (mg/L)	Arsenic (mg/L)	Copper (mg/L)	Lead (mg/L)	Manganese (mg/L)	Nickel (mg/L)	Zinc (mg/L)	Mercury (mg/L)	Nitrite (mg/L)	Nitrate (mg/L)
MB47A	6.5-8.5	600	250	0.2	0.01	1	0.01	0.1	0.02	3	–	3	50
MB62	5.7-8.5	600	250	0.2	0.01	1	0.01	0.1	0.02	3	–	3	50
MB48	6.4-8.5	600	250	0.2	0.01	1	0.01	1.62	0.02	3	–	3	50
MB49	6.5-8.5	600	250	0.2	0.01	1	0.01	0.68	0.02	3	–	3	50
MB53	6.5-8.5	600	250	0.2	0.01	1	0.01	–	0.02	3	–	3	50
MB54	6.1-8.5	600	250	0.7	0.01	1	0.01	0.1	0.02	3	–	3	50
MB56	6.2-8.5	600	250	0.2	0.01	1	0.01	0.1	0.02	3	–	3	50
MB63	5.2-8.5	600	250	0.2	0.01	1	0.01	0.1	0.02	3	–	3	50
MB64	6.5-8.5	600	250	0.2	0.01	1	0.01	–	0.02	3	–	3	50
MB65	6.5-8.5	600	250	0.2	0.01	1	0.01	0.1	0.02	3	–	3	50
MB83	6.5-8.5	600	250	0.2	0.01	1	0.01	0.5	0.02	3	0.001	3	50
MB84	6.5-8.5	600	250	0.2	0.01	1	0.01	0.5	0.02	3	0.001	3	50
MB85	6.5-8.5	600	250	0.2	0.01	1	0.01	0.5	0.02	3	0.001	3	50
MB86	6.5-8.5	600	250	0.2	0.01	1	0.01	0.5	0.02	3	0.001	3	50
MB87	6.5-8.5	600	250	0.2	0.01	1	0.01	0.5	0.02	3	0.001	3	50
MB88	6.5-8.5	600	250	0.2	0.01	1	0.01	0.1	0.02	3	0.001	3	50
MB89	6.5-8.5	600	250	0.2	0.01	1	0.01	0.1	0.02	3	0.001	3	50

Notes: trigger values for metals refer to dissolved concentrations; and

* value greater than drinking or stock water guideline.

Table 2.5 Tailings Storage Facility impact assessment triggers (Table 6-3 of WMP)

Bore	pH (pH units)	TDS (mg/L)	Sulfate (mg/L)	Aluminium (mg/L)	Arsenic (mg/L)	Copper (mg/L)	Lead (mg/L)	Manganese (mg/L)	Nickel (mg/L)	Zinc (mg/L)	Mercury (mg/L)	Nitrite (mg/L)	Nitrate (mg/L)
MB20	6.5-8.5	6910*	3090*	10*	0.5	0.4	0.1	-	1	20	-	33	132
MB21	6.5-8.5	4000	1000	5	0.5	0.4	0.1	-	1	20	-	33	132
MB68	6.5-8.5	4000	1000	5	0.5	0.4	0.1	-	1	20	-	33	132
MB69	6.5-8.5	4000	1000	5	0.01**	0.4	0.01**	0.5**	1	20	0.001**	33	132
MB70	6.5-8.5	4000	1000	5	0.5	0.4	0.1	-	1	20	-	33	132
MB77A	6.5-8.5	4000	1000	5	0.5	0.4	0.1	-	1	20	-	33	132
MB77B	6.5-8.5	4000	1000	5	0.5	0.4	0.1	-	1	20	-	33	132
MB78	6.5-8.5	4000	1000	5	0.01**	0.4	0.01**	0.5**	1	20	0.001**	33	132
MB79	6.5-8.5	2000	1000	5	0.01**	0.4 (sheep); 0.1 (cattle)	0.01**	0.5**	1	20	0.001**	9.1	90.3

Notes: trigger values for metals refer to dissolved concentrations;

* value greater than drinking or stock water guideline; and

** value is recommended by DPI Water Letter dated 7 February 2017 (Ref: OUT17/6198).

Table 2.6 Pit TSF groundwater quality triggers for proposed bores (Table 6-4 of WMP)

Bore	pH (pH units)	TDS (mg/L)	Sulfate (mg/L)	Aluminium (mg/L)	Manganese (mg/L)	Nickel (mg/L)	Zinc (mg/L)	Nitrite (mg/L)	Nitrate (mg/L)	Arsenic (mg/L)	Copper (mg/L)	Lead (mg/L)	Mercury (mg/L)
MB91, MB92, MB93, MB94 [4], MB95, MB96 [4], MB97 [4]	6.5-8.5 [1]	4000[1]	1000[1]	5[1]	0.5[1]	0.02[1]	20[1]	33[1]	132[1]	0.01[2]	0.4[2]	0.01[2]	0.001[2]

Notes: [1] ANZECC/ARMCANZ (2000) Guidelines (Livestock);

[2] value is recommended by DPI Water Letter dated 2 May 2017 (Ref: OUT17/17244); and

[4] proposed bores – to be drilled during 2019-20.

3 Environmental setting

3.1 Climate

The climate is temperate, with warm to hot summers and cold winters. There are occasional snowfalls, particularly at Mount Canobolas that rises to around 1,400 mAHD.

Rainfall is distributed fairly evenly throughout the year averaging approximately 860 mm/year at the Orange Agricultural Institute (Station No. 063254). The Institute is located about 14 km to the northeast of the Cadia Hill Mine, at an elevation of 922 mAHD. Rainfall is controlled by topography and generally reduces as the land elevation decreases to the south towards the Belubula River. The average annual evaporation rate is 1,394 mm/year, and this exceeds rainfall for eight months of the year from September through to April.

The total rainfall recorded at Station No. 063254 during the annual reporting period is 1117 mm which is 36.9% more rain than the long-term 30 year average of 860 mm. The Cumulative Rainfall Departure (CRD) is a graphical means of presenting long-term trends in rainfall. Figure 3.1 presents a plot of annual rainfall data collected at the Orange Agricultural Institute and the CRD trend since 1990. On the CRD plot a rising slope indicates above average rainfall, while a falling slope indicates below average rainfall. CRD trends on Figure 3.1 indicate prolonged periods of below average rainfall between 2002 to 2010, 2012 to 2016, and more recently 2017 into early 2020. Periods of above average rainfall have occurred between 1998 to 2002, 2010 to 2012, 2016 and recently since 2020.

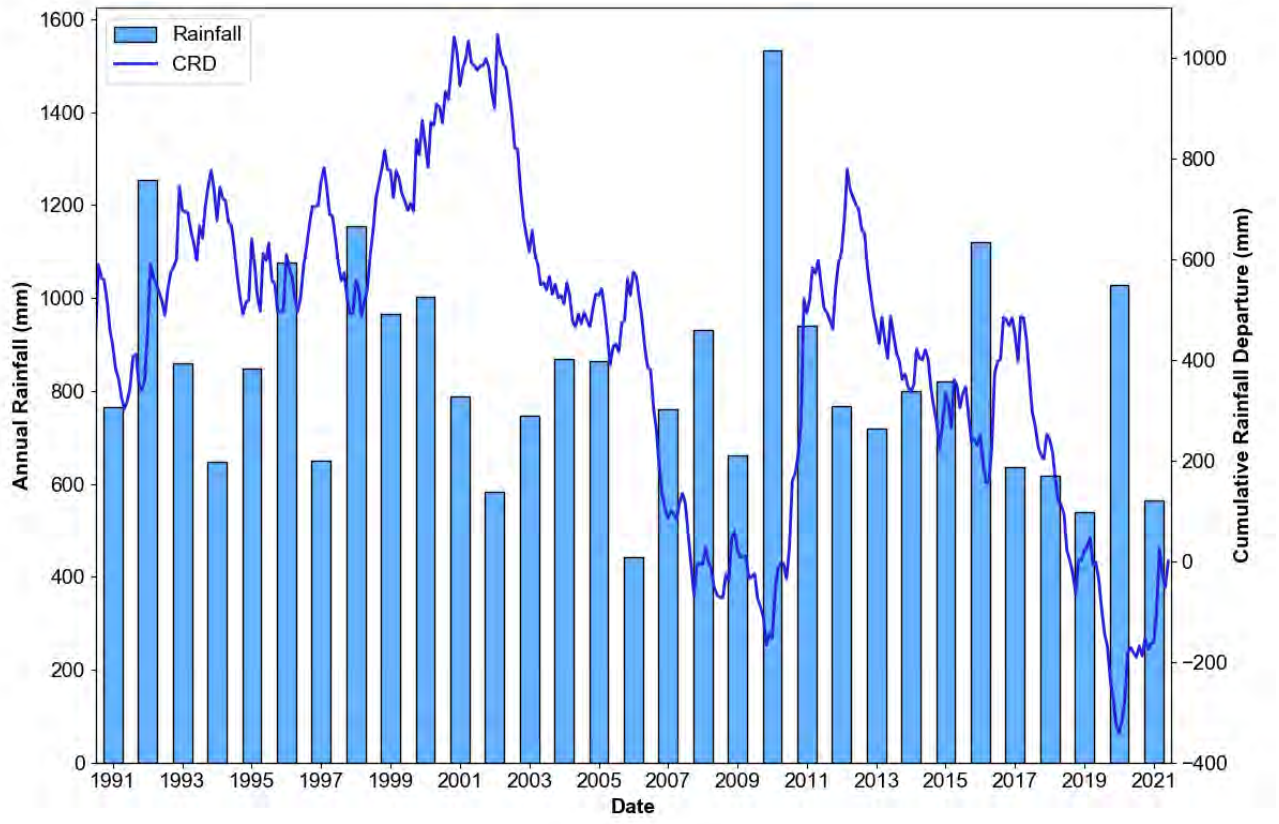


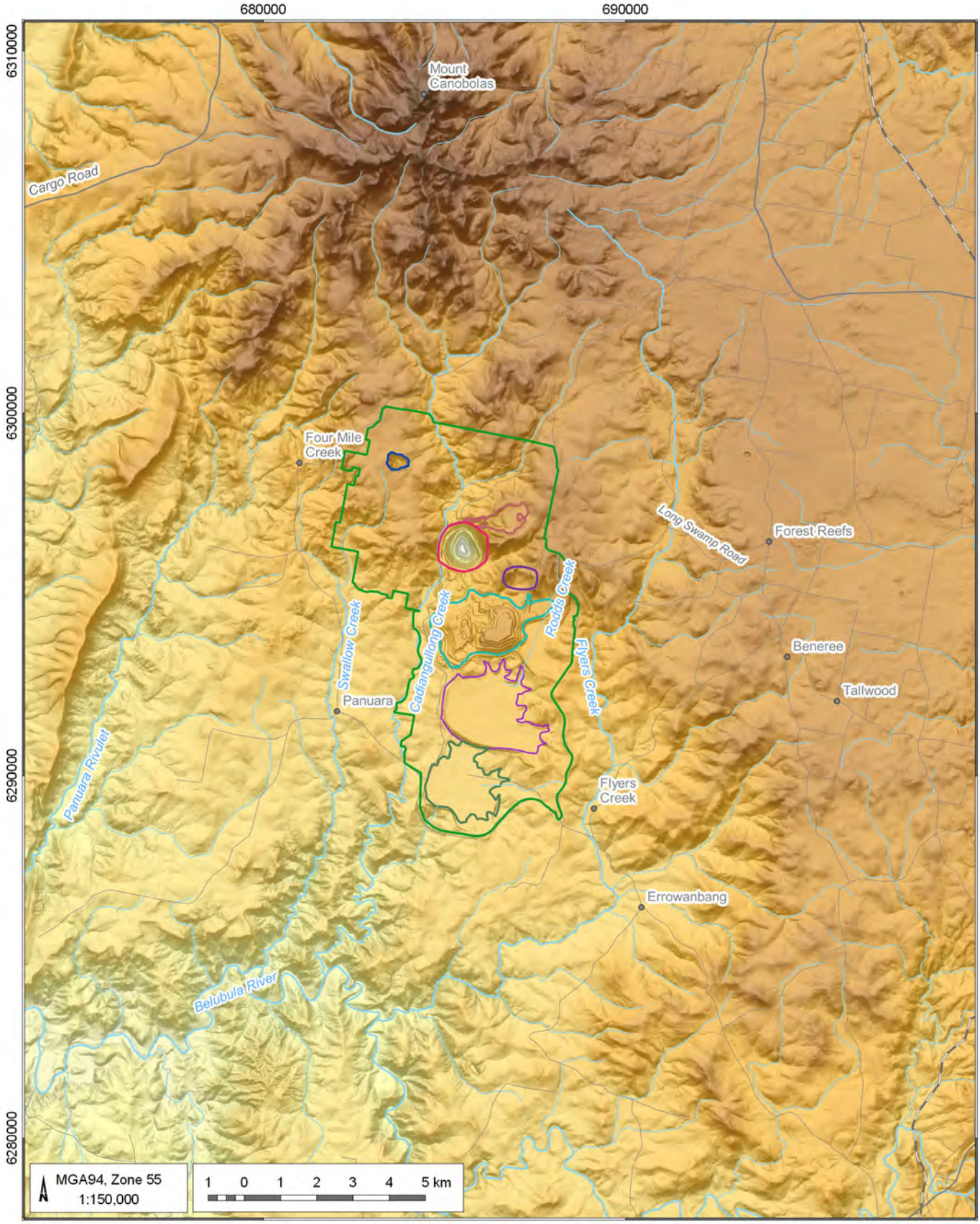
Figure 3.1 Cumulative rainfall departure and annual rainfall quantities (source Orange Agricultural Institute)

3.2 Terrain and drainage

The most significant natural topographic feature of CVO is the Cadia Valley, which runs in a north-south orientation, between a series of rolling hills that form ridgelines to the east and west of Cadiangullong Creek (Figure 3.2). The local terrain within the CVO mining leases falls from approximately 1,000 mAHD at the northern boundary, down to approximately 600 mAHD on the southern boundary. Further to the south, the Cadia Valley opens out to gently undulating land (Figure 3.2).

Cadiangullong Creek is the major watercourse in the Cadia Valley. Local tributaries of Cadiangullong Creek include Cadia Creek, Hoares Creek, Copper Gully Creek, and Rodds Creek. Other watercourses near CVO include Swallow Creek and Flyers Creek, which are respectively located to the west and east of mining operations. Cadiangullong Creek, Swallow Creek and Flyers Creek flow generally north to south, before joining the Belubula River.

Many of these creeks and their tributaries are naturally ephemeral and show no measurable flow during extended dry periods. The exception is Flyers Creek, which is likely perennial downstream of Long Swamp Road due to baseflow contributions from groundwater fed springs. Riparian flows in Cadiangullong Creek are maintained by CVO via a low-flow release protocol from the Cadiangullong Dam.



LEGEND

- Populated place
- Place name
- Major road
- Rail
- Major drainage
- Minor drainage
- Cadia Hill Pit
- Cadia East subsidence zone
- Ridgeway cave mine subsidence zone
- Mining lease
- North Waste Rock Dump
- Ore Processing Facilities
- South Waste Rock Dump
- Northern Tailings Storage Facility
- Southern Tailings Storage Facility

Elevation (mAHD)

- 200
- 500
- 800
- 1000
- 1200
- 1400

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Terrain and drainage

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FIGURE No: **3.2**

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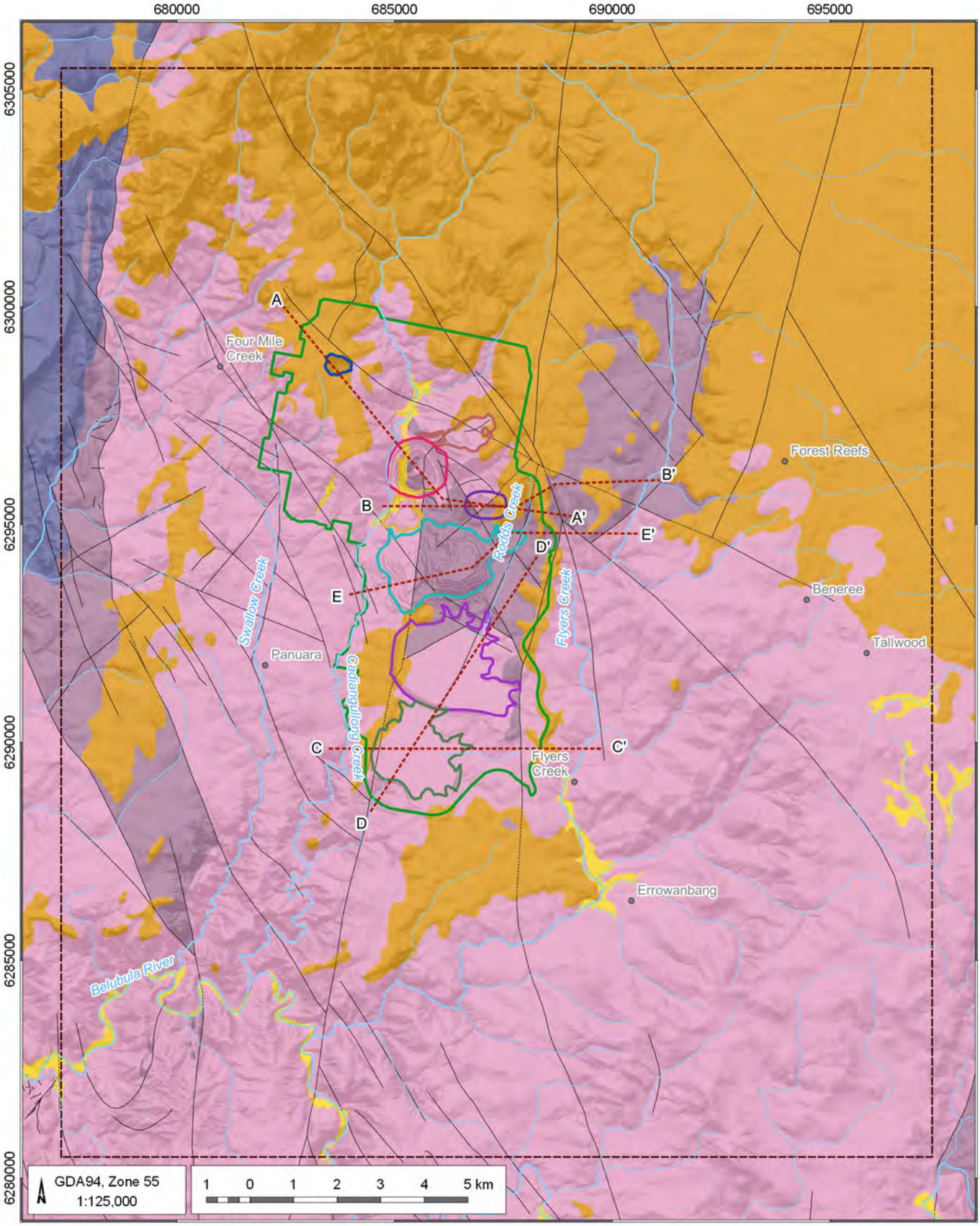
3.3 Geology

CVO is located within the eastern Lachlan Fold Belt, where northerly trending volcanic and sedimentary belts have experienced several episodes of intrusive volcanism. Regional mapping (Figure 3.3) shows that surface geology of the local area is primarily comprised of sedimentary turbidites and volcanic/volcaniclastic units, which are Ordovician, Silurian or Devonian in age. These geological units are overlain by younger Tertiary aged basalt flows, largely to the north of CVO, and more recent Quaternary alluvium which generally occurs along drainage lines. The gold/copper porphyry deposit at Cadia is associated with monzonite intrusives, accompanied by low grade alteration within Ordovician host rocks.

Within the Lachlan Fold Belt, the dominant regional structure consists of a series of roughly north striking faults and splays. These faults were caused by several tectonic events that occurred between the Ordovician and the Carboniferous Periods, with deformation generally driven by east-west crustal shortening (Washburn, 2008).



LEGEND

- Place name
- Drainage
- Fault lineaments
- Fault lineaments beneath Tertiary cover
- Hydrogeology section lines
- Mining lease
- Cadia Hill Pit
- Cadia East subsidence zone
- Ridgeway cave mine subsidence zone
- Numerical model extent

Surface geological age

- Quaternary
- Tertiary
- Devonian
- Silurian
- Ordovician

- North Waste Rock Dump
- Ore Processing Facilities
- South Waste Rock Dump
- Northern Tailings Storage Facility
- Southern Tailings Storage Facility

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Regional geology plan

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FIGURE No: **3.3**

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Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
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3.3.1 Geological units

3.3.1.1 Alluvium

The alluvium generally comprises clays, sands and some gravels deposited by meandering fluvial systems that are generally well incised. Alluvial deposits are generally less than 5 m thick along the creeks in the Cadia region. Creeks are commonly incised into the bedrock with alluvium largely absent. The thickness of alluvium is known to be greater along the Belubula River south of Cadia.

3.3.1.2 Tertiary basalt

The Tertiary basalt originated from numerous extrusive episodes from Mount Canobolas and surrounding volcanic vents, covering an area of about 530 square kilometres (km^2). The nature of the basalt varies from relatively massive to vesicular (scoriaceous). Ash or clay layers may be present between successive basalt flows, which reflect periods of dormancy between flows. The Tertiary basalt thickness is dependent on the topography of the underlying land surface, with the basalt being thickest along paleochannels. Pogson and Watkins (1998) indicate that the thickness of the Tertiary basalt varies from a few metres to over 150 m. In the Cadia area, the Tertiary basalt cover is predominantly to the north/northeast of the Cadia mine, but also outcrops along elevated ridgelines adjacent to both the NTSF and the STSF.

3.3.1.3 Silurian sediments

The Silurian sediments proximal to CVO are low energy shallow to deep water sediments that were deposited in the early Silurian period (430 to 400 million years ago). The Silurian rocks that occur at Cadia Hill (and to the east) are overlain by Tertiary basalt flows. In the Cadia Valley area, the Silurian aged Waugoola Group is present, which is predominantly comprised of siltstones and sandstones, with minor conglomerate and calcirudite (limestone) layers at the base. The unit represents fluctuating transgressive/regressive marine depositional conditions. The Waugoola Group unconformably overlies the Ordovician rocks.

The southern and western extent of the Silurian sediments is marked by a faulted contact with Ordovician volcanics and has been well defined by exploration drilling. To the north and east, the Silurian sediments are overlain by the Tertiary basalt and the extent of the formation in this area is not well known as limited exploration drilling has been undertaken in this area.

Exploration drilling above the Cadia East orebody has typically intersected between 100 m and 300 m of Silurian sediments, with an average thickness of approximately 100 m. The exception is a single exploration drill hole (NC599) that intersected about 1,000 m of Silurian sediments overlying Ordovician volcaniclastics. Drill hole NC599 indicates the presence of a substantial Silurian basin northeast of the Cadia East mine.

3.3.1.4 Late Ordovician intrusives

The Cadia Intrusive Complex (CIC) intrudes the Weemalla Formation and the Forest Reefs Volcanics during the late Ordovician. The intrusions range in composition from monzodiorite, diorite, and minor gabbro, to quartz monzonite (Washburn, 2009).

3.3.1.5 Ordovician volcaniclastics and other sedimentary units

The Ordovician units in the region comprise the Forest Reef Volcanics that conformably overly the Weemalla Formation. The Ordovician rocks are generally exposed at surface around CVO, except where there are overlying Silurian sediments and/or Tertiary basalt. The Forest Reefs Volcanics are prevalent in the area and host the Cadia orebodies. The Forest Reef Volcanics are dominated by volcaniclastic lithologies, which comprise lithic conglomerates, breccias, sandstones, and lesser siliceous siltstone. Exploration drilling works have investigated the Forest Reefs Volcanics to a vertical depth of approximately 1,800 m, although the total thickness of the sequence is not known.

The Weemalla Formation comprises turbidite sediments that consist of fine grained and thinly laminated, carbonaceous to volcanic siltstones, with minor arenaceous volcanic beds, including pillow basalts.

3.3.2 Geological structure

Within the Lachlan Fold Belt, the dominant regional structures are a series of roughly north striking reverse faults and related splays. These reverse faults are moderately to steeply dipping to the west, curviplanar, and commonly have a strike slip component. These faults were caused by several tectonic events that occurred between the Ordovician and the Carboniferous Periods, with deformation generally driven by east-west crustal shortening (Washburn, 2008).

Major regional faults include the north striking Werribee Fault (known as the Cadiangullong Fault in the Cadia area) and the Warrengong Fault, which is located approximately 1 km east of the Cadia East Mine. The north to north-northeast trending Cadiangullong Fault is inferred to underly the western margin of the STSF and slightly to the west of the NTSF, within the Ordovician aged Forest Reef volcanoclastic rocks. The Cadiangullong Fault extends north between the waste rock dump and Cadiangullong Creek within the Ordovician Weemalla Formation, before skirting the western side of the Cadia Hill Pit. The fault has a westerly dipping thrust with a strike-slip component and truncates several north-northwest trending faults. The structure has a damage zone noted up to 200 m to 400 m wide, with a vertical offset of about 300 m (KCB, 2019).

Mapping of faults to the north of the Cadia East workings shows a series of carbonate faults which appear to be of late Devonian age and are related to the Gibb Fault. The faults are dipping to the southwest and intersect the Cadia East workings.

3.4 Land use

The Cadia Valley is characterised by cleared open grassland, scattered remnant native vegetation and State Forest Monterey Pine (Pinus radiata) plantations. Land use in the vicinity of the Cadia Valley is dominated by sheep and cattle grazing in flat areas, and private and state forestry operations on poorer soil and steeper slopes. The Canobolas State Forest is located to the east and north of the mine. Within the mining leases, the main land use is mining and associated activities (e.g. ore processing, waste rock management, and tailings deposition). The Forestry Corporation of NSW conducts forestry operations at the Canobolas State Forest with periodic harvesting/thinning campaigns likely to continue over the life of mining activities. Pine plantations are typical within the Canobolas State Forest and are predominately comprised of Radiata Pine trees.

3.5 Mining and tailings deposition history

CVO comprises one open cut mine (the Cadia Hill Pit) and two underground mines (the Ridgeway and Cadia East mines). Mining commenced at the Cadia Hill Pit in 1998, with the pit closing in mid-2012. The Ridgeway Mine opened in 2001 using the sub-level caving (SLC) mining method and operated until 2010. The Ridgeway Deeps Mine commenced in 2009 using cave mining and involves the continuous dewatering of the underground workings after the end of mining in 2016. Mining at the Cadia East Mine commenced in late 2012 using panel cave mining methods. Construction of the NTSF and the STSF was completed in May 1998 and November 2001 respectively, and tailings emplacement within the Cadia Hill Pit commenced in May 2018. All three of the tailing storage facilities are still active, with both the NTSF and STSF having a number of embankment raises since their initial construction. A summary of mining and tailings deposition dates are presented below in Table 3.1.

Table 3.1 Mining and tailings deposition summary – CVO

Mine/TSF	Start date	End date	Mining method
Cadia Hill	1998	2012	Open cut
Cadia Hill Extended	2003	2004	Open cut
Ridgeway	2001	2010	Sub-level caving
Ridgeway Deeps	2009	2016	Cave mining (with continuous dewatering)
Cadia East	2012	Ongoing	Cave mining with continuous dewatering
NTSF	1998	Ongoing	-
STSF	2002	Ongoing	-
Cadia Hill tailings	2018	Ongoing	-

3.6 Hydrogeology

3.6.1 Conceptual groundwater model

The geological units described previously can be grouped into the following hydrostratigraphic units based on their ability to store and transmit groundwater:

- **Quaternary alluvium** - forms minor saturated porous systems that are limited to major drainage lines, although of limited extent, thin, and of variable permeability;
- **Tertiary basalt flows** - variable permeability unit that forms fractured aquifer systems or aquitards;
- **Silurian sediments** - generally fine grained and forms low permeability aquitards, except in zones of fracturing where permeability (and storage) is enhanced; and
- **Ordovician volcanics and intrusives** - rock matrix has inherently low permeability and forms competent aquitards, except in zones of fracturing where permeability is enhanced.

The main aquifers in the Cadia region are within fractured systems of the Tertiary basalt and structural zones in the underlying Silurian and Ordovician rocks. The extent of the fractured aquifer system is highly uncertain and is dependent on the connectivity of fracture networks, as well as the occurrence of chemical precipitates or clay infill restricting groundwater flow. The transmission of groundwater within these fractured systems may be enhanced in the weathered zone and restricted at depth, due to a combination of rock mass loading (which reduces fracture apertures) and an absence of weathering.

Perched groundwater systems may form at the interface between weathered and fractured units (including Silurian/Ordovician rocks and Tertiary basalt), which overly fresh massive rock. These systems will drain downslope and emanate as surface seepage typically within creek lines or topographic breaks of slope.

The CVO hydrogeological conceptualisation is supported by hydrogeological cross section A – A' (Figure 3.4) and cross-sections provided in Section 4. Cross section A – A' extends from west of the Ridgeway Mine to the southeast/east through Cadia Hill Pit, Cadia East Mine, and to Flyers Creek. Cross section alignments are shown on Figure 3.3.

3.6.2 Hydrostratigraphic units description

3.6.2.1 Quaternary alluvium

The Quaternary alluvium in the Cadia area generally occurs above the water table, due to its limited thickness (typically less than 5 m along creeks). Alluvium along creeks (i.e. Cadiangullong Creek) may be temporarily saturated in places where there is baseflow from weathered rock, especially during wetter periods. There are some locations along drainage lines where permanent baseflow contributions from adjacent units report to the alluvial sediments, such as parts of Flyers Creek for example. The saturated thickness of these alluvial systems is very thin, and typically they are not very laterally extensive. Anecdotal evidence suggests most of the Quaternary alluvium consists of silty/clayey sediments of low permeability. Therefore, the alluvium along creeks form only minor aquifers. The nearest alluvial system of significance is most likely the Belubula River, which is located to the south of CVO. The Quaternary alluvium is not known to form a significant groundwater resource locally.

3.6.2.2 Tertiary basalt

The Tertiary basalt hosts the Orange Basalt fractured rock aquifer. The nature of the basalt varies spatially from relatively massive and low yielding, to vesicular (scoriaceous) and highly transmissive. The presence of fracturing that is associated with magma cooling is highly variable. Contacts between lava flows may form preferential groundwater flow paths, due to weathering and the presence of porous paleo-sediments. The basalt aquifers are generally unconfined at shallow depths, although may be semi-confined at deeper depths because of poor vertical connectivity between layers of low permeability (e.g. massive basalt, clay, or ash). Vertical connectivity with underlying Silurian/Ordovician units is generally limited due to the low permeability of these units (see discussion below). As such, the effect of mining induced depressurisation in the lower units is dampened in the overlying basalt, particularly when accounting for the higher rate of recharge in the basalt relative to the Silurian/Ordovician units . However, vertical connectivity is likely enhanced where the Tertiary basalt overlies fractured or weathered Silurian/Ordovician units, due to locally enhanced permeability.

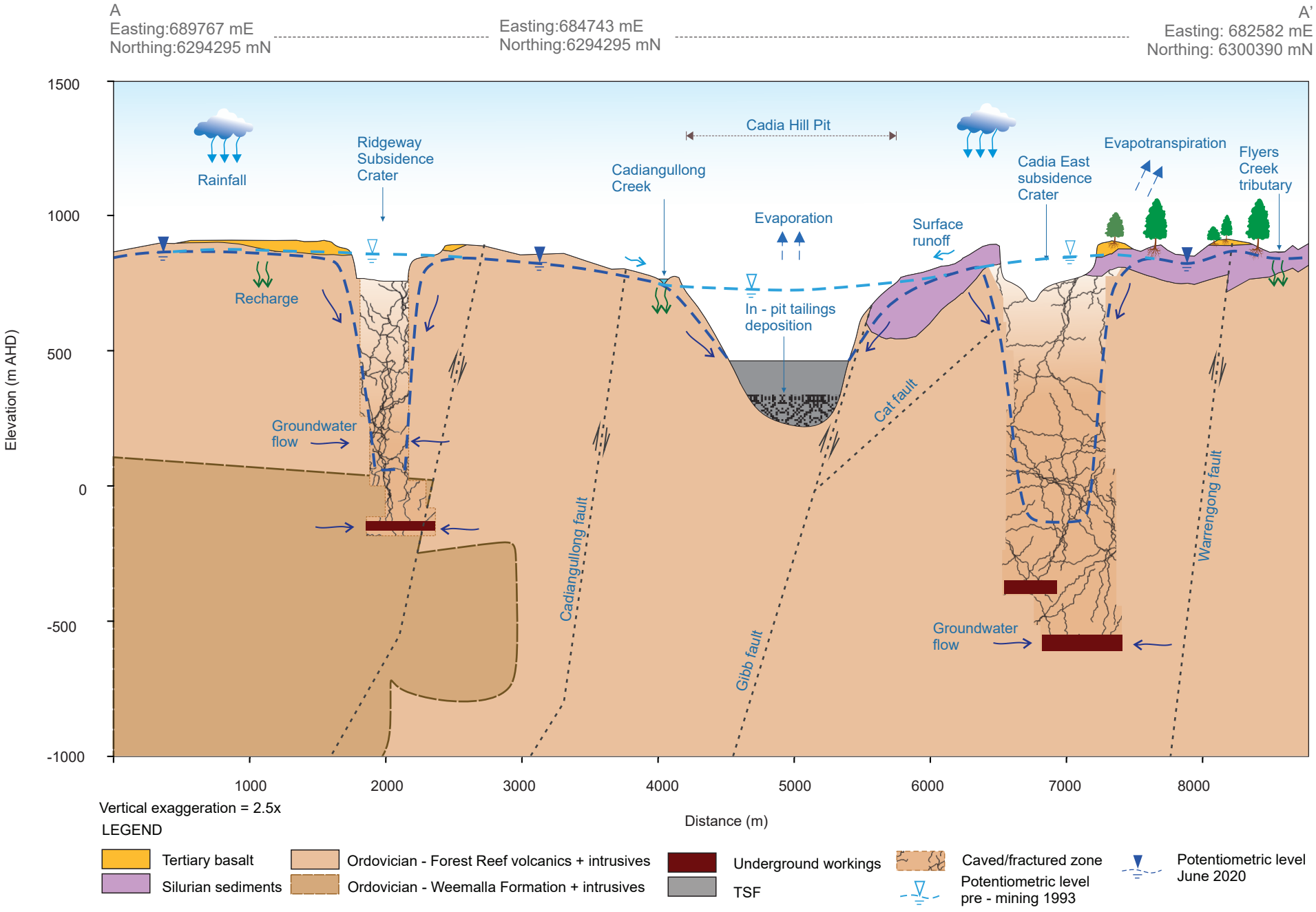
3.6.2.3 Silurian sediments

The Silurian sediments are largely fine grained rocks that were formed in a low energy environment. The rock mass is inherently of low permeability and of very low primary porosity, which generally forms an effective aquitard. Groundwater flow within the Silurian sediments is primarily due to secondary porosity induced by fracturing and weathering.

In zones of fracturing and within karstic zones of the basal limestone unit, the permeability and effective porosity of the Silurian sediments can be enhanced locally. Karstic conditions may be associated with geological structures such as faults, although these features are not pervasive throughout the limestone. In areas of massive limestone, the permeability is generally low. Where karstic conditions have been intercepted during mine development, high initial inflows have been recorded. Groundwater inflows have typically waned shortly afterwards, as the storage is depleted from the fractures or karstic voids. Airlift yields of bores are typically less than 1 L/s but may range up to 12 L/s in fractured rock.

3.6.2.4 Ordovician units

Like the Silurian sediments, the Ordovician rock mass is inherently of low permeability and of very low primary porosity. In general, the unit therefore forms a competent aquitard. Groundwater flow is primarily due to secondary porosity that is induced by fracturing and weathering. In zones of fracturing the permeability and effective porosity is enhanced. Airlift yields of bores are typically less than 1 L/s. Initial airlift yields of bores in fractured zones can in some instances be relatively high (> 15 L/s), although these rates typically diminish in the short term (a couple of hours), as the available storage within fractured zones is generally poor.



CVO conceptual cross section (A - A')

Figure - 3.4

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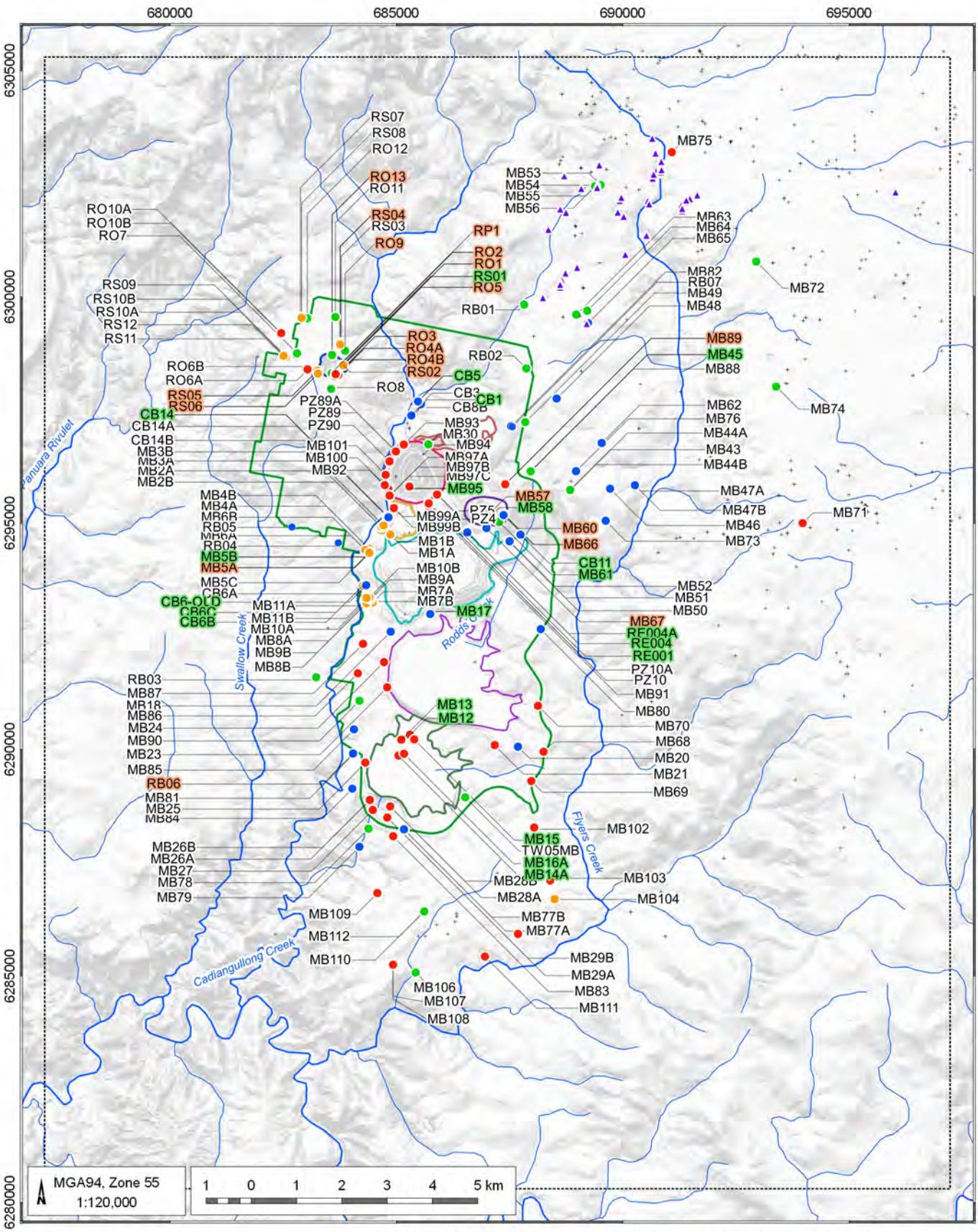
3.6.3 Groundwater monitoring network

The CVO monitoring bore network has continuously expanded over time, and currently there are approximately 150 groundwater bores active within and surrounding CVO. There are a number of bores that have been decommissioned or abandoned due to mine site operations or bore blockages. Figure 3.5 shows the location of active and decommissioned/abandoned bores, including the screened geological units for each of the bores. Note that screened geology is presented as per the CVO environmental database. A review of geological mapping and modelling, which was completed as part of the AGE (2021) model update, identified a number of bores where the CVO environmental database/WMP defined screened interval is likely incorrect. Likely errors are detailed in Appendix A and amendment of the environmental database/WMP should be considered.



LEGEND

- Drainage
- Cadia Hill Pit
- Cadia East subsidence zone
- Ridgeway cave mine subsidence zone
- Rodds Creek dam
- Mining lease
- Model boundary
- North Waste Rock Dump
- Ore Processing Facilities
- South Waste Rock Dump
- Northern Tailings Storage Facility
- Southern Tailings Storage Facility

- Private landholder bores
- Springs
- Ordovician Volcanics
- Silurian Sediments
- Soil/Clay
- Tertiary Basalt

NOTE:
"MB83" - Active bore
"MB16A" - Decomissioned
"MB60" - Abandoned

NOTE:
Cadia geological units assigned to monitoring bores is from the CVO Environmental database

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Monitoring bore network

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FIGURE No: **3.5**

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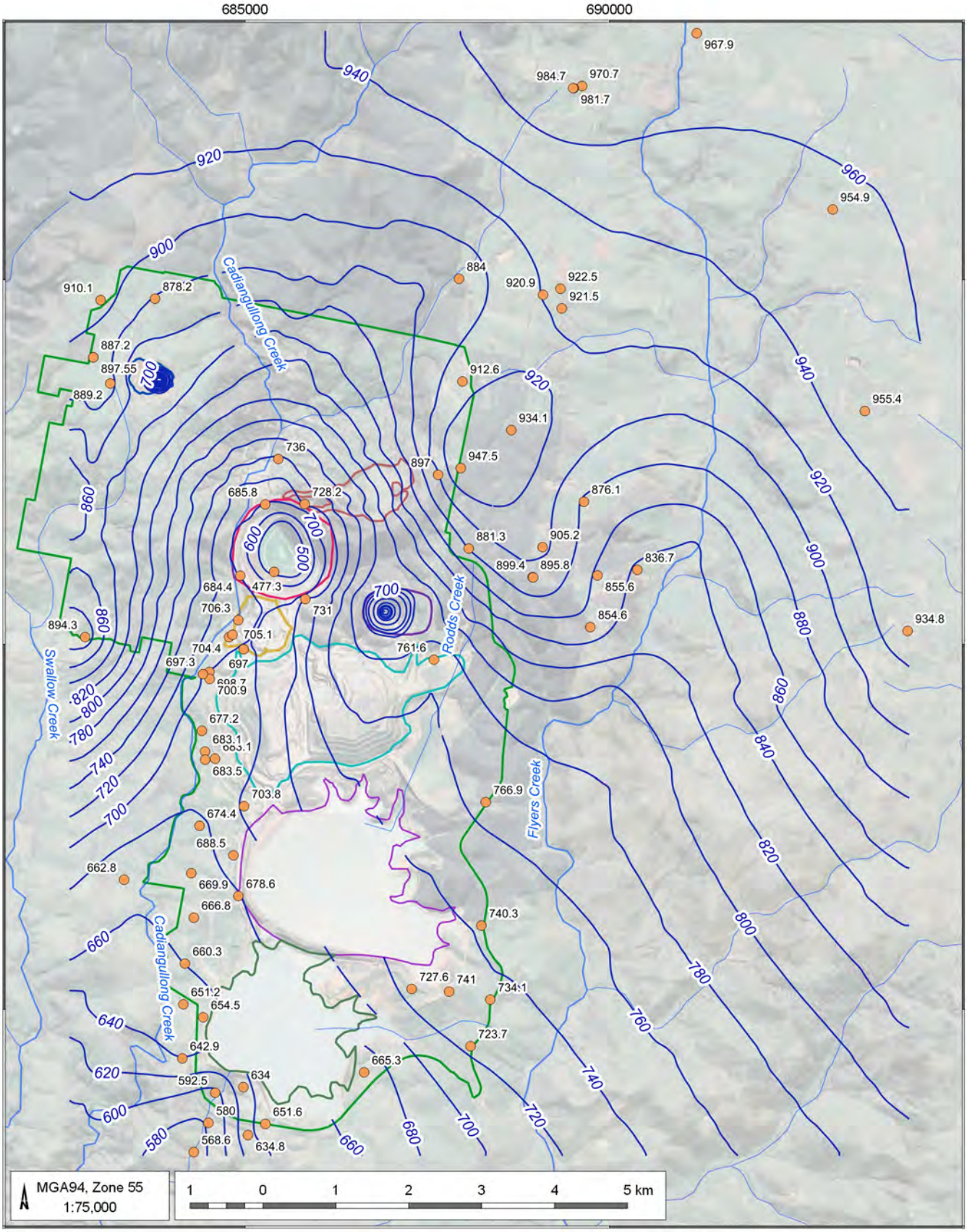
3.6.4 Groundwater levels and flow

The pre-mining characteristics of the groundwater system in the Cadia Valley were described in the Cadia Hill Pit environmental impact statement (Newcrest, 1995) as follows:

- the water table generally mimics the topography of the valley;
- groundwater flows are generally toward the southwest;
- a significant groundwater table high (> 915 mAHD) occurs under the Cadia Hill and Canobolas State Forest areas;
- steep hydraulic gradients exist in the north and east, becoming gentler towards the south and west (reflecting topographic contrast); and
- the groundwater flow patterns are strongly controlled by the major catchments in the Cadia Valley area, particularly Cadiangullong Creek and to a lesser extent Rodds Creek/Cadia Creek.

Relatively recent groundwater levels and contours generated from bore observation data are presented for June 2020 in Figure 3.6. The contours were generated using available groundwater level data and where appropriate, water levels of major creek lines, floor or tailings levels of the Cadia Hill Pit, and floor levels of the Ridgeway/Cadia East mines. The piezometric surface on a regional scale has been relatively stable over time, with the exception of the steep zone of depressurisation that has developed locally around the Cadia Hill Pit and the Ridgeway/Cadia East mines. The groundwater contours beneath TSF infrastructure and waste rock dumps are approximations, as there is limited groundwater monitoring conducted in these areas.



LEGEND

- Drainage
- Cadia Hill Pit
- Cadia East subsidence zone
- Ridgeway cave mine subsidence zone
- Mining lease
- Rodds Creek dam
- Ore Processing Facilities
- North Waste Rock Dump
- South Waste Rock Dump
- Northern Tailings Storage Facility
- Southern Tailings Storage Facility
- Cadia monitoring bores
- Groundwater level contours (mAHD)

Cadia AGMR 2020/2021 (G1383AA)

June 2020 - Interpreted water table elevation and contours

AGE

DATE 20/08/2021

FIGURE No: **3.6**

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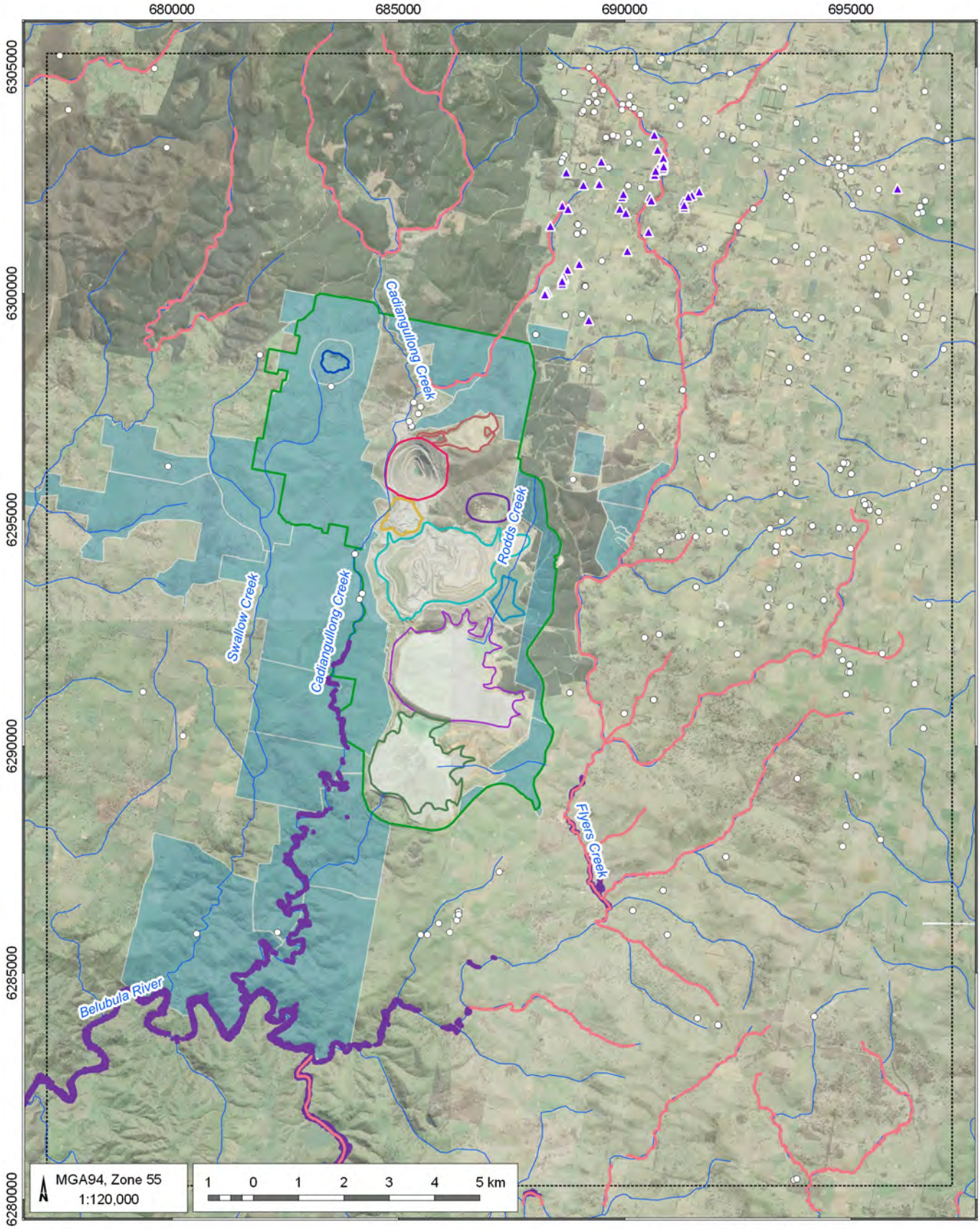
3.6.5 Groundwater dependent assets

Groundwater dependant assets includes private water supply bores, springs, creeks and streams with a reliance on groundwater baseflow, and groundwater dependant ecosystems.

There are over 250 private bores within 10 km of CVO, with the majority of the bores present to the east/northeast and screened within the Tertiary basalt (Figure 3.7).

Mapped springs (Figure 3.7) are present in the upper headwaters of Cadia and Flyers Creeks as discharge from the Tertiary basalt, Tertiary paleochannel sediments, or fractured Silurian sediments. These springs provide a source of water on farms, with water diverted into storage dams. Baseflow in Flyers Creek, which is likely perennial, is partially maintained by an area of springs approximately 1.2km downstream of Long Swamp Road. Adjacent to the CVO owned Woodville property, discharge from Silurian sediments is conceptualised to occur and is likely influenced by local fracture networks. There are likely groundwater contributions to other creeks in the Cadia Valley, although these may be ephemeral and dependant on rainfall recharge events (e.g. Cadiangullong Creek).

High potential aquatic groundwater dependent ecosystems (GDEs), as defined by the BoM (2019) GDE Atlas, are mapped in the upper reaches of Cadiangullong Creek and the Panuara Rivulet, in Flyers Creek and its tributaries to the east of CVO, and in some tributaries of the Belubula River to the south of mining operations (Figure 3.7). The GDE Atlas also maps high potential terrestrial GDEs that comprise River Oak and River Red Gum trees in small areas adjacent to Flyers Creek (to the east and southeast of the STSF), adjacent to Cadiangullong Creek (downstream of the NTSF), and along the Belubula River (Figure 3.7). These high potential terrestrial GDE's are consistent with the High Ecological Value Aquatic Ecosystems (HEVAE) framework (CSIRO, 2019), which in turn constitute high priority GDEs under 2020 updates to the Water Sharing Plan (WSP) for the NSW Murray Darling Basin Fractured Rock Groundwater Sources.



LEGEND

- Springs
- Private landholder bores
- Drainage
- Cadia Hill Pit
- Cadia East subsidence zone
- Ridgeway cave mine subsidence zone
- Rodds Creek dam
- North Waste Rock Dump
- Ore Processing Facilities
- South Waste Rock Dump
- Northern Tailings Storage Facility
- Southern Tailings Storage Facility
- Mining lease
- Model boundary
- CVO owned property

Aquatic GDEs - national assessment

- High potential GDE

Terrestrial GDE national assessment

- High potential GDE

Satellite image : NSW Aerial

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Groundwater dependent assets

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FIGURE No: **3.7**

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3.6.6 Numerical groundwater modelling

A regional numerical groundwater flow model has been developed to predict impacts from mining and tailings storage at CVO. The initial model in 2009 was developed to assess the impact of the Cadia East Mine on the groundwater regime. This model has been modified, refined, and improved to replicate site conditions and prediction capacity through subsequent updates in 2013, 2016, and 2021. There was a verification of existing model performance undertaken in 2019, which led to the model being rebuilt in 2021 due to divergences in predictions versus observed monitoring data.

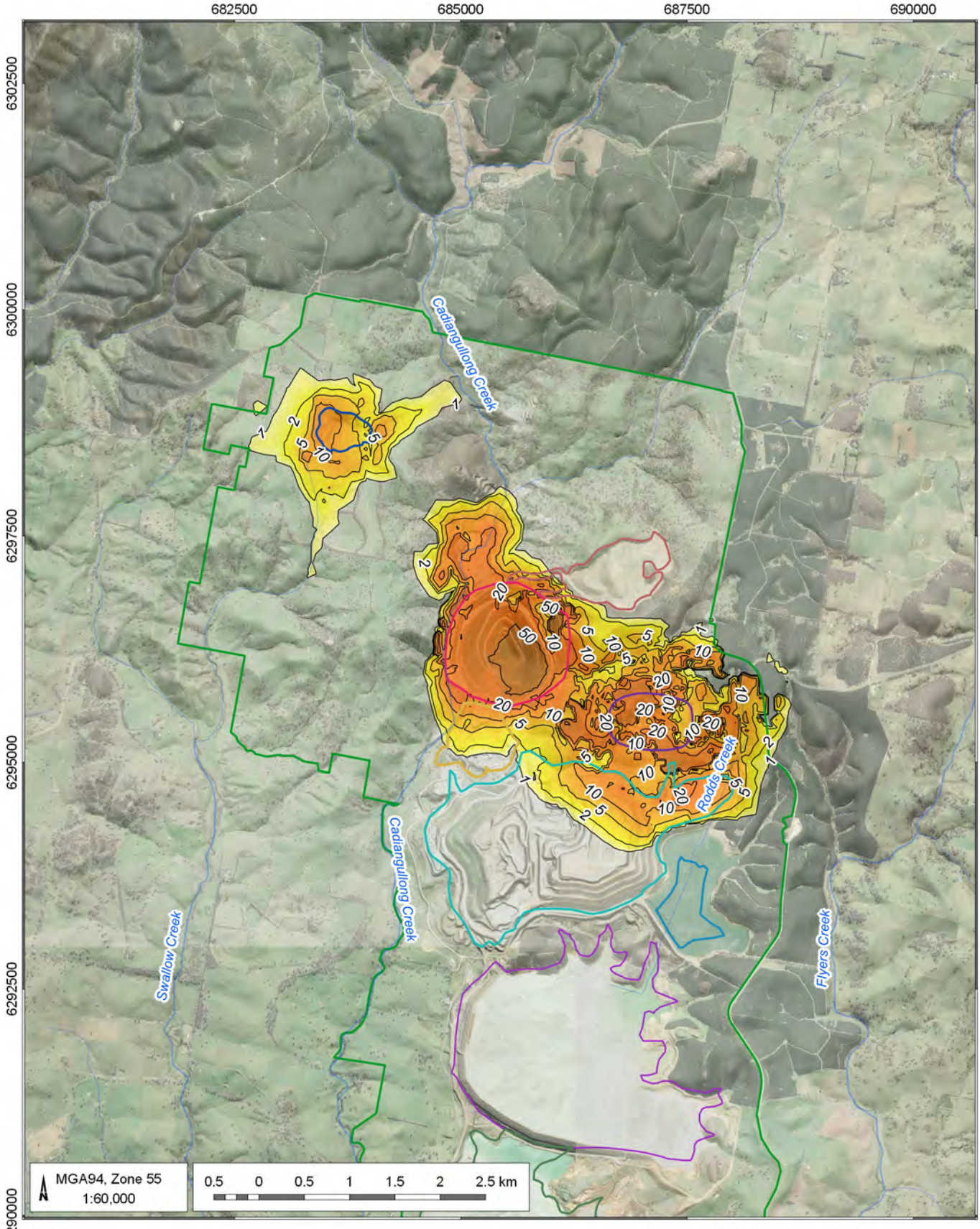
The latest model (AGE, 2021) was developed using monitoring data up to mid-2020, is more complex in its layering/refinement, and uses transient data for calibration. Predictive simulations are provided for maximum groundwater level drawdowns, inflows to mining areas and pits, leakage from TSFs, and baseflow losses in creeks/streams.

The progression of model updates since 2009 is presented in Table 3.2. Current predictions of maximum water table drawdown though to the end of approved mining (2038) is provided in Figure 3.8. Connectivity of groundwater between the shallow system and the deeper system is constrained due to the low permeability of the deeper rock mass (see Section 3.3.1.2).

Table 3.2 Progressive updates of numerical groundwater model and groundwater level predictions

Year developed	Model type	Progressive changes in model development	Groundwater level predictions
2009	Modflow - Surfact	Model simulated the three key hydrostratigraphic units, comprising the Tertiary basalts, Silurian sediments and Ordovician volcaniclastics. The model was calibrated to steady state (average) water level measurements and provided estimated drawdown in steady state conditions (infinite timeframe and not constrained to mining period). Steady state modelling outcomes would therefore provide conservative (over prediction) of outcomes.	1 m predicted drawdown for steady state conditions in top layer extends approx. 8 km north, 3 km east, west and southwest of Cadia East subsidence crater and includes the adjacent area of the Cadia Pit.
2013	Modflow - Surfact	Modified the model layers and Cadia East subsidence zone, redefining the extent of the Tertiary basalt, adjusting the aquifer parameters, altering the representation of the TSFs, and adding transient mining and recharge data. Recalibrated the model using transient groundwater level and mine inflow data. Applied PEST software to assist with calibration. Drawdown estimates provided for hydrostratigraphic units at the end of mining. A sensitivity analysis of drawdown was completed.	The groundwater drawdown extent reduced relative to 2009 model as 2013 model provided transient conditions of predictions to the end of mining. The 1 m predicted drawdown in Tertiary basalt at end of mining extends approximately 2.5 km to the northeast and 3 km to the southwest.
2016	Modflow - USG	Changed the model code to Modflow USG, allowing the use of an unstructured grid, which provides advantages for modelling groundwater flow in this environment. Updated mine plan and modified recharge/discharge inputs. Modified boundary conditions. First model to provide estimates of uncertainty (probability estimates of predicted drawdown).	The groundwater drawdown extent at end of mining reduced relative to the 2016 model. The calibrated base case indicates the basalt layer 1 m drawdown extent is within 1 km from the Cadia East subsidence crater.
2019	Modflow - USG	Verification assessment of existing model. The 2016 model was updated with a new mine plan and climate data, to better align the model to what had occurred at the site since 2016. The model performance review showed that while the model was still calibrated to statistical measures, there were some critical mismatches (divergence in observed and predicted groundwater levels) that needed to be addressed such as changes to conceptual model, recharge zoning and implications of geological structure.	-

Year developed	Model type	Progressive changes in model development	Groundwater level predictions
2021	Modflow - USG	Model increased in regional domain extent and rebuilt with layering. Model layering refined in mine cave areas to better represent the progression of mining. More refinement of geological structure. Update in Cadia East mining progression. In-pit tailings deposition at Cadia Hill added. Greater detail of surface – groundwater interaction through incorporated packages, such as SWAT to refine recharge quantities due to land use and stream routing; and SFR2 to simulate surface drainage beneath streams. Added time variance of hydraulic properties in vicinity of cave mining. Hydraulic properties of layers adjusted to acceptable ranges from field tests and published in literature. Model recalibrated and uncertainty analysis undertaken.	Provides drawdown extent of water table at the end of mining. The predicted 1 m drawdown extent is 1 km around Cadia East subsidence crater and envelops Cadia Hill Pit. Slightly greater extent of drawdown predicted compared to 2016 model.



LEGEND

- Drainage
- Contour line
- Cadia Hill Pit
- Cadia East subsidence zone
- Ridgeway cave mine subsidence zone
- Rodds Creek dam
- Ore Processing Facilities
- North Waste Rock Dump
- South Waste Rock Dump
- Northern Tailings Storage Facility
- Southern Tailings Storage Facility
- Mining lease

Drawdown (m)

- 0
- 1
- 2
- 5
- 10
- 20
- 50
- 100
- 200
- 500

Cadia AGMR 2020/2021 (G1383AA)

Water table – maximum drawdown to the end of approved mining

AGE

DATE 10/08/2021

FIGURE No: **3.8**

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4 Review of operational area monitoring data

Given the complex history and variability of CVO mining activities/tailings deposition (Section 3.5), the review of groundwater monitoring data is split into several operational areas that include the:

- Cadia Hill Pit (Section 4.2);
- Ridgeway Mine (Section 4.3);
- Cadia East Mine (Section 4.4);
- NTSF and STSF (Section 4.5);
- Southern Waste Rock Dump (SWRD) (Section 4.6); and
- other areas, including the ore processing area and regional monitoring sites (Section 4.7)

For each of these operational areas, a conceptualisation of the local hydrogeology is first presented, which was informed by monitoring data and groundwater investigations completed to date. Also presented for each of these operational areas are plans of the monitoring network, surrounding groundwater dependent assets, and modelled drawdown predictions. These modelled predictions are the maximum values of drawdown at any stage of mining and at any depth. Generally, model predictions show that drawdown is more significant at depth due to lower storage, with layers closer to the surface less impacted. This is then followed by a review of the monitoring data, which is used to assess any potential impacts that may be associated with each of these operational areas.

4.1 Summary of guideline/trigger exceedances

The monitoring data for the 2020/2021 water year was assessed against the groundwater level guidelines and groundwater quality triggers stipulated within the WMP (Section 2.2). A summary of groundwater level and groundwater quality exceedances are presented below (Table 4.1 and Table 4.2, respectively). A more detailed identification of exceedances is presented in appended hydrographs (Appendix B) and tabulated water quality data for the 2020/2021 water year (Appendix C).

A single groundwater level exceedance and 210 groundwater quality exceedances were recorded over the 2020/2021 water year. As per the trigger action response plan (TARP) defined in the WMP, 151 'level 1 investigations' for groundwater quality exceedances were completed internally by CVO. None of these water quality exceedances were deemed by CVO as likely to be linked to a 'mining related impact or influence', and as such no 'level 2 investigations' were undertaken. There is no TARP defined in the WMP for groundwater level guideline exceedances, although groundwater levels are reviewed annually.

Further consideration of these exceedances, including potential impacts to groundwater dependent assets, is discussed with reference to specific operational areas in Section 4.2 through to Section 4.7.

Table 4.1 Summary of groundwater level guideline exceedances – 2020/2021 water year

Bore ID	Nearest operational area [a]	Guideline level exceedance (yes/no)
RO6A	Ridgeway Mine	no
RO6B	Ridgeway Mine	no
RO7	Ridgeway Mine	no
RO10A	Ridgeway Mine	no
RO10B	Ridgeway Mine	no
RO12	Ridgeway Mine	no
MB43	Cadia East Mine	no [b]
MB44A	Cadia East Mine	yes (~ 3 m decline) [b]
MB44B	Cadia East Mine	no [b]

Bore ID	Nearest operational area [a]	Guideline level exceedance (yes/no)
MB47A	Cadia East Mine	no [b]
MB47B	Cadia East Mine	no [b]
MB62	Cadia East Mine	no [b]
MB76	Cadia East Mine	no [b]
MB25 [d]	NTSF/STSF	no
MB26B	NTSF/STSF	no
MB27	NTSF/STSF	no
MB28B	NTSF/STSF	no
MB29B	NTSF/STSF	no
MB77A	NTSF/STSF	no
MB77B	NTSF/STSF	no
MB78 [d]	NTSF/STSF	no
MB81	NTSF/STSF	no
MB23	NTSF/STSF	no
MB24	NTSF/STSF	no
MB18	WRD	no
RB01	Regional monitoring [c]	no [b]
MB55	Regional monitoring [c]	no [b]
MB71	Regional monitoring [c]	no [b]

Notes: [a] grouping differs from Table 6-5 to Table 6-7 of the WMP and are based on monitoring bore distance from operational areas;

[b] 'greater than 3m of drawdown above what is considered normal climatic variation' assessed using transfer function noise (TFN) modelling, where CRD trends are compared to groundwater level variations (see Appendix D);

[c] monitoring bores are outside the maximum extent of modelled drawdown; and

[d] there appears to be an error in the initial measured level in Table 6-7 of the WMP.

Table 4.2 Summary of groundwater quality trigger exceedances – 2020/2021 water year

Bore ID	Nearest operational area [a]	Analytes exceeded	Months an exceedance occurred [b]
MB92	Cadia Hill Pit	Manganese	Apr-21, May-21, Jun-21
MB93	Cadia Hill Pit	Manganese, Arsenic	Jul-20, Aug-20, Sep-20, Oct-20, Nov-20, Dec-20, Mar-21, Jan-21, Apr-21, Jun-21, Feb-21
MB94	Cadia Hill Pit	pH, Manganese, Arsenic, Sulfate	Nov-20, Mar-21, Apr-21, May-21, Jun-21, Feb-21
MB47A	Cadia East Mine	Manganese	Aug-20, Nov-20, Apr-21, Jan-21
MB62	Cadia East Mine	pH	Aug-20, Nov-20, Apr-21, Jan-21
MB88	Cadia East Mine	Manganese, pH	Jul-20, Aug-20, Sep-20, Oct-20, Nov-20, Dec-20, Mar-21, Jan-21, Apr-21, May-21, Feb-21
MB20	NTSF/STSF	pH, Sulfate	Aug-20, Nov-20, Apr-21, Jan-21
MB69	NTSF/STSF	Manganese	Nov-20, Apr-21, Jan-21
MB70	NTSF/STSF	pH	Aug-20
MB77A	NTSF/STSF	pH, Sulfate	Aug-20, Apr-21

Bore ID	Nearest operational area [a]	Analytes exceeded	Months an exceedance occurred [b]
MB77B	NTSF/STSF	Sulfate	Aug-20, Apr-21
MB83	NTSF/STSF	TDS, Manganese, Sulfate	Jul-20, Aug-20, Sep-20, Oct-20, Nov-20, Mar-21, Apr-21, Jan-21, May-21, Jun-21, Feb-21, Dec-20
MB84	NTSF/STSF	TDS, pH, Sulfate	Jul-20, Aug-20, Sep-20, Oct-20, Nov-20, Dec-20, Mar-21, Apr-21, May-21, Jun-21, Feb-21, Jan-21
MB85	NTSF/STSF	TDS	Jul-20, Aug-20, Sep-20, Oct-20, Nov-20, Dec-20, Mar-21, Apr-21, Jan-21, May-21, Jun-21, Feb-21
MB86	NTSF/STSF	TDS, pH, Sulfate	Jul-20, Aug-20, Sep-20, Oct-20, Nov-20, Dec-20, Mar-21, Apr-21, Jan-21, Jun-21, Feb-21, May-21
MB87	NTSF/STSF	TDS, Manganese, Nickel, Sulfate	Jul-20, Aug-20, Sep-20, Oct-20, Nov-20, Dec-20, Mar-21, Apr-21, Jan-21, May-21, Jun-21, Feb-21
MB48	WRD	Manganese, pH	Aug-20, Nov-20, Apr-21
MB54	Regional monitoring [c]	pH	Aug-20, Nov-20, Apr-21, Jan-21
MB56	Regional monitoring [c]	pH	Aug-20, Nov-20, Apr-21, Jan-21
MB63	Regional monitoring [c]	pH	Sep-20, Nov-20, Apr-21, Jan-21
MB64	Regional monitoring [c]	pH	Sep-20, Nov-20, Apr-21, Jan-21
MB65	Regional monitoring [c]	Zinc, pH	Sep-20, Nov-20

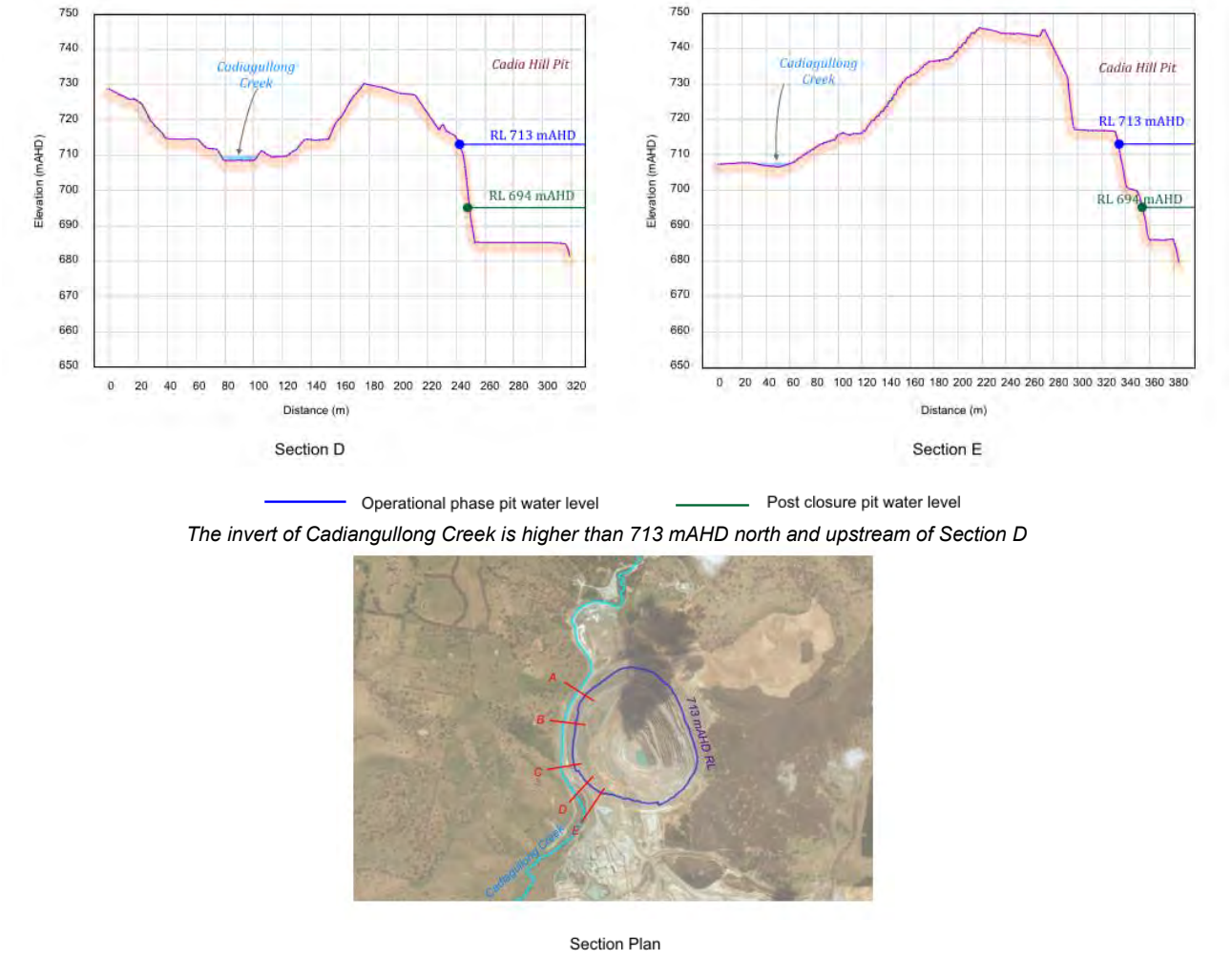
Notes: [a] grouping differs from Table 6-2 to Table 6-4 of the WMP and are based on monitoring bore distance from operational areas;
[b] dates relate to any month an exceedance has occurred and does not indicate that all analytes exceed for each month; and
[c] monitoring bores are outside the maximum extent of modelled drawdown.

4.2 Cadia Hill Pit

4.2.1 Overview and hydrogeological conceptualisation

The Cadia Hill Pit has two distinct operational periods, namely open cut mining between 1998 and 2012 and in pit tailings deposition since 2018. At present, the Cadia Hill Pit is conceptualised to behave as a groundwater sink, with mining having resulted in the drawdown of groundwater heads (depressurisation) in the surrounding Ordovician and Silurian groundwater systems (Figure 3.4). Drawdown is not laterally extensive, primarily due to the low permeability of the Ordovician and Silurian rock mass. The volume of groundwater intercepted is therefore conceptualised and modelled to be relatively minor. Tailings are also confined to the pit, with inwards hydraulic gradients preventing tailings impacted water from migrating away from the pit. If increases in the height of the emplaced tailings exceeds the rate at which the underlying Ordovician/Silurian groundwater units are able to equilibrate, there is some potential for very localised tailings/groundwater mixing beneath the pit. However, groundwater movement is still constrained by the overarching inwards hydraulic gradients. There is a pit lake which forms above the tailings level in the Cadia Hill Pit. The depth of this pit lake (lake surface to top of tailings) has approximately ranged between 10 m to 26 m over the 2020/2021 water year.

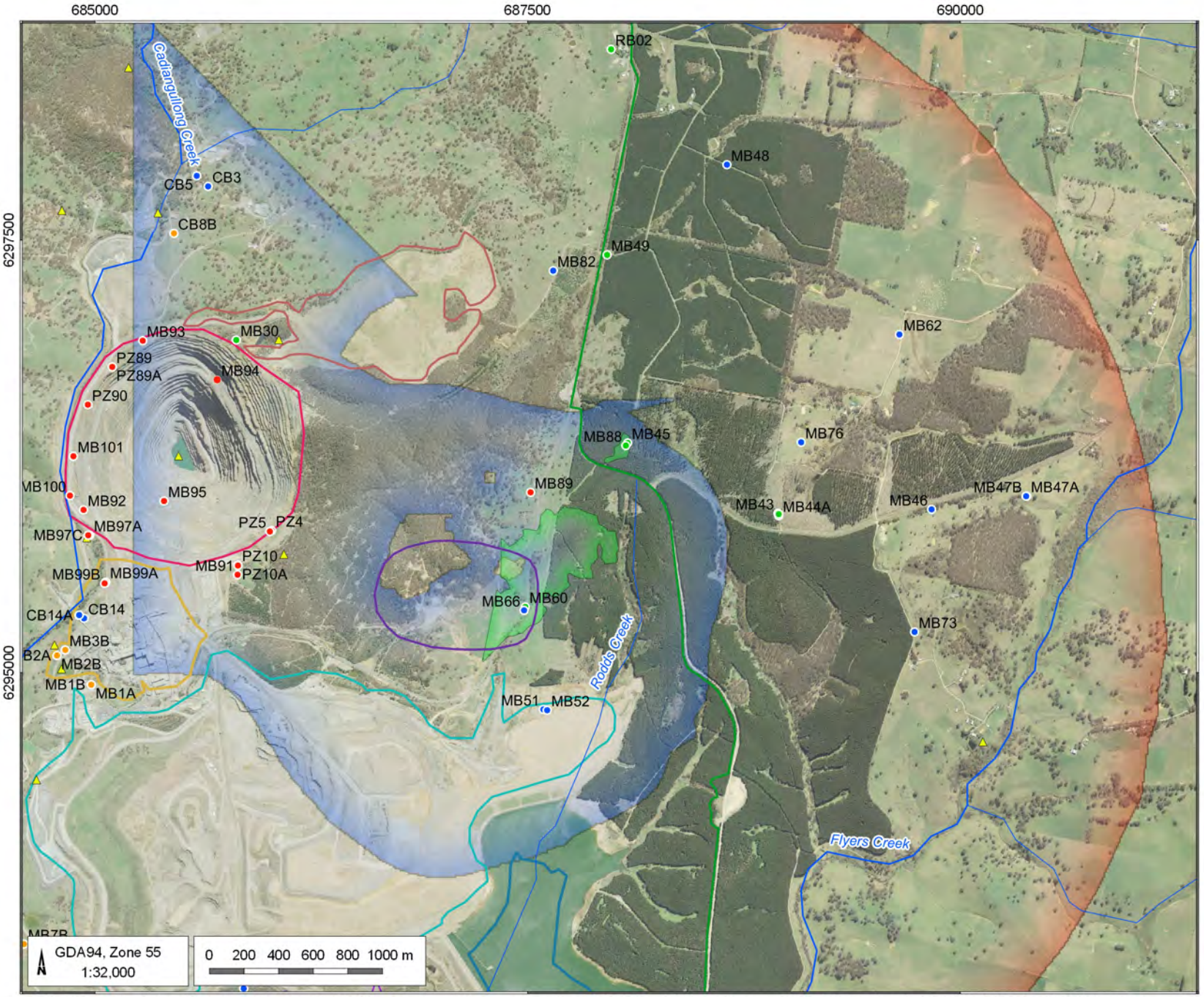
The Cadia Hill Pit will remain a groundwater sink until tailings deposition reaches an approved elevation of 713 mAHD. At this point, the tailings level will be slightly above the invert of Cadiangullong Creek to the southwest of the pit (Figure 4.1) and there is some risk that groundwater may migrate from the pit to Cadiangullong Creek through transmissive fractures and geological structure. Following consolidation of the tailings, the long-term behaviour of the pit will revert to that of a groundwater sink (Golder, 2018; HEC, 2019).



The invert of Cadiangullong Creek is higher than 713 mAHD north and upstream of Section D

Figure 4.1 MOD13 maximum tailings emplacement height and Cadiangullong Creek invert (AGE, 2019)

The monitoring bore network that surrounds the Cadia Hill Pit is largely installed into the more prevalent Ordovician units, with an emphasis on monitoring to the west and southwest of the pit, where Cadiangullong Creek is in close proximity to the pit (Figure 4.2). Monitoring bores are screened at a variety of depths, ranging from near surface to 186 mbgl. As per Table 6-9 of the WMP, groundwater levels and quality at bores adjacent to the pit are monitored on a monthly basis, although piezometers PZ4, PZ5, PZ10, PZ10A, PZ89, PZ89A, and PZ90 are monitored for groundwater levels only. The MB97, MB99, MB100, and MB101 monitoring sites were installed in late 2020/early 2021 to investigate the potential for impacts to Cadiangullong Creek that are associated with a greater height of approved tailings emplacement (713 mAHD). Bore MB95 was inundated by tailings in May 2020 and bore MB94 was installed as a replacement. The pit water level at the end of June 2021 was 556 mAHD, which represents a rise of approximately 257 mAHD since the start of deposition, while the tailings level was 530 mAHD.



LEGEND

- Surface water monitoring sites

Monitoring bore network

- Ordovician Volcanics
- Silurian Sediments
- Soil/Clay
- Tertiary Basalt
- Drainage
- Cadia Hill Pit
- Cadia East subsidence zone
- Rodds Creek dam
- Ore Processing Facilities
- North Waste Rock Dump
- South Waste Rock Dump
- Northern Tailings Storage Facility
- Mining lease
- Modelled maximum extent of basalt drawdown/depressurisation that exceeds 3 m
- Modelled maximum extent of Silurian drawdown/depressurisation that exceeds 3 m
- Modelled maximum extent of Ordovician drawdown/depressurisation that exceeds 3 m

Cadia AGMR 2020/2021 (G1383AA)

Cadia Hill Pit and Cadia East Mine – surrounding monitoring bores and maximum modelled drawdown

DATE
13/08/2021

AGE

FIGURE No:
4.2

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4.2.2 Groundwater monitoring data

4.2.2.1 Groundwater levels

There are no WMP groundwater guideline levels assigned for monitoring bores surrounding the Cadia Hill Pit.

If groundwater levels in the Cadia Hill Pit monitoring bores were to be directly influenced by the current deposition of tailings, this would be evident through rising groundwater levels after mid-2018. These groundwater level increases are seen in Ordovician bores MB94 (Figure 4.3) and MB95 (decommissioned in July 2020 due to inundation by tailings, Figure 4.4), as well as Tertiary basalt bore MB30 (Figure 4.5). Bores MB94 and the now decommissioned bore MB95 are both located in close proximity to the pit lake and are screened below the pit water level of 556 mAHD (June 2021). As such, the strong correlation of rising groundwater with pit water levels that has been observed in MB94 and MB95 is as expected. Bore MB30 is screened more than 130 m above the current pit water level and a correlation between the deposition of tailings and an increasing groundwater level is therefore considered unlikely. The cause of recent groundwater level increases at MB30 is unknown and may warrant further investigation.

No rising trends were identified in any of the other monitoring bores adjacent to the Cadia Hill Pit (MB91, MB92, MB93, PZ4, PZ5, PZ10, PZ10A, PZ89, PZ89A, and PZ90) as they are screened above the pit tailings level . There is inadequate data available to investigate groundwater level trends in newly installed bores (MB97A, MB97B, MB97C, MB99A, MB99B, MB100, and MB101) (Appendix B) although these bores are screened above the height of current tailings level in the Cadia Pit. The 2019 declines that are observed in bores PZ89A and MB93 are likely a response from the extraction of stored water in the Cadia Extended Pit, while post 2017 declines in bores PZ4, PZ5, MB91, and PZ10 are likely associated with mining at the Cadia East Mine (see Section 4.4.2.1).

Hydraulic gradients around the pit were assessed by comparing recent groundwater levels of bore MB94 to the rest of the monitoring network. The June 2021 groundwater level in bore MB94 was 554.82 mAHD, while groundwater level in the rest of the monitoring network ranged between 649.51 mAHD and 733 mAHD. This demonstrates that the local groundwater flow direction is towards the pit, given that bore MB94 is 81 m from the current elevation of the pit lake, while the rest of the monitoring network is between 246 m and 485 m away.

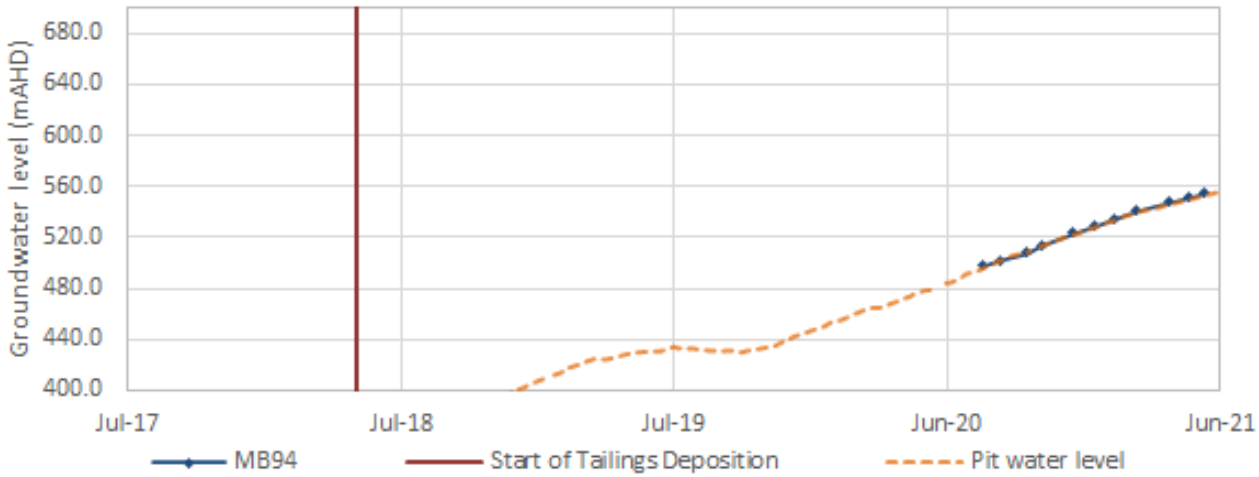


Figure 4.3 MB94 groundwater level/pit lake water level variation

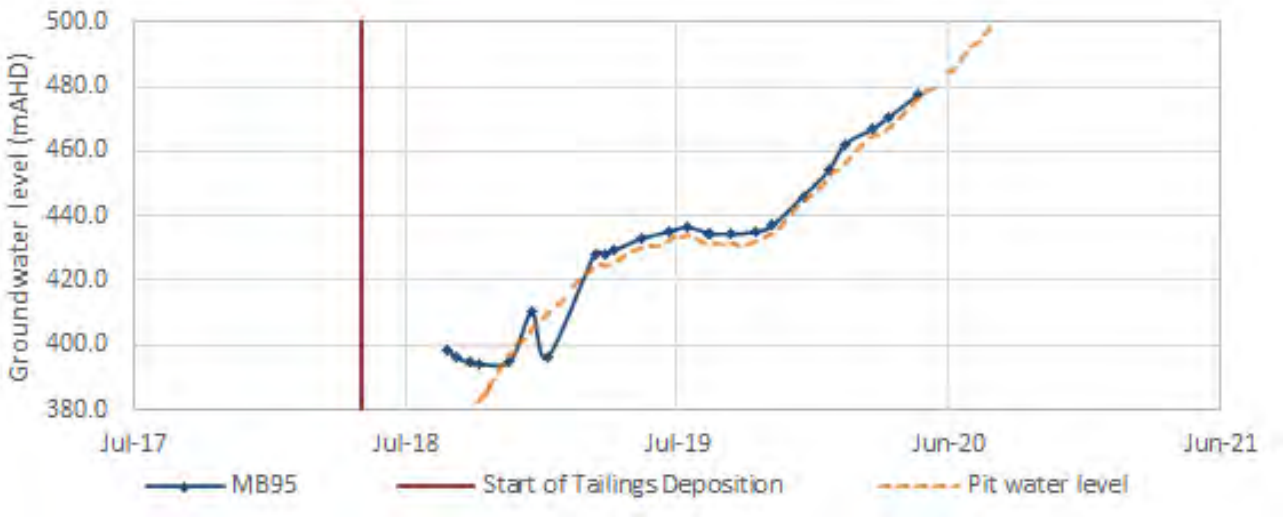


Figure 4.4 MB95 groundwater level/pit lake water level variation

Figure 4.5 MB30 groundwater level/pit lake water level variation

4.2.2.2 Groundwater quality

Over the 2020/2021 water year, groundwater quality trigger exceedances were recorded in Ordovician monitoring bores MB92 (manganese), MB93 (arsenic and manganese), and MB94 (pH, sulfate, arsenic, and manganese). Internal CVO 'level 1 investigations' concluded that exceedances observed in bores MB92 and MB94 were likely due to seepage from the pit, while exceedances observed in bore MB93 are largely indicative of background conditions. These CVO conclusions are further considered below.

A review of long-term trends for select analytes (pH, TDS, sulfate, aluminium, arsenic, copper, lead, manganese, nickel, zinc, mercury, and nitrite/nitrate) was undertaken, with time series plots provided in Appendix E. Concentrations of these analytes at monitoring bores adjacent to the Cadia Hill Pit have generally remained stable over the period of monitoring, with notable trends including:

- Elevated concentrations of TDS, sulfate, manganese, and zinc at bore MB30 between 2006 and 2016 (while the Cadia Hill Pit was open), with a subsequent fall between 2016 and 2019 and then relatively stable concentrations until the present. This period of stabilisation is generally consistent with the period of rising groundwater levels (see Section 4.2.2.1).
- Slight increases of TDS, sulfate, and some dissolved metals at bores MB92, MB93, and MB94 throughout 2021.

Due to similarities between the water quality of the pit lake and native groundwater, it is difficult to easily identify bores where mixing may be taking place. However, once groundwater levels at bore MB95 started to consistently match the water level in Cadia Hill Pit (i.e. from March 2019), two noticeable groundwater quality trends were apparent, which include:

- a significant increase in arsenic concentrations, with an average concentration before and after March 2019 of 0.003 mg/L/0.02 mg/L, respectively; and
- a reduction in sulfate-chloride mass ratios, with an average ratio of 21.2 prior to March 2019 and an average ratio of 5.8 after.

A similar increase in arsenic concentrations from below the limit of detection (< 0.001 mg/L) to a maximum of 0.019 mg/L (May 2021) was observed at bore MB94, where groundwater levels also suggest connectivity to the Cadia Hill Pit lake. Sulfate-chloride mass ratios are also reducing at this location (93.4 in October 2020 to 65.3 in May 2021), although the change is not yet as significant as what was observed in bore MB95. These trends are not apparent in bore MB30, where both the arsenic concentration and sulfate-chloride mass ratio have remained relatively stable since the onset of monitoring. This further supports the conclusion that rising groundwater levels in bore MB30 are not related to tailings deposition in the Cadia Hill Pit. Similarly, these arsenic /sulfate-chloride mass ratio trends are also absent in bore MB92 observations, where concentrations of manganese that exceed the trigger value are consistent with historical observations and are likely typical of native groundwater at this location.

4.2.3 Assessment of potential impacts

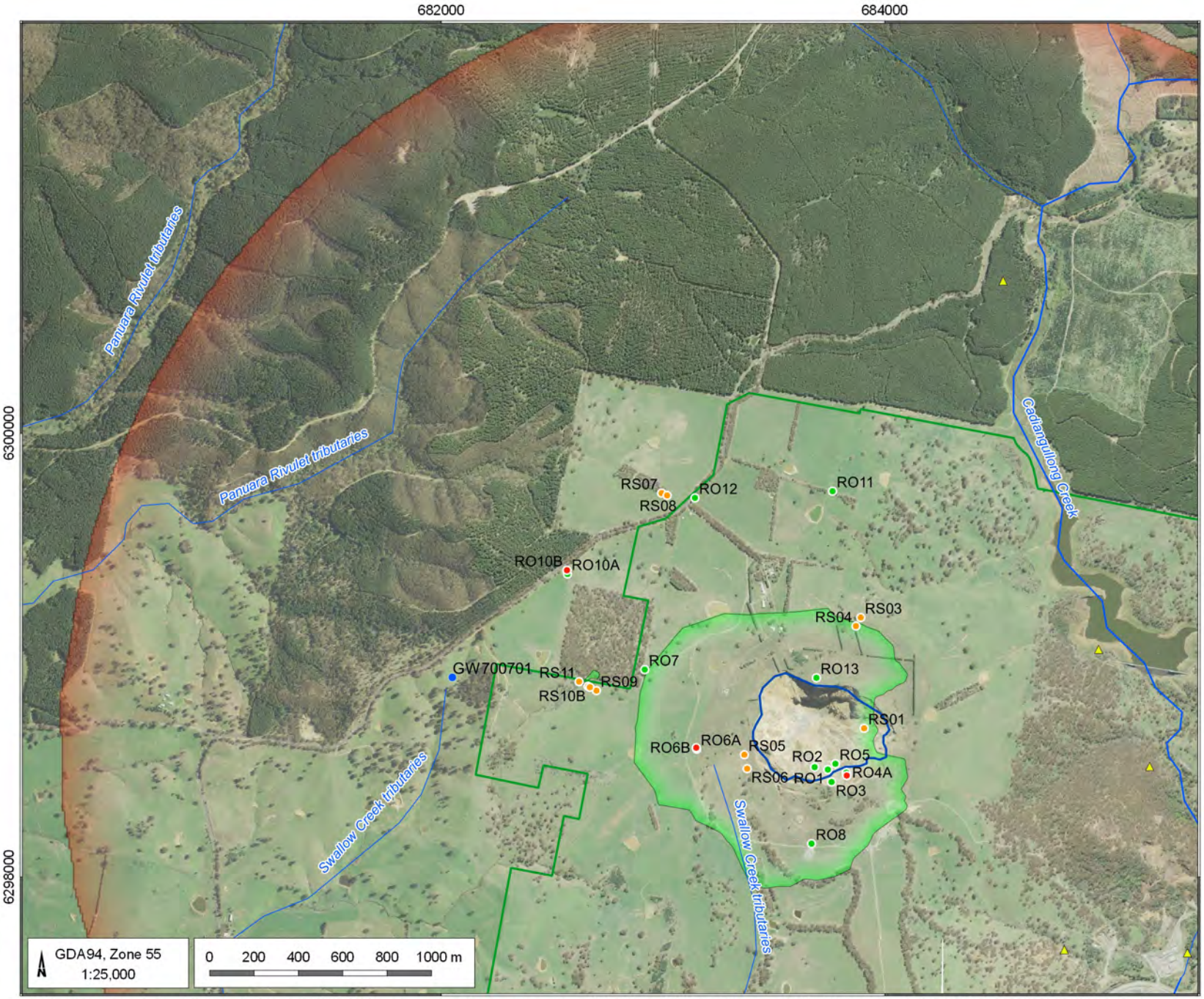
A review of groundwater monitoring data suggests that only Ordovician bores MB94 and the now decommissioned MB95 have been impacted by tailings deposition. This is evident through clear increases in groundwater levels that correlate with the level of the Cadia Hill Pit lake (see Section 4.2.2.1), as well as increases in arsenic concentrations and a decrease in the sulfate-chloride mass ratio (see Section 4.2.2.2). These localised impacts are consistent with operational impacts that were predicted as part of the MOD13 groundwater assessment (AGE, 2019). The risk of this groundwater migrating away from the pit is minimal, given that monitoring data (see Section 4.2.2.1) and numerical modelling (AGE, 2021) both show and predict an inwards hydraulic gradient, with the Cadia Hill Pit acting as a groundwater sink. The potential for the offsite migration of impacted groundwater is adequately monitored, with a large number of groundwater monitoring bores installed at various depths. These bores are largely located to the west and southwest of the pit in the direction of Cadiangullong Creek, which is the nearest environmental receptor.

4.3 Ridgeway Mine

4.3.1 Overview and hydrogeological conceptualisation

Mining at the Ridgeway Mine took place between 1998 and 2016, with the more recent ‘Ridgeway Deeps’ being mined from 2009 to 2016. Although the Ridgeway Mine is no longer actively mined, it is understood that the underground workings are still dewatered. At present, the Ridgeway Mine is conceptualised to behave as a groundwater sink, with mining and continued dewatering having resulted in the drawdown of groundwater systems in surrounding Ordovician units, as well as the Tertiary basalt (Figure 3.4). Drawdown is not laterally extensive, primarily due to the low permeability of the Ordovician rock mass, which the Ridgeway Mine largely intercepts.

The monitoring network that surrounds the Cadia East mine is comprised of the ‘RO’ and ‘RS’ series of bores, with a total of 27 surrounding bores (Figure 4.6), 16 of which are still in use. Of the active monitoring bores, there are eight shallow (< 12 mbgl) bore installed into soil/clay, six Tertiary basalt bores (< 62 mbgl), and two deeper Ordovician bores that are screened to 136 mbgl. As per Table 6-9 of the WMP, groundwater levels from these bores are recorded biannually. There are no requirements to collect groundwater quality samples from these bores, although there are some historical records (Appendix E). Nearby groundwater receptors include Cadiangullong Creek to the east (~ 1.2 km), Swallow Creek to the south-southwest, and a registered supply bore to the west (~ 1.4 km), which is on privately owned and installed into the Ordovician volcanics (GW700701) (Figure 3.7).



LEGEND

- Surface water monitoring sites
- Private registered bore

Monitoring bore network

- Ordovician Volcanics
- Soil/Clay
- Tertiary Basalt
- Drainage
- Ridgeway
- Mining lease
- Modelled maximum extent of basalt drawdown/depressurisation that exceeds 3 m
- Modelled maximum extent of Ordovician drawdown/depressurisation that exceeds 3 m

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Ridgeway Mine – surrounding monitoring bores and maximum modelled drawdown

DATE
20/08/2021

AGE

FIGURE No:
4.6

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4.3.2 Groundwater monitoring data

4.3.2.1 Groundwater levels

There were no exceedances of the WMP defined groundwater level guidelines in any Ridgeway Mine monitoring bore over the 2020/2021 water year.

Historical observations show that groundwater levels in a number of monitoring bores fell rapidly after the Ridgeway Mine breakthrough at ground surface in August 2002 (Figure 4.7 and Figure 4.8). These bores are largely situated adjacent to the mine, although declining groundwater levels are also observed in bores RO11 and RO12, which are located more than 800 m north of the mine (Figure 4.6). Groundwater declines that preceded the 2002 breakthrough were observed in the deeper Ordovician bore (RO4B), with significant decreases observed at the start of mining in 1998 (Appendix B). Moving away from the mine to the west and northwest, monitoring bores were largely unaffected by mining and historical observations match climatic conditions (Figure 4.9). Groundwater level variations in recent years (2018 to the present) are minimal and generally correlate with climatic conditions (Appendix B), noting that a number of the monitoring bores listed in the WMP are now dry (bores RO8, RS03, and potentially RO11).

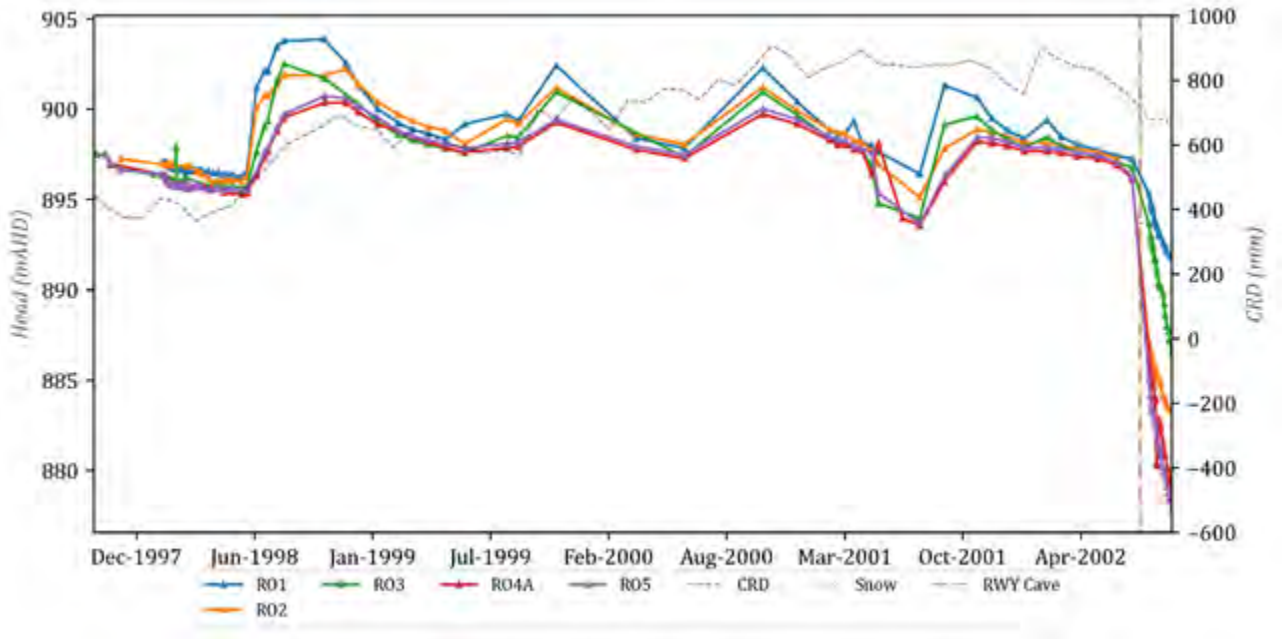


Figure 4.7 Ridgeway Mine bores with declines after 2002 breakthrough (1 of 2) (AGE, 2021)

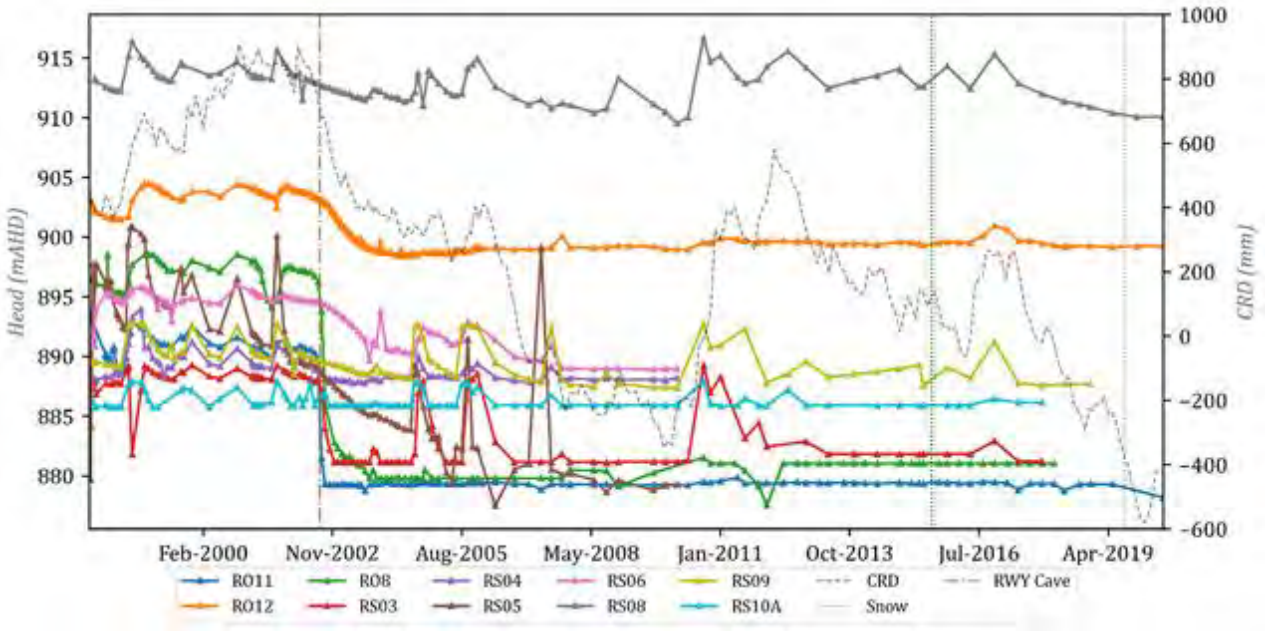


Figure 4.8 Ridgeway Mine bores with declines after 2002 breakthrough (2 of 2) (AGE, 2021)

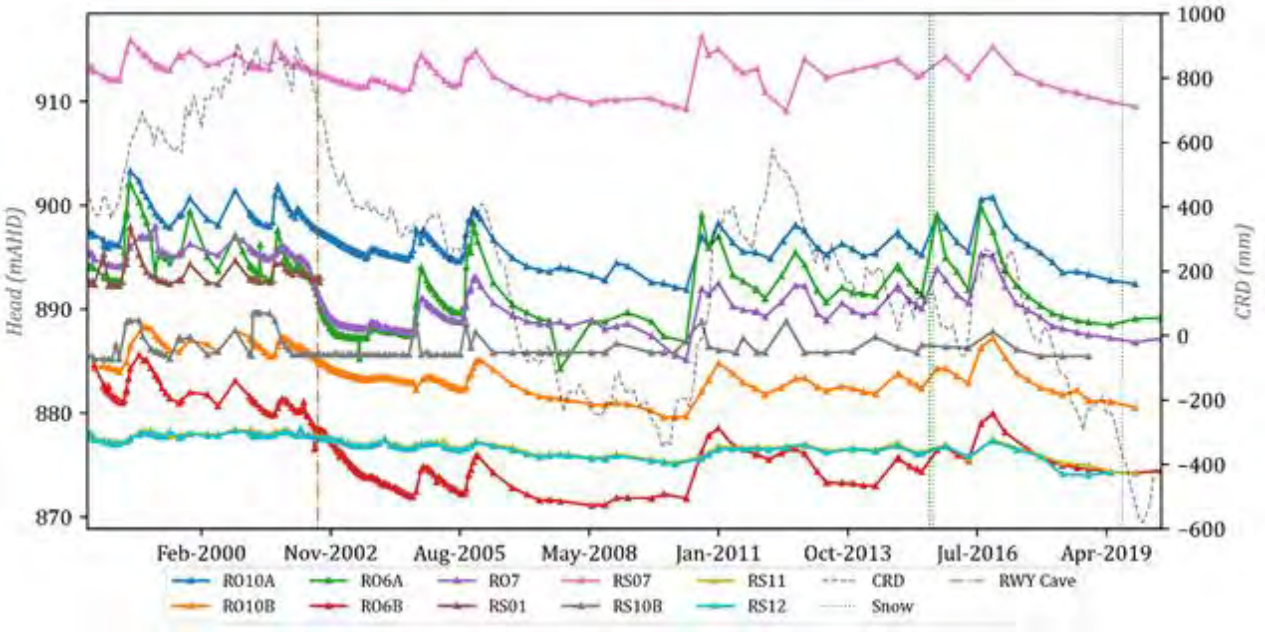


Figure 4.9 Ridgeway Mine bores with typical climatic responses (AGE, 2021)

4.3.2.2 Groundwater quality

As per Table 6-9 of the WMP, the collection of groundwater quality samples is not required from Ridgeway monitoring bores. Where available, historical data for select analytes (pH, TDS, sulfate, aluminium, arsenic, copper, lead, manganese, nickel, zinc, mercury, and nitrite/nitrate) is presented in Appendix E.

4.3.3 Assessment of potential impacts

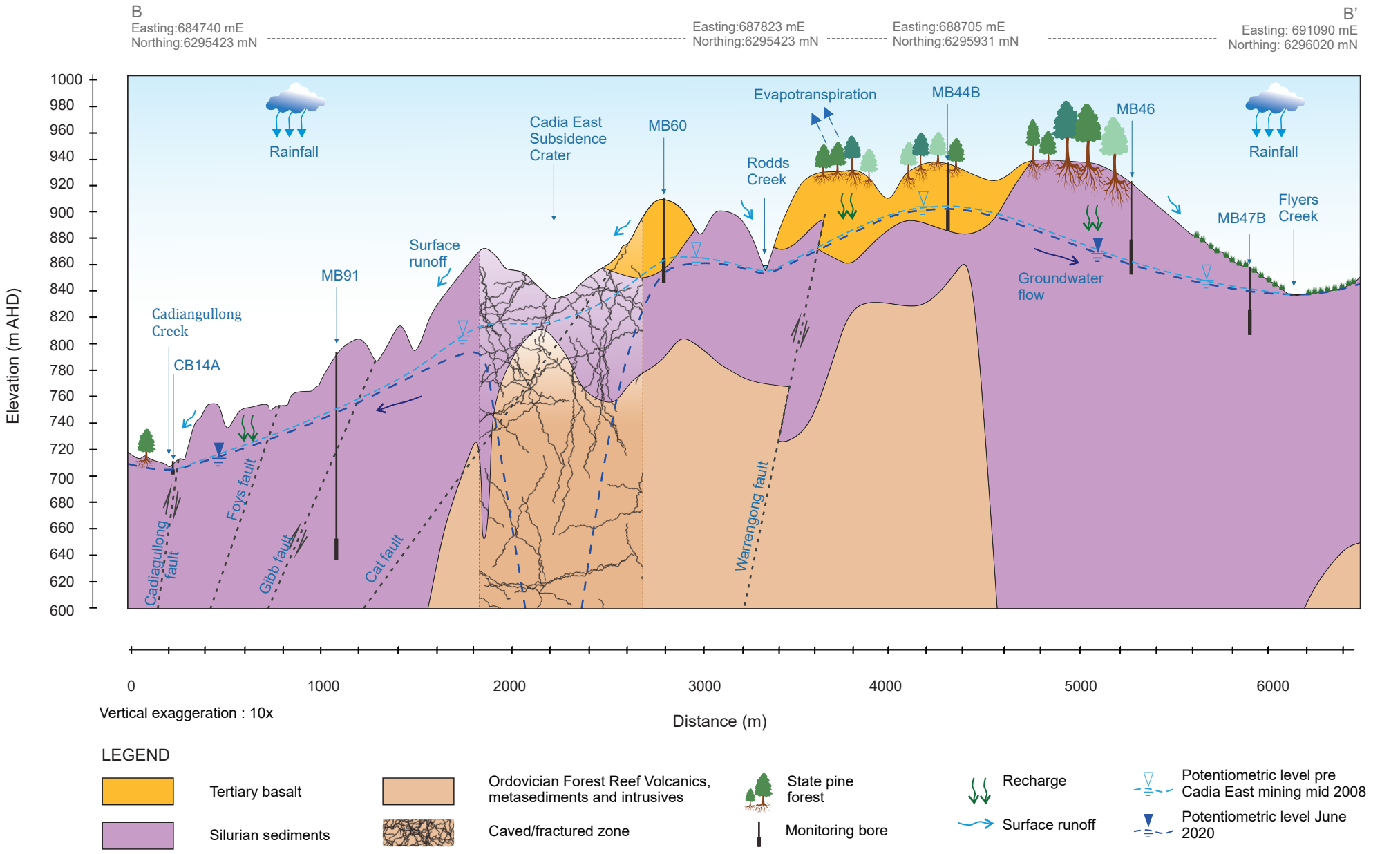
Drawdown of the groundwater systems that are associated with shallower sediments and the Tertiary basalt is consistent with impacts predicted for the Cadia East environmental assessment (AGE, 2009) and is well delineated to the west of Ridgeway Mine. There are a large number of active monitoring bores installed in this area, most of which have historical groundwater levels that are consistent with climatic conditions. Potential impacts to the nearby private supply bore (GW700701) need to be taken into consideration, particularly as this bore is installed into the Ordovician volcanics, which is the groundwater system predicted to be most impacted by mining. It is unlikely that there is any mining related effect on groundwater-surface water interactions (if present) at nearby sections of Cadiangullong Creek/Swallow Creek, given that water table drawdown is not predicted to be extensive around the Ridgeway Mine (Figure 3.8).

4.4 Cadia East Mine

4.4.1 Overview and hydrogeological conceptualisation

Cave mining at the Cadia East Mine is ongoing, with works beginning in 2012 and cave breakthrough at ground surface occurring in August 2002. At present, the Cadia East Mine is conceptualised to behave as a groundwater sink, with mining/dewatering resulting in the drawdown of groundwater systems in surrounding Ordovician/Silurian units, as well as the Tertiary basalt, although to a lesser extent (Figure 4.10). Groundwater drawdown is not modelled to be laterally extensive (AGE, 2021), primarily due to the low permeability of the Ordovician/Silurian rock mass, which the Cadia East Mine largely intercepts. A number of faults are known to intersect the underground workings and these faults may increase the range of drawdown if permeability is enhanced arounds these features relative to the bulk rock mass.

As per Table 6-9 of the WMP, there are 30 bores that are attributed to Cadia East Mine monitoring; however, previous investigations (AGE, 2021) have also found that several of the bores between the Cadia East Mine and the Cadia Hill Pit are also influenced by the Cadia East Mine (Figure 4.2). Monitoring bores are largely installed into Silurian sediments and the Tertiary basalt, with three bores installed into the Ordovician volcanics (MB71, MB75, and MB89). The frequency of groundwater level and groundwater quality monitoring is dependent on the purpose of the monitoring bore, although groundwater levels are collected at least quarterly for all bores (apart from biannual measurements in bores RB01 and RB02), while groundwater quality samples are collected in 18 of 30 bores (samples collected monthly from two bores and quarterly from 16). Nearby groundwater receptors include Cadiangullong Creek to the west (~ 1.7 km), Flyers Creek to the east/southeast (~ 3 km/~ 2 km), a large number of registered supply bores to the northeast/east/southeast (nearest ~ 1.5 km to the northeast), and a number of mapped springs to the north-northeast (> 4 km) (Figure 3.7).



Cadia East Mine conceptual cross section (B - B')

Figure - 4.10

Cadia AGMR 2020/2021 (G1383AA)

AGE

4.4.2 Groundwater monitoring data

4.4.2.1 Groundwater levels

Exceedances of the WMP defined groundwater guidelines were estimated to have occurred in one of the ten assessable bores (Table 4.3). A 'greater than 3 m of drawdown above what is considered normal climatic variation' was assessed using transfer function noise (TFN) modelling, where CRD trends are compared to groundwater level variations (Appendix D). TFN modelling indicated that there was a reasonable level of evidence to suggest that non-climatic drawdown has taken place in bores MB43, MB44, and MB44B, all of which are located approximately 1.5 km east-northeast of the Cadia East Mine. It should be noted that the WMP TARP's do not stipulate a requirement for any further investigations following an exceedance of a groundwater level guideline.

Table 4.3 Review of groundwater level guidelines for Cadia East Mine monitoring bores

Bore ID	Groundwater system	Groundwater level drawdown guideline (m)	Post 2012 estimate of variation from 'normal climatic variation'	Exceedance of guideline (yes/no)
RB01	Tertiary basalt	3	potential evidence of minor drawdown	no
MB43	Silurian sediments	3	< 3 m, although drawdown evident	no
MB44A	Silurian sediments	3	~ 3 m	yes
MB44B	Tertiary basalt	3	< 3 m, although drawdown evident	no
MB47A	Silurian sediments	3	variations consistent with climatic conditions	no
MB47B	Silurian sediments	3	variations consistent with climatic conditions	no
MB55	Tertiary basalt	3	variations consistent with climatic conditions	no
MB62	Silurian sediments	3	variations consistent with climatic conditions	no
MB71	Ordovician volcanics	3	variations consistent with climatic conditions	no
MB76	Silurian sediments	3	variations consistent with climatic conditions	no

In addition to the monitoring bores with guideline values that are discussed above, a more simplistic review of hydrographs (Appendix B) suggests that there are 11 other monitoring bores that may be impacted by drawdown from the Cadia East Mine. The potential for some observed mining related groundwater level declines were identified in total of 14 bores, where: two are installed into the Ordovician volcanics (bores PZ4 and PZ5); seven are installed into the Silurian sediments (bores MB43, MB44A, MB46, MB48, MB73, MB82, and RB07); and five are installed into the Tertiary basalt (bores MB44B, MB45, MB49, MB60, and MB88). The locations of these bores suggests that observed drawdown at present may extend up to 2.5 km to the north-northeast of the subsidence crater (Silurian sediments bore MB48) and 2.3 km to the east (Silurian sediment bores MB46 and MB73) (Figure 4.11). The potential for declines to be associated with pine plantations was also considered, although aerial imagery shows that these plantations to the east of the Cadia East Mine were well established (by 2000 in the southern section and 2009 in the northern section) prior to observed groundwater level declines. Observed declines are conceptualised to either propagate through mine induced fracturing, or through faults within the underlying Ordovician/Silurian rocks.

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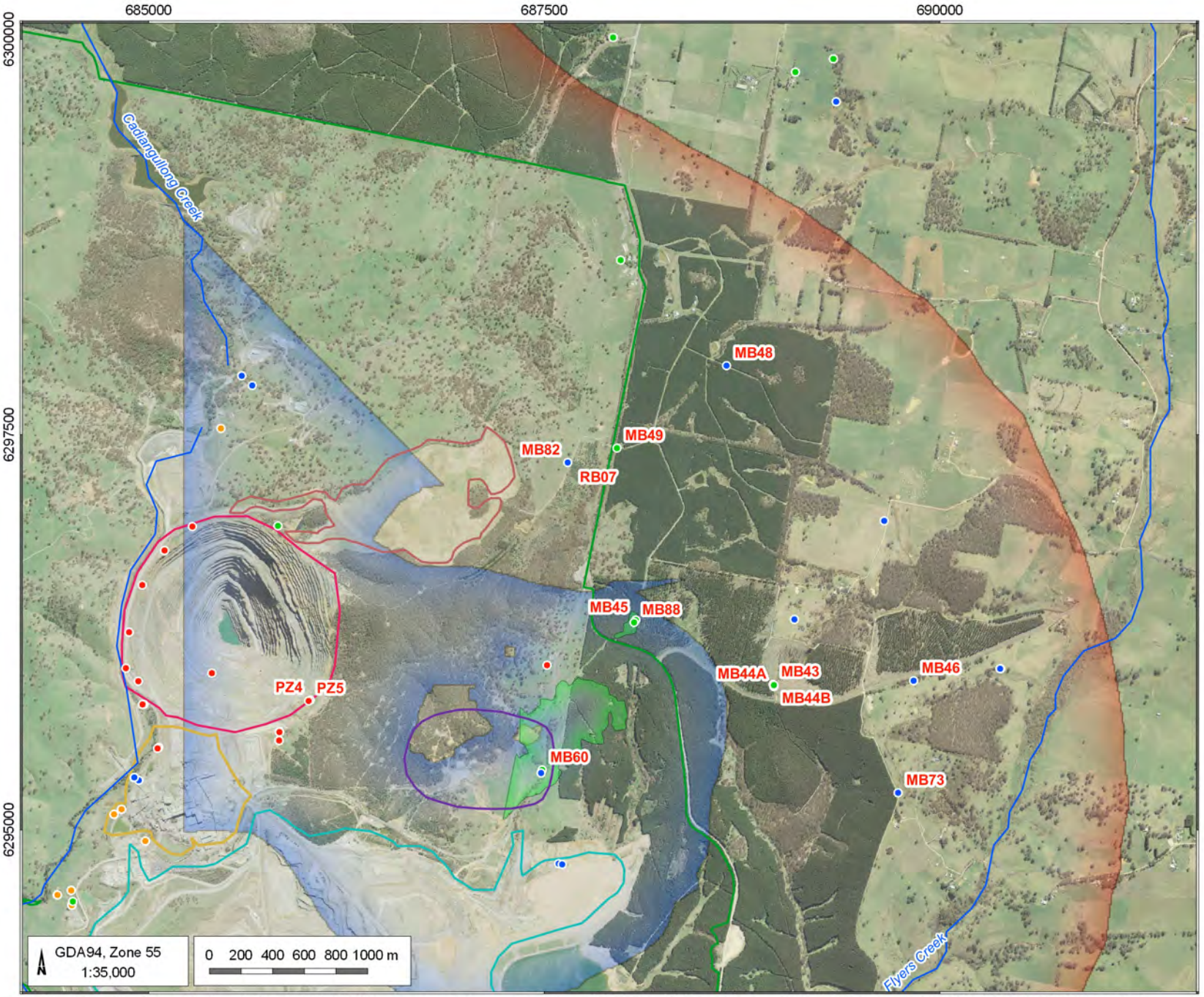

LEGEND

Monitoring bore network

- Ordovician Volcanics
- Silurian Sediments
- Soil/Clay
- Tertiary Basalt
- Drainage
- Cadia Hill Pit
- Cadia East subsidence zone
- Rodds Creek dam
- Ore Processing Facilities
- North Waste Rock Dump
- South Waste Rock Dump
- Mining lease
- Modelled maximum extent of basalt drawdown/depressurisation that exceeds 3 m
- Modelled maximum extent of Silurian drawdown/depressurisation that exceeds 3 m
- Modelled maximum extent of Ordovician drawdown/depressurisation that exceeds 3 m

Cadia AGMR 2020/2021 (G1383AA)

Cadia East Mine – monitoring bores where observed groundwater level declines may be associated with mining

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13/08/2021

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FIGURE No:
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4.4.2.2 Groundwater quality

Over the 2020/2021 water year, groundwater quality trigger exceedances were recorded in Silurian sediment bores MB47A (manganese) and MB62 (pH), as well as in Tertiary basalt bore MB88 (pH and manganese). Internal CVO 'level 1 investigations' concluded that exceedances observed in bores MB62 and MB88 are indicative of background conditions, while a rising trend in manganese was identified in bore MB47A. These CVO conclusions are further considered below.

A review of long-term trends for select analytes (pH, TDS, sulfate, aluminium, arsenic, copper, lead, manganese, nickel, zinc, mercury, and nitrite/nitrate) was undertaken, with time series plots provided in Appendix E. Concentrations of these analytes at monitoring bores surrounding the Cadia East Mine have generally remained stable over the period of monitoring, with notable trends and observations including:

- In bore MB47A increasing trends of manganese (from 2020) and nitrite + nitrate (from 2015) have been identified. Post 2018, concentrations of zinc are also observed to have declined to non-detectable levels. Increases of manganese/nitrite + nitrate concentrations are unlikely to be related to mining given that groundwater level variations are consistent with climate. Current increases of manganese are also consistent with historical concentrations.
- Bore MB51 has stable elevated concentrations of sulfate (long term average of 465 mg/L) relative to the rest of the Cadia East Mine monitoring network and the reason for these elevated concentrations is not known. Detectable concentrations of arsenic were recorded in January 2021, although this concentration is still low (0.005 mg/L) and less than the trigger level used for surrounding bores. A marked reduction in zinc concentrations to near the LOR is evident from 2018.
- pH levels in bore MB62 that fall below the WMP defined trigger level is consistent with historical data, although the reason for this relative acidity is unknown.
- pH levels and manganese concentrations in bore MB88 are consistent with historical observations, although it should be noted that only data from July 2019 is available. A slight increasing trend in arsenic concentrations is evident from 2020, although concentrations are still well below the WMP defined trigger.

Given that the potential impacts from mining at the Cadia East Mine are drawdown of the surrounding groundwater systems, any water quality variations that can be attributed to mining would therefore be linked to a changed flow regime. There is no explicit source of potential contaminants for this activity, which is dissimilar to other operational areas where tailings or surface water storages are present.

4.4.3 Assessment of potential impacts

To the north and east of the mine, drawdown appears to be more extensive than AGE (2021) modelled predictions (Figure 4.11). However, it should be noted, with respect to bores north/north-northwest of the mine, that bores MB48, MB82 and RB07 are likely installed into the Ordovician Volcanics rather than the Silurian sediments (Appendix A). As such, groundwater declines at these locations would be consistent with modelled predictions. Additionally, groundwater level declines in Tertiary basalt bore MB49 have been occurring since installation of the bore in April 2008, and as such declines cannot be solely attributed to the Cadia East mine, where mining first began in 2012.

Parts of Flyers Creek are conceptualised to be connected to the Silurian groundwater system (Figure 4.10). As such, apparent mining related groundwater level declines that have been observed in Silurian sediment bores MB43, MB44A, MB46, and MB73 should continue to be closely monitored (noting that bores MB43 and MB44A may be installed into the Ordovician volcanics). Drawdown and depressurisation at these locations is not predicted by recent numerical modelling (AGE, 2021). The potential for climatic influences resulting in the groundwater level declines that are observed in these Silurian sediment bores cannot be ruled out, given that post 2020 increases in the CRD generally correlate to a reduced rate of drawdown, or a stabilisation of levels. More data will be needed to confidently confirm the source of these declines, although the potential for a mining related impact means that they should be closely monitored. Irrespective of the cause, these same declines have not been observed in Silurian sediment bores MB47A and MB47B, which are the nearest monitoring points to Flyers Creek (where the mapped Silurian sediments underly the creek); and as such there is no evidence that Flyers Creek has been impacted by mining.

Groundwater level declines that have been observed in Tertiary basalt bore MB44B were not predicted by the AGE (2021) groundwater model. Declines at this location may be linked to a structural feature with enhanced permeability further propagating impacts, which is consistent with the conceptualisation for declines in bores MB45 and MB88.

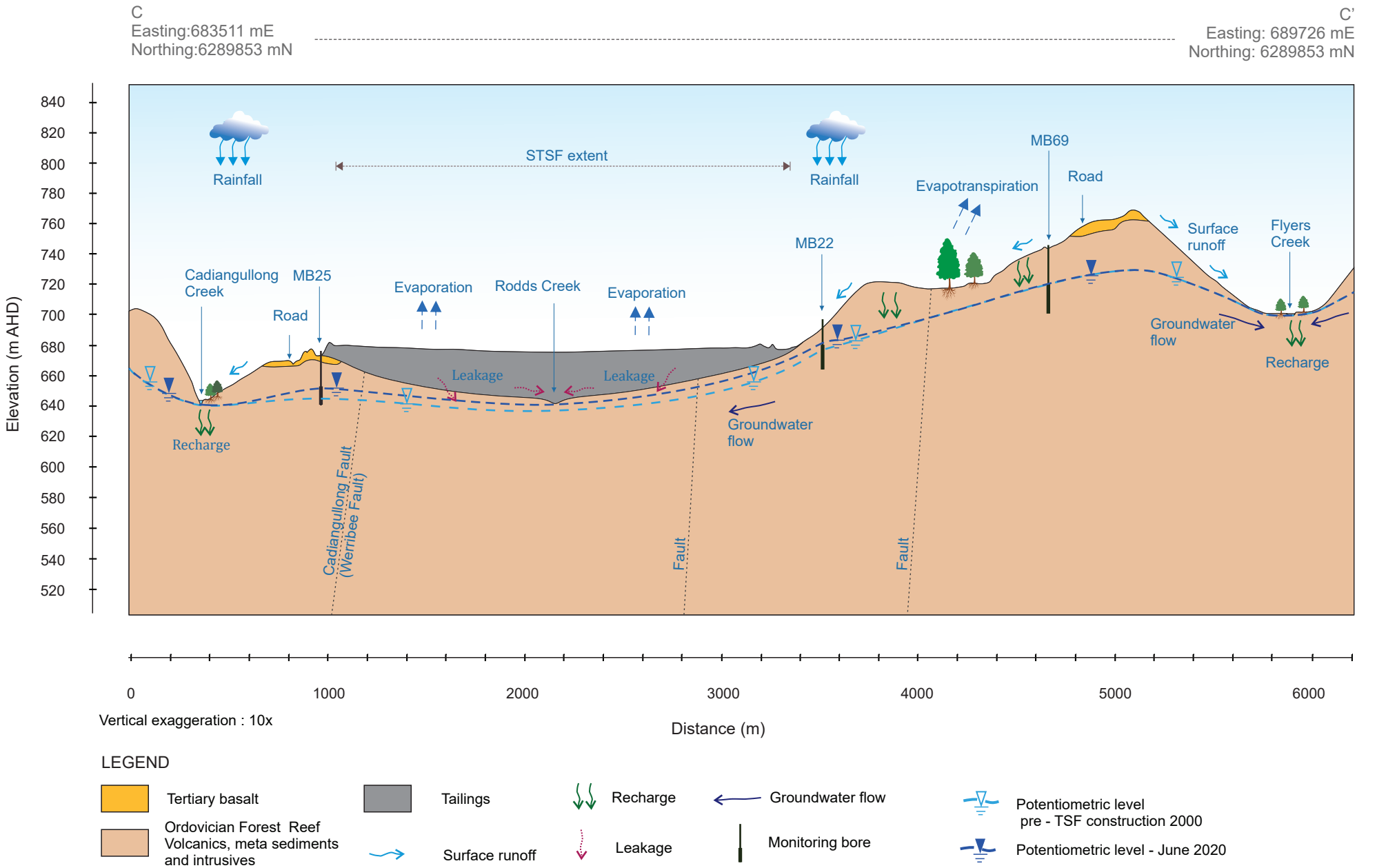
Several registered supply bores on privately owned land (Figure 3.7) are located within the zone of drawdown that is predicted to occur within the Ordovician volcanics. It is expected that most of these bores will be installed into the more productive Tertiary basalt, although a review of screened stratigraphies should be undertaken.

4.5 NTSF and STSF

4.5.1 Overview and hydrogeological conceptualisation

Tailings deposition in the NTSF and the STSF has been taking place since 1998 and 2002, respectively, although no deposition in the NTSF has taken place following an embankment slump in March 2018. Both the NTSF and the STSF are conceptualised to compress the underlying groundwater system due to the mass of the tailings (Figure 4.12 and Figure 4.13). Some seepage from the TSFs may occur, particularly from the STSF, where the clay seal blanket only partially covers the Rodds Creek channel. Conversely, the clay seal blanket constructed for the NTSF covers the entire Rodds Creek channel (GHD, 2018; KCB, 2019). Seepage to the west of the STSF is considered unlikely due to a conceptualised groundwater divide that results in flow towards the centre of the TSF, where Rodds Creek previously resided (GHD, 2018).

There is an extensive monitoring network that surrounds the NTSF/STSF (Figure 4.14), with most bores installed hydraulically down gradient of the TSFs (Figure 3.6), either between Cadiangullong Creek and the TSFs, or to the south of the STSF around the Rodds Creek channel. Several bores are also installed hydraulically upgradient of the TSFs (Figure 4.14). Many of the monitoring bores to the west of the TSFs are screened at relatively shallow depths (< 20 mbgl) to ensure that the shallow groundwater system, which may interact with Cadiangullong Creek, is actively monitored. As per Table 6-9 of the WMP, groundwater level and groundwater quality data from the monitoring network is generally collected on a quarterly basis, as well as from select bores that are hydraulically down gradient of the TSFs. Nearby groundwater dependent assets include Rodds Creek to the south of the STSF and Cadiangullong Creek, which is at its closest, approximately 1 km from the NTSF and 0.6 km from the STSF. It should be noted that nearby portions of Cadiangullong Creek constitute high priority GDEs under 2020 updates to the Water Sharing Plan (WSP) for the NSW Murray Darling Basin Fractured Rock Groundwater Sources.

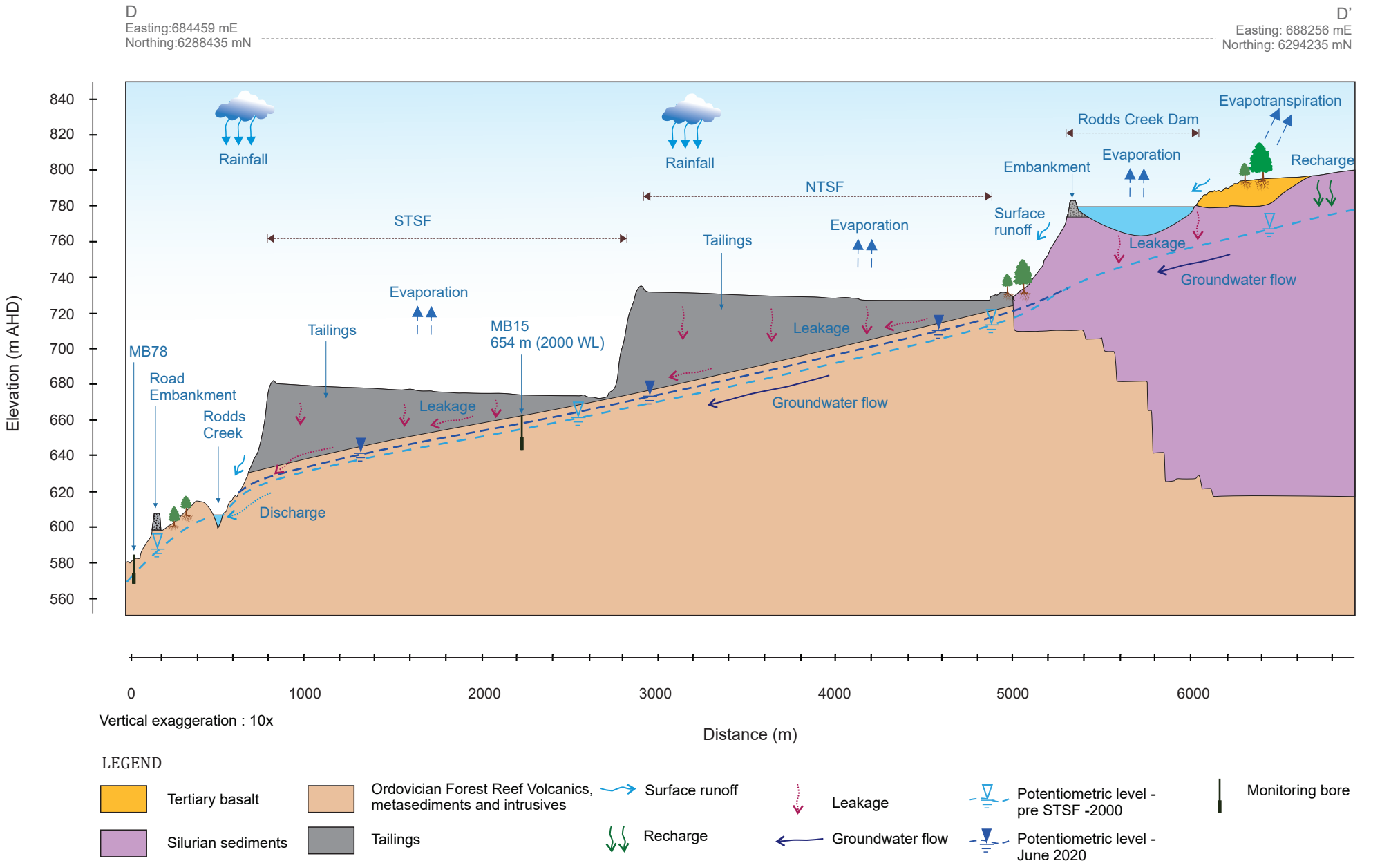


STSF conceptual cross section (C - C')

Figure - 4.12

Cadia AGMR 2020/2021 (G1383AA)

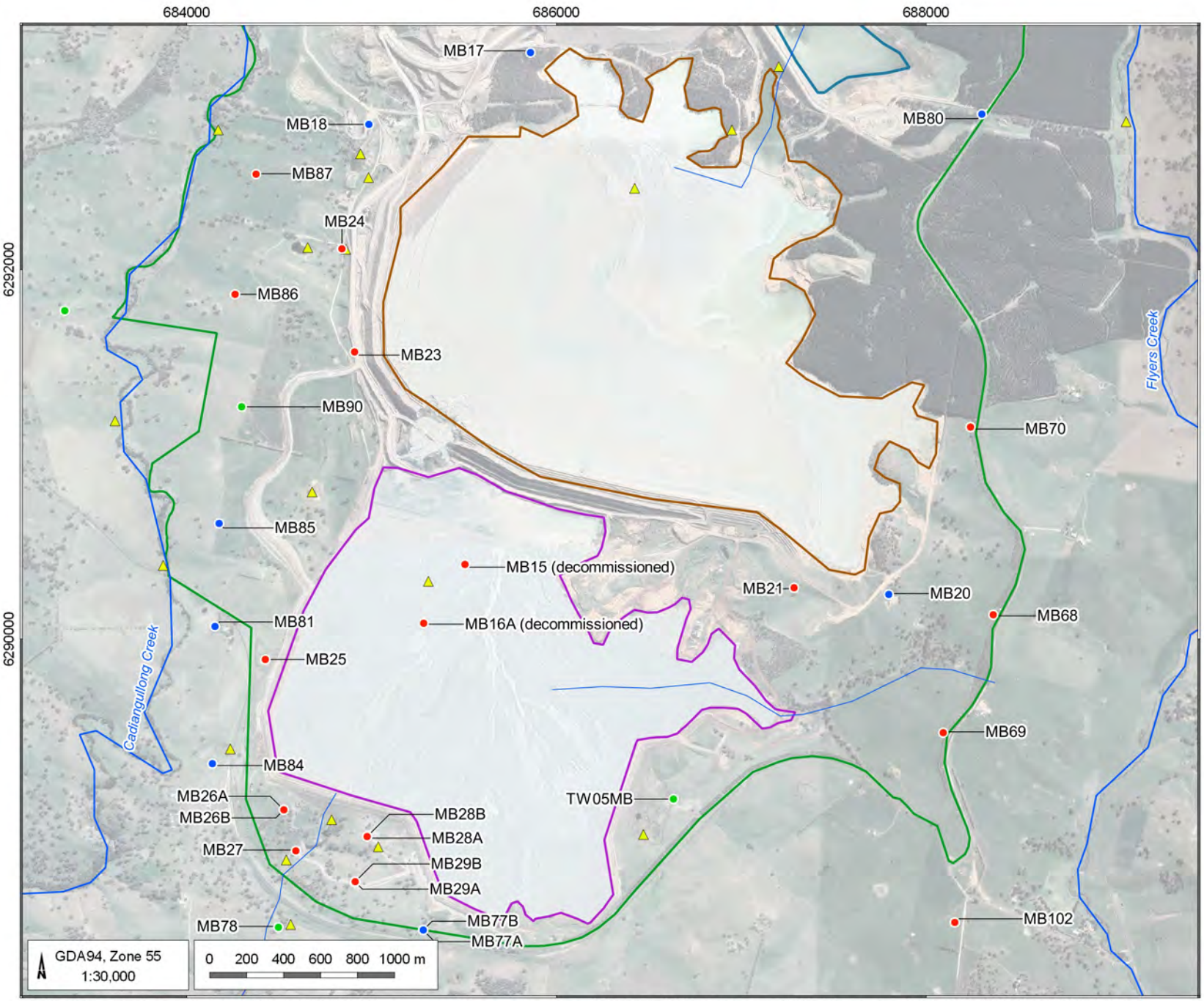
AGE



NTSF/STSF conceptual cross section (D - D')

Figure - 4.13

Cadia AGMR 2020/2021 (G1383AA)



LEGEND

- Surface water monitoring sites

Monitoring bore network

- Ordovician Volcanics
- Silurian Sediments
- Tertiary Basalt
- Drainage
- Mining lease
- Northern Tailings Storage Facility
- Southern Tailings Storage Facility
- Rodds Creek dam

Cadia AGMR 2020/2021 (G1383AA)

NTSF/STSF – surrounding monitoring bores

DATE
13/08/2021

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FIGURE No:
4.14

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4.5.2 Groundwater monitoring data

4.5.2.1 Groundwater levels

There were no exceedances of the WMP defined groundwater level guidelines in any NTSF/STSF monitoring bore over the 2020/2021 water year. A review of these guideline values indicates that several are excessive and would represent artesian conditions (bores MB23, MB25, and MB28B with a +40 m guideline; and bore MB24 with a +20 m guideline).

Groundwater level increases that can be attributed to the TSF were identified in 13 bores, six surrounding the NTSF and seven surrounding the STSF. The maximum groundwater level increase measured in each of these impacted bores is provided below in Table 4.4, with hydrographs provided in Figure 4.15, Figure 4.16, and in Appendix B. These bores are generally within 150 m of the TSF embankment, which indicates that increased groundwater levels are generally constrained to the area immediately surrounding the TSFs. Monitoring bores where groundwater level increases have been observed are largely located hydraulically downgradient of the TSFs, with the exception of bore MB22, which is interpreted to be hydraulically upgradient of the STSF.

Groundwater level variations in the remainder of the monitoring network are either consistent with climatic conditions, or stable with little variation of levels.

Table 4.4 Summary of groundwater level increases around NTSF/STSF

NTSF/STSF	ID	Initial groundwater level (mAHD)	Latest groundwater level (mAHD)	Maximum groundwater level (mAHD)	Maximum rise (m)	WMP guideline level of groundwater rise (m)
NTSF	MB15	650.06 Feb-1998	654.84 May-2004	654.93 Sep-2000	4.87	-
NTSF	MB16A	641.33 Feb-1998	644.01 Aug-2002	644.72 Sep-2000	3.39	-
NTSF	MB16B	641.14 Feb-1998	645.28 Feb-2003	645.28 Feb-2003	4.14	-
NTSF	MB18	698.2 Mar-1999	704.74 Apr-2021	704.74 Apr-2021	6.54	20
NTSF	MB23	668.56 Mar-1999	679.59 Apr-2021	679.59 Apr-2021	11.03	40
NTSF	MB24	680.99 Mar-1999	689.84 Apr-2021	689.84 Apr-2021	8.85	20
STSF	MB19A	648.6 Mar-1999	678.2 May-2018	679.55 Nov-2017	30.95	-
STSF	MB22	673.32 Mar-1999	683.71 Nov-2014	683.71 Nov-2014	10.39	-
STSF	MB25	649.99 Aug-2001	654.44 Apr-2021	658.46 Aug-2016	8.47	40
STSF	MB26A	642.48 Aug-2001	644.87 Apr-2021	648.32 Aug-2016	5.84	-
STSF	MB26B	631.36 Aug-2001	644.36 Apr-2021	646.5 Nov-2016	15.14	20
STSF	MB27	590.87 Aug-2001	592.49 May-2021	592.68 Apr-2021	1.81	5
STSF	MB28B	630.33 Aug-2001	634.62 Apr-2021	635.28 Aug-2016	4.95	40

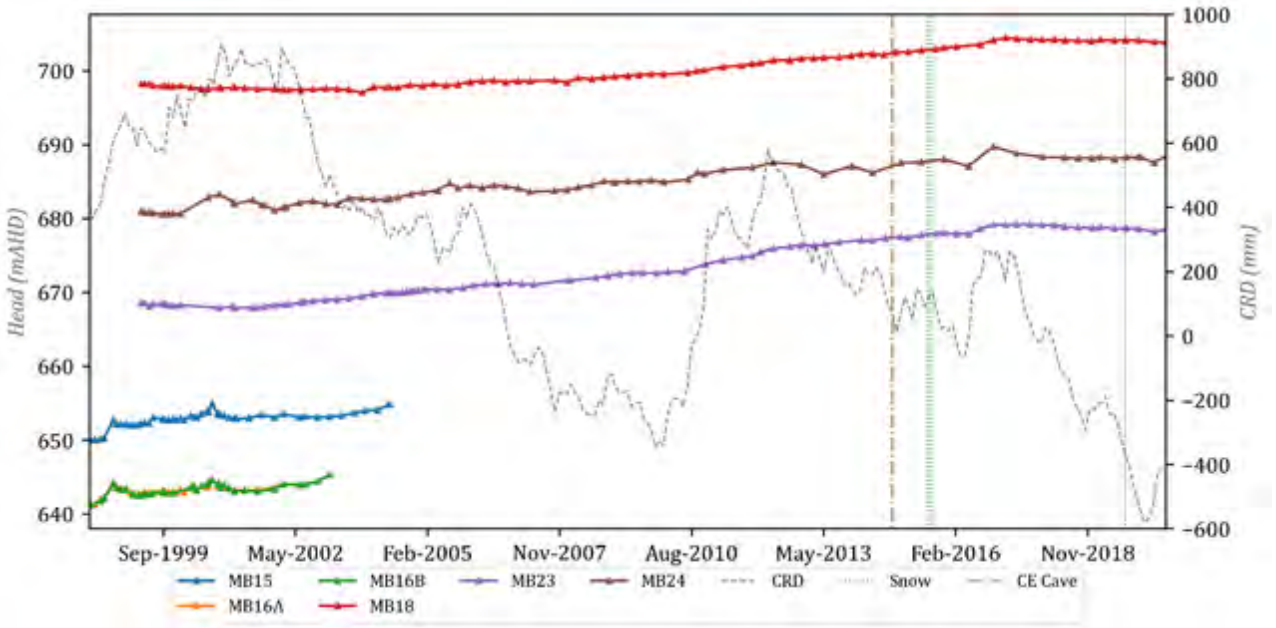


Figure 4.15 NTSF bores with increasing groundwater levels (AGE, 2021)

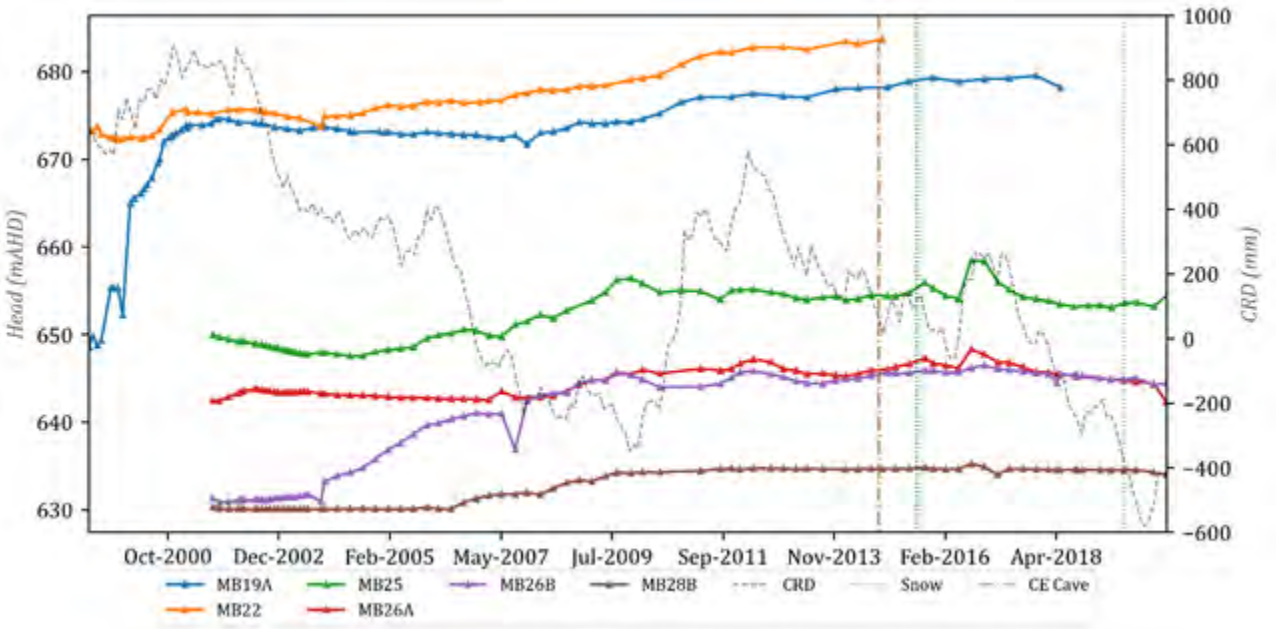


Figure 4.16 STSF bores with increasing groundwater levels (AGE, 2021)

4.5.2.2 Groundwater quality

Over the 2020/2021 water year, groundwater quality trigger exceedances were recorded in Ordovician bores MB69 (manganese), MB70 (pH), MB83 (TDS, sulfate, manganese), MB86 (pH, TDS, sulfate), and MB87 (TDS, sulfate, manganese, nickel); as well as Silurian bores MB20 (pH and sulfate), MB77A (pH, sulfate), MB77B (sulfate), and MB84 (pH, TDS, sulfate). Internal CVO 'level 1 investigations' concluded that exceedances observed are largely indicative of background conditions and are unlikely to be mine related. These CVO conclusions are further considered below, although it should be noted that all three of these bores are interpreted to be hydraulically upgradient of the TSFs.

A review of long-term trends for select analytes (pH, TDS, sulfate, aluminium, arsenic, copper, lead, manganese, nickel, zinc, mercury, and nitrite/nitrate) was undertaken, with time series plots provided in Appendix E. Concentrations of these analytes at monitoring bores surrounding the NTSF/STSF have generally remained stable over the period of monitoring, with notable trends and observations including:

- In bore MB20, post 2020 decreases of sulfate, aluminium, lead, and nickel haven been observed. Sulfate concentrations above the WMP defined trigger value (3,090 mg/L) were recorded over the 2020/2021 water year, although levels in the most recent three sampling events fell below this trigger (1,480 mg/L recorded in April 2021). Compared to other bores to the east of the TSFs, concentrations of major cations/anions and dissolved metals are relatively elevated in bore MB20. These elevated concentrations precede the construction of the TSF.
- Periods of increasing TDS and sulfate concentrations were recorded in bores MB21 (2014 to present), MB24 (1999 to 2004), MB25 (2010 to present), MB27 (2004 to present), MB78 (2018 to present), MB83 (2017 to 2019), MB84 (start of monitoring to present), and MB87 (2018 to present).
- Periods of increasing manganese concentrations were recorded in bores MB21 (2014 to present) and MB25 (2018 to present).
- Compared to the rest of the monitoring network, relatively high concentrations of mercury have been detected in bore MB77A (maximum of 0.016 mg/L); however this appears to be isolated.
- Periods of decreasing TDS, sulfate, and manganese concentrations were recorded in bores MB70 (2012 to 2018), MB79 (2016 to 2018), MB80 (2015 to 2018).

To identify potential seepage impacts, previous investigations (GHD, 2018) have used increasing sulfate concentrations as a correlation indicator. As discussed above, periods of increasing sulfate have been identified in bores MB21, MB24, MB25, MB27, MB78, MB83, and MB84. Similarly, a review of sulfate-chloride mass ratios shows increasing trends for bores MB23, MB25, MB27. MB78, and MB84. Chloride exhibits chemically conservative behaviour and has few sources except for meteoric deposition and mixing with higher chloride end-member waters. A common method in hydrochemistry is to normalise the concentrations of other major ions/elements to the concentration of chloride to identify the potential for source/sink mechanisms.

It is difficult to identify the potential for interactions between seepage and natural groundwater given that the water quality of the TSF decant water has similarities with native groundwater, is of low salinity, and has low concentrations of dissolved metals.

4.5.3 Assessment of potential impacts

Beneath the NTSF and the STSF groundwater levels have likely risen due to the mass of emplaced tailings compressing the underlying groundwater system. The result of this is seen clearly in bores that are directly adjacent to the TSFs, with up to a 31 m rise having been observed. The extent of these pressure induced groundwater level increases is not laterally extensive and is generally observed to only occur within 150 m of the TSF embankments. The extent of these impacts is well constrained/monitored in the direction of Cadiangullong Creek, where groundwater level variations in shallow monitoring bores MB87, MB86, MB90, MB85, MB81, and MB84 are consistent with climatic conditions. Impacts are similarly well constrained and monitored, up hydraulic gradient of the TSFs, and to the south of the STSF, in the direction of Rodds Creek (Figure 4.14).

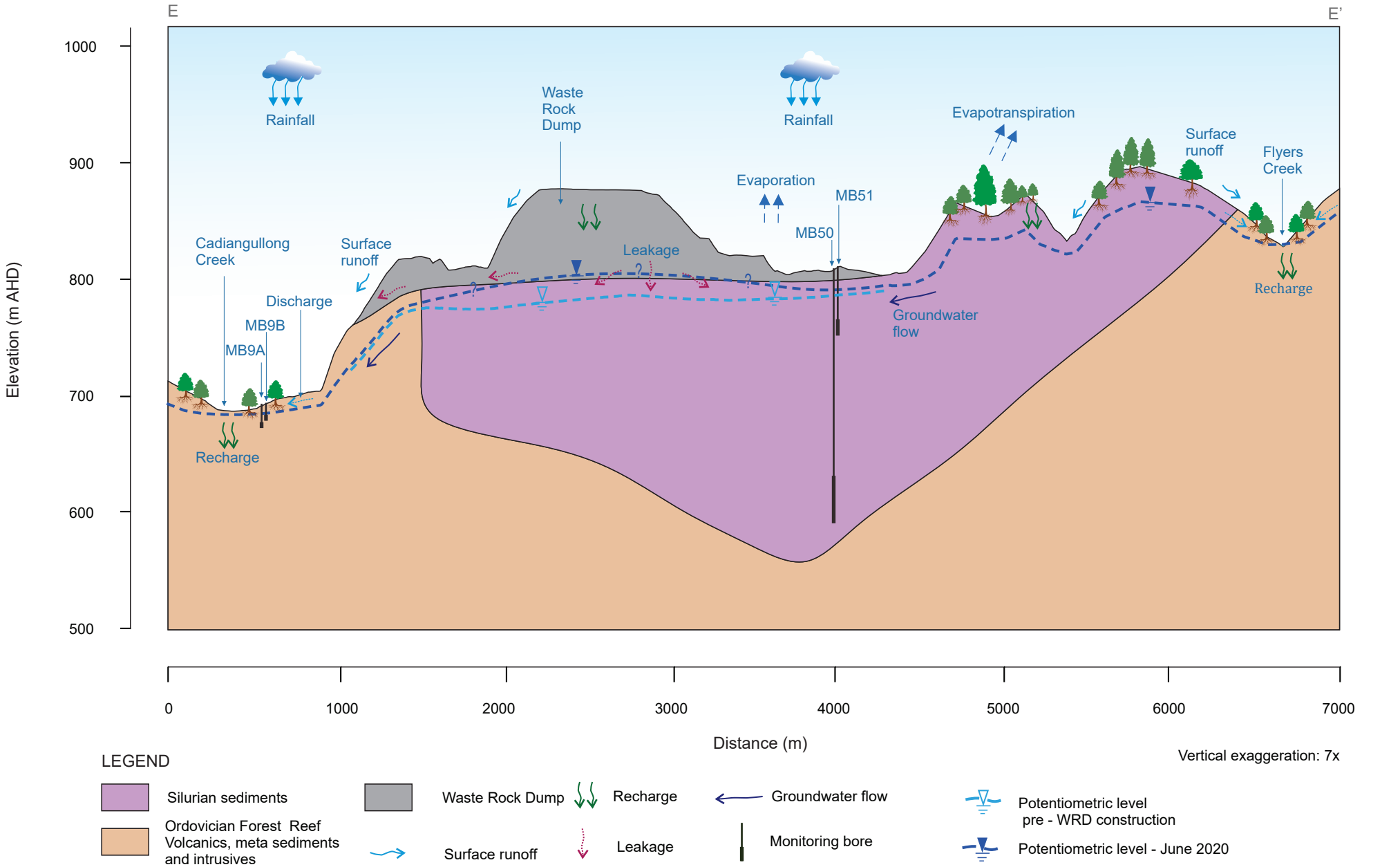
Direct seepage from the TSF is conceptualised and modelled to be a relatively small flux, with predictions from the recent AGE (2021) numerical model providing an average of 0.4 ML/day and 0.2 ML/day from the NTSF/STSF, respectively. These predictions are also consistent with the findings of other seepage investigations (KCB, 2019; GHD, 2018). Increasing sulfate concentrations have historically been used as an indicator for seepage contributions in groundwater. While these trends have been observed in several monitoring bores that are down hydraulic gradient of the TSFs, it is difficult to confidently attribute these increases to seepage. This is because the water quality of the TSF decant water has similarities with the native groundwater and is of low salinity and has low concentrations of dissolved metals. Regardless, a review of groundwater quality within the monitoring network indicates that there are no material exceedances of WMP defined triggers, nor do monitoring results suggest that there is any appreciable risk of environmental harm.

4.6 Southern Waste Rock Dump

4.6.1 Overview and hydrogeological conceptualisation

The southern waste rock dump has been in use since mining at the Cadia Hill Pit began in 1998, and it is still in use to support development activities at the Cadia East Mine. Although not observed in the current monitoring network, groundwater levels beneath the SWRD are expected to be elevated relative to natural conditions on account of: (a) compressional forces associated with the mass of the waste material; (b) enhanced recharge through what is inferred to be more permeable waste material relative to the natural geology; or (c) a combination of the two (Figure 4.17). Groundwater flow beneath the SWRD is inferred to be largely from the east-northeast to the west-southwest, in the direction of Cadiangullong Creek (Figure 3.6). There are two seepage collection dams on the western side of the SWRD and Rodds Creek Dam is located on the eastern side of the SWRD.

The groundwater monitoring network that surrounds the SWRD is comprised of three deeper Silurian sediment bores that are located hydraulically up gradient, as well as 17 shallow bores that are located hydraulically down gradient (Figure 4.14). An active production bore CB6 is also present adjacent to monitoring bore CB6A. As per Table 6-9 of the WMP, groundwater level and groundwater quality data is collected from thirteen of these shallow bores either quarterly or biannually. Hydraulically up gradient bores MB50, MB51, and MB52 are monitored as part of the monitoring program for the Cadia East Mine. The nearest groundwater dependent asset is Cadiangullong Creek, which is located approximately 500 m from the foot of the SWRD.



Southern Waste Rock Dump conceptual cross section (E - E')

Figure - 4.17

Cadia regular data reviews (G1383AA)

AGE

LEGEND

- Surface water monitoring sites
- Drainage
- Mining lease
- Cadia East subsidence zone
- Ore Processing Facilities
- South Waste Rock Dump
- Northern Tailings Storage Facility
- Rodds Creek dam

Monitoring network

- Ordovician Volcanics
- Silurian Sediments
- Soil/Clay
- Tertiary Basalt

Cadia AGMR 2020/2021 (G1383AA)

Southern Waste Rock Dump – surrounding monitoring bores

DATE
23/08/2021

AGE

FIGURE No:
4.18

©2021 Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) - www.ageconsultants.com.au; Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006

G:\Projects\G1383AA.Cadia regular data reviews\3_GIS\Workspaces\001_Deliverable1\04.18_G1383AA_Southern Waste Rock Dump – surrounding monitoring bores.qgs

4.6.2 Groundwater monitoring data

4.6.2.1 Groundwater levels

Groundwater level variations in the MB4 to MB11 series of shallow monitoring bores are all consistent with climatic conditions and variations strongly correlate with the CRD (Appendix B). Monitoring bore CB6A is clearly influenced by extraction from the adjacent production bore CB6 (Appendix B). Bores MB50, MB51, and MB52 are located near raised bore VR81 and the decommissioned raised bore VR71, which was drilled in early 2011. The groundwater elevation of bore MB50 is much lower than the groundwater elevations of bores MB51 and MB52 (Figure 4.19), which may be due to the draining of groundwater from a water bearing breccia structure at the contact between the Silurian limestone and the underlying Forest Reef Volcanics during the drilling of raised bore VR71. Increasing groundwater levels that could be associated with the SWRD are not apparent at these up hydraulic gradient locations (Appendix B).

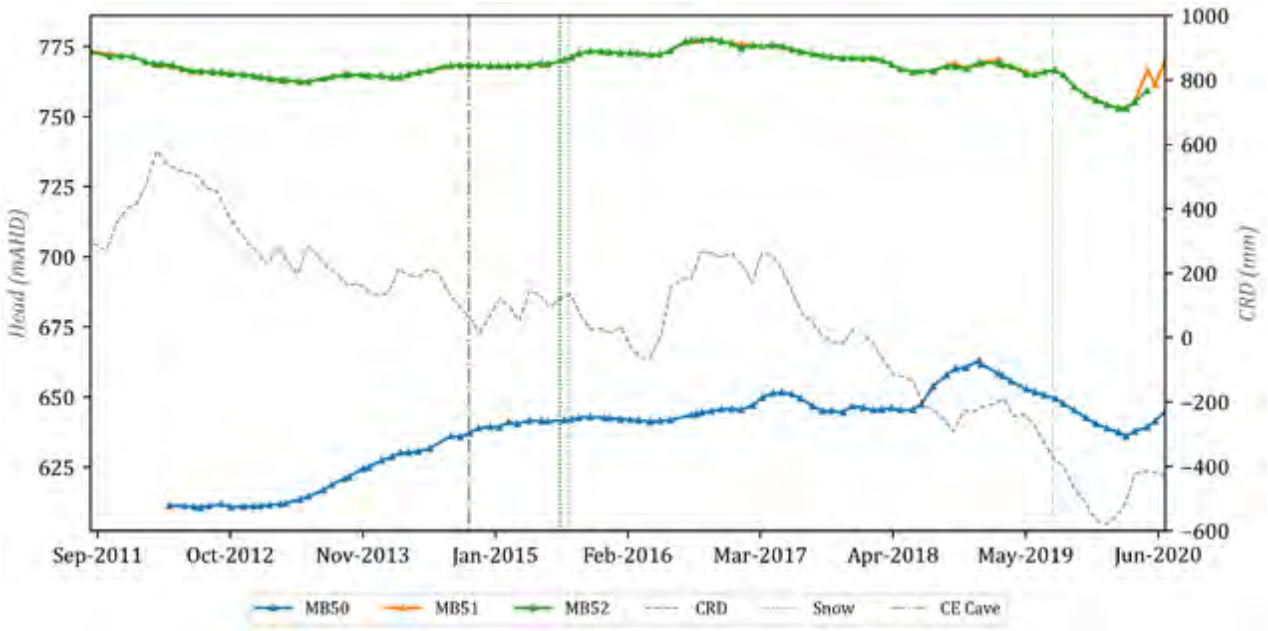


Figure 4.19 Hydrographs for bores up hydraulic gradient of WRD (AGE, 2021)

4.6.2.2 Groundwater quality

The WMP does not stipulate any groundwater quality triggers for the shallow monitoring bores that are hydraulically down gradient of the WRD. However, groundwater quality data is still collected at the frequencies prescribed in Table 6-9 of the WMP. A review of long-term trends for select analytes (pH, TDS, sulfate, aluminium, arsenic, copper, lead, manganese, nickel, zinc, mercury, and nitrite/nitrate) was undertaken, with time series plots provided in Appendix E. Notable trends and observations include:

- Largely ubiquitous increases of TDS and sulfate, which have been observed in bores MB4A (2000 to 2004), MB5C (2015 to present), MB6A (2004 to present), MB7A (1998 to present). MB8A (2012 to present), MB9A (2002 to 2018), MB10A (2007 to present), and MB11A (2002 to present).
- Relative to their deeper paired monitoring sites, nitrite + nitrate concentrations in the ‘B” series of bores are much higher, although there are a limited number of observations. Bore MB10A has also had relatively high concentration of nitrite + nitrate compared to the rest of the ‘A’ series of monitoring bores.
- Increases of manganese observed in bores MB4A (2016 to 2019, although subsequent decline), MB7A (1998 to present). And MB8A (2012 to present).

The waste rock dump leachate (leachate gauging stations CAWS34 and CAWS35) is chemically distinct from groundwater in its very high concentrations of nitrogen oxides, (CAWS34/CAWS35 long-term median of 73.6 mg/L and 73.3 mg/L, respectively; noting that concentrations are declining), and sulfate concentrations that are higher than that of groundwater (CAWS34/CAWS35 median of 1,930 mg/L and 2,340 mg/L, respectively), particularly with reference to early groundwater concentrations. Although elevated concentrations of nitrogen oxides are largely absent from groundwater, increasing concentrations of sulfate that have been observed may be indicative of some influence from the SWRD leachate.

4.6.3 Assessment of potential impacts

Groundwater levels in bores that are hydraulically down gradient of the WRD are consistent with climate, and no increases associated with the WRD are apparent. There is some evidence of WRD leachate influencing the groundwater quality of these monitoring bores, namely ubiquitous increases in sulfate and elevated concentrations of nitrogen oxides in the shallower soil/clay 'B" series of monitoring bores. Impacts to the nearby Cadiangullong Creek appear to be absent, with waste rock dump leachate being ionically dissimilar to the water in Cadiangullong Creek at surface water monitoring point 412161 (GHD, 2020).

4.7 Other areas

The groundwater monitoring network that surround the ore processing area is comprised of three paired monitoring sites, each of which have a shallow bore (< 7 mbgl) installed into soil/clay (bores MB1B, MB2B, and MB3B) and a deeper bore that is installed into Ordovician/Silurian units (bores MB1A, MB2A, and MB3A) (Figure 3.5). There are also two monitoring bores that are adjacent to the now decommissioned production bore CB14. Groundwater level variations are generally consistent with climate, noting that more than a 15 m decline was observed in bore MB1A between 2005 and 2008, and a steep decline in bore CB14B was also observed in 2007/2008, likely due to extraction from production bore CB14 (Appendix B). Groundwater levels have since recovered at these locations. No major changes in groundwater quality have been observed over the 2020/2021 water year and previous surface water investigations (GHD, 2020) have concluded that it is unlikely that the water from the site runoff pond is influencing groundwater, given that the salinity of groundwater is higher (Appendix E). Similarly, elevated concentrations of nitrogen oxides and molybdenum, which characterise water from the site runoff pond, are also absent in groundwater

For the purposes of this investigation, monitoring bores are classified as 'regional' where the bore is more than 2 km distant from any of the previously defined operational areas (Figure 3.5). These bores are largely located to the north and east of the Cadia East Mine outside, or on the outer edge of modelled drawdown predictions (bores MB53, MB54, MB55, MB56, MB63, MB64, MB65, MB71, MB72, MB74, MB75, RB01). Groundwater level hydrographs (Appendix B) for several of these bores show groundwater level variations that are likely indicative of private extraction from nearby supply bores. Groundwater level variations in regional bores MB53, MB54, MB56, and RB01 are consistent with climatic conditions (Appendix B). Increasing concentrations of nitrogen oxides are seen in bores MB54, MB56, and MB63 and are most likely associated with agricultural activities (Appendix E).

5 Statement of compliance

Groundwater monitoring over the 2020/2021 water year was largely compliant with the prescribed sampling locations and frequency listed in Table 6-9 of the WMP. With respect to the data that was provided to AGE, some minor disparities to the WMP were identified, although these would not impact the findings of this investigation. These disparities include:

- no data collected from bore MB89 due to the bore being abandoned on account of its proximity to the subsidence zone (monthly sampling stipulated);
- an absence of groundwater quality monitoring in bore MB91 after September 2020 due to damage from ground movement (monthly sampling stipulated);
- due to prohibition notice that was issued by the NSW Natural Resources Regulator in January 2019, no data was collected from bores PZ4, PZ5, PZ10, PZ10A, PZ89, PZ89A, and PZ90, due to restricted access;
- an absence of groundwater level monitoring data for productions bores CB6, CB8, and CB9, although it is noted that water level observations from active production bores are not particularly useful due to pumping related fluctuations (quarterly groundwater level sampling stipulated); and
- no data collected from the 'TW' series of bores, although these were proposed when the WMP was developed and post-installation, only bore TW05MB was considered suitable for conversion to a monitoring bore (monthly sampling stipulated).

6 Conclusions

Cadia Hill Pit

Increased groundwater levels that can likely be attributed to tailings deposition were identified in two Ordovician bores, MB94 and the now decommissioned MB95. Increases in arsenic concentrations and a decrease in the sulfate-chloride mass ratio, were also observed in these bores, which further supports localised interaction between the tailings decant water and groundwater. The risk of this groundwater migrating away from the pit is minimal, given that monitoring data and numerical modelling both show and predict an inwards hydraulic gradient, which means that groundwater flow is towards the pit. The potential for the offsite migration of impacted groundwater is adequately monitored, with a large number of groundwater monitoring bores installed at various depths, particularly in the direction of Cadiangullong Creek.

Ridgeway Mine

Groundwater level declines after the 2002 surface breakthrough were observed in many monitoring bores, and in general the levels have since stabilised. There are a large number of active monitoring bores that delineate the extent of drawdown associated with the mine, particularly to the west. It is considered unlikely that there is any mining related effect on groundwater-surface water interactions (if present) at nearby sections of Cadiangullong Creek/Swallow Creek. Potential impacts to the nearby registered supply bore (GW700701) should be taken into consideration.

Cadia East Mine

Observed groundwater level declines are generally consistent with modelled predictions, although there is some evidence that drawdown in the Silurian sediments to the east of the mine may be more extensive than predicted. However, declines have not been observed in Silurian sediment bores MB47A and MB47B, which are the nearest monitoring points to Flyers Creek, nor can the potential for climate related declines be ruled out, particularly due to the severity of the 2017 to 2019 drought. Similarly, observed groundwater declines at Tertiary basalt bore MB48 were not predicted and may be associated with a structural feature in the underlying rocks further propagating impacts. Several private supply bores are located within the predicted zone of depressurisation for the Ordovician volcanics, and as such the screened intervals of these bores should be verified. The existing monitoring network is considered adequate in its ability to monitor the extent of impacts, although monitoring in the Ordovician volcanics is limited to the north and east of the mine.

NTSF/STSF

Around the NTSF and the STSF groundwater level increases have been observed in bores that are directly adjacent to the TSFs, likely due to the mass of emplaced tailings compressing the underlying groundwater system. The extent of these pressure induced groundwater level increases is not laterally extensive. Direct seepage from the TSF is conceptualised and modelled to be relatively minor, and although there may be some indicators of seepage effecting groundwater chemistry, the potentially impacted groundwater is still of good enough quality that it is unlikely to represent a risk to the surrounding environment. The extent of potential impacts are well constrained and monitored in the direction of down gradient receptors, Cadiangullong Creek and Rodds Creek.

Southern Waste Rock Dump

Groundwater levels in bores that are hydraulically down gradient of the SWRD are consistent with climatic conditions, and no increases associated with the SWRD are apparent. There is some evidence of SWRD leachate influencing the groundwater quality of down gradient monitoring bores, namely increasing concentrations of sulfate and elevated concentrations of nitrogen oxides. However, impacts to the nearby Cadiangullong Creek appear to be absent, with waste rock dump leachate being ionically dissimilar to the water in Cadiangullong Creek.

Other areas

No major changes in groundwater quality were observed within monitoring network for the ore processing area over the 2020/2021 water year. Regional monitoring bores, which are located at least 2 km away from operational activities, show no influence of operational activities on water levels. These bores show trends similar to climatic variations, or water level variations associated with pumping from surrounding landholder bores. Increasing concentrations of nitrogen oxides are seen in some bores and are most likely associated with agricultural activities.

7 Recommendations

Based on this investigation, AGE recommend the following:

- *Potential errors in current WMP*
  - Revise some of the aquifer attribution details for select monitoring bores as per Appendix A of this report. A review of geological mapping and modelling, which was completed as part of the AGE (2021) model update, identified a number of bores where the CVO environmental database/WMP defined screened interval of Ordovician volcanics/Silurian sediments is likely incorrect.
  - Amend the initial groundwater levels for bores MB25 and MB78 that are provided in Table 6-7 of the WMP. A review of historical data indicates that the currently provided levels in the WMP are incorrect.
  - Amend water level trigger guidelines for several of the bores surrounding the STSF/NTSF, as these assigned guideline levels are above ground surface.
- *WMP amendments*
  - Consider introducing a TARP for groundwater level guidelines. Currently the WMP does not require any further investigations following an exceedance of these guideline values. Given that the potential impacts from mining/tailings emplacement are decreases/increases in groundwater levels, it is importance that when identified, these variations trigger further investigatory works.
  - AGE believe the groundwater monitoring program can be better refined, which will reduce the frequency and scope of water quality monitoring. For example, quarterly groundwater sampling of 'regional' monitoring bores (Section 4.7) to the north and east of the Cadia East Mine may not be necessary, given the distance from operations and the low likelihood of mining related impacts. Additionally, if groundwater level TARPs are appropriately put into place, it is possible to tie these into groundwater quality TARPs. For instance, a more extensive sampling frequency/analyte suite (e.g. quarterly sampling with full suite) could be triggered if groundwater declines/increases have previously been observed.
- *Additional monitoring*
  - Collect biannual water quality data from WRD monitoring bores MB4B, MB6B, MB7B, MB8B, MB9B, MB10B, and MB11B. Current water quality is only collected from the deeper 'A' series of bores. However, monitoring from the shallower 'B' series is recommended given that: (a) a potential groundwater-surface water connectivity with Cadiangullong Creek is most likely to occur through the shallowest system; and (b) historical observations in the 'B' series of bores have shown elevated concentrations of nitrogen oxides, which is similarly elevated in WRD leachate.
  - Additional deep monitoring multilevel piezometers installed in the Ordovician Volcanics and overlying units to the north, east and south of Cadia East to better assess the propagation of mine induced drawdown upwards through the deeper strata and potentially into the basalt. The tertiary basalt is actively extracted from within the region. Multilevel groundwater level observations will ensure that future numerical modelling can better refine the extent of drawdown.
  - Additional deep monitoring bores/multilevel piezometers around the Ridgway Mine subsidence zone to better assess and model drawdown impacts.
  - Consideration of more groundwater monitoring adjacent to Flyers Creek, where additional monitoring bores will allow for the better detection of potential impacts to Flyers Creek.
- *Groundwater dependent assets*
  - With reference to the most recent model predictions (AGE, 2021), determine if any private bores are predicted to be impacted by groundwater drawdown, and if so, consider monitoring for potential impacts. This is particularly important where private bores extract from the Ordovician volcanics, where drawdown may be significant.

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Appendix A

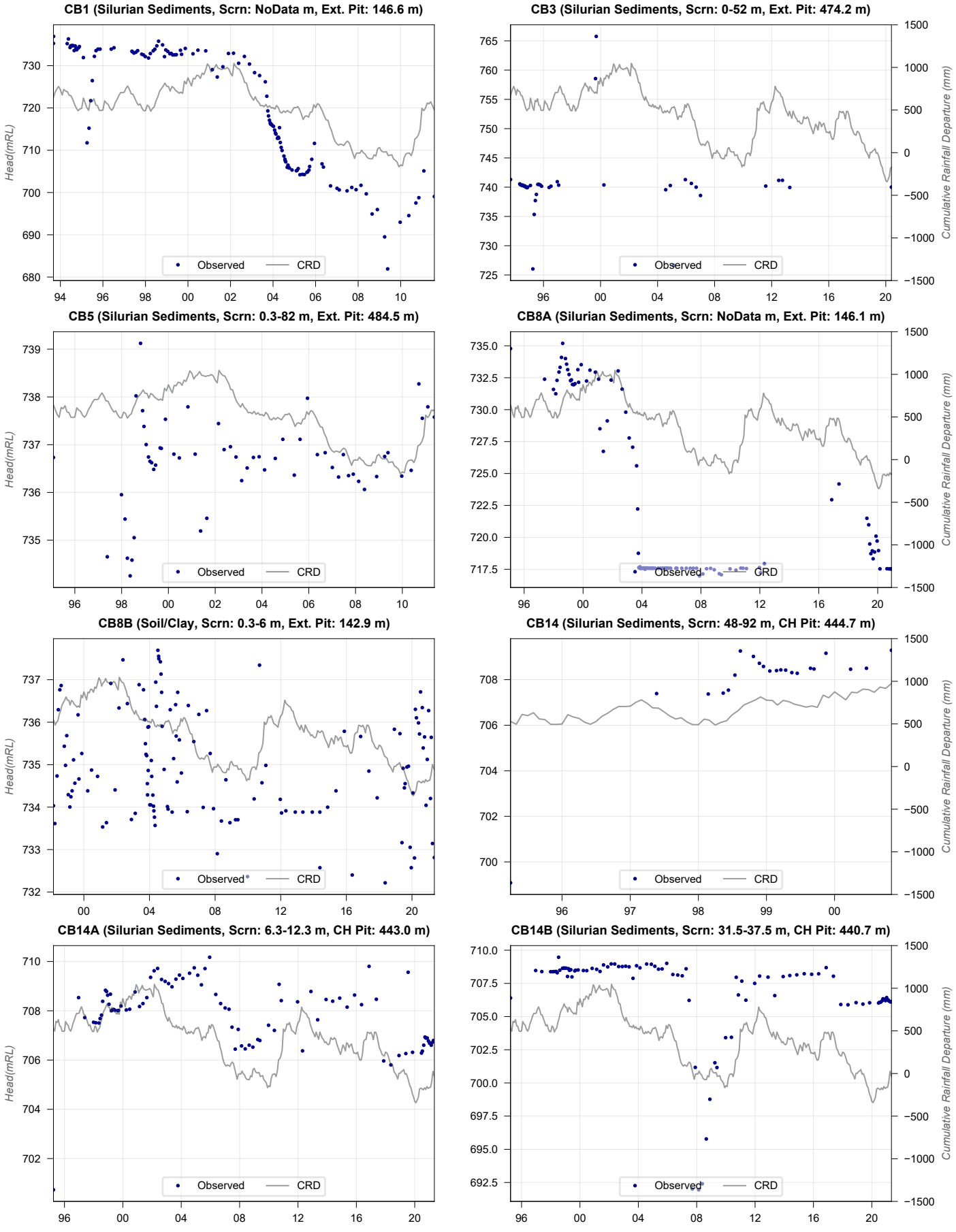
Potential errors in CVO database defined screened aquifer

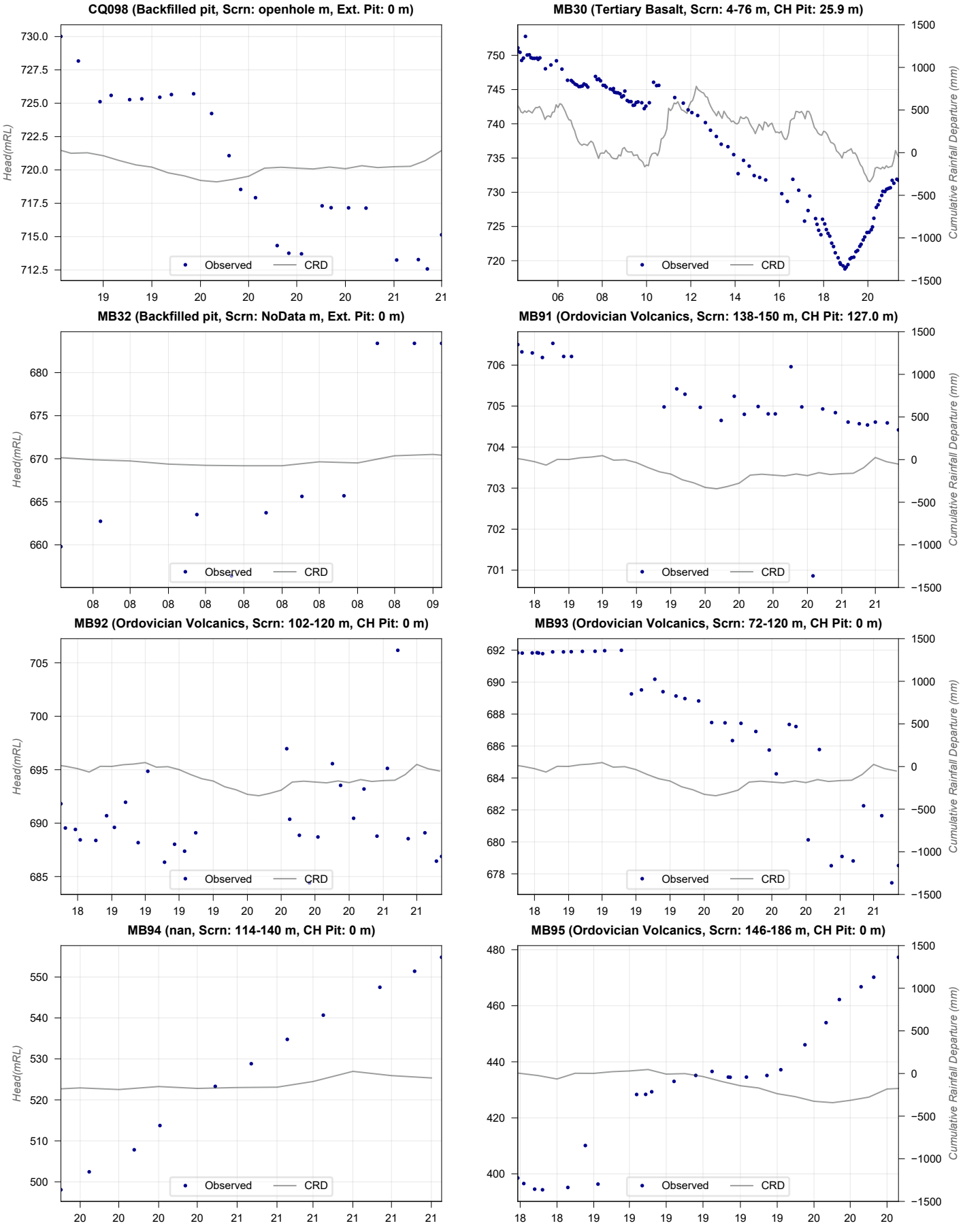
Bore ID	Easting (m)	Northing (m)	CVO aquifer attribution	Proposed aquifer attribution	Screened Interval (mbgl)	Screen top (mAHD)	Screen base (mAHD)
CB3	685654	6297811	Silurian Sediments	Ordovician Volcanics	0-52	765	713
CB5	685588	6297872	Silurian Sediments	Ordovician Volcanics	0.3-82	741	659
CB6A	684407	6293813	Silurian Sediments	Ordovician Volcanics	0.5-38	688	650
CB14	684937	6295314	Silurian Sediments	Ordovician Volcanics	48-92	673	629
CB14A	684907	6295331	Silurian Sediments	Ordovician Volcanics	6.3-12.3	705	699
CB14B	684909	6295333	Silurian Sediments	Ordovician Volcanics	31.5-37.5	680	674
MB1A	684980	6294930	Silurian Sediments	Ordovician Volcanics	28.5-34.5	694	688
MB3A	684827	6295130	Silurian Sediments	Ordovician Volcanics	10-16	701	695
MB7A	684588	6293430	Silurian Sediments	Ordovician Volcanics	12-18	675	669
MB8A	684452	6293416	Silurian Sediments	Ordovician Volcanics	11.5-17.5	673	667
MB10A	684516	6293538	Silurian Sediments	Ordovician Volcanics	12-18	676	670
MB11A	684450	6293529	Silurian Sediments	Ordovician Volcanics	12-18	675	669
MB18	684985	6292785	Silurian Sediments	Ordovician Volcanics	17.6-29.6	704	692
MB43	688945	6295921	Silurian Sediments	Ordovician Volcanics	75-175	858	758
MB44A	688951	6295907	Silurian Sediments	Ordovician Volcanics	82-142	851	791
MB48	688651	6297936	Silurian Sediments	Ordovician Volcanics	26-69	948	905
MB65	689344	6299606	Silurian Sediments	Ordovician Volcanics	26-62	902	866
MB71	694087	6295182	Ordovician Volcanics	Tertiary Basalt	21.8-33.8	930	918
MB77A	685278	6288427	Silurian Sediments	Ordovician Volcanics	6-12	654	648
MB77B	685280	6288426	Silurian Sediments	Ordovician Volcanics	23-29	637	631
MB79	684296	6288041	Silurian Sediments	Ordovician Volcanics	34-40	541	535
MB80	688301	6292840	Silurian Sediments	Ordovician Volcanics	54-64	750	740
MB81	684153	6290069	Silurian Sediments	Ordovician Volcanics	14-19	643	638
MB82	687648	6297324	Silurian Sediments	Ordovician Volcanics	91-103	872	860
MB84	684139	6289326	Silurian Sediments	Ordovician Volcanics	10.97-13.97	639	636
MB85	684175	6290626	Silurian Sediments	Ordovician Volcanics	25.84-22.84	651	654
MB89	687517	6296042	Ordovician Volcanics	Silurian Sediments	114-126	799	787
MB91	685820	6295564	Ordovician Volcanics	Silurian Sediments	138-150	649	637
PZ4	686021	6295821	Ordovician Volcanics	Silurian Sediments	36-45	713	704

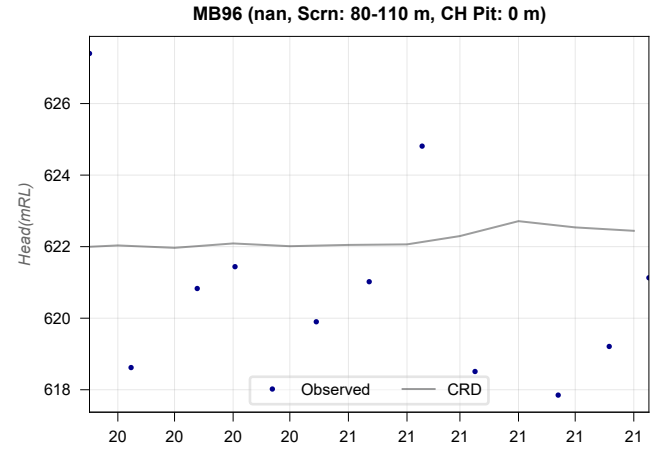
Bore ID	Easting (m)	Northing (m)	CVO aquifer attribution	Proposed aquifer attribution	Screened Interval (mbgl)	Screen top (mAHD)	Screen base (mAHD)
PZ5	686011	6295816	Ordovician Volcanics	Silurian Sediments	83-95	665	653
PZ10	685826	6295622	Ordovician Volcanics	Silurian Sediments	75-85	698	688
PZ10A	685826	6295619	Ordovician Volcanics	Silurian Sediments	30-54	743	719

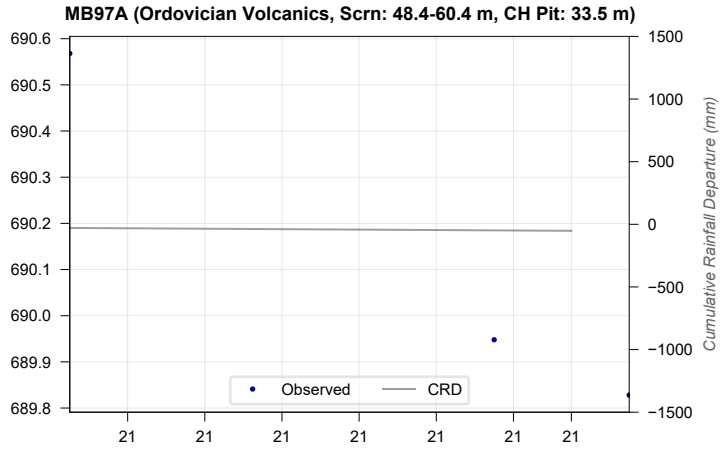
Appendix B

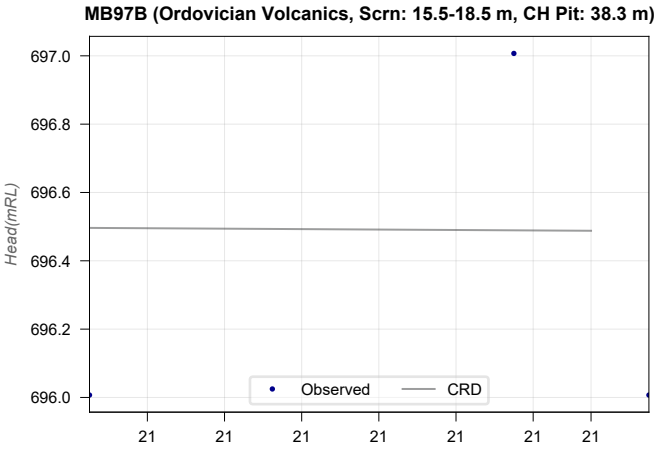
CVO hydrographs

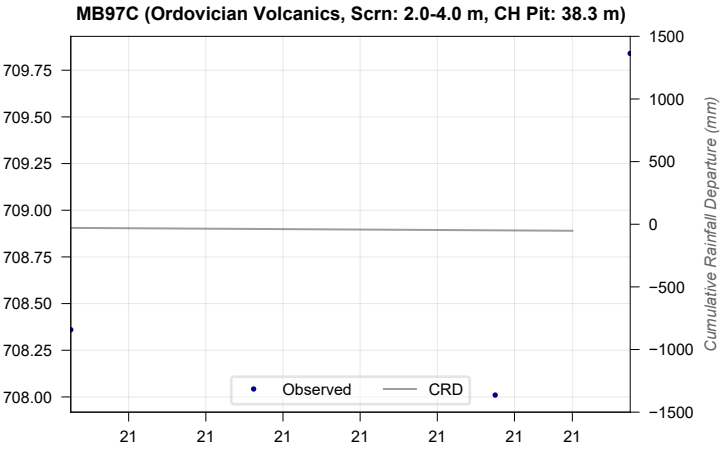

CB1 (Silurian Sediments, Scrn: NoData m, Ext. Pit: 146.6 m)
CB3 (Silurian Sediments, Scrn: 0-52 m, Ext. Pit: 474.2 m)
CB5 (Silurian Sediments, Scrn: 0.3-82 m, Ext. Pit: 484.5 m)
CB8A (Silurian Sediments, Scrn: NoData m, Ext. Pit: 146.1 m)
CB8B (Soil/Clay, Scrn: 0.3-6 m, Ext. Pit: 142.9 m)
CB14 (Silurian Sediments, Scrn: 48-92 m, CH Pit: 444.7 m)
CB14A (Silurian Sediments, Scrn: 6.3-12.3 m, CH Pit: 443.0 m)
CB14B (Silurian Sediments, Scrn: 31.5-37.5 m, CH Pit: 440.7 m)
Head(mRL)
Cumulative Rainfall Departure (mm)
Observed
CRD

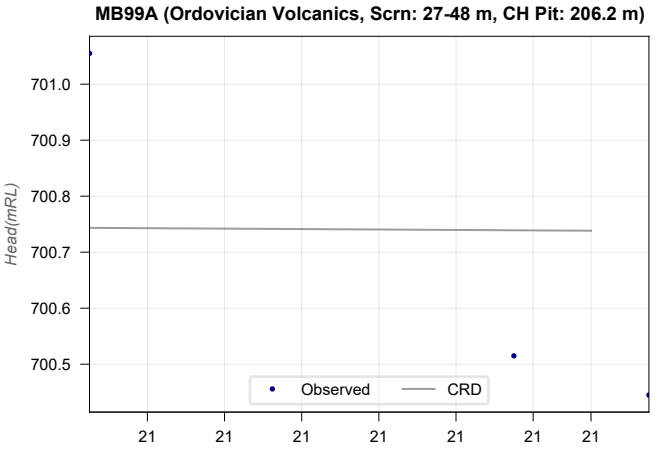

CQ098 (Backfilled pit, Scrn: openhole m, Ext. Pit: 0 m)
MB30 (Tertiary Basalt, Scrn: 4-76 m, CH Pit: 25.9 m)
MB32 (Backfilled pit, Scrn: NoData m, Ext. Pit: 0 m)
MB91 (Ordovician Volcanics, Scrn: 138-150 m, CH Pit: 127.0 m)
MB92 (Ordovician Volcanics, Scrn: 102-120 m, CH Pit: 0 m)
MB93 (Ordovician Volcanics, Scrn: 72-120 m, CH Pit: 0 m)
MB94 (nan, Scrn: 114-140 m, CH Pit: 0 m)
MB95 (Ordovician Volcanics, Scrn: 146-186 m, CH Pit: 0 m)
Head(mRL)
Cumulative Rainfall Departure (mm)
Observed
CRD

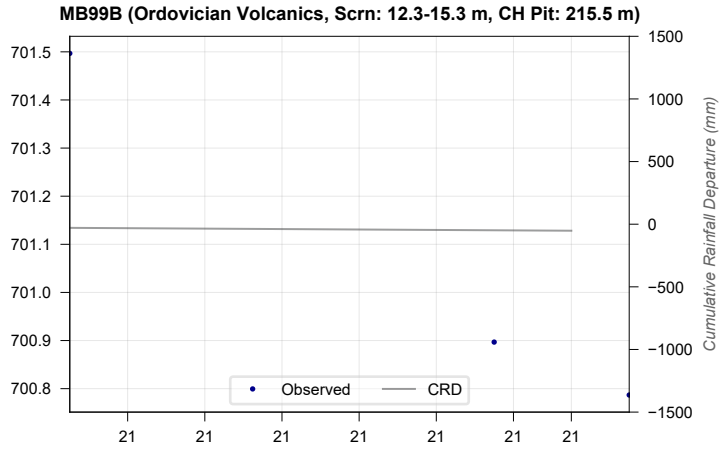

MB96 (nan, Scrn: 80-110 m, CH Pit: 0 m)
Head(mRL)
Observed
CRD

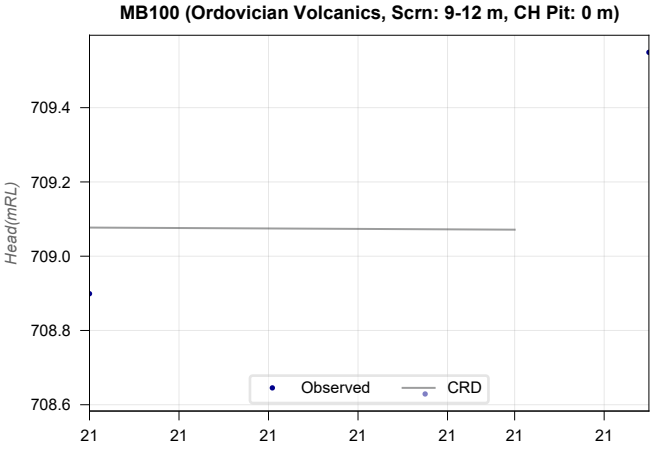

MB97A (Ordovician Volcanics, Scrn: 48.4-60.4 m, CH Pit: 33.5 m)
Cumulative Rainfall Departure (mm)
Observed
CRD

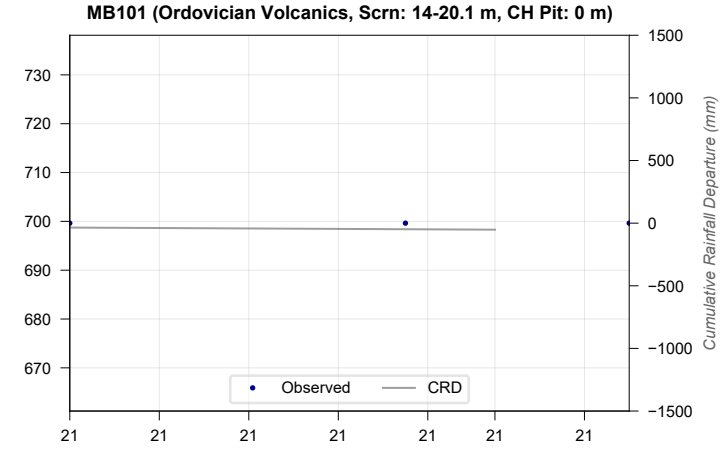

MB97B (Ordovician Volcanics, Scrn: 15.5-18.5 m, CH Pit: 38.3 m)
Head(mRL)
Observed
CRD

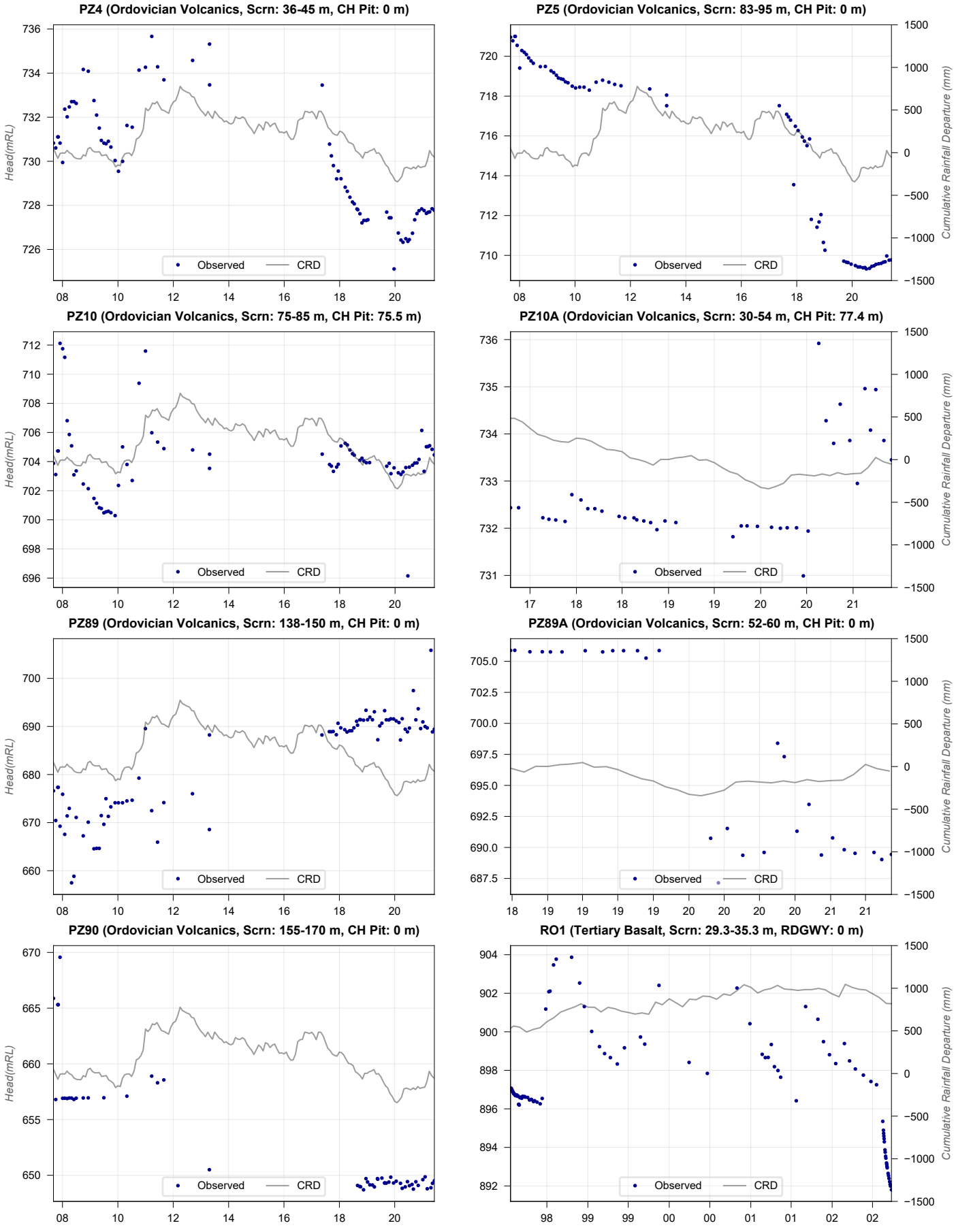

MB97C (Ordovician Volcanics, Scrn: 2.0-4.0 m, CH Pit: 38.3 m)
Cumulative Rainfall Departure (mm)
Observed
CRD

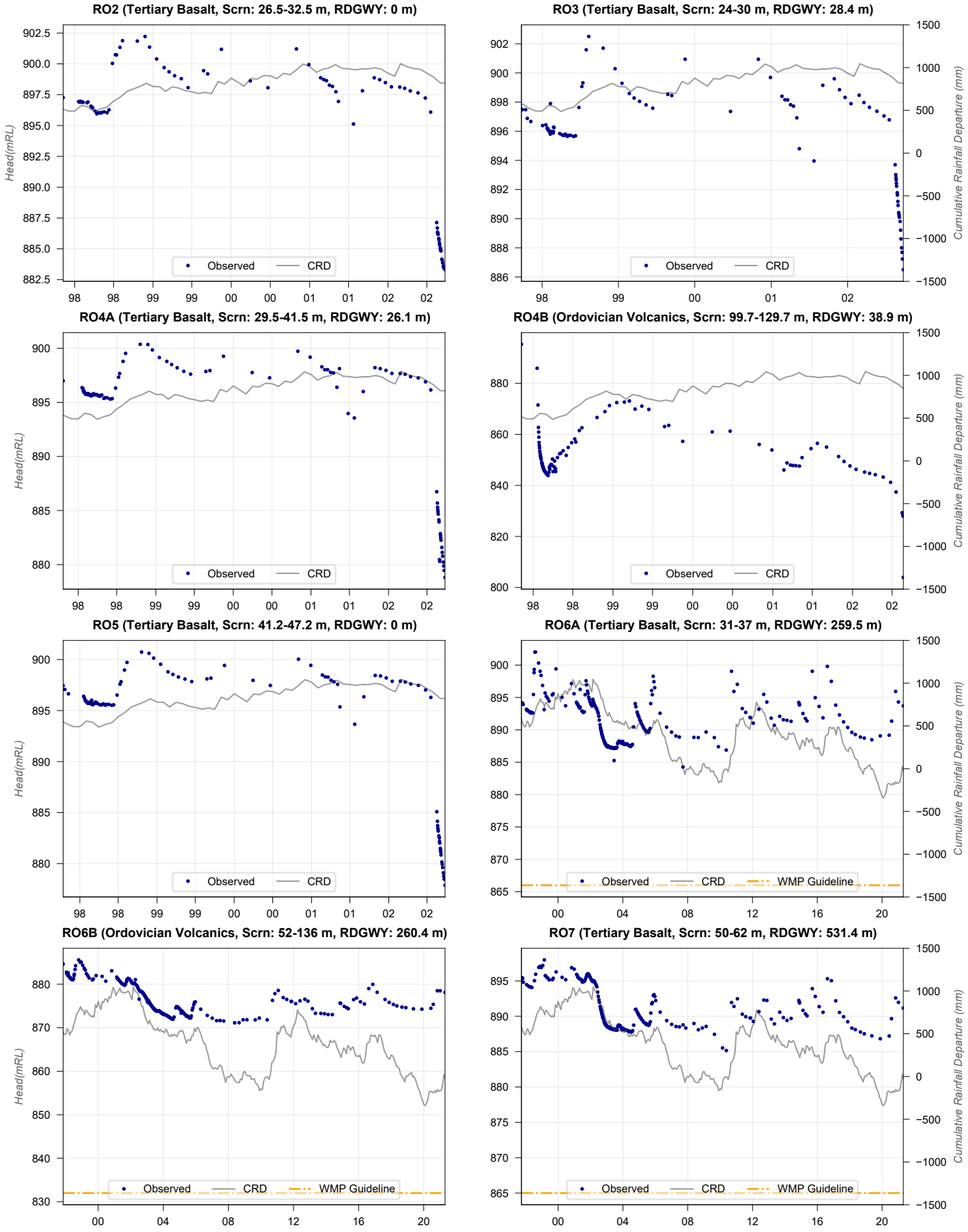

MB99A (Ordovician Volcanics, Scrn: 27-48 m, CH Pit: 206.2 m)
Head(mRL)
Observed
CRD

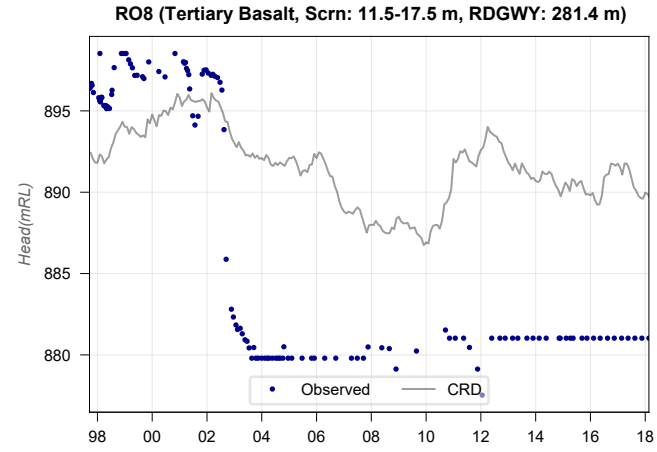

MB99B (Ordovician Volcanics, Scrn: 12.3-15.3 m, CH Pit: 215.5 m)
Cumulative Rainfall Departure (mm)
Observed
CRD

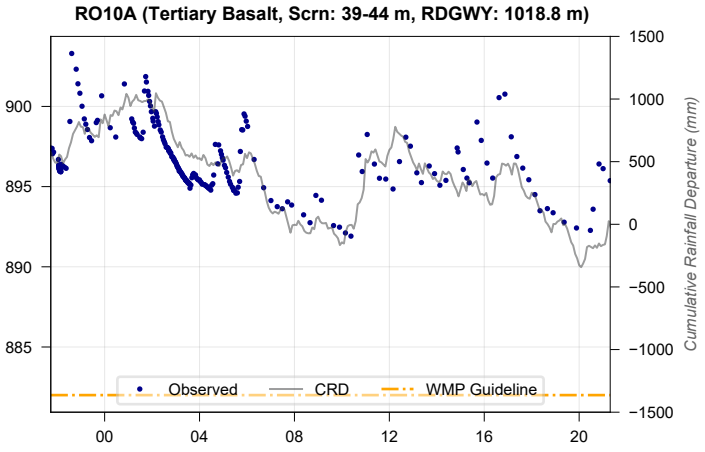

MB100 (Ordovician Volcanics, Scrn: 9-12 m, CH Pit: 0 m)
Head(mRL)
Observed
CRD

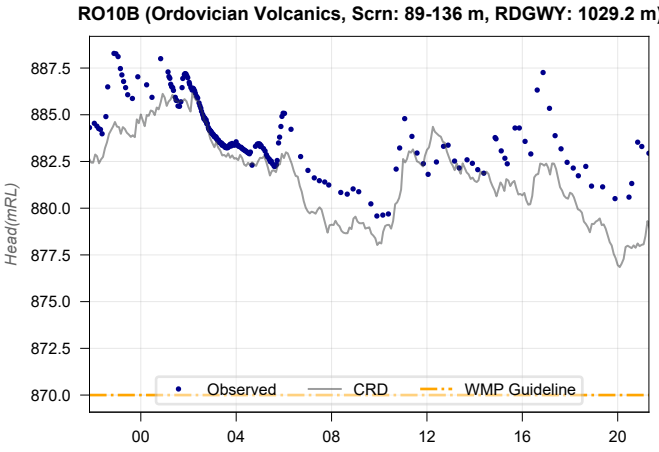

MB101 (Ordovician Volcanics, Scrn: 14-20.1 m, CH Pit: 0 m)
Cumulative Rainfall Departure (mm)
Observed
CRD

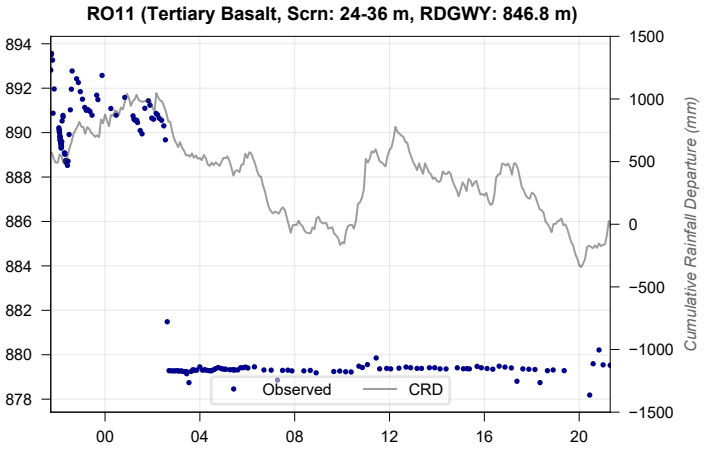

PZ4 (Ordovician Volcanics, Scrn: 36-45 m, CH Pit: 0 m)
PZ5 (Ordovician Volcanics, Scrn: 83-95 m, CH Pit: 0 m)
PZ10 (Ordovician Volcanics, Scrn: 75-85 m, CH Pit: 75.5 m)
PZ10A (Ordovician Volcanics, Scrn: 30-54 m, CH Pit: 77.4 m)
PZ89 (Ordovician Volcanics, Scrn: 138-150 m, CH Pit: 0 m)
PZ89A (Ordovician Volcanics, Scrn: 52-60 m, CH Pit: 0 m)
PZ90 (Ordovician Volcanics, Scrn: 155-170 m, CH Pit: 0 m)
RO1 (Tertiary Basalt, Scrn: 29.3-35.3 m, RDGWY: 0 m)
Head(mRL)
Cumulative Rainfall Departure (mm)
Observed
CRD

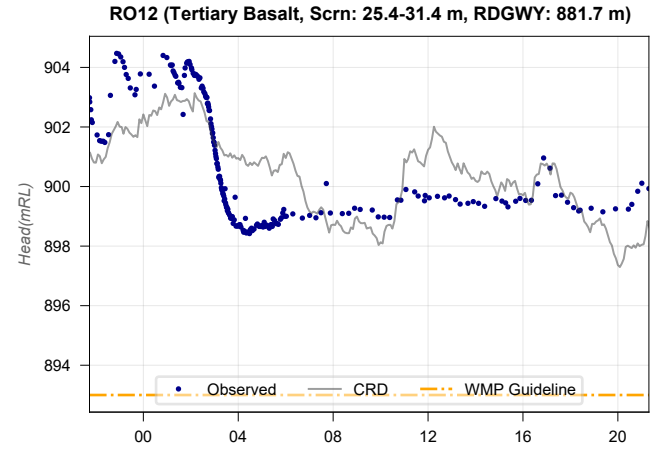

RO2 (Tertiary Basalt, Scrn: 26.5-32.5 m, RDGWY: 0 m)
RO3 (Tertiary Basalt, Scrn: 24-30 m, RDGWY: 28.4 m)
RO4A (Tertiary Basalt, Scrn: 29.5-41.5 m, RDGWY: 26.1 m)
RO4B (Ordovician Volcanics, Scrn: 99.7-129.7 m, RDGWY: 38.9 m)
RO5 (Tertiary Basalt, Scrn: 41.2-47.2 m, RDGWY: 0 m)
RO6A (Tertiary Basalt, Scrn: 31-37 m, RDGWY: 259.5 m)
RO6B (Ordovician Volcanics, Scrn: 52-136 m, RDGWY: 260.4 m)
RO7 (Tertiary Basalt, Scrn: 50-62 m, RDGWY: 531.4 m)
Head(mRL)
Cumulative Rainfall Departure (mm)
Observed
CRD
WMP Guideline

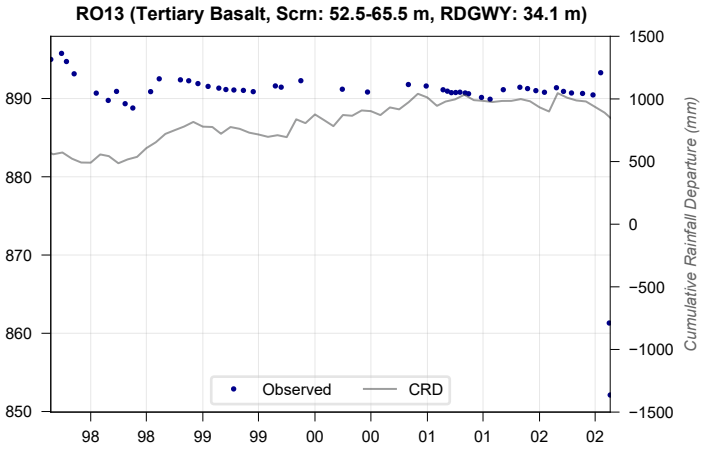

RO8 (Tertiary Basalt, Scrn: 11.5-17.5 m, RDGWY: 281.4 m)
Head(mRL)
Observed
CRD

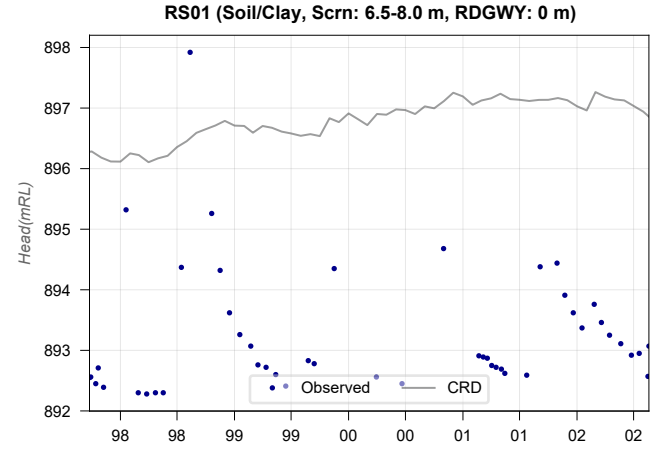

RO10A (Tertiary Basalt, Scrn: 39-44 m, RDGWY: 1018.8 m)
Cumulative Rainfall Departure (mm)
Observed
CRD
WMP Guideline

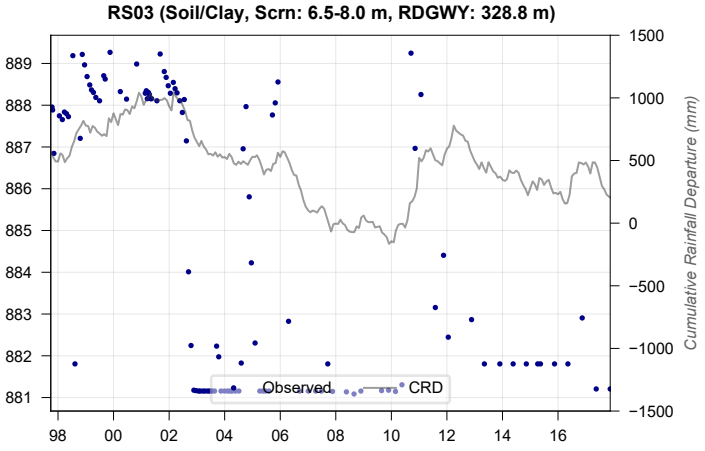

RO10B (Ordovician Volcanics, Scrn: 89-136 m, RDGWY: 1029.2 m)
Head(mRL)
Observed
CRD
WMP Guideline

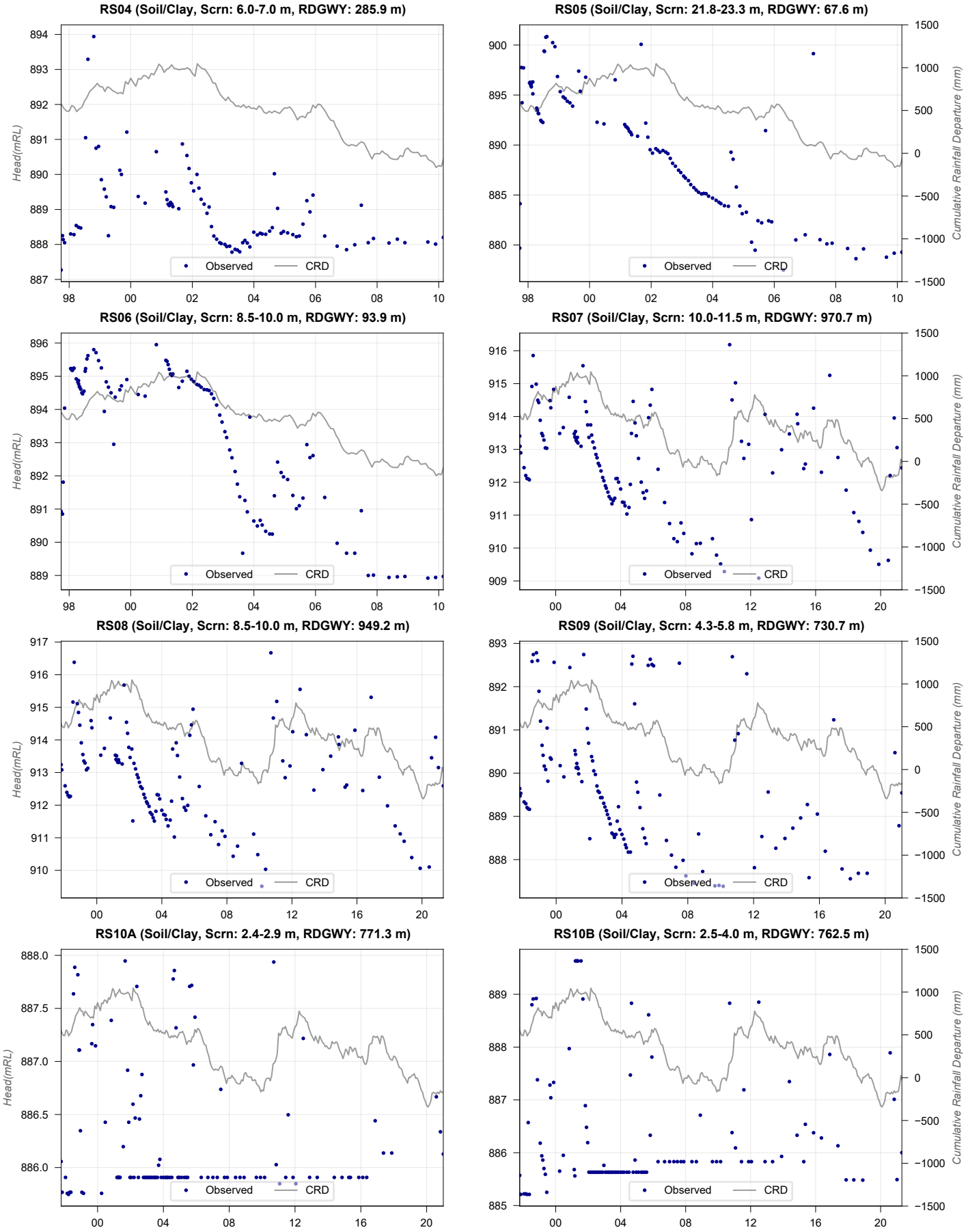

RO11 (Tertiary Basalt, Scrn: 24-36 m, RDGWY: 846.8 m)
Cumulative Rainfall Departure (mm)
Observed
CRD

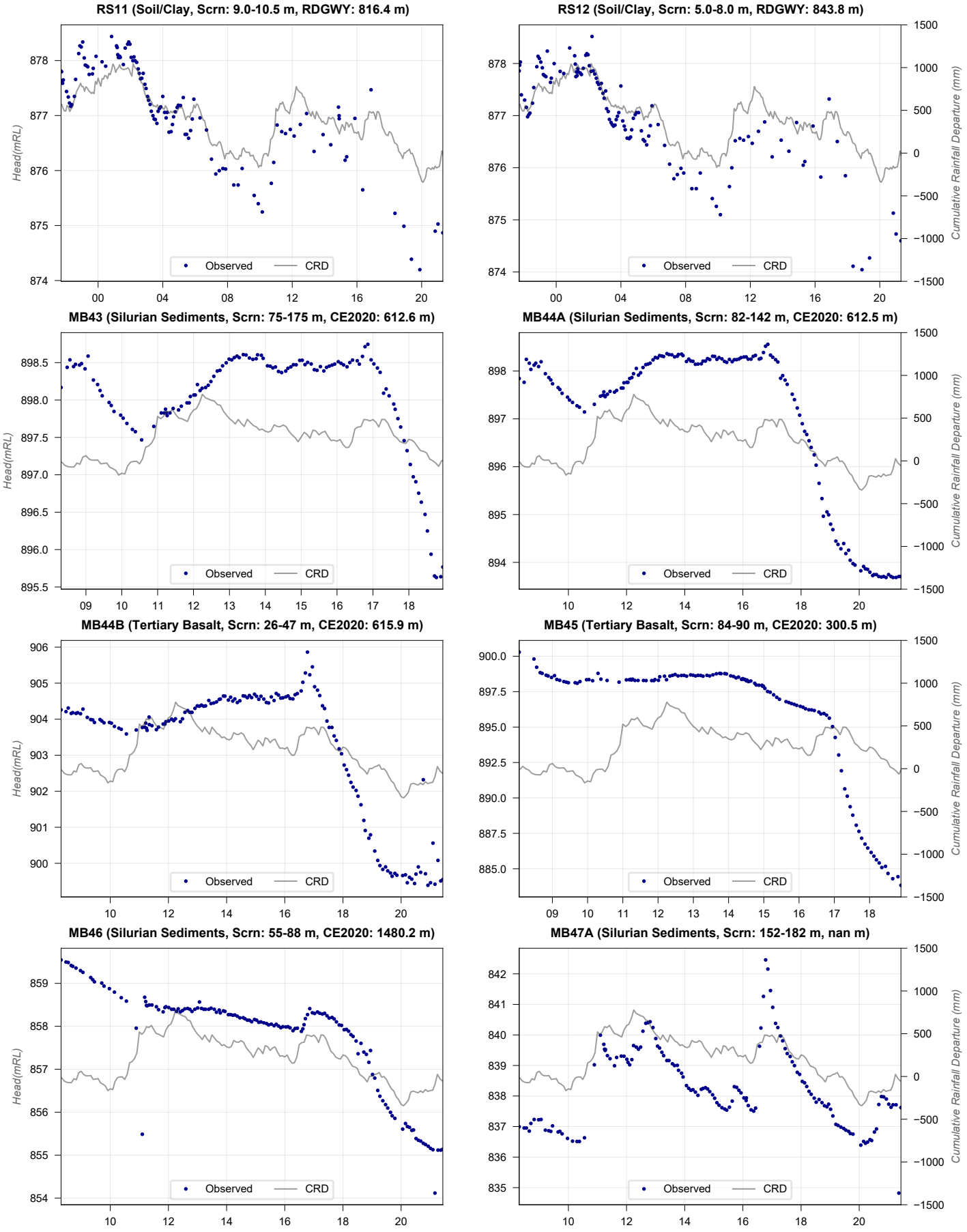

RO12 (Tertiary Basalt, Scrn: 25.4-31.4 m, RDGWY: 881.7 m)
Head(mRL)
Observed
CRD
WMP Guideline

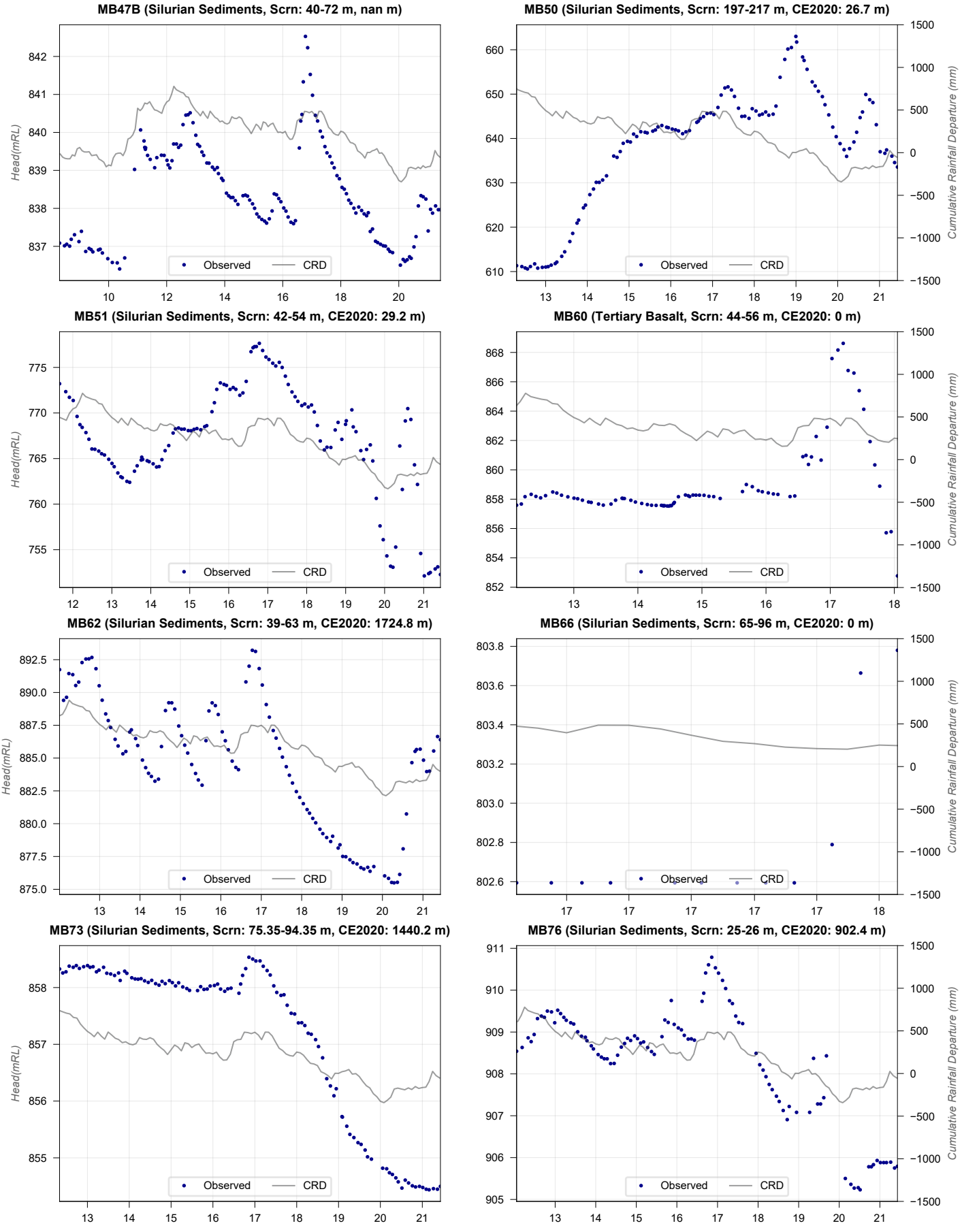

RO13 (Tertiary Basalt, Scrn: 52.5-65.5 m, RDGWY: 34.1 m)
Cumulative Rainfall Departure (mm)
Observed
CRD

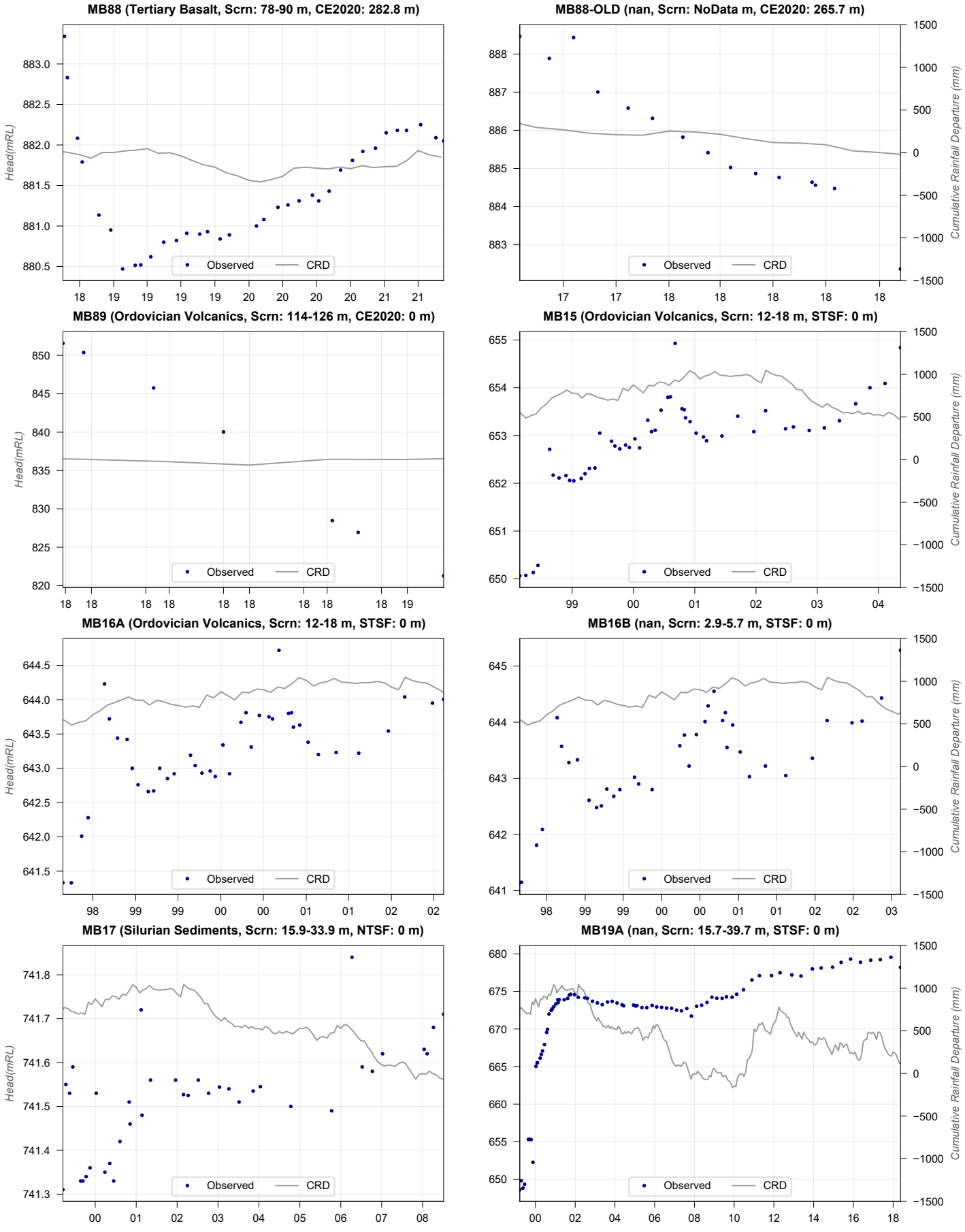

RS01 (Soil/Clay, Scrn: 6.5-8.0 m, RDGWY: 0 m)
Head(mRL)
Observed
CRD

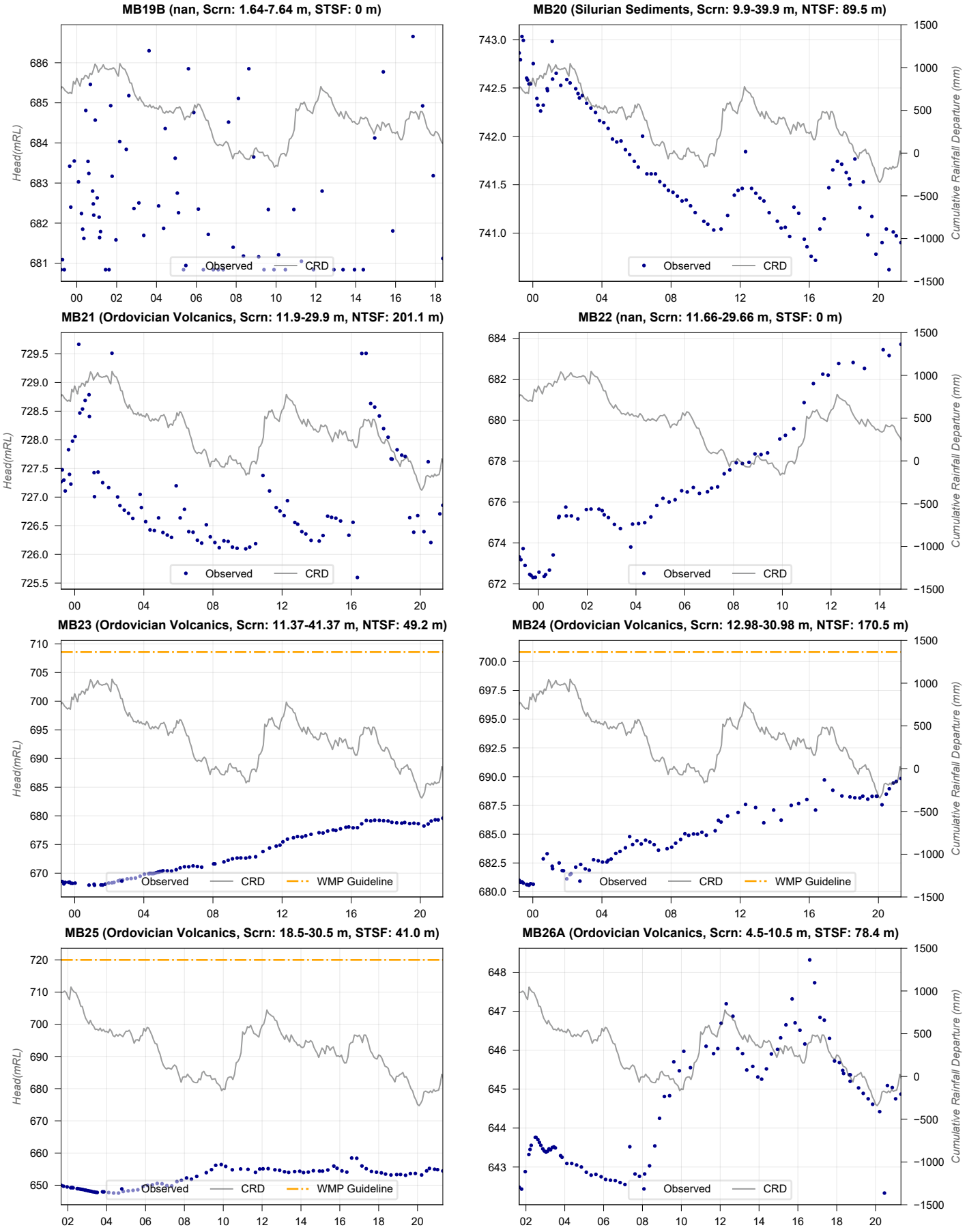

RS03 (Soil/Clay, Scrn: 6.5-8.0 m, RDGWY: 328.8 m)
Cumulative Rainfall Departure (mm)
Observed
CRD

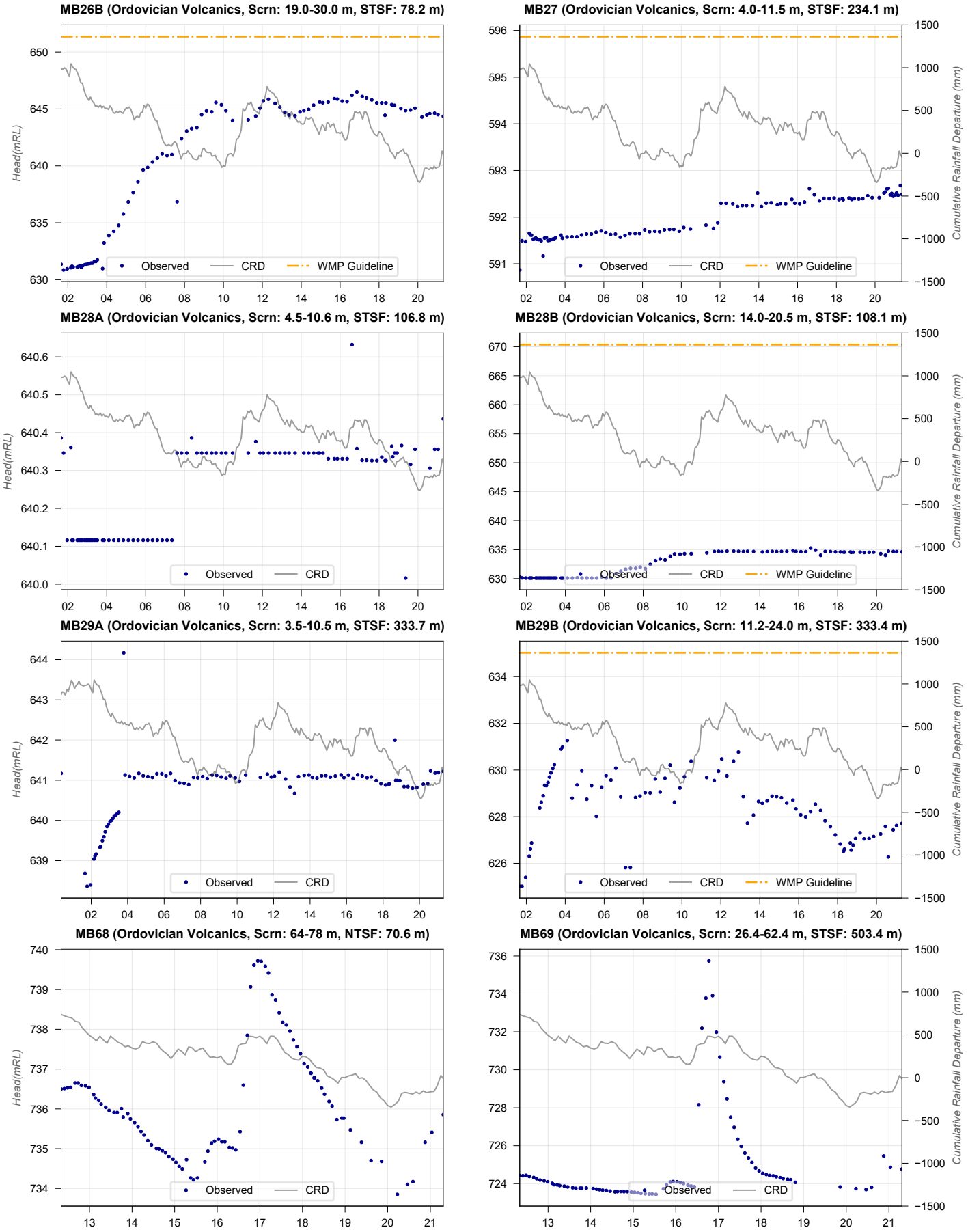

RS04 (Soil/Clay, Scrn: 6.0-7.0 m, RDGWY: 285.9 m)
RS05 (Soil/Clay, Scrn: 21.8-23.3 m, RDGWY: 67.6 m)
RS06 (Soil/Clay, Scrn: 8.5-10.0 m, RDGWY: 93.9 m)
RS07 (Soil/Clay, Scrn: 10.0-11.5 m, RDGWY: 970.7 m)
RS08 (Soil/Clay, Scrn: 8.5-10.0 m, RDGWY: 949.2 m)
RS09 (Soil/Clay, Scrn: 4.3-5.8 m, RDGWY: 730.7 m)
RS10A (Soil/Clay, Scrn: 2.4-2.9 m, RDGWY: 771.3 m)
RS10B (Soil/Clay, Scrn: 2.5-4.0 m, RDGWY: 762.5 m)
Head(mRL)
Cumulative Rainfall Departure (mm)
Observed
CRD

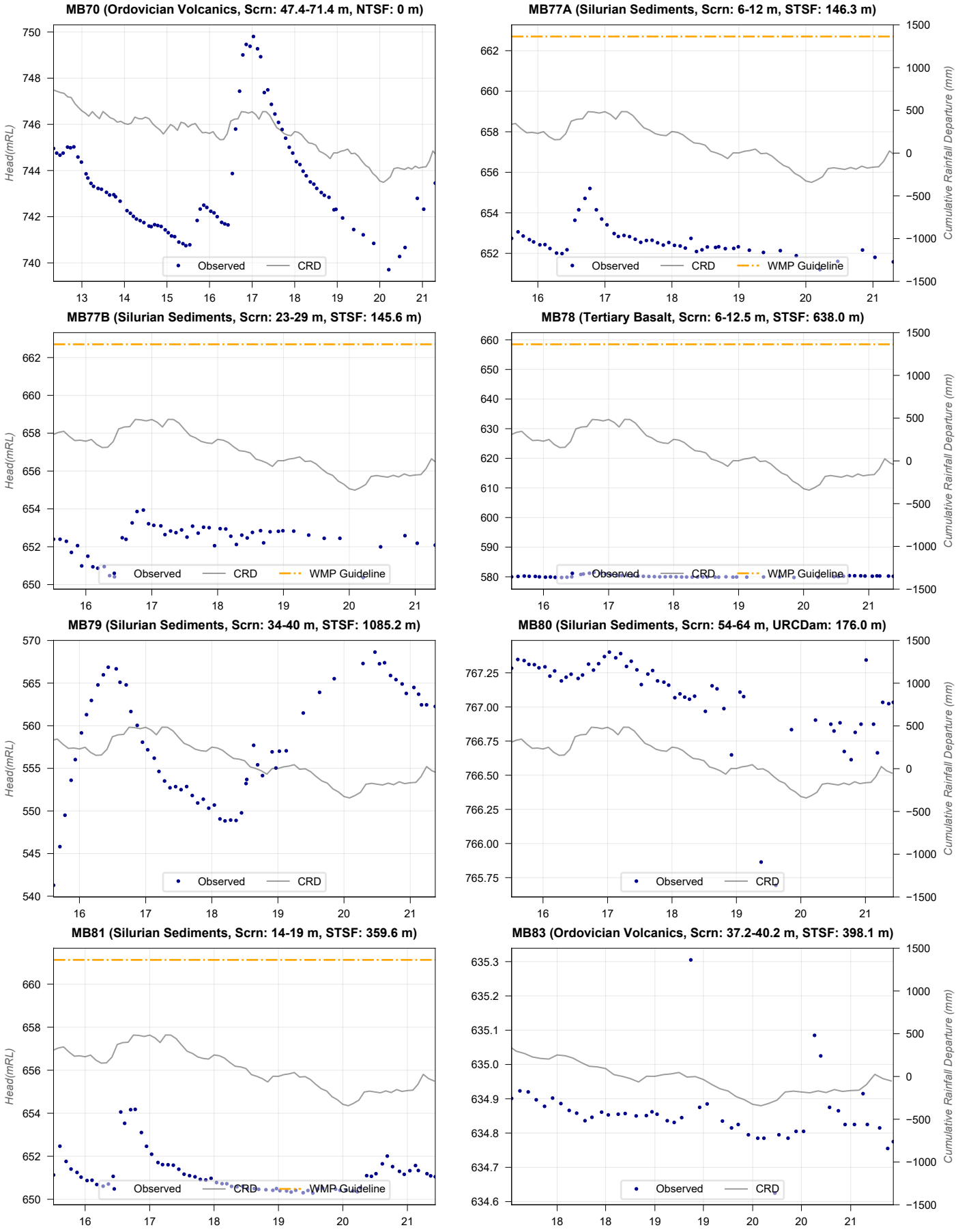

RS11 (Soil/Clay, Scrn: 9.0-10.5 m, RDGWY: 816.4 m)
RS12 (Soil/Clay, Scrn: 5.0-8.0 m, RDGWY: 843.8 m)
MB43 (Silurian Sediments, Scrn: 75-175 m, CE2020: 612.6 m)
MB44A (Silurian Sediments, Scrn: 82-142 m, CE2020: 612.5 m)
MB44B (Tertiary Basalt, Scrn: 26-47 m, CE2020: 615.9 m)
MB45 (Tertiary Basalt, Scrn: 84-90 m, CE2020: 300.5 m)
MB46 (Silurian Sediments, Scrn: 55-88 m, CE2020: 1480.2 m)
MB47A (Silurian Sediments, Scrn: 152-182 m, nan m)
Head(mRL)
Cumulative Rainfall Departure (mm)
Observed
CRD

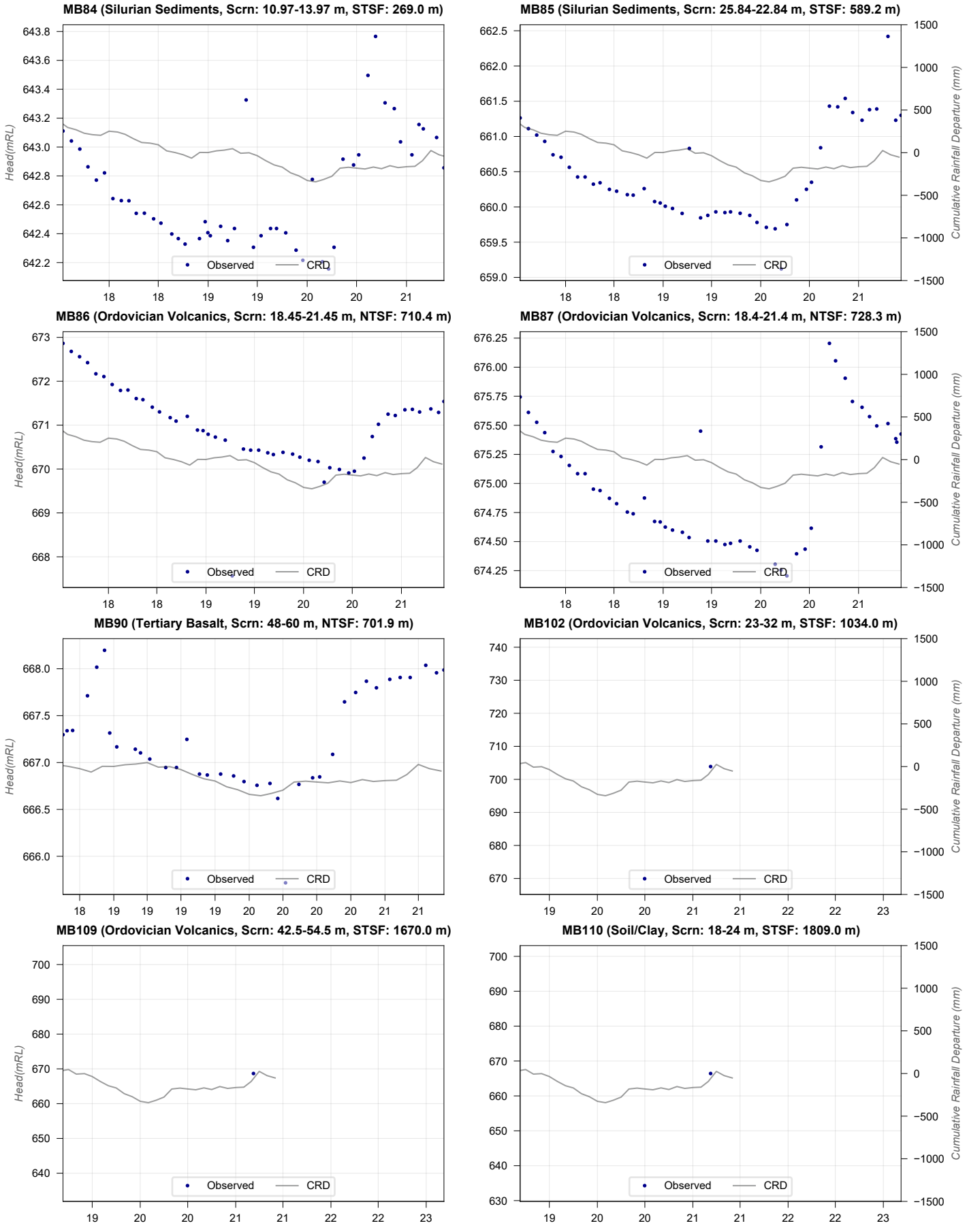

MB47B (Silurian Sediments, Scrn: 40-72 m, nan m)
MB50 (Silurian Sediments, Scrn: 197-217 m, CE2020: 26.7 m)
MB51 (Silurian Sediments, Scrn: 42-54 m, CE2020: 29.2 m)
MB60 (Tertiary Basalt, Scrn: 44-56 m, CE2020: 0 m)
MB62 (Silurian Sediments, Scrn: 39-63 m, CE2020: 1724.8 m)
MB66 (Silurian Sediments, Scrn: 65-96 m, CE2020: 0 m)
MB73 (Silurian Sediments, Scrn: 75.35-94.35 m, CE2020: 1440.2 m)
MB76 (Silurian Sediments, Scrn: 25-26 m, CE2020: 902.4 m)
Head(mRL)
Cumulative Rainfall Departure (mm)
Observed
CRD

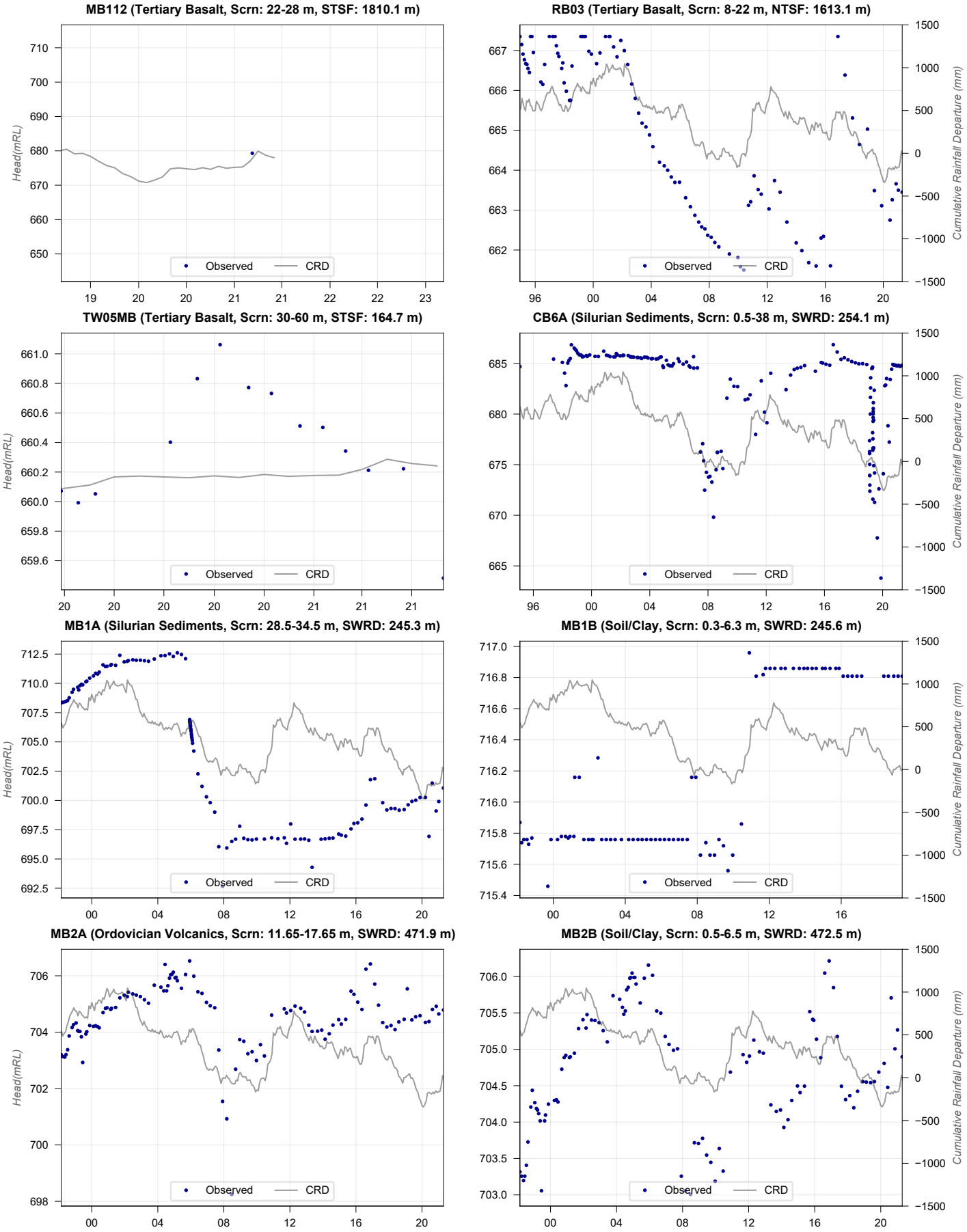

MB88 (Tertiary Basalt, Scrn: 78-90 m, CE2020: 282.8 m)
MB88-OLD (nan, Scrn: NoData m, CE2020: 265.7 m)
MB89 (Ordovician Volcanics, Scrn: 114-126 m, CE2020: 0 m)
MB15 (Ordovician Volcanics, Scrn: 12-18 m, STSF: 0 m)
MB16A (Ordovician Volcanics, Scrn: 12-18 m, STSF: 0 m)
MB16B (nan, Scrn: 2.9-5.7 m, STSF: 0 m)
MB17 (Silurian Sediments, Scrn: 15.9-33.9 m, NTSF: 0 m)
MB19A (nan, Scrn: 15.7-39.7 m, STSF: 0 m)
Head(mRL)
Cumulative Rainfall Departure (mm)
Observed
CRD

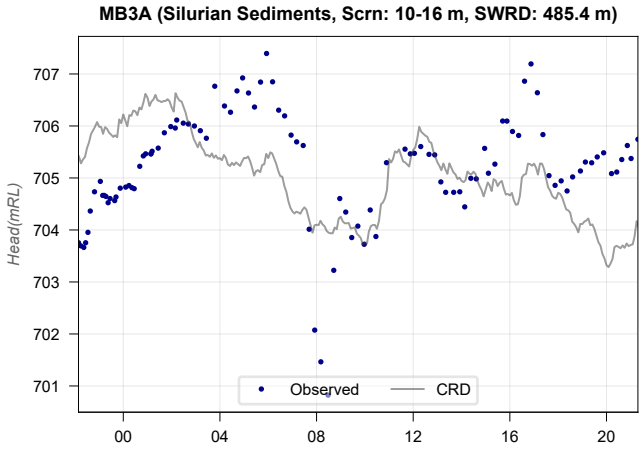

MB19B (nan, Scrn: 1.64-7.64 m, STSF: 0 m)
MB20 (Silurian Sediments, Scrn: 9.9-39.9 m, NTSF: 89.5 m)
MB21 (Ordovician Volcanics, Scrn: 11.9-29.9 m, NTSF: 201.1 m)
MB22 (nan, Scrn: 11.66-29.66 m, STSF: 0 m)
MB23 (Ordovician Volcanics, Scrn: 11.37-41.37 m, NTSF: 49.2 m)
MB24 (Ordovician Volcanics, Scrn: 12.98-30.98 m, NTSF: 170.5 m)
MB25 (Ordovician Volcanics, Scrn: 18.5-30.5 m, STSF: 41.0 m)
MB26A (Ordovician Volcanics, Scrn: 4.5-10.5 m, STSF: 78.4 m)
Head(mRL)
Cumulative Rainfall Departure (mm)
Observed
CRD
WMP Guideline

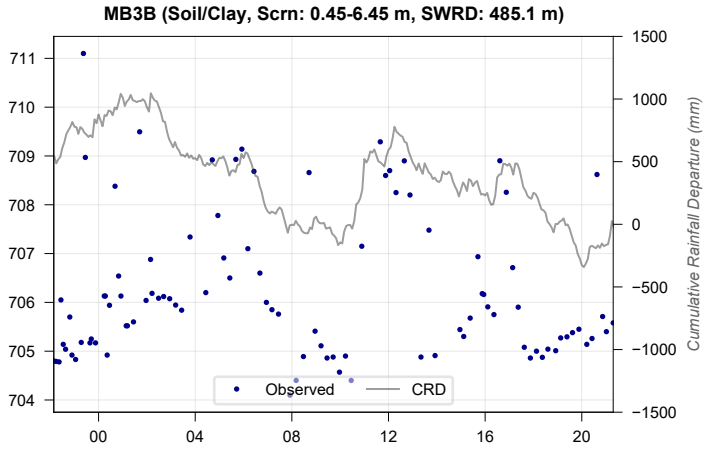

MB26B (Ordovician Volcanics, Scrn: 19.0-30.0 m, STSF: 78.2 m)
MB27 (Ordovician Volcanics, Scrn: 4.0-11.5 m, STSF: 234.1 m)
MB28A (Ordovician Volcanics, Scrn: 4.5-10.6 m, STSF: 106.8 m)
MB28B (Ordovician Volcanics, Scrn: 14.0-20.5 m, STSF: 108.1 m)
MB29A (Ordovician Volcanics, Scrn: 3.5-10.5 m, STSF: 333.7 m)
MB29B (Ordovician Volcanics, Scrn: 11.2-24.0 m, STSF: 333.4 m)
MB68 (Ordovician Volcanics, Scrn: 64-78 m, NTSF: 70.6 m)
MB69 (Ordovician Volcanics, Scrn: 26.4-62.4 m, STSF: 503.4 m)
Head(mRL)
Cumulative Rainfall Departure (mm)
Observed
CRD
WMP Guideline

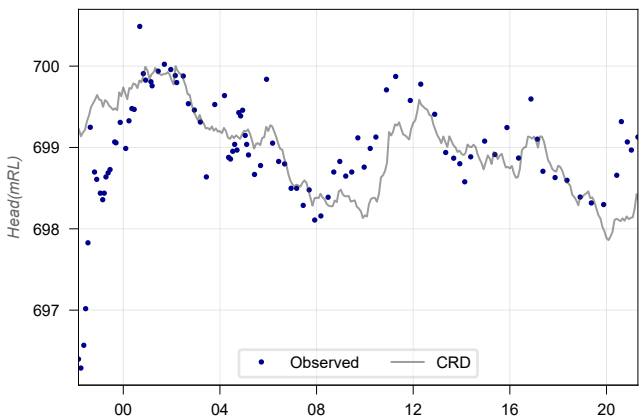

MB70 (Ordovician Volcanics, Scrn: 47.4-71.4 m, NTSF: 0 m)
MB77A (Silurian Sediments, Scrn: 6-12 m, STSF: 146.3 m)
MB77B (Silurian Sediments, Scrn: 23-29 m, STSF: 145.6 m)
MB78 (Tertiary Basalt, Scrn: 6-12.5 m, STSF: 638.0 m)
MB79 (Silurian Sediments, Scrn: 34-40 m, STSF: 1085.2 m)
MB80 (Silurian Sediments, Scrn: 54-64 m, URCDam: 176.0 m)
MB81 (Silurian Sediments, Scrn: 14-19 m, STSF: 359.6 m)
MB83 (Ordovician Volcanics, Scrn: 37.2-40.2 m, STSF: 398.1 m)
Head(mRL)
Cumulative Rainfall Departure (mm)
Observed
CRD
WMP Guideline

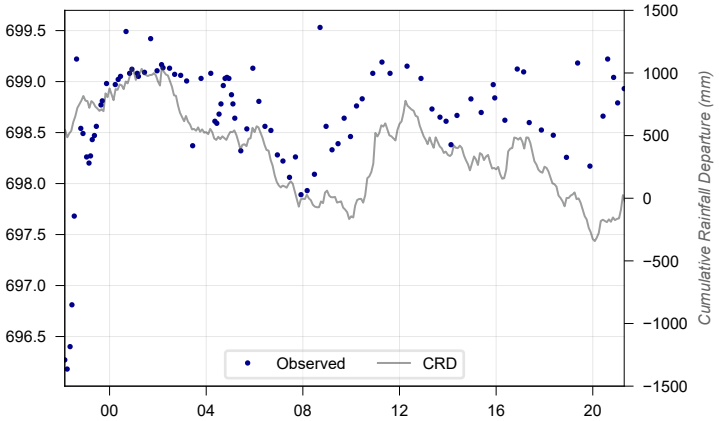

MB84 (Silurian Sediments, Scrn: 10.97-13.97 m, STSF: 269.0 m)
MB85 (Silurian Sediments, Scrn: 25.84-22.84 m, STSF: 589.2 m)
MB86 (Ordovician Volcanics, Scrn: 18.45-21.45 m, NTSF: 710.4 m)
MB87 (Ordovician Volcanics, Scrn: 18.4-21.4 m, NTSF: 728.3 m)
MB90 (Tertiary Basalt, Scrn: 48-60 m, NTSF: 701.9 m)
MB102 (Ordovician Volcanics, Scrn: 23-32 m, STSF: 1034.0 m)
MB109 (Ordovician Volcanics, Scrn: 42.5-54.5 m, STSF: 1670.0 m)
MB110 (Soil/Clay, Scrn: 18-24 m, STSF: 1809.0 m)
Head(mRL)
Cumulative Rainfall Departure (mm)
Observed
CRD

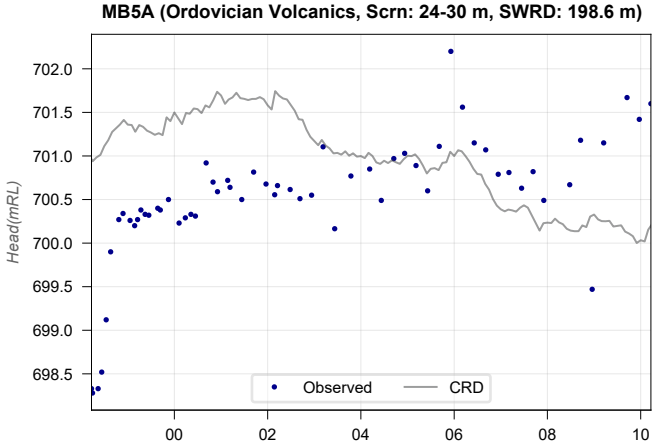

MB112 (Tertiary Basalt, Scrn: 22-28 m, STSF: 1810.1 m)
RB03 (Tertiary Basalt, Scrn: 8-22 m, NTSF: 1613.1 m)
TW05MB (Tertiary Basalt, Scrn: 30-60 m, STSF: 164.7 m)
CB6A (Silurian Sediments, Scrn: 0.5-38 m, SWRD: 254.1 m)
MB1A (Silurian Sediments, Scrn: 28.5-34.5 m, SWRD: 245.3 m)
MB1B (Soil/Clay, Scrn: 0.3-6.3 m, SWRD: 245.6 m)
MB2A (Ordovician Volcanics, Scrn: 11.65-17.65 m, SWRD: 471.9 m)
MB2B (Soil/Clay, Scrn: 0.5-6.5 m, SWRD: 472.5 m)
Head(mRL)
Cumulative Rainfall Departure (mm)
Observed
CRD

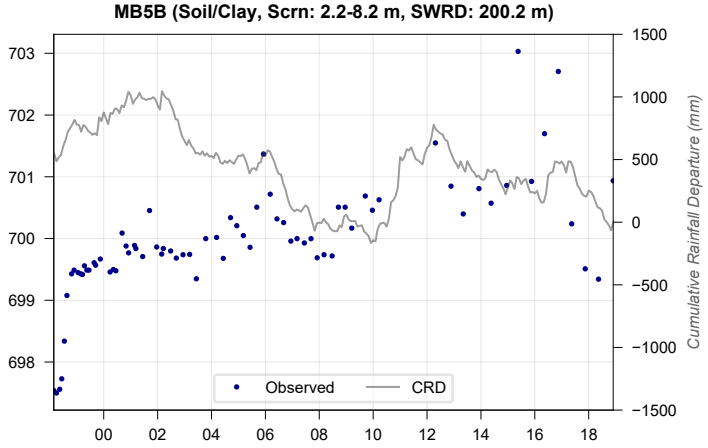

MB3A (Silurian Sediments, Scrn: 10-16 m, SWRD: 485.4 m)
Head(mRL)
Observed
CRD

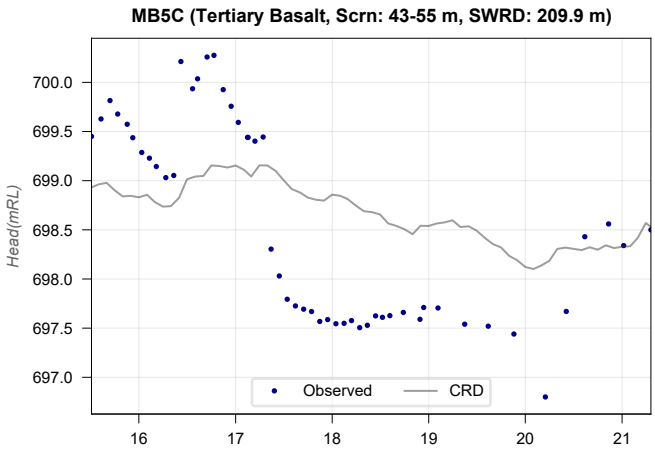

MB3B (Soil/Clay, Scrn: 0.45-6.45 m, SWRD: 485.1 m)
Cumulative Rainfall Departure (mm)
Observed
CRD

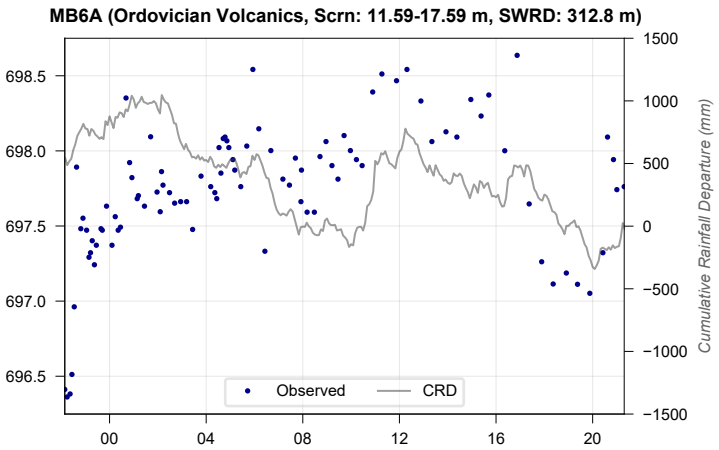

MB4A (Ordovician Volcanics, Scrn: 17.1-23.1 m, SWRD: 266.7 m)
Head(mRL)
Observed
CRD

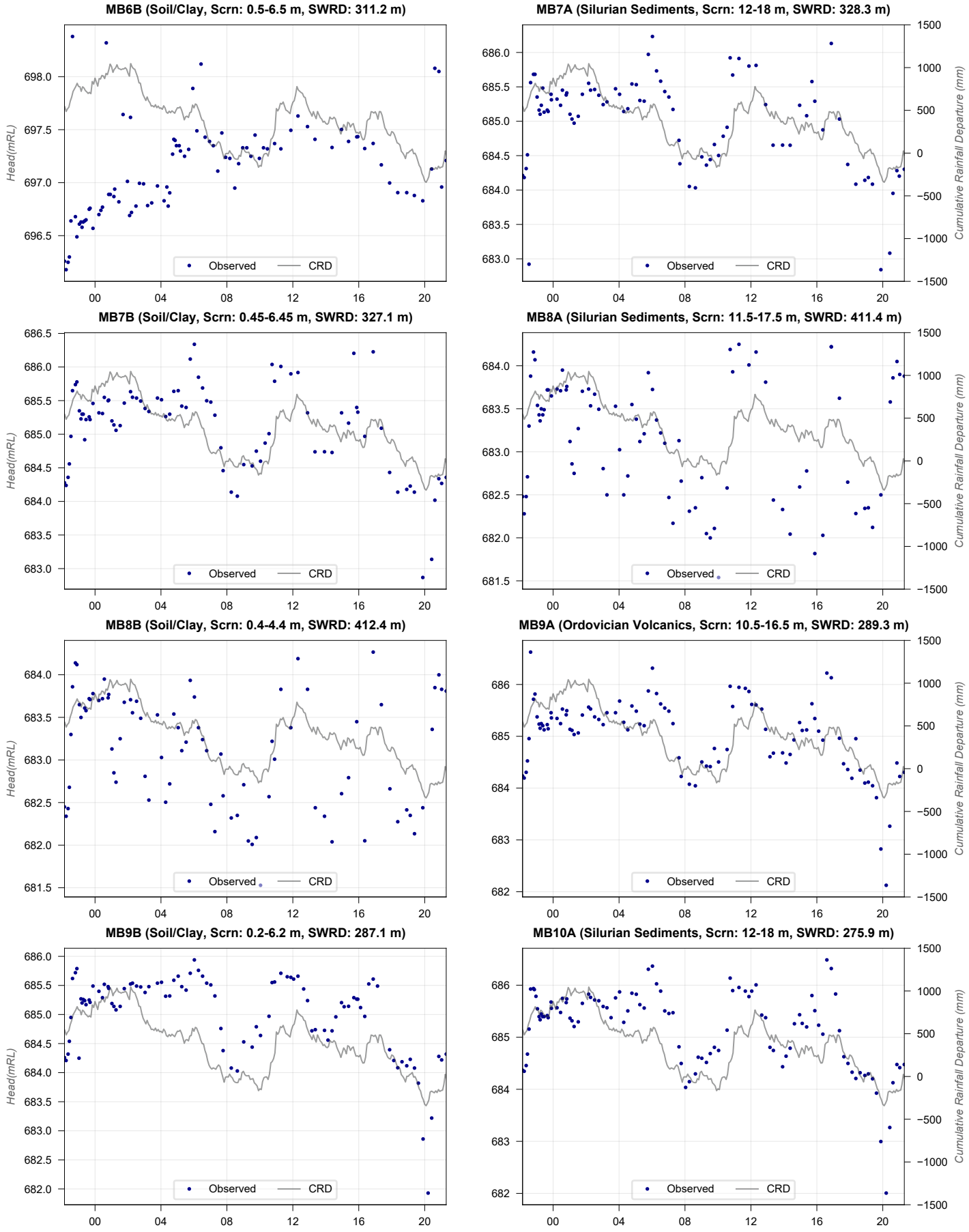

MB4B (Soil/Clay, Scrn: 0.3-6.3 m, SWRD: 265.3 m)
Cumulative Rainfall Departure (mm)
Observed
CRD

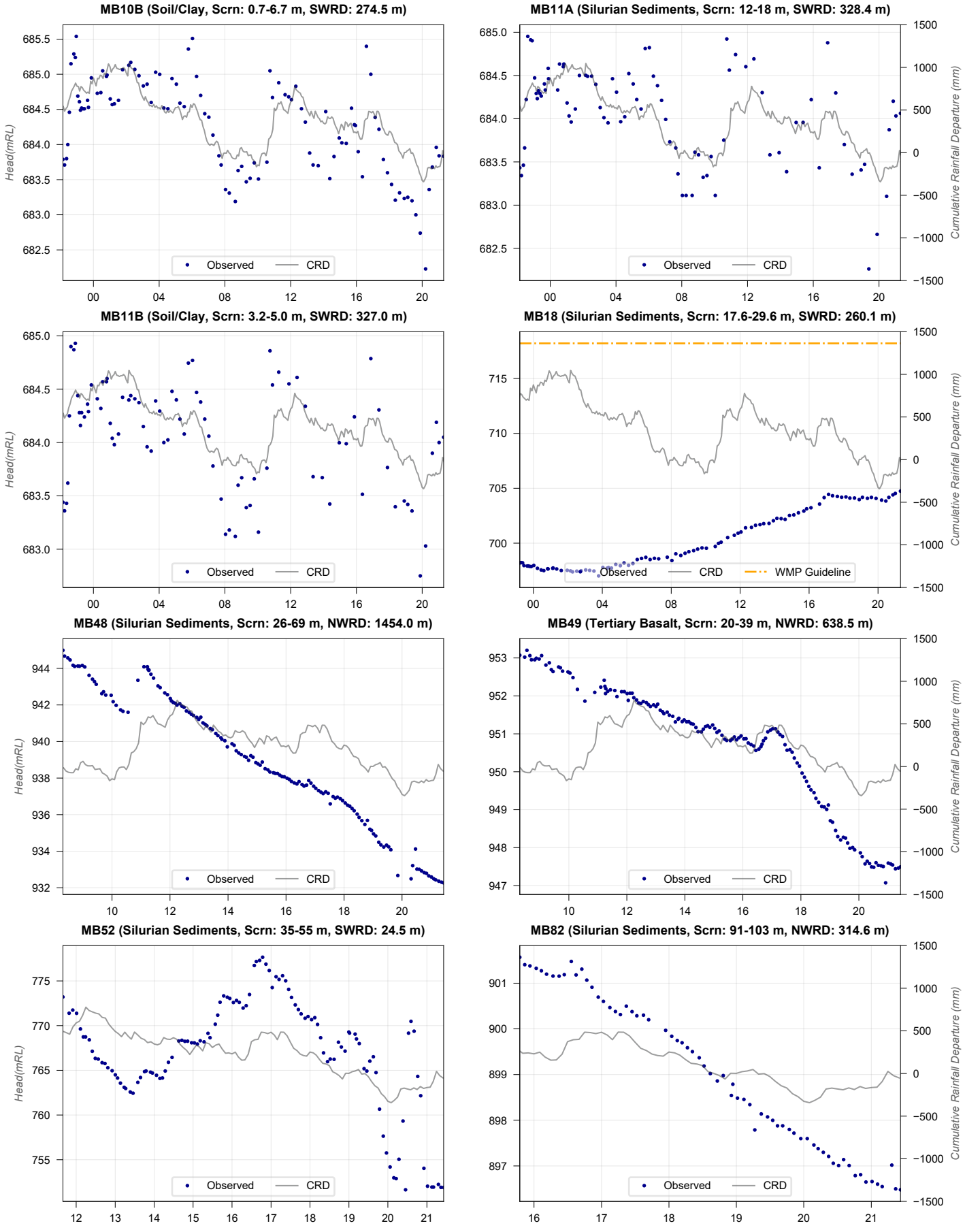

MB5A (Ordovician Volcanics, Scrn: 24-30 m, SWRD: 198.6 m)
Head(mRL)
Observed
CRD

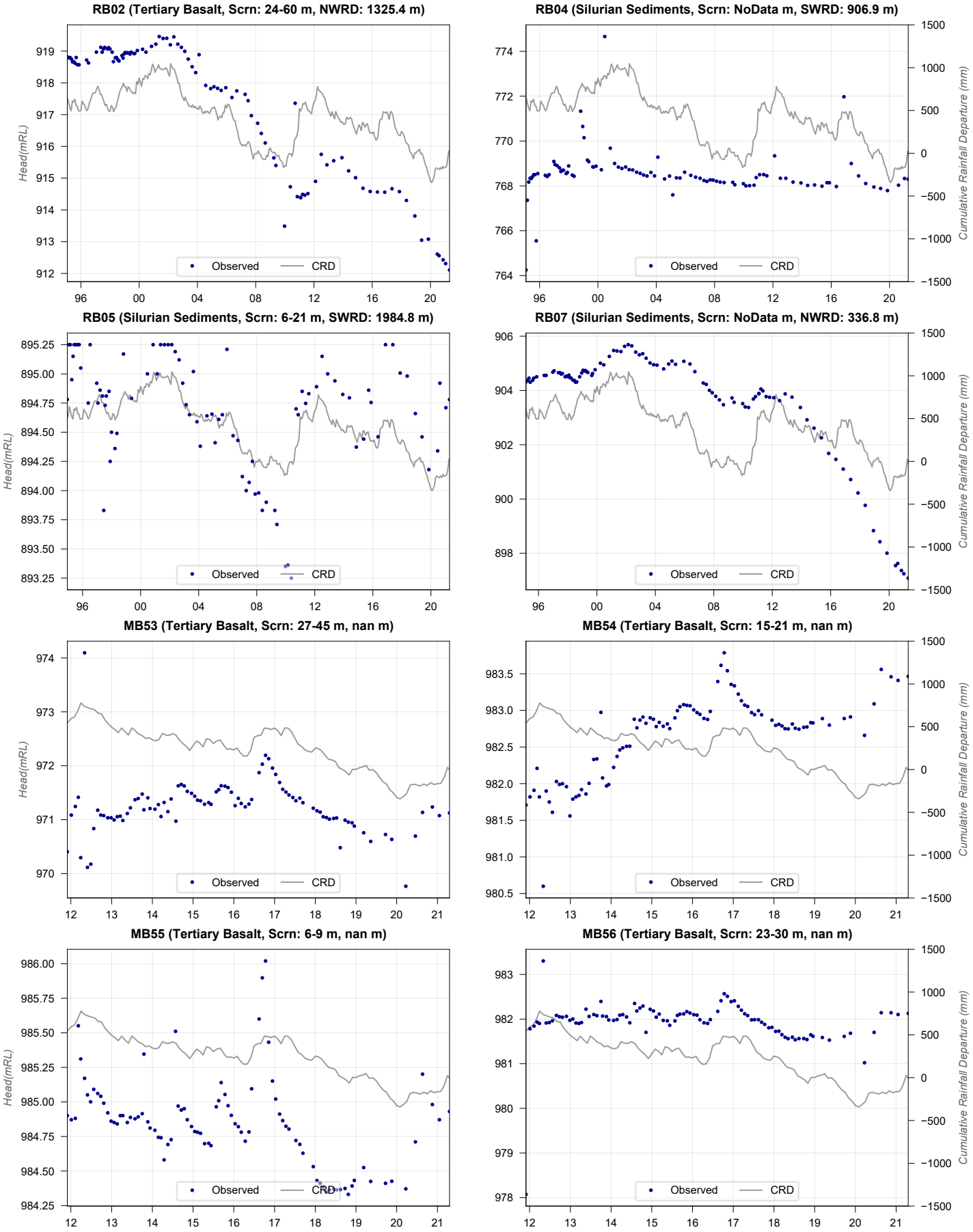

MB5B (Soil/Clay, Scrn: 2.2-8.2 m, SWRD: 200.2 m)
Cumulative Rainfall Departure (mm)
Observed
CRD

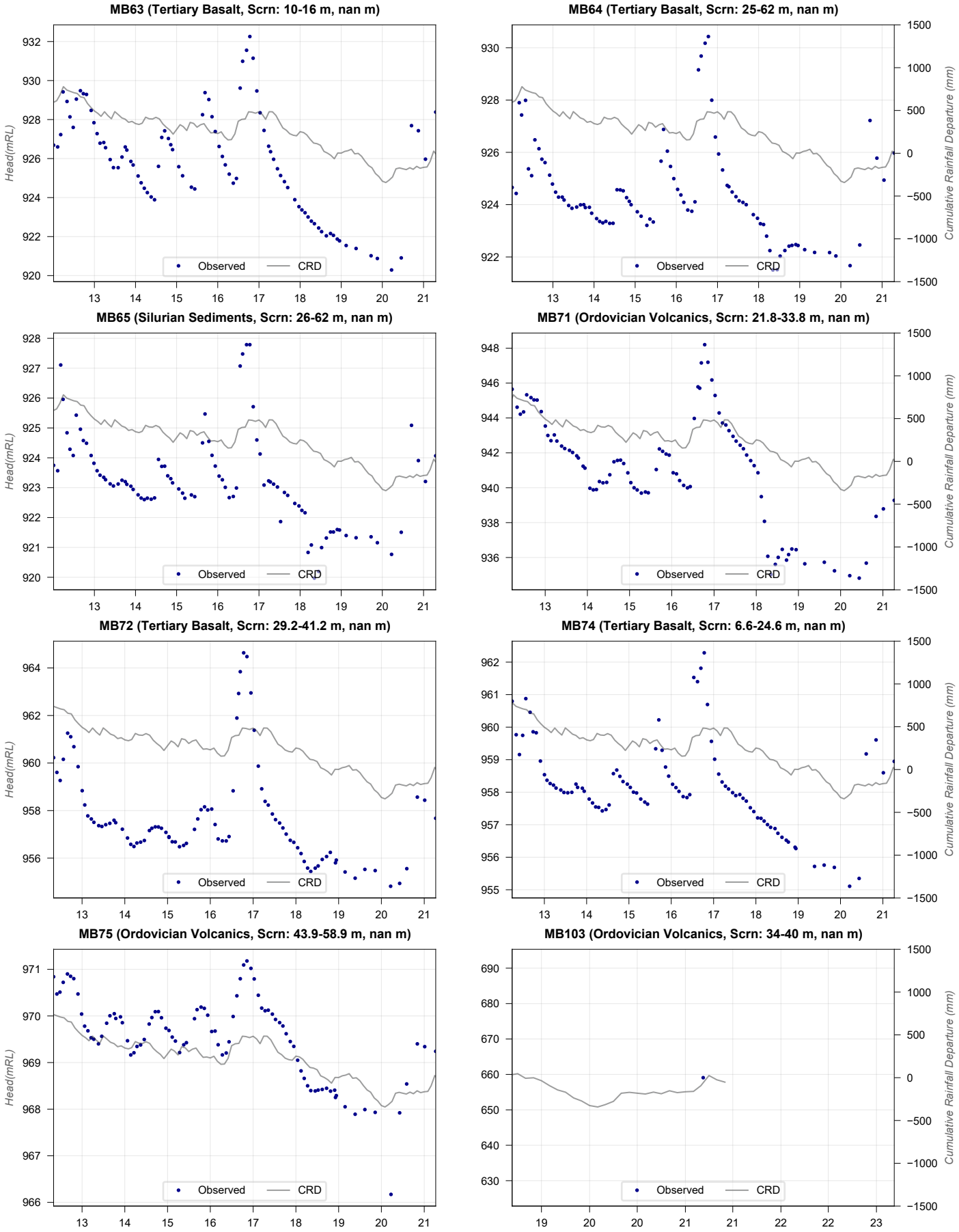

MB5C (Tertiary Basalt, Scrn: 43-55 m, SWRD: 209.9 m)
Head(mRL)
Observed
CRD

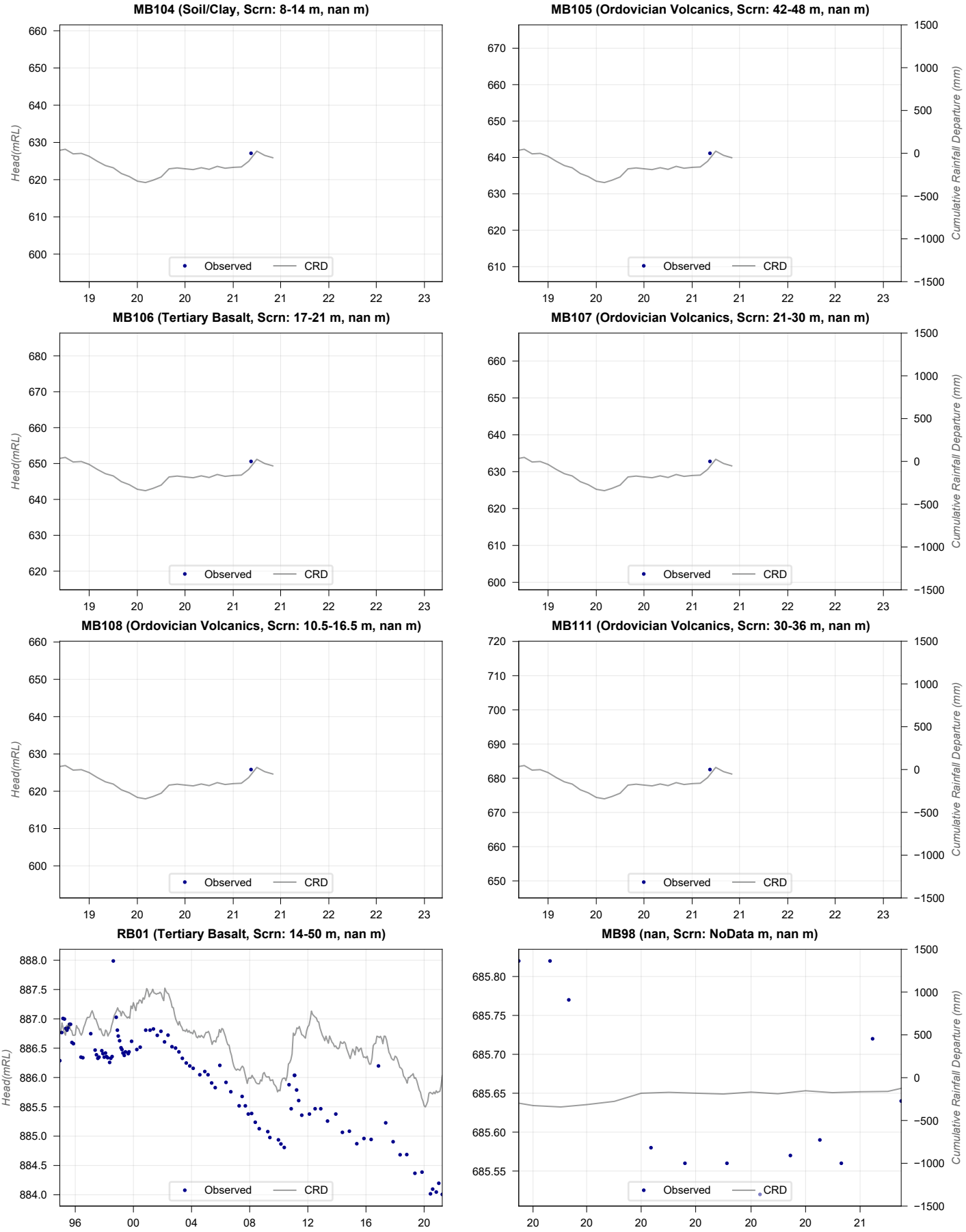

MB6A (Ordovician Volcanics, Scrn: 11.59-17.59 m, SWRD: 312.8 m)
Cumulative Rainfall Departure (mm)
Observed
CRD


MB6B (Soil/Clay, Scrn: 0.5-6.5 m, SWRD: 311.2 m)
MB7A (Silurian Sediments, Scrn: 12-18 m, SWRD: 328.3 m)
MB7B (Soil/Clay, Scrn: 0.45-6.45 m, SWRD: 327.1 m)
MB8A (Silurian Sediments, Scrn: 11.5-17.5 m, SWRD: 411.4 m)
MB8B (Soil/Clay, Scrn: 0.4-4.4 m, SWRD: 412.4 m)
MB9A (Ordovician Volcanics, Scrn: 10.5-16.5 m, SWRD: 289.3 m)
MB9B (Soil/Clay, Scrn: 0.2-6.2 m, SWRD: 287.1 m)
MB10A (Silurian Sediments, Scrn: 12-18 m, SWRD: 275.9 m)
Head(mRL)
Cumulative Rainfall Departure (mm)
Observed
CRD


MB10B (Soil/Clay, Scrn: 0.7-6.7 m, SWRD: 274.5 m)
MB11A (Silurian Sediments, Scrn: 12-18 m, SWRD: 328.4 m)
MB11B (Soil/Clay, Scrn: 3.2-5.0 m, SWRD: 327.0 m)
MB18 (Silurian Sediments, Scrn: 17.6-29.6 m, SWRD: 260.1 m)
MB48 (Silurian Sediments, Scrn: 26-69 m, NWRD: 1454.0 m)
MB49 (Tertiary Basalt, Scrn: 20-39 m, NWRD: 638.5 m)
MB52 (Silurian Sediments, Scrn: 35-55 m, SWRD: 24.5 m)
MB82 (Silurian Sediments, Scrn: 91-103 m, NWRD: 314.6 m)
Head(mRL)
Cumulative Rainfall Departure (mm)
Observed
CRD
WMP Guideline


RB02 (Tertiary Basalt, Scrn: 24-60 m, NWRD: 1325.4 m)
RB04 (Silurian Sediments, Scrn: NoData m, SWRD: 906.9 m)
RB05 (Silurian Sediments, Scrn: 6-21 m, SWRD: 1984.8 m)
RB07 (Silurian Sediments, Scrn: NoData m, NWRD: 336.8 m)
MB53 (Tertiary Basalt, Scrn: 27-45 m, nan m)
MB54 (Tertiary Basalt, Scrn: 15-21 m, nan m)
MB55 (Tertiary Basalt, Scrn: 6-9 m, nan m)
MB56 (Tertiary Basalt, Scrn: 23-30 m, nan m)
Head(mRL)
Cumulative Rainfall Departure (mm)
Observed
CRD


MB63 (Tertiary Basalt, Scrn: 10-16 m, nan m)
MB64 (Tertiary Basalt, Scrn: 25-62 m, nan m)
MB65 (Silurian Sediments, Scrn: 26-62 m, nan m)
MB71 (Ordovician Volcanics, Scrn: 21.8-33.8 m, nan m)
MB72 (Tertiary Basalt, Scrn: 29.2-41.2 m, nan m)
MB74 (Tertiary Basalt, Scrn: 6.6-24.6 m, nan m)
MB75 (Ordovician Volcanics, Scrn: 43.9-58.9 m, nan m)
MB103 (Ordovician Volcanics, Scrn: 34-40 m, nan m)
Head(mRL)
Cumulative Rainfall Departure (mm)
Observed
CRD


MB104 (Soil/Clay, Scrn: 8-14 m, nan m)
MB105 (Ordovician Volcanics, Scrn: 42-48 m, nan m)
MB106 (Tertiary Basalt, Scrn: 17-21 m, nan m)
MB107 (Ordovician Volcanics, Scrn: 21-30 m, nan m)
MB108 (Ordovician Volcanics, Scrn: 10.5-16.5 m, nan m)
MB111 (Ordovician Volcanics, Scrn: 30-36 m, nan m)
RB01 (Tertiary Basalt, Scrn: 14-50 m, nan m)
MB98 (nan, Scrn: NoData m, nan m)
Head(mRL)
Cumulative Rainfall Departure (mm)
Observed
CRD

Appendix C

Tabulated water quality data - 2020/2021 water year

AGE

Project ID: G1383AA
Groundwater quality data

Sample Location			CB6A	CB6A	CB6A	CB6A	CX1	MB10A	MB10A	MB10A	MB10A	MB11A	MB11A	MB11A	MB11A
Date Sampled			13/08/2020	9/11/2020	11/01/2021	22/04/2021	10/07/2020	14/08/2020	9/11/2020	11/01/2021	22/04/2021	14/08/2020	12/11/2020	11/01/2021	22/04/2021
Field Parameters	**Units**	**LOD**													
Field pH	pH units	-	6.85	6.84	7.08	6.96	7.01	6.51	6.57	6.78	6.78	6.5	6.72	7.05	6.88
Field Electrical Conductivity (EC)	µS/cm	-	813.6	11.98	1544	1699	3568	3801	3646	3541	3764	3713	3621	3568	3693
Field Temperature	deg c	-	16.12	16.5	16.3	15.8	14.63	16.46	16.9	16.7	16.3	16.2	16.2	16.5	16.3
Physical Parameters															
Electrical conductivity	µS/cm	1	782	1270	1570	1640	3610	3310	3670	3700	3720	3230	3850	3700	3650
Hydroxide Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Carbonate Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Bicarbonate Alkalinity as $CaCO_3$	mg/l	1	221	305	356	339	831	391	402	383	426	433	447	466	456
Total Alkalinity as $CaCO_3$	mg/l	1	221	305	356	339	831	391	402	383	426	433	447	466	456
Suspended Solids (SS)	mg/l	5	15	5	12	12	5	15	11	10	16	10	7	5	5
Total Dissolved Solids @180°C	mg/l	10	560	882	1170	1260	3370	3780	3600	3490	3690	3610	3760	3430	3540
Redox Potential	mV	-	-142	-56	-92	-61	90.11	8.7	46	-39	-61	-47.2	174	136	108
Major Ions															
Sulfate as SO_4 - Turbidimetric	mg/l	1	137	310	405	475	1770	2080	1920	2080	2210	1920	1840	1820	2010
Chloride	mg/l	1	38	76	110	121	24	62	71	69	81	87	86	81	104
Calcium	mg/l	1	96	154	186	206	509	557	586	578	596	587	509	586	588
Magnesium	mg/l	1	30	53	75	84	210	216	201	197	214	170	160	180	175
Sodium	mg/l	1	29	47	60	66	192	148	159	155	155	152	171	203	196
Potassium	mg/l	1	2	2	3	3	7	4	4	4	4	3	3	2	2
Nutrients															
Nitrite as N	mg/l	0.01	0.01	0.01	0.01	0.01	0.68	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01
Nitrate as N	mg/l	0.01	0.07	0.01	0.01	0.01	16.2	0.1	0.01	0.01	0.01	0.08	0.01	0.05	0.01
Nitrite + Nitrate as N	mg/l	0.01	0.07	0.01	0.01	0.01	16.9	0.1	0.01	0.01	0.01	0.08	0.01	0.07	0.01
Total Kjeldahl Nitrogen as N	mg/l	0.1	0.3	0.1	0.1	0.1	2.2	0.1	0.1	0.1	1.4	0.4	0.1	0.1	0.1
Total Nitrogen as N	mg/l	0.1	0.4	0.1	0.1	0.1	19.1	0.1	0.1	0.1	1.4	0.5	0.1	0.1	0.1
Total Phosphorus as P	mg/l	0.01	0.22	0.06	0.04	0.06	0.01	0.09	0.07	0.04	0.25	0.05	0.01	0.01	0.02
Dissolved Metals															
Aluminium	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Antimony	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Arsenic	mg/l	0.001	0.045	0.014	0.015	0.014	0.001	0.001	0.001	0.001	0.004	0.001	0.001	0.001	0.001
Cadmium	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0003	0.0001
Chromium	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cobalt	mg/l	0.001	0.001	0.001	0.001	0.001	0.005	0.007	0.006	0.006	0.002	0.005	0.003	0.002	0.003
Copper	mg/l	0.001	0.001	0.001	0.001	0.001	0.016	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Iron	mg/l	0.05	3.63	2.08	3.13	3.88	0.05	1.13	2.57	3.06	4.8	1.24	0.21	0.05	0.3
Lead	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Manganese	mg/l	0.001	0.343	0.36	0.395	0.448	1.27	1.58	1.48	1.36	1.78	1.25	0.651	0.494	0.7
Mercury	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Molybdenum	mg/l	0.001	0.002	0.002	0.002	0.003	0.005	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Nickel	mg/l	0.001	0.001	0.001	0.001	0.001	0.004	0.006	0.005	0.004	0.001	0.019	0.012	0.009	0.011
Selenium	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Silver	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Zinc	mg/l	0.005	0.005	0.005	0.005	0.005	0.008	0.01	0.005	0.005	0.005	0.021	0.009	0.015	0.005

Notes

	Analytes with trigger (WMP)
	Exceeding trigger

Project ID: G1383AA
Groundwater quality data

Sample Location			MB18	MB18	MB18	MB18	MB1A	MB1A	MB1A	MB1A	MB20	MB20	MB20	MB20	MB21
Date Sampled			18/08/2020	12/11/2020	11/01/2021	21/04/2021	19/08/2020	9/11/2020	7/01/2021	20/04/2021	11/08/2020	10/11/2020	12/01/2021	21/04/2021	11/08/2020
Field Parameters	**Units**	**LOD**													
Field pH	pH units	-	6.37	6.42	6.64	6.55	6.44	6.53	6.68	6.61	5.43	5.88	6.15	5.63	7.11
Field Electrical Conductivity (EC)	µS/cm	-	4220	4360	4233	4397	3617.8	3547	3444	3550	7241	7070	6756	3277	1802
Field Temperature	deg c	-	15.9	17.2	17.5	16.9	16.7	17.5	17.9	17.3	15.51	16.7	17.6	15.9	17.25
Physical Parameters															
Electrical conductivity	µS/cm	1	3950	4600	4430	4400	3210	3530	3580	3560	6530	7080	7160	3220	1710
Hydroxide Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Carbonate Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Bicarbonate Alkalinity as $CaCO_3$	mg/l	1	485	530	491	424	636	627	601	643	69	132	146	35	880
Total Alkalinity as $CaCO_3$	mg/l	1	485	530	491	424	636	627	601	643	69	132	146	35	880
Suspended Solids (SS)	mg/l	5	5	11	5	5	8	7	10	5	8	10	10	11	5
Total Dissolved Solids @180°C	mg/l	10	3360	3620	3570	2820	3190	3410	3320	1640	6580	6680	6690	2880	1090
Redox Potential	mV	-	121	254	110	295	32.4	179	95	222	223.7	130	149	260	141
Major Ions															
Sulfate as SO_4 - Turbidimetric	mg/l	1	1350	1290	990	1180	1770	1690	1760	1640	3160	2720	2760	1480	67
Chloride	mg/l	1	770	716	760	679	92	102	75	89	960	1110	1160	307	73
Calcium	mg/l	1	436	443	442	443	447	461	468	465	566	617	540	301	94
Magnesium	mg/l	1	249	234	256	257	234	241	226	242	544	567	493	205	73
Sodium	mg/l	1	246	240	253	256	155	162	157	168	414	414	358	195	220
Potassium	mg/l	1	3	3	3	3	6	6	6	6	11	11	10	8	7
Nutrients															
Nitrite as N	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.04
Nitrate as N	mg/l	0.01	1.4	1.4	1.39	1.54	0.09	0.01	0.01	0.02	1.88	1.1	0.74	0.78	13.4
Nitrite + Nitrate as N	mg/l	0.01	1.4	1.4	1.39	1.54	0.1	0.01	0.01	0.02	1.88	1.1	0.74	0.78	13.4
Total Kjeldahl Nitrogen as N	mg/l	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	2.5
Total Nitrogen as N	mg/l	0.1	1.4	1.4	1.4	1.5	0.1	0.1	0.1	0.1	2	1.2	0.8	1	15.9
Total Phosphorus as P	mg/l	0.01	0.02	0.06	0.01	0.01	0.02	0.03	0.01	0.01	0.02	0.03	0.01	0.04	0.02
Dissolved Metals															
Aluminium	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	5.28	2.44	1.58	3.34	0.01
Antimony	mg/l	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001
Arsenic	mg/l	0.001	0.001	0.001	0.001	0.001	0.002	0.003	0.002	0.002	0.001	0.001	0.001	0.001	0.001
Cadmium	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002	0.0001	0.0001	0.0001	0.0048	0.0029	0.002	0.0012	0.0001
Chromium	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cobalt	mg/l	0.001	0.001	0.001	0.001	0.001	0.003	0.003	0.002	0.003	0.298	0.226	0.163	0.098	0.001
Copper	mg/l	0.001	0.001	0.001	0.001	0.001	0.004	0.001	0.003	0.001	0.015	0.005	0.004	0.012	0.006
Iron	mg/l	0.05	0.05	0.05	0.05	0.05	0.21	0.59	0.15	0.24	0.05	0.05	0.05	0.05	0.05
Lead	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Manganese	mg/l	0.001	0.002	0.001	0.002	0.001	0.324	0.361	0.264	0.309	27.8	25.1	20.9	8.04	0.009
Mercury	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002	0.0001	0.0003	0.0002	0.0001
Molybdenum	mg/l	0.001	0.001	0.001	0.001	0.001	0.006	0.005	0.004	0.008	0.001	0.001	0.001	0.001	0.001
Nickel	mg/l	0.001	0.001	0.001	0.001	0.001	0.012	0.01	0.01	0.01	0.098	0.069	0.047	0.036	0.001
Selenium	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Silver	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Zinc	mg/l	0.005	0.005	0.005	0.005	0.005	0.04	0.028	0.023	0.022	0.454	0.327	0.224	0.158	0.005

Notes

	Analytes with trigger (WMP)
	Exceeding trigger

AGE

Project ID: G1383AA
Groundwater quality data

Sample Location			MB21	MB21	MB23	MB23	MB23	MB23	MB24	MB24	MB24	MB24	MB25	MB25	MB25
Date Sampled			17/02/2021	21/04/2021	18/08/2020	12/11/2020	13/01/2021	21/04/2021	18/08/2020	12/11/2020	13/01/2021	21/04/2021	12/08/2020	17/11/2020	12/01/2021
Field Parameters	**Units**	**LOD**													
Field pH	pH units	-	6.68	6.94	5.78	5.84	5.97	5.97	6.4	6.4	6.87	6.91	6.82	7.21	7.12
Field Electrical Conductivity (EC)	µS/cm	-	1800	1862	5922	6215	6064	6336	2098	2175	2846	2968	2060	1727	1932
Field Temperature	deg c	-	16.7	15.6	15.6	16.7	18.1	16.1	17.1	17.8	17.4	16.4	16.95	19	17.8
Physical Parameters															
Electrical conductivity	µS/cm	1	1830	1820	5340	6590	6410	6370	2110	2340	2970	2960	1930	1850	1990
Hydroxide Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Carbonate Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Bicarbonate Alkalinity as $CaCO_3$	mg/l	1	958	923	203	195	190	185	135	139	387	372	356	302	369
Total Alkalinity as $CaCO_3$	mg/l	1	958	923	203	195	190	185	135	139	387	372	356	302	369
Suspended Solids (SS)	mg/l	5	5	5	5	9	5	14	5	7	5	5	5	5	5
Total Dissolved Solids @180°C	mg/l	10	1140	1170	4140	6160	6190	4640	1510	1640	2290	2350	1500	1280	1510
Redox Potential	mV	-	221	150	185	209	196	304	158	282	80	237	55.9	202	-125
Major Ions															
Sulfate as SO_4 - Turbidimetric	mg/l	1	36	38	3160	2840	3070	3200	488	565	960	982	629	541	548
Chloride	mg/l	1	48	60	572	658	672	678	331	306	216	202	177	107	168
Calcium	mg/l	1	127	115	474	488	493	496	103	106	216	241	187	156	191
Magnesium	mg/l	1	79	79	591	565	604	603	90	88	114	116	130	110	128
Sodium	mg/l	1	232	232	334	341	361	366	227	231	333	336	84	74	80
Potassium	mg/l	1	8	7	10	10	10	11	2	3	3	4	1	1	2
Nutrients															
Nitrite as N	mg/l	0.01	0.3	0.29	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.05	0.02	0.01
Nitrate as N	mg/l	0.01	14	14.6	2.4	2.42	2.36	2.55	2.98	2.79	0.03	0.05	0.54	4.75	0.03
Nitrite + Nitrate as N	mg/l	0.01	14.3	14.9	2.4	2.42	2.36	2.55	3	2.81	0.03	0.05	0.59	4.77	0.03
Total Kjeldahl Nitrogen as N	mg/l	0.1	1	0.7	0.1	0.1	0.1	0.1	0.5	-	0.1	0.1	0.1	0.6	0.3
Total Nitrogen as N	mg/l	0.1	15.3	15.6	2.4	2.5	2.5	2.6	3.5	3.6	0.1	0.1	0.6	5.4	0.3
Total Phosphorus as P	mg/l	0.01	0.01	0.01	0.07	0.05	0.07	0.06	0.11	0.13	0.02	0.04	0.06	0.09	0.05
Dissolved Metals															
Aluminium	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Antimony	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Arsenic	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.001	0.001	0.002
Cadmium	mg/l	0.0001	0.0001	0.0001	0.0004	0.0004	0.0005	0.0004	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Chromium	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cobalt	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.003	0.001	0.008
Copper	mg/l	0.001	0.009	0.008	0.001	0.001	0.001	0.001	0.013	0.014	0.001	0.001	0.001	0.001	0.001
Iron	mg/l	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.09	0.05	0.05	0.05	0.29
Lead	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001
Manganese	mg/l	0.001	0.193	0.177	0.008	0.01	0.013	0.009	0.199	0.242	0.832	0.81	1.57	0.004	1.86
Mercury	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Molybdenum	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.005	0.004	0.001	0.001	0.001	0.001	0.001
Nickel	mg/l	0.001	0.001	0.001	0.004	0.005	0.005	0.005	0.018	0.018	0.002	0.002	0.002	0.001	0.004
Selenium	mg/l	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Silver	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Zinc	mg/l	0.005	0.005	0.005	0.006	0.006	0.005	0.008	0.068	0.09	0.005	0.005	0.005	0.025	0.005

Notes

	Analytes with trigger (WMP)
	Exceeding trigger

Project ID: G1383AA
Groundwater quality data

Sample Location			MB25	MB26B	MB26B	MB26B	MB26B	MB27	MB27	MB27	MB27	MB27	MB27	MB27	MB27
Date Sampled			21/04/2021	11/08/2020	10/11/2020	12/01/2021	22/04/2021	8/07/2020	11/08/2020	8/09/2020	13/10/2020	10/11/2020	9/12/2020	12/01/2021	9/02/2021
Field Parameters	**Units**	**LOD**													
Field pH	pH units	-	7.08	6.49	7.06	6.5	6.53	7.53	6.67	6.81	6.73	6.71	6.94	7	6.73
Field Electrical Conductivity (EC)	µS/cm	-	1987	2264	2290	2168	2193	2076.1	2272	2187	2231	2207	2099	2122	1932
Field Temperature	deg c	-	16.2	17.03	20	17.9	16.9	15.23	17.63	17.8	21.2	17.8	18.2	17.8	17.8
Physical Parameters															
Electrical conductivity	µS/cm	1	1950	2120	2280	2250	2210	2120	2130	2180	2160	2210	2240	2180	2180
Hydroxide Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Carbonate Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Bicarbonate Alkalinity as $CaCO_3$	mg/l	1	405	365	383	376	386	437	440	444	440	449	484	410	441
Total Alkalinity as $CaCO_3$	mg/l	1	405	365	383	376	386	437	440	444	440	449	484	410	441
Suspended Solids (SS)	mg/l	5	5	5	5	5	5	5	5	7	5	5	6	5	5
Total Dissolved Solids @180°C	mg/l	10	1630	1160	1520	1350	1620	1630	1670	1680	1720	1710	1620	1620	1460
Redox Potential	mV	-	-122	71.2	177	54	259	-145	33.3	68.1	261	178	111	73	117
Major Ions															
Sulfate as SO_4 - Turbidimetric	mg/l	1	538	230	202	204	199	623	716	624	675	593	623	554	642
Chloride	mg/l	1	166	430	519	497	477	172	181	189	194	195	178	174	187
Calcium	mg/l	1	202	104	113	110	108	206	214	210	236	227	212	214	211
Magnesium	mg/l	1	128	146	146	146	145	120	125	117	128	128	120	123	119
Sodium	mg/l	1	80	135	133	136	136	113	123	120	127	124	117	122	118
Potassium	mg/l	1	2	7	7	7	7	1	1	2	2	1	1	1	1
Nutrients															
Nitrite as N	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.03	0.01	0.01	0.01	0.01	0.01
Nitrate as N	mg/l	0.01	0.01	0.42	0.45	0.37	0.35	0.66	0.74	0.8	0.99	1.17	1.15	1.18	1.12
Nitrite + Nitrate as N	mg/l	0.01	0.01	0.42	0.45	0.37	0.35	0.66	0.76	0.83	0.99	1.17	1.15	1.18	1.12
Total Kjeldahl Nitrogen as N	mg/l	0.1	1.2	0.1	0.2	0.1	0.1	0.1	0.1	0.4	0.1	0.1	0.1	0.1	0.1
Total Nitrogen as N	mg/l	0.1	1.2	0.5	0.6	0.4	0.4	0.8	0.8	1.2	1	1.3	1.2	1.3	1.1
Total Phosphorus as P	mg/l	0.01	0.24	0.09	0.02	0.01	0.04	0.05	0.03	0.03	0.02	0.02	0.02	0.01	0.01
Dissolved Metals															
Aluminium	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Antimony	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Arsenic	mg/l	0.001	0.009	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cadmium	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Chromium	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cobalt	mg/l	0.001	0.004	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Copper	mg/l	0.001	0.001	0.004	0.001	0.001	0.001	0.001	0.001	0.005	0.001	0.001	0.001	0.001	0.001
Iron	mg/l	0.05	1.35	0.1	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Lead	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Manganese	mg/l	0.001	2.39	0.206	0.007	0.198	0.201	0.001	0.002	0.002	0.001	0.001	0.001	0.001	0.001
Mercury	mg/l	0.0001	0.0001	0.0053	0.0016	0.0048	0.0054	0.0001	0.0003	0.0002	0.0003	0.0002	0.0002	0.0002	0.0002
Molybdenum	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Nickel	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Selenium	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Silver	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Zinc	mg/l	0.005	0.005	0.023	0.023	0.005	0.005	0.008	0.009	0.012	0.005	0.005	0.005	0.005	0.005

Notes

	Analytes with trigger (WMP)
	Exceeding trigger

Project ID: G1383AA
Groundwater quality data

Sample Location			MB27	MB27	MB27	MB28A	MB28B	MB28B	MB28B	MB29B	MB29B	MB29B	MB29B	MB2A	MB2A
Date Sampled			9/03/2021	22/04/2021	20/05/2021	11/08/2020	10/11/2020	12/01/2021	20/04/2021	11/08/2020	10/11/2020	12/01/2021	22/04/2021	19/08/2020	11/11/2020
Field Parameters	**Units**	**LOD**													
Field pH	pH units	-	7.02	6.91	7.02	6.9	6.73	7.09	7.12	7.52	7.76	7.75	7.63	6.71	6.68
Field Electrical Conductivity (EC)	µS/cm	-	2130	2166	2122	1850	1992	1928	1987	451.23	472.7	458	475.5	3286	3384
Field Temperature	deg c	-	17.8	17.3	17.5	16.27	17.3	17.7	17	16.91	18.6	17.9	17.2	14.5	17.1
Physical Parameters															
Electrical conductivity	µS/cm	1	2310	2180	2170	1920	2020	1990	1950	461	477	457	455	3080	3650
Hydroxide Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Carbonate Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Bicarbonate Alkalinity as $CaCO_3$	mg/l	1	476	442	448	444	436	425	406	229	231	227	221	625	630
Total Alkalinity as $CaCO_3$	mg/l	1	476	442	448	444	436	425	406	229	231	227	221	625	630
Suspended Solids (SS)	mg/l	5	5	5	5	5	5	5	5	5	12	5	5	20	15
Total Dissolved Solids @180°C	mg/l	10	1820	1670	1650	1430	1310	1400	1100	360	278	292	287	2920	3090
Redox Potential	mV	-	30	265	197	86	75	68	279	52.6	101	27	243	-11	-26
Major Ions															
Sulfate as SO_4 - Turbidimetric	mg/l	1	641	660	667	515	484	437	446	15	14	12	13	1580	1500
Chloride	mg/l	1	155	174	174	165	185	162	149	13	14	12	13	119	127
Calcium	mg/l	1	210	222	208	111	118	115	124	43	46	46	48	392	349
Magnesium	mg/l	1	120	126	117	103	103	102	102	8	9	8	8	224	212
Sodium	mg/l	1	118	126	122	195	193	195	198	48	48	49	47	176	172
Potassium	mg/l	1	2	1	1	2	2	2	2	1	1	1	1	1	2
Nutrients															
Nitrite as N	mg/l	0.01	0.01	0.01	0.01	0.01	0.1	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Nitrate as N	mg/l	0.01	1.14	1.16	1.08	1.28	1.09	2.23	2.13	1.16	1.08	1.33	0.95	0.03	0.01
Nitrite + Nitrate as N	mg/l	0.01	1.14	1.16	1.08	1.28	1.19	2.24	2.14	1.16	1.08	1.33	0.95	0.03	0.01
Total Kjeldahl Nitrogen as N	mg/l	0.1	0.2	0.1	0.1	0.2	0.1	0.2	-	0.1	0.2	0.1	0.1	0.2	0.1
Total Nitrogen as N	mg/l	0.1	1.3	1.3	1.2	1.5	1.3	2.4	2.4	1.2	1.3	1.3	1	0.2	0.1
Total Phosphorus as P	mg/l	0.01	0.03	0.03	0.03	0.06	0.05	0.04	0.06	0.02	0.03	0.01	0.03	0.12	0.09
Dissolved Metals															
Aluminium	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Antimony	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Arsenic	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.004	0.006	0.003	0.003	0.021	0.019
Cadmium	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Chromium	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cobalt	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.004	0.006
Copper	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.003	0.001	0.002	0.001	0.001	0.001
Iron	mg/l	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	4.15	3.48
Lead	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Manganese	mg/l	0.001	0.001	0.001	0.001	0.015	0.097	0.022	0.005	0.001	0.023	0.001	0.001	0.245	0.261
Mercury	mg/l	0.0001	0.0002	0.0002	0.0003	0.0005	0.0002	0.0005	0.0006	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Molybdenum	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.003	0.003	0.002	0.002	0.002	0.002
Nickel	mg/l	0.001	0.001	0.001	0.001	0.012	0.013	0.005	0.005	0.001	0.001	0.001	0.001	0.002	0.002
Selenium	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Silver	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Zinc	mg/l	0.005	0.006	0.005	0.005	0.012	0.017	0.009	0.009	0.005	0.005	0.005	0.005	0.005	0.005

Notes

	Analytes with trigger (WMP)
	Exceeding trigger

AGE

Project ID: G1383AA
Groundwater quality data

Sample Location			MB2A	MB2A	MB30	MB30	MB30	MB30	MB30	MB30	MB30	MB30	MB30	MB30	MB30
Date Sampled			7/01/2021	20/04/2021	13/07/2020	17/08/2020	4/09/2020	7/10/2020	6/11/2020	8/12/2020	6/01/2021	5/02/2021	5/03/2021	23/04/2021	20/05/2021
Field Parameters	**Units**	**LOD**													
Field pH	pH units	-	6.91	6.81	6.83	7.07	6.89	6.98	6.84	7.13	7.01	-	6.92	6.99	7.07
Field Electrical Conductivity (EC)	µS/cm	-	3250	3513	1561	1464	1534	1471	1530	1510	1513	-	1534	1559	1512
Field Temperature	deg c	-	17.2	17	13	14.2	16	15.8	16.3	16.2	16.8	-	16.9	15.9	16.2
Physical Parameters															
Electrical conductivity	µS/cm	1	3310	3520	1520	1460	1560	1560	1620	1580	1550	1560	1580	1510	1540
Hydroxide Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Carbonate Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Bicarbonate Alkalinity as $CaCO_3$	mg/l	1	546	559	454	426	423	407	442	458	429	430	461	375	386
Total Alkalinity as $CaCO_3$	mg/l	1	546	559	454	426	423	407	442	458	429	430	461	375	386
Suspended Solids (SS)	mg/l	5	16	6	5	5	17	5	12	6	5	8	10	5	5
Total Dissolved Solids @180°C	mg/l	10	3020	1580	1260	1170	1090	1070	1170	1060	1170	1060	1190	1140	1100
Redox Potential	mV	-	-69	201	224	-15	102	231	280	144	130	-	169	147	211
Major Ions															
Sulfate as SO_4 - Turbidimetric	mg/l	1	1530	1580	454	450	436	477	420	452	459	480	455	478	488
Chloride	mg/l	1	85	114	42	43	40	36	39	37	38	38	38	38	36
Calcium	mg/l	1	392	410	210	199	221	184	239	204	207	200	200	208	197
Magnesium	mg/l	1	215	248	57	56	60	53	55	56	58	57	57	58	55
Sodium	mg/l	1	166	185	80	78	82	74	78	78	81	80	80	82	79
Potassium	mg/l	1	2	2	3	3	4	4	4	3	3	3	3	3	3
Nutrients															
Nitrite as N	mg/l	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Nitrate as N	mg/l	0.01	1.76	0.1	0.09	0.11	0.09	0.12	0.07	0.07	0.07	0.08	0.13	0.08	0.08
Nitrite + Nitrate as N	mg/l	0.01	1.78	0.1	0.09	0.11	0.09	0.12	0.07	0.07	0.07	0.08	0.13	0.08	0.08
Total Kjeldahl Nitrogen as N	mg/l	0.1	0.3	0.1	0.1	0.1	0.1	0.1	-	0.1	0.1	0.2	0.2	0.1	0.1
Total Nitrogen as N	mg/l	0.1	2.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.2	0.3	0.3	0.1	0.1
Total Phosphorus as P	mg/l	0.01	0.05	0.04	0.01	0.06	0.02	0.02	0.02	0.01	0.01	0.01	0.03	0.01	0.01
Dissolved Metals															
Aluminium	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Antimony	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Arsenic	mg/l	0.001	0.013	0.004	0.004	0.004	0.004	0.003	0.005	0.005	0.005	0.004	0.005	0.004	0.005
Cadmium	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Chromium	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cobalt	mg/l	0.001	0.003	0.004	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Copper	mg/l	0.001	0.001	0.001	0.002	0.003	0.005	0.002	0.005	0.005	0.005	0.008	0.002	0.001	0.003
Iron	mg/l	0.05	1.72	0.1	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Lead	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Manganese	mg/l	0.001	0.17	0.12	0.021	0.015	0.017	0.004	0.011	0.013	0.007	0.006	0.004	0.001	0.001
Mercury	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Molybdenum	mg/l	0.001	0.002	0.004	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.001	0.001	0.002	0.001
Nickel	mg/l	0.001	0.002	0.003	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Selenium	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Silver	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Zinc	mg/l	0.005	0.005	0.005	0.008	0.009	0.01	0.005	0.016	0.033	0.021	0.015	0.009	0.009	0.008

Notes

	Analytes with trigger (WMP)
	Exceeding trigger

Project ID: G1383AA
Groundwater quality data

Sample Location			MB30	MB3A	MB3A	MB3A	MB3A	MB47A	MB47A	MB47A	MB47A	MB48	MB48	MB48	MB48
Date Sampled			17/06/2021	19/08/2020	11/11/2020	7/01/2021	20/04/2021	5/08/2020	3/11/2020	6/01/2021	8/04/2021	4/08/2020	4/11/2020	5/01/2021	8/04/2021
Field Parameters	**Units**	**LOD**													
Field pH	pH units	-	6.86	6.65	6.73	6.92	6.81	7.16	7.03	7.19	7.08	6.35	6.24	6.48	6.46
Field Electrical Conductivity (EC)	µS/cm	-	1509	4370	4522	4415	4818	486.1	527	568	562	249.1	250.3	239	257.6
Field Temperature	deg c	-	15.7	14.9	16.7	16.9	16.3	15.1	19	17.1	17.4	13.5	14.2	15.8	15.2
Physical Parameters															
Electrical conductivity	µS/cm	1	1500	4000	4860	4570	4840	438	499	488	479	233	250	243	263
Hydroxide Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Carbonate Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Bicarbonate Alkalinity as $CaCO_3$	mg/l	1	435	516	546	530	540	264	280	279	287	122	120	124	120
Total Alkalinity as $CaCO_3$	mg/l	1	435	516	546	530	540	264	280	279	287	122	120	124	120
Suspended Solids (SS)	mg/l	5	5	6	7	9	5	141	884	891	1420	5	45	100	62
Total Dissolved Solids @180°C	mg/l	10	1000	4040	4150	4320	3110	340	303	368	277	155	170	140	158
Redox Potential	mV	-	270	114	204	93	256	-100	-127	-117	-141	116	75	27	190
Major Ions															
Sulfate as SO_4 - Turbidimetric	mg/l	1	486	2100	2250	2180	2230	1	3	3	3	11	10	7	11
Chloride	mg/l	1	38	389	326	291	315	4	4	4	4	10	10	4	11
Calcium	mg/l	1	195	475	427	477	515	79	78	85	86	8	8	7	9
Magnesium	mg/l	1	60	314	306	316	364	9	8	8	9	17	17	16	17
Sodium	mg/l	1	80	241	240	260	296	8	8	8	9	19	18	17	19
Potassium	mg/l	1	3	2	2	2	2	2	2	2	3	2	1	2	2
Nutrients															
Nitrite as N	mg/l	0.01	0.01	0.34	1.23	0.08	0.3	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Nitrate as N	mg/l	0.01	0.09	8.14	6.51	11.5	8.27	0.01	0.23	0.18	0.27	0.02	0.01	0.01	0.08
Nitrite + Nitrate as N	mg/l	0.01	0.09	8.48	7.74	11.6	8.57	0.01	0.23	0.18	0.27	0.02	0.01	0.01	0.08
Total Kjeldahl Nitrogen as N	mg/l	0.1	0.1	0.4	1.3	0.7	0.5	0.1	-	0.8	0.5	0.1	0.1	0.2	0.1
Total Nitrogen as N	mg/l	0.1	0.1	8.9	9	12.3	9.1	0.1	0.7	1	0.5	0.1	0.1	0.2	0.1
Total Phosphorus as P	mg/l	0.01	0.01	0.04	0.05	0.02	0.04	0.03	1.21	0.78	1.02	0.54	0.7	0.88	0.95
Dissolved Metals															
Aluminium	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Antimony	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Arsenic	mg/l	0.001	0.004	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cadmium	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Chromium	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cobalt	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Copper	mg/l	0.001	0.003	0.002	0.002	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.006
Iron	mg/l	0.05	0.05	0.05	0.05	0.05	0.05	7.16	4.75	7.46	3.88	0.8	0.74	0.69	0.5
Lead	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Manganese	mg/l	0.001	0.006	0.081	0.106	0.033	0.127	0.114	0.164	0.227	0.21	1.65	1.57	1.46	1.65
Mercury	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Molybdenum	mg/l	0.001	0.003	0.006	0.006	0.006	0.007	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Nickel	mg/l	0.001	0.001	0.004	0.005	0.003	0.005	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Selenium	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Silver	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Zinc	mg/l	0.005	0.015	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.006	0.007	0.017	0.014

Notes

	Analytes with trigger (WMP)
	Exceeding trigger

Project ID: G1383AA
Groundwater quality data

Sample Location			MB49	MB49	MB49	MB49	MB4A	MB4A	MB4A	MB4A	MB51	MB51	MB51	MB51	MB53
Date Sampled			4/08/2020	3/11/2020	5/01/2021	6/04/2021	13/08/2020	11/11/2020	11/01/2021	20/04/2021	5/08/2020	4/11/2020	7/01/2021	19/04/2021	20/08/2020
Field Parameters	**Units**	**LOD**													
Field pH	pH units	-	6.18	6.16	6.48	6.42	6.83	6.75	7.07	6.95	6.71	6.7	6.83	7.42	7.53
Field Electrical Conductivity (EC)	µS/cm	-	264.4	255	249	252	2102	2132	2088	2158	1249	1349	2066	1932	400.5
Field Temperature	deg c	-	13.3	15.4	15.7	14.9	15.78	17.8	16.4	16.6	13.2	18.5	16.6	16.6	12.8
Physical Parameters															
Electrical conductivity	µS/cm	1	251	258	250	251	1980	2350	2130	2110	1210	1370	2140	1880	367
Hydroxide Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Carbonate Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Bicarbonate Alkalinity as $CaCO_3$	mg/l	1	145	137	136	122	327	327	320	319	350	426	419	115	214
Total Alkalinity as $CaCO_3$	mg/l	1	145	137	136	122	327	327	320	319	350	426	419	115	214
Suspended Solids (SS)	mg/l	5	5	5	5	5	12	12	6	5	15	9	453	103	11
Total Dissolved Solids @180°C	mg/l	10	125	188	180	197	1870	1820	1810	1460	820	956	1970	1840	232
Redox Potential	mV	-	64	68	53	-7	-93.9	-17	-32	189	236	173	-52	160	228
Major Ions															
Sulfate as SO_4 - Turbidimetric	mg/l	1	2	1	1	1	875	915	643	807	357	349	984	830	10
Chloride	mg/l	1	8	7	8	8	34	31	119	42	21	41	27	19	4
Calcium	mg/l	1	21	20	19	18	322	339	346	335	213	204	412	359	29
Magnesium	mg/l	1	10	9	9	8	87	87	89	93	28	47	78	62	16
Sodium	mg/l	1	20	18	20	16	72	71	73	77	41	44	40	40	26
Potassium	mg/l	1	5	5	4	4	2	2	2	2	3	2	3	3	18
Nutrients															
Nitrite as N	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Nitrate as N	mg/l	0.01	0.04	0.08	0.01	0.01	0.07	0.01	0.01	0.02	9	0.63	0.1	0.68	0.1
Nitrite + Nitrate as N	mg/l	0.01	0.04	0.08	0.01	0.01	0.07	0.01	0.01	0.02	9	0.63	0.1	0.68	0.1
Total Kjeldahl Nitrogen as N	mg/l	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0.4	0.1	-	0.2	0.1
Total Nitrogen as N	mg/l	0.1	0.1	0.1	0.1	0.1	0.3	0.2	0.1	0.1	9.4	0.6	0.6	0.9	0.2
Total Phosphorus as P	mg/l	0.01	0.07	0.07	0.12	0.13	0.1	0.13	0.03	0.03	0.01	0.01	0.82	0.16	0.13
Dissolved Metals															
Aluminium	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Antimony	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Arsenic	mg/l	0.001	0.001	0.001	0.001	0.001	0.015	0.016	0.011	0.004	0.001	0.001	0.005	0.001	0.001
Cadmium	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Chromium	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cobalt	mg/l	0.001	0.001	0.001	0.001	0.001	0.01	0.008	0.008	0.001	0.001	0.001	0.042	0.007	0.001
Copper	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.012	0.002	0.001	0.001	0.004
Iron	mg/l	0.05	1.86	0.82	1.63	1.89	1.11	1.01	0.68	0.09	0.05	0.05	0.41	0.25	0.05
Lead	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Manganese	mg/l	0.001	0.398	0.215	0.358	0.36	3.43	3.1	2.81	2.01	0.03	0.096	3.16	0.41	0.413
Mercury	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Molybdenum	mg/l	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.001	0.001	0.001	0.003	0.002
Nickel	mg/l	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.001	0.006	0.05	0.008	0.001
Selenium	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Silver	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Zinc	mg/l	0.005	0.006	0.012	0.005	0.005	0.008	0.005	0.005	0.005	0.014	0.024	0.005	0.012	0.027

Notes

	Analytes with trigger (WMP)
	Exceeding trigger

AGE

Project ID: G1383AA
Groundwater quality data

Sample Location			MB53	MB53	MB53	MB54	MB54	MB54	MB54	MB56	MB56	MB56	MB56	MB5C	MB5C
Date Sampled			16/11/2020	18/01/2021	19/04/2021	20/08/2020	16/11/2020	18/01/2021	19/04/2021	20/08/2020	16/11/2020	18/01/2021	19/04/2021	13/08/2020	11/11/2020
Field Parameters	**Units**	**LOD**													
Field pH	pH units	-	7.27	7.61	7.4	5.9	5.58	5.9	5.93	5.99	5.62	6.18	6.02	6.67	6.75
Field Electrical Conductivity (EC)	µS/cm	-	398	397	407.1	123.3	117	145	157.9	136.3	143	142	148.2	3598	3625
Field Temperature	deg c	-	15.2	15.6	14.6	11.7	15.9	14.9	14.3	12.2	15.3	15.2	14.4	16.72	17.5
Physical Parameters															
Electrical conductivity	µS/cm	1	423	397	392	123	121	147	154	-	149	143	147	3280	3930
Hydroxide Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	-	1	1	1	1	1
Carbonate Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	-	1	1	1	1	1
Bicarbonate Alkalinity as $CaCO_3$	mg/l	1	214	209	201	22	18	18	18	-	45	40	40	523	535
Total Alkalinity as $CaCO_3$	mg/l	1	214	209	201	22	18	18	18	-	45	40	40	523	535
Suspended Solids (SS)	mg/l	5	5	5	5	6	5	19	5	-	5	5	5	95	64
Total Dissolved Solids @180°C	mg/l	10	278	313	260	132	146	192	202	-	170	186	184	3280	3250
Redox Potential	mV	-	85	-40	132	245	291	181	327	253	266	135	259	-113.6	-67
Major Ions															
Sulfate as SO_4 - Turbidimetric	mg/l	1	10	9	10	1	1	1	1	-	1	1	1	1390	1440
Chloride	mg/l	1	3	4	4	4	4	5	5	-	5	4	4	322	306
Calcium	mg/l	1	28	31	30	6	5	8	8	-	7	8	9	429	399
Magnesium	mg/l	1	16	17	17	2	2	3	3	-	2	3	3	224	217
Sodium	mg/l	1	24	24	24	10	9	10	11	-	8	9	10	154	149
Potassium	mg/l	1	17	18	18	7	6	9	10	-	11	13	13	4	5
Nutrients															
Nitrite as N	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	-	0.01	0.01	0.01	0.01	0.01
Nitrate as N	mg/l	0.01	0.05	0.01	0.02	9.16	8.1	10.6	12.2	-	6.05	5.64	6.26	0.06	0.02
Nitrite + Nitrate as N	mg/l	0.01	0.05	0.01	0.02	9.16	8.1	10.6	12.2	-	6.05	5.64	6.26	0.06	0.02
Total Kjeldahl Nitrogen as N	mg/l	0.1	0.1	0.1	0.1	0.4	1.2	0.6	0.4	-	1	0.4	0.3	0.1	0.1
Total Nitrogen as N	mg/l	0.1	0.1	0.1	0.1	9.6	9.3	11.2	12.6	-	7	6	6.6	0.1	0.1
Total Phosphorus as P	mg/l	0.01	0.16	0.13	0.12	0.06	0.06	0.06	0.07	-	0.14	0.14	0.16	0.32	0.2
Dissolved Metals															
Aluminium	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	-	0.01	0.01	0.01	0.01	0.01
Antimony	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	0.001	0.001
Arsenic	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	0.011	0.01
Cadmium	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	-	0.0001	0.0001	0.0001	0.0001	0.0001
Chromium	mg/l	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.001	-	0.001	0.001	0.001	0.001	0.001
Cobalt	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	0.001	0.001
Copper	mg/l	0.001	0.001	0.001	0.001	0.006	0.006	0.001	0.001	-	0.001	0.001	0.001	0.001	0.001
Iron	mg/l	0.05	0.06	0.05	0.07	0.05	0.05	0.05	0.05	-	0.05	0.05	0.05	6.59	4.78
Lead	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	0.001	0.001
Manganese	mg/l	0.001	0.347	0.359	0.371	0.011	0.008	0.003	0.003	-	0.002	0.001	0.001	0.86	0.842
Mercury	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	-	0.0001	0.0001	0.0001	0.0001	0.0001
Molybdenum	mg/l	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	0.002	0.002
Nickel	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	0.001	0.001
Selenium	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	-	0.01	0.01	0.01	0.01	0.01
Silver	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	0.001	0.001
Zinc	mg/l	0.005	0.005	0.005	0.005	0.104	0.042	0.005	0.005	-	0.014	0.013	0.008	0.023	0.005

Notes

	Analytes with trigger (WMP)
	Exceeding trigger

Project ID: G1383AA
Groundwater quality data

Sample Location			MB5C	MB5C	MB62	MB62	MB62	MB62	MB63	MB63	MB63	MB63	MB64	MB64	MB64
Date Sampled			7/01/2021	20/04/2021	5/08/2020	4/11/2020	6/01/2021	8/04/2021	16/09/2020	16/11/2020	18/01/2021	19/04/2021	16/09/2020	16/11/2020	18/01/2021
Field Parameters	**Units**	**LOD**													
Field pH	pH units	-		6.87	5	5.08	5.36	5.34	4.7	4.57	5.08	5.06	5.57	5.53	5.97
Field Electrical Conductivity (EC)	µS/cm	-		3612	65	76	77	68	48.5	48	46	4649	72.3	71.1	77
Field Temperature	deg c	-		17.3	14	18.4	15.5	15.7	15.7	15.3	15.3	15	14.8	15.2	15.3
Physical Parameters															
Electrical conductivity	µS/cm	1	3640	3590	65	78	79	69	46	48	45	45	72	73	78
Hydroxide Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Carbonate Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Bicarbonate Alkalinity as $CaCO_3$	mg/l	1	518	519	25	20	15	11	9	10	7	7	31	27	32
Total Alkalinity as $CaCO_3$	mg/l	1	518	519	25	20	15	11	9	10	7	7	31	27	32
Suspended Solids (SS)	mg/l	5	45	103	5	11	5	10	44	7	5	5	5	5	5
Total Dissolved Solids @180°C	mg/l	10	3180	1880	55	59	46	59	33	52	50	48	79	82	86
Redox Potential	mV	-	-	-27	249	249	261	347	266	298	243	353	217	280	165
Major Ions															
Sulfate as SO_4 - Turbidimetric	mg/l	1	1510	1450	1	1	1	1	1	1	1	1	1	1	1
Chloride	mg/l	1	318	293	11	14	16	12	5	4	5	5	2	2	3
Calcium	mg/l	1	470	455	2	2	1	1	1	1	1	1	4	4	5
Magnesium	mg/l	1	222	230	2	3	3	2	1	1	1	1	3	3	4
Sodium	mg/l	1	144	157	7	8	8	8	6	5	6	6	4	5	6
Potassium	mg/l	1	5	4	1	1	1	1	1	1	1	1	1	1	1
Nutrients															
Nitrite as N	mg/l	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Nitrate as N	mg/l	0.01	0.01	0.02	0.49	0.33	0.21	0.65	2.02	1.88	1.45	1.61	2.02	1.6	1.38
Nitrite + Nitrate as N	mg/l	0.01	0.01	0.02	0.49	0.35	0.21	0.65	2.02	1.89	1.45	1.61	2.02	1.61	1.38
Total Kjeldahl Nitrogen as N	mg/l	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.4	0.2	0.1
Total Nitrogen as N	mg/l	0.1	0.1	0.1	0.5	0.4	0.2	0.6	2.2	2	1.6	1.6	2.4	1.8	1.4
Total Phosphorus as P	mg/l	0.01	0.09	0.41	0.01	0.04	0.01	0.02	0.02	0.01	0.01	0.01	0.06	0.04	0.03
Dissolved Metals															
Aluminium	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.18	0.04	0.09
Antimony	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Arsenic	mg/l	0.001	0.011	0.01	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cadmium	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Chromium	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.001	0.002	0.001	0.002
Cobalt	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.003	0.003	0.002	0.002	0.001	0.001	0.001
Copper	mg/l	0.001	0.001	0.001	0.001	0.003	0.001	0.001	0.003	0.001	0.001	0.001	0.001	0.001	0.001
Iron	mg/l	0.05	5.36	6.2	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.05	0.05
Lead	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Manganese	mg/l	0.001	0.815	0.852	0.006	0.017	0.006	0.008	0.014	0.013	0.013	0.015	0.001	0.001	0.002
Mercury	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Molybdenum	mg/l	0.001	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Nickel	mg/l	0.001	0.001	0.001	0.003	0.004	0.004	0.004	0.005	0.004	0.004	0.004	0.002	0.002	0.002
Selenium	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Silver	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Zinc	mg/l	0.005	0.005	0.005	0.005	0.023	0.009	0.01	0.026	0.03	0.016	0.011	0.005	0.005	0.005

Notes

	Analytes with trigger (WMP)
	Exceeding trigger

AGE

Project ID: G1383AA
Groundwater quality data

Sample Location			MB64	MB65	MB65	MB65	MB65	MB68	MB68	MB68	MB68	MB69	MB69	MB69	MB69
Date Sampled			19/04/2021	16/09/2020	16/11/2020	18/01/2021	19/04/2021	12/08/2020	17/11/2020	14/01/2021	22/04/2021	12/08/2020	17/11/2020	14/01/2021	22/04/2021
Field Parameters	**Units**	**LOD**													
Field pH	pH units	-	5.77	6.43	6.5	6.71	6.91	6.76	6.88	7.08	6.98	6.85	6.68	6.91	6.92
Field Electrical Conductivity (EC)	µS/cm	-	71.6	161.6	178	159	161.8	1707	1696	1650	1696	2317	2553	2449	2512
Field Temperature	deg c	-	14.4	13.2	20.1	18.6	14.5	15.35	16.2	17.6	16.1	13.51	16	18.2	15
Physical Parameters															
Electrical conductivity	µS/cm	1	72	162	177	160	158	1630	1820	1730	1660	2170	2630	2580	2480
Hydroxide Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Carbonate Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Bicarbonate Alkalinity as $CaCO_3$	mg/l	1	27	78	80	74	70	386	408	398	368	617	638	610	615
Total Alkalinity as $CaCO_3$	mg/l	1	27	78	80	74	70	386	408	398	368	617	638	610	615
Suspended Solids (SS)	mg/l	5	5	5	6	5	5	8	24	5	7	22	6	12	9
Total Dissolved Solids @180°C	mg/l	10	109	108	151	139	152	1180	1150	1150	1140	1510	2090	1770	1880
Redox Potential	mV	-	362	220	278	141	294	128.6	291	90	245	96.8	46	-84	73
Major Ions															
Sulfate as SO_4 - Turbidimetric	mg/l	1	1	2	1	1	1	319	294	285	297	404	505	458	541
Chloride	mg/l	1	2	7	8	7	7	195	203	220	196	207	311	335	308
Calcium	mg/l	1	4	13	12	13	13	132	136	148	148	172	230	255	240
Magnesium	mg/l	1	3	8	7	8	8	85	82	78	85	120	129	125	137
Sodium	mg/l	1	6	6	7	8	8	116	112	109	118	161	152	149	162
Potassium	mg/l	1	1	2	2	2	2	2	2	2	3	2	4	5	4
Nutrients															
Nitrite as N	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.02	0.02	0.01	0.01
Nitrate as N	mg/l	0.01	2.09	1.38	1.13	0.93	1.39	4.46	4.57	4.78	4.99	26.7	0.01	0.01	0.03
Nitrite + Nitrate as N	mg/l	0.01	2.09	1.38	1.13	0.93	1.39	4.48	4.59	4.78	4.99	26.7	0.03	0.01	0.03
Total Kjeldahl Nitrogen as N	mg/l	0.1	0.2	0.2	0.1	0.2	0.1	0.4	0.4	0.4	0.5	0.2	0.1	0.1	0.1
Total Nitrogen as N	mg/l	0.1	2.3	1.6	1.1	1.1	1.4	4.9	5	5.2	5.5	26.9	0.1	0.1	0.1
Total Phosphorus as P	mg/l	0.01	0.03	0.08	0.05	0.04	0.24	0.03	0.06	0.06	0.05	0.06	0.12	0.12	0.12
Dissolved Metals															
Aluminium	mg/l	0.01	0.05	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Antimony	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Arsenic	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cadmium	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Chromium	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cobalt	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.004	0.004	0.004
Copper	mg/l	0.001	0.001	0.003	0.003	0.026	0.001	0.003	0.001	0.001	0.001	0.006	0.001	0.001	0.001
Iron	mg/l	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	1.33	2.77	1.95
Lead	mg/l	0.001	0.001	0.001	0.001	0.003	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Manganese	mg/l	0.001	0.002	0.018	0.039	0.247	0.026	0.002	0.002	0.001	0.001	0.012	1.04	1.08	1.25
Mercury	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0003	0.0003	0.0003	0.0003	0.0001	0.0001	0.0001	0.0001
Molybdenum	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Nickel	mg/l	0.001	0.002	0.003	0.006	0.007	0.002	0.001	0.001	0.001	0.001	0.001	0.003	0.002	0.001
Selenium	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Silver	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Zinc	mg/l	0.005	0.005	3.2	6.57	1.44	0.227	0.005	0.012	0.005	0.005	0.017	0.005	0.005	0.005

Notes

	Analytes with trigger (WMP)
	Exceeding trigger

AGE

Project ID: G1383AA
Groundwater quality data

Sample Location			MB6A	MB6A	MB6A	MB6A	MB70	MB70	MB70	MB70	MB71	MB71	MB71	MB71	MB72
Date Sampled			13/08/2020	11/11/2020	11/01/2021	22/04/2021	12/08/2020	18/11/2020	12/01/2021	21/04/2021	10/08/2020	3/11/2020	5/01/2021	9/04/2021	5/08/2020
Field Parameters	**Units**	**LOD**													
Field pH	pH units	-	6.68	6.71	6.94	6.93	6.42	6.5	6.63	6.58	5.83	5.8	6.1	6.11	6.6
Field Electrical Conductivity (EC)	µS/cm	-	2832	2754	2682	2772	497.35	412.6	431	407.3	276.3	283	264	183	188
Field Temperature	deg c	-	15.77	16.5	16.6	16	14.95	16.4	16.4	15.9	14.3	15.7	15.2	15.3	12.9
Physical Parameters															
Electrical conductivity	µS/cm	1	2520	3010	2780	2760	481	425	437	394	279	292	266	181	179
Hydroxide Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Carbonate Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Bicarbonate Alkalinity as $CaCO_3$	mg/l	1	375	376	350	372	211	180	188	166	69	74	72	44	98
Total Alkalinity as $CaCO_3$	mg/l	1	375	376	350	372	211	180	188	166	69	74	72	44	98
Suspended Solids (SS)	mg/l	5	6	5	5	5	383	42	8	9	5	5	5	40	9
Total Dissolved Solids @180°C	mg/l	10	2640	2490	2500	2610	342	290	318	320	198	198	176	134	150
Redox Potential	mV	-	41.3	156	149	-11	211.9	301	154	294	246	180	169	311	246
Major Ions															
Sulfate as SO_4 - Turbidimetric	mg/l	1	1370	1410	1540	1530	29	12	13	12	38	42	32	25	1
Chloride	mg/l	1	51	49	49	57	15	13	14	13	24	24	24	12	2
Calcium	mg/l	1	414	377	416	426	32	27	30	30	18	19	17	11	16
Magnesium	mg/l	1	136	128	138	140	26	20	23	21	11	11	10	6	10
Sodium	mg/l	1	108	107	112	115	26	24	26	24	18	17	18	14	8
Potassium	mg/l	1	2	2	2	2	3	3	3	3	1	2	1	1	4
Nutrients															
Nitrite as N	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Nitrate as N	mg/l	0.01	0.28	0.16	0.17	0.01	2.48	5.26	5.17	5.39	0.72	0.86	0.6	0.54	2.41
Nitrite + Nitrate as N	mg/l	0.01	0.28	0.16	0.17	0.01	2.48	5.29	5.17	5.39	0.72	0.86	0.6	0.54	2.42
Total Kjeldahl Nitrogen as N	mg/l	0.1	0.1	0.1	0.1	0.2	0.5	0.7	0.7	0.5	0.1	0.1	0.2	0.1	0.1
Total Nitrogen as N	mg/l	0.1	0.3	0.2	0.2	0.2	3	6	5.9	5.9	0.7	0.9	0.8	0.5	2.4
Total Phosphorus as P	mg/l	0.01	0.04	0.03	0.01	0.03	6.26	0.94	0.24	0.27	0.07	0.09	0.08	0.08	0.02
Dissolved Metals															
Aluminium	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.03	0.01
Antimony	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Arsenic	mg/l	0.001	0.001	0.001	0.001	0.009	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cadmium	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Chromium	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cobalt	mg/l	0.001	0.001	0.001	0.001	0.012	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Copper	mg/l	0.001	0.002	0.001	0.001	0.001	0.001	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001
Iron	mg/l	0.05	0.05	0.05	0.05	1.43	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Lead	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Manganese	mg/l	0.001	0.902	0.787	0.515	6.9	0.005	0.039	0.005	0.002	0.006	0.002	0.003	0.011	0.009
Mercury	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Molybdenum	mg/l	0.001	0.001	0.001	0.001	0.002	0.004	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001
Nickel	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Selenium	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Silver	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Zinc	mg/l	0.005	0.009	0.005	0.005	0.005	0.005	0.04	0.013	0.005	0.005	0.005	0.005	0.005	0.005

Notes

	Analytes with trigger (WMP)
	Exceeding trigger

AGE

Project ID: G1383AA
Groundwater quality data

Sample Location			MB72	MB72	MB72	MB74	MB74	MB74	MB74	MB75	MB75	MB75	MB75	MB77A	MB77A
Date Sampled			3/11/2020	5/01/2021	9/04/2021	10/08/2020	3/11/2020	5/01/2021	9/04/2021	4/08/2020	3/11/2020	5/01/2021	9/04/2021	27/08/2020	5/11/2020
Field Parameters	**Units**	**LOD**													
Field pH	pH units	-	6.12	6.88	6.55	5.62	5.4	6.73	5.95	7.22	7.06	7.35	7.14	6.37	6.6
Field Electrical Conductivity (EC)	µS/cm	-	195	277	186.8	89.2	85	196	93.2	246.3	250	249	254.8	2819	2879
Field Temperature	deg c	-	14	14.4	14.4	14.2	13.8	14.7	14.9	11.6	13.8	14.7	14.7	16.4	16.1
Physical Parameters															
Electrical conductivity	µS/cm	1	196	278	191	91	83	198	97	217	252	249	256	2870	2990
Hydroxide Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Carbonate Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Bicarbonate Alkalinity as $CaCO_3$	mg/l	1	100	175	92	34	26	110	30	140	141	140	146	414	431
Total Alkalinity as $CaCO_3$	mg/l	1	100	175	92	34	26	110	30	140	141	140	146	414	431
Suspended Solids (SS)	mg/l	5	5	5	5	6	39	5	5	5	5	5	5	22	86
Total Dissolved Solids @180°C	mg/l	10	140	168	138	104	83	127	88	157	155	140	150	2410	2440
Redox Potential	mV	-	166	113	321	254	222	157	368	77	19	-18	145	212	262
Major Ions															
Sulfate as SO_4 - Turbidimetric	mg/l	1	1	1	1	1	1	10	1	1	1	1	1	1360	879
Chloride	mg/l	1	2	1	2	3	2	1	3	2	2	2	2	140	140
Calcium	mg/l	1	17	28	16	6	5	17	6	13	17	17	18	285	272
Magnesium	mg/l	1	9	14	9	3	3	10	4	7	8	8	10	147	138
Sodium	mg/l	1	10	12	8	7	6	10	7	22	20	22	21	184	186
Potassium	mg/l	1	2	4	3	3	1	3	1	7	7	6	7	5	6
Nutrients															
Nitrite as N	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Nitrate as N	mg/l	0.01	1.72	0.16	3.18	3.39	3.94	0.01	3.96	0.02	0.06	0.01	0.04	0.44	0.62
Nitrite + Nitrate as N	mg/l	0.01	1.72	0.16	3.18	3.39	3.94	0.01	3.96	0.02	0.06	0.01	0.04	0.44	0.62
Total Kjeldahl Nitrogen as N	mg/l	0.1	0.1	0.1	0.1	0.4	0.4	0.1	0.3	0.1	0.1	0.1	0.1	0.1	0.2
Total Nitrogen as N	mg/l	0.1	1.7	0.2	3.2	3.8	4.3	0.1	4.3	0.1	0.1	0.1	0.1	0.5	0.8
Total Phosphorus as P	mg/l	0.01	0.06	0.04	0.04	0.08	0.04	0.01	0.02	0.08	0.15	0.14	0.12	0.06	0.09
Dissolved Metals															
Aluminium	mg/l	0.01	0.01	0.01	0.01	0.03	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Antimony	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Arsenic	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cadmium	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Chromium	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cobalt	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Copper	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.007
Iron	mg/l	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.07	0.16	0.14	0.17	0.05	0.05
Lead	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Manganese	mg/l	0.001	0.003	0.005	0.002	0.73	0.001	0.068	0.001	0.212	0.252	0.269	0.278	0.004	0.004
Mercury	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	-	-
Molybdenum	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.004	0.003	0.003	0.003	0.001	0.001
Nickel	mg/l	0.001	0.001	0.001	0.001	0.02	0.001	0.005	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Selenium	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Silver	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Zinc	mg/l	0.005	0.005	0.005	0.005	0.078	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.008	0.02

Notes

	Analytes with trigger (WMP)
	Exceeding trigger

Project ID: G1383AA
Groundwater quality data

Sample Location			MB77A	MB77A	MB77B	MB77B	MB77B	MB77B	MB78	MB78	MB78	MB78	MB78	MB78	MB78
Date Sampled			12/01/2021	22/04/2021	11/08/2020	5/11/2020	12/01/2021	22/04/2021	15/07/2020	12/08/2020	14/09/2020	14/10/2020	17/11/2020	11/12/2020	21/01/2021
Field Parameters	**Units**	**LOD**													
Field pH	pH units	-	7	6.91	6.91	6.97	7.14	7.27	6.84	6.8	6.87	6.74	6.89	7.05	7.05
Field Electrical Conductivity (EC)	µS/cm	-	2739	2771	2782	2749	2657	2741	22.7	2263	2120	2155	2082	1915	1950
Field Temperature	deg c	-	16.4	16	8.2	16	17.7	16	14.3	16.19	17.1	17.2	16.5	16.6	16.2
Physical Parameters															
Electrical conductivity	µS/cm	1	2860	2760	2610	2840	2750	2720	2240	2090	2200	2100	2180	2010	2010
Hydroxide Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Carbonate Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Bicarbonate Alkalinity as $CaCO_3$	mg/l	1	410	365	442	465	439	442	538	513	474	443	494	474	451
Total Alkalinity as $CaCO_3$	mg/l	1	410	365	442	465	439	442	538	513	474	443	494	474	451
Suspended Solids (SS)	mg/l	5	98	5	16	29	7	8	5	7	5	5	5	5	5
Total Dissolved Solids @180°C	mg/l	10	2300	2310	2200	2300	2200	2230	1580	1530	1490	1620	1290	1540	1560
Redox Potential	mV	-	4	207	11	-12	-102	-35	-4	-18.5	34	19	-162	-94	-63
Major Ions															
Sulfate as SO_4 - Turbidimetric	mg/l	1	964	1080	1220	812	874	1130	556	570	481	534	503	475	503
Chloride	mg/l	1	129	131	121	136	127	132	214	202	217	221	192	167	179
Calcium	mg/l	1	279	282	268	329	288	289	212	195	212	206	189	176	194
Magnesium	mg/l	1	153	153	130	123	132	135	126	120	128	123	114	110	105
Sodium	mg/l	1	207	205	223	213	218	222	130	130	135	135	127	121	117
Potassium	mg/l	1	5	5	3	4	3	3	2	2	2	2	1	1	2
Nutrients															
Nitrite as N	mg/l	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01
Nitrate as N	mg/l	0.01	0.75	0.78	0.02	0.01	0.01	0.01	0.3	0.31	0.39	0.31	0.47	0.71	0.79
Nitrite + Nitrate as N	mg/l	0.01	0.75	0.78	0.03	0.01	0.01	0.01	0.3	0.33	0.39	0.31	0.48	0.71	0.79
Total Kjeldahl Nitrogen as N	mg/l	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1
Total Nitrogen as N	mg/l	0.1	1	0.8	0.1	0.1	0.1	0.1	0.4	0.3	0.4	0.3	0.6	0.9	0.9
Total Phosphorus as P	mg/l	0.01	0.08	0.09	0.07	0.04	0.03	0.08	0.1	0.05	0.03	0.03	0.06	0.06	0.07
Dissolved Metals															
Aluminium	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Antimony	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Arsenic	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cadmium	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Chromium	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cobalt	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Copper	mg/l	0.001	0.003	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Iron	mg/l	0.05	0.05	0.05	2.7	1.84	1.93	2.41	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Lead	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Manganese	mg/l	0.001	0.015	0.009	0.915	0.796	0.811	0.869	0.094	0.02	0.021	0.02	0.052	0.023	0.015
Mercury	mg/l	0.0001	-	0.0073	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Molybdenum	mg/l	0.001	0.001	0.001	0.002	0.003	0.002	0.003	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Nickel	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Selenium	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Silver	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Zinc	mg/l	0.005	0.021	0.005	0.016	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005

Notes

	Analytes with trigger (WMP)
	Exceeding trigger

Project ID: G1383AA
Groundwater quality data

Sample Location			MB78	MB78	MB78	MB78	MB79	MB79	MB79	MB79	MB79	MB79	MB79	MB79	MB79
Date Sampled			16/02/2021	4/03/2021	22/04/2021	19/05/2021	15/07/2020	12/08/2020	14/09/2020	14/10/2020	17/11/2020	10/12/2020	21/01/2021	16/02/2021	4/03/2021
Field Parameters	**Units**	**LOD**													
Field pH	pH units	-	6.7	7.05	7.03	7.03	8.2	8.01	7.62	8	8.09	8.09	8.24	7.95	8.15
Field Electrical Conductivity (EC)	µS/cm	-	1967	1971	2012	1932	884	813.76	877	887.2	881	843.1	866	859	871
Field Temperature	deg c	-	16.3	16.4	16	16.2	14.1	16.66	17.5	18.6	17.8	18.9	18.6	18.7	18.3
Physical Parameters															
Electrical conductivity	µS/cm	1	1990	2050	1980	1980	893	871	897	860	934	880	876	882	897
Hydroxide Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Carbonate Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Bicarbonate Alkalinity as $CaCO_3$	mg/l	1	448	515	496	498	144	137	162	133	136	134	136	124	144
Total Alkalinity as $CaCO_3$	mg/l	1	448	515	496	498	144	137	162	133	136	134	136	124	144
Suspended Solids (SS)	mg/l	5	5	5	5	5	32	7	5	19	5	28	5	5	5
Total Dissolved Solids @180°C	mg/l	10	1450	1610	1430	1440	567	548	551	539	580	458	584	536	508
Redox Potential	mV	-	-92	-78	-48	-18	3	-202.4	5	-76	-130	-151	-121	31	-93
Major Ions															
Sulfate as SO_4 - Turbidimetric	mg/l	1	482	494	515	503	186	199	176	190	190	204	207	190	200
Chloride	mg/l	1	166	154	164	151	52	62	68	66	55	59	70	62	65
Calcium	mg/l	1	220	182	186	170	15	13	14	15	13	13	16	17	14
Magnesium	mg/l	1	112	111	114	102	1	1	1	1	1	1	1	1	1
Sodium	mg/l	1	122	118	125	116	174	171	186	179	174	171	176	174	168
Potassium	mg/l	1	2	1	1	1	1	1	1	1	1	1	1	1	1
Nutrients															
Nitrite as N	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Nitrate as N	mg/l	0.01	0.8	0.83	0.79	0.84	0.16	0.02	0.03	0.01	0.03	0.04	0.01	0.01	0.01
Nitrite + Nitrate as N	mg/l	0.01	0.8	0.83	0.79	0.84	0.16	0.02	0.03	0.01	0.03	0.04	0.01	0.01	0.01
Total Kjeldahl Nitrogen as N	mg/l	0.1	0.2	0.2	0.2	0.1	0.4	0.1	0.5	0.1	0.1	0.1	0.1	0.1	0.2
Total Nitrogen as N	mg/l	0.1	1	1	1	0.9	0.6	0.1	0.5	0.1	0.1	0.1	0.1	0.1	0.2
Total Phosphorus as P	mg/l	0.01	0.06	0.05	0.05	0.08	0.19	0.13	0.12	0.1	0.1	0.14	0.11	0.12	0.13
Dissolved Metals															
Aluminium	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Antimony	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Arsenic	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cadmium	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Chromium	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cobalt	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Copper	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Iron	mg/l	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Lead	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Manganese	mg/l	0.001	0.02	0.014	0.009	0.012	0.028	0.024	0.019	0.019	0.015	0.016	0.016	0.016	0.014
Mercury	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Molybdenum	mg/l	0.001	0.001	0.001	0.001	0.001	0.004	0.005	0.002	0.005	0.005	0.005	0.004	0.005	0.003
Nickel	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Selenium	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Silver	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Zinc	mg/l	0.005	0.005	0.005	0.005	0.024	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005

Notes

	Analytes with trigger (WMP)
	Exceeding trigger

Project ID: G1383AA
Groundwater quality data

Sample Location			MB79	MB79	MB7A	MB7A	MB7A	MB7A	MB80	MB80	MB80	MB80	MB81	MB81	MB81
Date Sampled			6/04/2021	19/05/2021	14/08/2020	9/11/2020	11/01/2021	22/04/2021	10/08/2020	4/11/2020	5/01/2021	9/04/2021	12/08/2020	17/11/2020	15/01/2021
Field Parameters	**Units**	**LOD**													
Field pH	pH units	-	8.06	8.16	6.27	6.36	6.65	6.48	6.53	6.32	6.54	6.6	6.73	6.59	6.99
Field Electrical Conductivity (EC)	µS/cm	-	882	861.1	4106	3953	3839	3995	652.1	646.4	636	646	2096	2042	2030
Field Temperature	deg c	-	18	17.2	16.2	17	17.4	14.9	14.1	16.8	16.9	167	16.64	17.3	17.3
Physical Parameters															
Electrical conductivity	µS/cm	1	895	870	-	3950	4030	3980	656	679	646	653	1980	2150	2090
Hydroxide Alkalinity as $CaCO_3$	mg/l	1	1	1	-	1	1	1	1	1	1	1	1	1	1
Carbonate Alkalinity as $CaCO_3$	mg/l	1	1	1	-	1	1	1	1	1	1	1	1	1	1
Bicarbonate Alkalinity as $CaCO_3$	mg/l	1	152	149	-	493	507	465	343	339	341	342	395	359	369
Total Alkalinity as $CaCO_3$	mg/l	1	152	149	-	493	507	465	343	339	341	342	395	359	369
Suspended Solids (SS)	mg/l	5	5	5	-	5	5	5	30	28	31	12	8	5	5
Total Dissolved Solids @180°C	mg/l	10	496	534	-	3680	3610	3820	446	410	388	372	1520	1570	1600
Redox Potential	mV	-	-83	-98	25.8	147	15	163	77	36	18	213	-1.8	75	28
Major Ions															
Sulfate as SO_4 - Turbidimetric	mg/l	1	184	199	-	2210	1830	2030	43	41	41	42	600	565	515
Chloride	mg/l	1	63	66	-	282	265	260	6	5	6	6	187	190	215
Calcium	mg/l	1	12	14	-	525	534	532	55	56	57	57	195	186	211
Magnesium	mg/l	1	1	1	-	250	256	250	31	32	33	32	111	111	105
Sodium	mg/l	1	166	171	-	188	189	187	40	38	40	39	114	113	109
Potassium	mg/l	1	1	1	-	3	3	3	3	3	3	4	2	2	2
Nutrients															
Nitrite as N	mg/l	0.01	0.01	0.01	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Nitrate as N	mg/l	0.01	0.01	0.01	-	0.01	0.01	0.01	0.07	0.05	0.02	0.06	0.13	0.5	0.39
Nitrite + Nitrate as N	mg/l	0.01	0.01	0.01	-	0.01	0.01	0.01	0.07	0.05	0.02	0.06	0.14	0.51	0.39
Total Kjeldahl Nitrogen as N	mg/l	0.1	0.2	0.1	-	0.1	0.1	0.1	0.1	0.1	0.3	0.1	0.1	0.1	0.1
Total Nitrogen as N	mg/l	0.1	0.2	0.1	-	0.1	0.1	0.1	0.2	0.1	0.3	0.2	0.1	0.5	0.4
Total Phosphorus as P	mg/l	0.01	0.1	0.12	-	0.01	0.01	0.01	0.14	0.16	0.18	0.12	0.01	0.01	0.07
Dissolved Metals															
Aluminium	mg/l	0.01	0.01	0.01	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Antimony	mg/l	0.001	0.001	0.001	-	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Arsenic	mg/l	0.001	0.001	0.001	-	0.001	0.001	0.001	0.002	0.002	0.001	0.001	0.001	0.001	0.001
Cadmium	mg/l	0.0001	0.0001	0.0001	-	0.0006	0.0005	0.0006	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Chromium	mg/l	0.001	0.001	0.001	-	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cobalt	mg/l	0.001	0.001	0.001	-	0.012	0.012	0.012	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Copper	mg/l	0.001	0.001	0.001	-	0.001	0.001	0.001	0.001	0.001	0.017	0.003	0.001	0.001	0.001
Iron	mg/l	0.05	0.05	0.05	-	0.86	0.93	0.82	1.31	0.78	0.39	0.38	0.15	0.08	0.11
Lead	mg/l	0.001	0.001	0.001	-	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Manganese	mg/l	0.001	0.014	0.014	-	0.677	0.664	0.688	0.401	0.35	0.359	0.313	0.794	0.498	0.533
Mercury	mg/l	0.0001	0.0001	0.0001	-	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Molybdenum	mg/l	0.001	0.004	0.004	-	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Nickel	mg/l	0.001	0.001	0.001	-	0.018	0.018	0.019	0.002	0.002	0.001	0.001	0.001	0.001	0.001
Selenium	mg/l	0.01	0.01	0.01	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Silver	mg/l	0.001	0.001	0.001	-	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Zinc	mg/l	0.005	0.005	0.005	-	0.049	0.053	0.048	0.009	0.014	0.04	0.042	0.005	0.005	0.005

Notes

	Analytes with trigger (WMP)
	Exceeding trigger

AGE

Project ID: G1383AA
Groundwater quality data

Sample Location			MB81	MB82	MB82	MB82	MB82	MB83	MB83	MB83	MB83	MB83	MB83	MB83	MB83
Date Sampled			22/04/2021	4/08/2020	4/11/2020	5/01/2021	22/04/2021	9/07/2020	18/08/2020	11/09/2020	14/10/2020	16/11/2020	11/12/2020	14/01/2021	16/02/2021
Field Parameters	**Units**	**LOD**													
Field pH	pH units	-	6.86	6.14	6.2	6.91	6.64	6.87	6.98	7	6.8	6.82	7.02	7.06	6.73
Field Electrical Conductivity (EC)	µS/cm	-	2052	283.4	292	267	271	2351	2326	2411	2471	2481	2346	2377	2381
Field Temperature	deg c	-	16.7	12.9	16.4	18.3	14.2	17.28	16.2	17.7	19.6	18.1	17.8	18.8	17.9
Physical Parameters															
Electrical conductivity	µS/cm	1	2030	264	296	264	265	2380	2290	2500	2350	2560	2430	2470	2360
Hydroxide Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Carbonate Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Bicarbonate Alkalinity as $CaCO_3$	mg/l	1	366	136	137	131	126	450	481	439	468	487	439	449	432
Total Alkalinity as $CaCO_3$	mg/l	1	366	136	137	131	126	450	481	439	468	487	439	449	432
Suspended Solids (SS)	mg/l	5	5	17	5	5	7	22	24	22	14	14	14	5	5
Total Dissolved Solids @180°C	mg/l	10	1510	152	162	134	143	1840	1680	2050	1830	1980	1880	1850	1750
Redox Potential	mV	-	186	92	60	172	157	-118.98	21	23	-57	-76	-88	-95	-43
Major Ions															
Sulfate as SO_4 - Turbidimetric	mg/l	1	615	4	4	3	3	651	604	546	639	628	603	564	631
Chloride	mg/l	1	196	15	15	15	15	253	296	258	293	268	254	288	256
Calcium	mg/l	1	192	15	15	15	14	252	254	266	276	248	251	276	303
Magnesium	mg/l	1	115	22	21	20	20	121	122	132	131	122	125	116	122
Sodium	mg/l	1	117	11	10	10	10	129	134	141	146	130	135	130	134
Potassium	mg/l	1	2	4	3	4	4	2	2	2	3	2	2	2	2
Nutrients															
Nitrite as N	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Nitrate as N	mg/l	0.01	0.55	0.05	0.01	0.01	0.01	0.01	0.04	0.06	0.02	0.03	0.01	0.01	0.01
Nitrite + Nitrate as N	mg/l	0.01	0.55	0.05	0.01	0.01	0.01	0.01	0.04	0.06	0.02	0.04	0.01	0.01	0.01
Total Kjeldahl Nitrogen as N	mg/l	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.3	0.3	0.4	0.3	0.2	0.2	0.1
Total Nitrogen as N	mg/l	0.1	0.6	0.1	0.1	0.1	0.1	0.3	0.3	0.4	0.4	0.3	0.2	0.2	0.1
Total Phosphorus as P	mg/l	0.01	0.01	0.01	0.02	0.01	0.05	0.13	0.08	0.04	0.04	0.06	0.03	0.06	0.04
Dissolved Metals															
Aluminium	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Antimony	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Arsenic	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.004	0.003	0.003	0.004	0.003	0.003	0.003	0.003
Cadmium	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Chromium	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cobalt	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.004	0.004	0.005	0.005	0.004	0.003	0.003	0.003
Copper	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Iron	mg/l	0.05	0.07	1.37	1.24	0.32	2.49	3.52	3.3	4.34	3.55	3.62	3.57	2.85	2.18
Lead	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Manganese	mg/l	0.001	0.455	0.257	0.201	0.082	0.318	0.849	0.848	1.05	1.22	0.842	0.734	0.648	0.448
Mercury	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Molybdenum	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Nickel	mg/l	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001
Selenium	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Silver	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Zinc	mg/l	0.005	0.015	0.005	0.005	0.005	0.005	0.01	0.005	0.006	0.005	0.005	0.005	0.01	0.005

Notes

	Analytes with trigger (WMP)
	Exceeding trigger

AGE

Project ID: G1383AA
Groundwater quality data

Sample Location			MB83	MB83	MB83	MB83	MB84	MB84	MB84	MB84	MB84	MB84	MB84	MB84	MB84
Date Sampled			4/03/2021	19/04/2021	19/05/2021	9/06/2021	9/07/2020	12/08/2020	9/09/2020	14/10/2020	4/11/2020	17/11/2020	10/12/2020	21/01/2021	16/02/2021
Field Parameters	**Units**	**LOD**													
Field pH	pH units	-	7.01	6.94	7.01	-	6.85	6.74	6.75	6.69	6.24	6.74	6.98	6.96	6.76
Field Electrical Conductivity (EC)	µS/cm	-	2360	2370	2336	-	2131.7	2237	2259	2205	250.3	2190	2089	2115	2124
Field Temperature	deg c	-	18.2	17.8	17.5	-	17.4	17.21	17.6	18.1	14.2	17.5	17.6	17.4	17.5
Physical Parameters															
Electrical conductivity	µS/cm	1	2450	2360	2380	-	2180	2120	2150	2150		2320	2190	2160	2130
Hydroxide Alkalinity as $CaCO_3$	mg/l	1	1	1	1	-	1	1	1	1		1	1	1	1
Carbonate Alkalinity as $CaCO_3$	mg/l	1	1	1	1	-	1	1	1	1		1	1	1	1
Bicarbonate Alkalinity as $CaCO_3$	mg/l	1	470	398	434	-	440	405	421	417		436	410	404	385
Total Alkalinity as $CaCO_3$	mg/l	1	470	398	434	-	440	405	421	417	-	436	410	404	385
Suspended Solids (SS)	mg/l	5	10	10	15	-	20	10	34	5	-	14	6	56	5
Total Dissolved Solids @180°C	mg/l	10	1890	1920	1780	-	1630	1600	1630	1730	-	1720	1670	1890	1650
Redox Potential	mV	-	-87	-9	-43	-	-70.6	152.5	99.7	139	75	66	98	38	232
Major Ions															
Sulfate as SO_4 - Turbidimetric	mg/l	1	638	547	664	-	631	676	610	626	-	635	594	582	606
Chloride	mg/l	1	239	244	252	-	184	187	195	203	-	184	173	177	162
Calcium	mg/l	1	246	273	248	-	194	193	190	213	-	197	199	215	240
Magnesium	mg/l	1	120	123	118	-	119	127	116	127	-	121	123	120	123
Sodium	mg/l	1	131	136	131	-	131	133	130	136	-	128	128	129	131
Potassium	mg/l	1	2	2	2	-	1	1	1	2	-	1	1	2	2
Nutrients															
Nitrite as N	mg/l	0.01	0.01	0.01	0.01	-	0.01	0.02	0.03	0.01	-	0.02	0.01	0.01	0.01
Nitrate as N	mg/l	0.01	0.01	0.02	0.01	-	4.78	4.98	5.15	5.43	-	5.9	6.17	6.3	6.51
Nitrite + Nitrate as N	mg/l	0.01	0.01	0.02	0.01	-	4.78	5	5.18	5.43	-	5.92	6.17	6.3	6.51
Total Kjeldahl Nitrogen as N	mg/l	0.1	0.1	0.1	0.2	-	0.4	0.4	0.5	-	-	0.5	0.4	0.6	0.6
Total Nitrogen as N	mg/l	0.1	0.1	0.1	0.2	-	5.2	5.4	5.7	6	-	6.4	6.6	6.9	7.1
Total Phosphorus as P	mg/l	0.01	0.05	0.04	0.06	-	0.2	0.05	0.09	0.03	-	0.05	0.04	0.1	0.05
Dissolved Metals															
Aluminium	mg/l	0.01	0.01	0.01	0.01	-	0.01	0.01	0.01	0.01	-	0.01	0.01	0.01	0.01
Antimony	mg/l	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	0.001
Arsenic	mg/l	0.001	0.003	0.002	0.005	-	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	0.001
Cadmium	mg/l	0.0001	0.0001	0.0001	0.0001	-	0.0001	0.0001	0.0001	0.0001	-	0.0001	0.0001	0.0001	0.0001
Chromium	mg/l	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	0.001
Cobalt	mg/l	0.001	0.002	0.002	0.004	-	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	0.001
Copper	mg/l	0.001	0.001	0.001	0.001	-	0.001	0.001	0.002	0.001	-	0.001	0.001	0.006	0.001
Iron	mg/l	0.05	2.58	2.45	4.42	-	0.05	0.05	0.05	0.05	-	0.05	0.05	0.05	0.05
Lead	mg/l	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	0.001
Manganese	mg/l	0.001	0.465	0.429	0.804	0.725	0.004	0.004	0.004	0.006	-	0.004	0.004	0.006	0.005
Mercury	mg/l	0.0001	0.0001	0.0001	0.0001	-	0.0001	0.0001	0.0001	0.0001	-	0.0001	0.0001	0.0001	0.0001
Molybdenum	mg/l	0.001	0.001	0.001	0.001	-	0.004	0.001	0.002	0.002	-	0.001	0.002	0.001	0.001
Nickel	mg/l	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	0.001
Selenium	mg/l	0.01	0.01	0.01	0.01	-	0.01	0.01	0.01	0.01	-	0.01	0.01	0.01	0.01
Silver	mg/l	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	0.001
Zinc	mg/l	0.005	0.005	0.005	0.005	-	0.008	0.005	0.005	0.005	-	0.005	0.007	0.022	0.005

Notes

	Analytes with trigger (WMP)
	Exceeding trigger

AGE

Project ID: G1383AA
Groundwater quality data

Sample Location			MB84	MB84	MB84	MB85	MB85	MB85	MB85	MB85	MB85	MB85	MB85	MB85	MB85
Date Sampled			4/03/2021	22/04/2021	19/05/2021	9/07/2020	12/08/2020	14/09/2020	15/10/2020	12/11/2020	10/12/2020	14/01/2021	11/02/2021	10/03/2021	21/04/2021
Field Parameters	**Units**	**LOD**													
Field pH	pH units	-	7	6.9	7.01	7.02	6.94	6.92	6.8	6.83	7.11	7.13	6.8	7.06	7.04
Field Electrical Conductivity (EC)	µS/cm	-	2110	2134	2074	2008	2055	2153	2189	2168	2082	2124	2154	2149	2183
Field Temperature	deg c	-	17.4	16.5	17	16.8	16.73	16.9	15.9	17.6	17.2	17.3	17	17.3	16.7
Physical Parameters															
Electrical conductivity	µS/cm	1	2210	2100	2120	2050	2030	2220	2130	2340	2190	2200	2180	2320	2180
Hydroxide Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Carbonate Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Bicarbonate Alkalinity as $CaCO_3$	mg/l	1	473	397	408	388	384	377	368	386	359	359	363	416	408
Total Alkalinity as $CaCO_3$	mg/l	1	473	397	408	388	384	377	368	386	359	359	363	416	408
Suspended Solids (SS)	mg/l	5	5	5	5	14	16	32	34	24	16	34	24	10	16
Total Dissolved Solids @180°C	mg/l	10	1760	1600	1580	1580	1430	1470	1510	1580	1580	1560	1380	1720	1780
Redox Potential	mV	-	34	255	123	-125.99	85.5	145	290	93	104	34	114	57	264
Major Ions															
Sulfate as SO_4 - Turbidimetric	mg/l	1	615	634	656	161	178	150	166	182	173	172	175	172	167
Chloride	mg/l	1	149	163	154	413	422	491	474	467	427	494	443	401	426
Calcium	mg/l	1	193	203	184	163	160	182	182	175	170	189	177	174	189
Magnesium	mg/l	1	119	124	113	102	106	115	110	102	105	101	110	106	111
Sodium	mg/l	1	127	131	123	111	116	123	123	113	118	116	117	116	120
Potassium	mg/l	1	1	2	1	1	2	2	2	2	1	2	2	2	2
Nutrients															
Nitrite as N	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.04	0.01	0.01	0.01	0.01
Nitrate as N	mg/l	0.01	6.46	6.49	6.42	7.43	7.36	8.76	7.1	7.6	7.12	7.37	7.48	7.47	7.81
Nitrite + Nitrate as N	mg/l	0.01	6.46	6.49	6.42	7.43	7.37	8.76	7.1	7.6	7.16	7.37	7.48	7.47	7.81
Total Kjeldahl Nitrogen as N	mg/l	0.1	1.1	0.5	0.4	0.7	0.5	0.6	-	1.4	0.6	0.6	1.2	0.4	0.3
Total Nitrogen as N	mg/l	0.1	7.6	7	6.8	8.1	7.9	9.4	7.7	9	7.8	8	8.7	7.9	8.1
Total Phosphorus as P	mg/l	0.01	0.06	0.04	0.06	0.07	0.07	0.04	0.02	0.07	0.03	0.04	0.04	0.03	0.04
Dissolved Metals															
Aluminium	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Antimony	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Arsenic	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cadmium	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Chromium	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cobalt	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Copper	mg/l	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Iron	mg/l	0.05	0.05	0.05	0.05	0.05	0.05	0.11	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Lead	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Manganese	mg/l	0.001	0.005	0.002	0.004	0.001	0.001	0.004	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Mercury	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Molybdenum	mg/l	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Nickel	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001
Selenium	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Silver	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Zinc	mg/l	0.005	0.005	0.005	0.005	0.01	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005

Notes

	Analytes with trigger (WMP)
	Exceeding trigger

AGE

Project ID: G1383AA
Groundwater quality data

Sample Location			MB85	MB85	MB86	MB86	MB86	MB86	MB86	MB86	MB86	MB86	MB86	MB86	MB86
Date Sampled			20/05/2021	9/06/2021	9/07/2020	14/08/2020	14/09/2020	7/10/2020	12/11/2020	9/12/2020	14/01/2021	11/02/2021	10/03/2021	21/04/2021	20/05/2021
Field Parameters	**Units**	**LOD**													
Field pH	pH units	-	7.07	-	6.52	6.42	6.6	6.43	6.47	6.71	6.72	6.46	6.68	6.63	6.68
Field Electrical Conductivity (EC)	µS/cm	-	2137	-	5048.7	5014	5101	5163	5081	4876	4951	5001	4996	5101	4975
Field Temperature	deg c	-	16.7	-	16.64	14	17	16.5	17.4	16.8	17	17.9	17	16.7	16.6
Physical Parameters															
Electrical conductivity	µS/cm	1	2190	-	5110	4540	5240	5210	5340	5220	5210	5100	5800	5110	5140
Hydroxide Alkalinity as $CaCO_3$	mg/l	1	1	-	1	1	1	1	1	1	1	1	1	1	1
Carbonate Alkalinity as $CaCO_3$	mg/l	1	1	-	1	1	1	1	1	1	1	1	1	1	1
Bicarbonate Alkalinity as $CaCO_3$	mg/l	1	381	-	423	420	410	463	438	453	414	396	413	414	430
Total Alkalinity as $CaCO_3$	mg/l	1	381	-	423	420	410	463	438	453	414	396	413	414	430
Suspended Solids (SS)	mg/l	5	13	-	34	18	16	8	5	29	75	19	40	9	10
Total Dissolved Solids @180°C	mg/l	10	1390	1490	4360	4410	3930	4700	4020	4070	4190	3690	4880	4380	3680
Redox Potential	mV	-	253	-	2.12	254	201	210	188	168	165	261	134	227	189
Major Ions															
Sulfate as SO_4 - Turbidimetric	mg/l	1	190	-	725	702	665	740	644	663	621	733	724	710	742
Chloride	mg/l	1	450	-	1190	1270	1320	1150	1240	1250	1300	1160	1100	1110	1230
Calcium	mg/l	1	166	-	524	524	573	477	474	518	488	539	524	540	498
Magnesium	mg/l	1	102	-	247	248	267	226	236	245	233	252	246	255	237
Sodium	mg/l	1	117	-	219	217	233	202	211	215	210	220	214	224	214
Potassium	mg/l	1	1	-	2	2	2	3	2	2	3	2	2	3	2
Nutrients															
Nitrite as N	mg/l	0.01	0.01	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Nitrate as N	mg/l	0.01	7.14	-	3.68	3.62	3.87	3.25	3.21	3.65	3.26	3.33	3.37	3.53	3.47
Nitrite + Nitrate as N	mg/l	0.01	7.14	-	3.68	3.62	3.87	3.25	3.21	3.65	3.26	3.33	3.37	3.53	3.47
Total Kjeldahl Nitrogen as N	mg/l	0.1	0.5	-	0.2	0.1	0.1	0.2	-	0.2	0.2	1	0.1	-	0.1
Total Nitrogen as N	mg/l	0.1	7.6	-	3.9	3.7	4	3.4	3.4	3.8	3.5	4.3	3.4	3.7	3.5
Total Phosphorus as P	mg/l	0.01	0.04	-	0.13	0.01	0.01	0.02	0.04	0.01	0.04	0.01	0.02	0.01	0.01
Dissolved Metals															
Aluminium	mg/l	0.01	0.01	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Antimony	mg/l	0.001	0.001	-	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Arsenic	mg/l	0.001	0.001	-	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cadmium	mg/l	0.0001	0.0001	-	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Chromium	mg/l	0.001	0.001	-	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cobalt	mg/l	0.001	0.001	-	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Copper	mg/l	0.001	0.001	-	0.004	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001
Iron	mg/l	0.05	0.05	-	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Lead	mg/l	0.001	0.001	-	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Manganese	mg/l	0.001	0.001	-	0.005	0.004	0.007	0.004	0.004	0.003	0.004	0.004	0.002	0.003	0.003
Mercury	mg/l	0.0001	0.0001	-	0.0004	0.0005	0.0004	0.0004	0.0001	0.0006	0.0005	0.0006	0.0006	0.0006	0.0007
Molybdenum	mg/l	0.001	0.001	-	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Nickel	mg/l	0.001	0.001	-	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Selenium	mg/l	0.01	0.01	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Silver	mg/l	0.001	0.001	-	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Zinc	mg/l	0.005	0.005	-	0.019	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005

Notes

	Analytes with trigger (WMP)
	Exceeding trigger

Project ID: G1383AA
Groundwater quality data

Sample Location			MB86	MB87	MB87	MB87	MB87	MB87	MB87	MB87	MB87	MB87	MB87	MB87	MB87
Date Sampled			9/06/2021	9/07/2020	14/08/2020	14/09/2020	7/10/2020	12/11/2020	9/12/2020	14/01/2021	5/02/2021	11/02/2021	10/03/2021	21/04/2021	20/05/2021
Field Parameters	**Units**	**LOD**													
Field pH	pH units	-	-	6.68	6.55	6.72	6.56	6.59	6.83	6.84	-	6.54	6.72	6.71	7.34
Field Electrical Conductivity (EC)	µS/cm	-	-	3057.4	3267	3188	3216	3189	3060	3101	-	3146	3150	3214	3153
Field Temperature	deg c	-	-	16.3	16.2	16.4	16.6	17.1	16.4	17.2	-	16.8	16.7	16	16.5
Physical Parameters															
Electrical conductivity	µS/cm	1	-	3100	2890	3240	3320	3380	3250	3250	-	3200	3520	3200	-
Hydroxide Alkalinity as $CaCO_3$	mg/l	1	-	1	1	1	1	1	1	1	-	1	1	1	-
Carbonate Alkalinity as $CaCO_3$	mg/l	1	-	1	1	1	1	1	1	1	-	1	1	1	-
Bicarbonate Alkalinity as $CaCO_3$	mg/l	1	-	509	504	508	552	490	554	503	-	473	526	494	-
Total Alkalinity as $CaCO_3$	mg/l	1	-	509	504	508	552	490	554	503	-	473	526	494	-
Suspended Solids (SS)	mg/l	5	-	12	15	9	5	6	8	5	-	5	6	5	-
Total Dissolved Solids @180°C	mg/l	10	3990	2540	2700	2590	2600	2530	2600	2580	2020	2490	2740	2580	-
Redox Potential	mV	-	-	-32.87	9	240	178	226	176	158	-	261	119	244	230
Major Ions															
Sulfate as SO_4 - Turbidimetric	mg/l	1	-	965	951	871	1170	865	877	873	-	1050	969	955	-
Chloride	mg/l	1	-	316	335	371	354	368	357	375	-	347	332	334	-
Calcium	mg/l	1	-	358	362	394	354	369	357	392	-	360	360	375	-
Magnesium	mg/l	1	-	180	182	199	167	174	179	170	-	185	185	186	-
Sodium	mg/l	1	-	140	142	157	137	144	146	142	-	150	147	151	-
Potassium	mg/l	1	-	2	2	2	2	2	2	2	-	2	2	2	-
Nutrients															
Nitrite as N	mg/l	0.01	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	-	0.01	0.01	0.01	-
Nitrate as N	mg/l	0.01	-	2.74	2.82	3.12	3.16	3.27	3.4	3.33	-	3.34	3.4	3.31	-
Nitrite + Nitrate as N	mg/l	0.01	-	2.74	2.82	3.12	3.16	3.27	3.4	3.33	-	3.34	3.4	3.31	-
Total Kjeldahl Nitrogen as N	mg/l	0.1	-	0.3	0.3	0.2	0.3	-	0.2	0.3	-	0.2	0.2	-	-
Total Nitrogen as N	mg/l	0.1	-	3	3.1	3.3	3.5	3.7	3.6	3.6	-	3.5	3.6	4	-
Total Phosphorus as P	mg/l	0.01	-	0.08	0.02	0.03	0.02	0.01	0.01	0.03	-	0.01	0.01	0.05	-
Dissolved Metals															
Aluminium	mg/l	0.01	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	-	0.01	0.01	0.01	-
Antimony	mg/l	0.001	-	0.001	0.001	0.001	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	-
Arsenic	mg/l	0.001	-	0.001	0.001	0.001	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	-
Cadmium	mg/l	0.0001	-	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	-	0.0001	0.0001	0.0001	-
Chromium	mg/l	0.001	-	0.001	0.001	0.001	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	-
Cobalt	mg/l	0.001	-	0.001	0.001	0.001	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	-
Copper	mg/l	0.001	-	0.003	0.001	0.001	0.001	0.001	0.005	0.001	-	0.001	0.001	0.001	-
Iron	mg/l	0.05	-	0.05	0.05	0.05	0.05	0.05	0.05	0.05	-	0.05	0.05	0.05	-
Lead	mg/l	0.001	-	0.001	0.001	0.001	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	-
Manganese	mg/l	0.001	-	0.002	0.006	0.005	0.001	0.001	0.001	0.001	1.43	0.001	0.003	0.003	-
Mercury	mg/l	0.0001	-	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	-	0.0001	0.0001	0.0001	-
Molybdenum	mg/l	0.001	-	0.001	0.001	0.001	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	-
Nickel	mg/l	0.001	-	0.007	0.013	0.012	0.001	0.001	0.001	0.001	0.052	0.001	0.002	0.001	-
Selenium	mg/l	0.01	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	-	0.01	0.01	0.01	-
Silver	mg/l	0.001	-	0.001	0.001	0.001	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	-
Zinc	mg/l	0.005	-	0.017	0.005	0.005	0.005	0.005	0.005	0.005	-	0.005	0.005	0.005	-

Notes

	Analytes with trigger (WMP)
	Exceeding trigger

Project ID: G1383AA
Groundwater quality data

Sample Location			MB87	MB87	MB88	MB88	MB88	MB88	MB88	MB88	MB88	MB88	MB88	MB88	MB88
Date Sampled			24/05/2021	9/06/2021	7/07/2020	4/08/2020	4/09/2020	6/10/2020	3/11/2020	7/12/2020	5/01/2021	4/02/2021	1/03/2021	8/04/2021	19/05/2021
Field Parameters	**Units**	**LOD**													
Field pH	pH units	-	6.79	-	6.9	6.51	6.47	6.42	6.48	6.86	6.73	6.26	6.25	6.67	6.96
Field Electrical Conductivity (EC)	µS/cm	-	3159	-	286.9	307.6	319.5	307.4	305	305.8	304	278.6	328	308	302
Field Temperature	deg c	-	16	-	11.21	14.1	14.7	20	17.3	14.7	16.2	16.4	17.2	15.9	11.7
Physical Parameters															
Electrical conductivity	µS/cm	1	3240	-	304	274	302	303	312	299	298	313	341	306	293
Hydroxide Alkalinity as $CaCO_3$	mg/l	1	1	-	1	1	1	1	1	1	1	1	1	1	1
Carbonate Alkalinity as $CaCO_3$	mg/l	1	1	-	1	1	1	1	1	1	1	1	1	1	1
Bicarbonate Alkalinity as $CaCO_3$	mg/l	1	519	-	152	147	139	147	155	164	149	151	166	147	155
Total Alkalinity as $CaCO_3$	mg/l	1	519	-	152	147	139	147	155	164	149	151	166	147	155
Suspended Solids (SS)	mg/l	5	28	-	26	5	18	17	13	21	28	64	51	33	54
Total Dissolved Solids @180°C	mg/l	10	2610	2620	227	230	213	234	233	194	212	212	245	204	223
Redox Potential	mV	-	303	-	24.26	49	-5	110	92	-11	-39	38	75	176	53
Major Ions															
Sulfate as SO_4 - Turbidimetric	mg/l	1	927	-	6	7	12	8	10	11	8	9	16	9	8
Chloride	mg/l	1	364	-	10	10	10	9	10	11	10	9	12	10	10
Calcium	mg/l	1	351	-	21	22	22	22	23	25	22	23	26	23	22
Magnesium	mg/l	1	180	-	16	16	14	16	16	15	15	15	17	15	16
Sodium	mg/l	1	152	-	17	16	16	15	18	16	17	16	18	16	16
Potassium	mg/l	1	2	-	4	4	4	5	5	5	4	4	5	5	4
Nutrients															
Nitrite as N	mg/l	0.01	0.01	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Nitrate as N	mg/l	0.01	3.29	-	0.01	0.04	0.02	0.07	0.06	0.02	0.01	0.03	0.04	0.05	0.01
Nitrite + Nitrate as N	mg/l	0.01	3.29	-	0.01	0.04	0.02	0.07	0.06	0.02	0.01	0.03	0.04	0.05	0.01
Total Kjeldahl Nitrogen as N	mg/l	0.1	0.6	-	0.2	0.1	0.1	0.2	0.1	0.4	0.1	0.8	0.5	0.1	0.1
Total Nitrogen as N	mg/l	0.1	3.9	-	0.2	0.1	0.1	0.3	0.1	0.4	0.1	0.8	0.5	0.1	0.1
Total Phosphorus as P	mg/l	0.01	0.03	-	0.13	0.18	0.28	0.15	0.16	0.25	0.22	0.28	0.32	0.17	0.31
Dissolved Metals															
Aluminium	mg/l	0.01	0.01	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Antimony	mg/l	0.001	0.001	-	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Arsenic	mg/l	0.001	0.001	-	0.004	0.004	0.006	0.001	0.001	0.004	0.004	0.004	0.005	0.002	0.01
Cadmium	mg/l	0.0001	0.0001	-	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Chromium	mg/l	0.001	0.001	-	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cobalt	mg/l	0.001	0.001	-	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.003	0.001	0.001
Copper	mg/l	0.001	0.001	-	0.002	0.001	0.002	0.008	0.002	0.005	0.001	0.006	0.004	0.002	0.002
Iron	mg/l	0.05	0.05	-	4.06	4.49	3.85	0.17	0.45	3.33	3.84	3.06	3.34	1.53	1.74
Lead	mg/l	0.001	0.001	-	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Manganese	mg/l	0.001	0.005	-	0.146	0.162	0.148	0.043	0.069	0.137	0.134	0.163	0.176	0.122	0.134
Mercury	mg/l	0.0001	0.0001	-	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Molybdenum	mg/l	0.001	0.001	-	0.01	0.012	0.014	0.012	0.013	0.014	0.013	0.012	0.012	0.017	0.016
Nickel	mg/l	0.001	0.001	-	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Selenium	mg/l	0.01	0.01	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Silver	mg/l	0.001	0.001	-	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Zinc	mg/l	0.005	0.005	-	0.029	0.007	0.01	0.012	0.016	0.114	0.015	0.077	0.041	0.02	0.014

Notes

	Analytes with trigger (WMP)
	Exceeding trigger

Project ID: G1383AA
Groundwater quality data

Sample Location			MB8A	MB8A	MB8A	MB8A	MB90	MB90	MB90	MB90	MB90	MB90	MB90	MB90	MB90
Date Sampled			14/08/2020	11/11/2020	11/01/2021	22/04/2021	9/07/2020	13/08/2020	14/09/2020	14/10/2020	12/11/2020	9/12/2020	14/01/2021	11/02/2021	10/03/2021
Field Parameters	**Units**	**LOD**													
Field pH	pH units	-	6.55	6.54	6.84	6.75	7.57	7.66	6.64	7.67	7.24	7.2	7.28	7.03	7.08
Field Electrical Conductivity (EC)	µS/cm	-	3772	3684	3624	3781	3768	3982	3968	3976	3778	3713	3767	3812	3833
Field Temperature	deg c	-	16	17.2	17	16.3	17.55	20	17.1	17.4	18.8	16.9	17.3	17.1	17.5
Physical Parameters															
Electrical conductivity	µS/cm	1	3280	3990	3790	3710	3800	3450	4060	3760	4050	3970	3940	3880	4390
Hydroxide Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Carbonate Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Bicarbonate Alkalinity as $CaCO_3$	mg/l	1	417	403	413	419	659	628	500	446	583	588	560	552	523
Total Alkalinity as $CaCO_3$	mg/l	1	417	403	413	419	659	628	500	446	583	588	560	552	523
Suspended Solids (SS)	mg/l	5	25	19	14	22	5	5	14	5	48	10	5	5	5
Total Dissolved Solids @180°C	mg/l	10	3610	3540	3510	3610	3050	3280	3200	3110	3090	3150	3180	2880	3510
Redox Potential	mV	-	-108.9	-29	-70	-49	-192.2	-239.5	-25	184	-217	-237	-187	-106	-134
Major Ions															
Sulfate as SO_4 - Turbidimetric	mg/l	1	1980	2050	1910	2090	789	750	942	1120	719	770	818	915	931
Chloride	mg/l	1	93	129	146	138	622	626	671	691	647	651	687	614	561
Calcium	mg/l	1	572	514	596	600	375	369	425	417	376	365	406	377	384
Magnesium	mg/l	1	183	176	200	196	228	227	265	253	223	236	222	240	239
Sodium	mg/l	1	156	159	175	173	179	176	208	206	182	189	181	191	188
Potassium	mg/l	1	4	4	4	4	5	5	4	5	6	5	6	5	5
Nutrients															
Nitrite as N	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Nitrate as N	mg/l	0.01	0.07	0.02	0.02	0.01	0.01	0.04	0.03	0.01	0.01	0.01	0.03	0.01	0.01
Nitrite + Nitrate as N	mg/l	0.01	0.07	0.02	0.02	0.01	0.01	0.04	0.03	0.01	0.01	0.01	0.03	0.01	0.01
Total Kjeldahl Nitrogen as N	mg/l	0.1	0.1	0.2	0.1	0.2	0.4	0.4	0.1	0.1	0.4	0.4	0.4	0.4	0.2
Total Nitrogen as N	mg/l	0.1	0.1	0.2	0.1	0.2	0.4	0.4	0.1	0.1	0.4	0.4	0.4	0.4	0.2
Total Phosphorus as P	mg/l	0.01	0.14	0.06	0.02	0.11	0.1	0.04	0.02	0.01	0.01	0.01	0.04	0.01	0.02
Dissolved Metals															
Aluminium	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Antimony	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001
Arsenic	mg/l	0.001	0.015	0.004	0.002	0.005	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cadmium	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Chromium	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cobalt	mg/l	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.002	0.002	0.001	0.001	0.001	0.001	0.001
Copper	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.005	0.001	0.001	0.001
Iron	mg/l	0.05	12.3	4.48	5.45	11.8	0.05	0.05	1.64	0.18	0.05	0.05	0.05	0.05	0.08
Lead	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Manganese	mg/l	0.001	0.895	0.89	0.811	1.05	0.517	0.474	0.499	0.419	0.254	0.25	0.358	0.384	0.554
Mercury	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Molybdenum	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Nickel	mg/l	0.001	0.006	0.006	0.003	0.003	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Selenium	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Silver	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Zinc	mg/l	0.005	0.009	0.005	0.006	0.005	0.005	0.005	0.005	0.005	0.005	0.006	0.005	0.005	0.005

Notes

	Analytes with trigger (WMP)
	Exceeding trigger

Project ID: G1383AA
Groundwater quality data

Sample Location			MB90	MB90	MB91	MB91	MB91	MB92	MB92	MB92	MB92	MB92	MB92	MB92	MB92
Date Sampled			21/04/2021	20/05/2021	7/07/2020	18/08/2020	16/09/2020	9/07/2020	17/08/2020	8/09/2020	13/10/2020	10/11/2020	15/12/2020	12/01/2021	9/02/2021
Field Parameters	**Units**	**LOD**													
Field pH	pH units	-	6.83	6.82	7.49	7.55	7.65	7.82	7.85	7.41	7.11	7.24	7.53	7.59	7.19
Field Electrical Conductivity (EC)	µS/cm	-	3960	3860	2151.6	2160	2276	969.1	986.1	1001	1003	1002	972	994	899
Field Temperature	deg c	-	16.5	16.7	16.03	13.7	20	13.56	13.5	18.9	19.1	16.8	17.6	17.6	17.5
Physical Parameters															
Electrical conductivity	µS/cm	1	3960	3970	2140	-	2220	966	947	984	986	1020	992	991	1010
Hydroxide Alkalinity as $CaCO_3$	mg/l	1	1	1	1	-	1	1	1	1	1	1	1	1	1
Carbonate Alkalinity as $CaCO_3$	mg/l	1	1	1	1	-	1	1	1	1	1	1	1	1	1
Bicarbonate Alkalinity as $CaCO_3$	mg/l	1	499	523	532	-	438	342	335	340	324	344	332	329	332
Total Alkalinity as $CaCO_3$	mg/l	1	499	523	532	-	438	342	335	340	324	344	332	329	332
Suspended Solids (SS)	mg/l	5	10	5	5	-	77	5	5	39	12	5	5	5	5
Total Dissolved Solids @180°C	mg/l	10	3340	3090	2000	-	1860	712	701	642	695	743	704	710	700
Redox Potential	mV	-	62	24	-142.6	-239	-240	-118.6	-228	-149	-241	-217	-223	-270	-180
Major Ions															
Sulfate as SO_4 - Turbidimetric	mg/l	1	1070	986	810	-	770	237	245	242	256	230	252	252	269
Chloride	mg/l	1	570	614	40	-	41	16	18	18	11	18	12	14	16
Calcium	mg/l	1	406	373	279	-	278	115	115	112	125	118	124	119	114
Magnesium	mg/l	1	247	231	134	-	125	56	55	53	58	56	57	58	55
Sodium	mg/l	1	198	190	92	-	92	23	24	24	25	24	24	25	23
Potassium	mg/l	1	4	3	9	-	9	3	3	3	3	3	3	3	2
Nutrients															
Nitrite as N	mg/l	0.01	0.01	0.01	0.01	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Nitrate as N	mg/l	0.01	0.01	0.01	0.31	-	0.03	0.01	0.04	0.01	0.01	0.01	0.01	0.01	0.01
Nitrite + Nitrate as N	mg/l	0.01	0.01	0.01	0.31	-	0.03	0.01	0.04	0.01	0.01	0.01	0.01	0.01	0.01
Total Kjeldahl Nitrogen as N	mg/l	0.1	0.1	0.1	0.4	-	0.4	0.5	0.7	0.5	0.4	0.4	0.5	0.7	0.4
Total Nitrogen as N	mg/l	0.1	0.1	0.1	0.7	-	0.4	0.5	0.7	0.5	0.4	0.4	0.5	0.7	0.4
Total Phosphorus as P	mg/l	0.01	0.02	0.02	0.01	-	0.05	0.03	0.18	0.12	0.02	0.02	0.01	0.01	0.02
Dissolved Metals															
Aluminium	mg/l	0.01	0.01	0.01	0.01	-	0.01	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.02
Antimony	mg/l	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Arsenic	mg/l	0.001	0.001	0.001	0.002	-	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cadmium	mg/l	0.0001	0.0001	0.0001	0.0001	-	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Chromium	mg/l	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cobalt	mg/l	0.001	0.002	0.002	0.001	-	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Copper	mg/l	0.001	0.001	0.001	0.001	-	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Iron	mg/l	0.05	1.67	1.47	0.05	-	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Lead	mg/l	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Manganese	mg/l	0.001	0.442	0.44	0.206	-	0.193	0.47	0.373	0.399	0.493	0.413	0.409	0.414	0.422
Mercury	mg/l	0.0001	0.0001	0.0001	0.0001	-	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Molybdenum	mg/l	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	0.003	0.001	0.001	0.001	0.001	0.001
Nickel	mg/l	0.001	0.001	0.001	0.002	-	0.004	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Selenium	mg/l	0.01	0.01	0.01	0.01	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Silver	mg/l	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Zinc	mg/l	0.005	0.005	0.005	0.007	-	0.012	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005

Notes

	Analytes with trigger (WMP)
	Exceeding trigger

AGE

Project ID: G1383AA
Groundwater quality data

Sample Location			MB92	MB92	MB92	MB92	MB93	MB93	MB93	MB93	MB93	MB93	MB93	MB93	MB93
Date Sampled			9/03/2021	23/04/2021	24/05/2021	7/06/2021	13/07/2020	17/08/2020	4/09/2020	7/10/2020	6/11/2020	8/12/2020	6/01/2021	5/02/2021	5/03/2021
Field Parameters	**Units**	**LOD**													
Field pH	pH units	-	7.42	7.06	7.42		6.91	7.09	6.82	6.79	6.94	7.03	6.95	-	6.95
Field Electrical Conductivity (EC)	µS/cm	-	999	1012	985.5		1850	1725	1661	1693	1680	1622	1653	-	1680
Field Temperature	deg c	-	17.7	16.7	16.4		14.5	14.9	16	16	17.1	16.1	17.3	-	16.2
Physical Parameters															
Electrical conductivity	µS/cm	1	1010	980	990		1810	1680	1700	1790	1780	1720	1690	1710	1730
Hydroxide Alkalinity as $CaCO_3$	mg/l	1	1	1	1		1	1	1	1	1	1	1	1	1
Carbonate Alkalinity as $CaCO_3$	mg/l	1	1	1	1		1	1	1	1	1	1	1	1	1
Bicarbonate Alkalinity as $CaCO_3$	mg/l	1	342	228	207		382	372	357	384	354	363	360	356	372
Total Alkalinity as $CaCO_3$	mg/l	1	342	228	207		382	372	357	384	354	363	360	356	372
Suspended Solids (SS)	mg/l	5	5	5	20		5	10	20	68	16	32	29	33	20
Total Dissolved Solids @180°C	mg/l	10	812	778	822	-	1530	1510	1260	1320	1400	1290	1300	1280	1400
Redox Potential	mV	-	-192	-97	-114	-	45	-2	39	13	197	-25	-57	-	-32
Major Ions															
Sulfate as SO_4 - Turbidimetric	mg/l	1	256	366	403	-	706	655	615	687	565	630	688	696	660
Chloride	mg/l	1	13	8	7	-	12	13	13	10	11	10	11	12	14
Calcium	mg/l	1	117	123	114	-	282	266	259	245	290	246	250	242	244
Magnesium	mg/l	1	55	56	52	-	80	76	73	66	70	70	73	73	71
Sodium	mg/l	1	23	22	20	-	66	62	58	54	58	56	59	58	56
Potassium	mg/l	1	3	2	2	-	4	4	4	4	4	3	4	4	4
Nutrients															
Nitrite as N	mg/l	0.01	0.01	0.01	0.01	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Nitrate as N	mg/l	0.01	0.01	0.01	0.05	-	0.05	0.04	0.01	0.04	0.01	0.01	0.02	0.01	0.01
Nitrite + Nitrate as N	mg/l	0.01	0.01	0.01	0.05	-	0.05	0.04	0.01	0.04	0.01	0.01	0.02	0.01	0.01
Total Kjeldahl Nitrogen as N	mg/l	0.1	0.3	0.1	0.3	-	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2
Total Nitrogen as N	mg/l	0.1	0.3	0.1	0.4	-	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2
Total Phosphorus as P	mg/l	0.01	0.01	0.08	0.04	-	0.01	0.07	0.03	0.06	0.01	0.01	0.02	0.04	0.02
Dissolved Metals															
Aluminium	mg/l	0.01	0.02	0.03	0.03	-	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Antimony	mg/l	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Arsenic	mg/l	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cadmium	mg/l	0.0001	0.0001	0.0001	0.0001	-	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Chromium	mg/l	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cobalt	mg/l	0.001	0.001	0.001	0.001	-	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.001
Copper	mg/l	0.001	0.001	0.001	0.001	-	0.001	0.002	0.001	0.001	0.004	0.001	0.002	0.001	0.001
Iron	mg/l	0.05	0.05	0.16	0.4	-	1.41	1.02	1.29	1.31	0.09	1.27	1.14	0.91	0.85
Lead	mg/l	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Manganese	mg/l	0.001	0.438	0.602	0.613	0.762	0.761	0.765	0.753	0.744	0.768	0.758	0.808	0.734	0.764
Mercury	mg/l	0.0001	0.0001	0.0001	0.0001	-	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Molybdenum	mg/l	0.001	0.001	0.001	0.001	-	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Nickel	mg/l	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Selenium	mg/l	0.01	0.01	0.01	0.01	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Silver	mg/l	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Zinc	mg/l	0.005	0.005	0.005	0.005	-	0.012	0.016	0.005	0.007	0.024	0.012	0.031	0.017	0.01

Notes

	Analytes with trigger (WMP)
	Exceeding trigger

AGE

Project ID: G1383AA
Groundwater quality data

Sample Location			MB93	MB93	MB94	MB94	MB94	MB94	MB94	MB94	MB94	MB94	MB94	MB96	MB96
Date Sampled			23/04/2021	20/05/2021	17/08/2020	13/10/2020	2/11/2020	15/12/2020	12/01/2021	9/02/2021	9/03/2021	22/04/2021	19/05/2021	17/08/2020	8/09/2020
Field Parameters	**Units**	**LOD**													
Field pH	pH units	-	7.13	7.81	-	7.35	5.83	7.46	7.56	7.24	7.48	7.71	7.7	-	7.79
Field Electrical Conductivity (EC)	µS/cm	-	2201	2128	-	1591	1469	1556	1588	1454	1627	2587	2536	-	1018
Field Temperature	deg c	-	16.1	16.7	-	23.6	20.4	19.6	19.4	19	18.2	16.4	17.7	-	17.3
Physical Parameters															
Electrical conductivity	µS/cm	1	2290	2180	1440	1580	1600	1620	1620	1630	1680	2590	2610	982	1000
Hydroxide Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Carbonate Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	10	1	1	1
Bicarbonate Alkalinity as $CaCO_3$	mg/l	1	444	430	128	131	140	144	147	147	160	376	382	247	246
Total Alkalinity as $CaCO_3$	mg/l	1	444	430	128	131	140	144	147	147	160	387	382	247	246
Suspended Solids (SS)	mg/l	5	91	36	10	6	38	5	446	6	22	21	31	43	74
Total Dissolved Solids @180°C	mg/l	10	1770	1690	1310	1300	1290	1260	1450	1260	1450	1890	1870	768	635
Redox Potential	mV	-	-9	165	-	98	-104	-151	-119	85	6	146	-108	-	110
Major Ions															
Sulfate as SO_4 - Turbidimetric	mg/l	1	905	814	728	747	708	741	663	757	762	1030	979	349	334
Chloride	mg/l	1	14	14	8	8	8	9	9	9	10	14	15	10	8
Calcium	mg/l	1	181	197	211	219	203	217	219	201	201	84	86	85	91
Magnesium	mg/l	1	76	71	85	84	77	80	80	81	82	64	59	71	66
Sodium	mg/l	1	296	243	41	55	53	58	58	61	66	466	419	43	42
Potassium	mg/l	1	2	2	4	6	5	6	6	5	6	6	5	5	5
Nutrients															
Nitrite as N	mg/l	0.01	0.01	0.01	0.23	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Nitrate as N	mg/l	0.01	0.01	0.01	0.21	0.01	0.05	0.01	0.06	0.02	0.01	0.01	0.01	0.18	0.01
Nitrite + Nitrate as N	mg/l	0.01	0.01	0.01	0.44	0.01	0.05	0.01	0.06	0.02	0.01	0.01	0.01	0.18	0.01
Total Kjeldahl Nitrogen as N	mg/l	0.1	0.1	0.1	0.1	0.2	0.4	0.2	0.3	0.2	0.3	0.3	0.4	1	0.5
Total Nitrogen as N	mg/l	0.1	0.1	0.1	0.5	0.2	0.4	0.2	0.4	0.2	0.3	0.3	0.4	1.2	0.5
Total Phosphorus as P	mg/l	0.01	0.07	0.02	0.01	0.01	0.06	0.01	0.01	0.01	0.03	0.05	0.06	0.19	0.08
Dissolved Metals															
Aluminium	mg/l	0.01	0.01	0.01	0.01	0.04	0.03	0.04	0.04	0.02	0.03	0.01	0.02	0.01	0.01
Antimony	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Arsenic	mg/l	0.001	0.051	0.007	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.017	0.019	0.002	0.002
Cadmium	mg/l	0.0001	0.0001	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Chromium	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cobalt	mg/l	0.001	0.001	0.001	0.003	0.003	0.002	0.001	0.001	0.001	0.001	0.005	0.003	0.001	0.001
Copper	mg/l	0.001	0.001	0.002	0.007	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.003	0.001
Iron	mg/l	0.05	3	0.05	0.05	0.36	0.45	0.22	0.19	0.29	0.26	0.06	0.49	0.05	0.06
Lead	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Manganese	mg/l	0.001	0.136	0.113	0.258	0.382	0.376	0.392	0.407	0.52	0.512	0.591	0.597	0.061	0.075
Mercury	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Molybdenum	mg/l	0.001	0.005	0.003	0.011	0.015	0.014	0.015	0.016	0.009	0.018	0.059	0.053	0.07	0.067
Nickel	mg/l	0.001	0.002	0.001	0.005	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001
Selenium	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Silver	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Zinc	mg/l	0.005	0.005	0.005	0.038	0.018	0.014	0.01	0.01	0.005	0.012	0.005	0.005	0.038	0.008

Notes

	Analytes with trigger (WMP)
	Exceeding trigger

AGE

Project ID: G1383AA
Groundwater quality data

Sample Location			MB96	MB96	MB96	MB96	MB96	MB96	MB96	MB96	MB97A	MB97B	MB97C	MB98	MB98
Date Sampled			13/10/2020	2/11/2020	15/12/2020	12/01/2021	9/02/2021	9/03/2021	22/04/2021	19/05/2021	28/05/2021	28/05/2021	28/05/2021	9/07/2020	12/08/2020
Field Parameters	**Units**	**LOD**													
Field pH	pH units	-	7.38	6.79	7.66	7.71	7.36	7.58	7.59	7.54	7.21	7.4	7.53	7.15	7.04
Field Electrical Conductivity (EC)	µS/cm	-	1033	954	988	1019	892	1002	1023	995.7	917.9	492.3	1378	1314	1360
Field Temperature	deg c	-	19.1	18.6	17.8	18.2	17.4	17.7	16.3	17.1	14.4	14.3	16.6	15.8	15.62
Physical Parameters															
Electrical conductivity	µS/cm	1	1040	1040	1020	1020	1000	1010	992	1010	869	460	1250	1350	1290
Hydroxide Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Carbonate Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Bicarbonate Alkalinity as $CaCO_3$	mg/l	1	246	265	296	303	298	305	275	322	216	209	115	508	530
Total Alkalinity as $CaCO_3$	mg/l	1	246	265	296	303	298	305	275	322	216	209	115	508	530
Suspended Solids (SS)	mg/l	5	114	60	9	36	5	23	5	6	38	26	159	5	5
Total Dissolved Solids @180°C	mg/l	10	747	748	736	736	636	726	707	630	654	304	990	851	805
Redox Potential	mV	-	174	-168	-184	-138	83	-76	195	-127	-59	-65	12	-79.6	138.7
Major Ions															
Sulfate as SO_4 - Turbidimetric	mg/l	1	340	322	309	285	289	280	290	298	271	62	717	122	135
Chloride	mg/l	1	8	9	10	10	9	10	9	10	24	7	3	111	105
Calcium	mg/l	1	95	92	94	86	84	84	85	92	92	50	216	90	85
Magnesium	mg/l	1	73	64	65	66	65	63	66	62	38	21	56	74	70
Sodium	mg/l	1	53	49	55	56	48	50	57	56	30	22	34	104	105
Potassium	mg/l	1	7	4	4	4	3	3	3	3	2	2	4	4	4
Nutrients															
Nitrite as N	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.03	0.01	0.02
Nitrate as N	mg/l	0.01	0.03	0.13	0.03	0.04	0.01	0.01	0.01	0.01	0.02	0.01	1.36	0.32	0.38
Nitrite + Nitrate as N	mg/l	0.01	0.03	0.13	0.03	0.04	0.01	0.01	0.01	0.01	0.02	0.01	1.39	0.32	0.4
Total Kjeldahl Nitrogen as N	mg/l	0.1	0.5	0.4	0.2	0.2	0.1	0.2	0.1	0.1	0.3	0.3	0.2	0.1	0.1
Total Nitrogen as N	mg/l	0.1	0.5	0.5	0.2	0.2	0.1	0.2	0.1	0.1	0.3	0.3	1.6	0.3	0.4
Total Phosphorus as P	mg/l	0.01	0.09	0.09	0.01	0.02	0.01	0.02	0.02	0.02	0.08	0.09	0.43	0.07	0.05
Dissolved Metals															
Aluminium	mg/l	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01
Antimony	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Arsenic	mg/l	0.001	0.003	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.003	0.001	0.001	0.001	0.001
Cadmium	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Chromium	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cobalt	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Copper	mg/l	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.003
Iron	mg/l	0.05	0.07	0.13	0.06	0.07	0.15	0.18	0.05	0.19	0.95	0.19	0.05	0.05	0.05
Lead	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Manganese	mg/l	0.001	0.221	0.242	0.265	0.269	0.216	0.225	0.22	0.238	0.658	0.438	0.072	0.002	0.001
Mercury	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Molybdenum	mg/l	0.001	0.066	0.032	0.008	0.015	0.013	0.014	0.017	0.01	0.006	0.004	0.019	0.001	0.001
Nickel	mg/l	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001
Selenium	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Silver	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Zinc	mg/l	0.005	0.005	0.011	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.007	0.091	0.007	0.005

Notes

	Analytes with trigger (WMP)
	Exceeding trigger

AGE

Project ID: G1383AA
Groundwater quality data

Sample Location			MB98	MB98	MB98	MB98	MB98	MB98	MB99A	MB99B	MB9A	MB9A	MB9A	MB9A	MW1
Date Sampled			11/09/2020	15/10/2020	17/11/2020	11/12/2020	14/01/2021	16/02/2021	28/05/2021	28/05/2021	14/08/2020	9/11/2020	11/01/2021	22/04/2021	19/01/2021
Field Parameters	**Units**	**LOD**													
Field pH	pH units	-	6.94	6.83	6.77	7.05	7.06	6.75	7.53	7.04	6.88	6.93	7.05	6.95	6.93
Field Electrical Conductivity (EC)	µS/cm	-	1320	1327	1337	1333	1357	1377	2564	3713	2277	2089	2435	2160	538
Field Temperature	deg c	-	17.5	16.4	17.6	16.6	17.5	16.8	14.3	15.1	16.2	17.6	17	16	14.5
Physical Parameters															
Electrical conductivity	µS/cm	1	1380	1340	1460	1370	1420	1370	2260	3100	2070	2090	2550	2140	520
Hydroxide Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Carbonate Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Bicarbonate Alkalinity as $CaCO_3$	mg/l	1	535	503	565	535	486	544	366	297	234	258	284	265	207
Total Alkalinity as $CaCO_3$	mg/l	1	535	503	565	535	486	544	366	297	234	258	284	265	207
Suspended Solids (SS)	mg/l	5	5	5	8	8	5	5	42	548	5	5	5	5	51
Total Dissolved Solids @180°C	mg/l	10	878	768	724	777	727	801	2280	3390	1990	1710	2220	1830	350
Redox Potential	mV	-	183	311	120	-135	-60	-6	-	177	65	161	172	233	-77
Major Ions															
Sulfate as SO_4 - Turbidimetric	mg/l	1	109	106	106	103	107	96	1090	1910	955	801	1250	854	36
Chloride	mg/l	1	103	102	110	115	136	127	124	102	41	33	34	29	32
Calcium	mg/l	1	91	92	85	88	96	109	293	338	273	251	321	285	29
Magnesium	mg/l	1	73	73	71	72	69	74	151	233	126	111	147	124	18
Sodium	mg/l	1	109	110	107	107	105	110	131	301	98	95	122	108	60
Potassium	mg/l	1	4	5	5	4	5	6	3	2	3	2	2	2	1
Nutrients															
Nitrite as N	mg/l	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.03	0.01	0.02	0.01	0.02	0.01
Nitrate as N	mg/l	0.01	0.35	0.35	0.03	0.01	0.02	0.01	0.03	1.52	7.32	16	18.5	18.6	0.01
Nitrite + Nitrate as N	mg/l	0.01	0.35	0.35	0.05	0.01	0.02	0.01	0.03	1.55	7.32	16	18.5	18.6	0.01
Total Kjeldahl Nitrogen as N	mg/l	0.1	0.3	0.1	1.3	2.6	2	2.2	0.1	0.5	0.7	2	0.6	0.1	0.3
Total Nitrogen as N	mg/l	0.1	0.6	0.4	1.4	2.6	2	2.2	0.1	1.6	8	16	19.1	18.7	0.3
Total Phosphorus as P	mg/l	0.01	0.21	0.04	0.24	0.29	0.25	0.29	0.06	1.1	0.01	0.01	0.01	0.01	0.09
Dissolved Metals															
Aluminium	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Antimony	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Arsenic	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.012	0.001	0.002	0.002	0.003	0.002	0.004
Cadmium	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Chromium	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cobalt	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.005
Copper	mg/l	0.001	0.003	0.002	0.001	0.001	0.001	0.001	0.005	0.004	0.001	0.001	0.001	0.001	0.001
Iron	mg/l	0.05	0.05	0.05	0.05	0.47	0.18	0.3	0.98	0.05	0.05	0.05	0.05	0.05	1.86
Lead	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Manganese	mg/l	0.001	0.002	0.001	0.006	0.132	0.145	0.229	0.607	0.266	0.033	0.02	0.005	0.014	1.81
Mercury	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Molybdenum	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.018	0.002	0.001	0.001	0.001	0.001	0.001
Nickel	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.004	0.002	0.002	0.001	0.002	0.001	0.005
Selenium	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Silver	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Zinc	mg/l	0.005	0.008	0.007	0.026	0.016	0.009	0.005	0.062	0.122	0.008	0.005	0.005	0.005	0.005

Notes

	Analytes with trigger (WMP)
	Exceeding trigger

Project ID: G1383AA
Groundwater quality data

Sample Location			MW1	MW1	MW1	MW1	MW3	MW3	MW3	MW3	MW3	MW4	MW4	MW4	TW05MB
Date Sampled			18/02/2021	11/03/2021	16/04/2021	21/05/2021	19/01/2021	18/02/2021	11/03/2021	16/04/2021	21/05/2021	15/03/2021	16/04/2021	21/05/2021	9/07/2020
Field Parameters	**Units**	**LOD**													
Field pH	pH units	-	6.46	6.79	6.4	6.64	6.58	6.07	6.6	6.76	6.47	5.98	6.35	6.58	7.77
Field Electrical Conductivity (EC)	µS/cm	-	490.8	504.9	486.6	525.1	253	252.2	245.1	242.7	227.6	975.1	967.7	950.1	626.4
Field Temperature	deg c	-	14.1	15	14.4	13.6	19.7	21.7	25.8	21.5	18.1	17.2	18.2	17.7	15.13
Physical Parameters															
Electrical conductivity	µS/cm	1	503	539	473	529	258	255	252	238	230	1020	957	968	638
Hydroxide Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Carbonate Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Bicarbonate Alkalinity as $CaCO_3$	mg/l	1	225	269	112	204	57	59	61	57	63	52	43	60	362
Total Alkalinity as $CaCO_3$	mg/l	1	225	269	112	204	57	59	61	57	63	52	43	60	362
Suspended Solids (SS)	mg/l	5	46	101	5	16	546	68	352	1350	428	300	41	15	5
Total Dissolved Solids @180°C	mg/l	10	294	353	302	374	350	183	340	288	295	902	902	931	394
Redox Potential	mV	-	-8	-85	77	59	47	91	32	230	162	286	309	261	-115.1
Major Ions															
Sulfate as SO_4 - Turbidimetric	mg/l	1	35	32	78	38	55	56	47	43	52	490	422	503	6
Chloride	mg/l	1	12	10	34	29	6	5	5	5	4	5	5	5	24
Calcium	mg/l	1	31	27	24	24	18	18	17	16	14	101	109	96	54
Magnesium	mg/l	1	18	18	14	16	13	13	13	12	11	50	50	46	35
Sodium	mg/l	1	61	64	57	65	11	12	12	12	11	40	36	37	37
Potassium	mg/l	1	1	1	1	1	2	2	2	2	1	1	1	1	1
Nutrients															
Nitrite as N	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Nitrate as N	mg/l	0.01	0.01	0.01	0.02	0.01	1.57	1.39	1.5	1.52	1.6	1.92	1.97	2.06	0.01
Nitrite + Nitrate as N	mg/l	0.01	0.01	0.01	0.02	0.01	1.57	1.39	1.5	1.52	1.6	1.92	1.97	2.06	0.01
Total Kjeldahl Nitrogen as N	mg/l	0.1	0.3	0.5	0.1	0.2	0.3	-	-	0.5	0.5	-	-	-	0.1
Total Nitrogen as N	mg/l	0.1	0.3	0.5	0.1	0.2	1.9	1.7	1.7	2	1.6	1.9	2.2	2.3	0.1
Total Phosphorus as P	mg/l	0.01	0.1	0.14	0.05	0.06	0.39	0.08	0.26	1.07	0.3	0.66	0.7	0.15	0.05
Dissolved Metals															
Aluminium	mg/l	0.01	0.02	0.03	0.01	0.01	0.02	0.02	0.02	0.04	0.07	0.01	0.01	0.01	0.01
Antimony	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Arsenic	mg/l	0.001	0.004	0.004	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cadmium	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Chromium	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001
Cobalt	mg/l	0.001	0.007	0.003	0.005	0.003	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Copper	mg/l	0.001	0.004	0.001	0.001	0.001	0.001	0.004	0.001	0.001	0.001	0.001	0.002	0.002	0.001
Iron	mg/l	0.05	1.54	1.81	0.91	0.91	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.07
Lead	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Manganese	mg/l	0.001	2.08	2.87	0.431	1.01	0.042	0.022	0.049	0.061	0.038	0.006	0.021	0.003	0.114
Mercury	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Molybdenum	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Nickel	mg/l	0.001	0.008	0.004	0.009	0.005	0.004	0.001	0.003	0.003	0.004	0.006	0.008	0.006	0.001
Selenium	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Silver	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Zinc	mg/l	0.005	0.008	0.015	0.017	0.006	0.005	0.008	0.014	0.006	0.005	0.011	0.024	0.013	0.005

Notes

	Analytes with trigger (WMP)
	Exceeding trigger

Project ID: G1383AA
Groundwater quality data

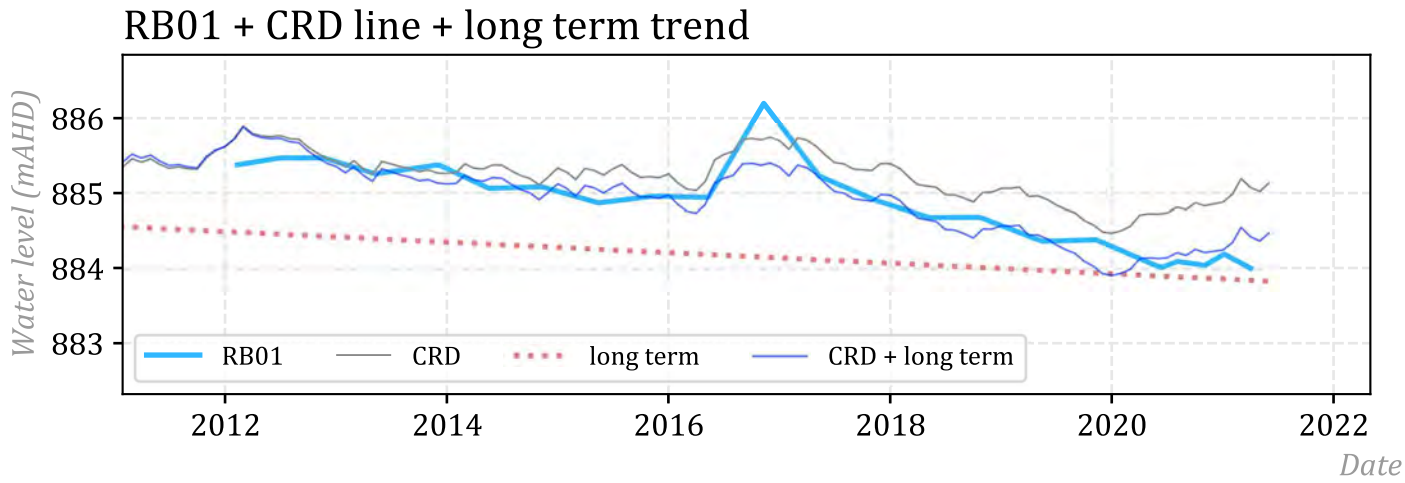
Sample Location			TW05MB	TW05MB	TW05MB	TW05MB	TW05MB	TW05MB	TW05MB	TW05MB	TW05MB	TW05MB
Date Sampled			11/08/2020	8/09/2020	13/10/2020	10/11/2020	15/12/2020	12/01/2021	9/02/2021	9/03/2021	21/04/2021	18/05/2021
Field Parameters	**Units**	**LOD**										
Field pH	pH units	-	7.56	7.05	7.49	7.58	7.63	7.76	7.39	7.87	5.06	7.74
Field Electrical Conductivity (EC)	µS/cm	-	662	623.9	668.1	666.1	658	651	592	655	7.7	651.7
Field Temperature	deg c	-	14.59	18.09	16.7	18.2	16.4	15.9	16.1	17.5	-8	15.9
Physical Parameters												
Electrical conductivity	µS/cm	1	655	648	631	693	657	662	670	672	650	677
Hydroxide Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	1	1	1	1	1
Carbonate Alkalinity as $CaCO_3$	mg/l	1	1	1	1	1	1	17	1	1	1	1
Bicarbonate Alkalinity as $CaCO_3$	mg/l	1	345	373	344	362	349	344	353	350	338	359
Total Alkalinity as $CaCO_3$	mg/l	1	345	373	344	362	349	361	353	350	338	359
Suspended Solids (SS)	mg/l	5	5	5	5	5	5	5	26	10	5	5
Total Dissolved Solids @180°C	mg/l	10	414	387	403	385	404	394	376	424	396	380
Redox Potential	mV	-	-137.1	-82.3	10	-49	-152	-123	-81	-109	687.3	-55
Major Ions												
Sulfate as SO_4 - Turbidimetric	mg/l	1	8	7	8	10	8	10	13	7	4	4
Chloride	mg/l	1	23	22	24	24	25	24	25	24	23	24
Calcium	mg/l	1	53	51	58	56	58	56	56	55	60	52
Magnesium	mg/l	1	34	32	37	36	36	37	34	34	36	37
Sodium	mg/l	1	41	37	40	39	40	40	38	38	40	40
Potassium	mg/l	1	1	1	2	2	2	2	1	1	2	1
Nutrients												
Nitrite as N	mg/l	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Nitrate as N	mg/l	0.01	0.1	0.01	0.07	0.01	0.01	0.03	0.05	0.02	0.03	0.01
Nitrite + Nitrate as N	mg/l	0.01	0.12	0.01	0.07	0.01	0.01	0.03	0.05	0.02	0.03	0.01
Total Kjeldahl Nitrogen as N	mg/l	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.1	0.1	0.2
Total Nitrogen as N	mg/l	0.1	0.3	0.2	0.3	0.2	0.2	0.3	0.2	0.1	0.1	0.2
Total Phosphorus as P	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02
Dissolved Metals												
Aluminium	mg/l	0.01	0.01	0.02	0.03	0.02	0.02	0.02	0.02	0.04	0.01	0.03
Antimony	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Arsenic	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cadmium	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Chromium	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cobalt	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Copper	mg/l	0.001	0.001	0.001	0.001	0.001	0.005	0.002	0.001	0.004	0.001	0.002
Iron	mg/l	0.05	0.06	0.05	0.06	0.05	0.05	0.05	0.06	0.1	0.05	0.06
Lead	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Manganese	mg/l	0.001	0.124	0.115	0.128	0.132	0.118	0.12	0.123	0.118	0.127	0.118
Mercury	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Molybdenum	mg/l	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001
Nickel	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Selenium	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Silver	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Zinc	mg/l	0.005	0.005	0.005	0.006	0.021	0.011	0.011	0.005	0.01	0.005	0.005

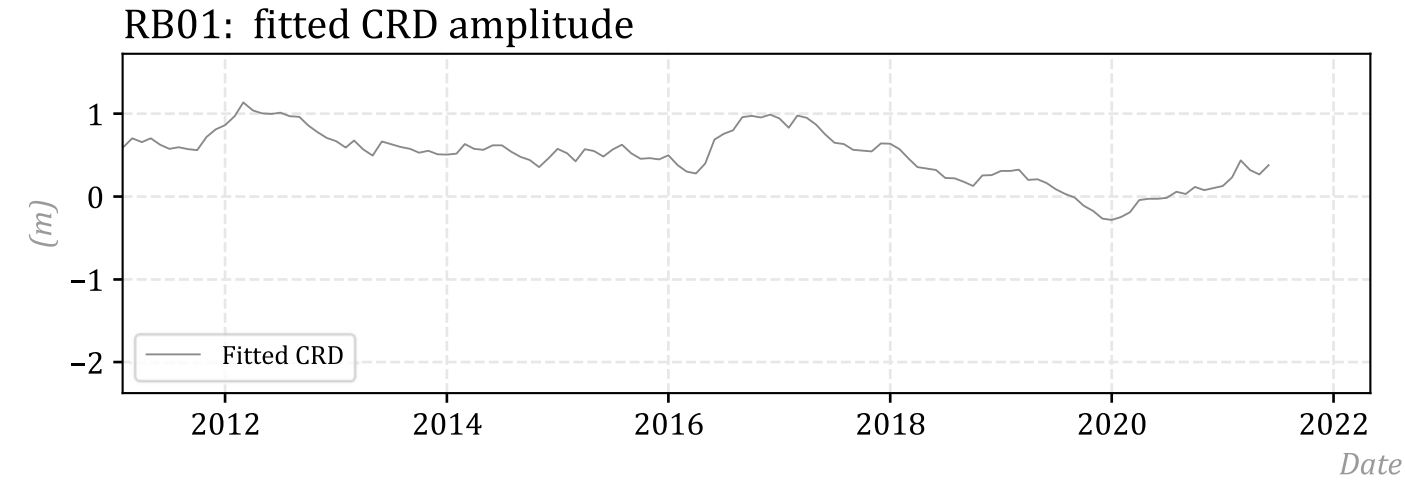
Notes

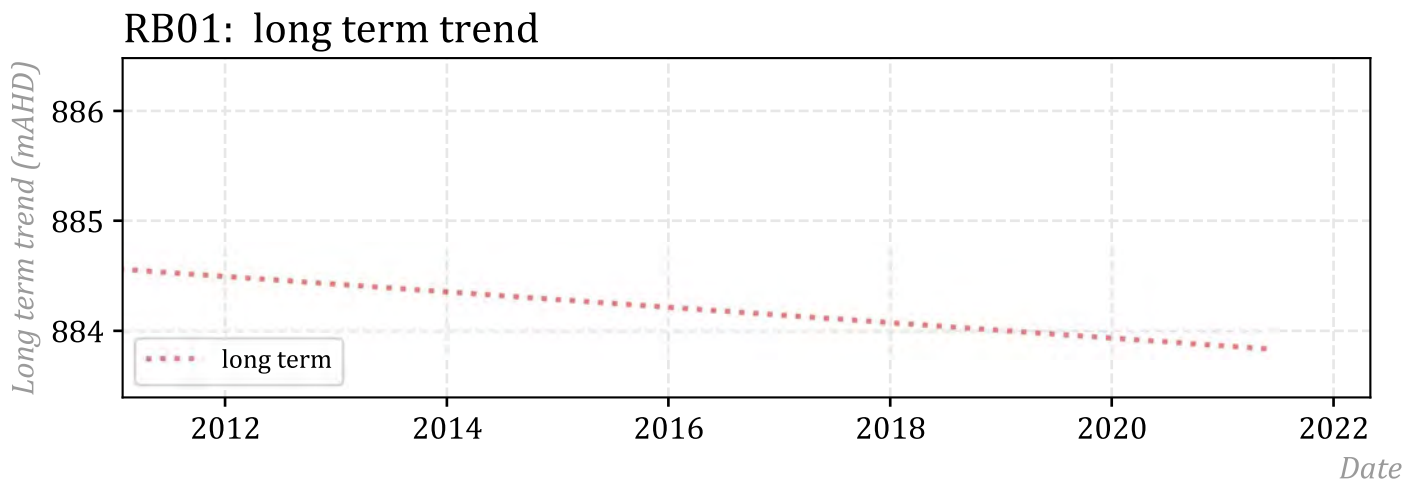
	Analytes with trigger (WMP)
	Exceeding trigger

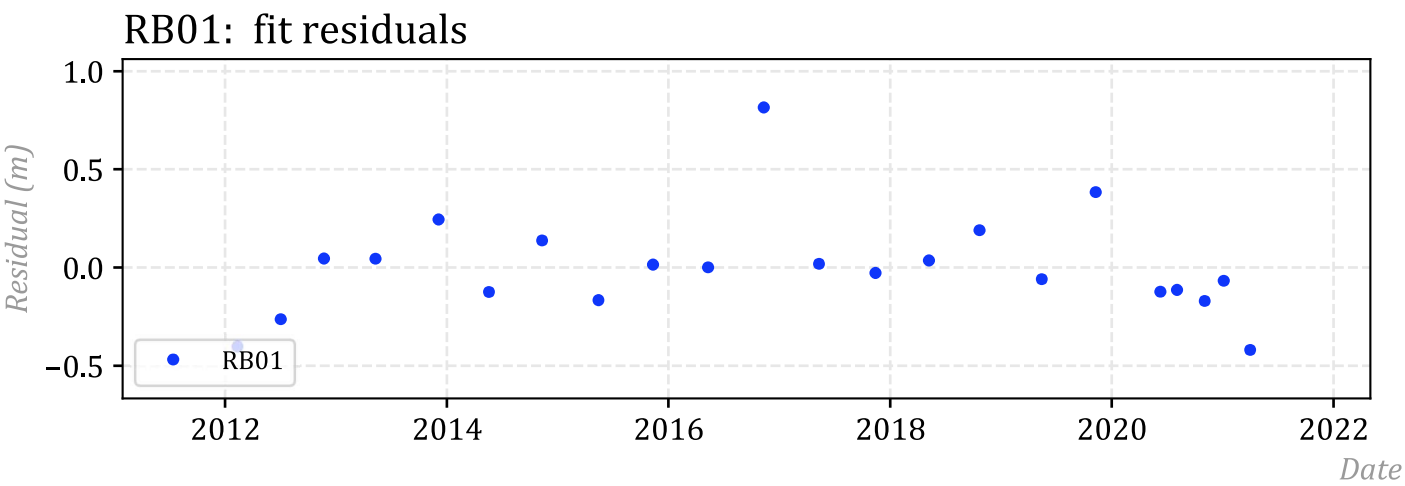
Appendix D

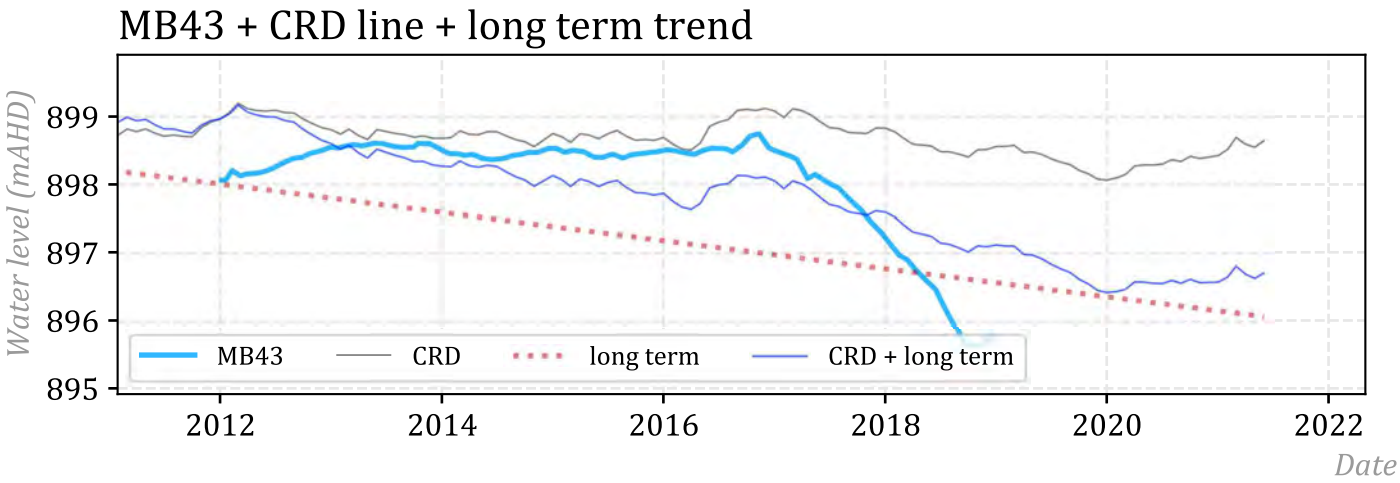
TFN modelling

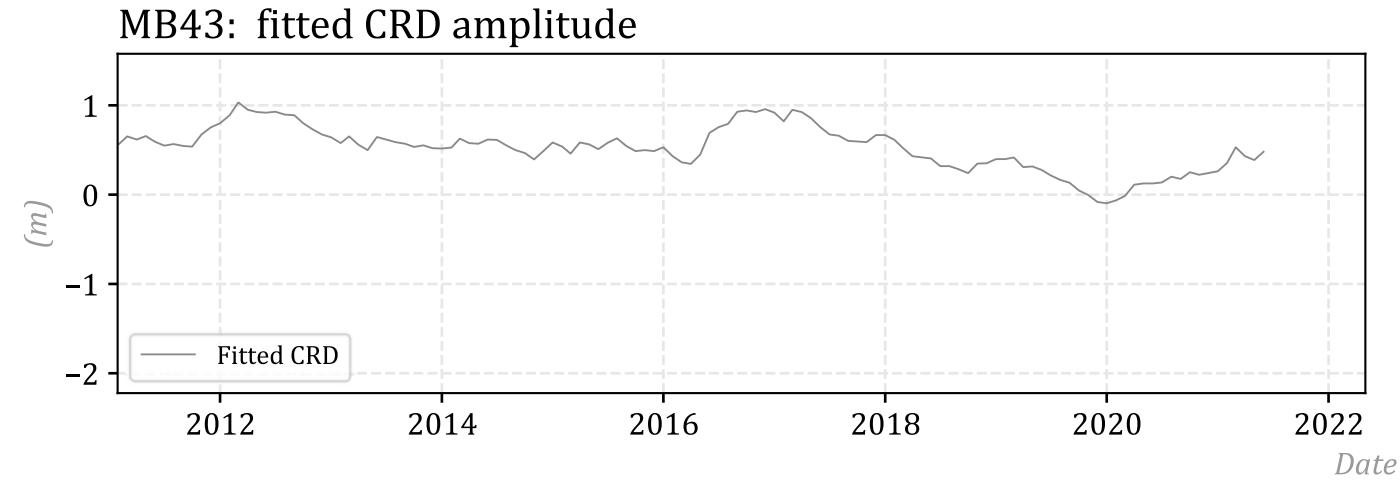

RB01 + CRD line + long term trend
Water level (mAHD)
886
885
884
883
RB01
CRD
long term
CRD + long term
2012
2014
2016
2018
2020
2022
Date

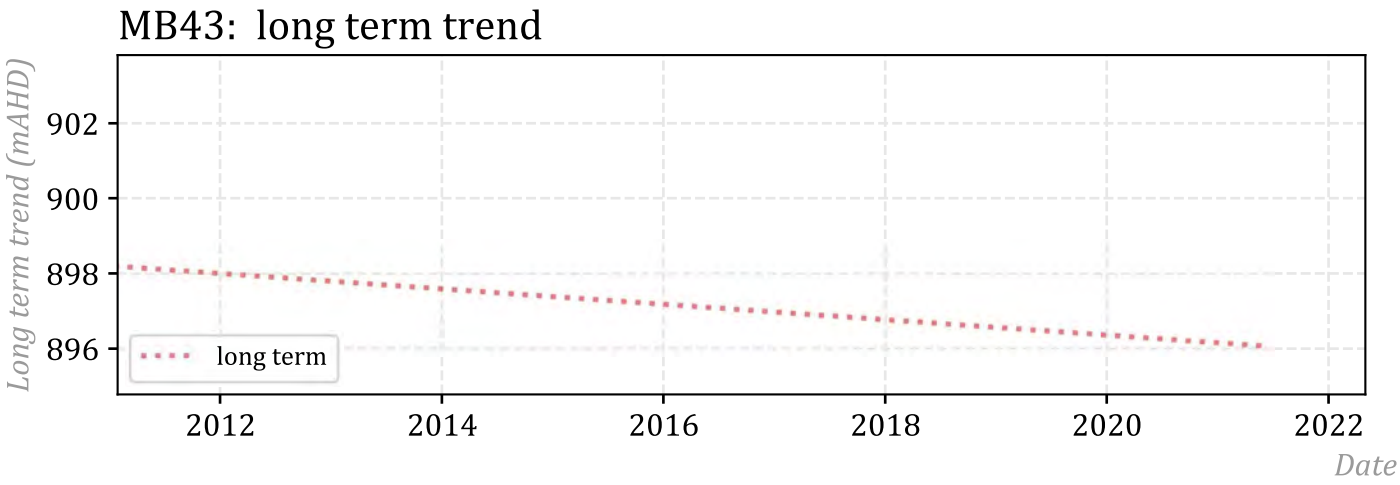

RB01: fitted CRD amplitude
(m)
1
0
−1
−2
Fitted CRD
2012
2014
2016
2018
2020
2022
Date

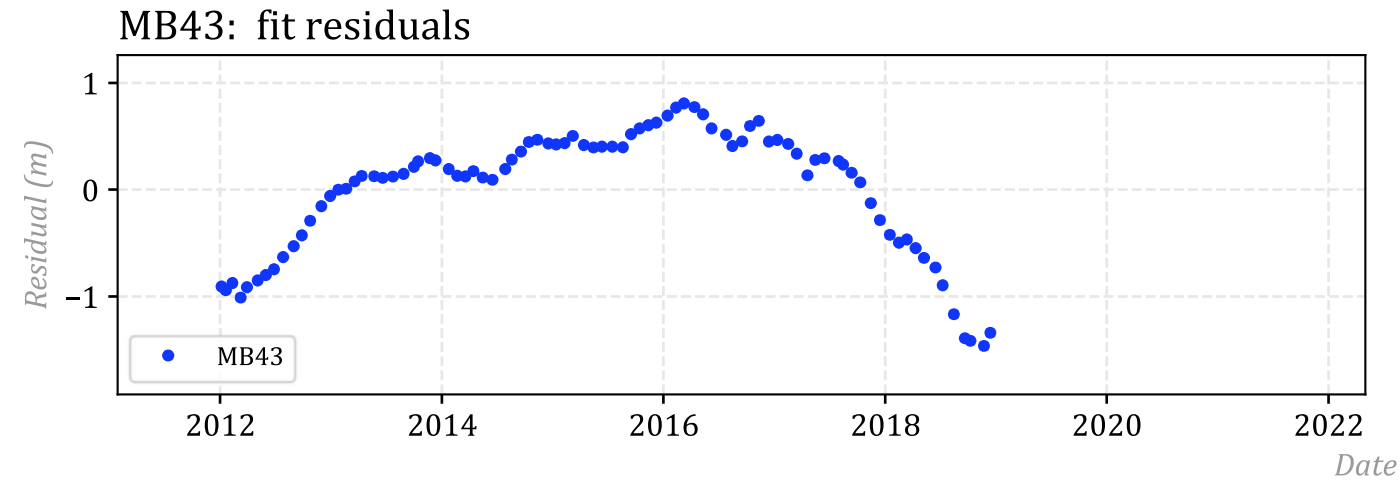

RB01: long term trend
Long term trend (mAHD)
886
885
884
long term
2012
2014
2016
2018
2020
2022
Date

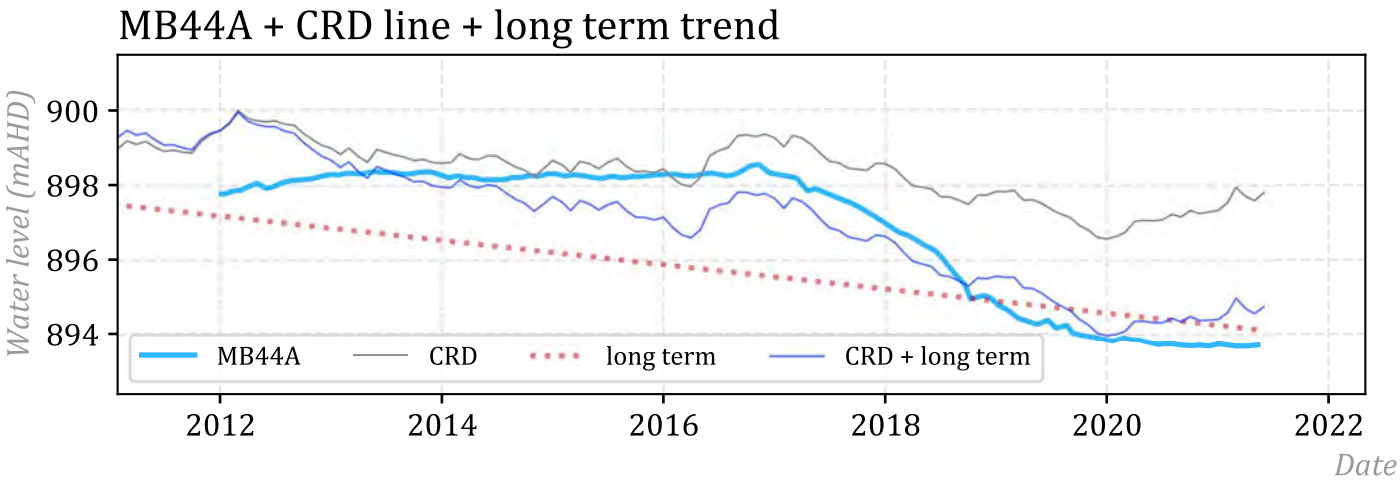

RB01: fit residuals
Residual (m)
1.0
0.5
0.0
−0.5
RB01
2012
2014
2016
2018
2020
2022
Date

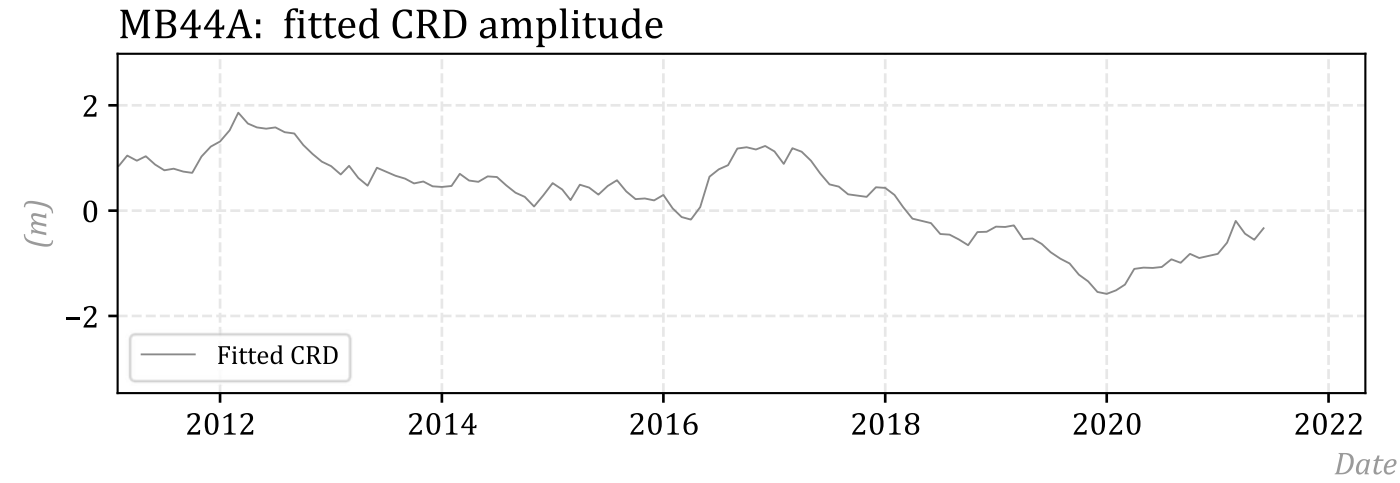

MB43 + CRD line + long term trend
Water level (mAHD)
899
898
897
896
895
MB43
CRD
long term
CRD + long term
2012
2014
2016
2018
2020
2022
Date

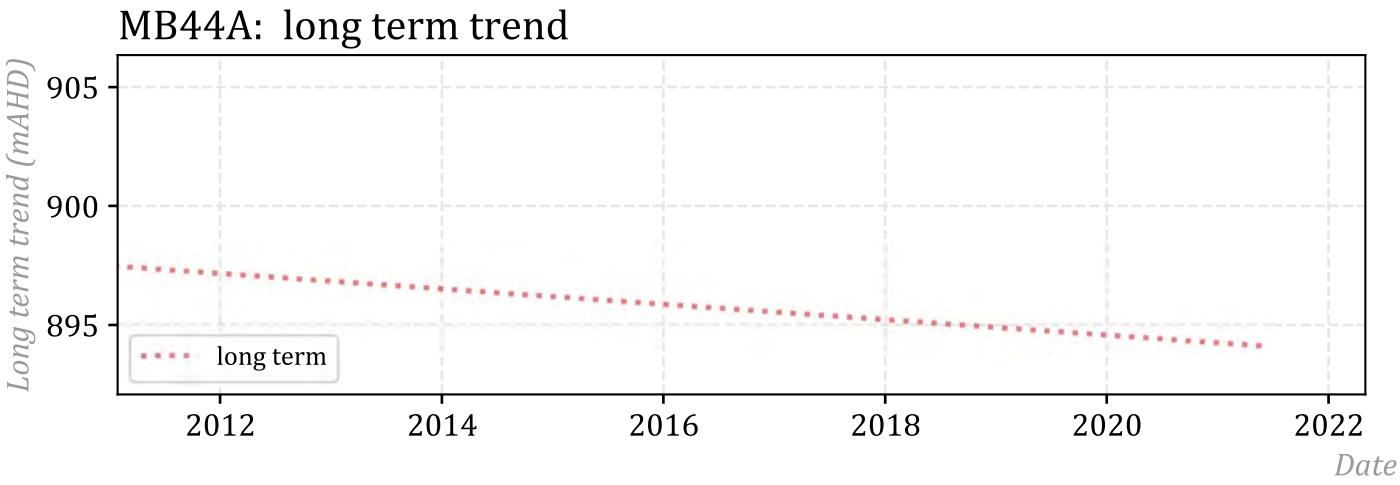

MB43: fitted CRD amplitude
(m)
1
0
−1
−2
Fitted CRD
2012
2014
2016
2018
2020
2022
Date

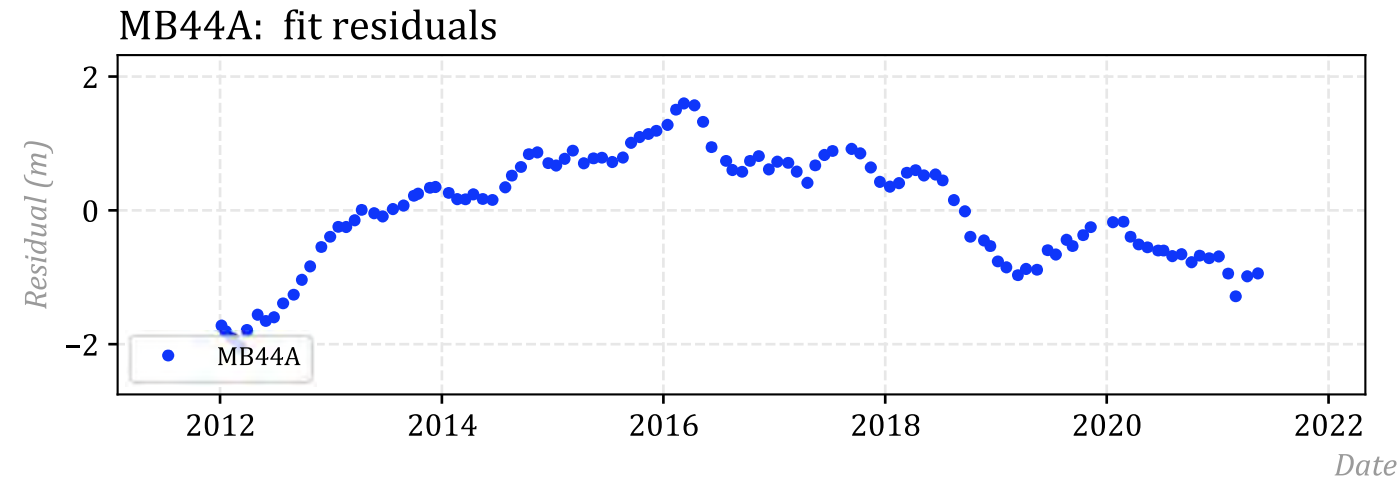

MB43: long term trend
Long term trend (mAHD)
902
900
898
896
long term
2012
2014
2016
2018
2020
2022
Date

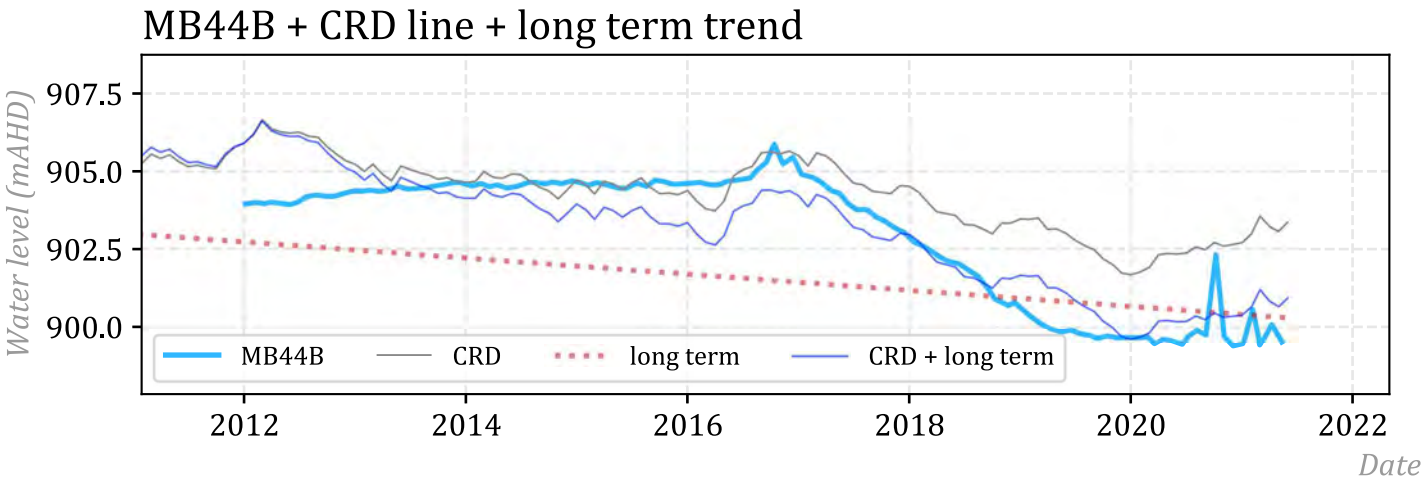

MB43: fit residuals
Residual (m)
1
0
−1
MB43
2012
2014
2016
2018
2020
2022
Date

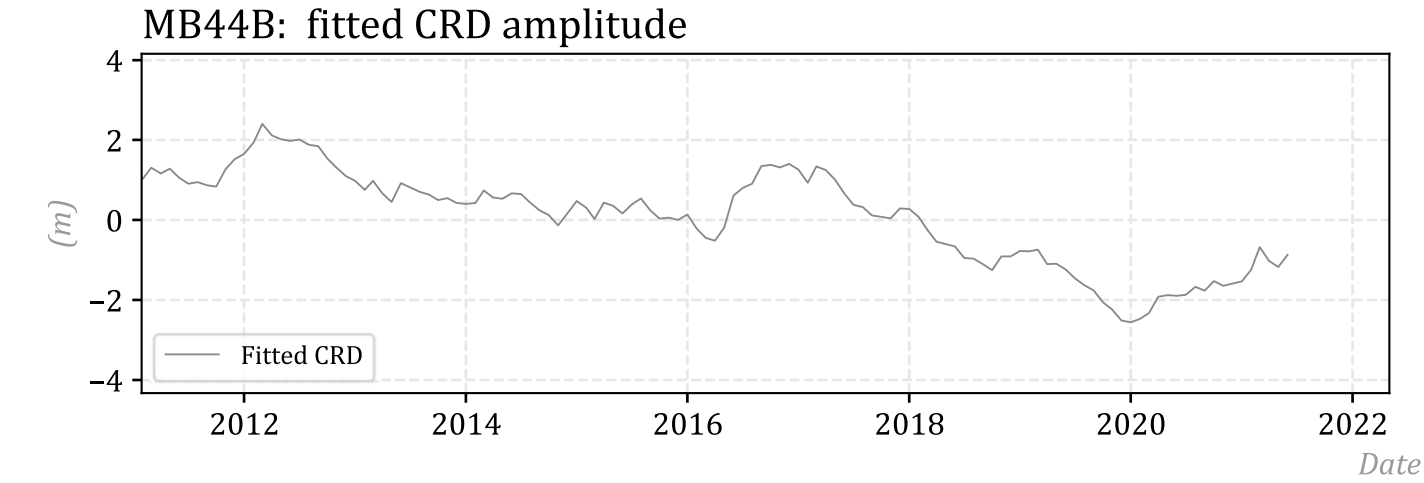

MB44A + CRD line + long term trend
Water level (mAHD)
900
898
896
894
MB44A
CRD
long term
CRD + long term
2012
2014
2016
2018
2020
2022
Date

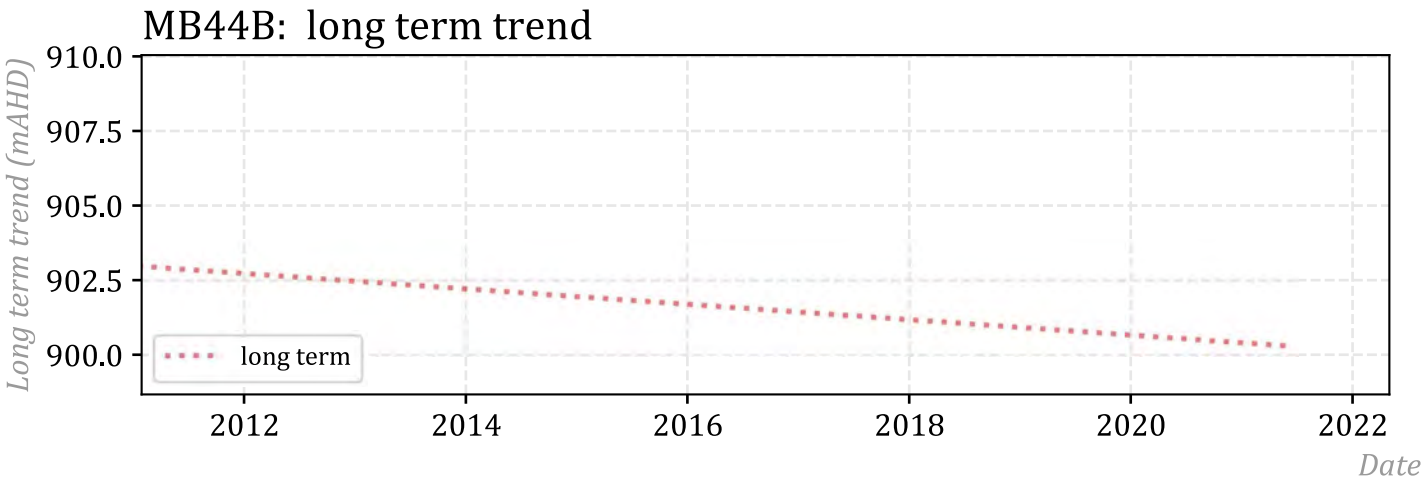

MB44A: fitted CRD amplitude
(m)
2
0
−2
Fitted CRD
2012
2014
2016
2018
2020
2022
Date

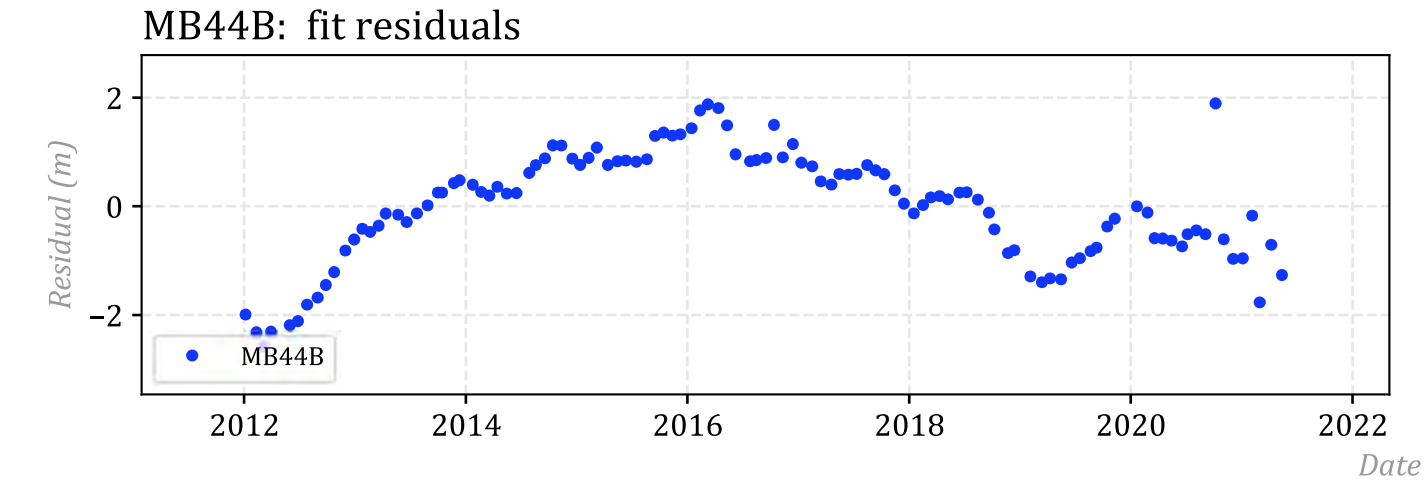

MB44A: long term trend
Long term trend (mAHD)
905
900
895
long term
2012
2014
2016
2018
2020
2022
Date

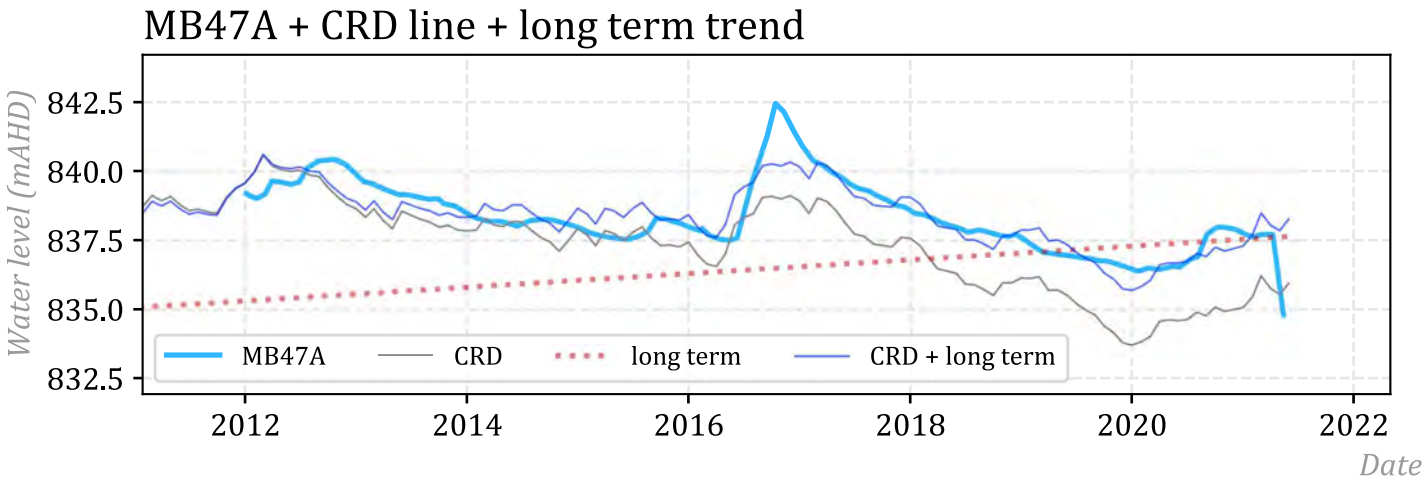

MB44A: fit residuals
Residual (m)
2
0
−2
MB44A
2012
2014
2016
2018
2020
2022
Date

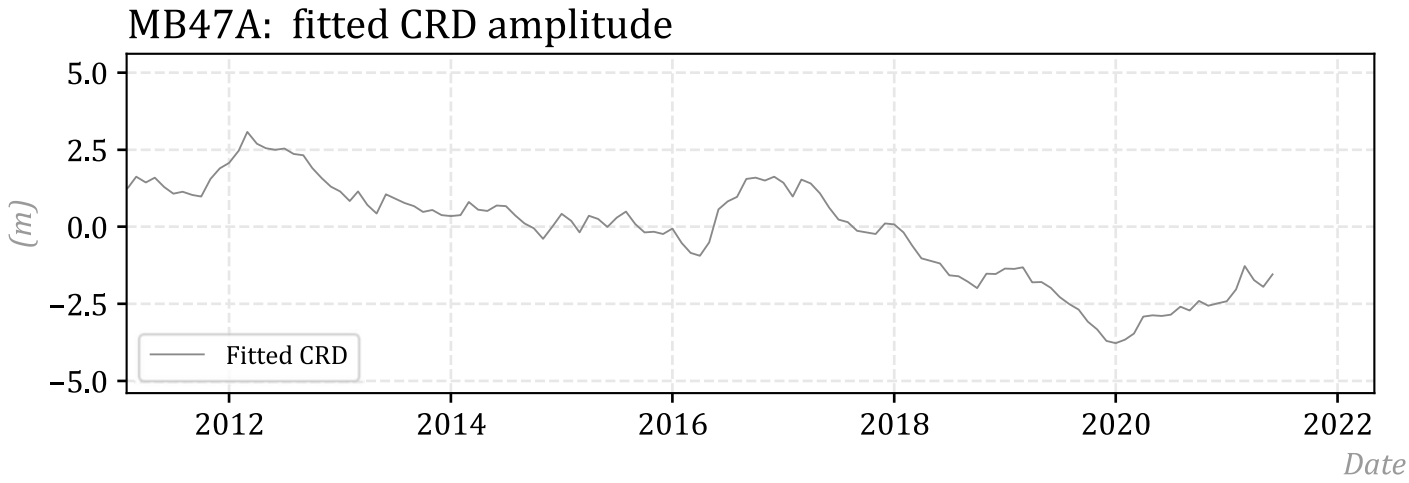

MB44B + CRD line + long term trend
Water level (mAHD)
907.5
905.0
902.5
900.0
MB44B
CRD
long term
CRD + long term
2012
2014
2016
2018
2020
2022
Date

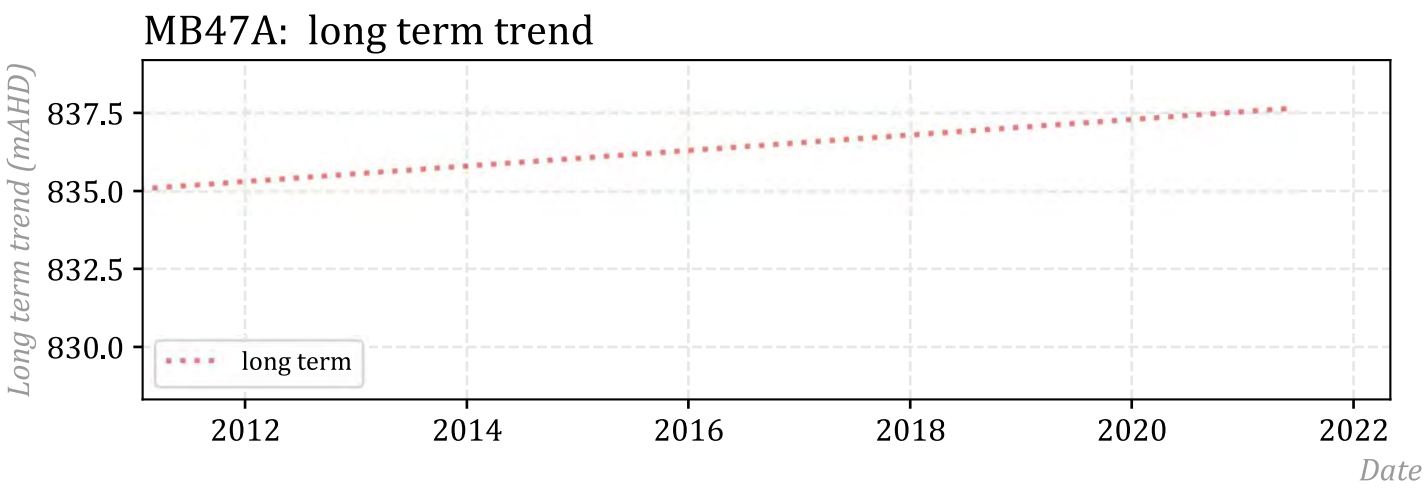

MB44B: fitted CRD amplitude
(m)
4
2
0
−2
−4
Fitted CRD
2012
2014
2016
2018
2020
2022
Date

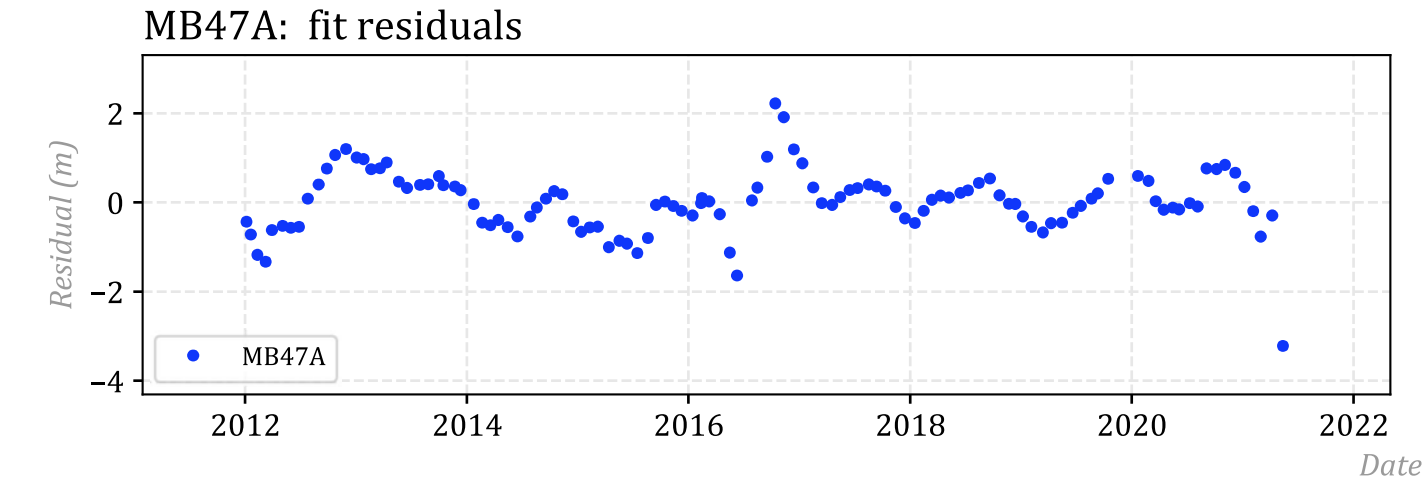

MB44B: long term trend
Long term trend (mAHD)
910.0
907.5
905.0
902.5
900.0
long term
2012
2014
2016
2018
2020
2022
Date

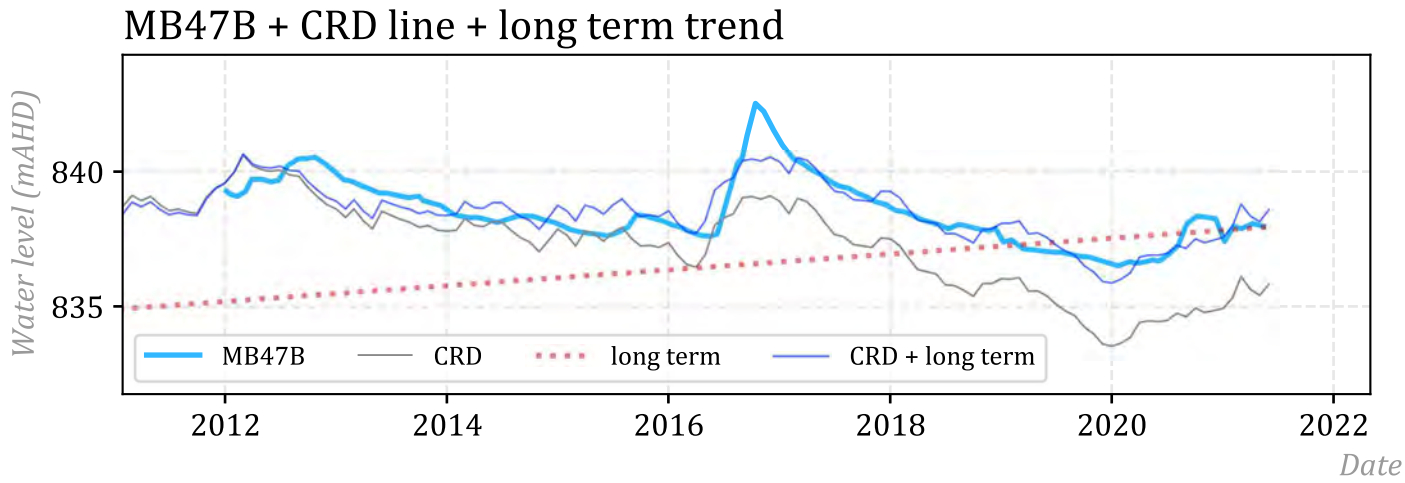

MB44B: fit residuals
Residual (m)
2
0
−2
MB44B
2012
2014
2016
2018
2020
2022
Date

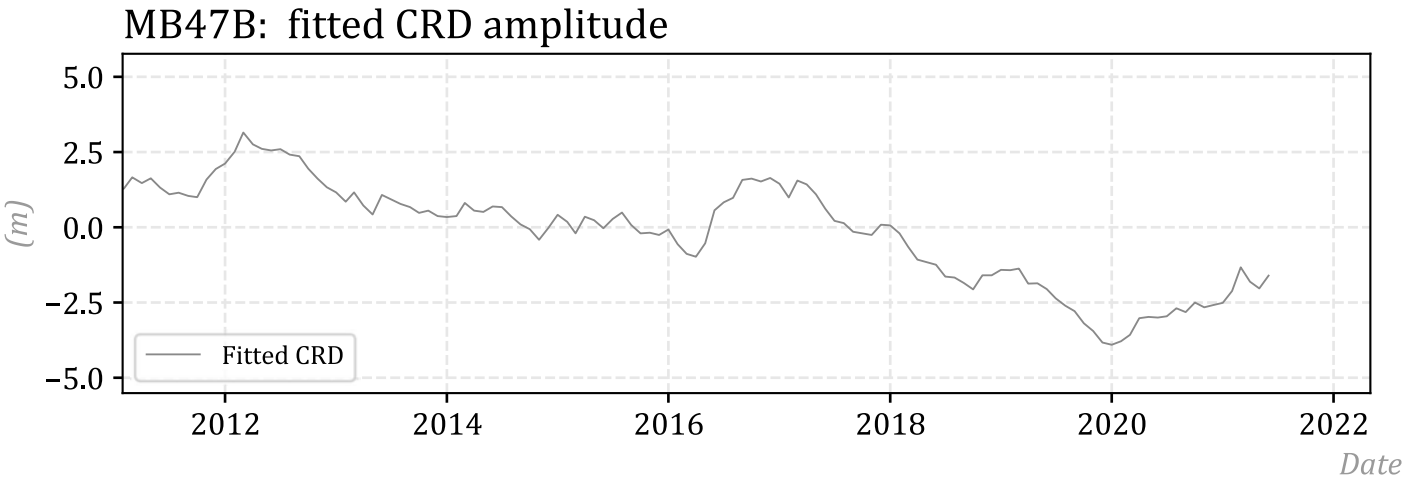

MB47A + CRD line + long term trend
Water level (mAHD)
842.5
840.0
837.5
835.0
832.5
MB47A
CRD
long term
CRD + long term
2012
2014
2016
2018
2020
2022
Date

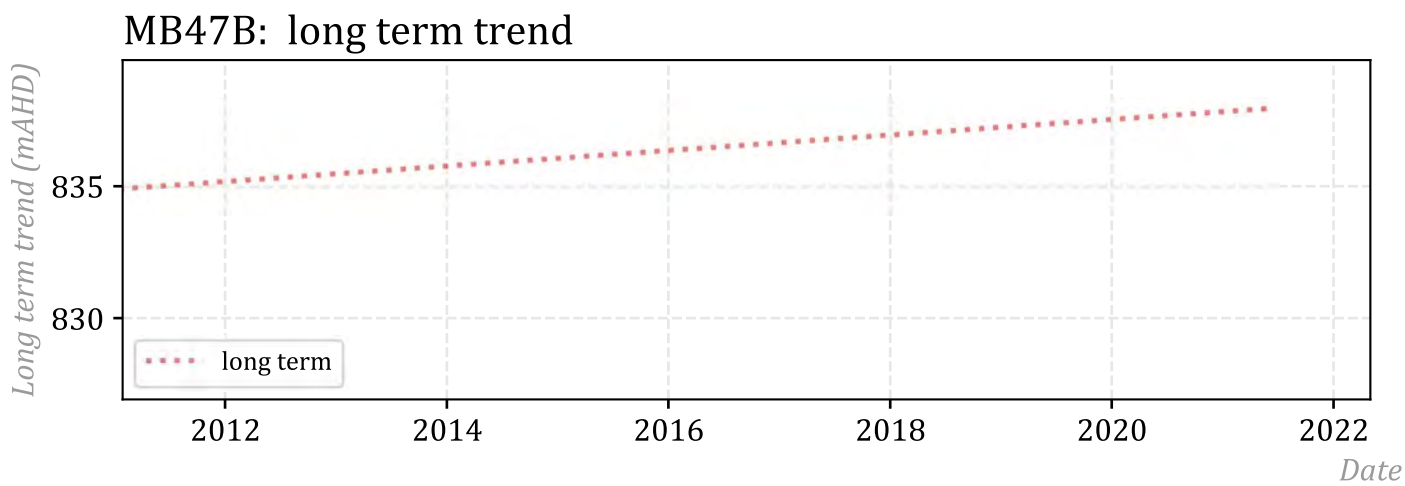

MB47A: fitted CRD amplitude
(m)
5.0
2.5
0.0
−2.5
−5.0
Fitted CRD
2012
2014
2016
2018
2020
2022
Date

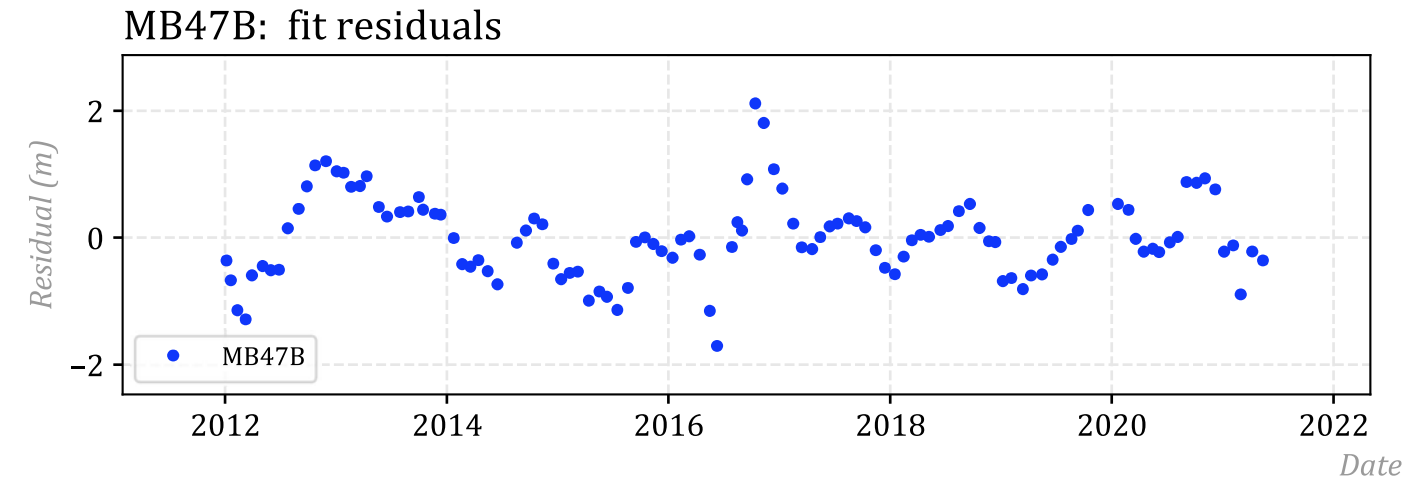

MB47A: long term trend
Long term trend (mAHD)
837.5
835.0
832.5
830.0
long term
2012
2014
2016
2018
2020
2022
Date

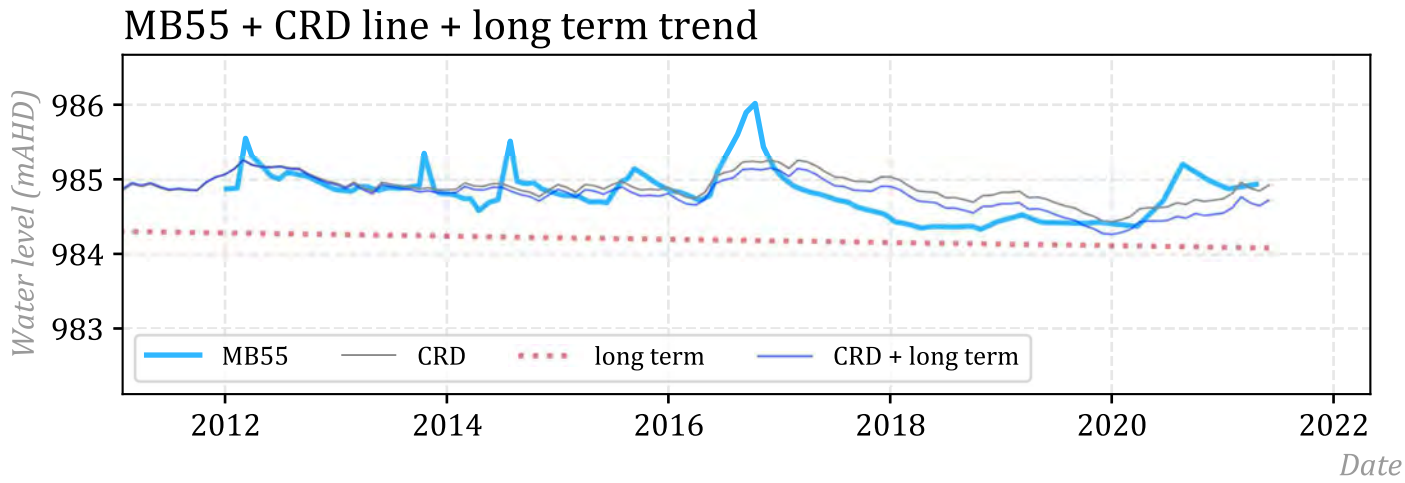

MB47A: fit residuals
Residual (m)
2
0
−2
−4
MB47A
2012
2014
2016
2018
2020
2022
Date

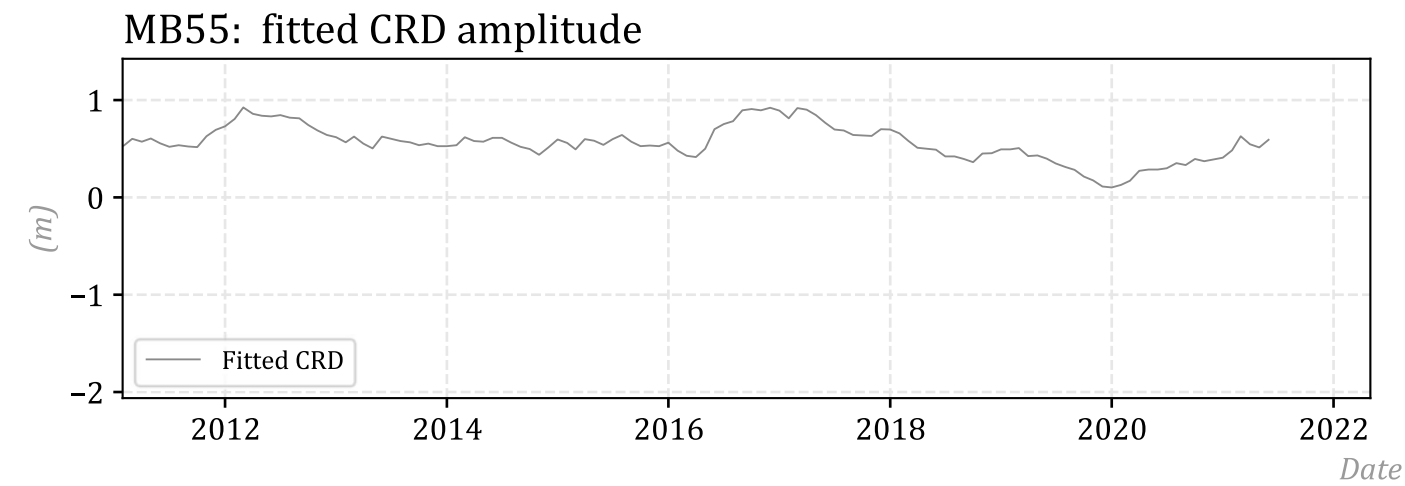

MB47B + CRD line + long term trend
Water level (mAHD)
840
835
MB47B
CRD
long term
CRD + long term
2012
2014
2016
2018
2020
2022
Date

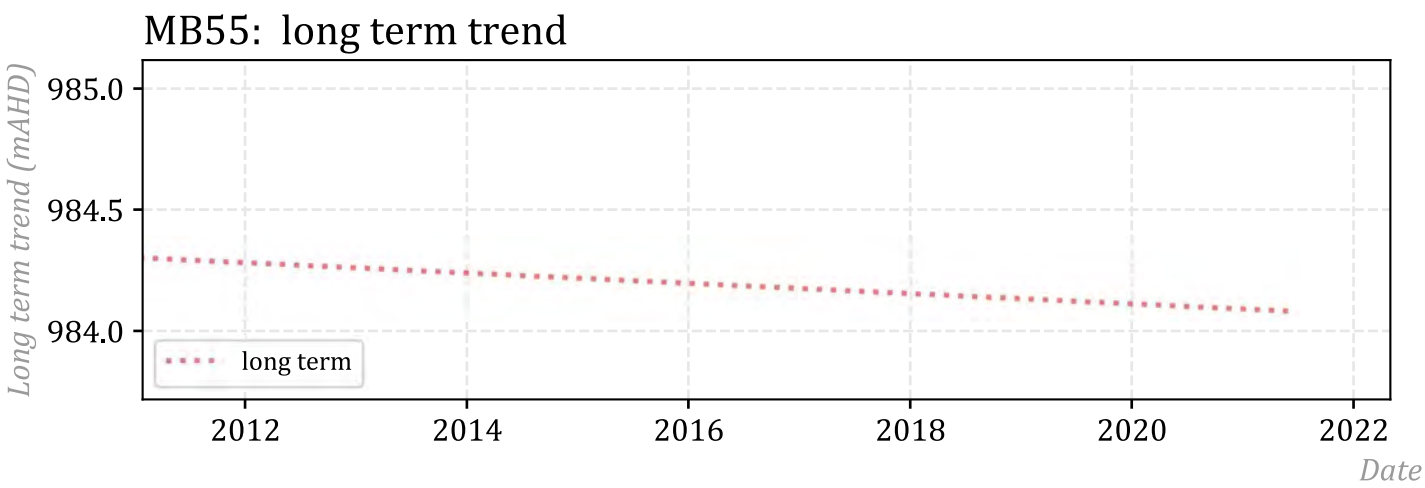

MB47B: fitted CRD amplitude
(m)
5.0
2.5
0.0
−2.5
−5.0
Fitted CRD
2012
2014
2016
2018
2020
2022
Date

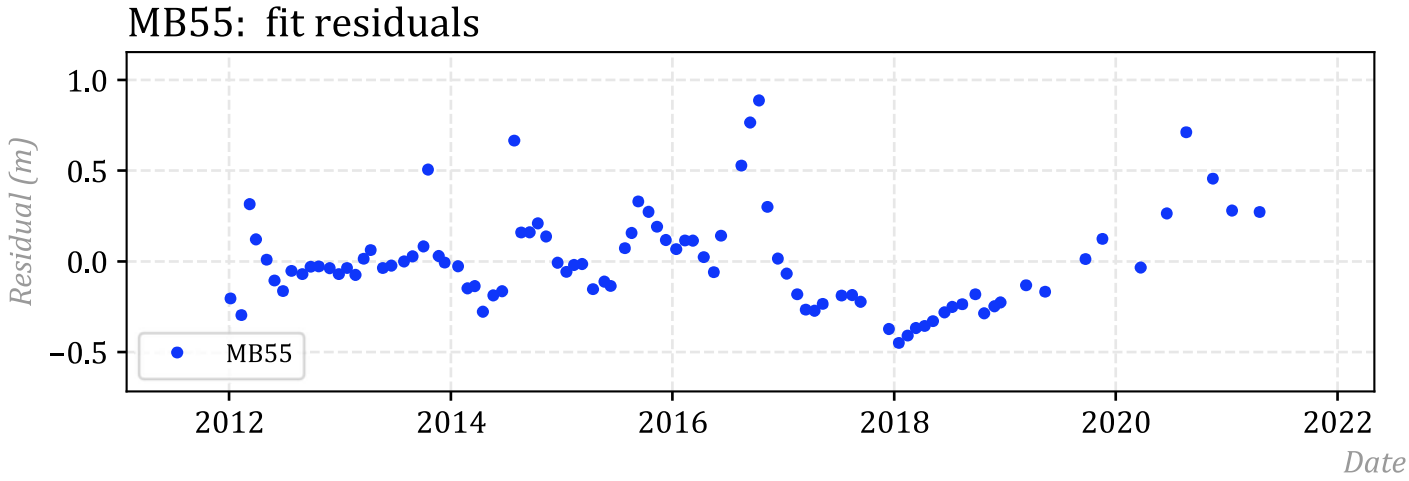

MB47B: long term trend
Long term trend (mAHD)
835
830
long term
2012
2014
2016
2018
2020
2022
Date

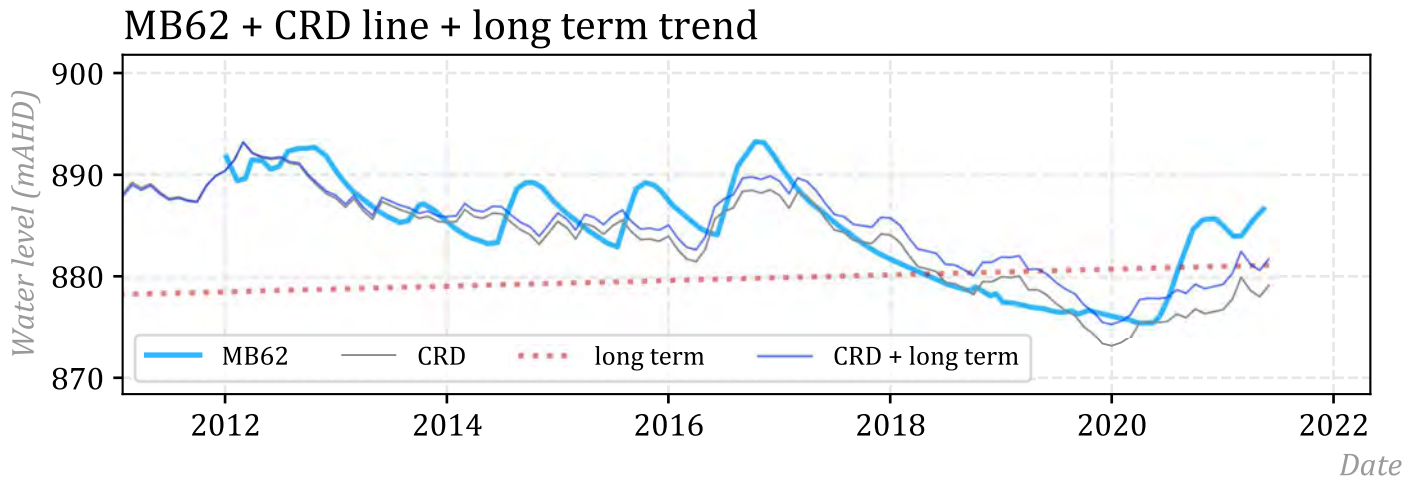

MB47B: fit residuals
Residual (m)
2
0
−2
MB47B
2012
2014
2016
2018
2020
2022
Date

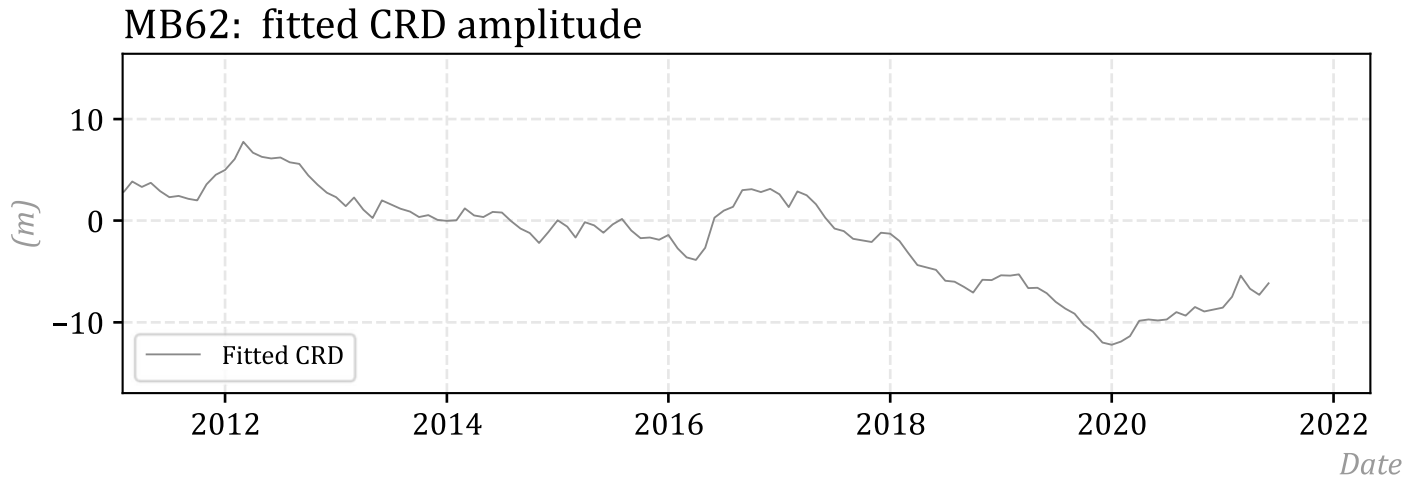

MB55 + CRD line + long term trend
Water level (mAHD)
986
985
984
983
MB55
CRD
long term
CRD + long term
2012
2014
2016
2018
2020
2022
Date

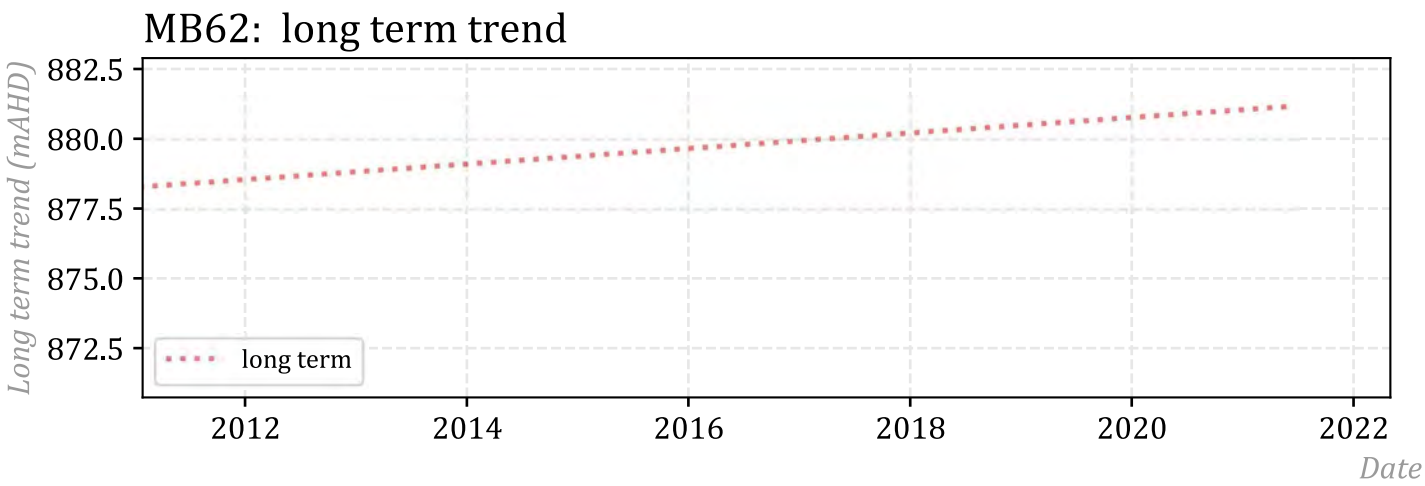

MB55: fitted CRD amplitude
(m)
1
0
−1
−2
Fitted CRD
2012
2014
2016
2018
2020
2022
Date

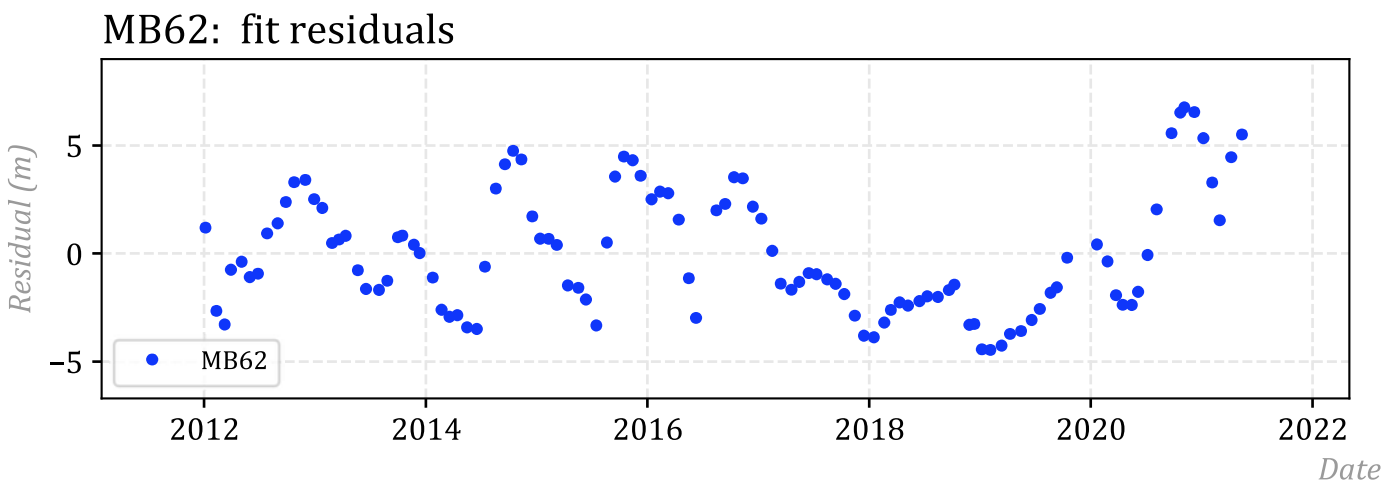

MB55: long term trend
Long term trend (mAHD)
985.0
984.5
984.0
long term
2012
2014
2016
2018
2020
2022
Date

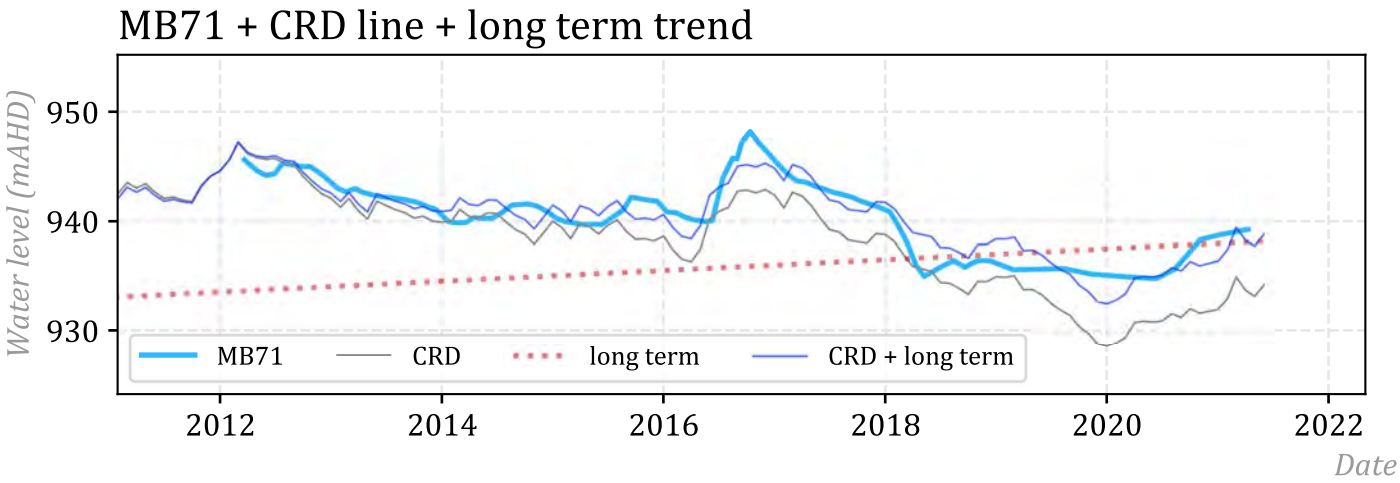

MB55: fit residuals
Residual (m)
1.0
0.5
0.0
−0.5
MB55
2012
2014
2016
2018
2020
2022
Date

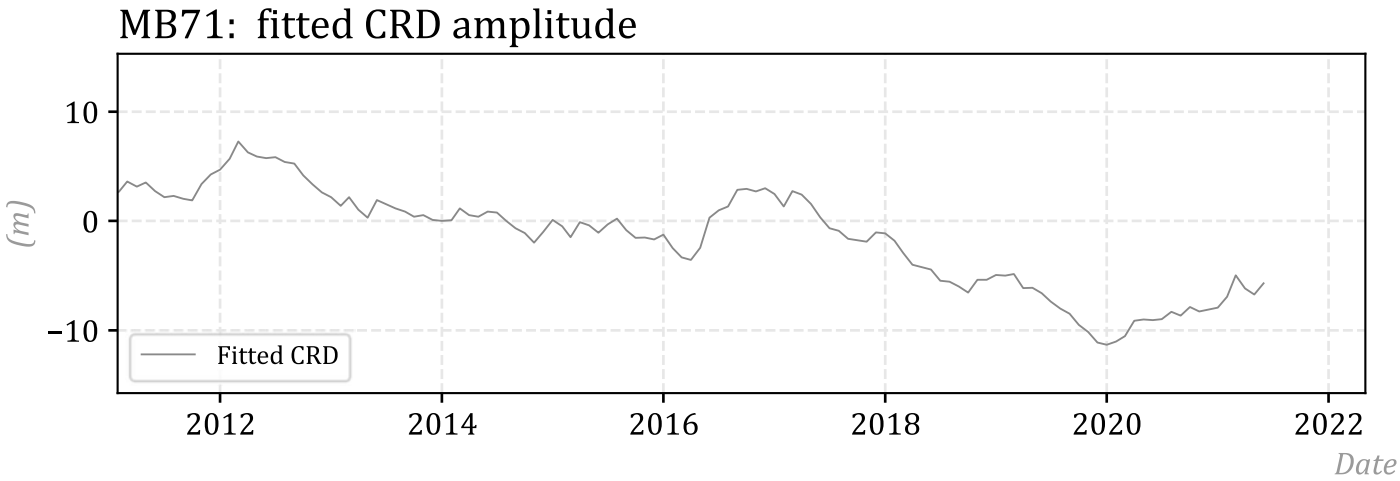

MB62 + CRD line + long term trend
Water level (mAHD)
900
890
880
870
MB62
CRD
long term
CRD + long term
2012
2014
2016
2018
2020
2022
Date

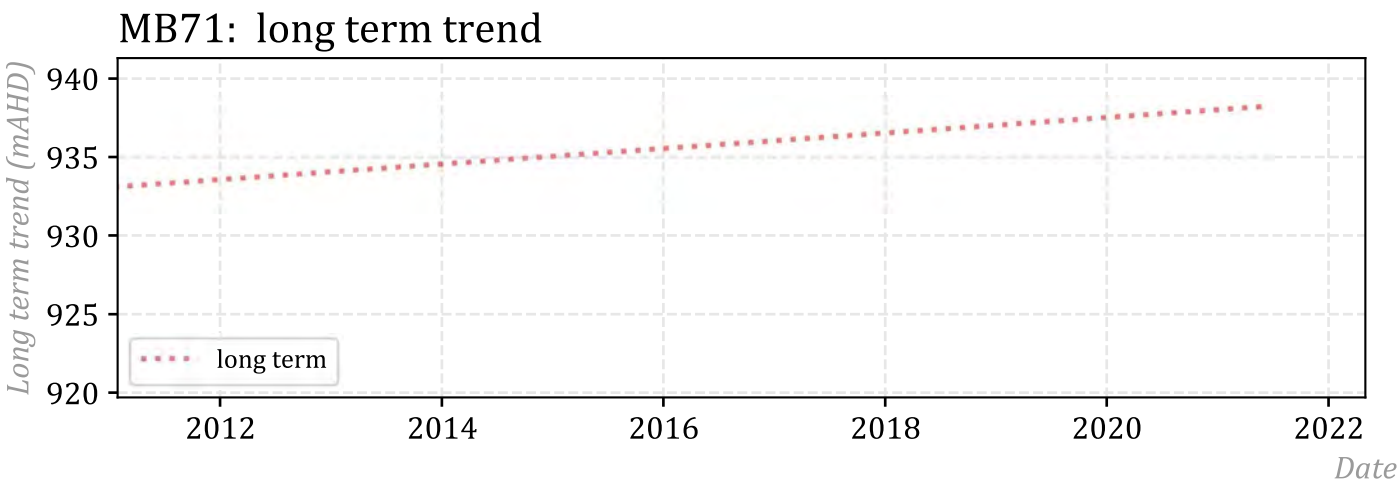

MB62: fitted CRD amplitude
(m)
10
0
−10
Fitted CRD
2012
2014
2016
2018
2020
2022
Date

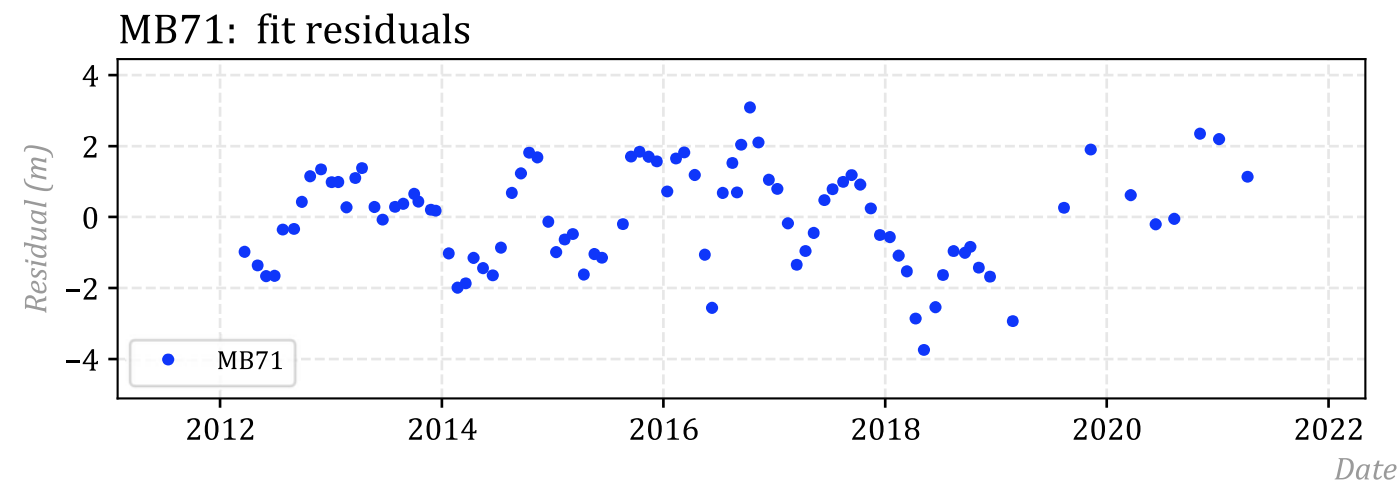

MB62: long term trend
Long term trend (mAHD)
882.5
880.0
877.5
875.0
872.5
long term
2012
2014
2016
2018
2020
2022
Date

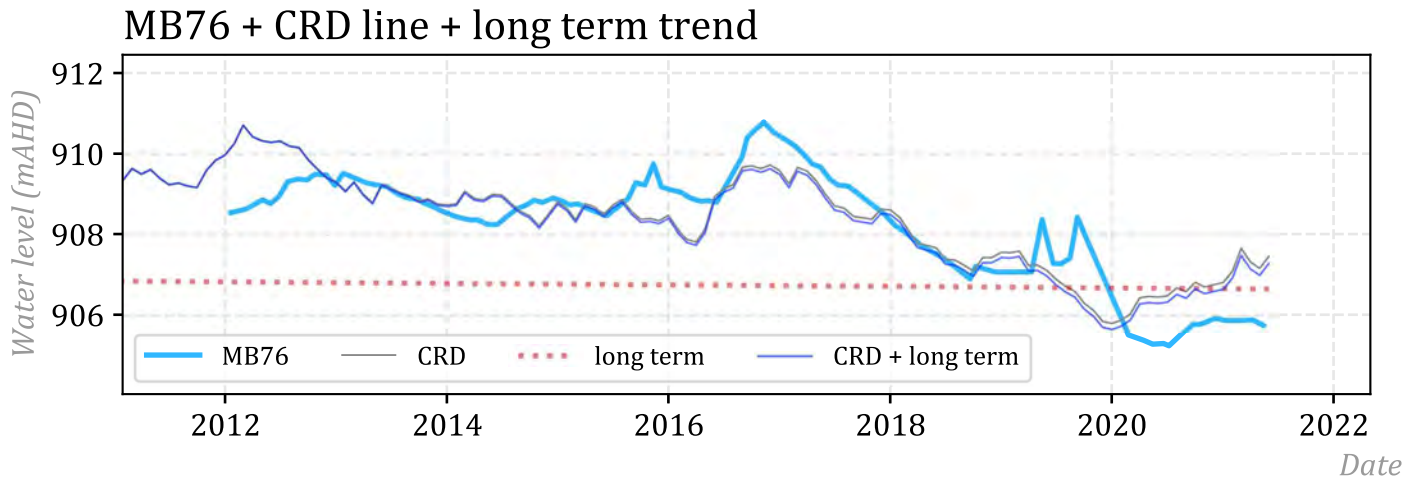

MB62: fit residuals
Residual (m)
5
0
−5
MB62
2012
2014
2016
2018
2020
2022
Date

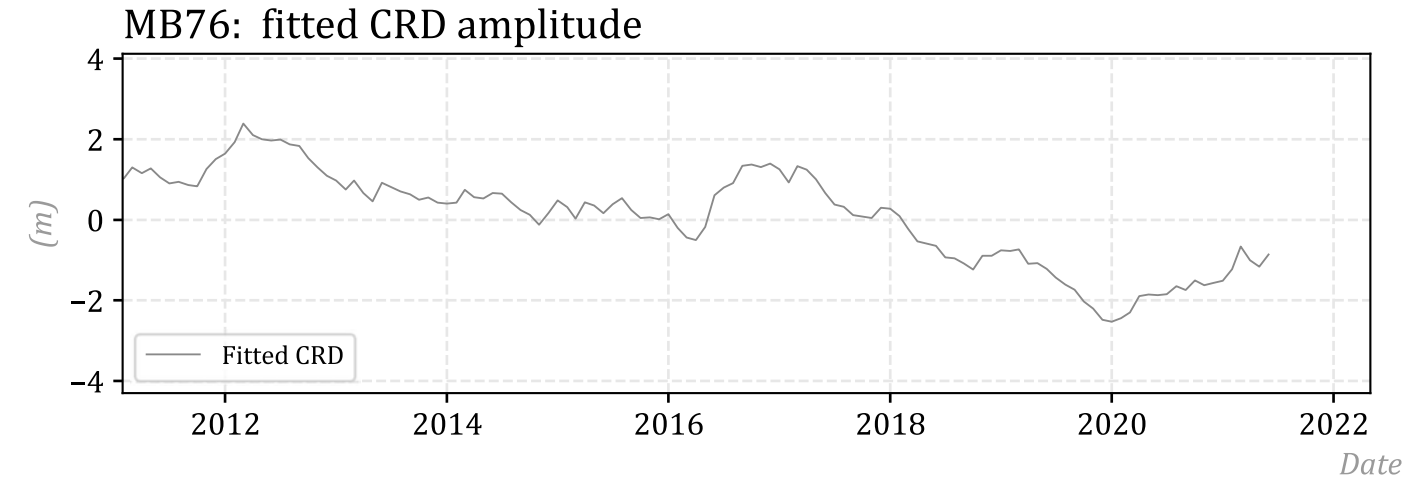

MB71 + CRD line + long term trend
Water level (mAHD)
950
940
930
MB71
CRD
long term
CRD + long term
2012
2014
2016
2018
2020
2022
Date

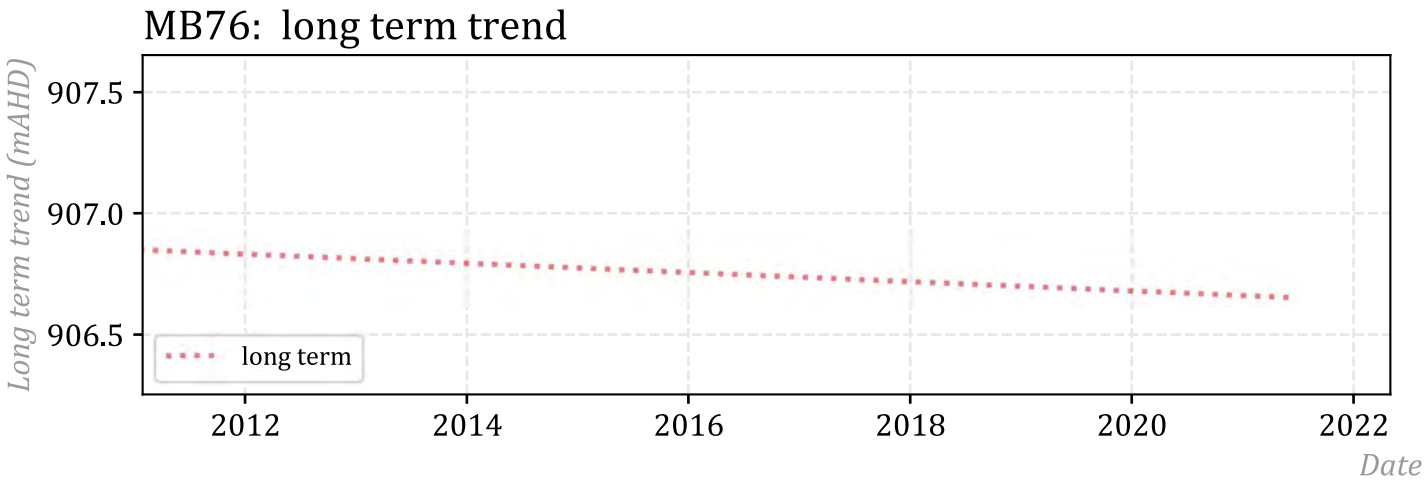

MB71: fitted CRD amplitude
(m)
10
0
−10
Fitted CRD
2012
2014
2016
2018
2020
2022
Date

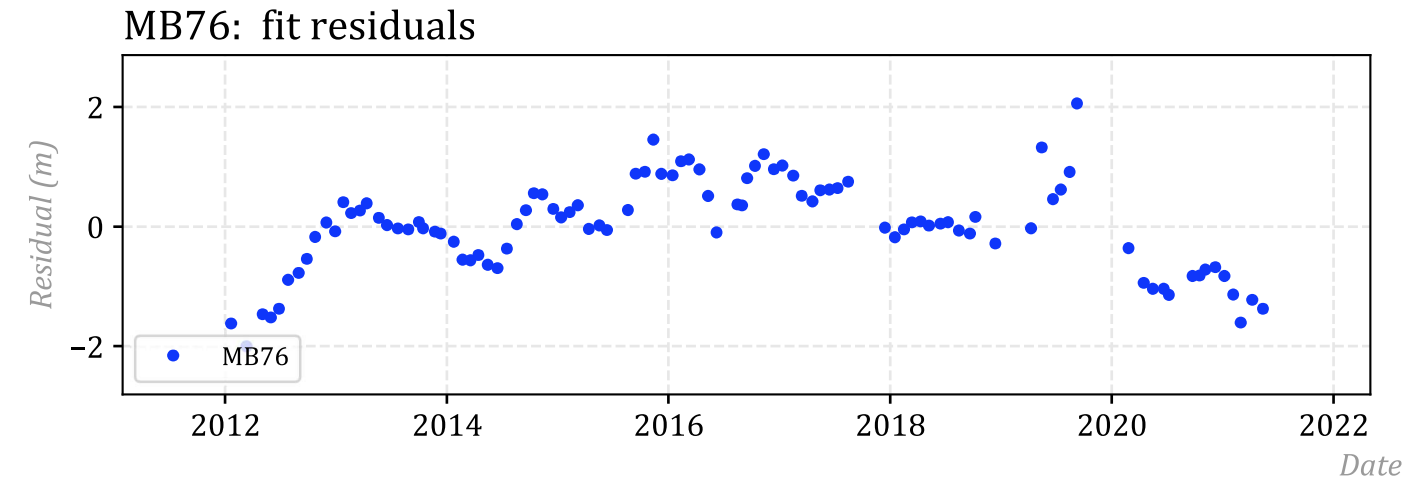

MB71: long term trend
Long term trend (mAHD)
940
935
930
925
920
long term
2012
2014
2016
2018
2020
2022
Date


MB71: fit residuals
Residual (m)
4
2
0
−2
−4
MB71
2012
2014
2016
2018
2020
2022
Date


MB76 + CRD line + long term trend
912
910
908
906
Water level (mAHD)
MB76
CRD
long term
CRD + long term
2012
2014
2016
2018
2020
2022
Date


MB76: fitted CRD amplitude
4
2
0
−2
−4
(m)
Fitted CRD
2012
2014
2016
2018
2020
2022
Date

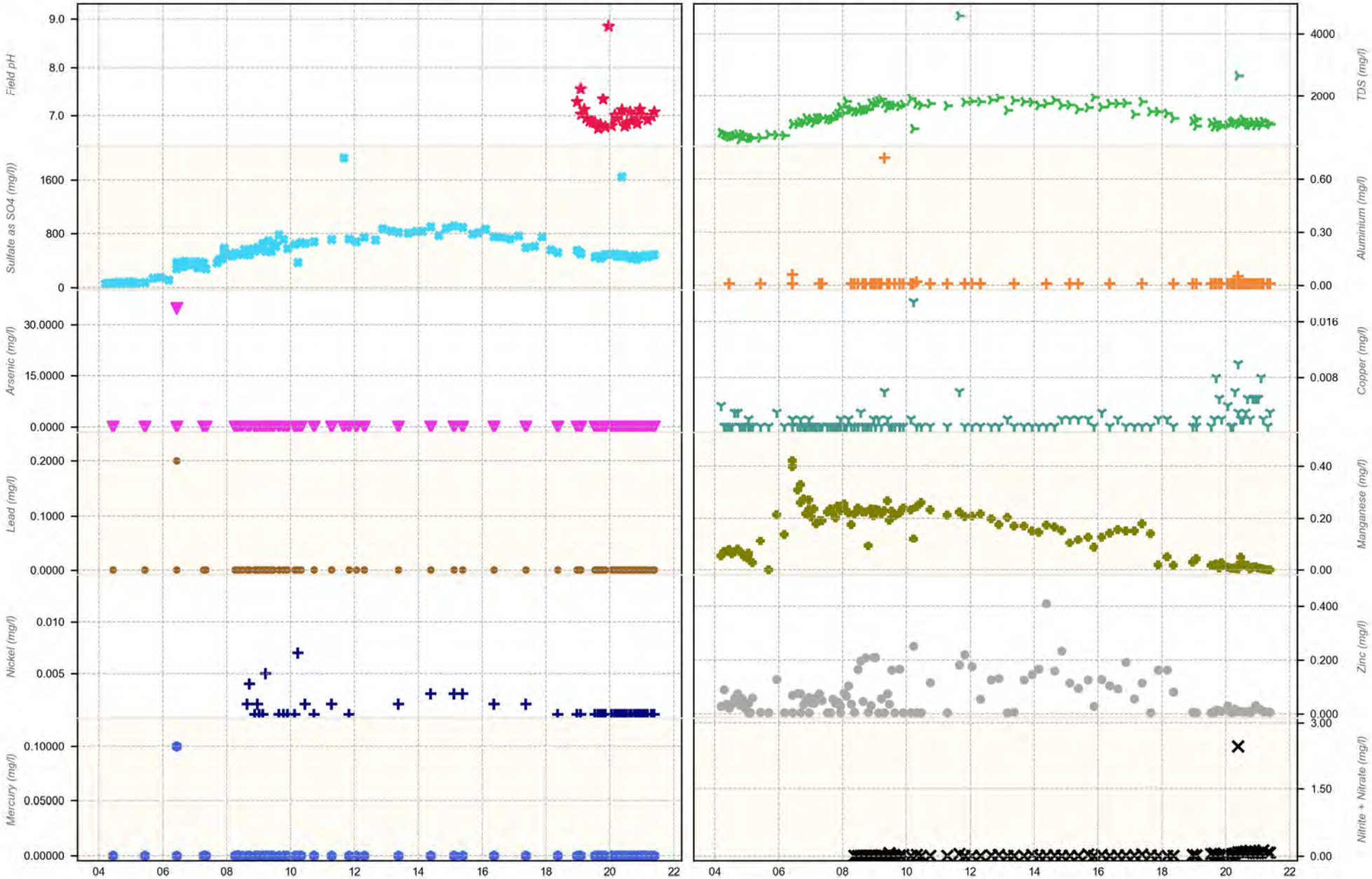

MB76: long term trend
907.5
907.0
906.5
Long term trend (mAHD)
long term
2012
2014
2016
2018
2020
2022
Date


MB76: fit residuals
2
0
−2
Residual (m)
MB76
2012
2014
2016
2018
2020
2022
Date

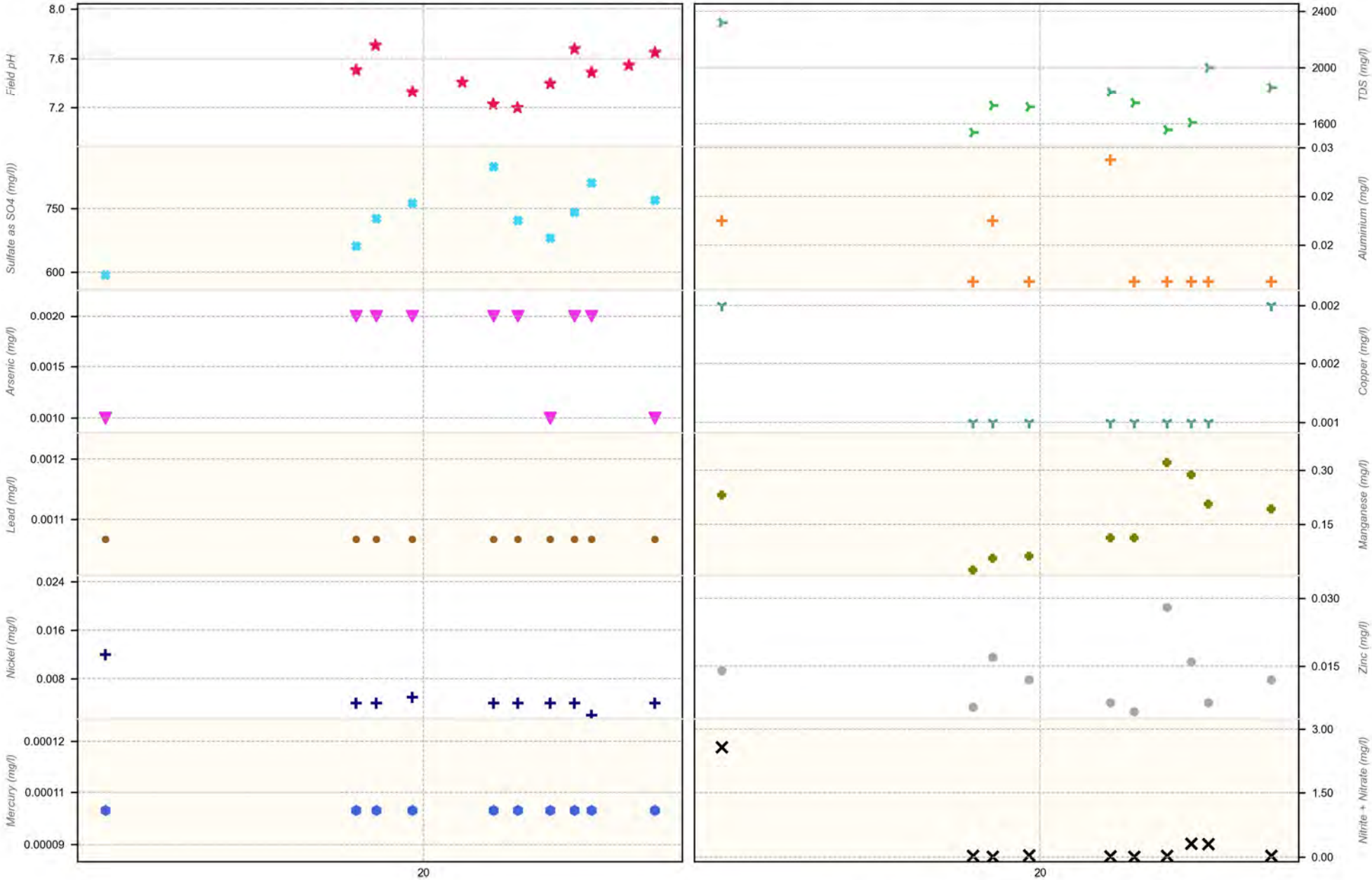
Appendix E

Groundwater quality time series plots

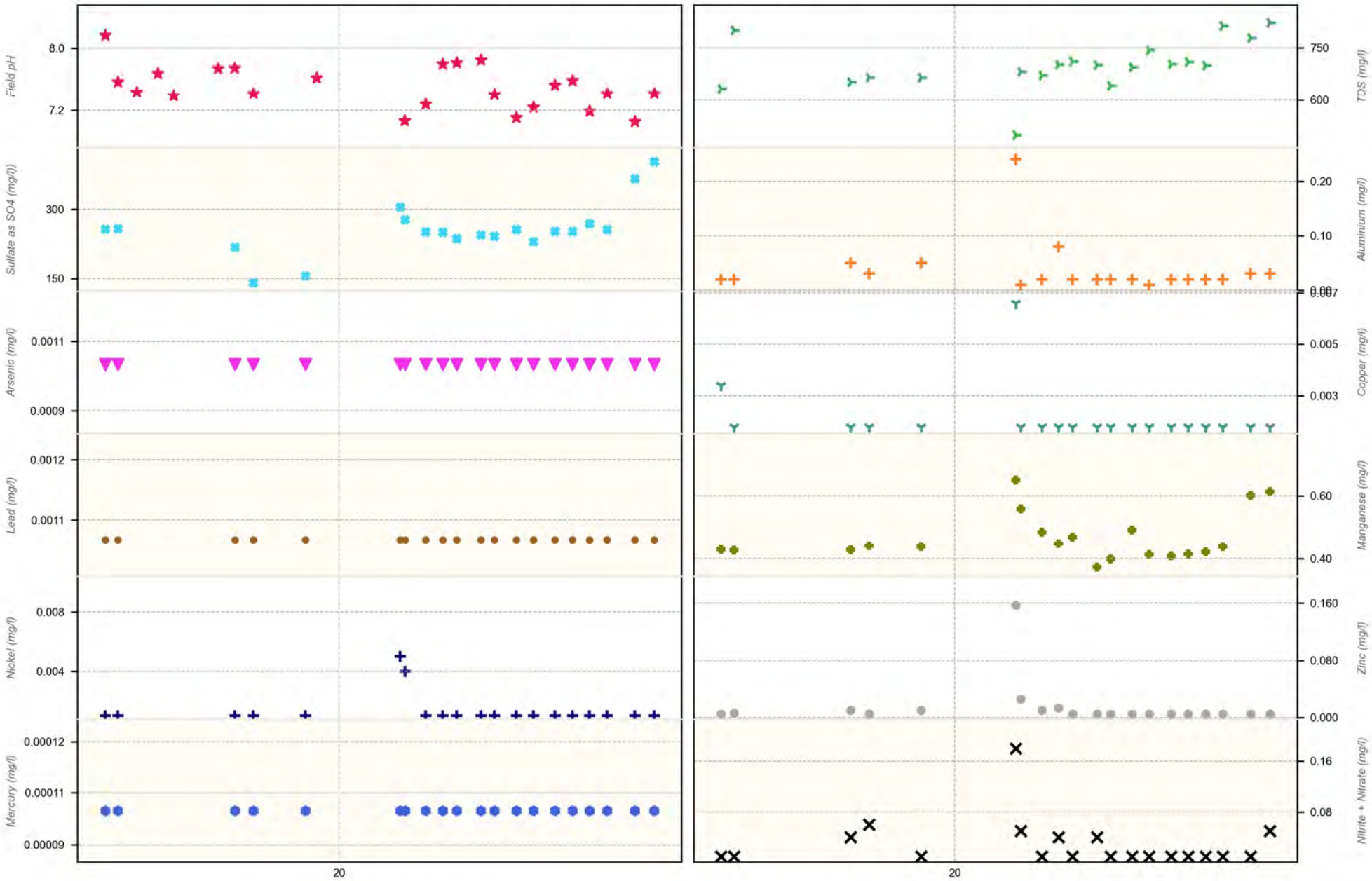
MB30 (Tertiary Basalt, Scrn: 4-76 m, CH Pit: 25.9 m)



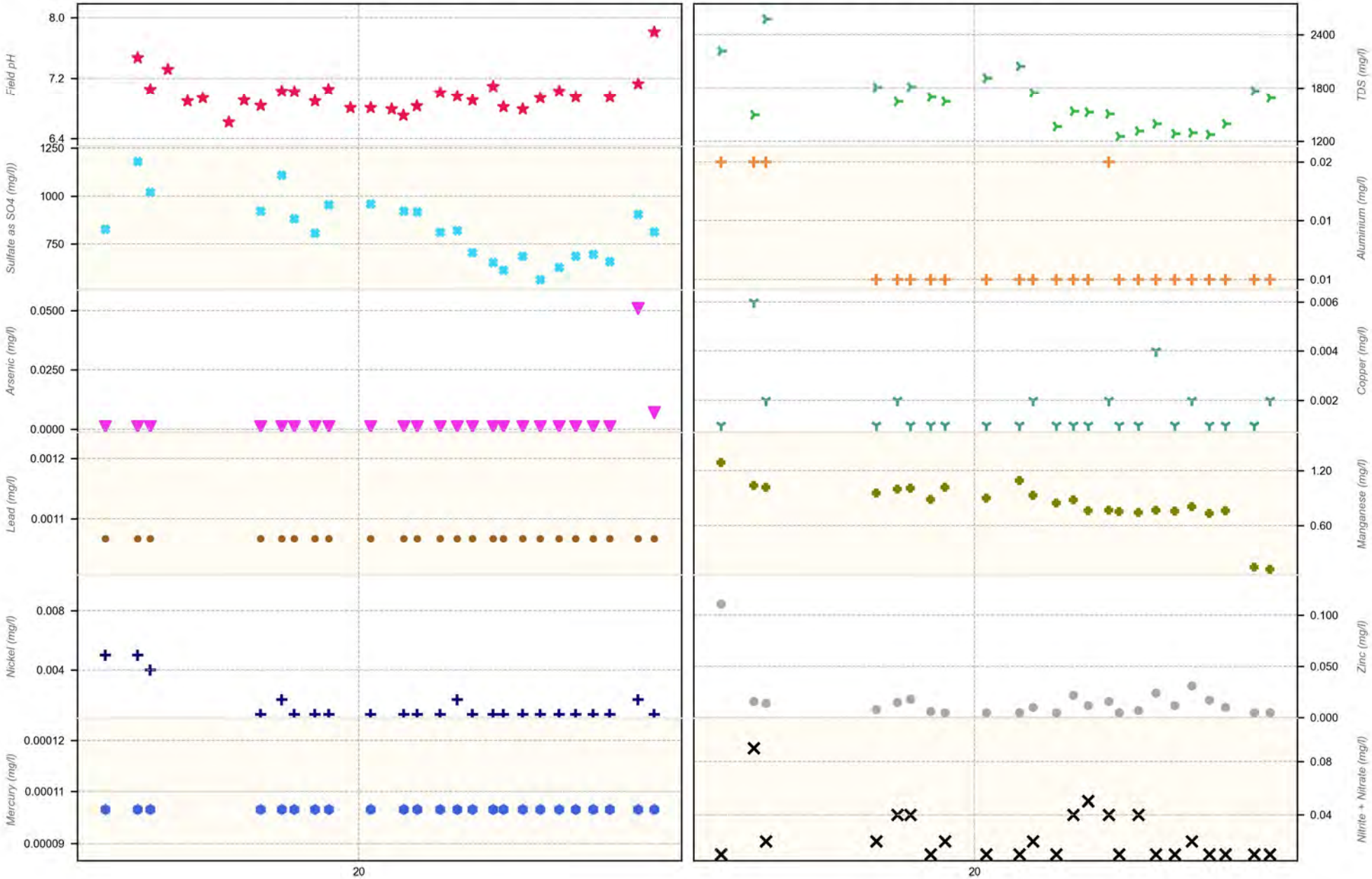
MB91 (Ordovician Volcanics, Scrn: 138-150 m, CH Pit: 127.0 m)



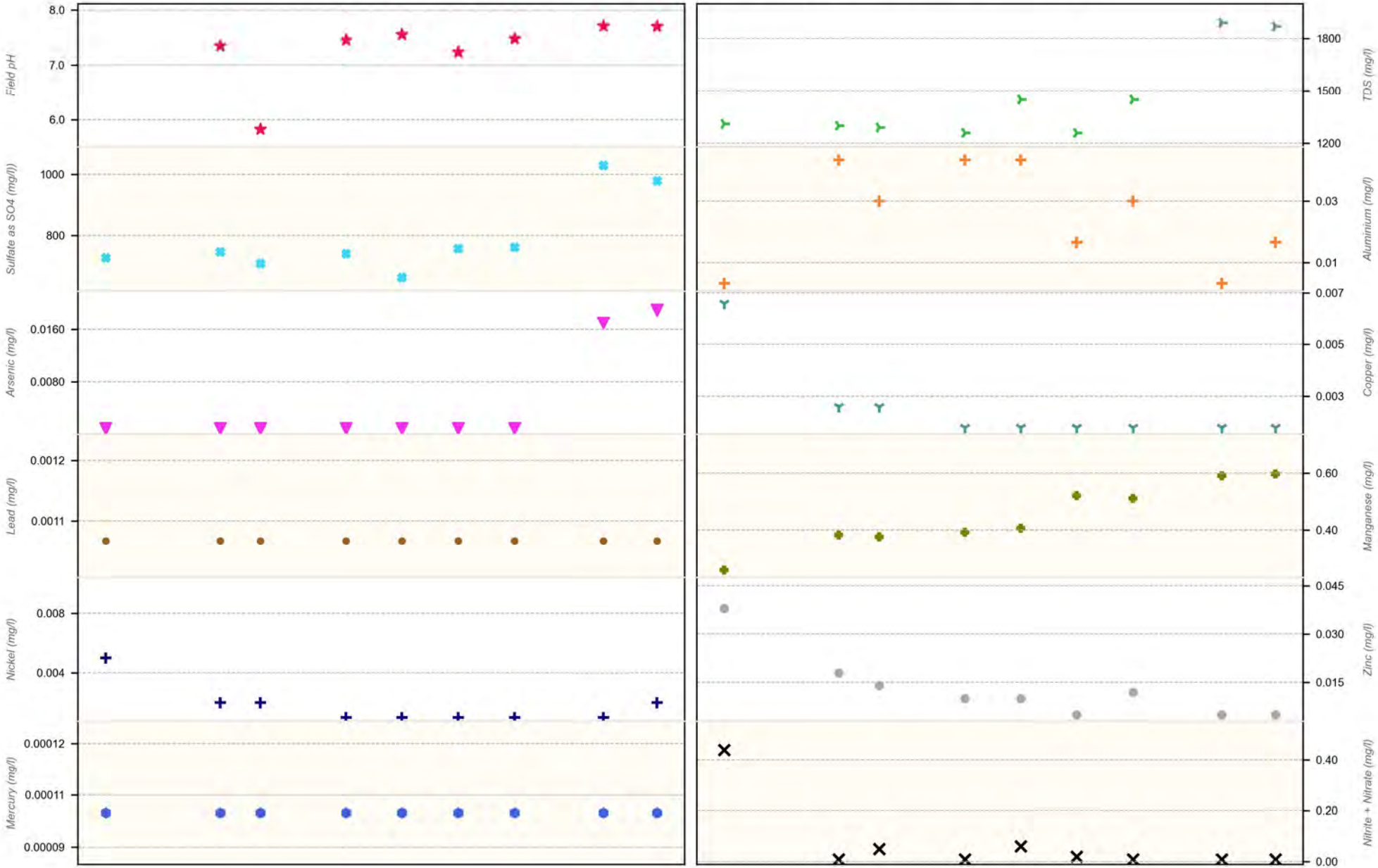
MB92 (Ordovician Volcanics, Scrn: 102-120 m, CH Pit: Within)



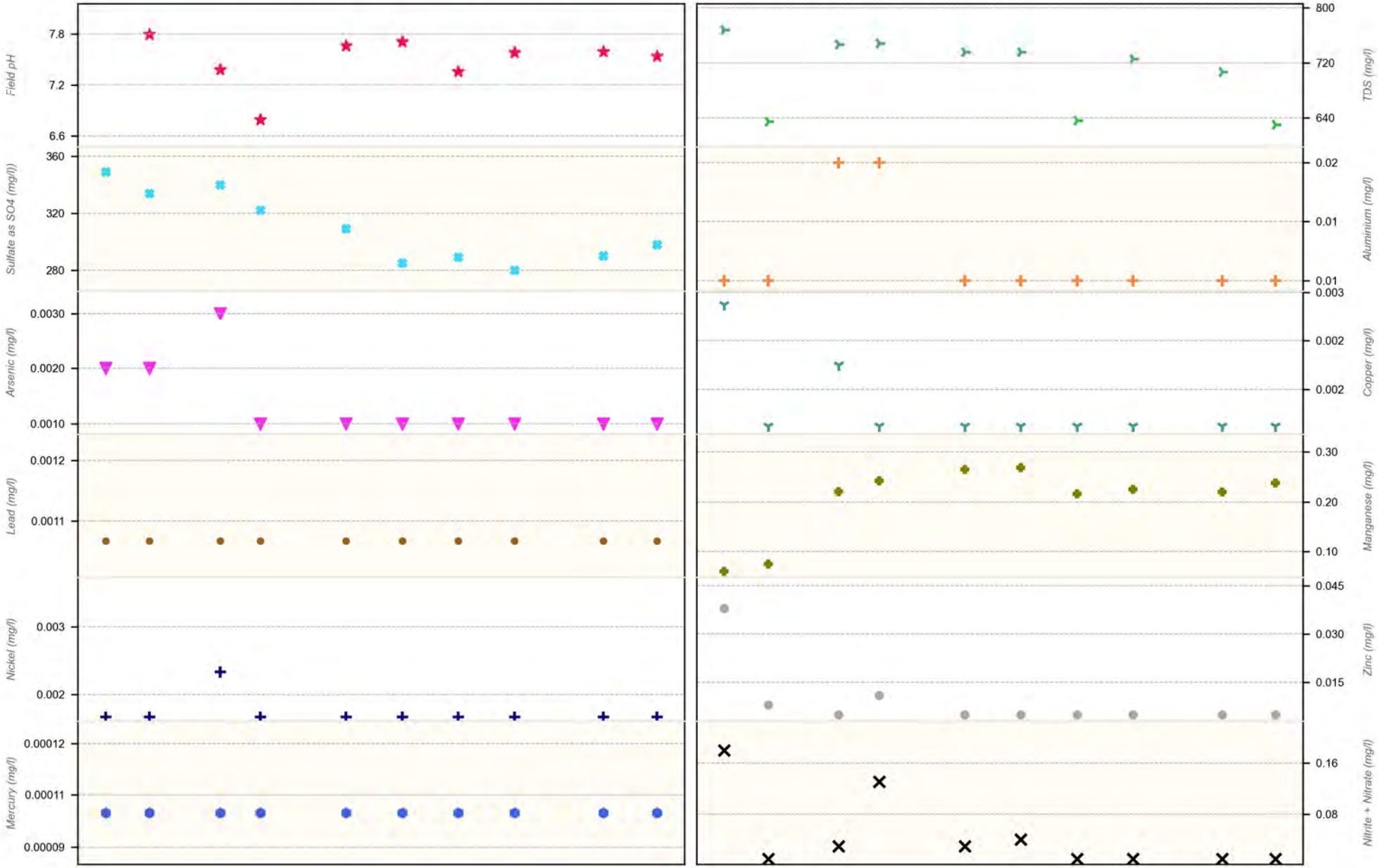
MB93 (Ordovician Volcanics, Scrn: 72-120 m, CH Pit: Within)



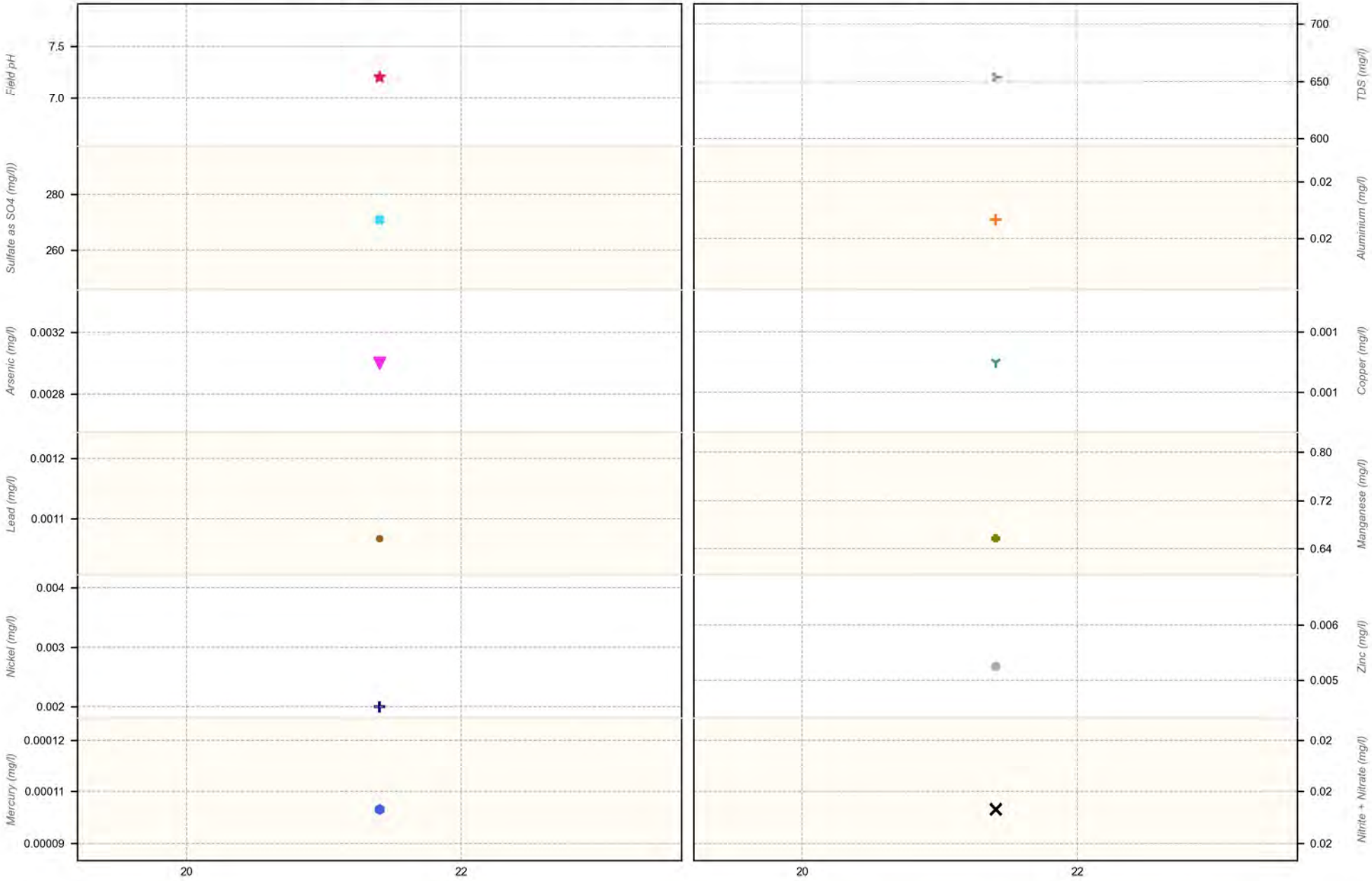
MB94 (No Aquifer formation data, Scrn: 114-140 m, CH Pit: Within)



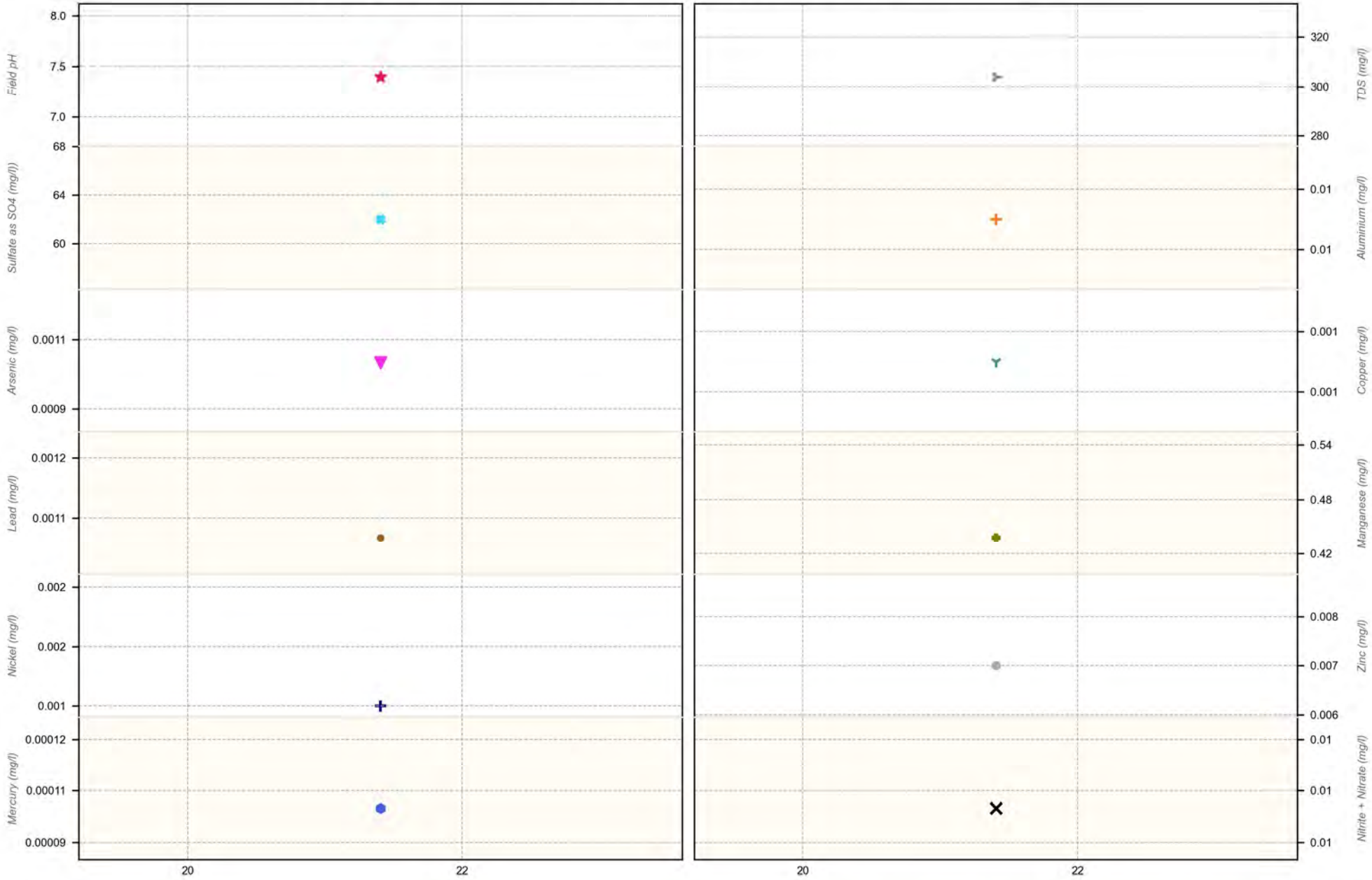
MB96 (No Aquifer formation data, Scrn: 80-110 m, CH Pit: Within)



MB97A (Ordovician Volcanics, Scrn: 48.4-60.4 m, CH Pit: 33.5 m)



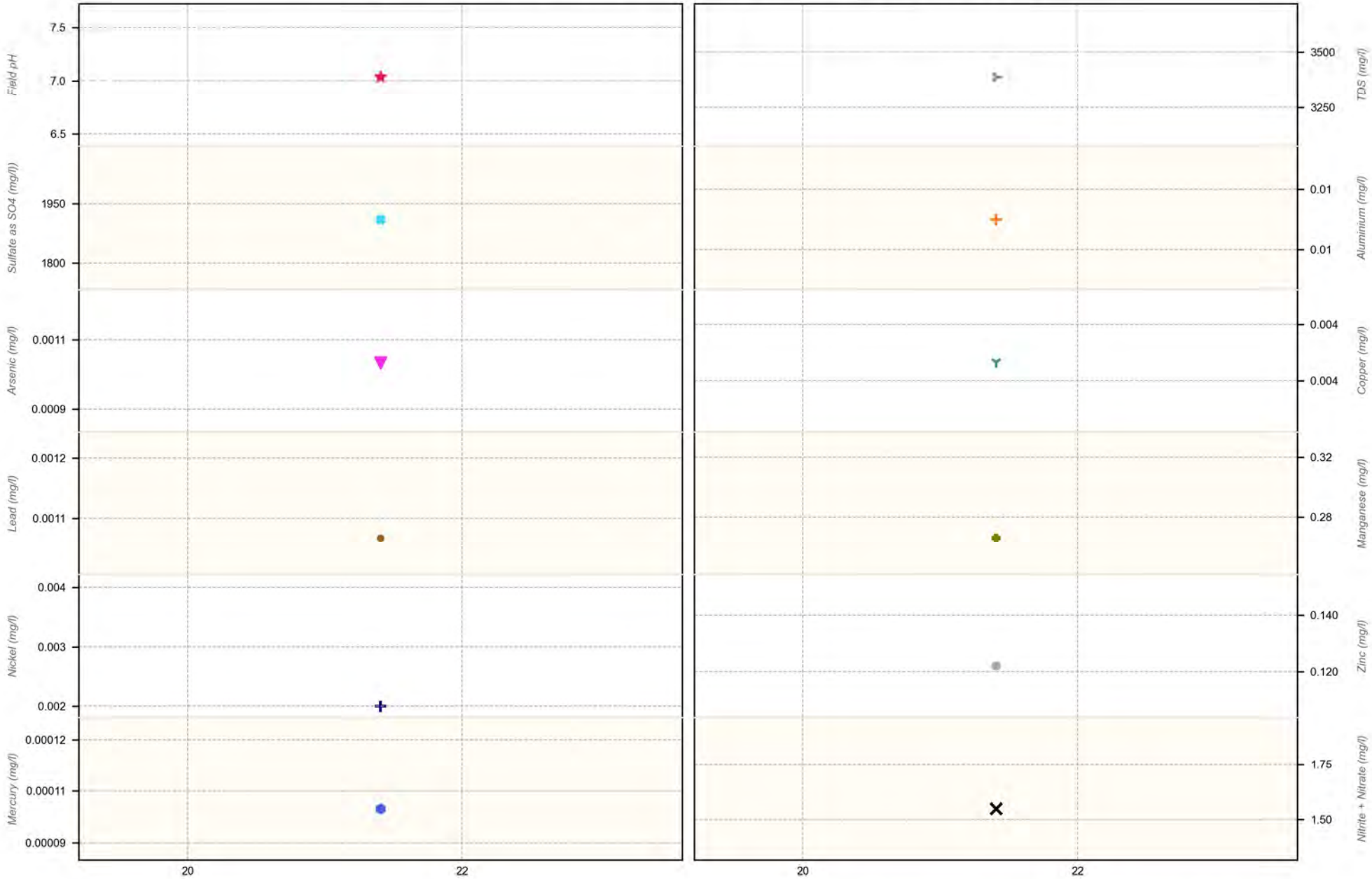
MB97B (Ordovician Volcanics, Scrn: 15.5-18.5 m, CH Pit: 38.3 m)



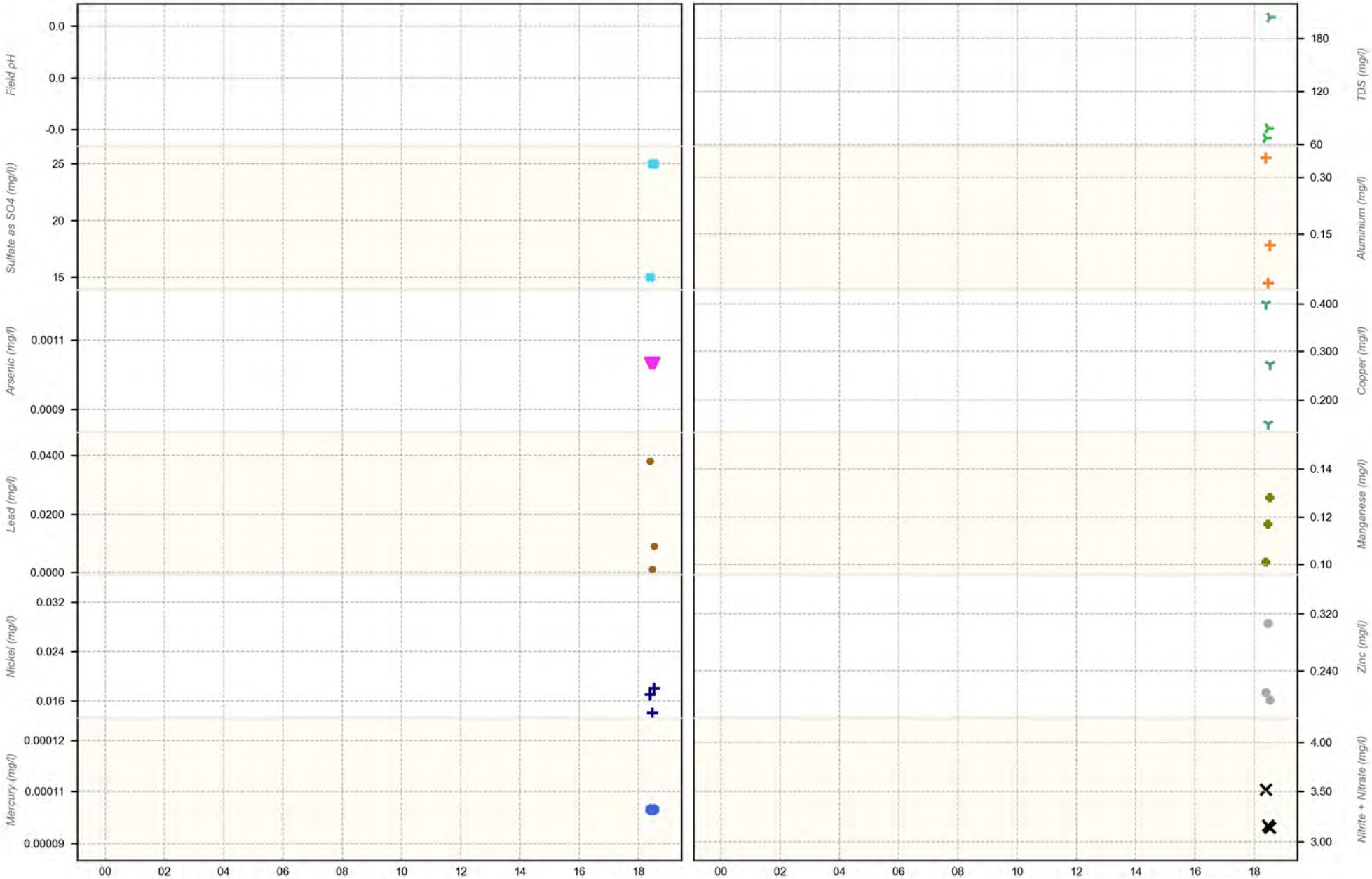
MB97C (Ordovician Volcanics, Scrn: 2.0-4.0 m, CH Pit: 38.3 m)

MB99A (Ordovician Volcanics, Scrn: 27-48 m, CH Pit: 206.2 m)

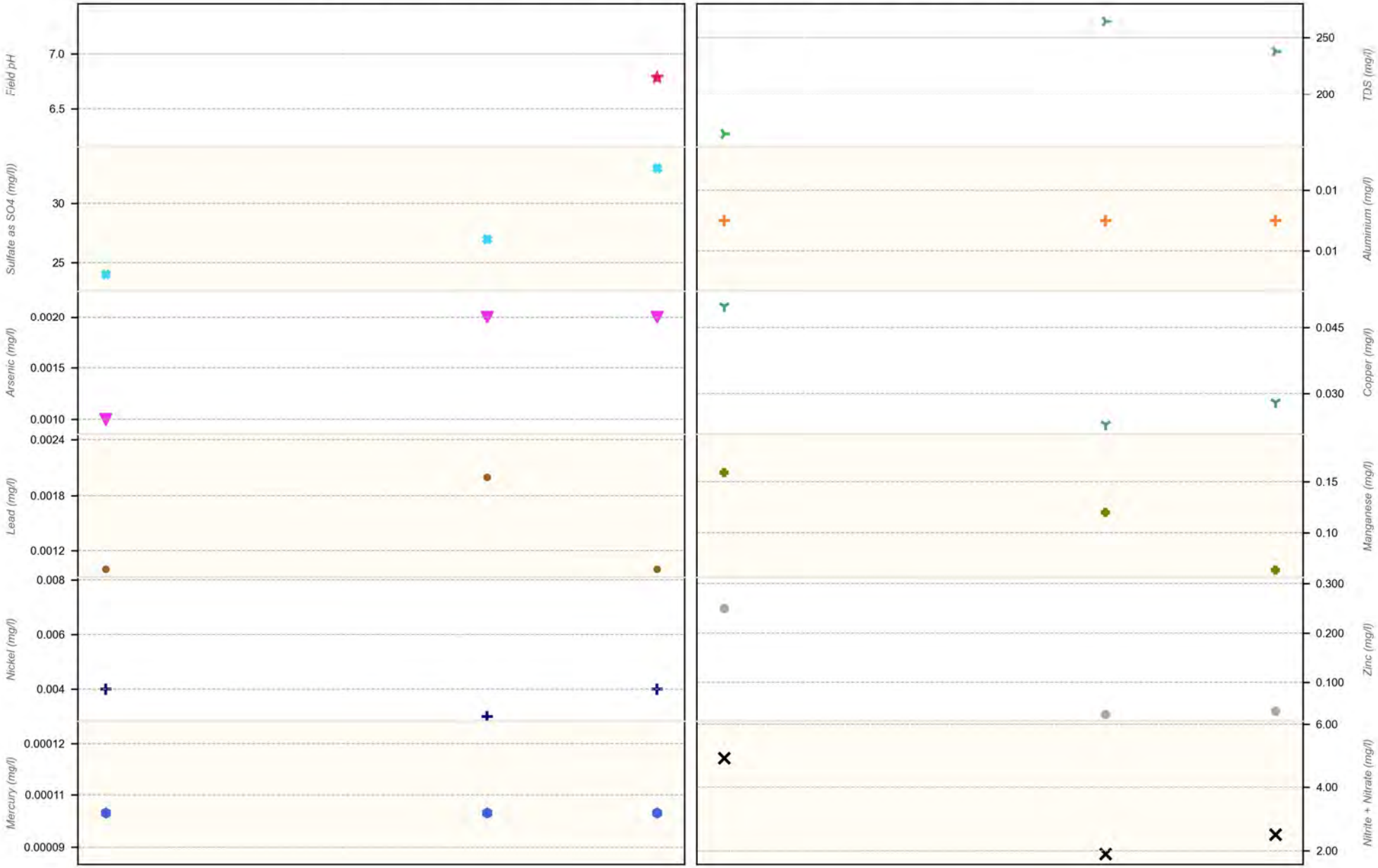
MB99B (Ordovician Volcanics, Scrn: 12.3-15.3 m, CH Pit: 215.5 m)



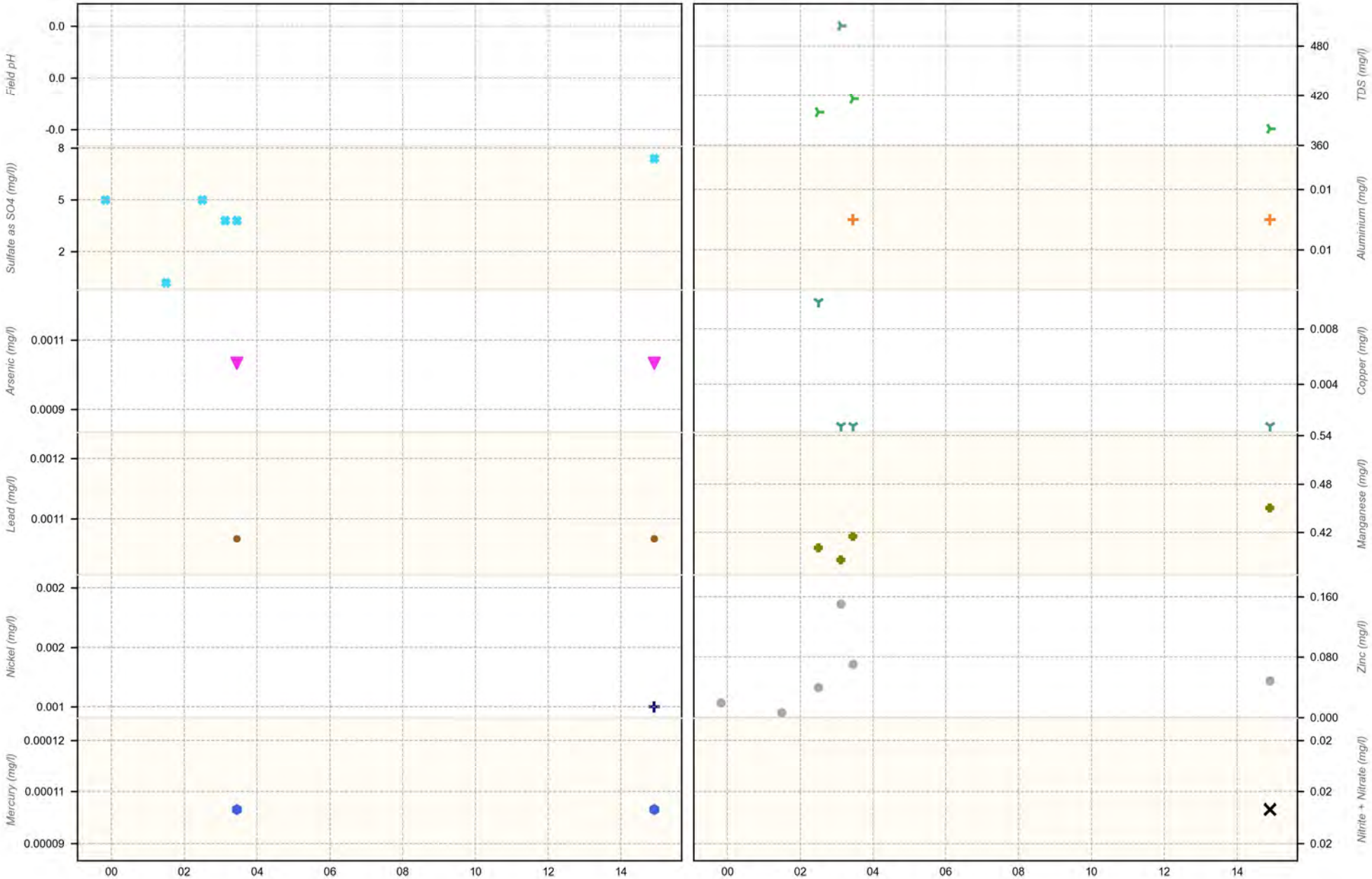
PZ4 (Ordovician Volcanics, Scrn: 36-45 m, CH Pit: Within)



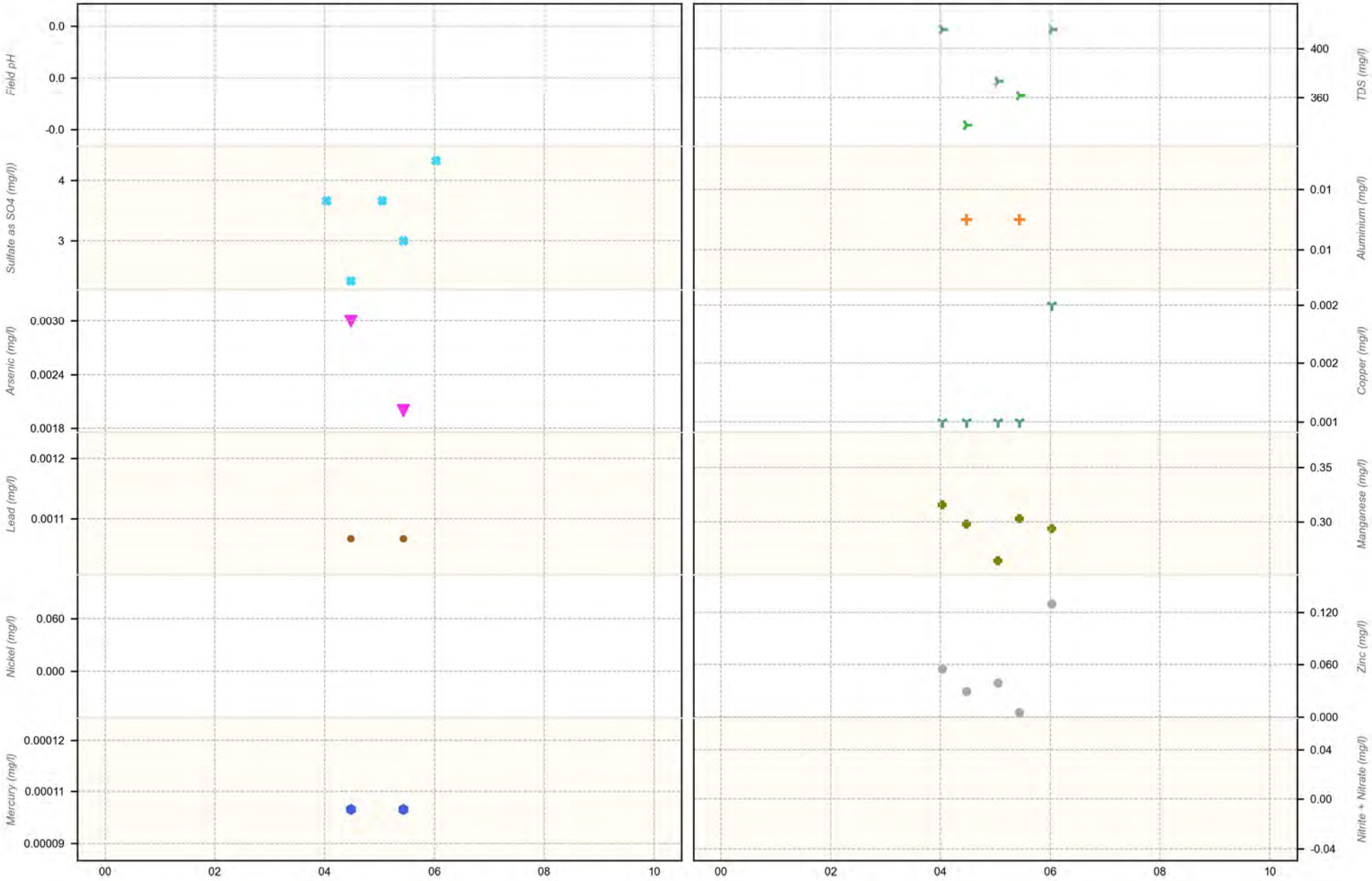
PZ5 (Ordovician Volcanics, Scrn: 83-95 m, CH Pit: Within)



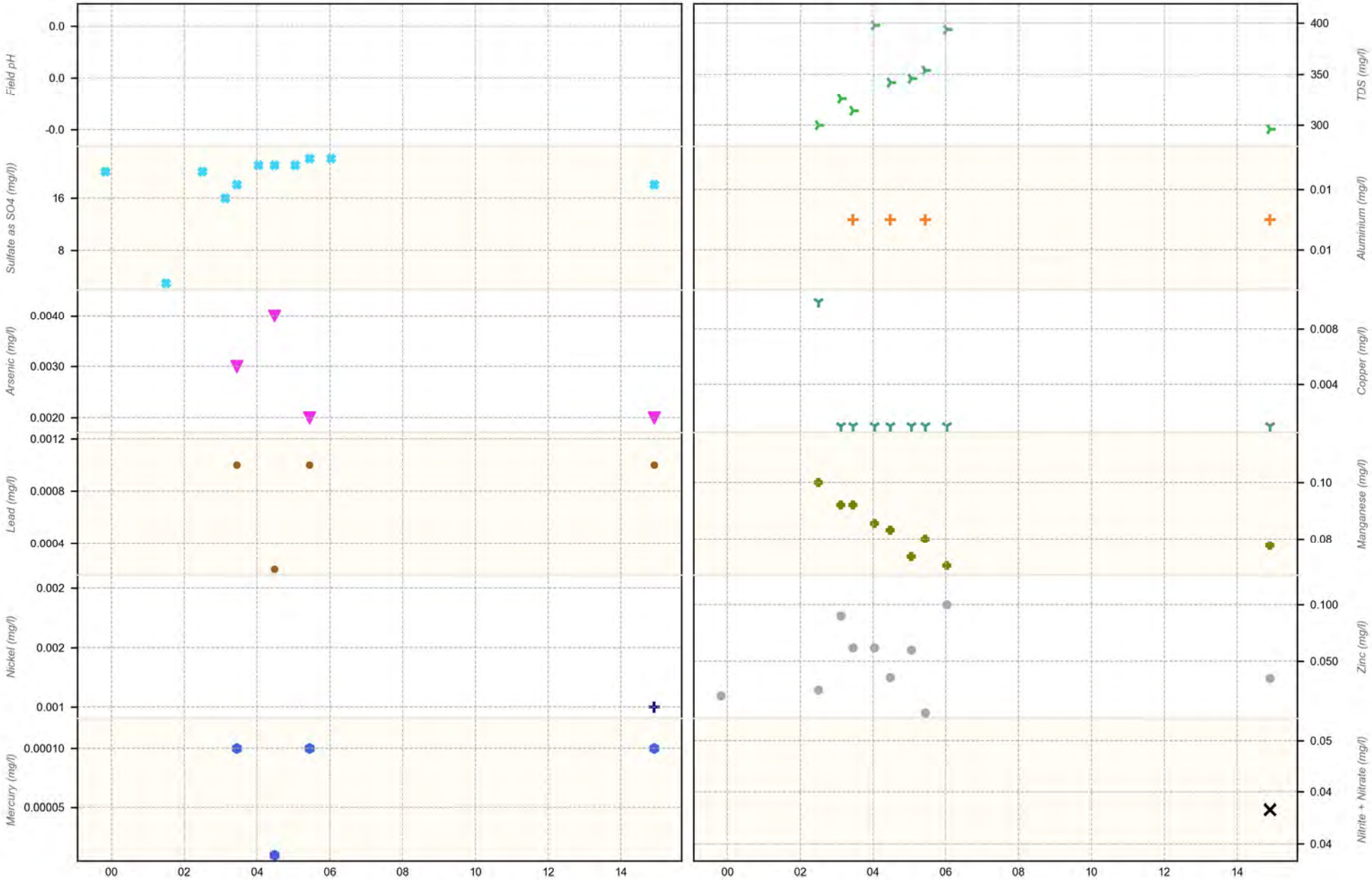
RO6A (Tertiary Basalt, Scrn: 31-37 m, RDGWY: 259.5 m)



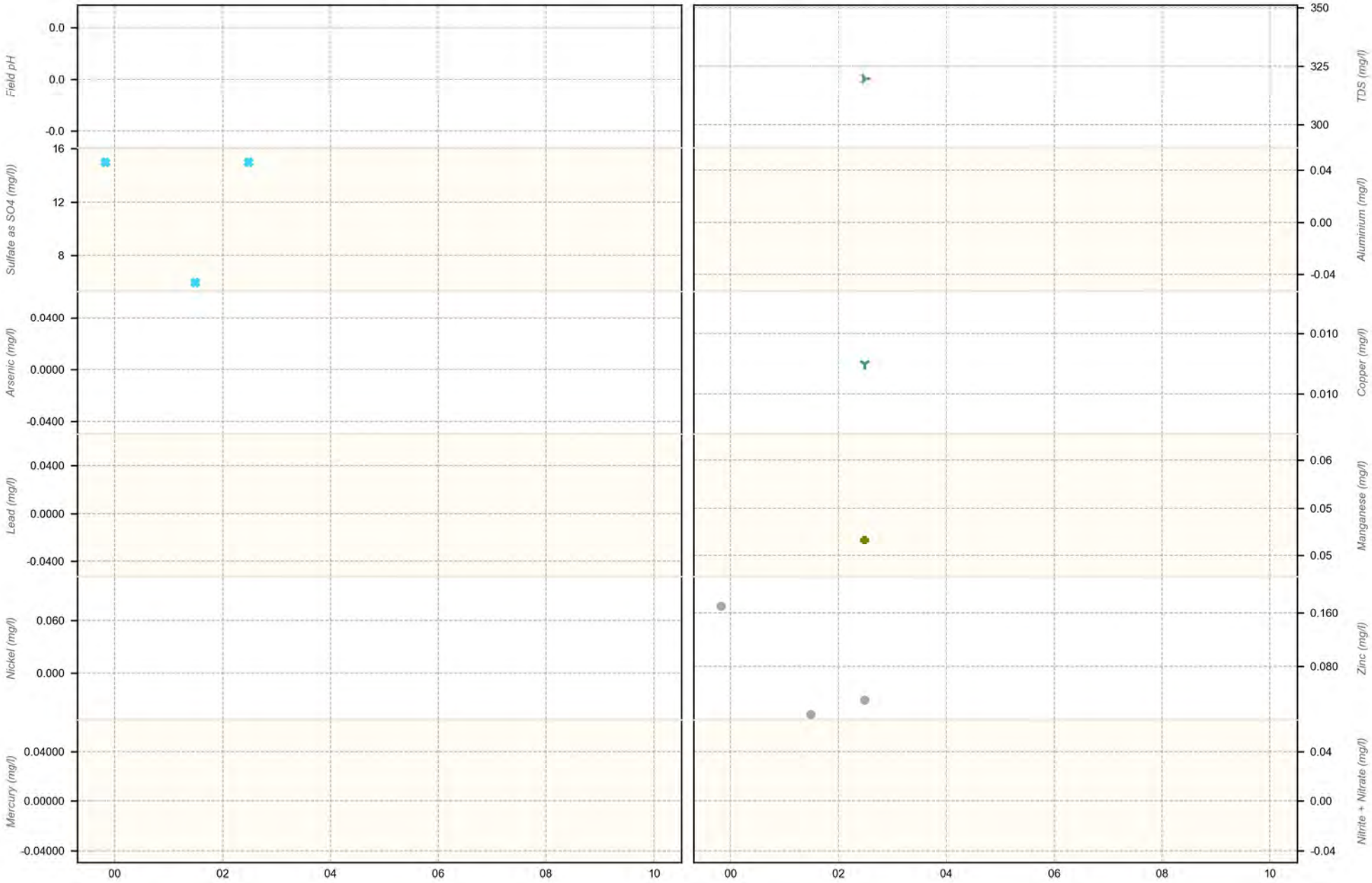
RO6B (Ordovician Volcanics, Scrn: 52-136 m, RDGWY: 260.4 m)



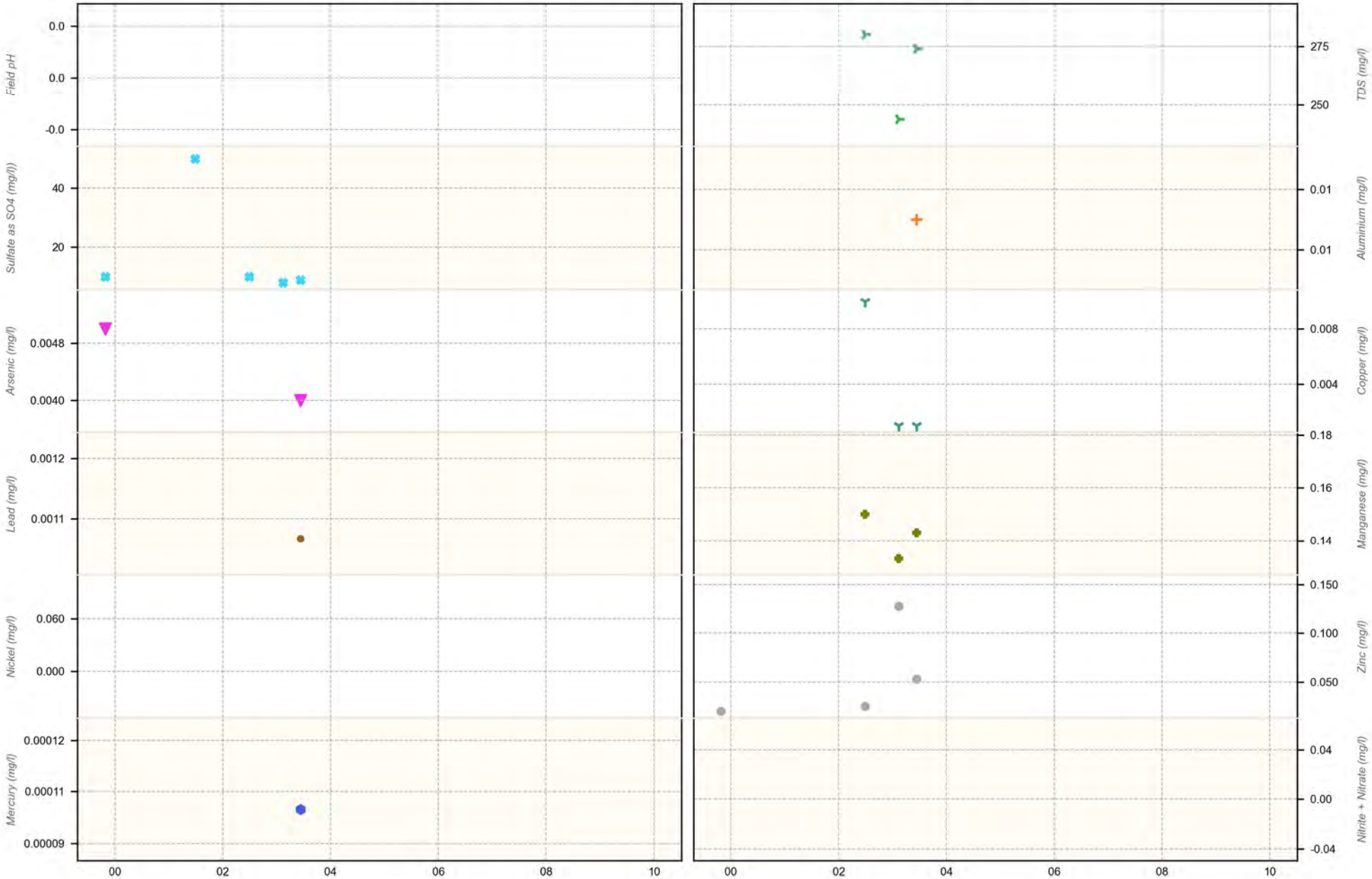
RO7 (Tertiary Basalt, Scrn: 50-62 m, RDGWY: 531.4 m)



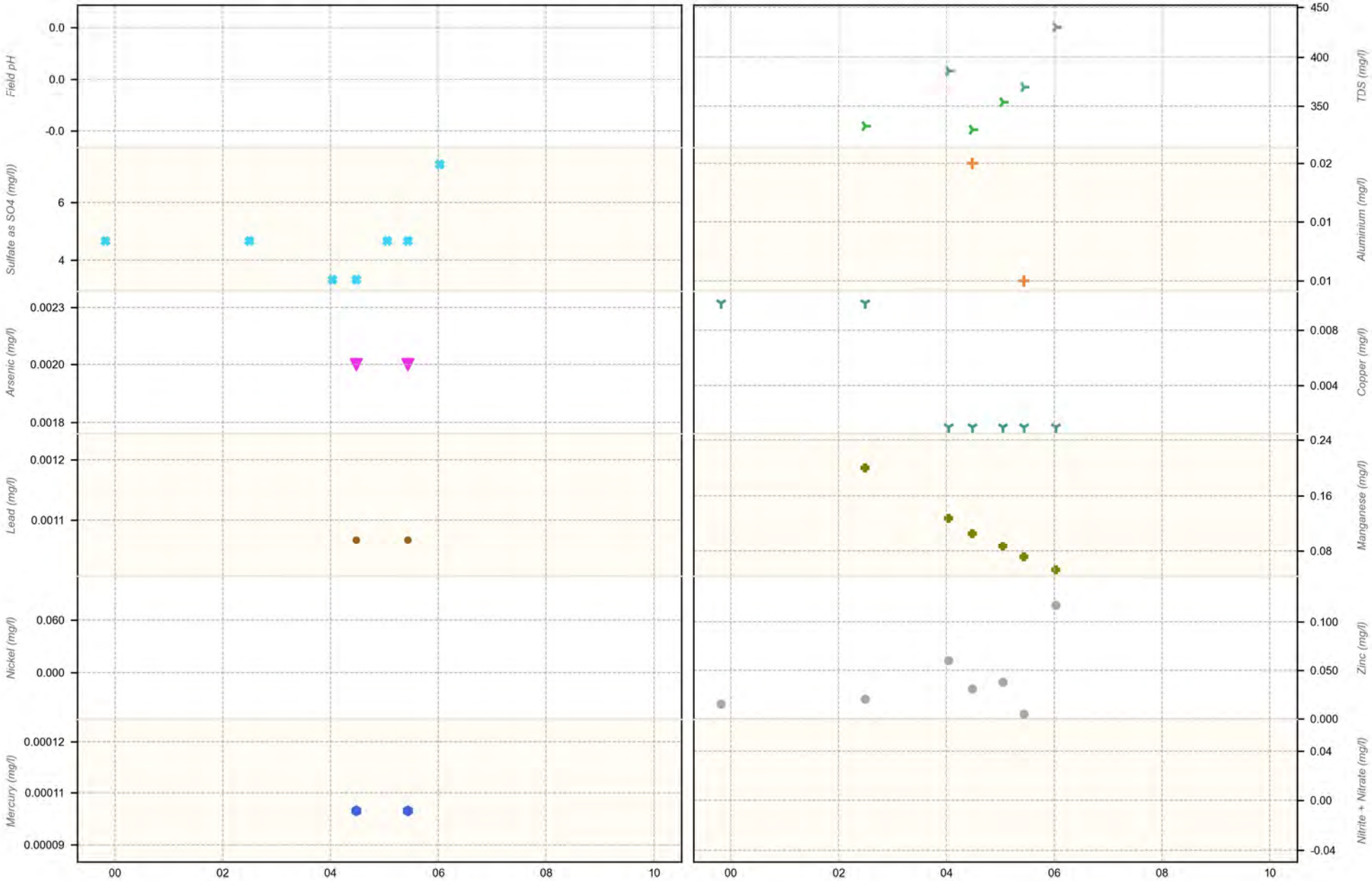
RO8 (Tertiary Basalt, Scrn: 11.5-17.5 m, RDGWY: 281.4 m)



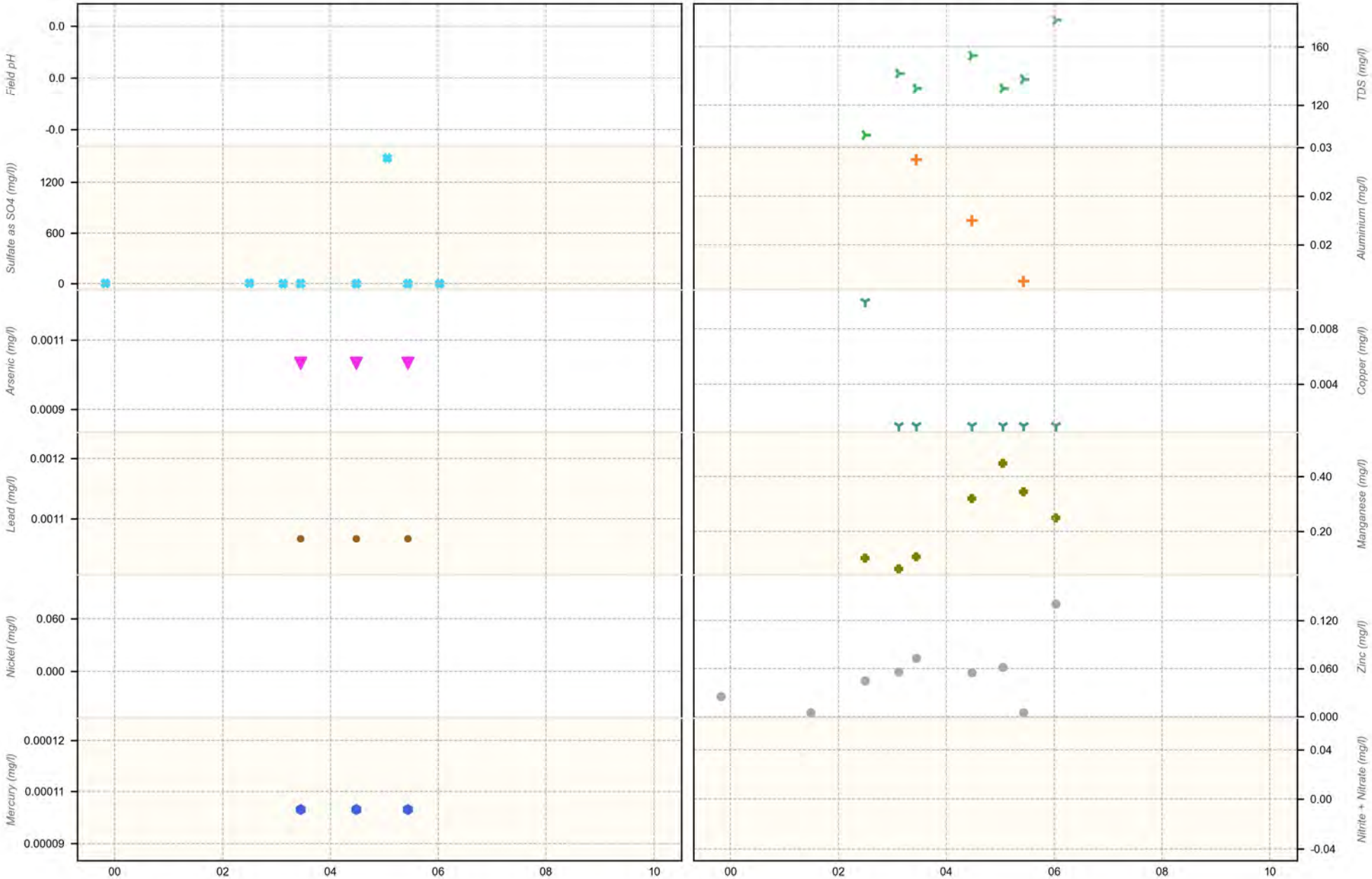
RO10A (Tertiary Basalt, Scrn: 39-44 m, RDGWY: 1018.8 m)



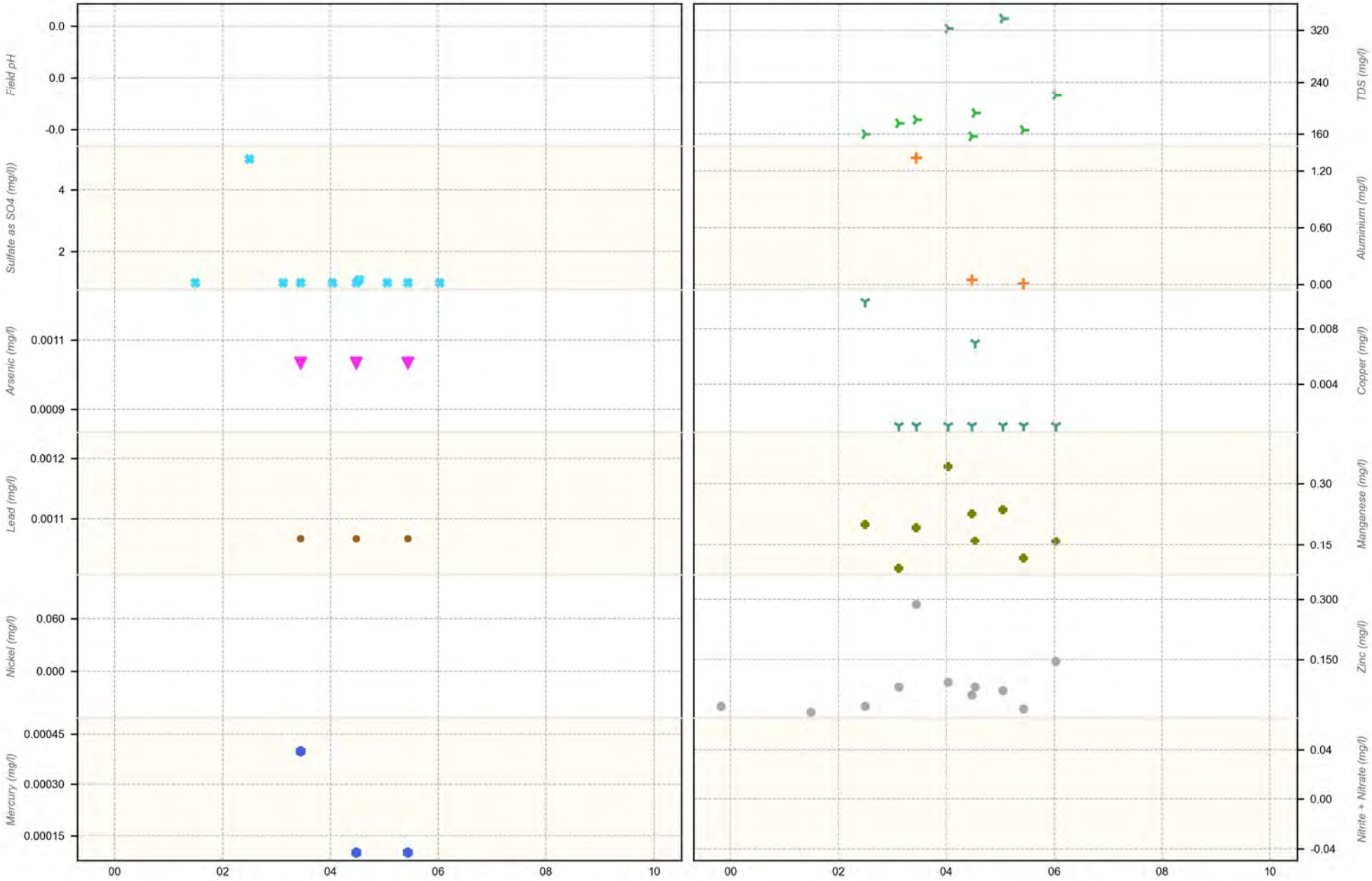
RO10B (Ordovician Volcanics, Scrn: 89-136 m, RDGWY: 1029.2 m)



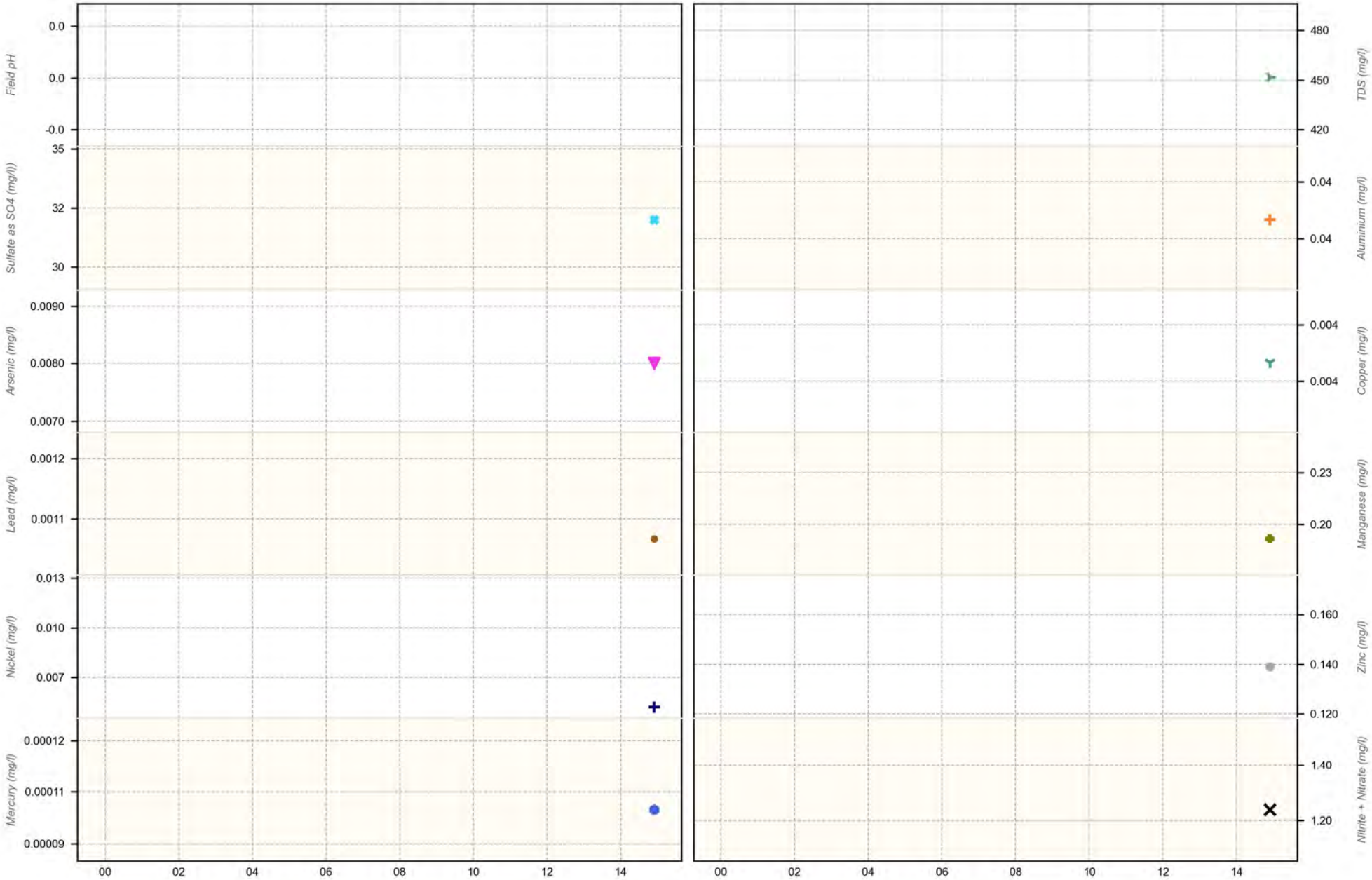
RO11 (Tertiary Basalt, Scrn: 24-36 m, RDGWY: 846.8 m)



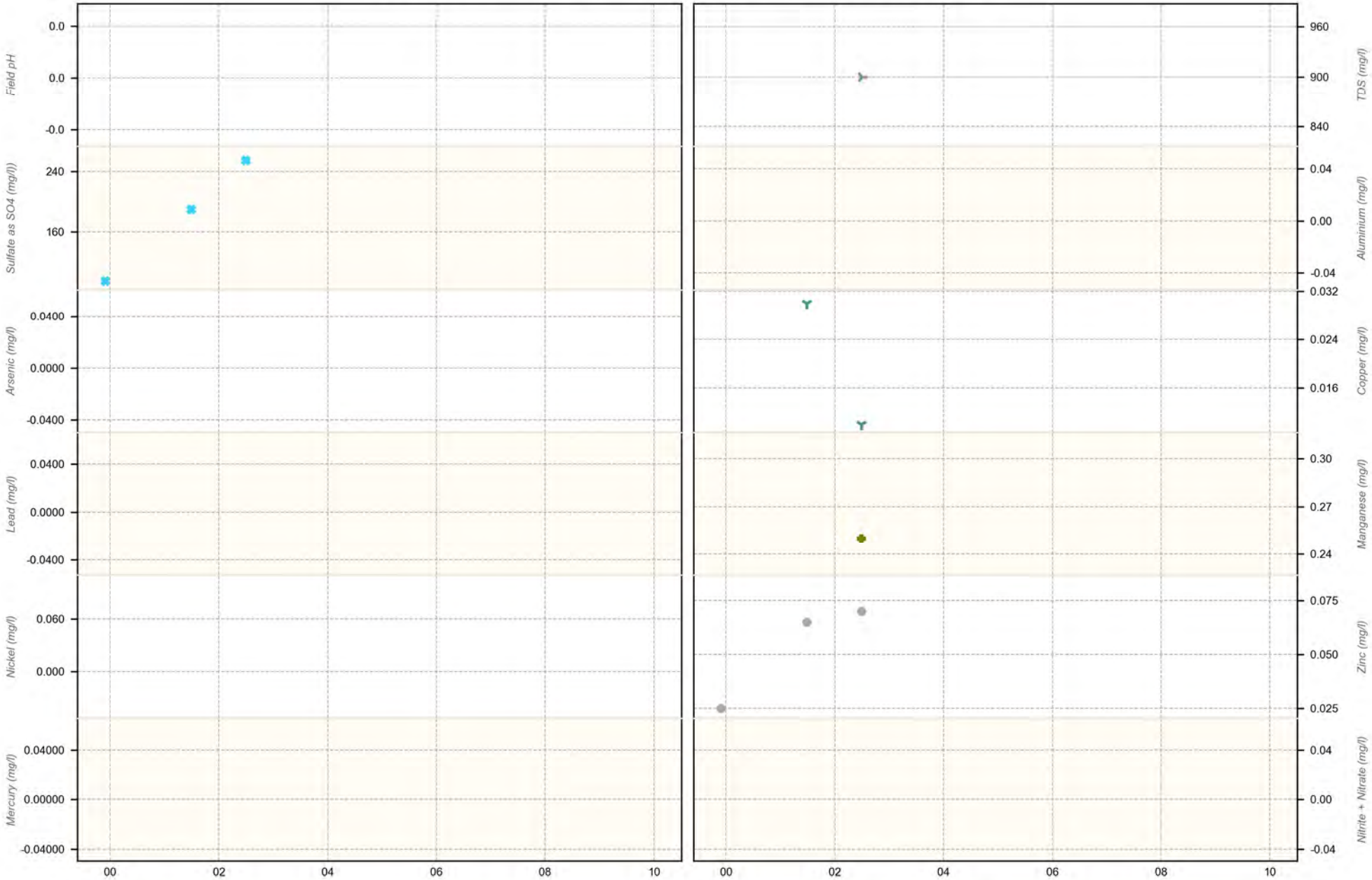
RO12 (Tertiary Basalt, Scrn: 25.4-31.4 m, RDGWY: 881.7 m)



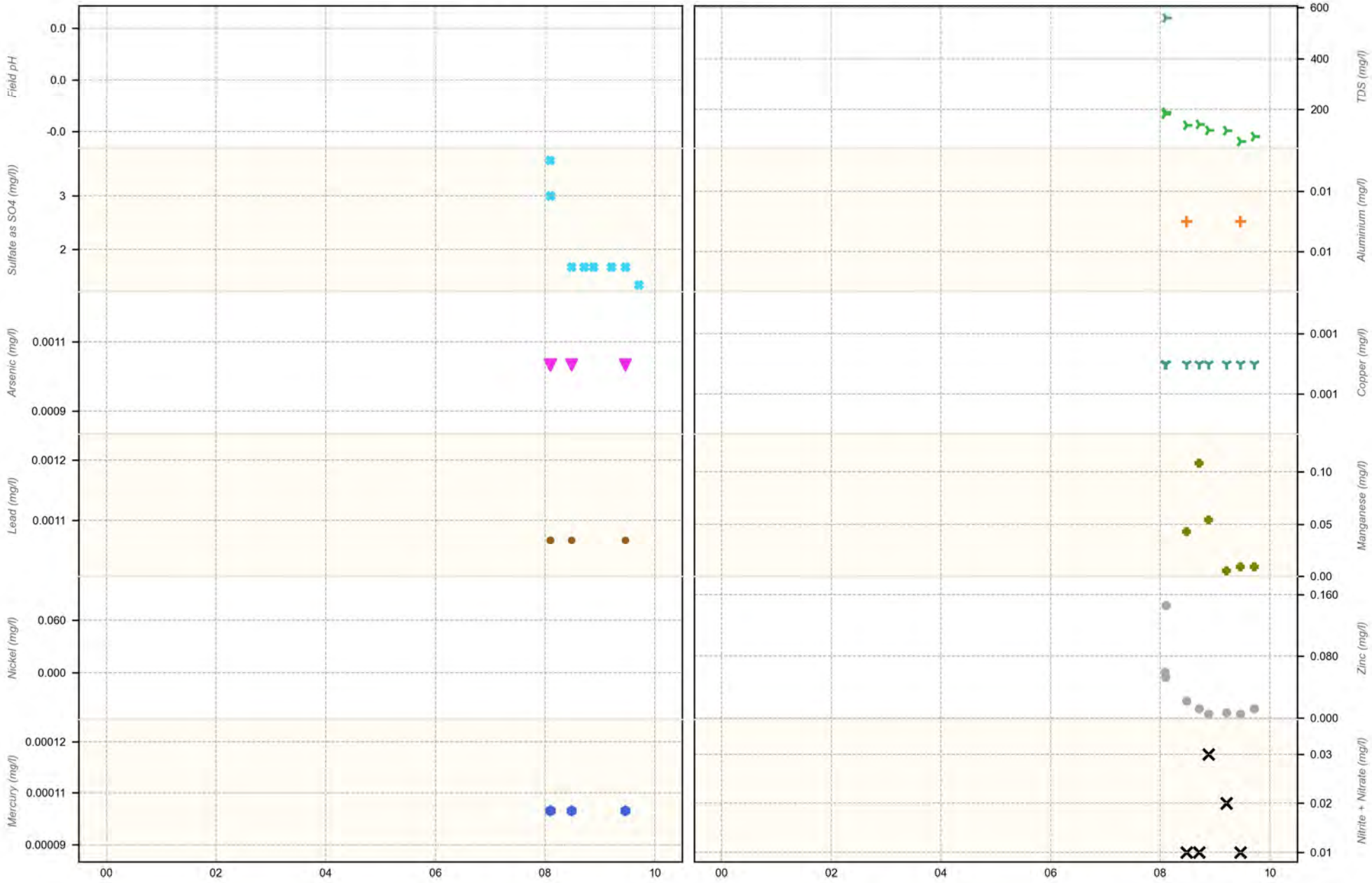
RS11 (Soil/Clay, Scrn: 9.0-10.5 m, RDGWY: 816.4 m)



RS12 (Soil/Clay, Scrn: 5.0-8.0 m, RDGWY: 843.8 m)

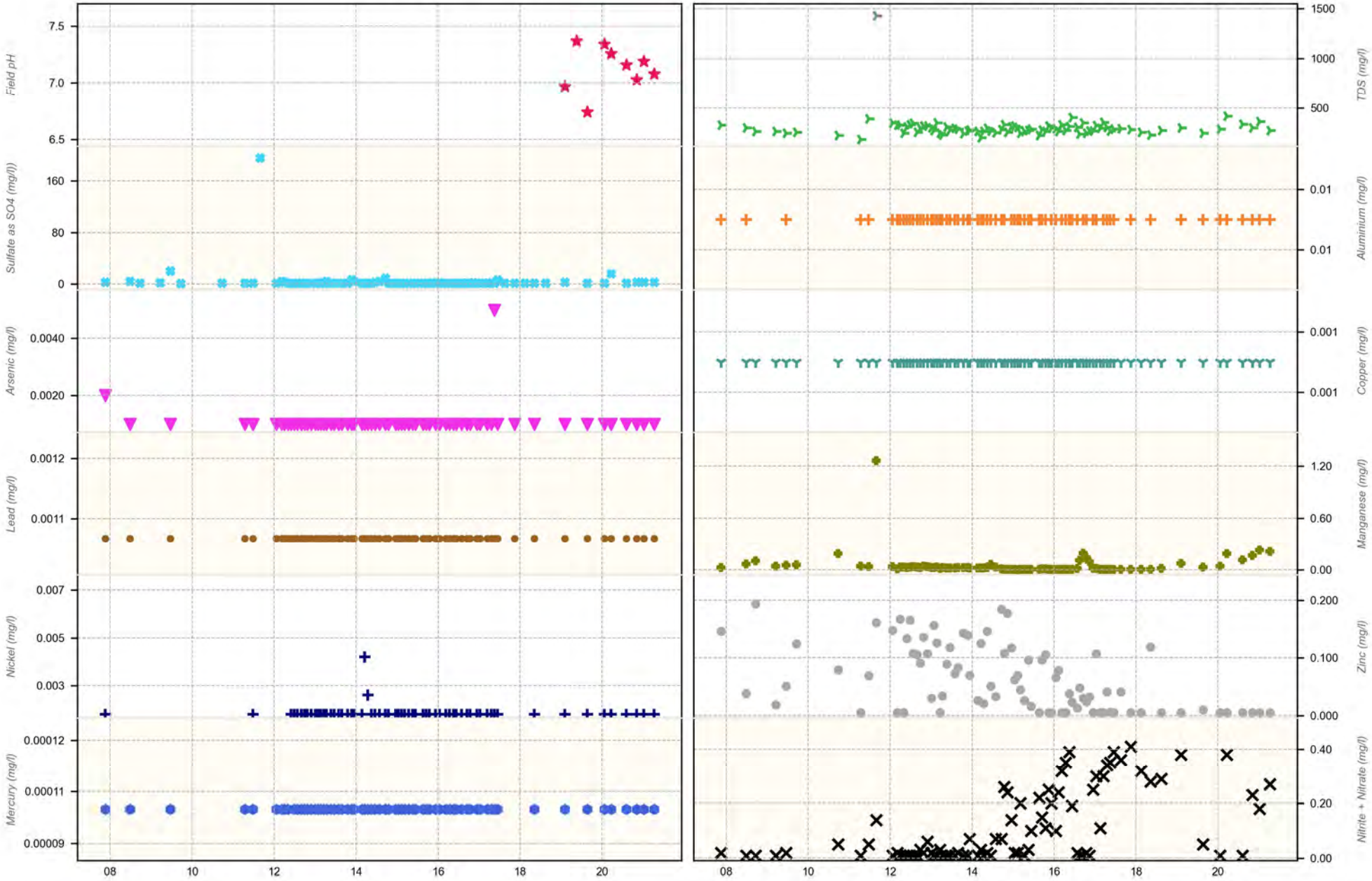


MB43 (Silurian Sediments, Scrn: 75-175 m, CE2020: 612.6 m)

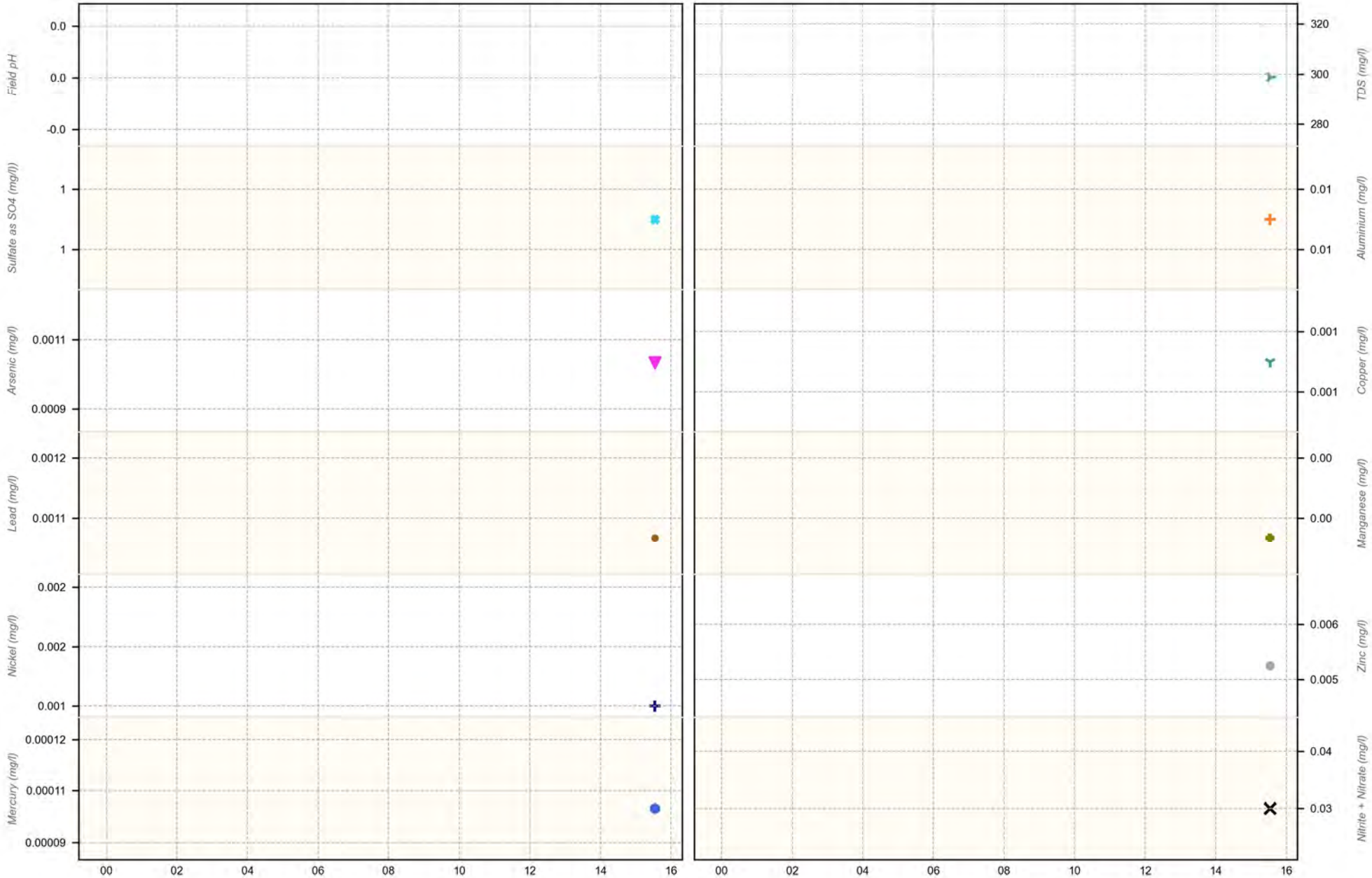


MB44A (Silurian Sediments, Scrn: 82-142 m, CE2020: 612.5 m)

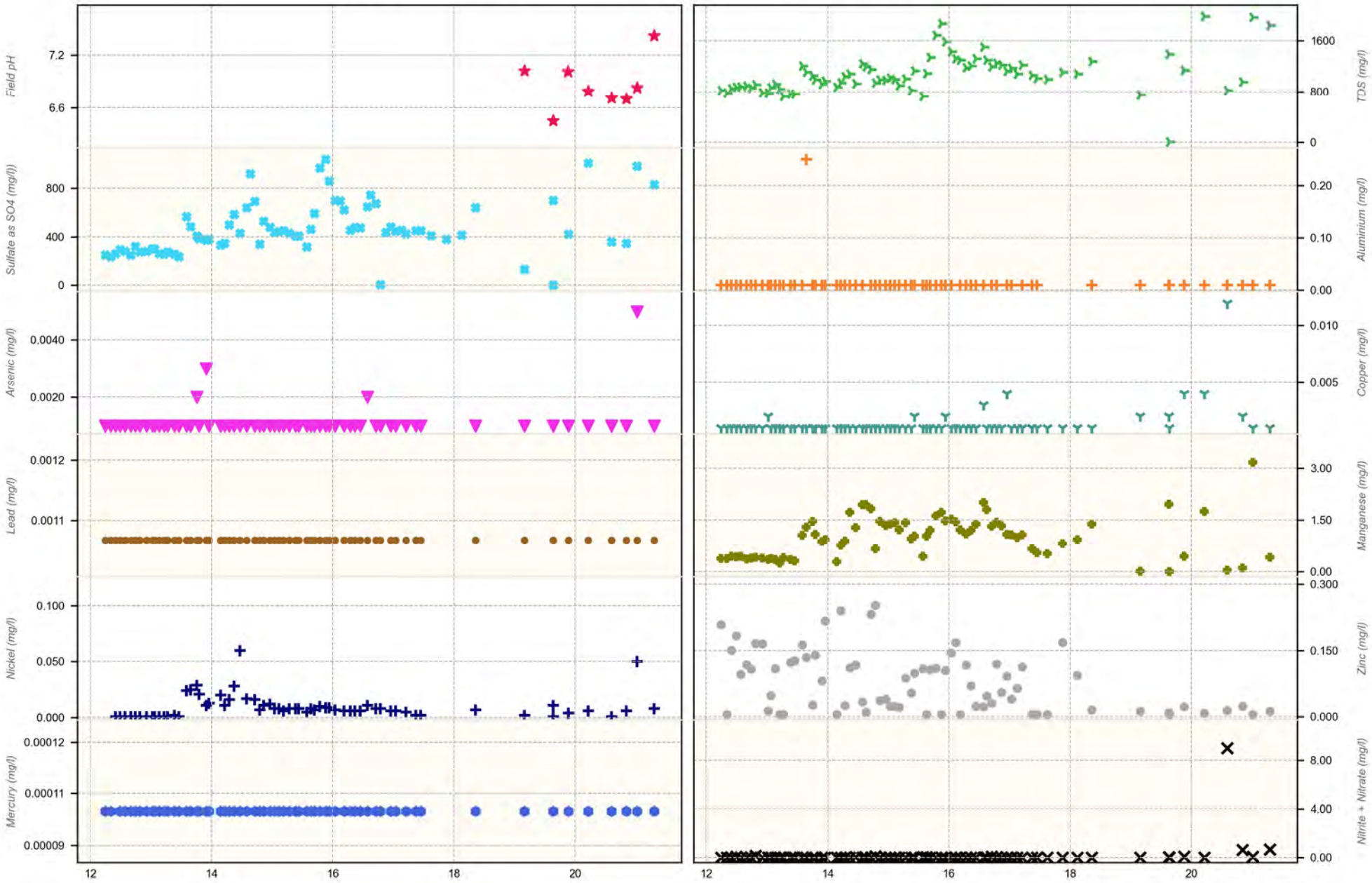
MB47A (Silurian Sediments, Scrn: 152-182 m, NoSites)



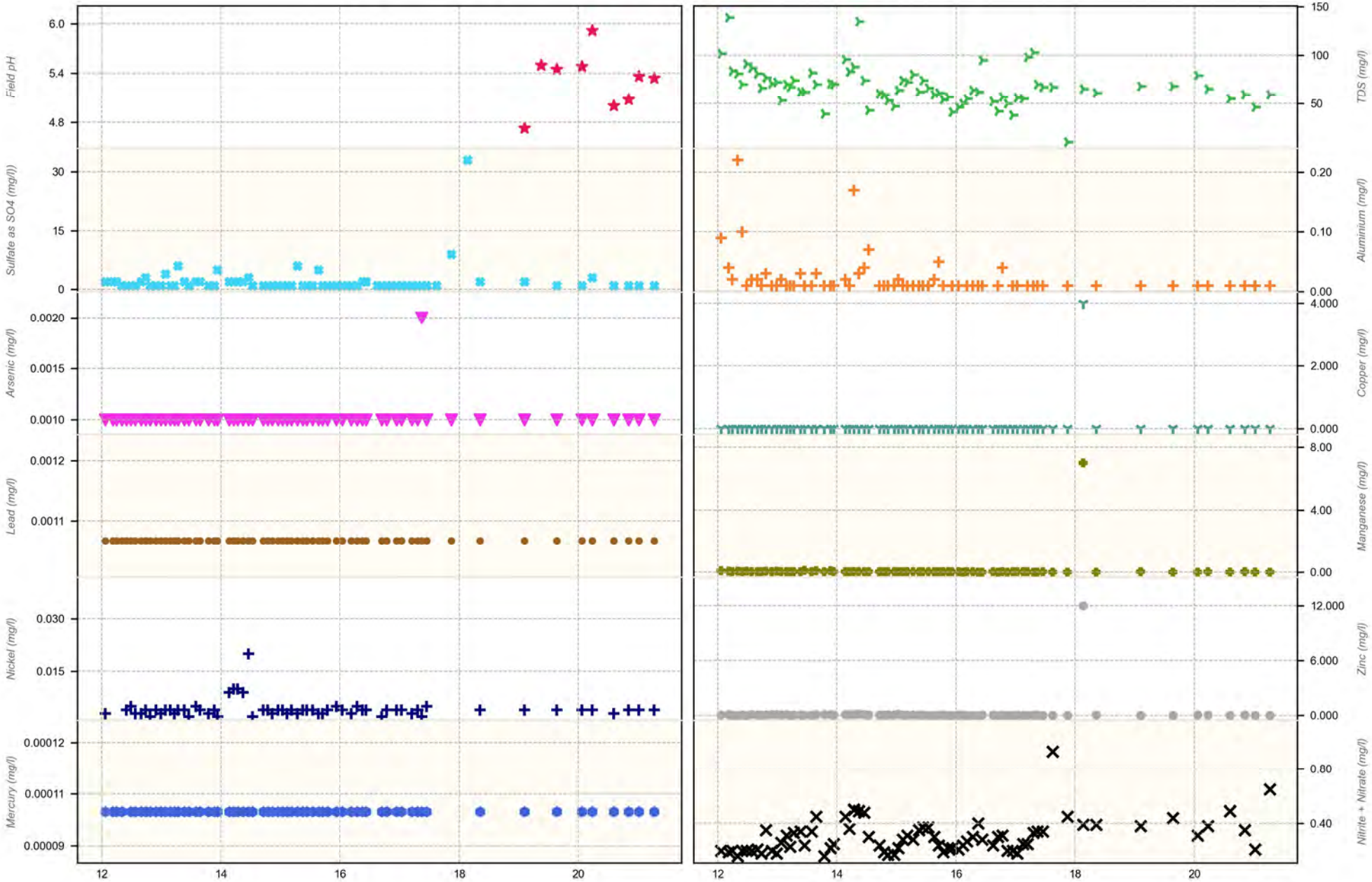
MB47B (Silurian Sediments, Scrn: 40-72 m, NoSites)



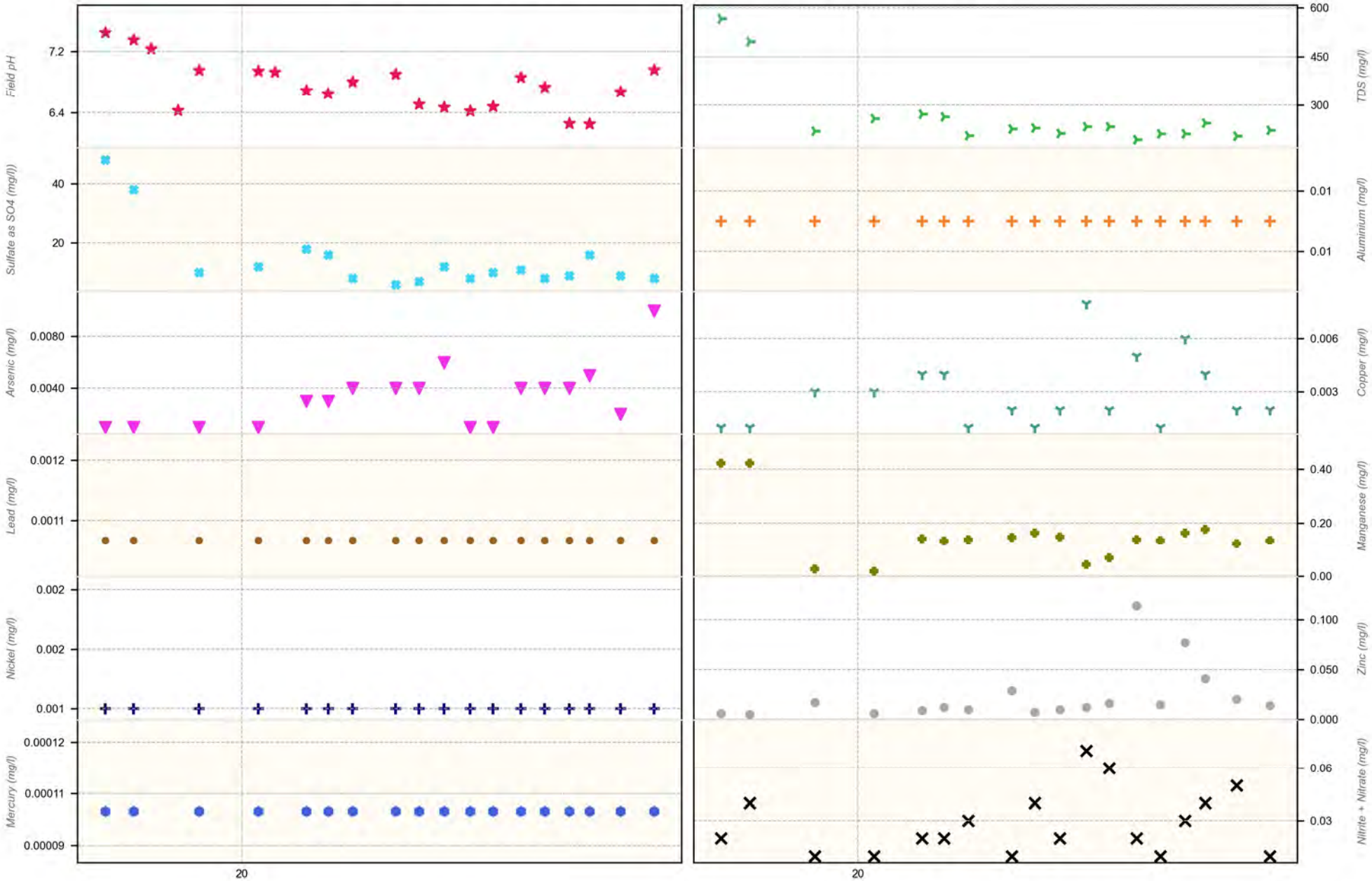
MB51 (Silurian Sediments, Scrn: 42-54 m, CE2020: 29.2 m)



MB62 (Silurian Sediments, Scrn: 39-63 m, CE2020: 1724.8 m)

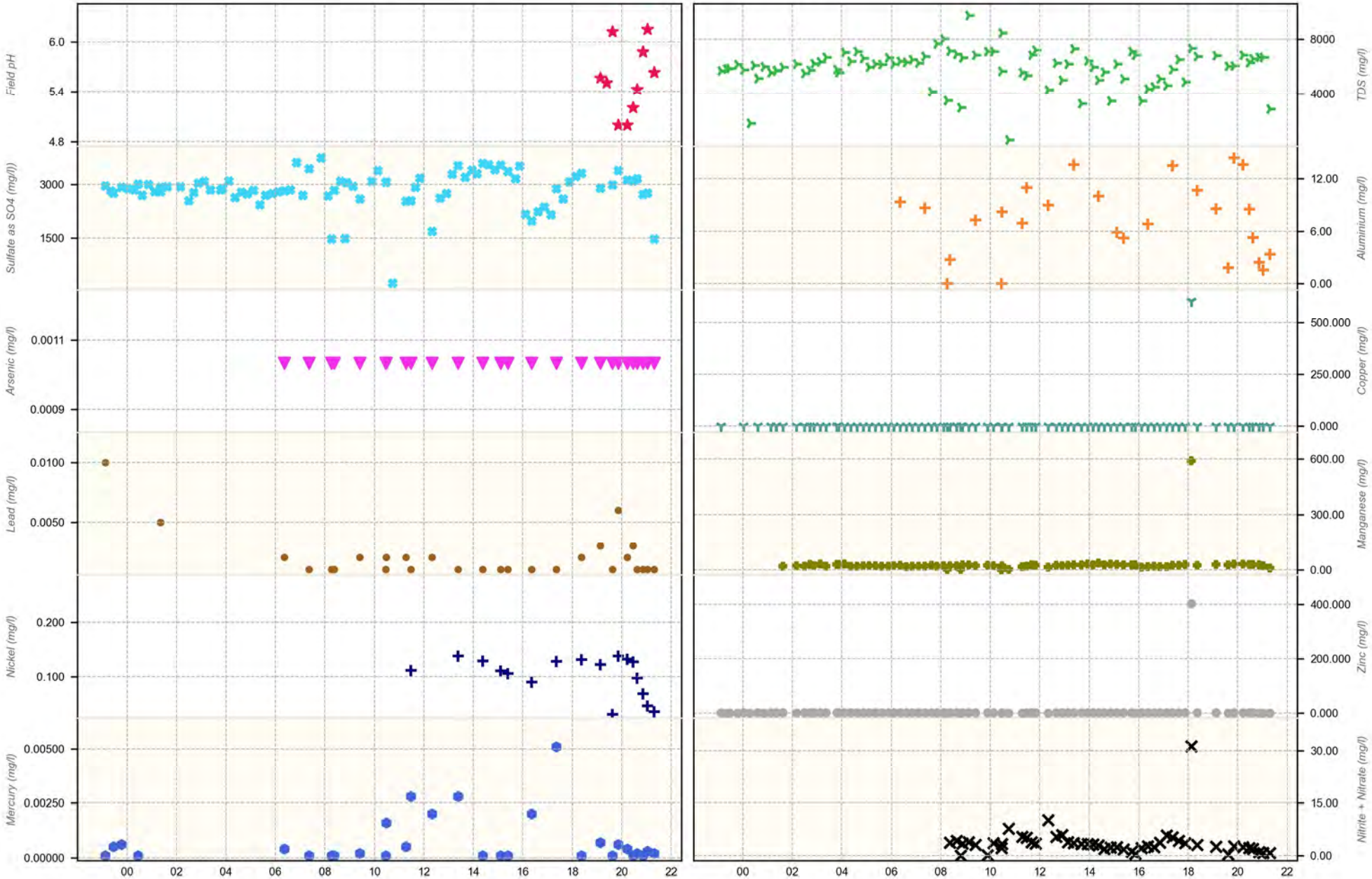


MB88 (Tertiary Basalt, Scrn: 78-90 m, CE2020: 282.8 m)

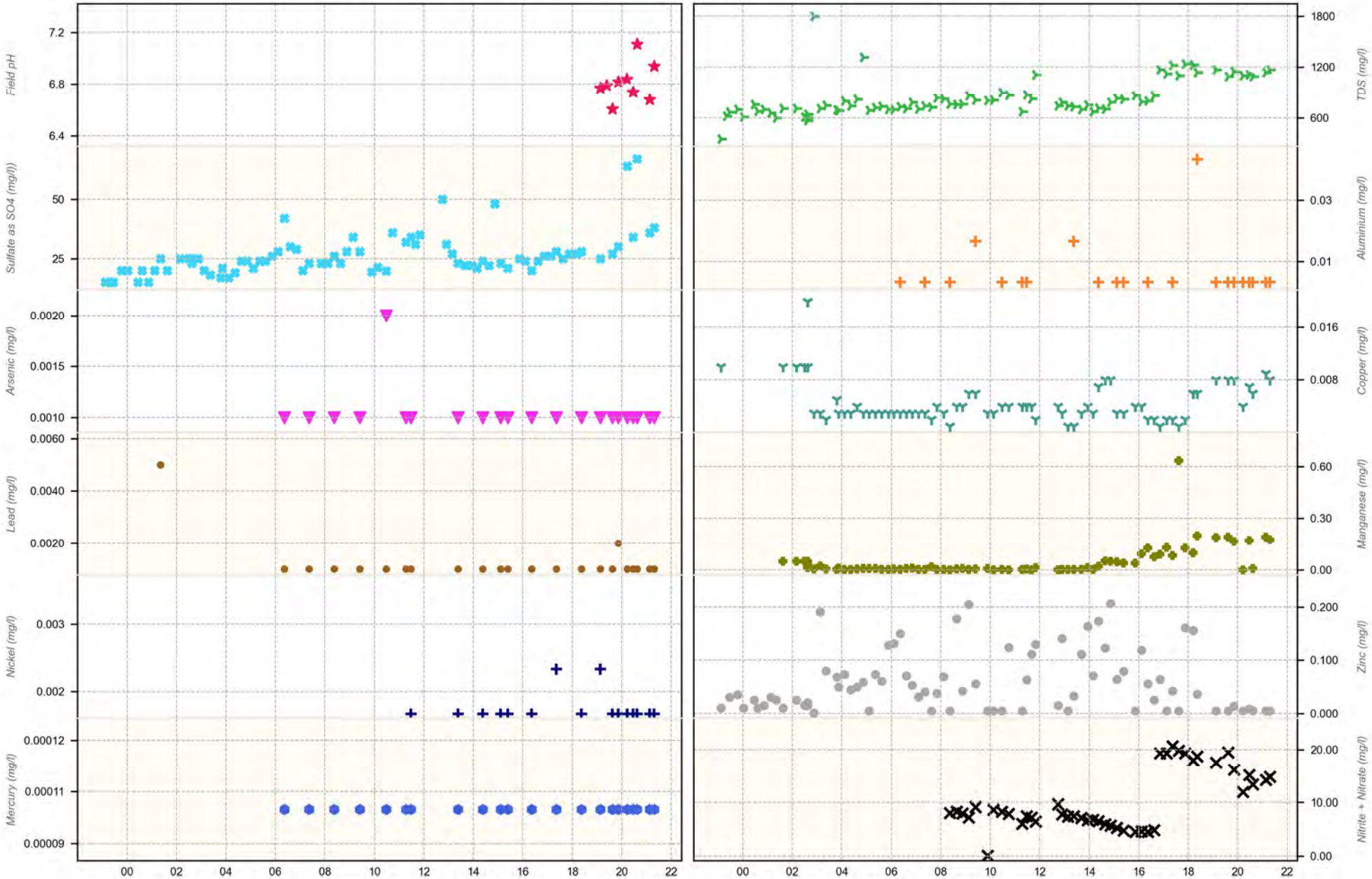


MB89 (Ordovician Volcanics, Scrn: 114-126 m, CE2020: Within)

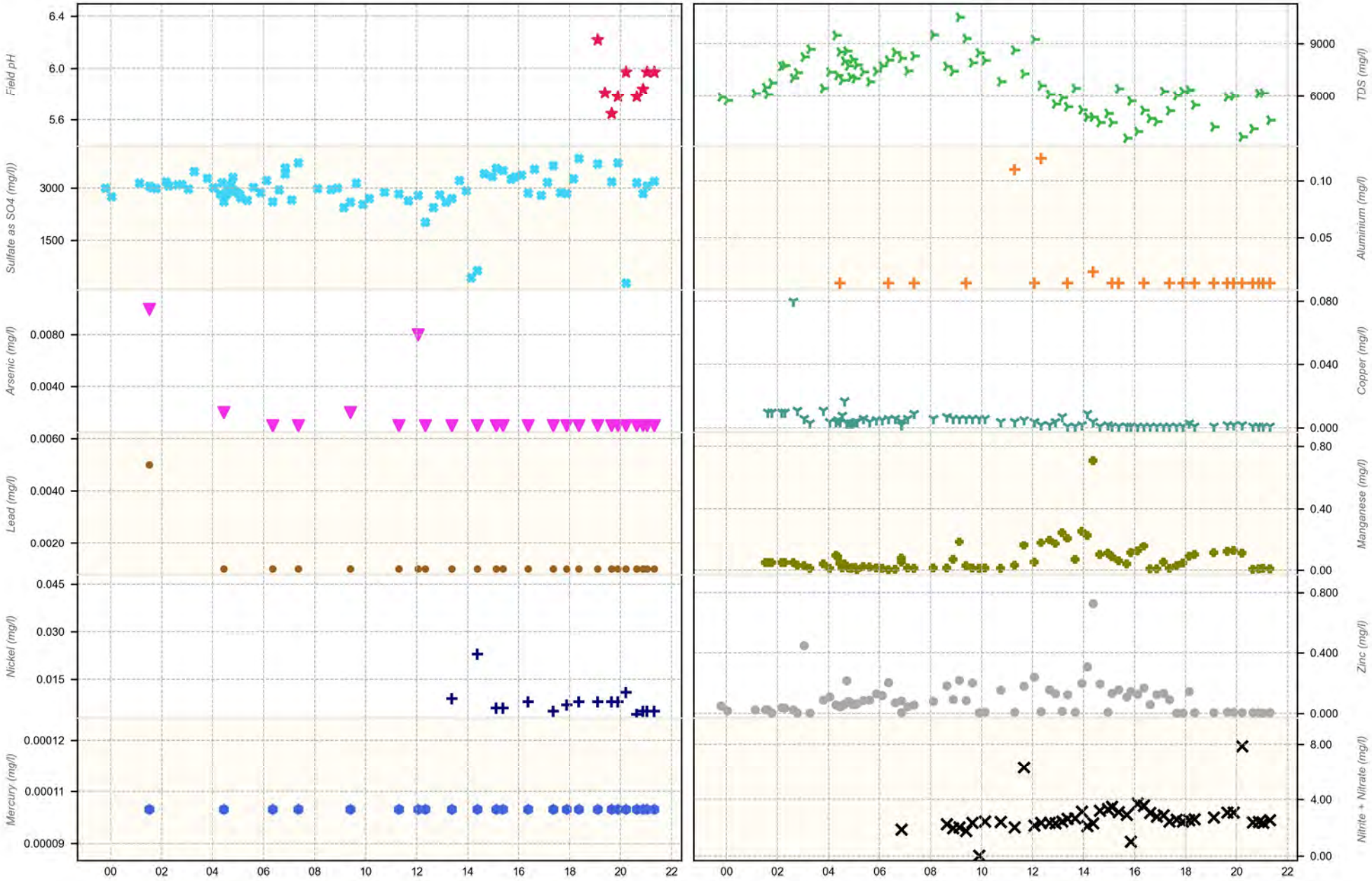
MB20 (Silurian Sediments, Scrn: 9.9-39.9 m, NTSF: 89.5 m)



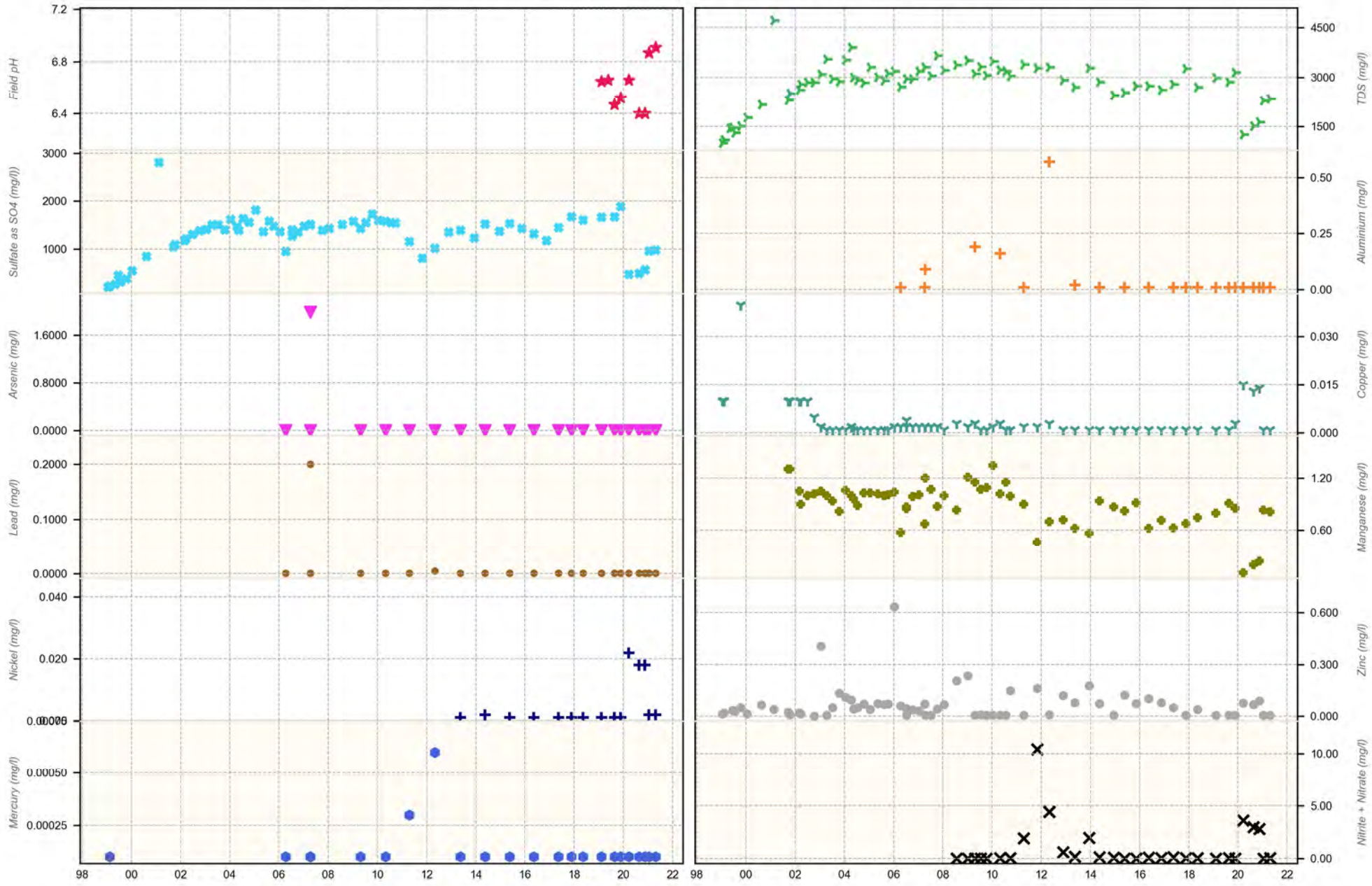
MB21 (Ordovician Volcanics, Scrn: 11.9-29.9 m, NTSF: 201.1 m)



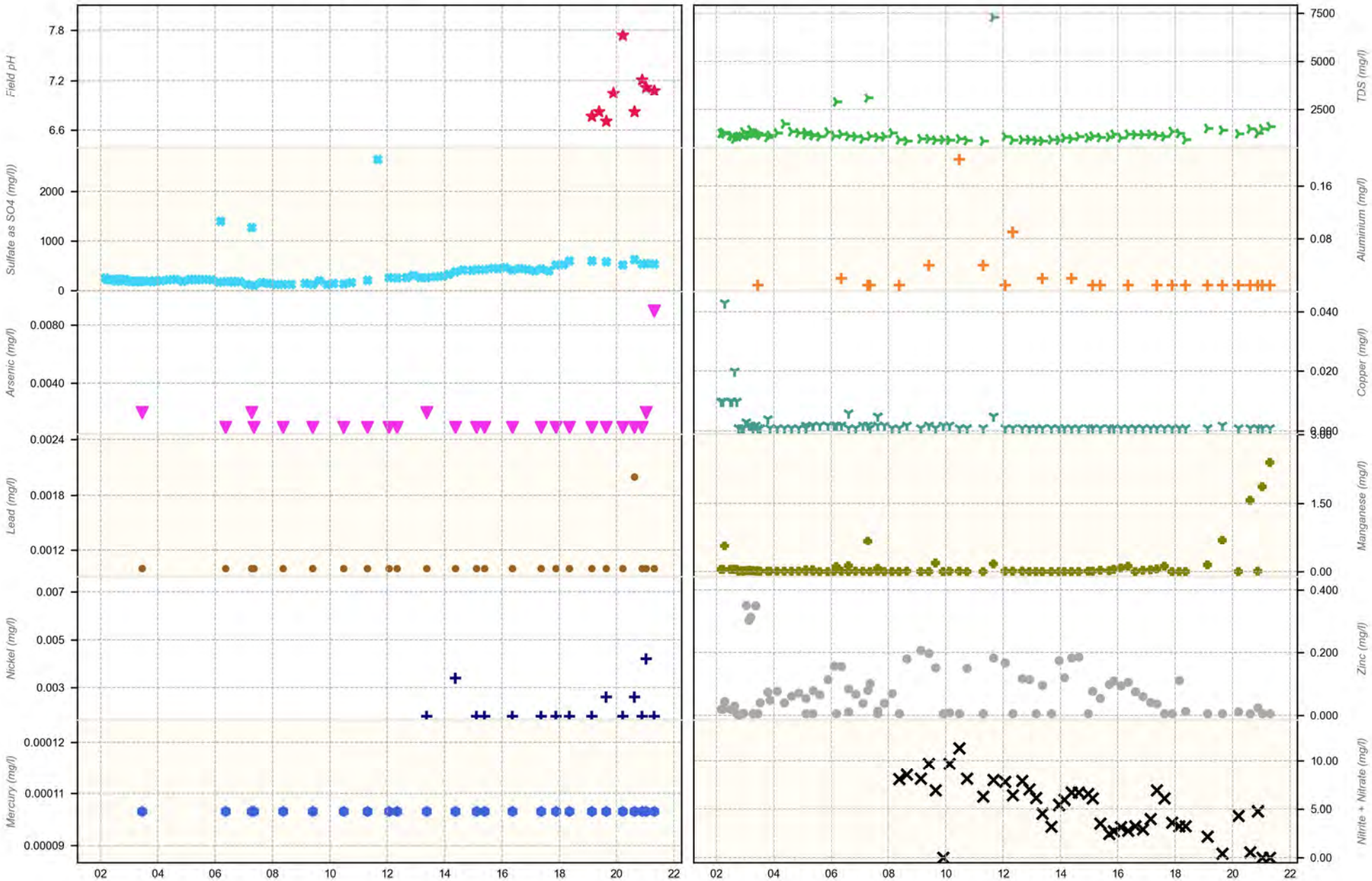
MB23 (Ordovician Volcanics, Scrn: 11.37-41.37 m, NTSF: 49.2 m)



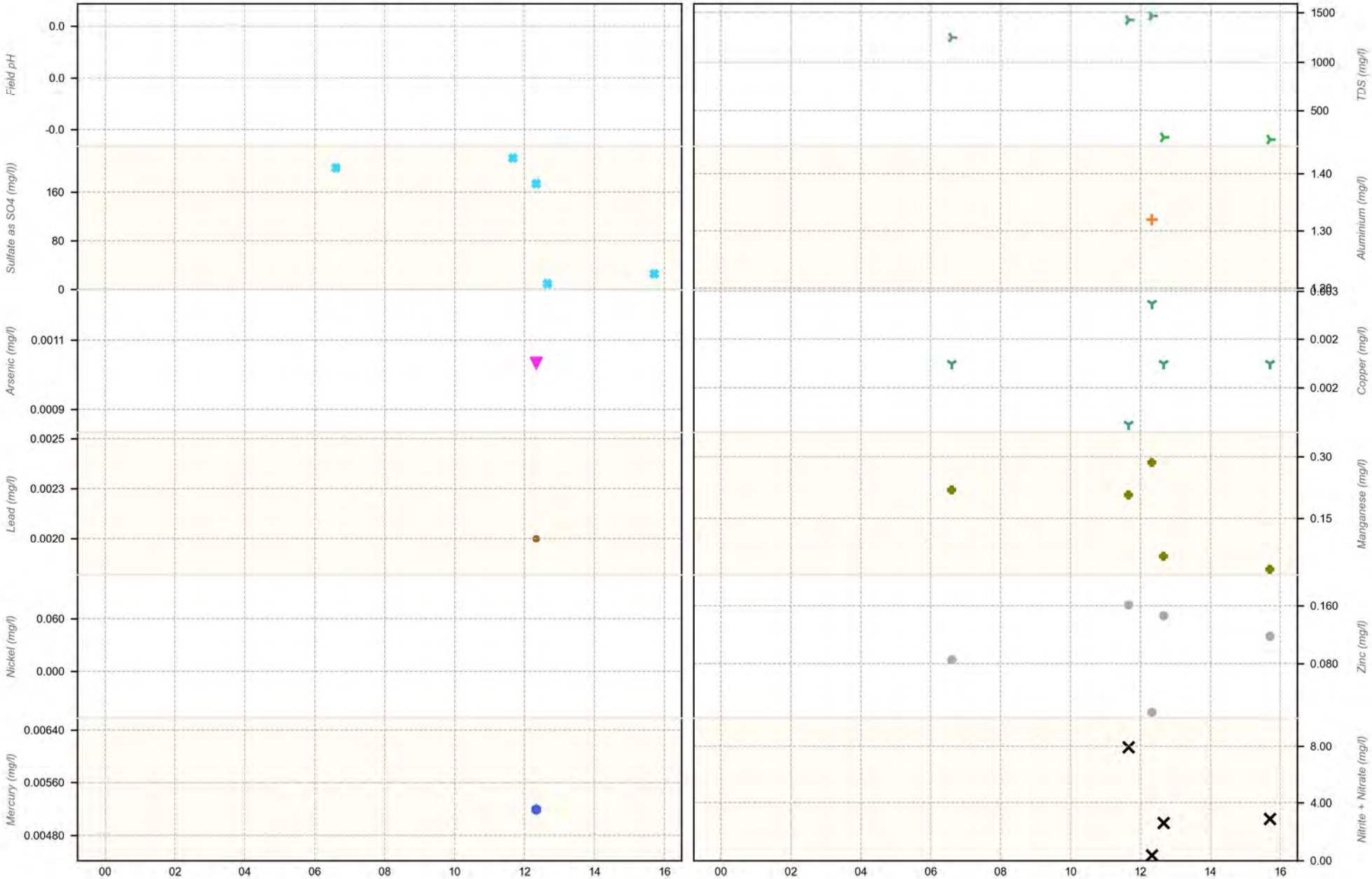
MB24 (Ordovician Volcanics, Scrn: 12.98-30.98 m, NTSF: 170.5 m)



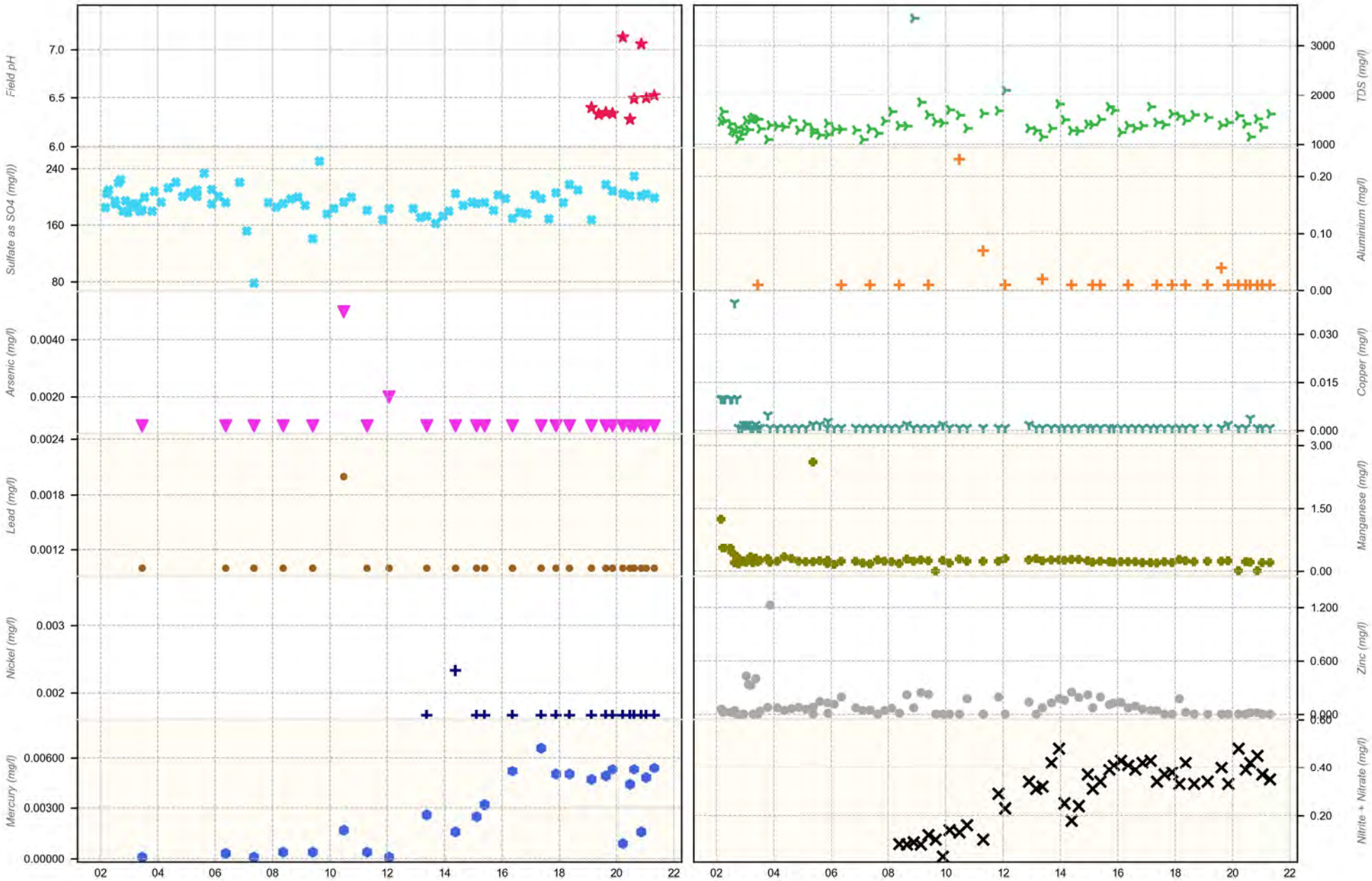
MB25 (Ordovician Volcanics, Scrn: 18.5-30.5 m, STSF: 41.0 m)



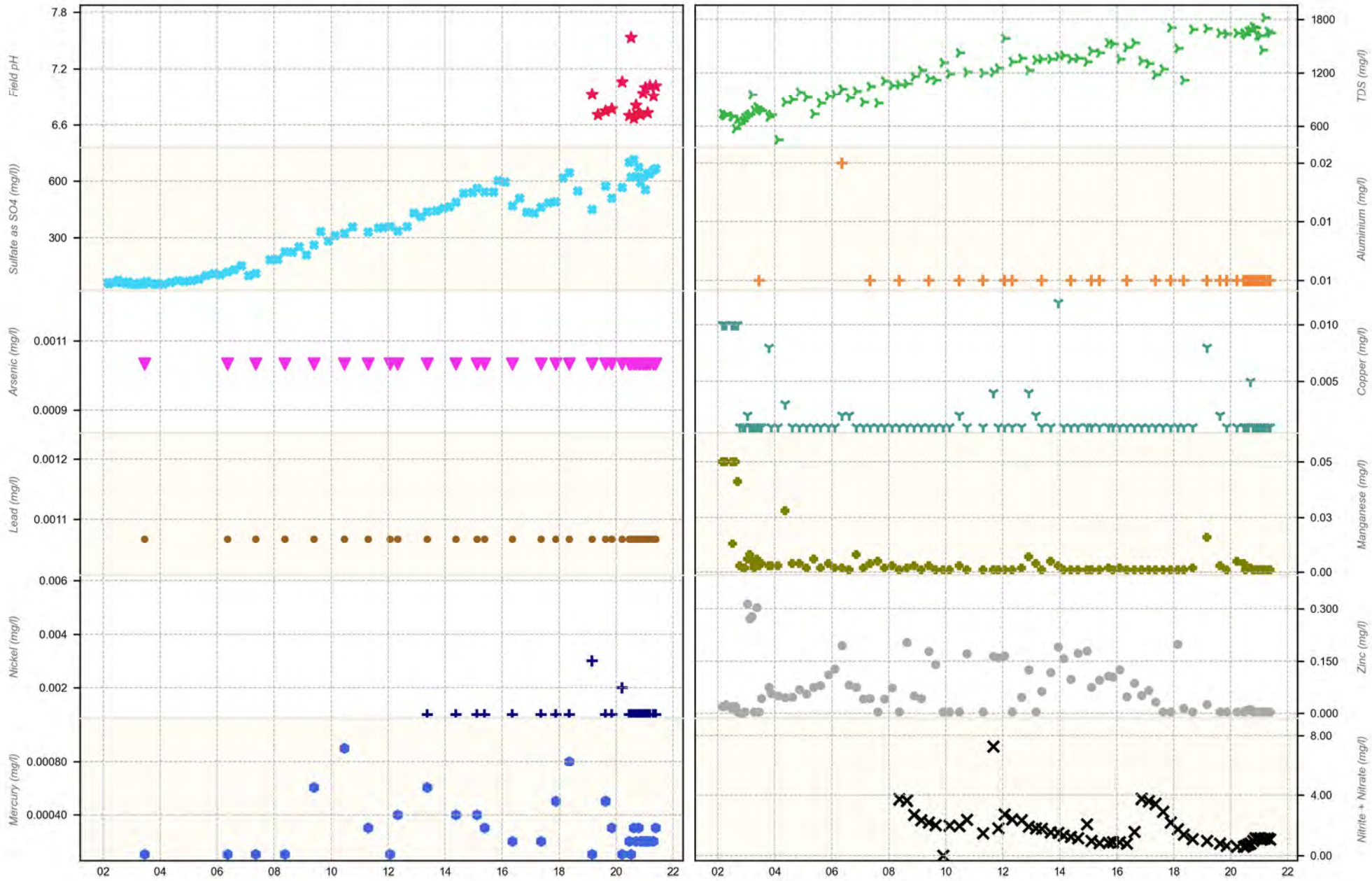
MB26A (Ordovician Volcanics, Scrn: 4.5-10.5 m, STSF: 78.4 m)



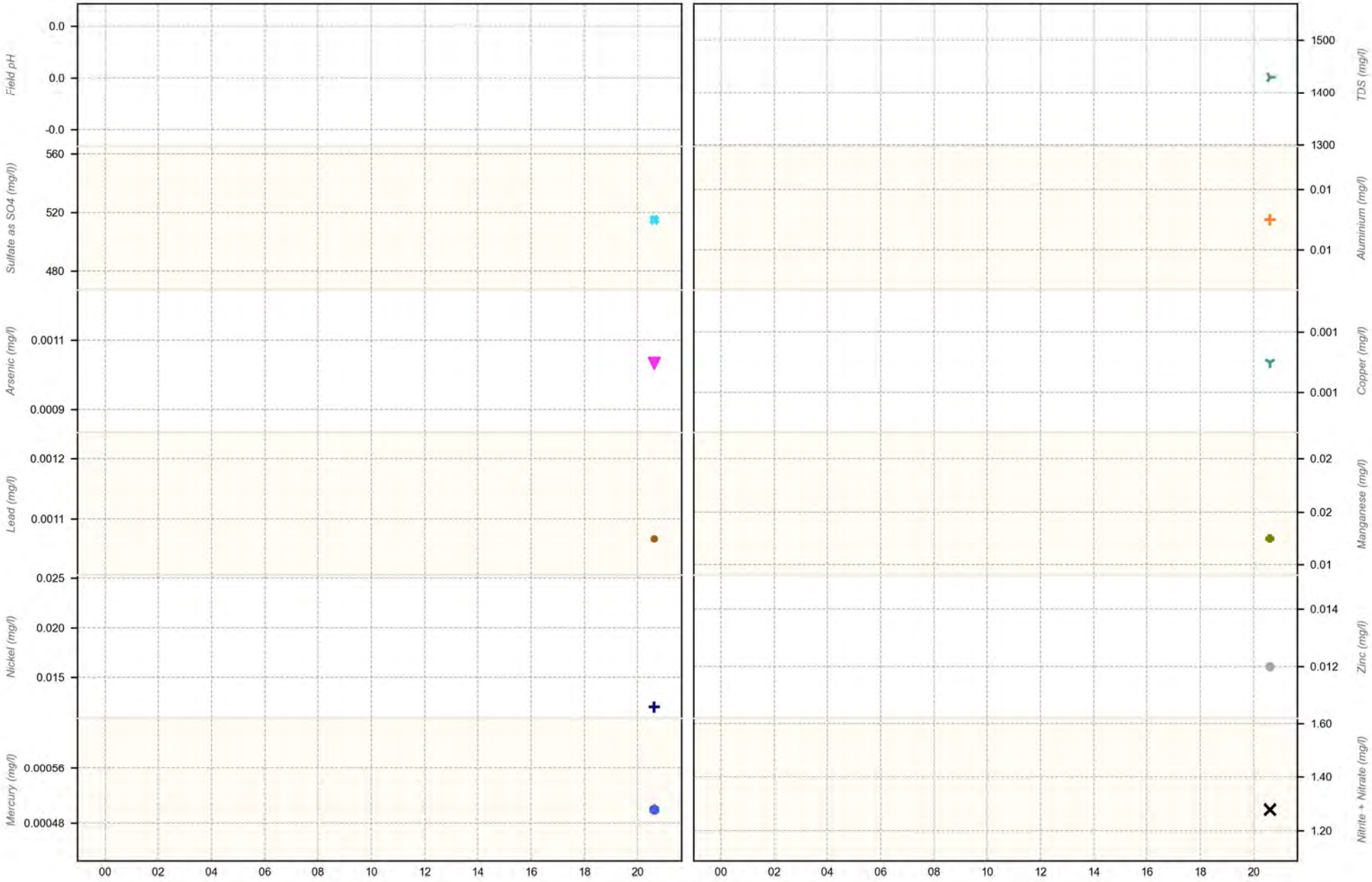
MB26B (Ordovician Volcanics, Scrn: 19.0-30.0 m, STSF: 78.2 m)



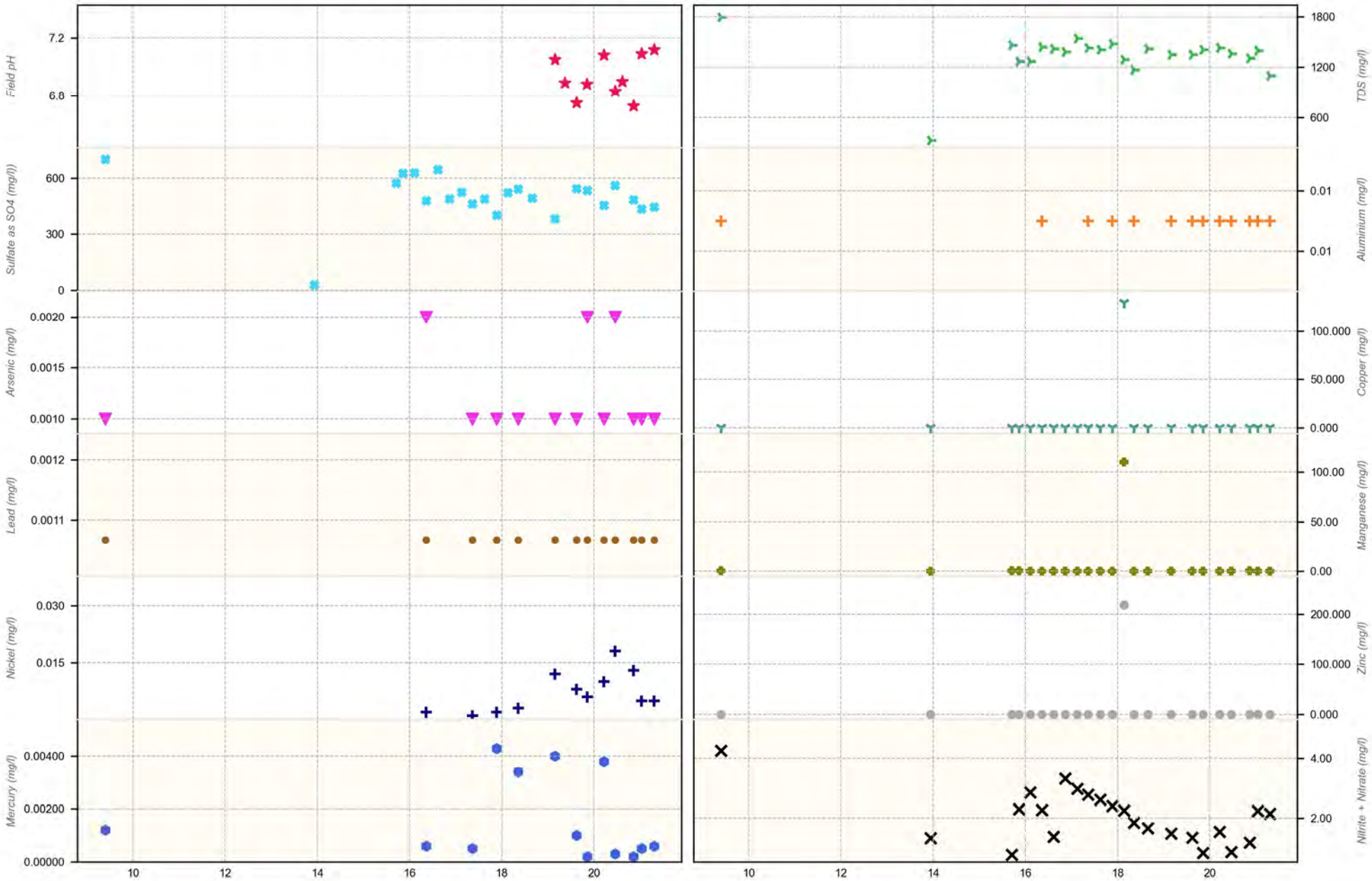
MB27 (Ordovician Volcanics, Scrn: 4.0-11.5 m, STSF: 234.1 m)



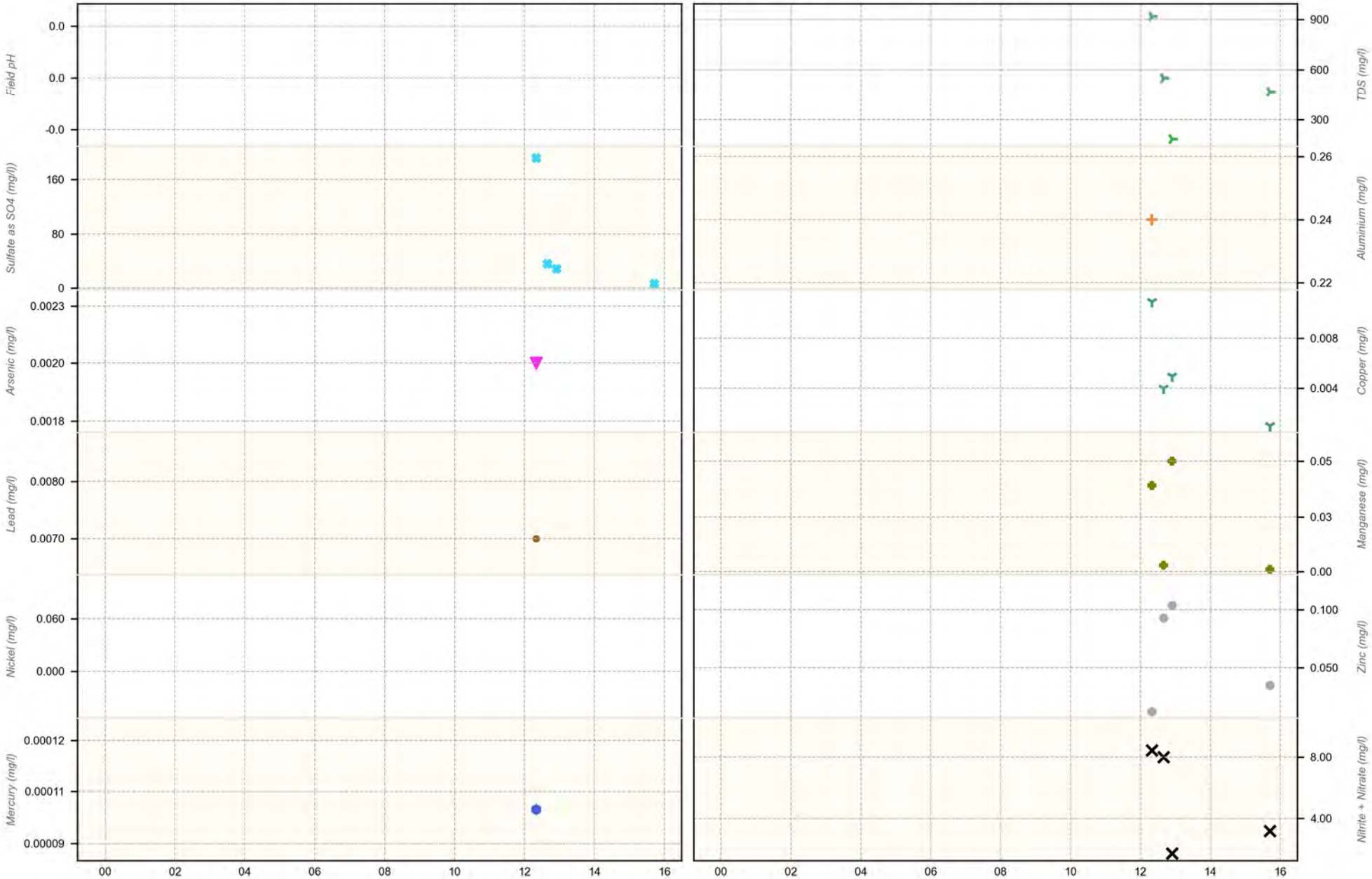
MB28A (Ordovician Volcanics, Scrn: 4.5-10.6 m, STSF: 106.8 m)



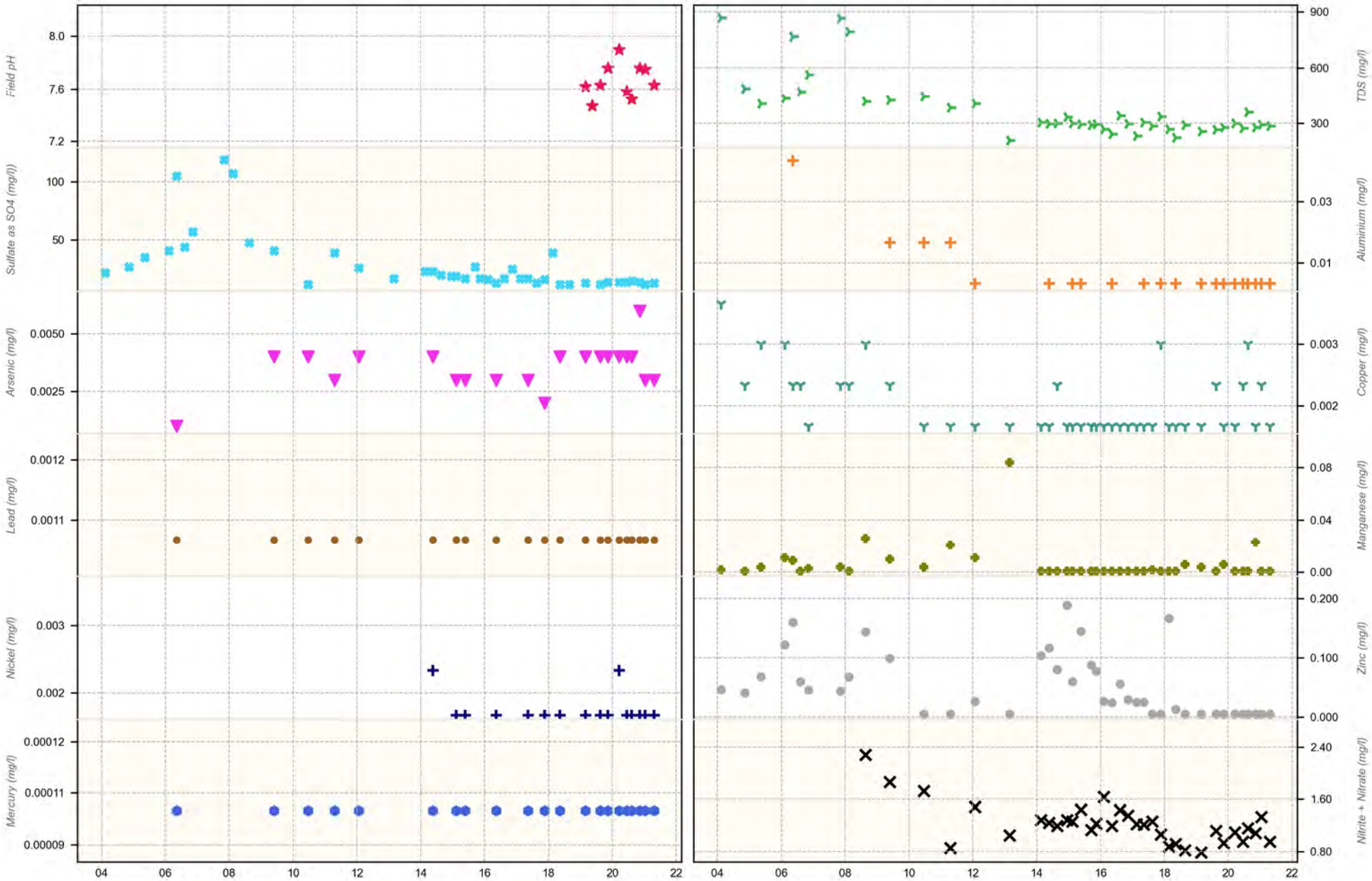
MB28B (Ordovician Volcanics, Scrn: 14.0-20.5 m, STSF: 108.1 m)



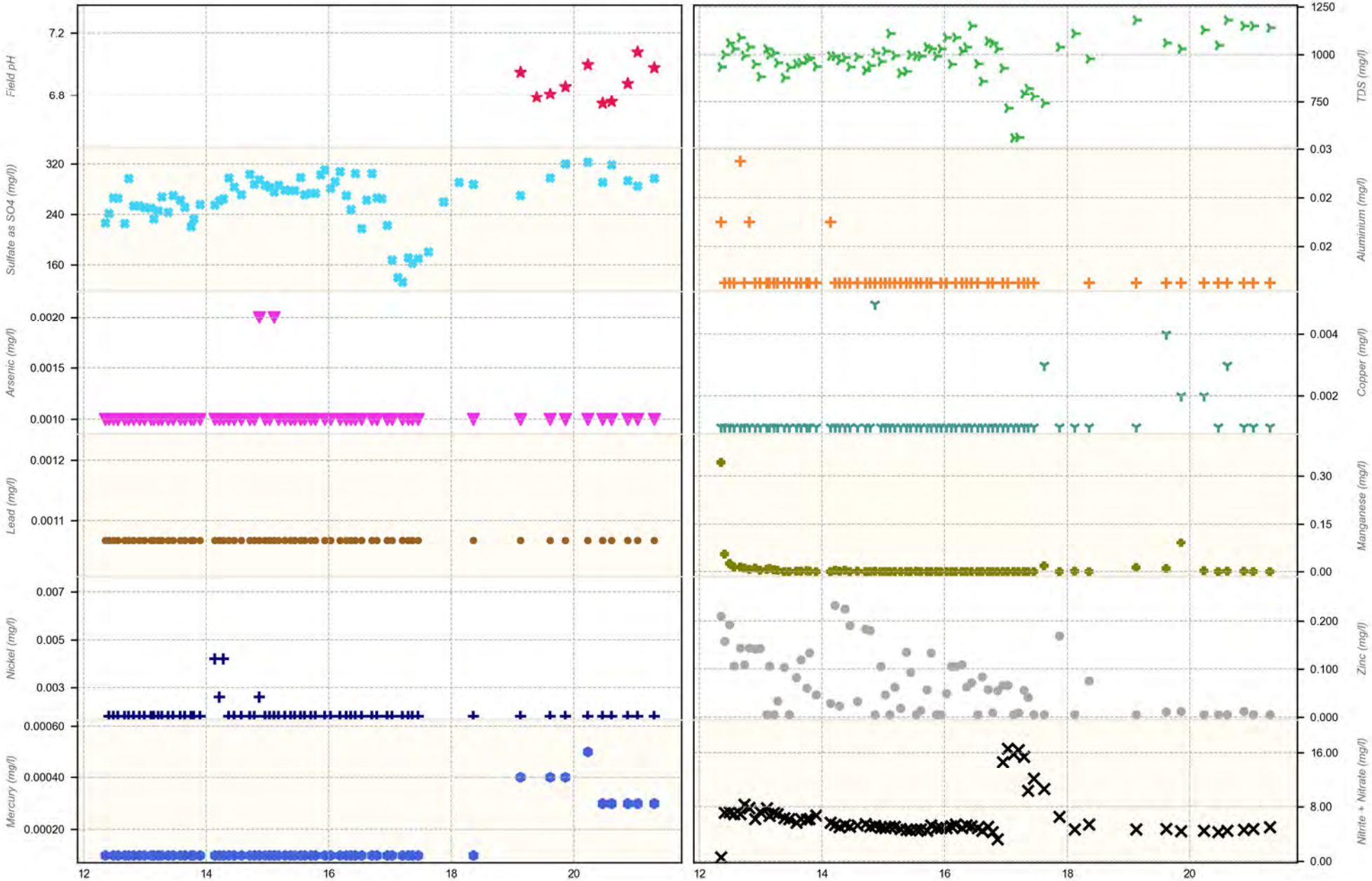
MB29A (Ordovician Volcanics, Scrn: 3.5-10.5 m, STSF: 333.7 m)



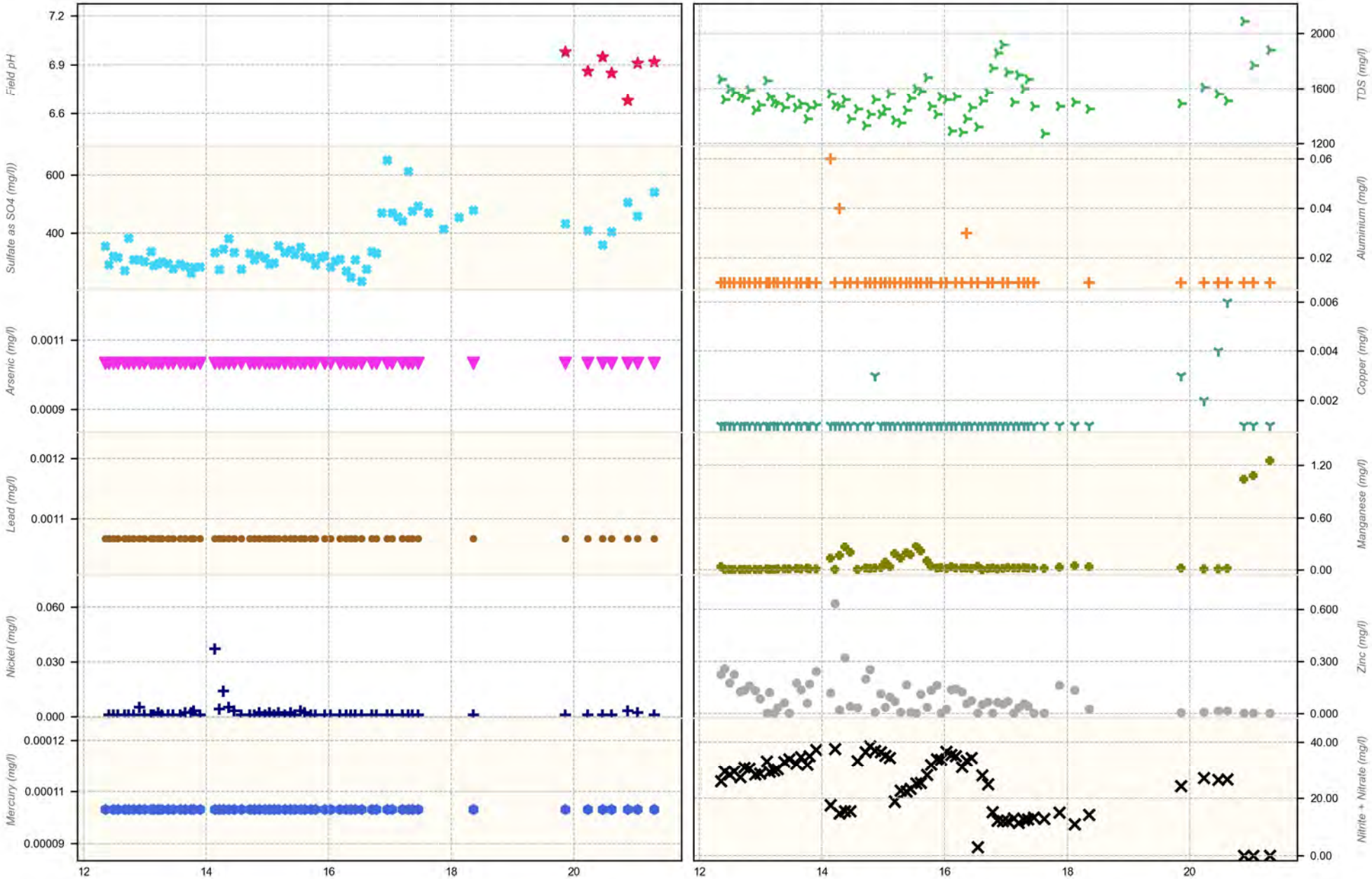
MB29B (Ordovician Volcanics, Scrn: 11.2-24.0 m, STSF: 333.4 m)



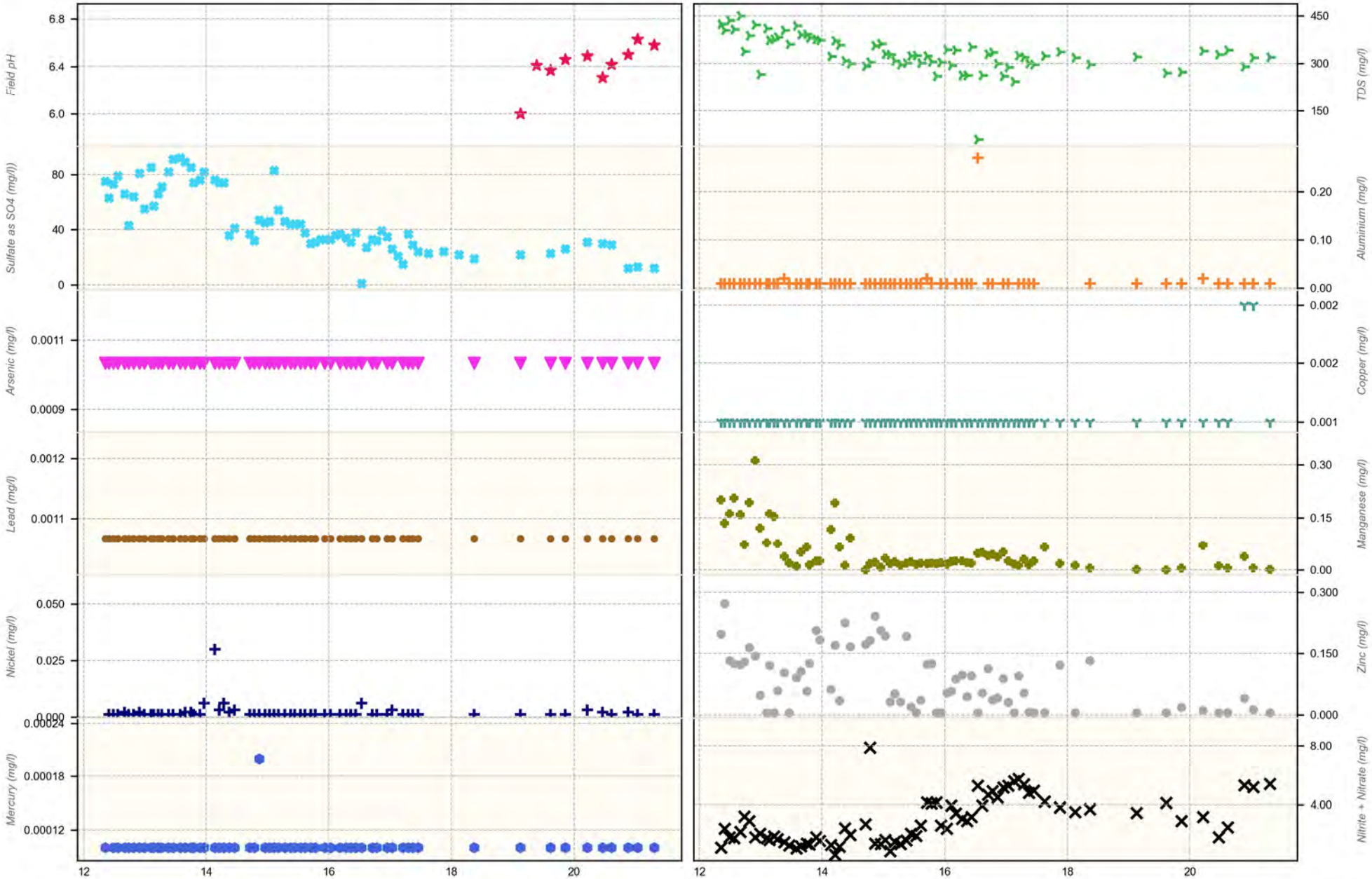
MB68 (Ordovician Volcanics, Scrn: 64-78 m, NTSF: 70.6 m)



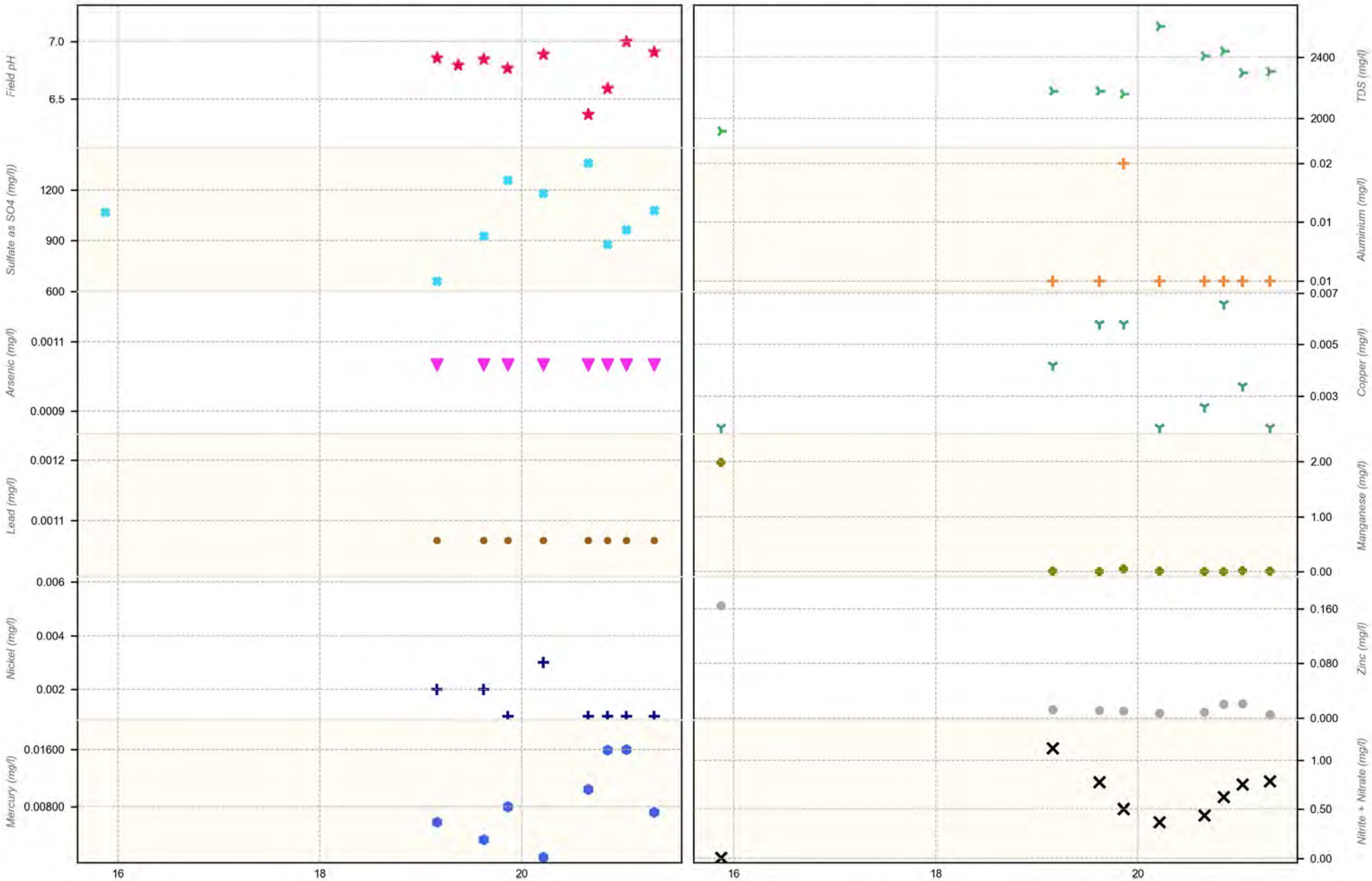
MB69 (Ordovician Volcanics, Scrn: 26.4-62.4 m, STSF: 503.4 m)



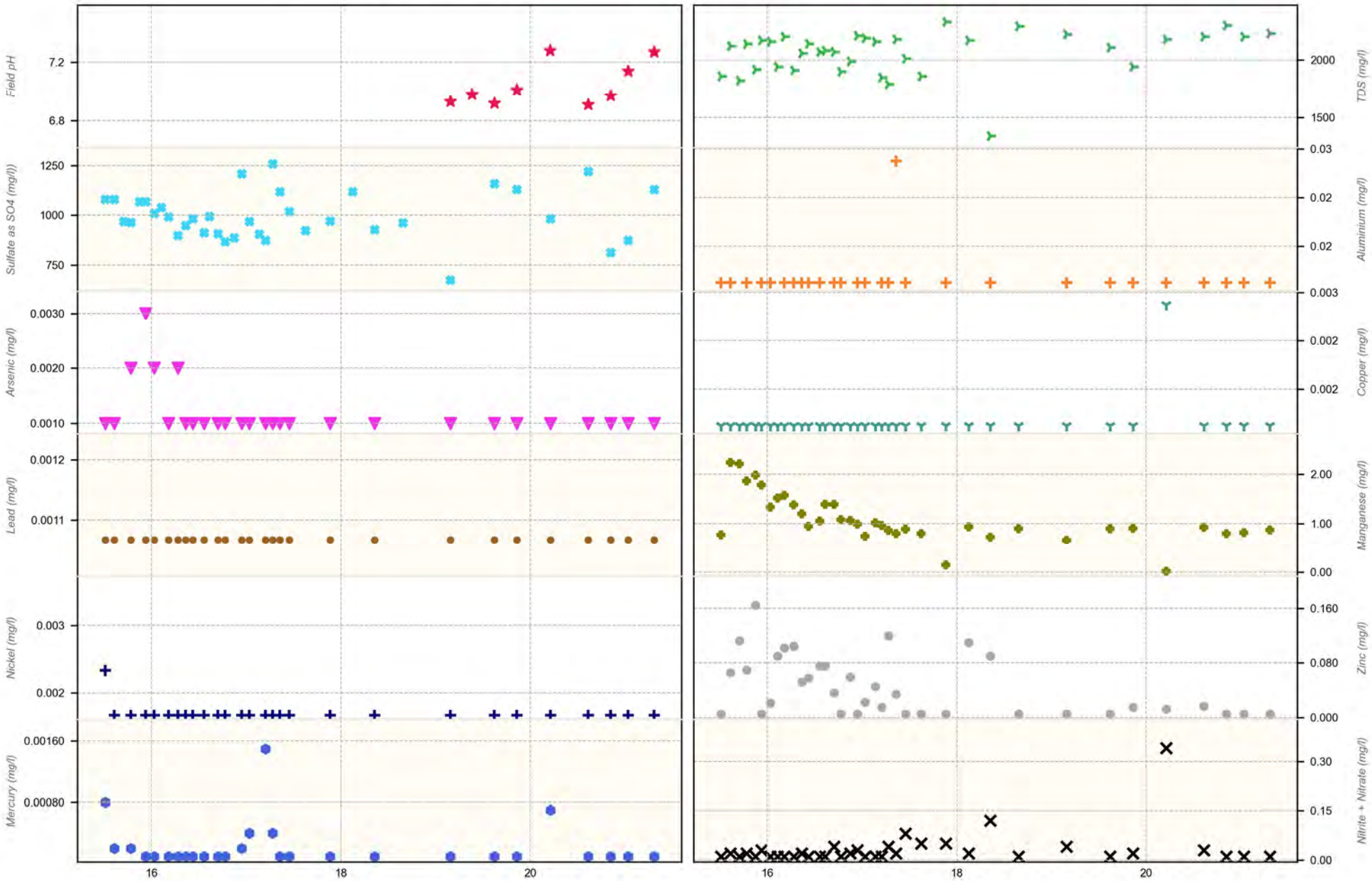
MB70 (Ordovician Volcanics, Scrn: 47.4-71.4 m, NTSF: Within)



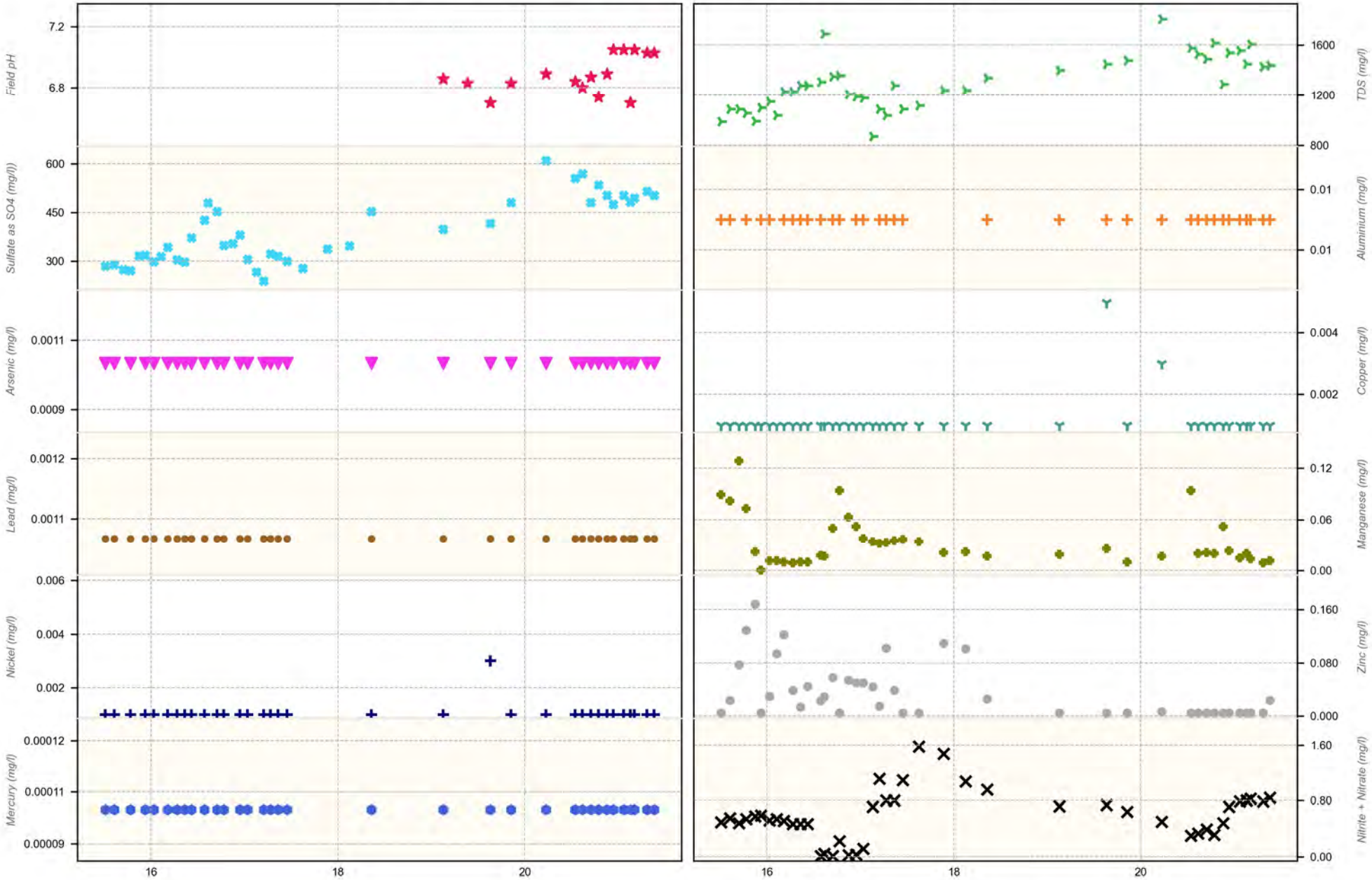
MB77A (Silurian Sediments, Scrn: 6-12 m, STSF: 146.3 m)



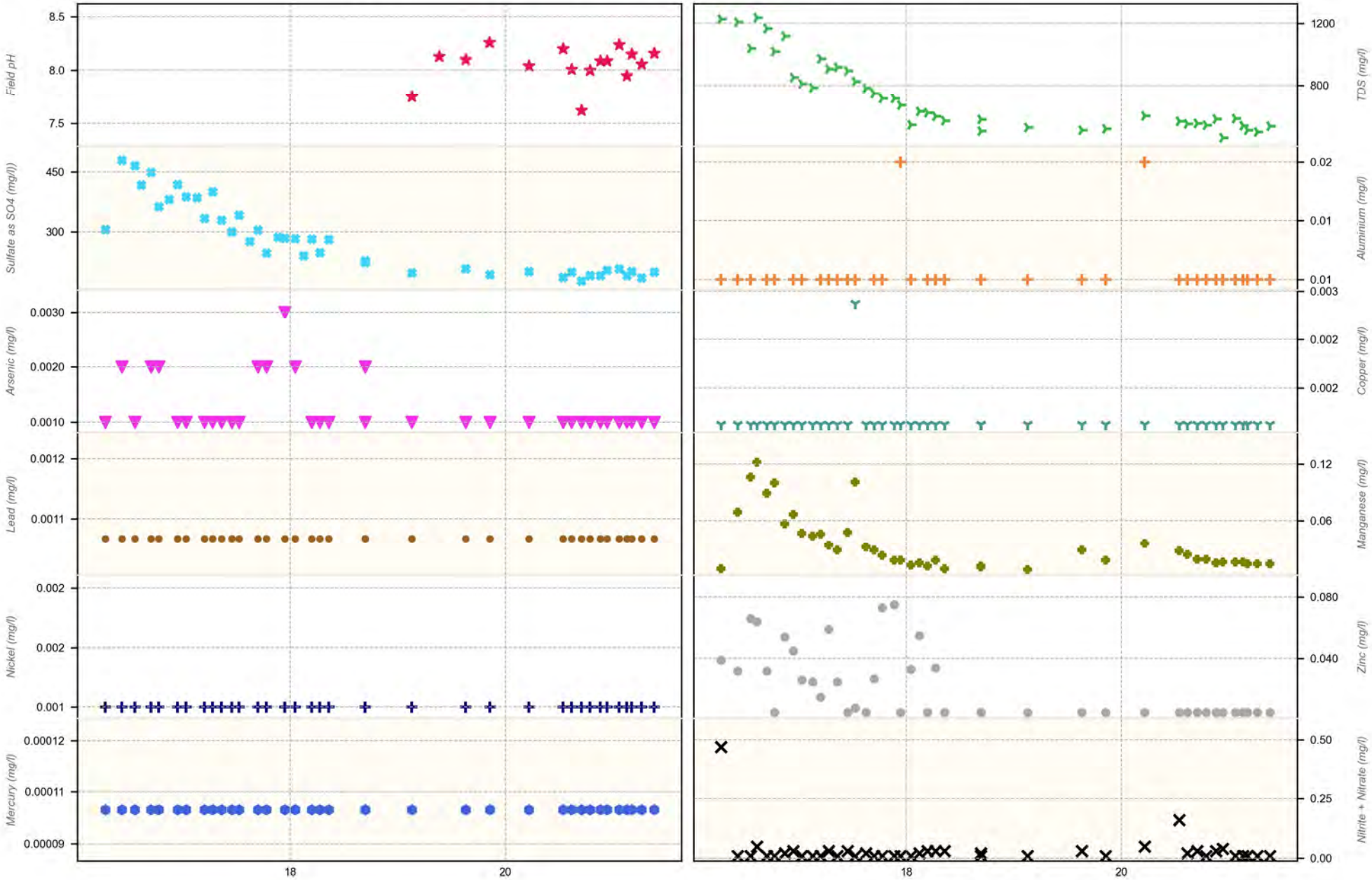
MB77B (Silurian Sediments, Scrn: 23-29 m, STSF: 145.6 m)



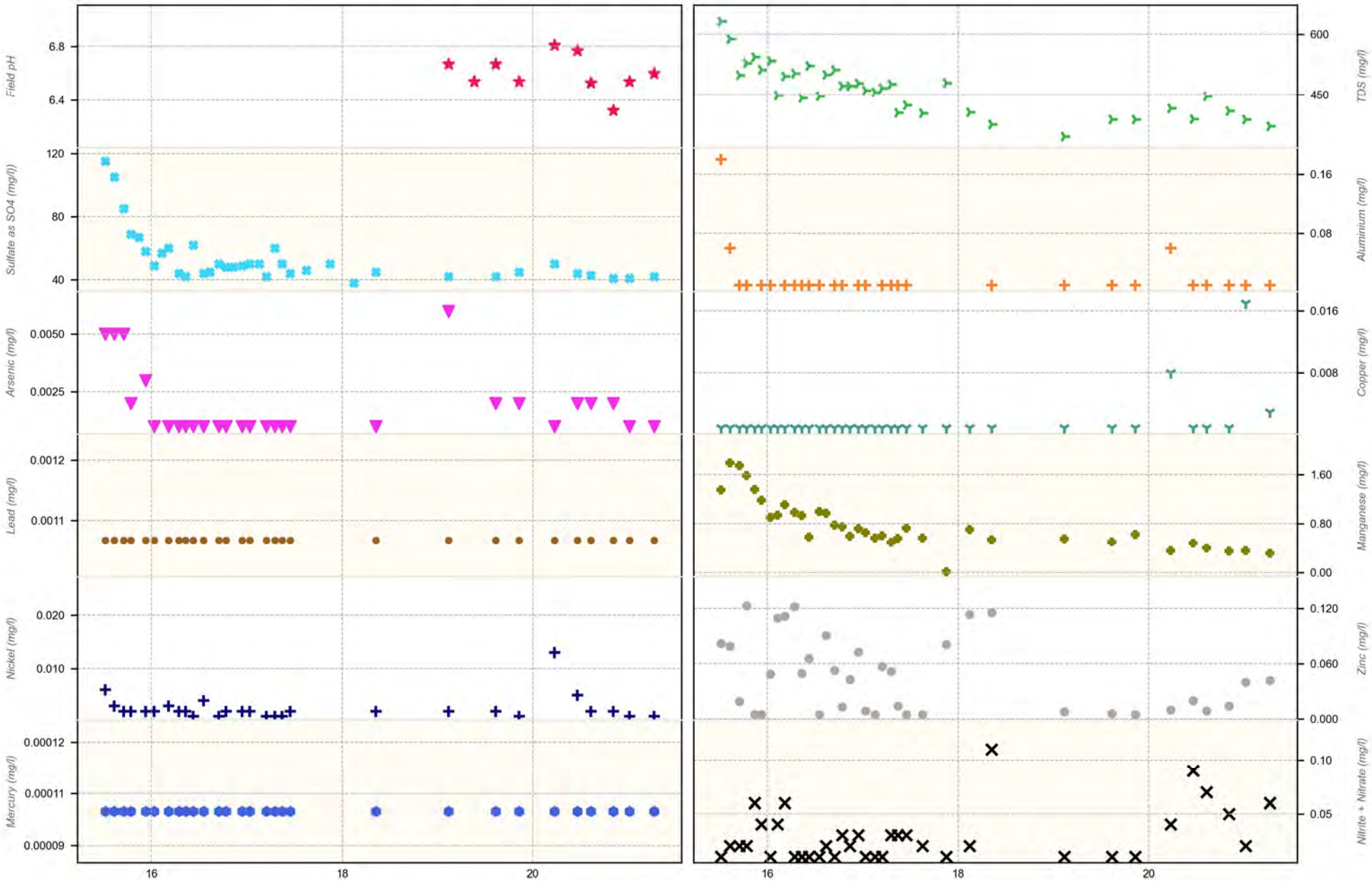
MB78 (Tertiary Basalt, Scrn: 6-12.5 m, STSF: 638.0 m)



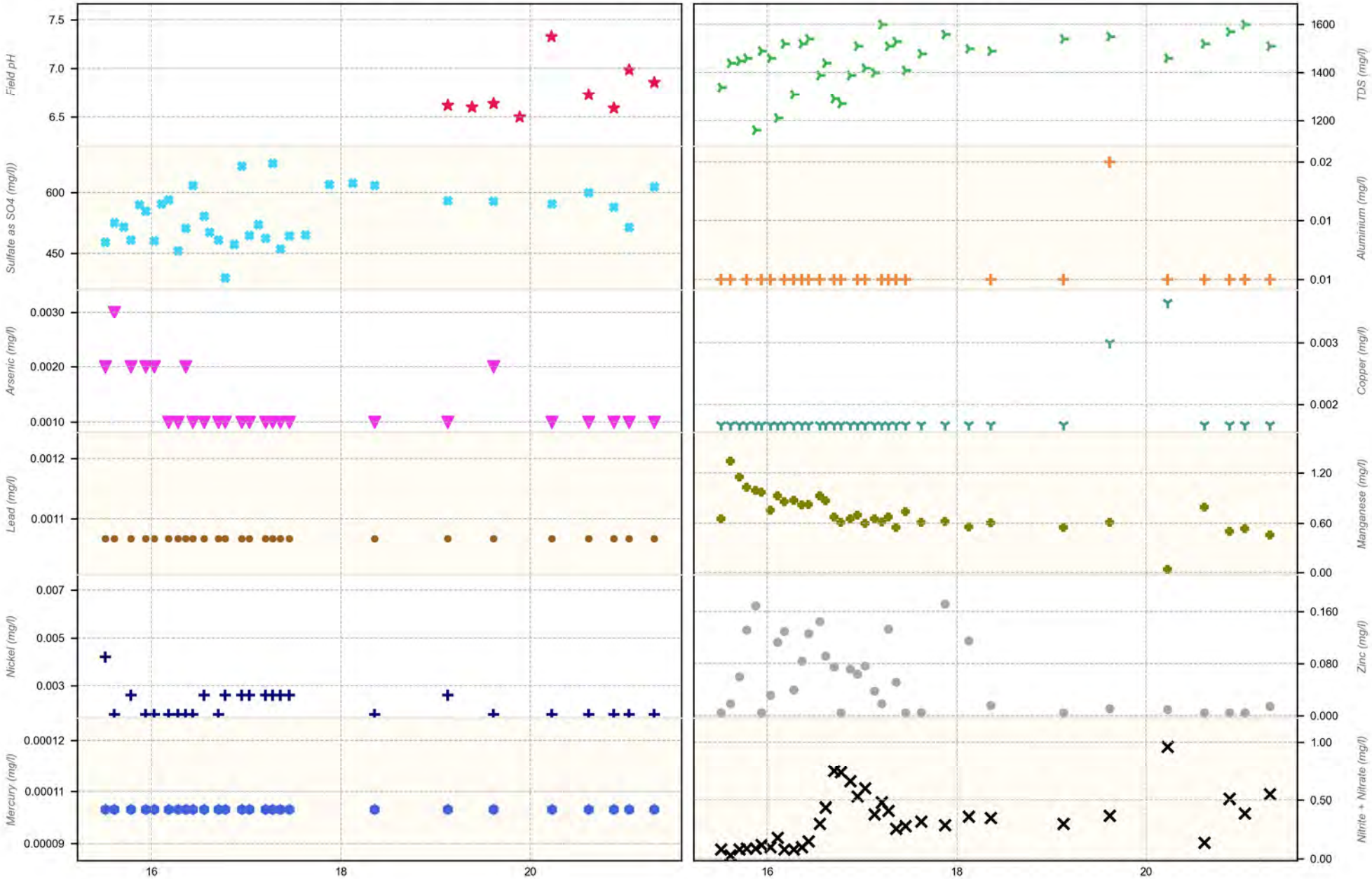
MB79 (Silurian Sediments, Scrn: 34-40 m, STSF: 1085.2 m)



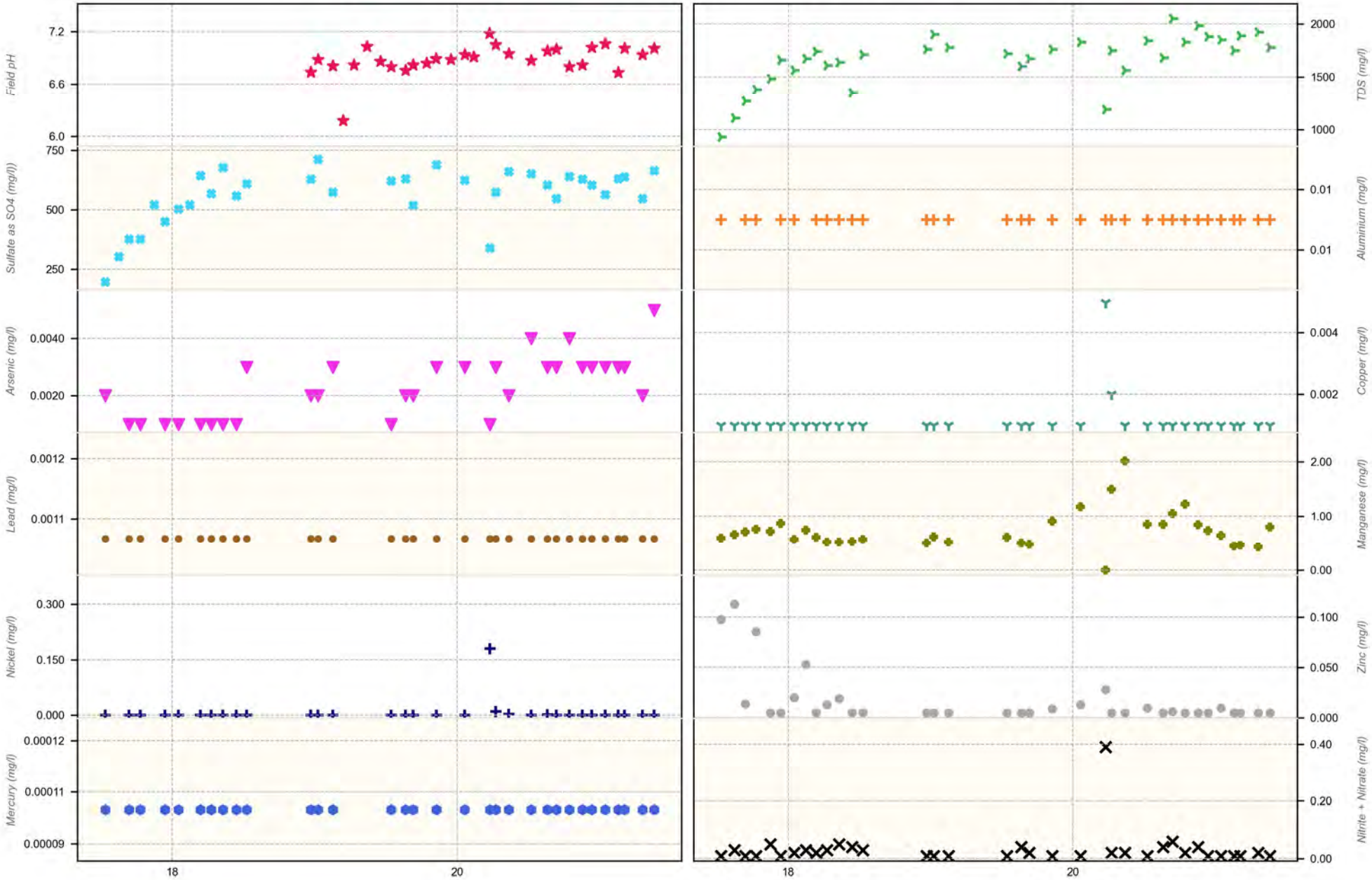
MB80 (Silurian Sediments, Scrn: 54-64 m, URCDam: 176.0 m)



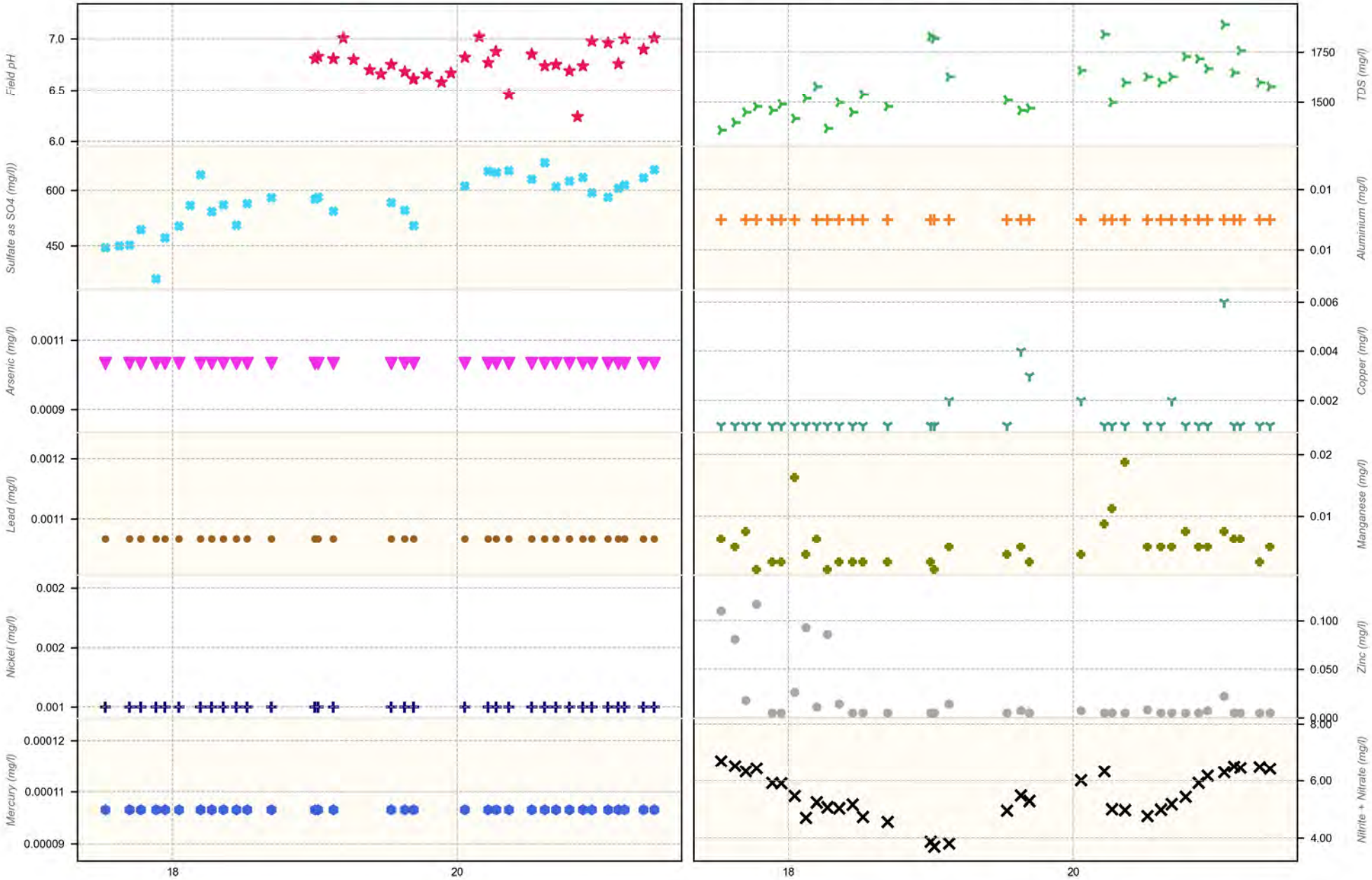
MB81 (Silurian Sediments, Scrn: 14-19 m, STSF: 359.6 m)



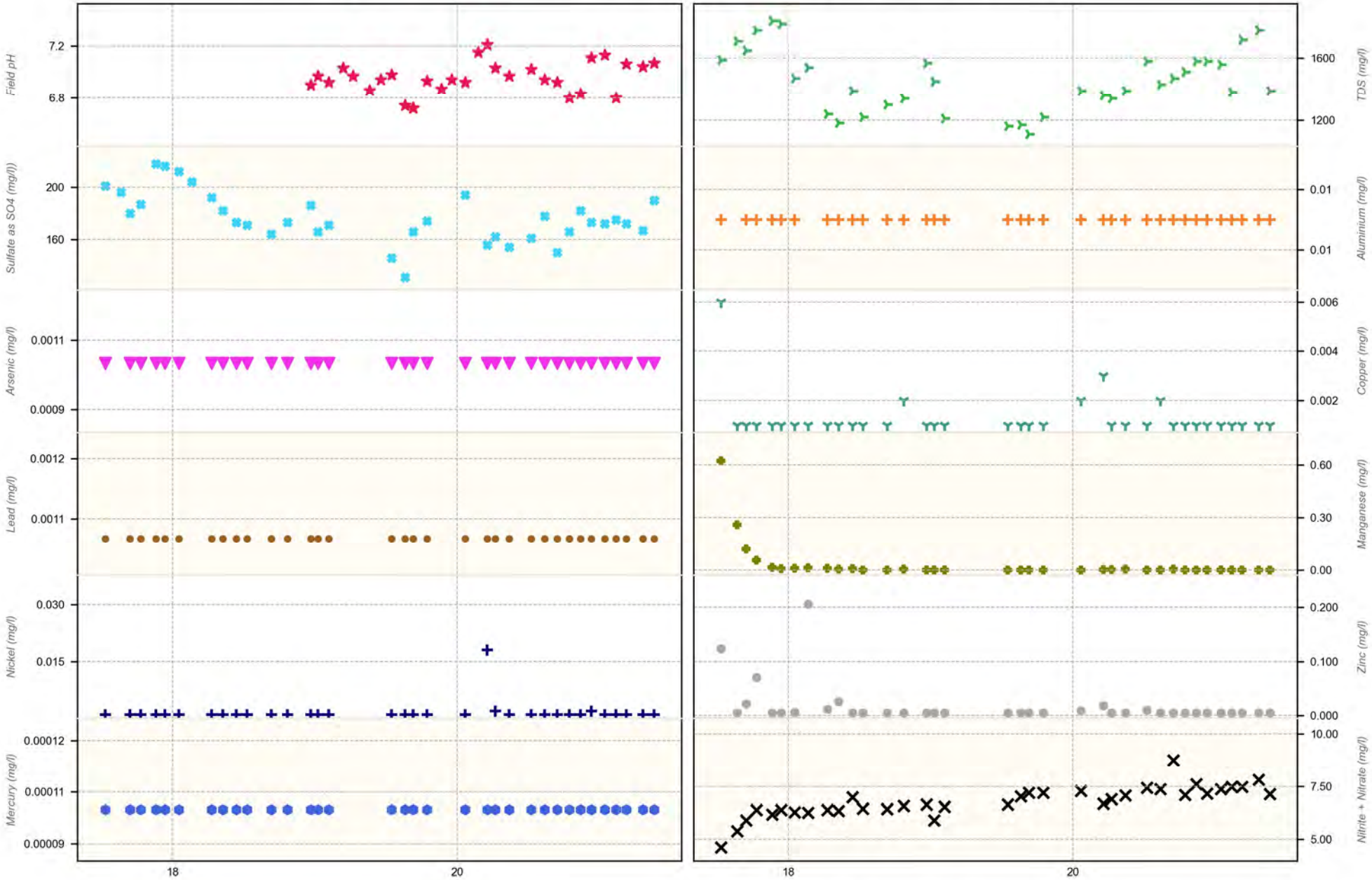
MB83 (Ordovician Volcanics, Scrn: 37.2-40.2 m, STSF: 398.1 m)



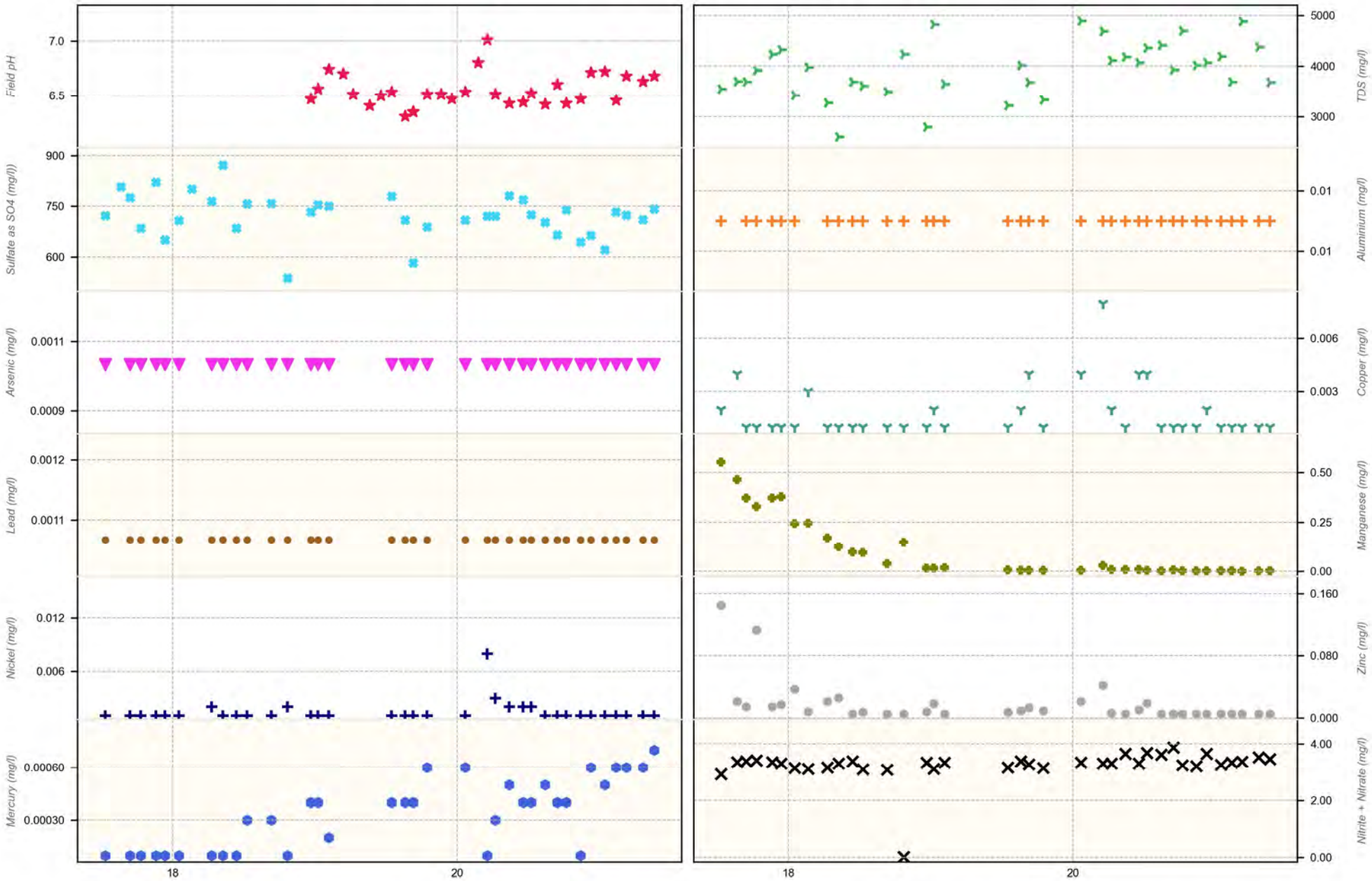
MB84 (Silurian Sediments, Scrn: 10.97-13.97 m, STSF: 269.0 m)



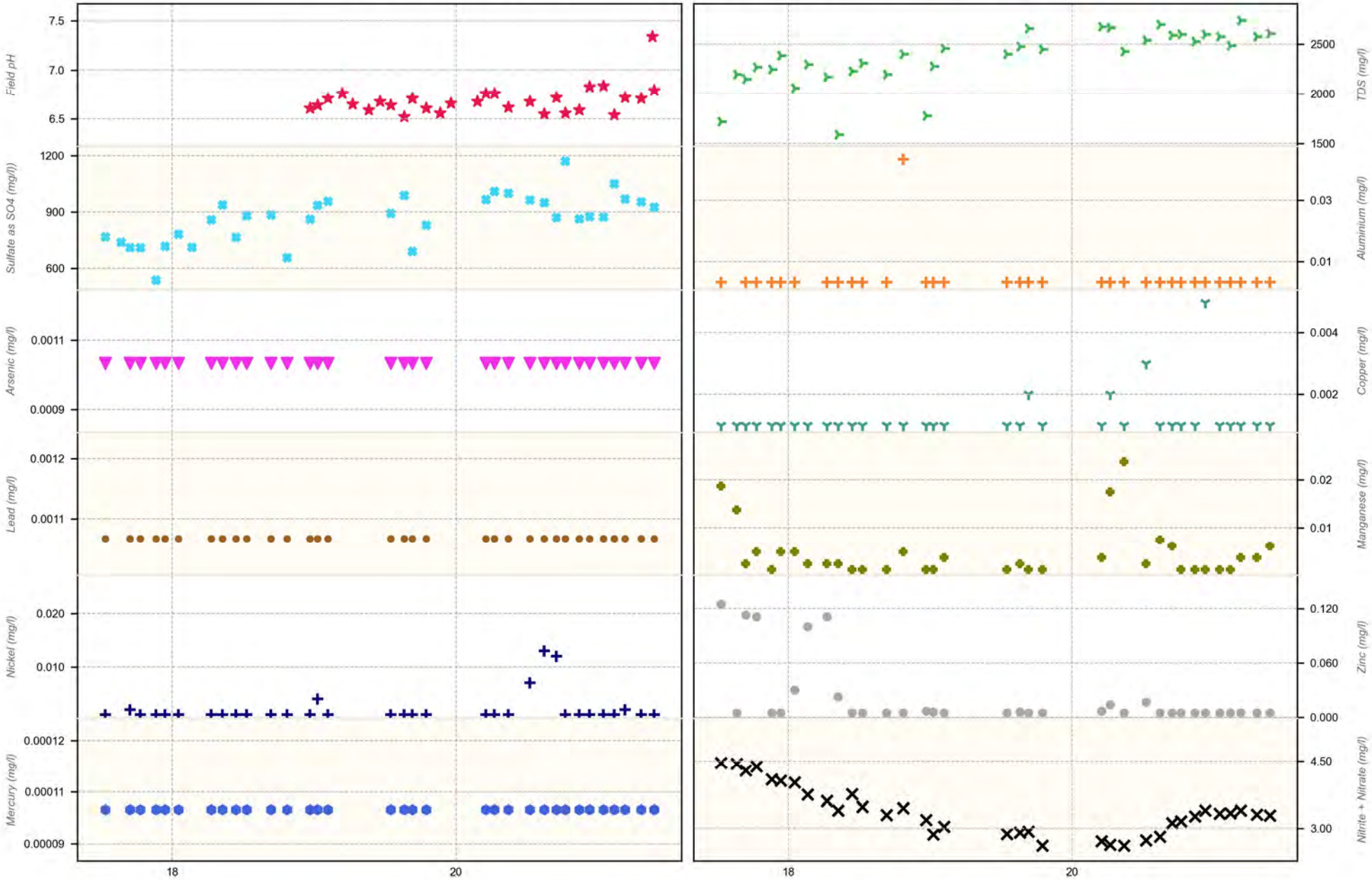
MB85 (Silurian Sediments, Scrn: 25.84-22.84 m, STSF: 589.2 m)



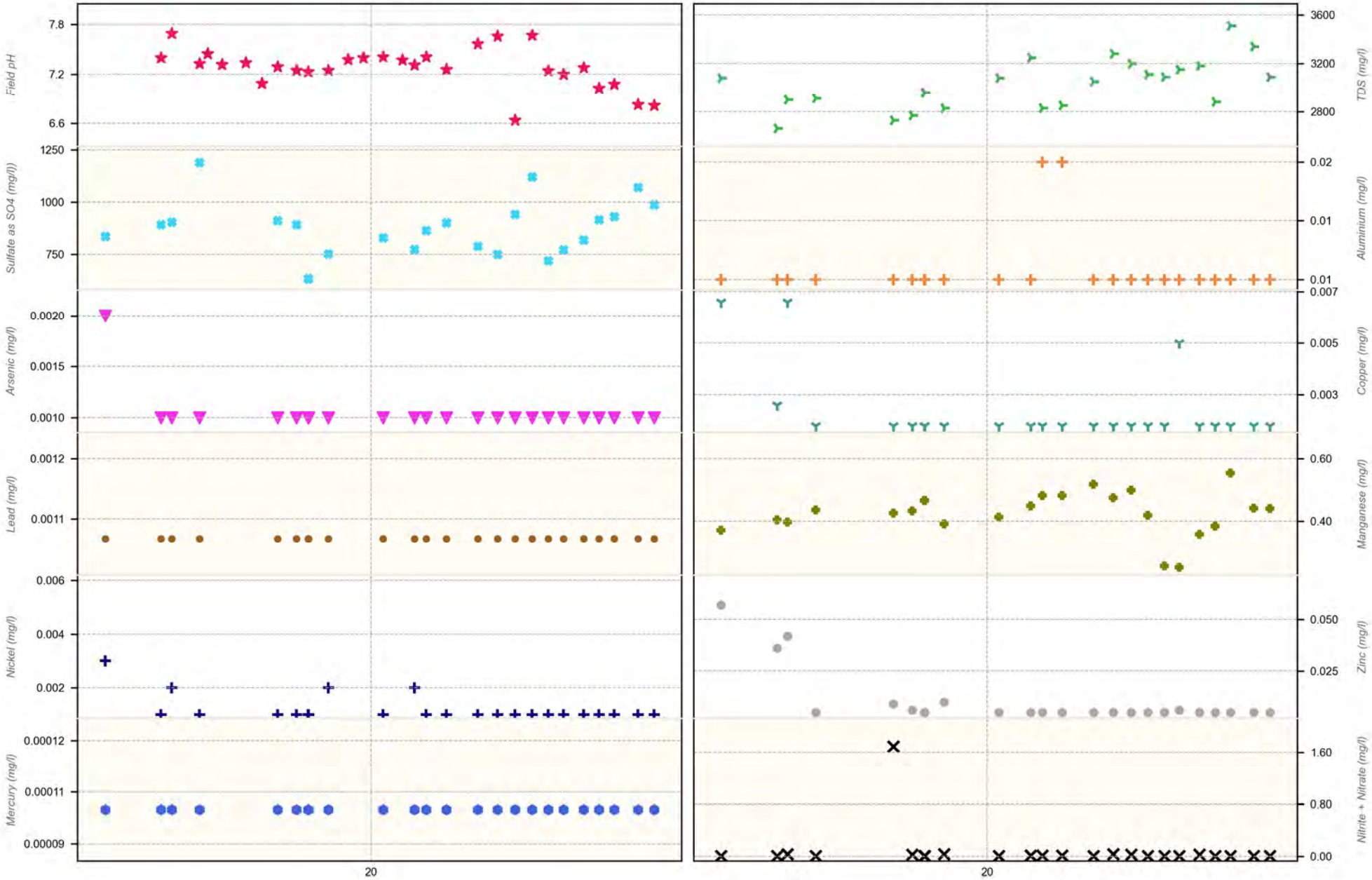
MB86 (Ordovician Volcanics, Scrn: 18.45-21.45 m, NTSF: 710.4 m)



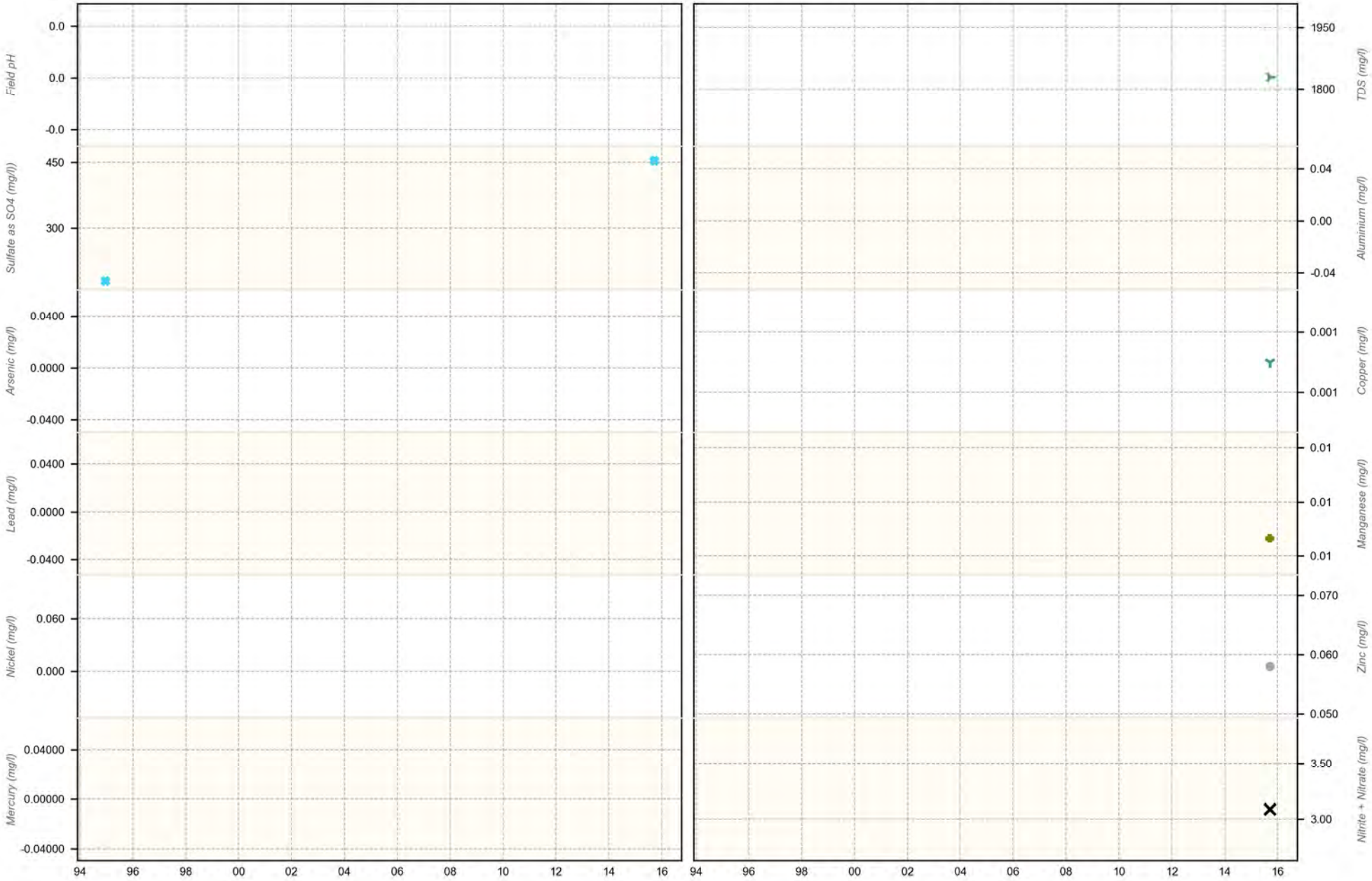
MB87 (Ordovician Volcanics, Scrn: 18.4-21.4 m, NTSF: 728.3 m)



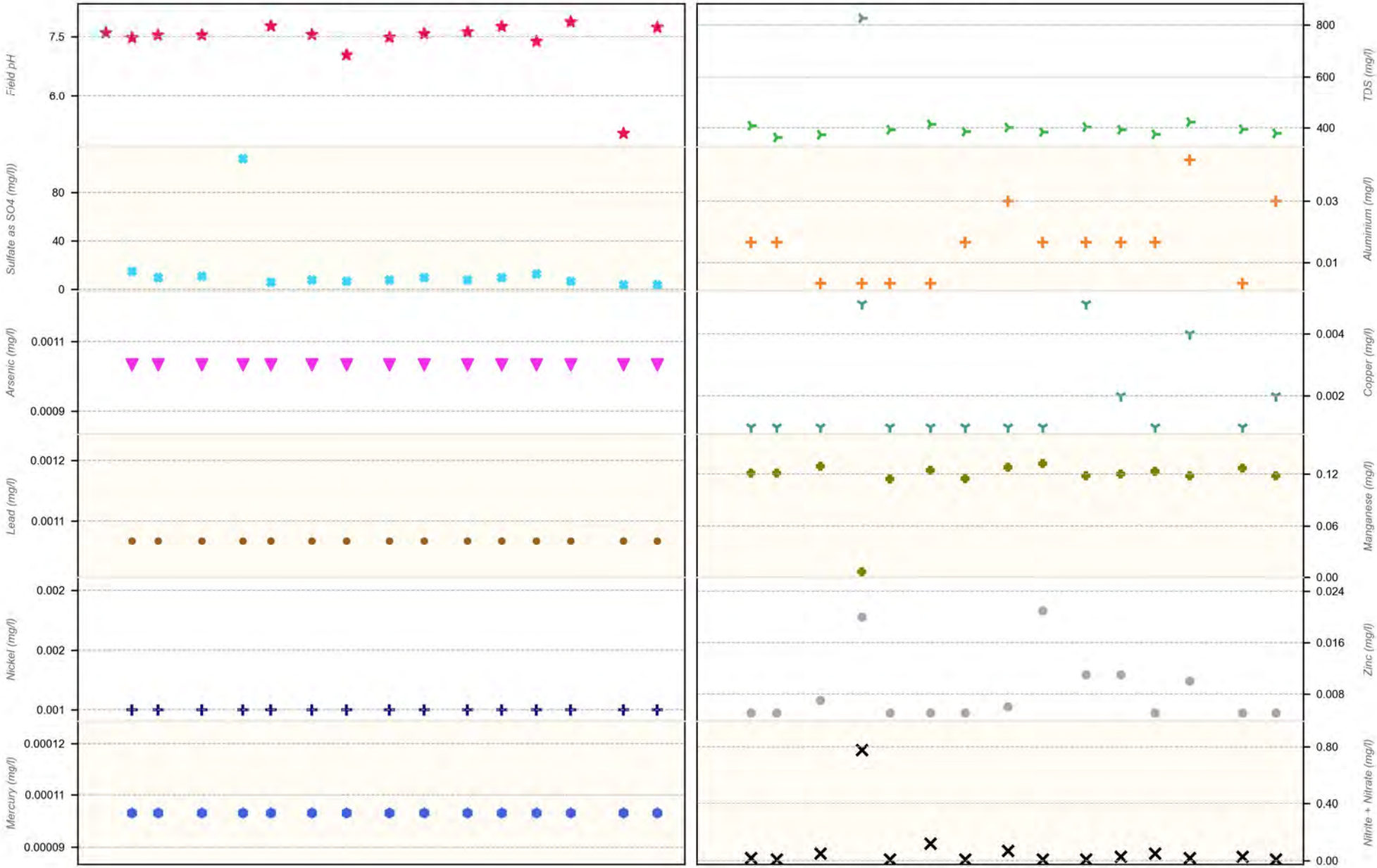
MB90 (Tertiary Basalt, Scrn: 48-60 m, NTSF: 701.9 m)



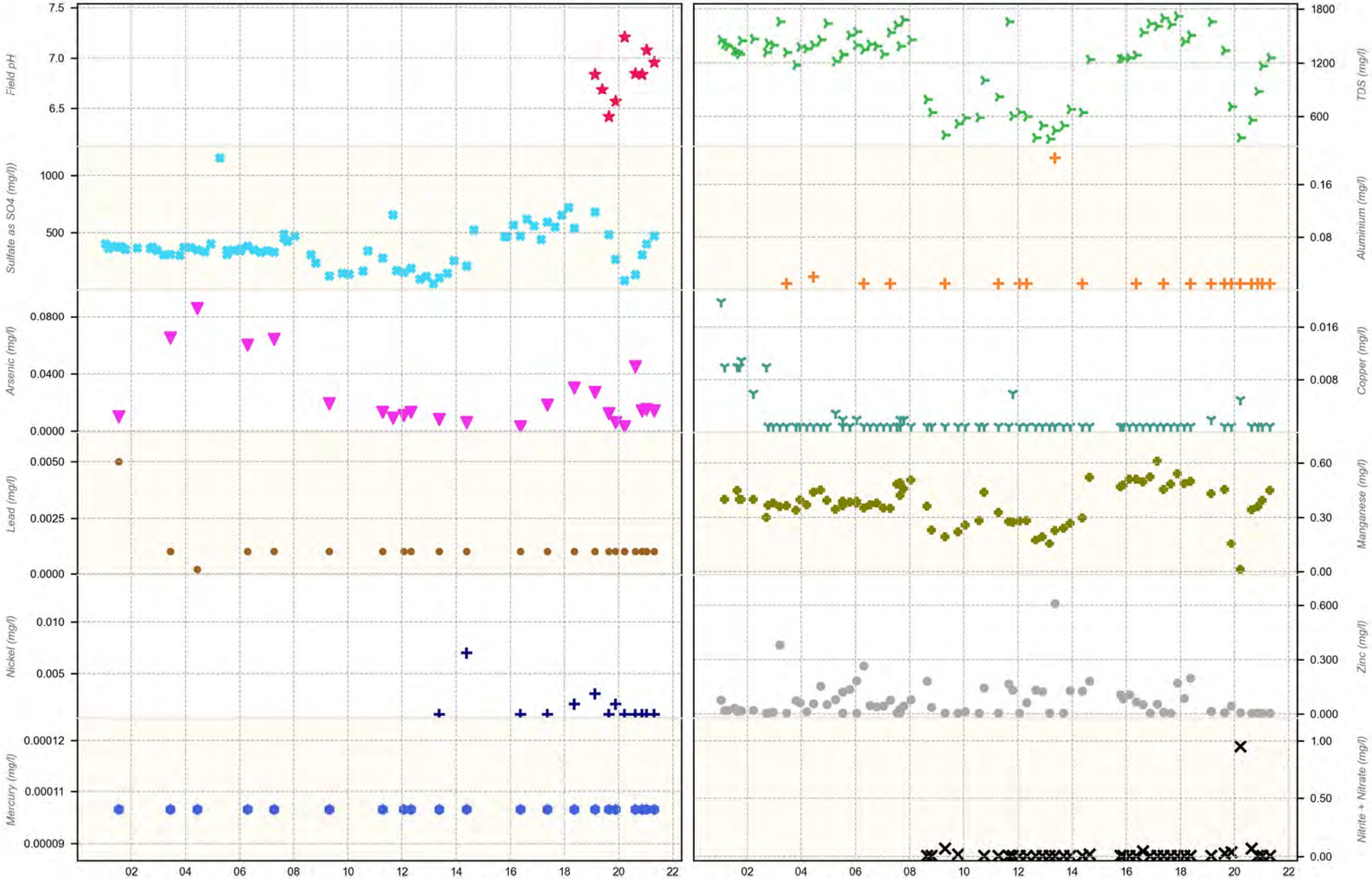
RB03 (Tertiary Basalt, Scrn: 8-22 m, NTSF: 1613.1 m)



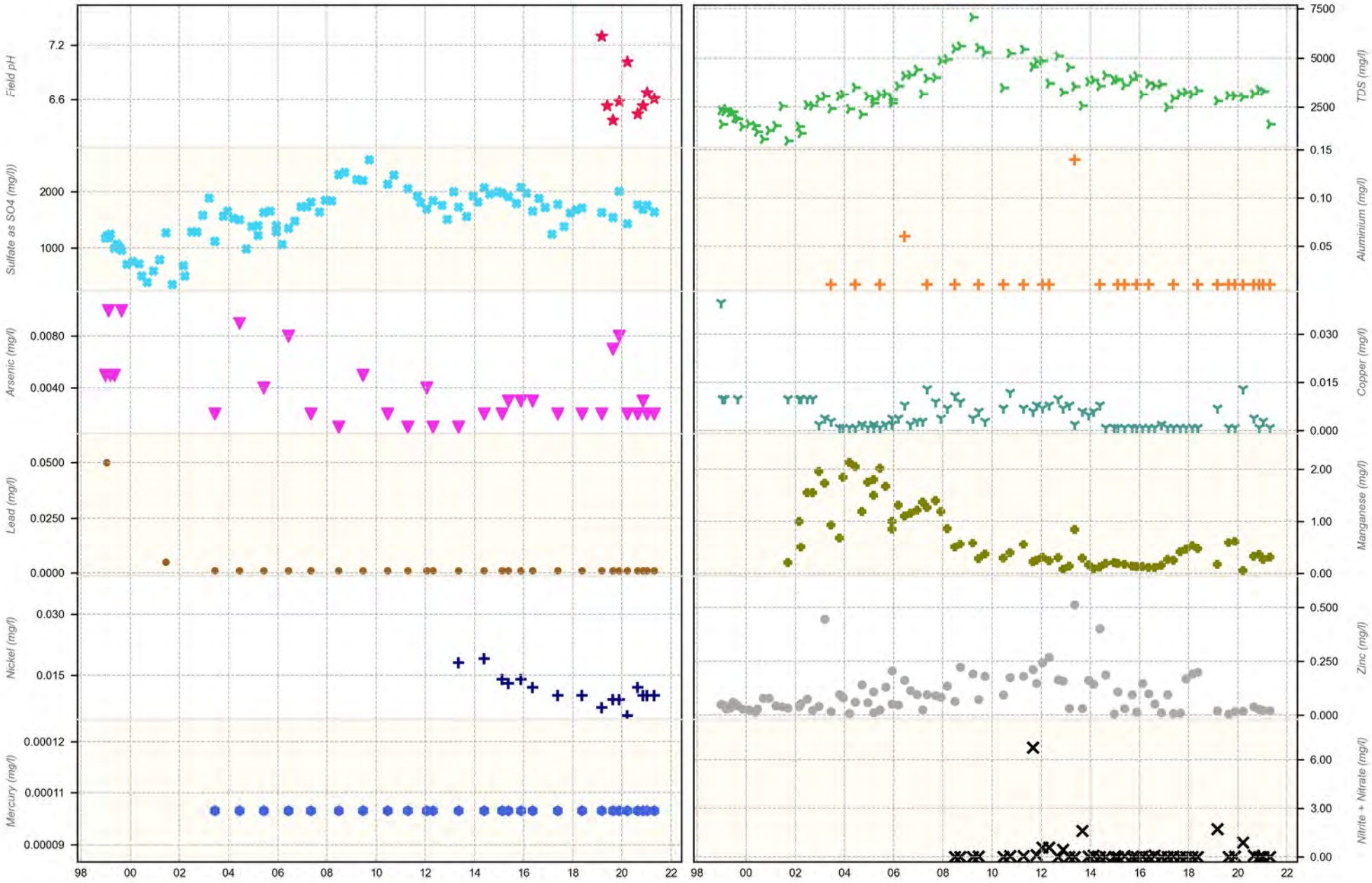
TW05MB (Tertiary Basalt, Scrn: 30-60 m, STSF: 164.7 m)



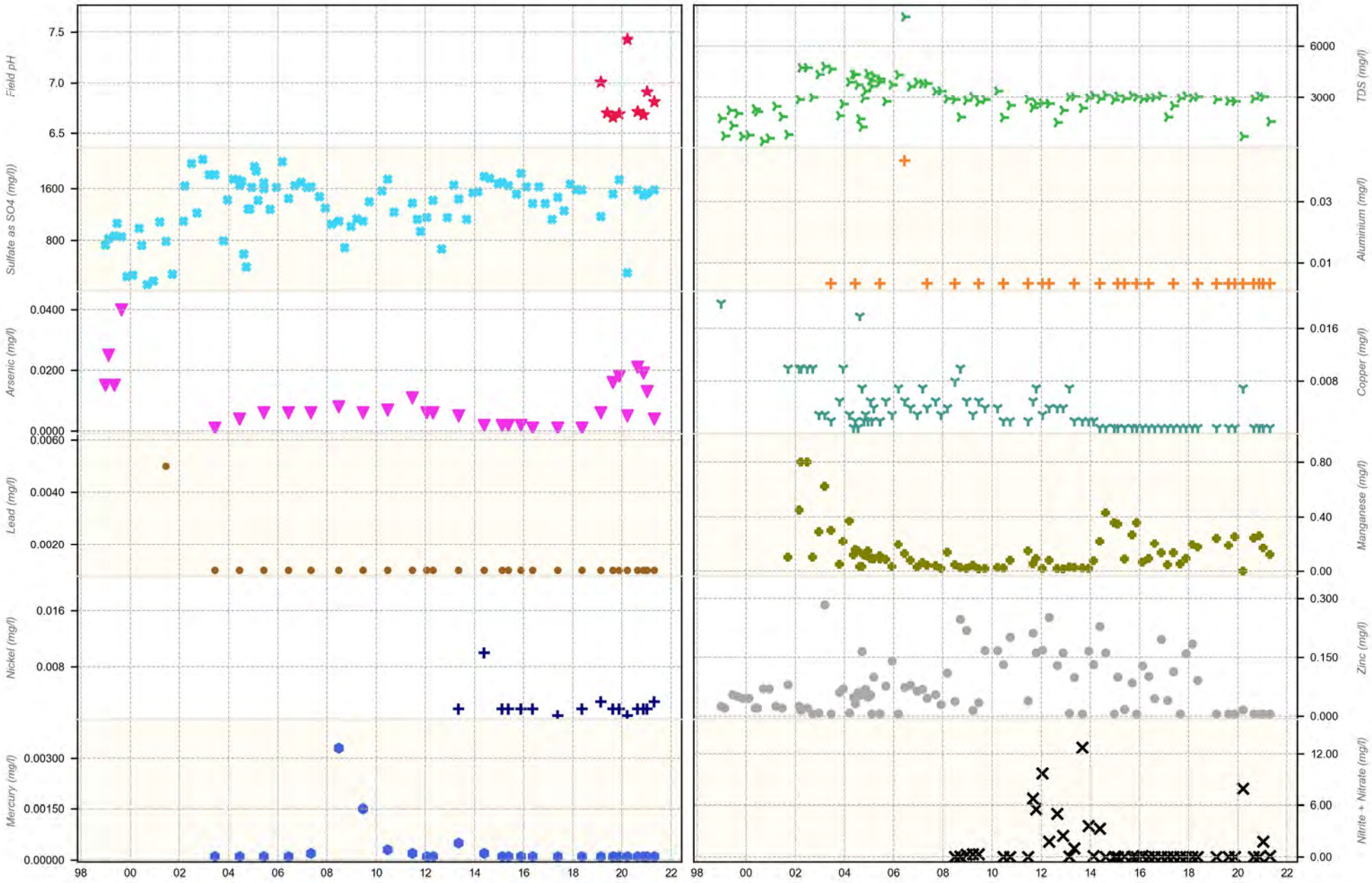
CB6A (Silurian Sediments, Scrn: 0.5-38 m, SWRD: 254.1 m)



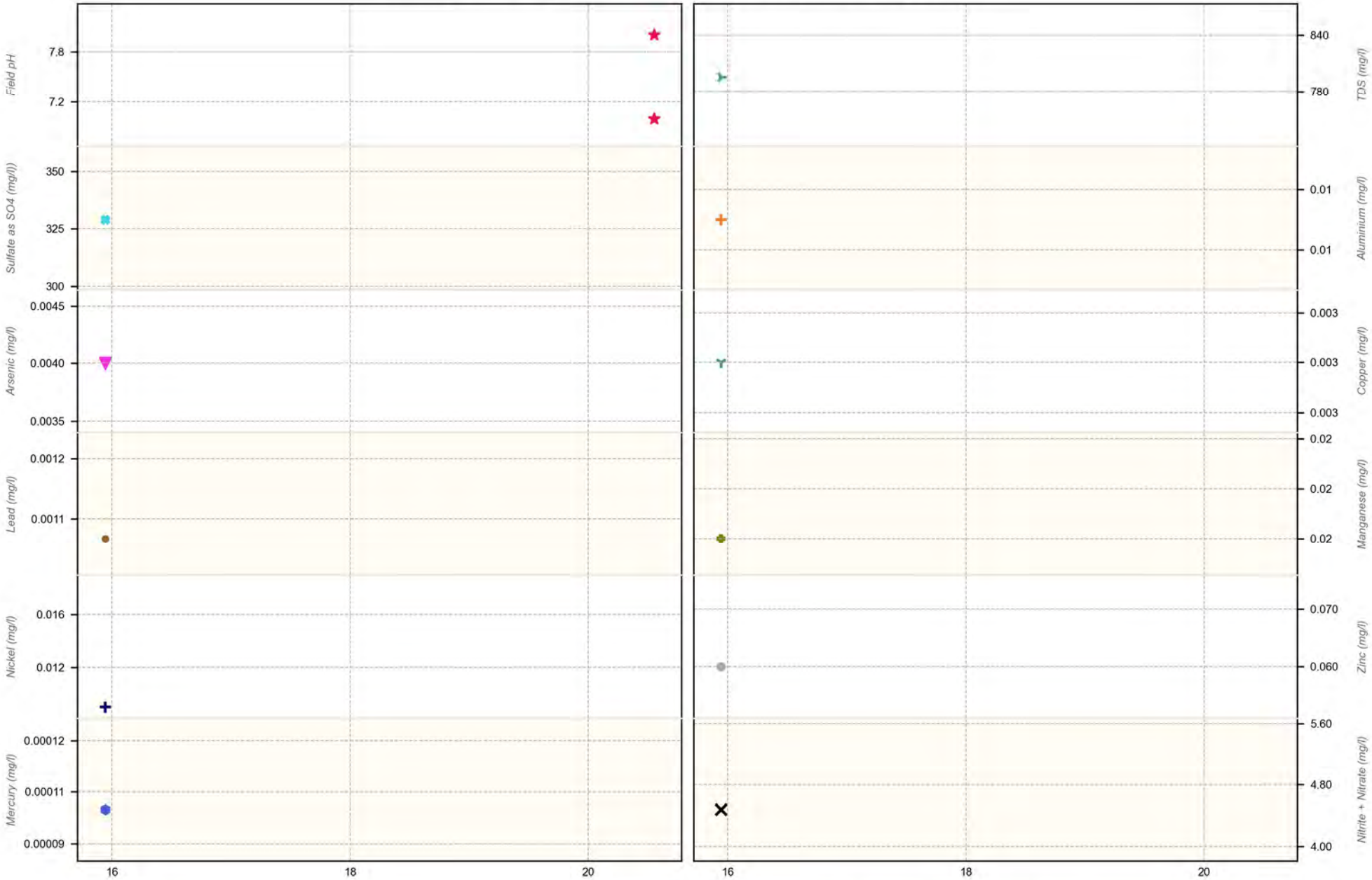
MB1A (Silurian Sediments, Scrn: 28.5-34.5 m, SWRD: 245.3 m)



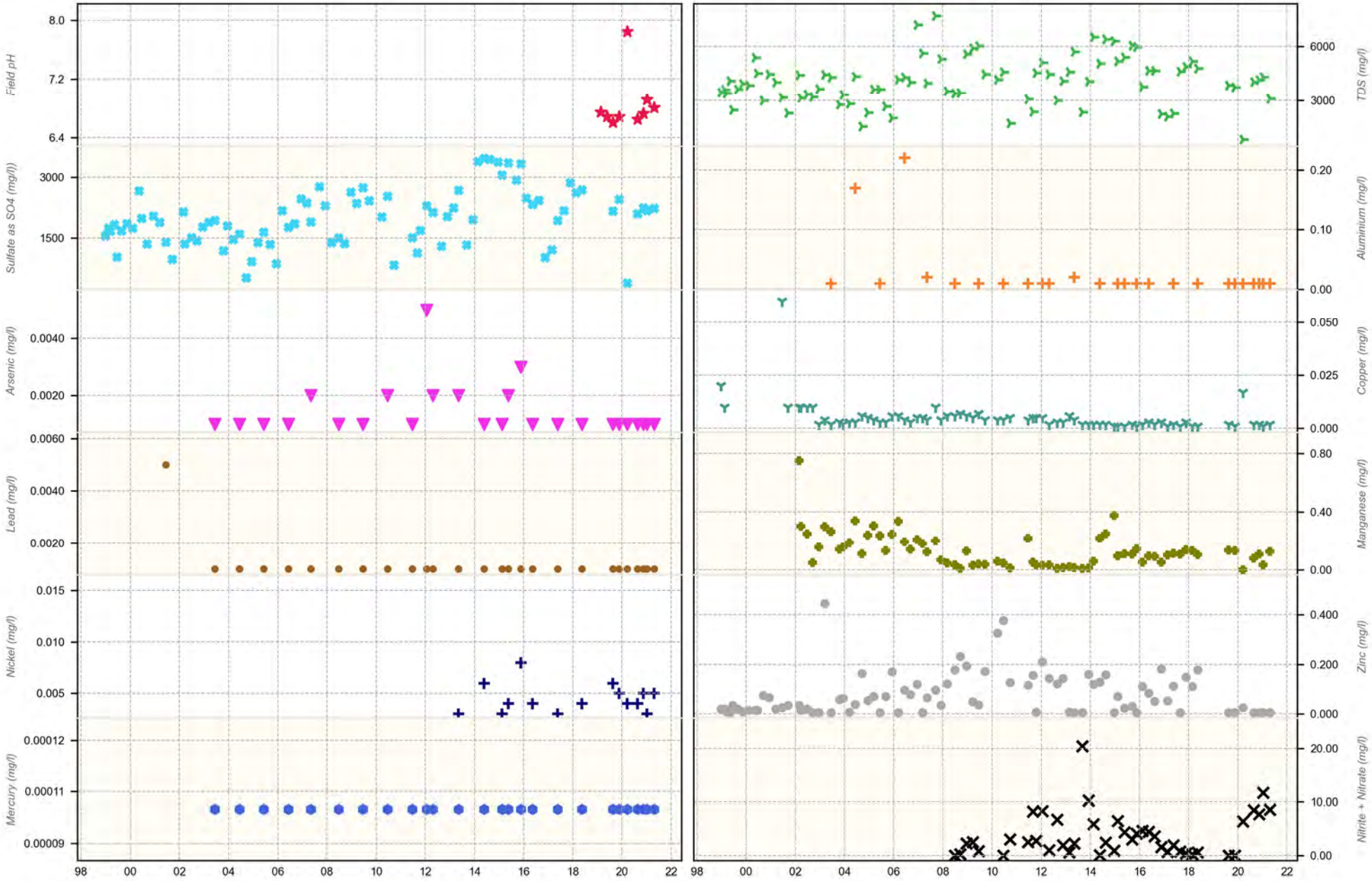
MB2A (Ordovician Volcanics, Scrn: 11.65-17.65 m, SWRD: 471.9 m)



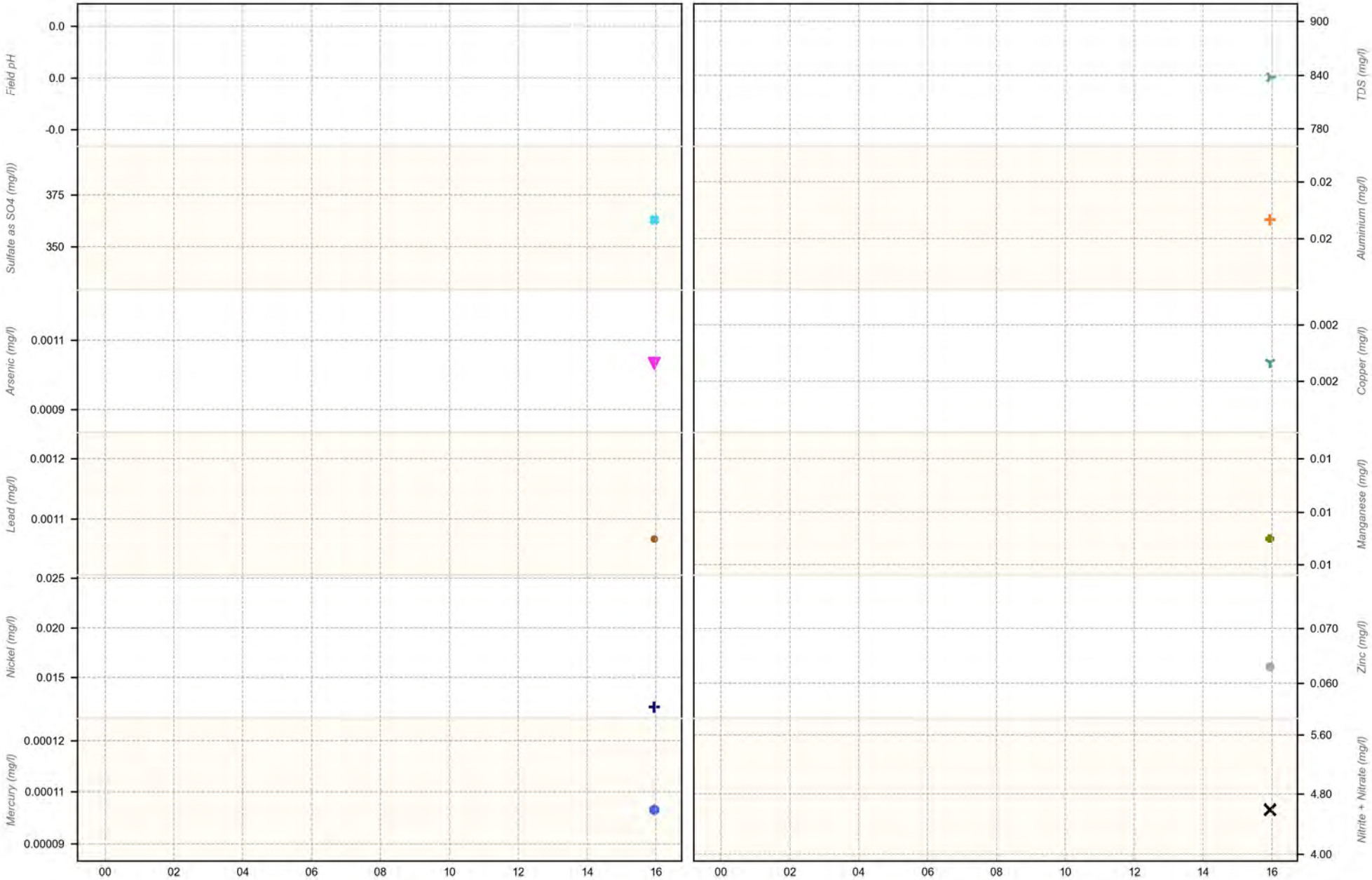
MB2B (Soil/Clay, Scrn: 0.5-6.5 m, SWRD: 472.5 m)



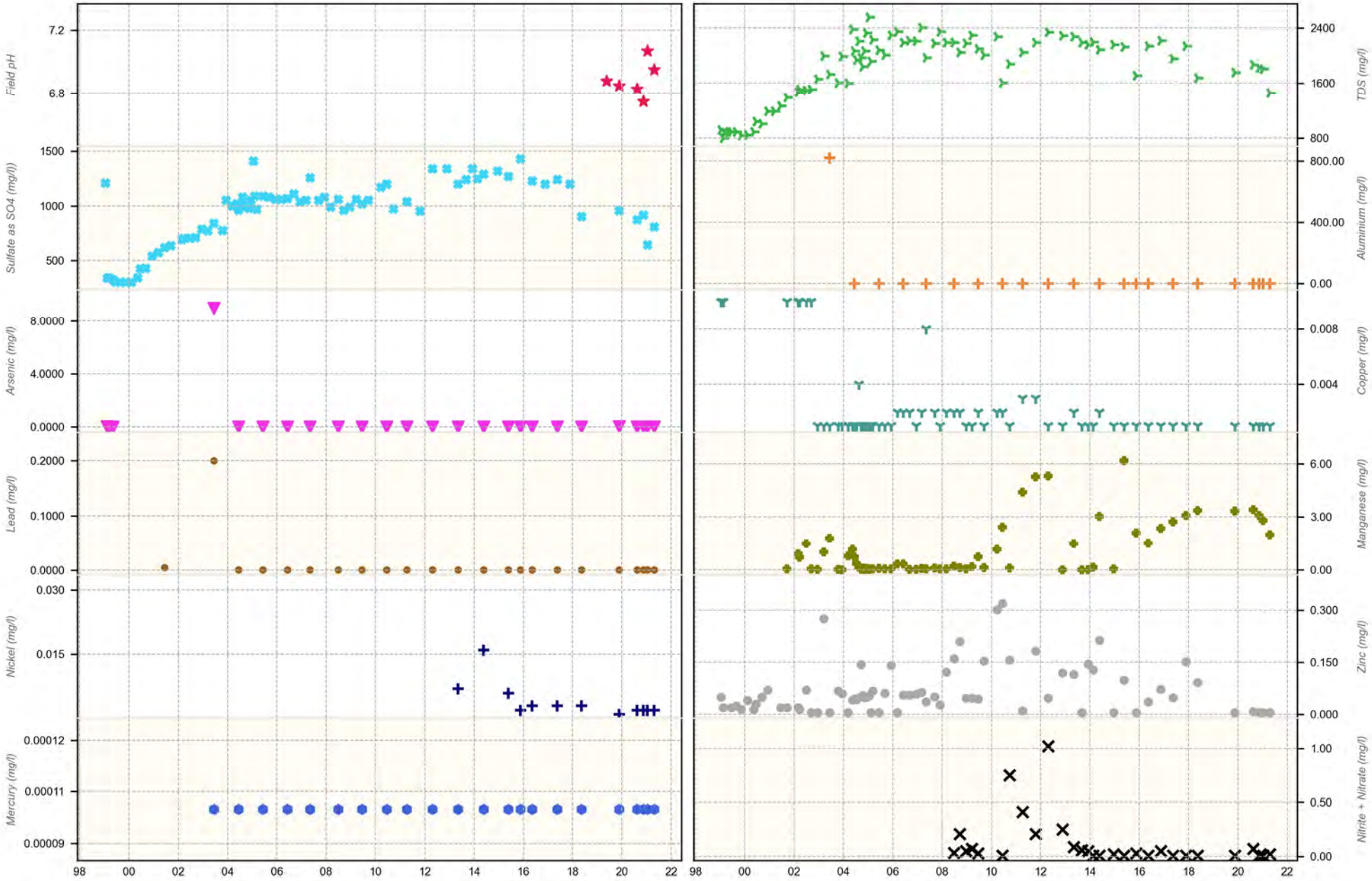
MB3A (Silurian Sediments, Scrn: 10-16 m, SWRD: 485.4 m)



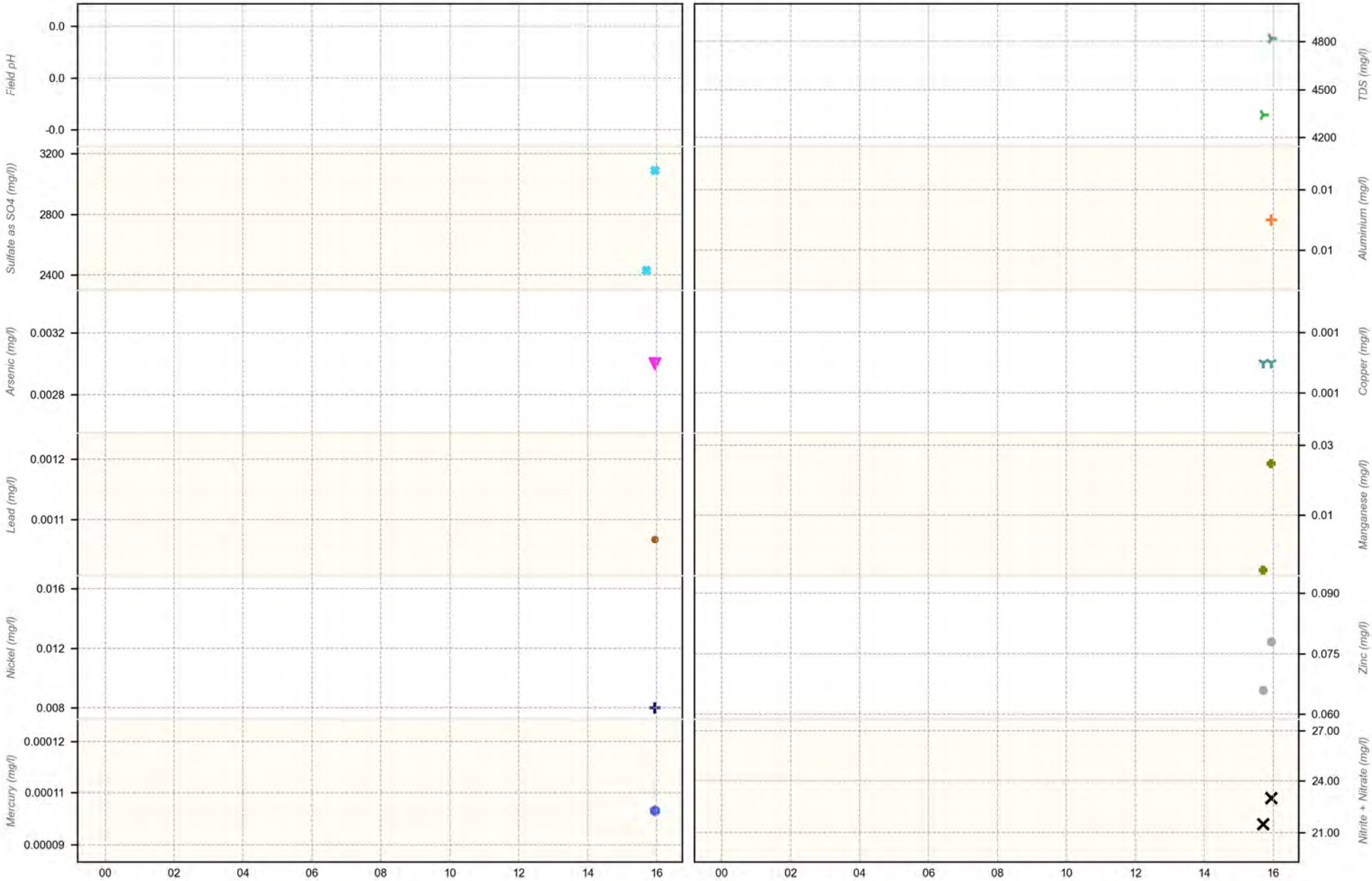
MB3B (Soil/Clay, Scrn: 0.45-6.45 m, SWRD: 485.1 m)



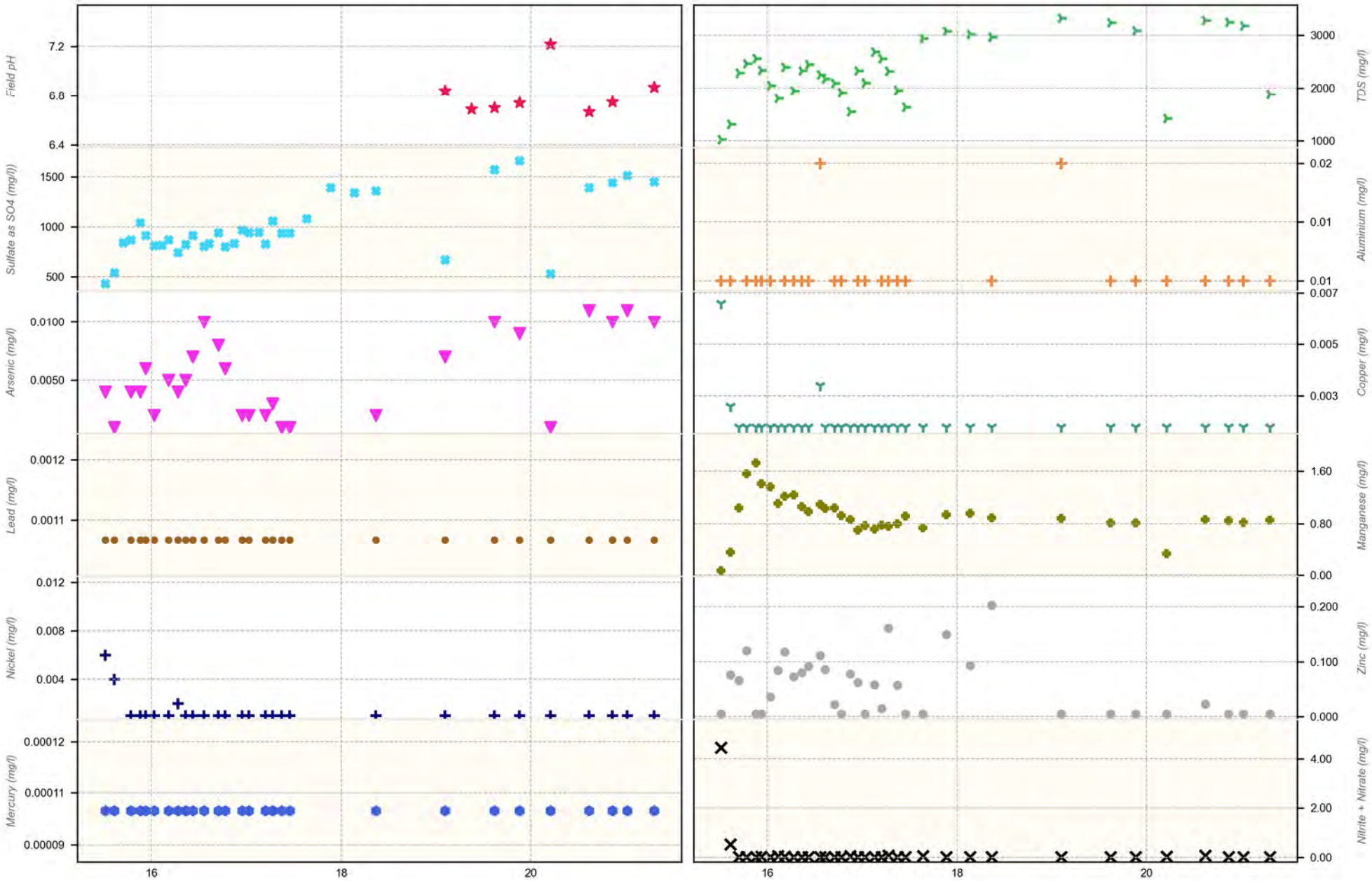
MB4A (Ordovician Volcanics, Scrn: 17.1-23.1 m, SWRD: 266.7 m)



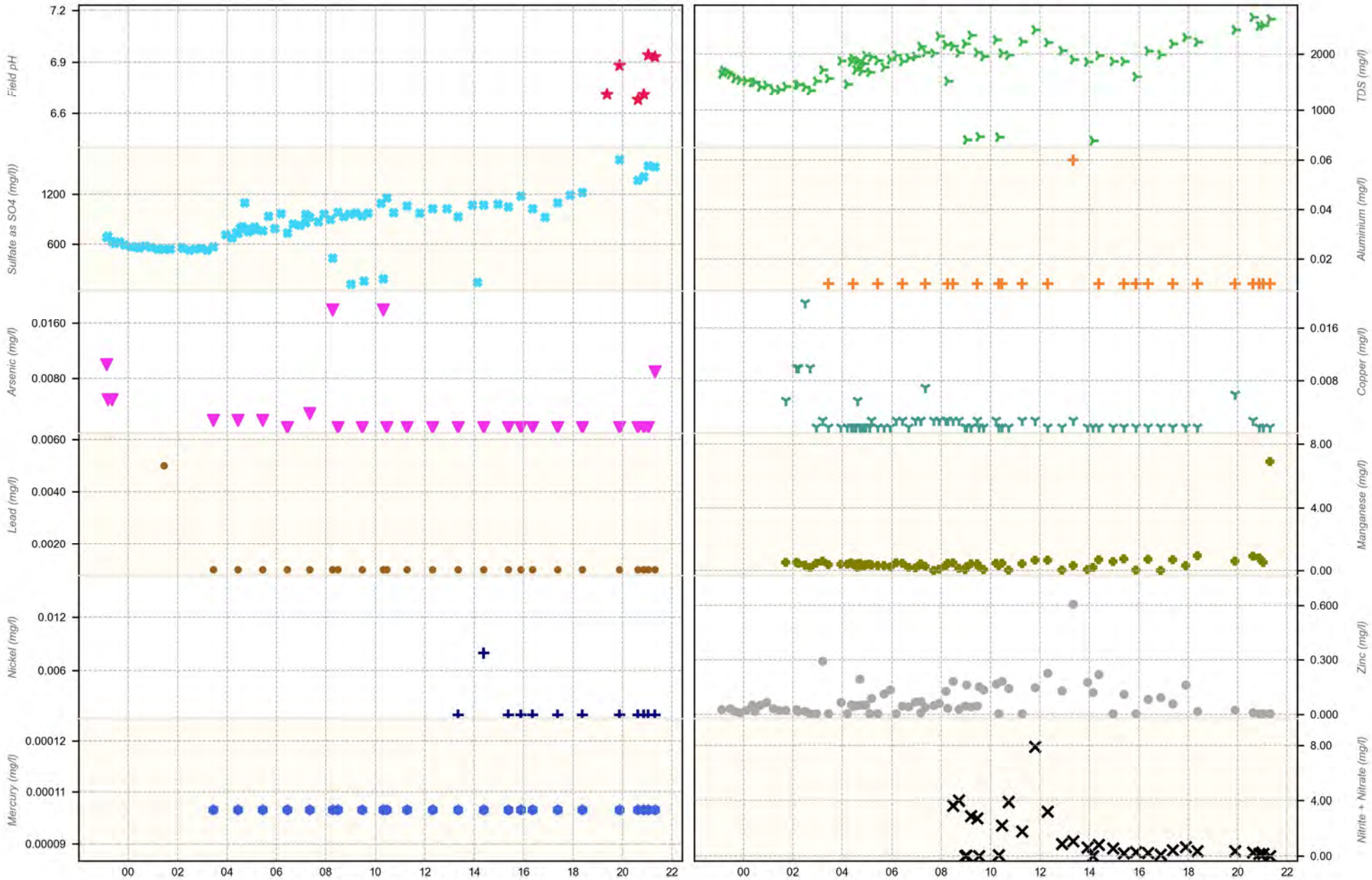
MB4B (Soil/Clay, Scrn: 0.3-6.3 m, SWRD: 265.3 m)



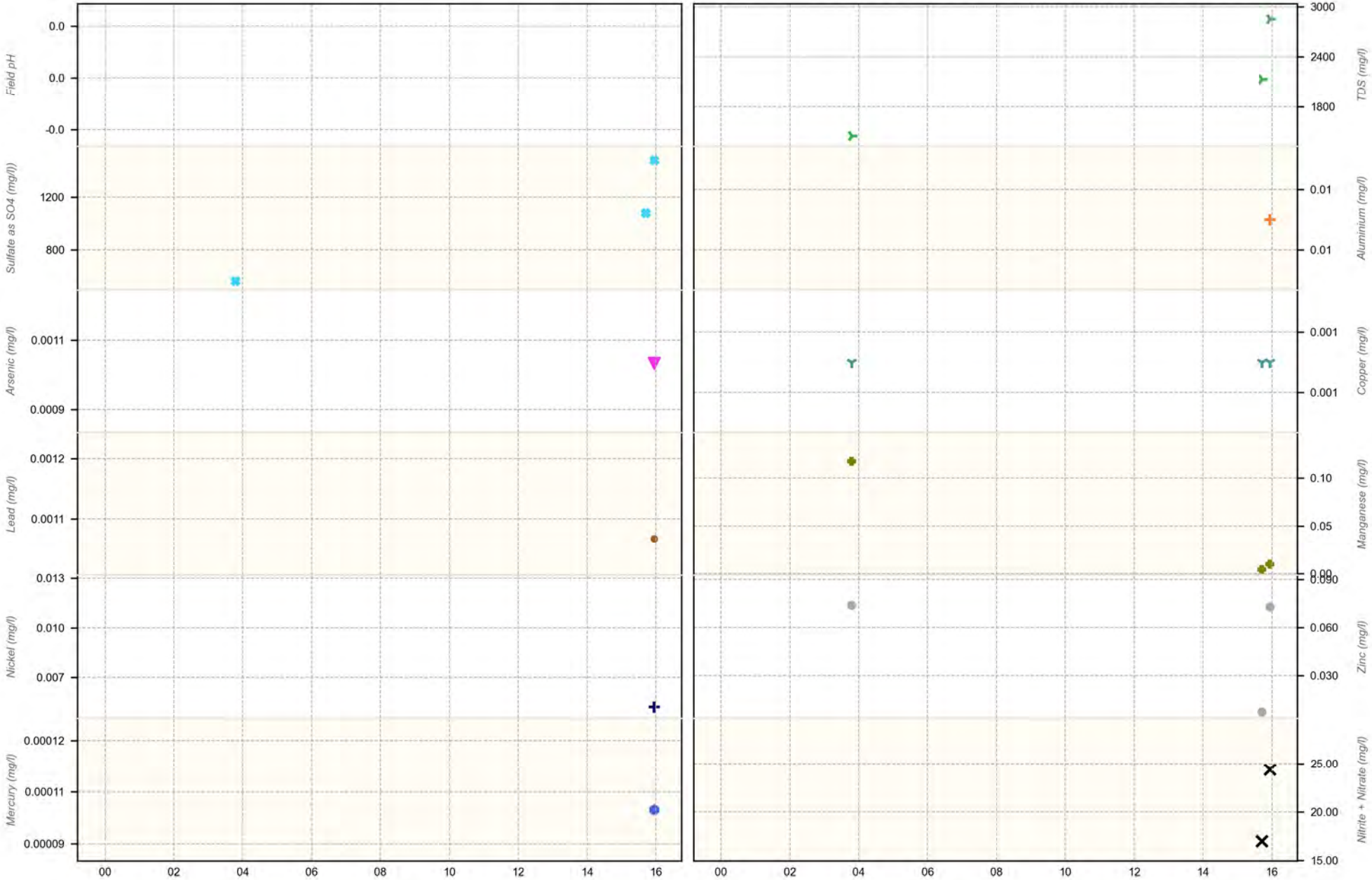
MB5C (Tertiary Basalt, Scrn: 43-55 m, SWRD: 209.9 m)



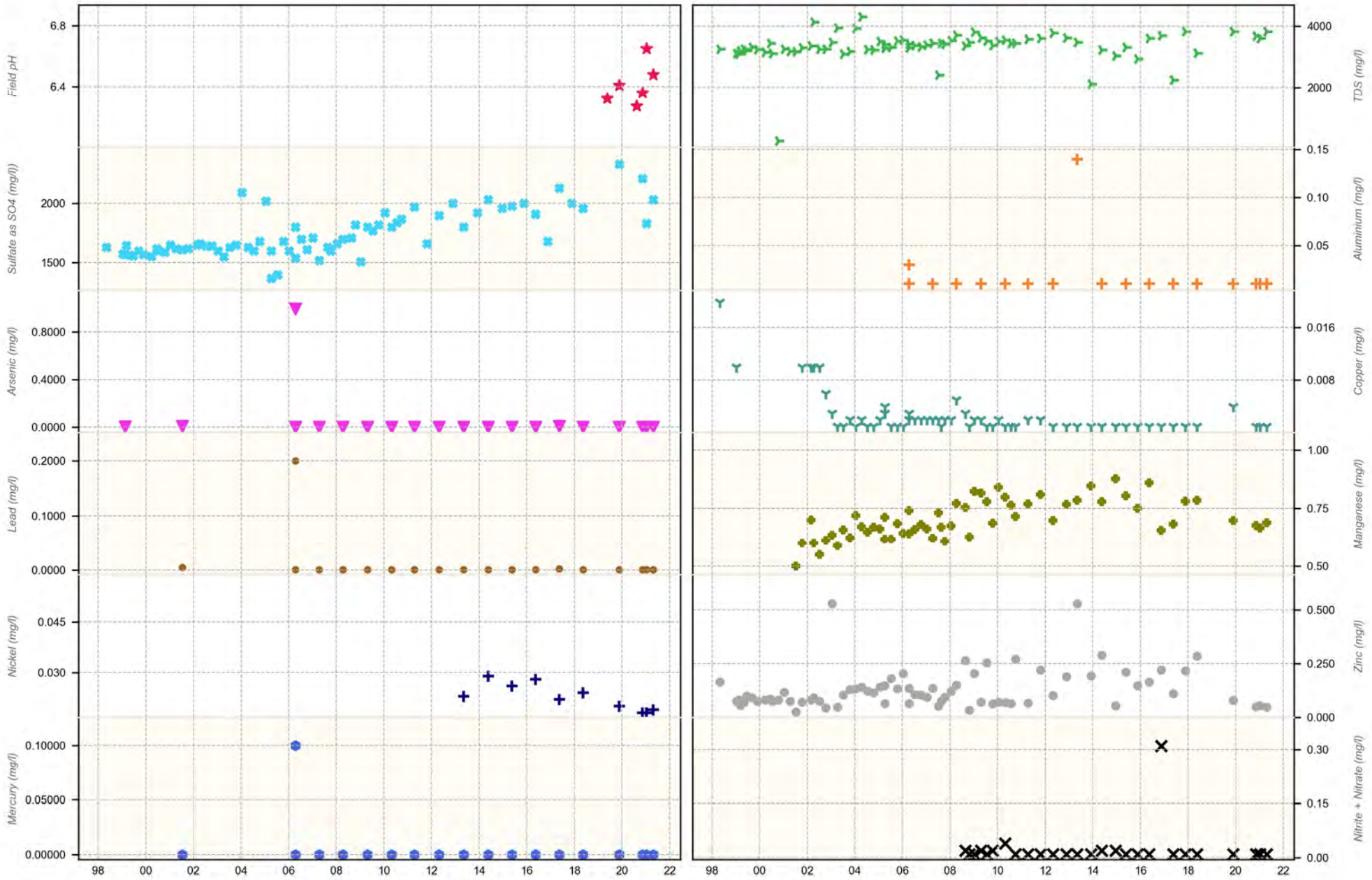
MB6A (Ordovician Volcanics, Scrn: 11.59-17.59 m, SWRD: 312.8 m)



MB6B (Soil/Clay, Scrn: 0.5-6.5 m, SWRD: 311.2 m)

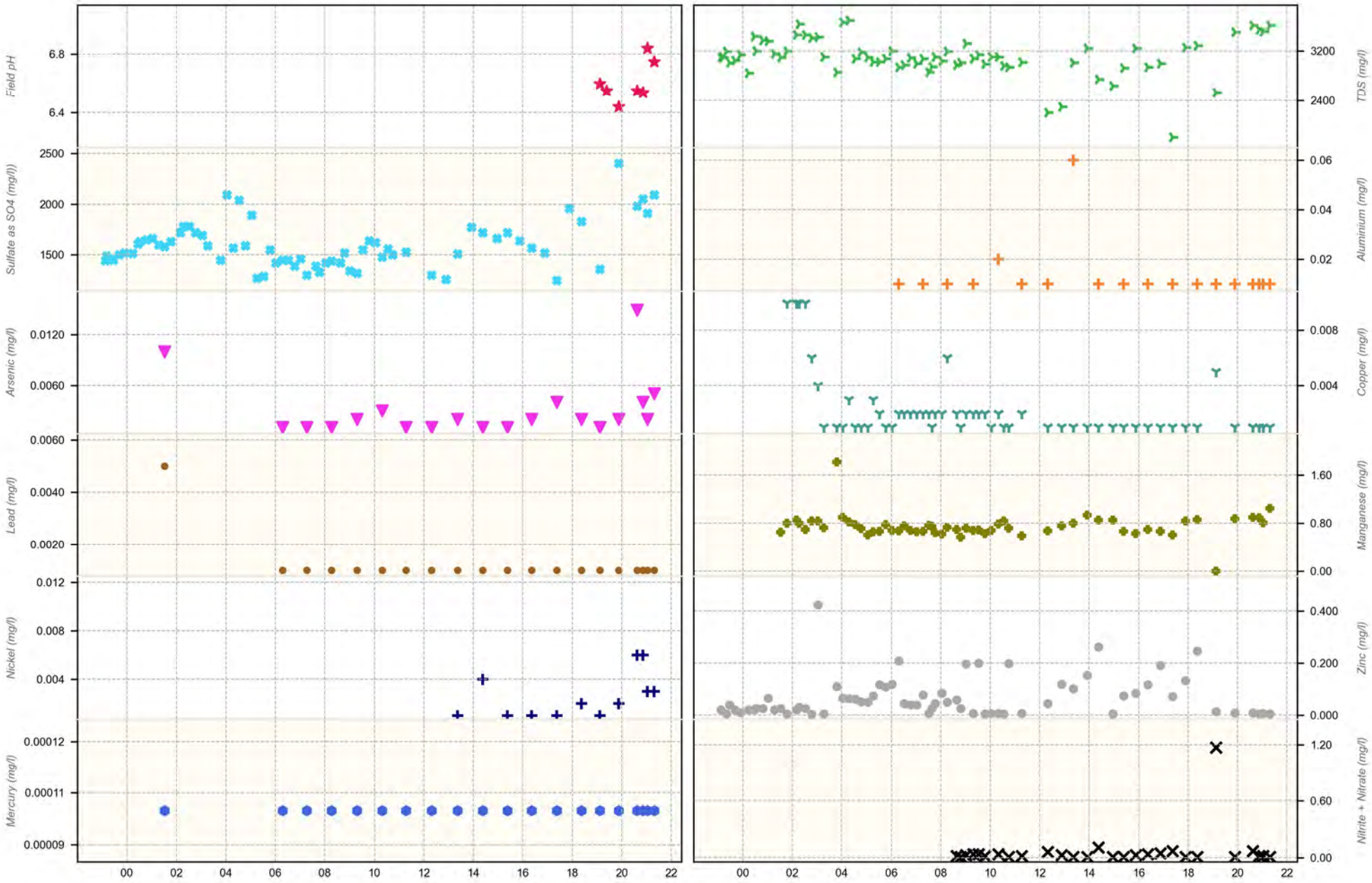


MB7A (Silurian Sediments, Scrn: 12-18 m, SWRD: 328.3 m)

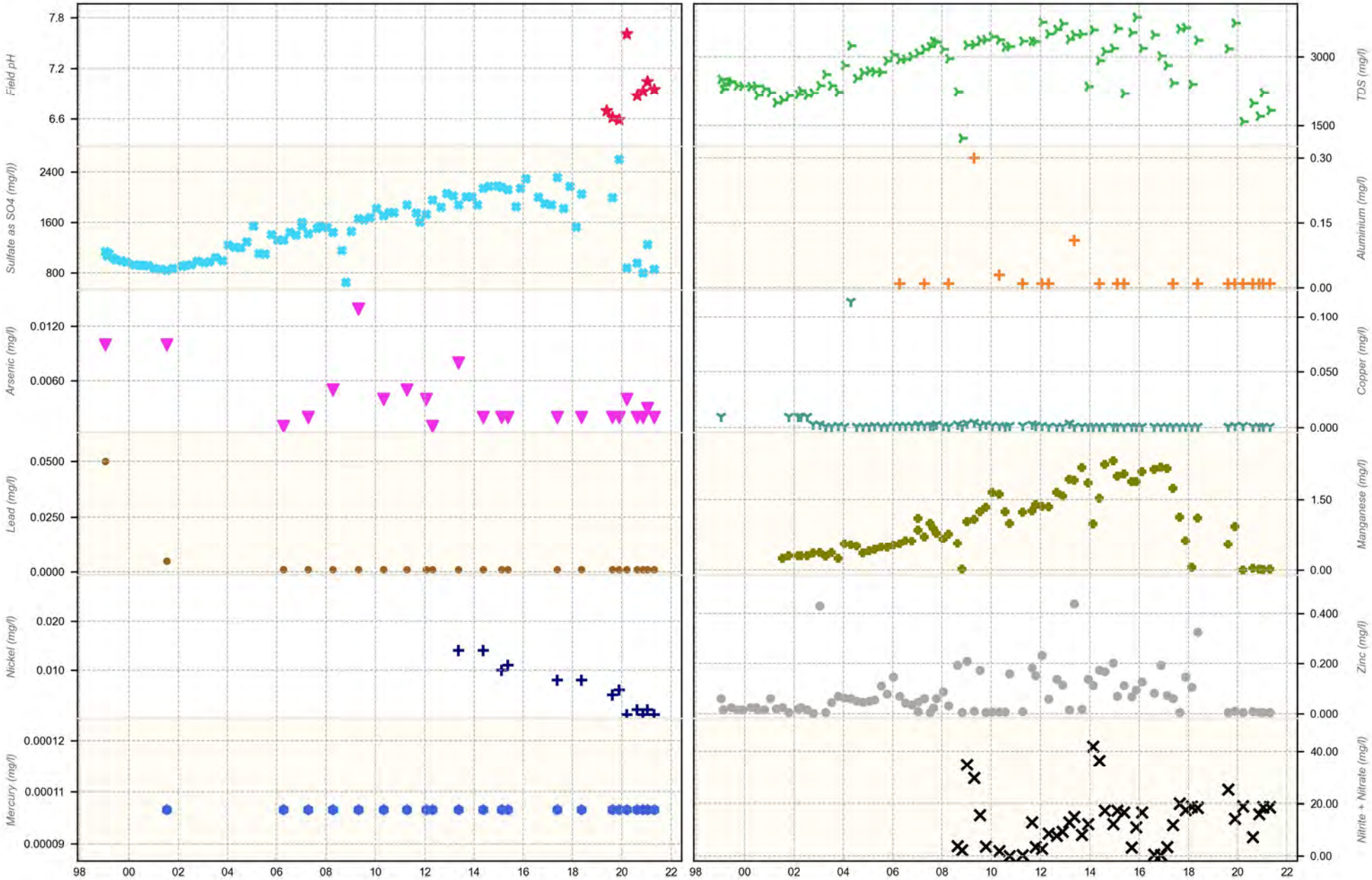


MB7B (Soil/Clay, Scrn: 0.45-6.45 m, SWRD: 327.1 m)

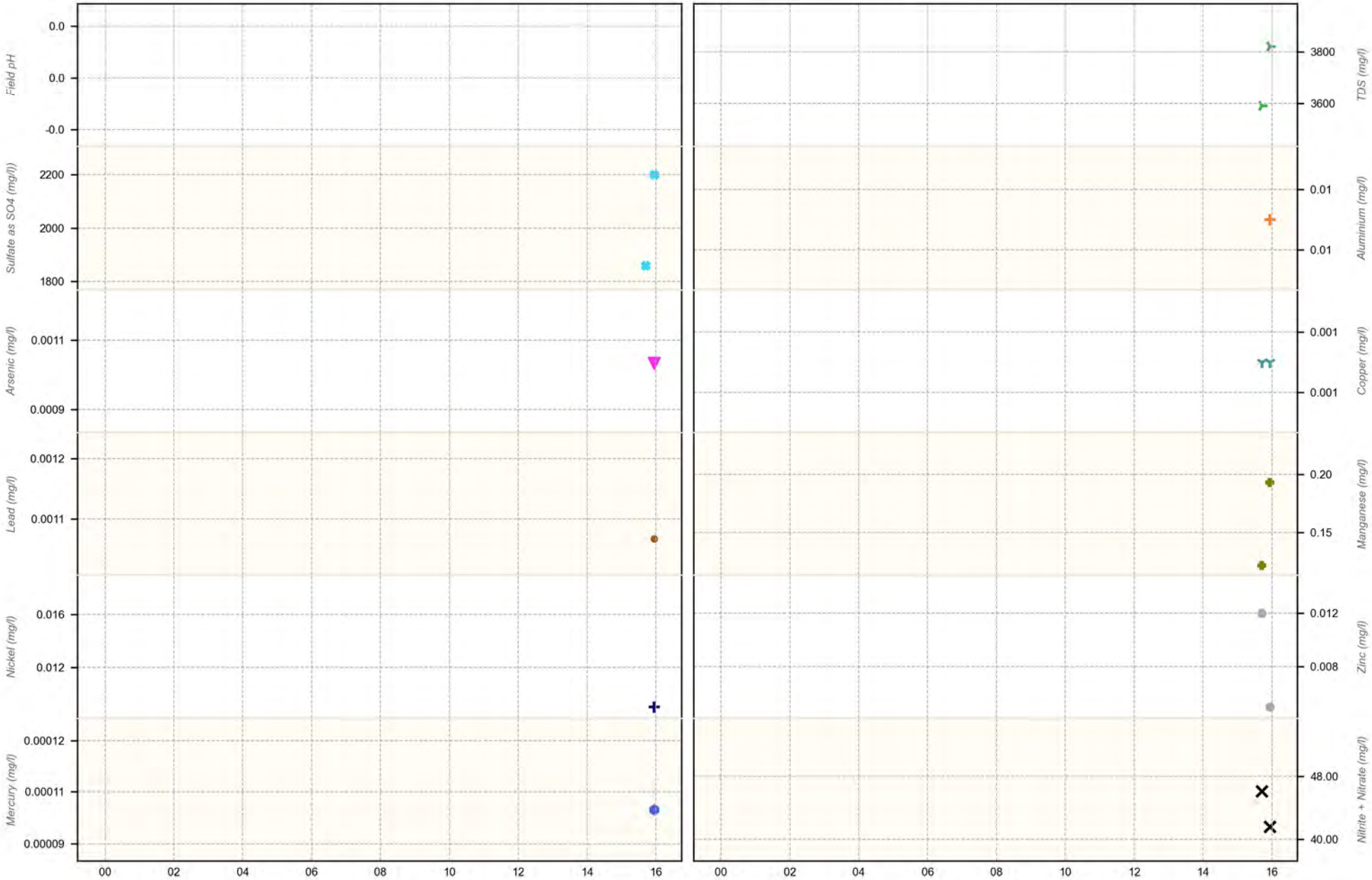
MB8A (Silurian Sediments, Scrn: 11.5-17.5 m, SWRD: 411.4 m)



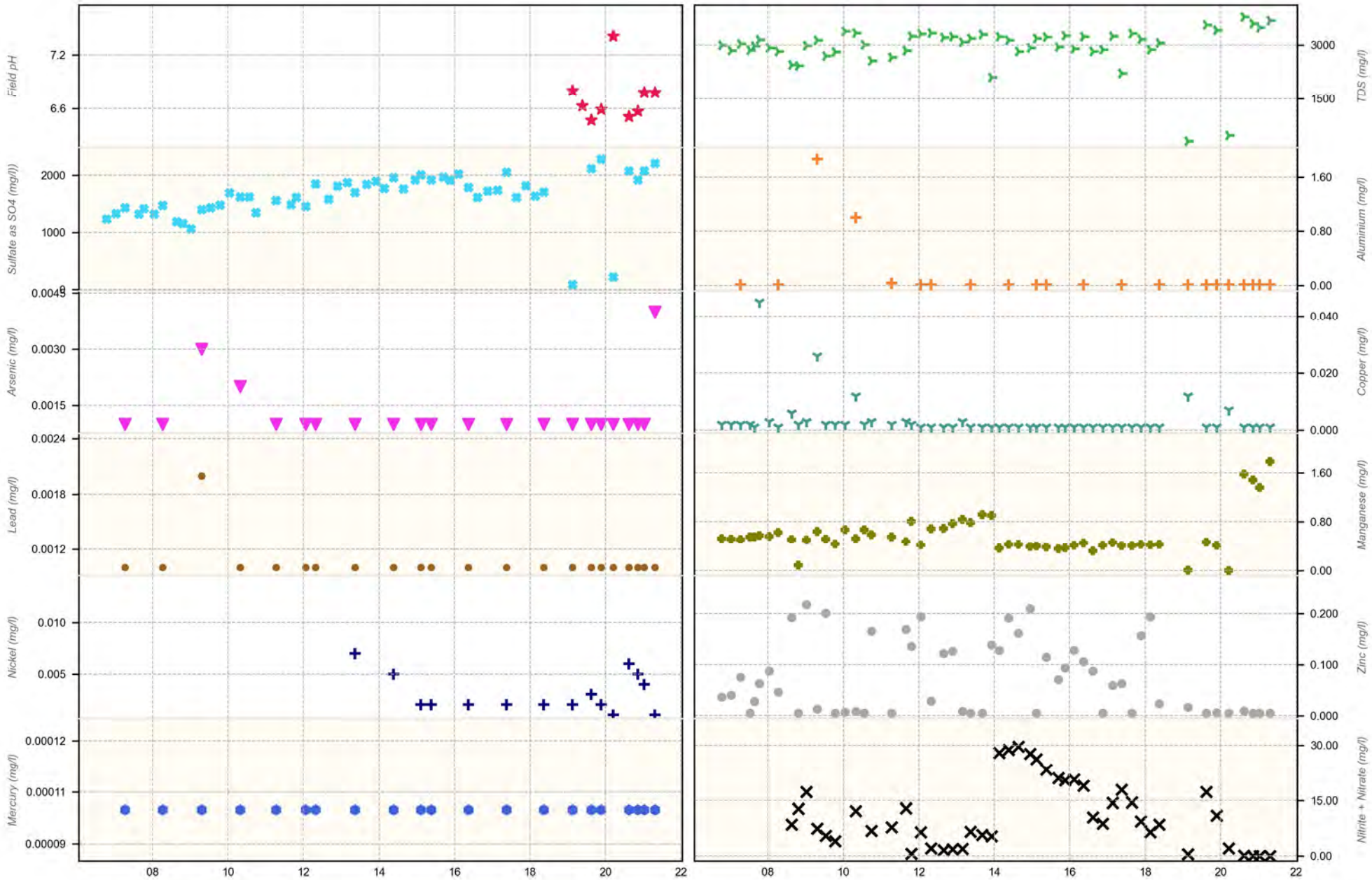
MB9A (Ordovician Volcanics, Scrn: 10.5-16.5 m, SWRD: 289.3 m)



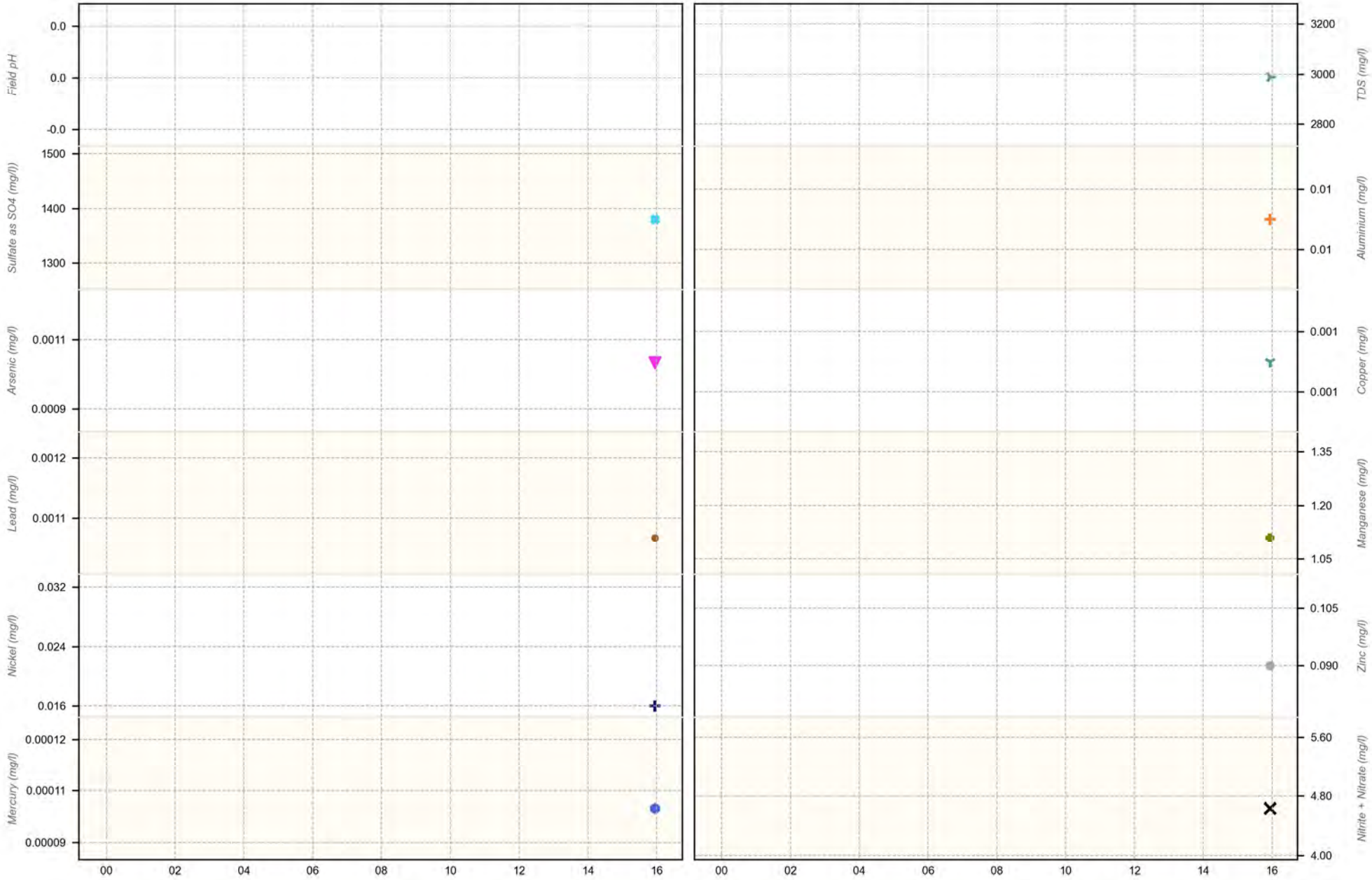
MB9B (Soil/Clay, Scrn: 0.2-6.2 m, SWRD: 287.1 m)



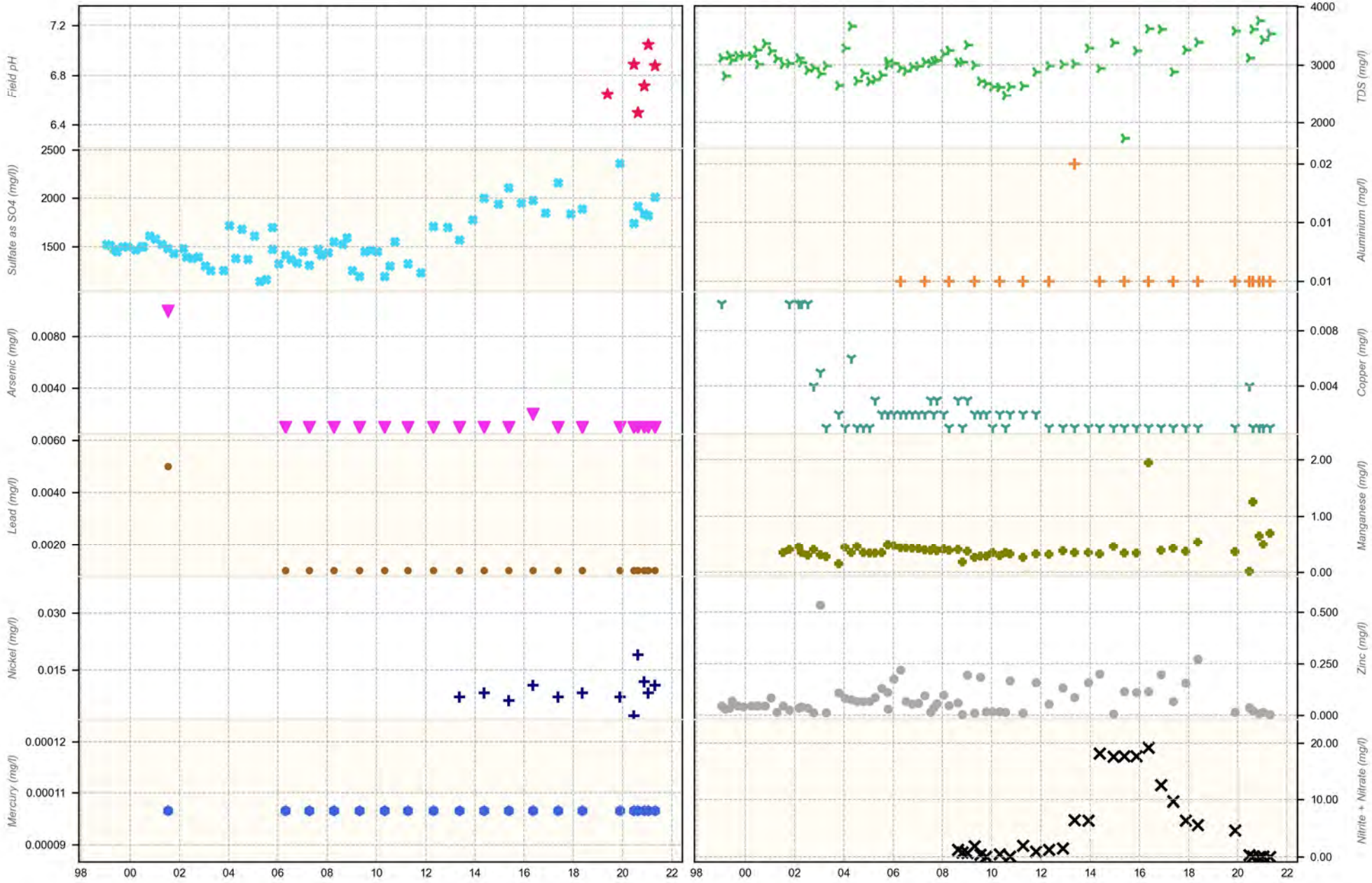
MB10A (Silurian Sediments, Scrn: 12-18 m, SWRD: 275.9 m)



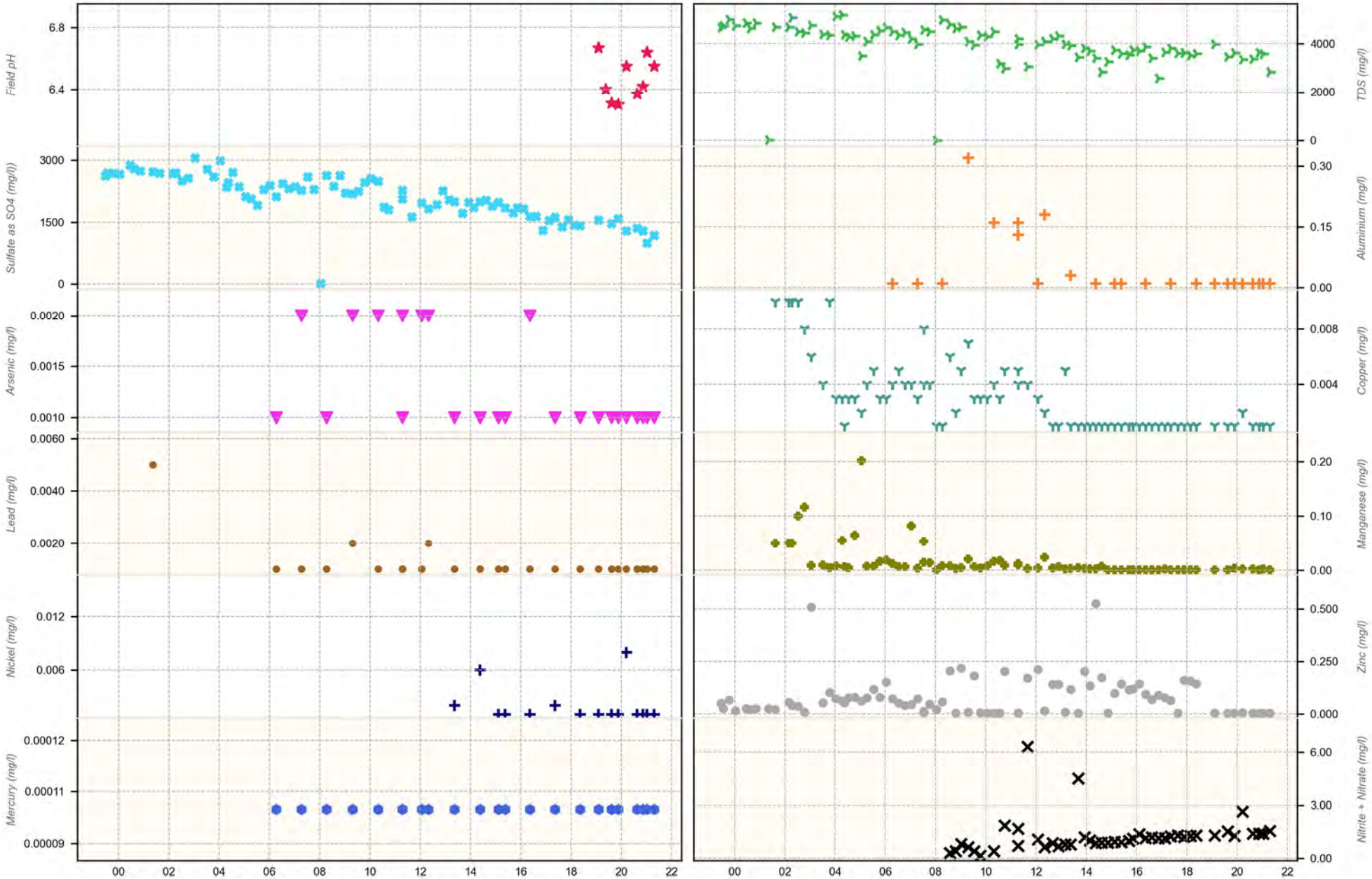
MB10B (Soil/Clay, Scrn: 0.7-6.7 m, SWRD: 274.5 m)



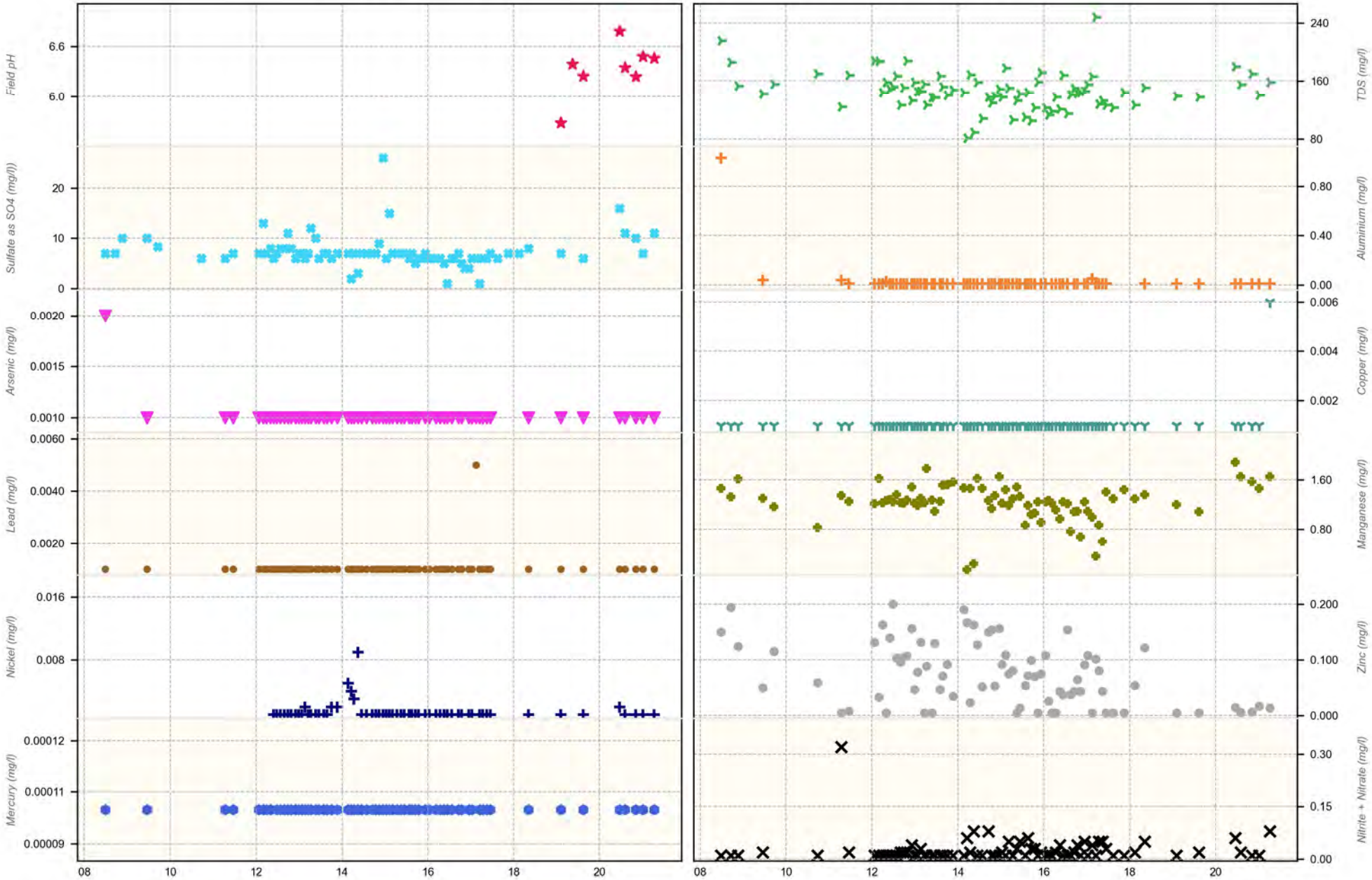
MB11A (Silurian Sediments, Scrn: 12-18 m, SWRD: 328.4 m)



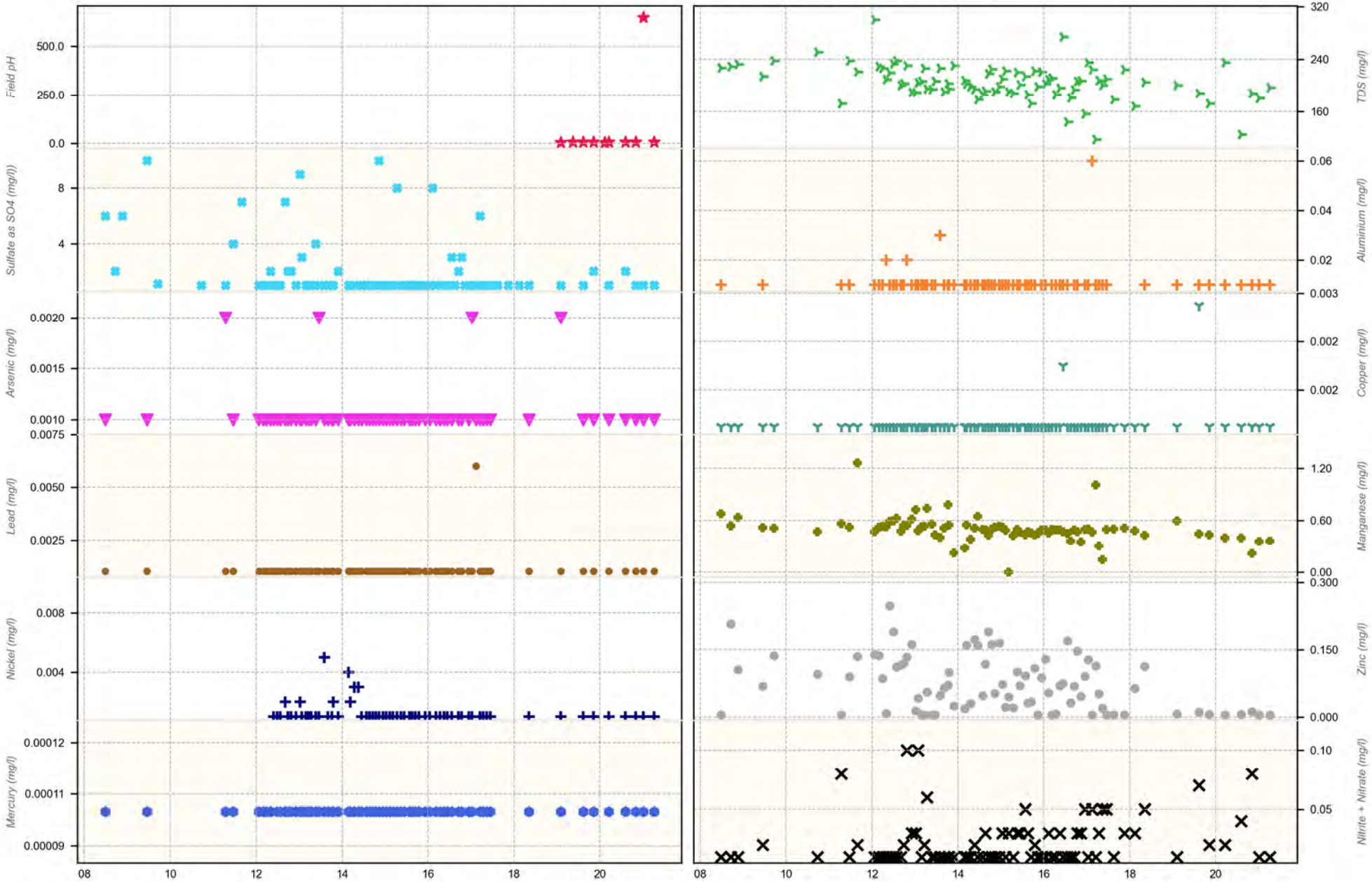
MB18 (Silurian Sediments, Scrn: 17.6-29.6 m, SWRD: 260.1 m)



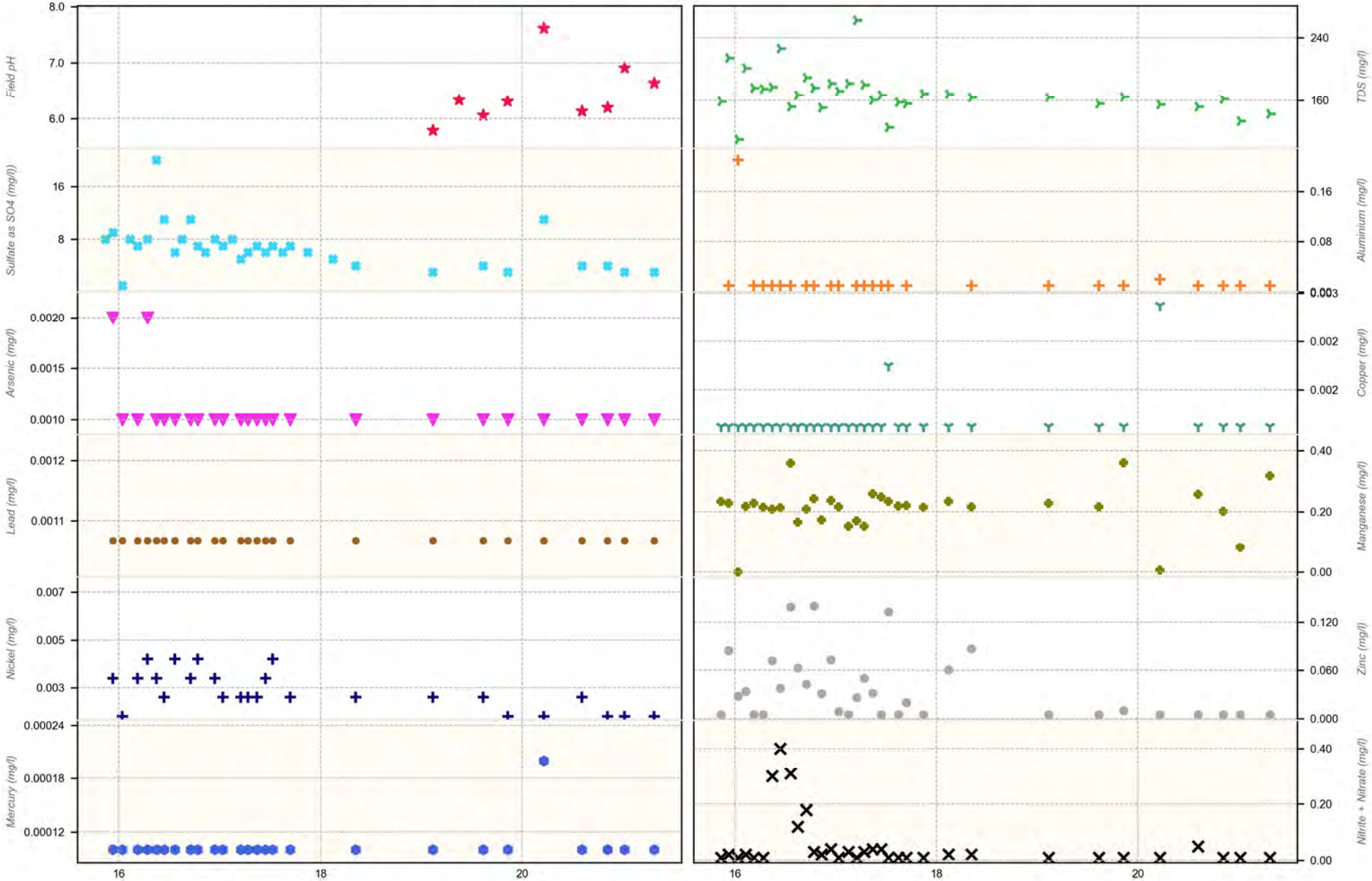
MB48 (Silurian Sediments, Scrn: 26-69 m, NWRD: 1454.0 m)



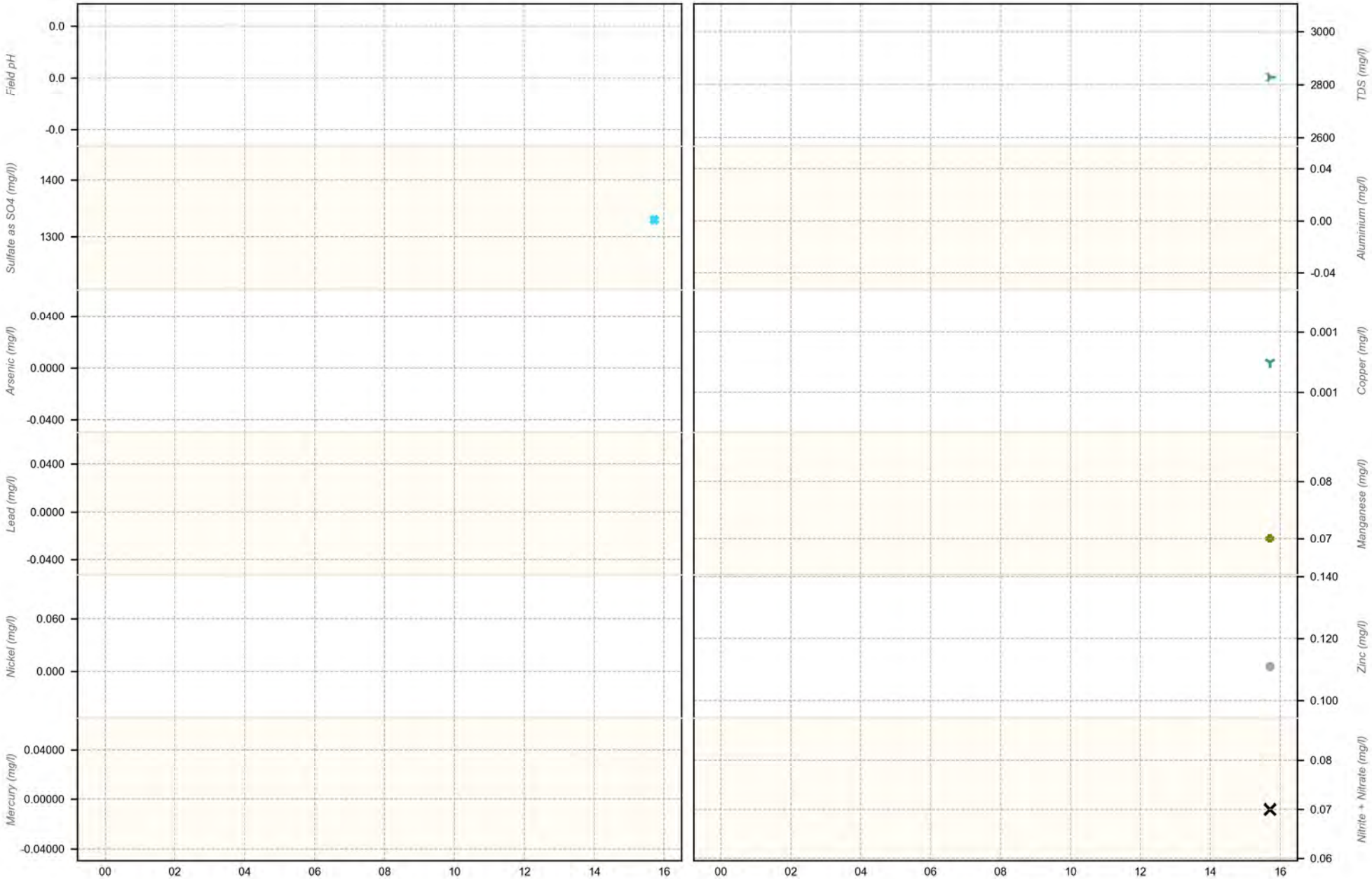
MB49 (Tertiary Basalt, Scrn: 20-39 m, NWRD: 638.5 m)



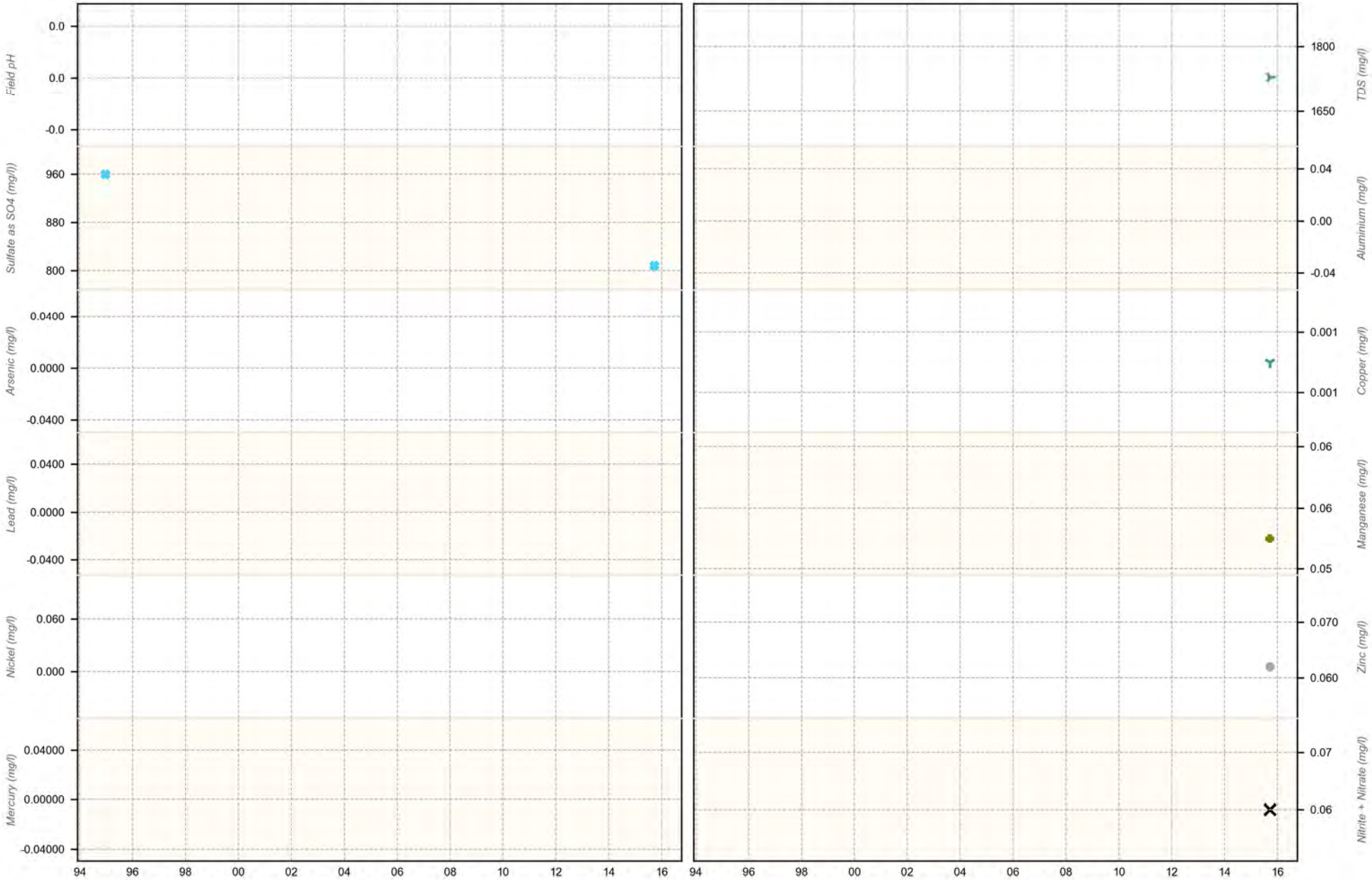
MB82 (Silurian Sediments, Scrn: 91-103 m, NWRD: 314.6 m)



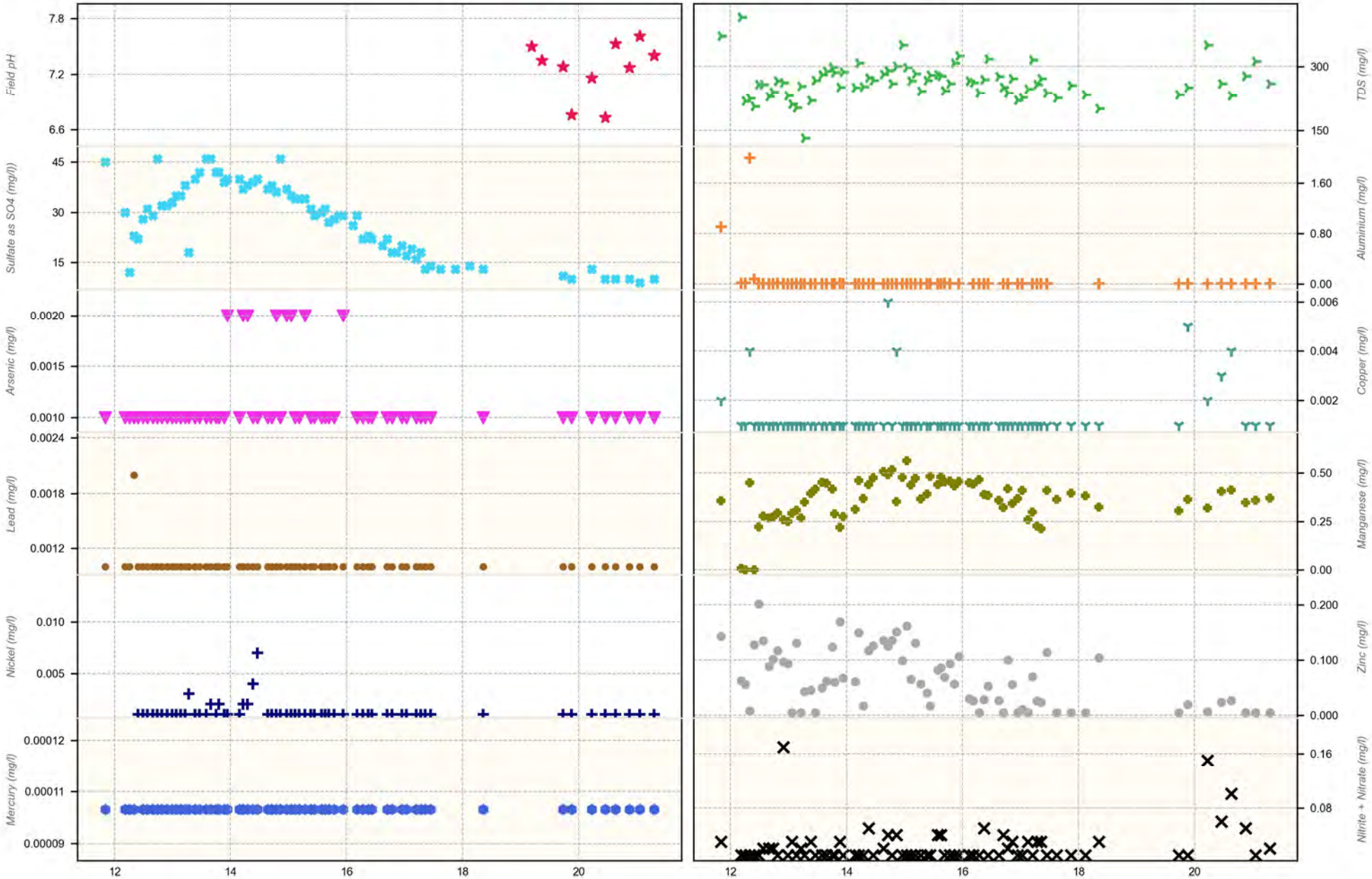
RB04 (Silurian Sediments, Scrn: NoData, SWRD: 906.9 m)



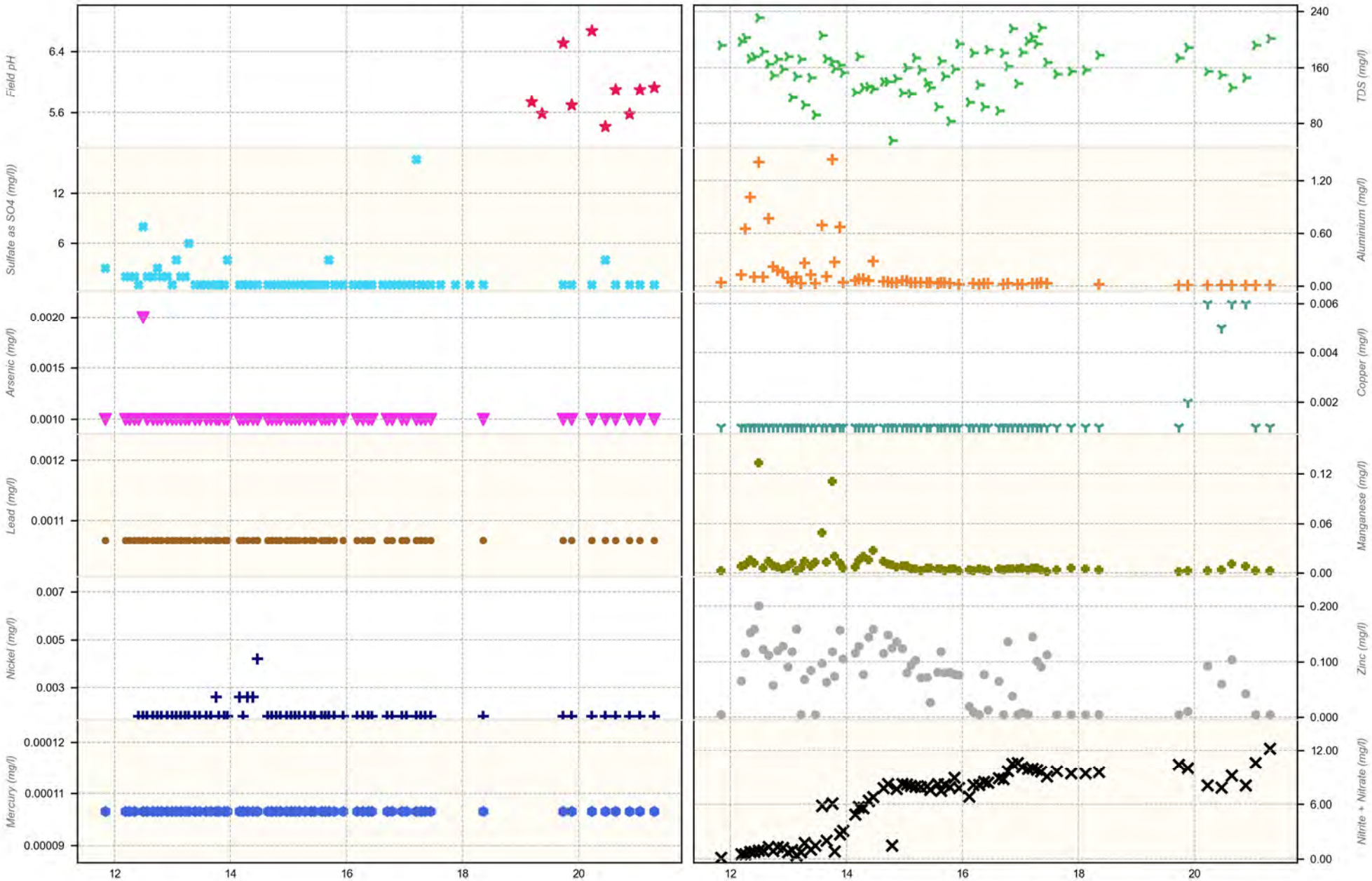
RB05 (Silurian Sediments, Scrn: 6-21 m, SWRD: 1984.8 m)



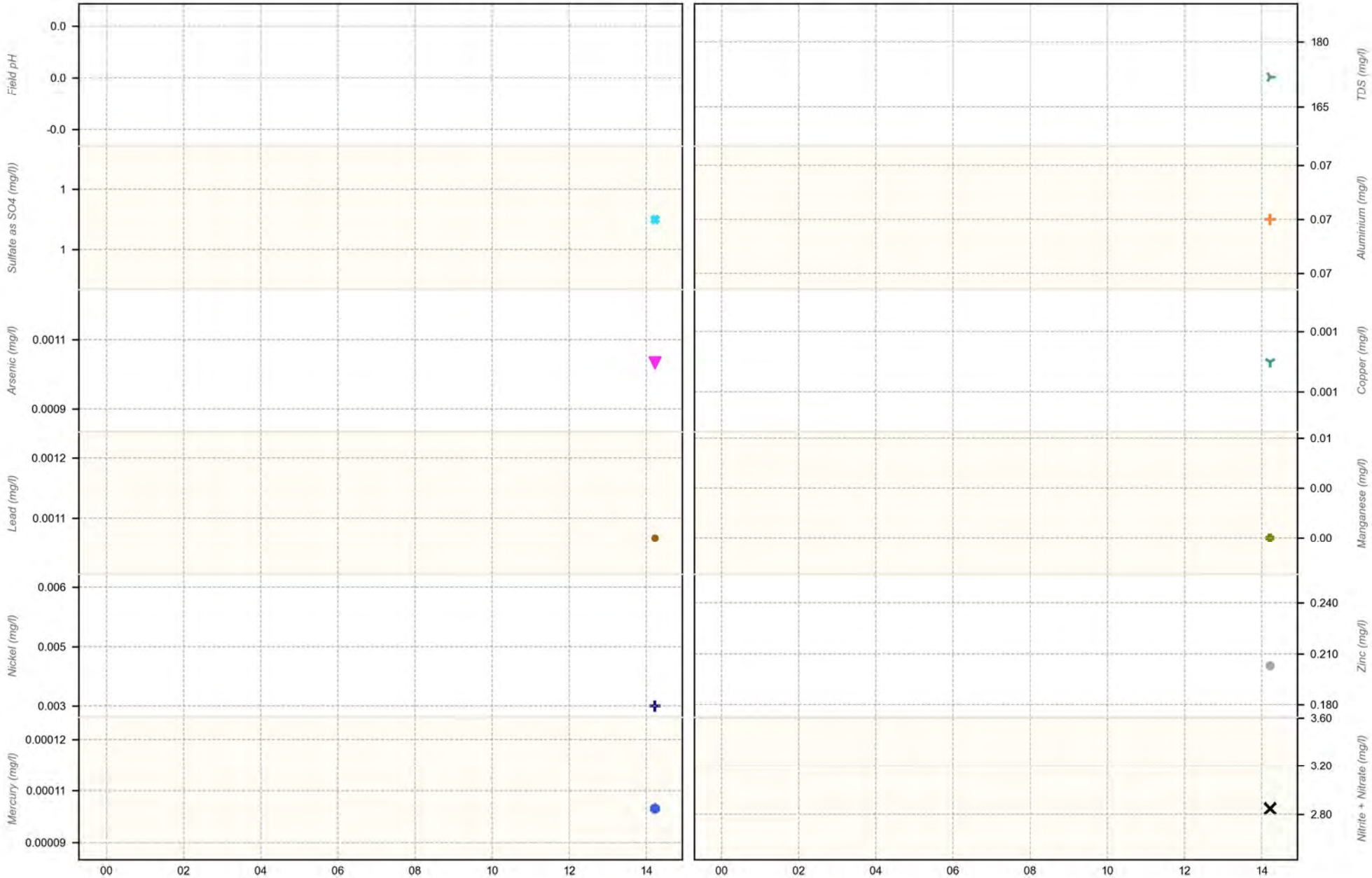
MB53 (Tertiary Basalt, Scrn: 27-45 m, NoSites)



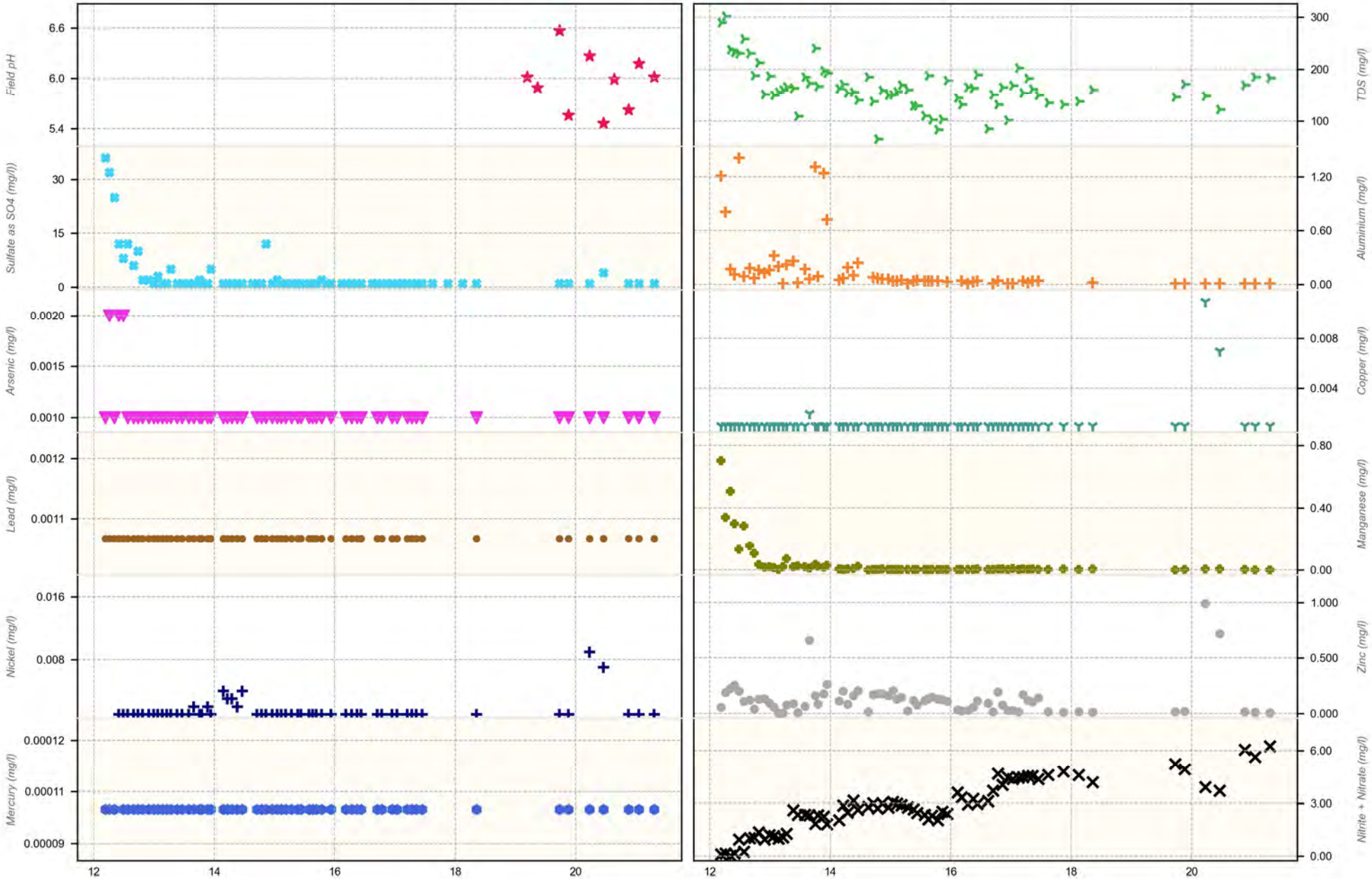
MB54 (Tertiary Basalt, Scrn: 15-21 m, NoSites)



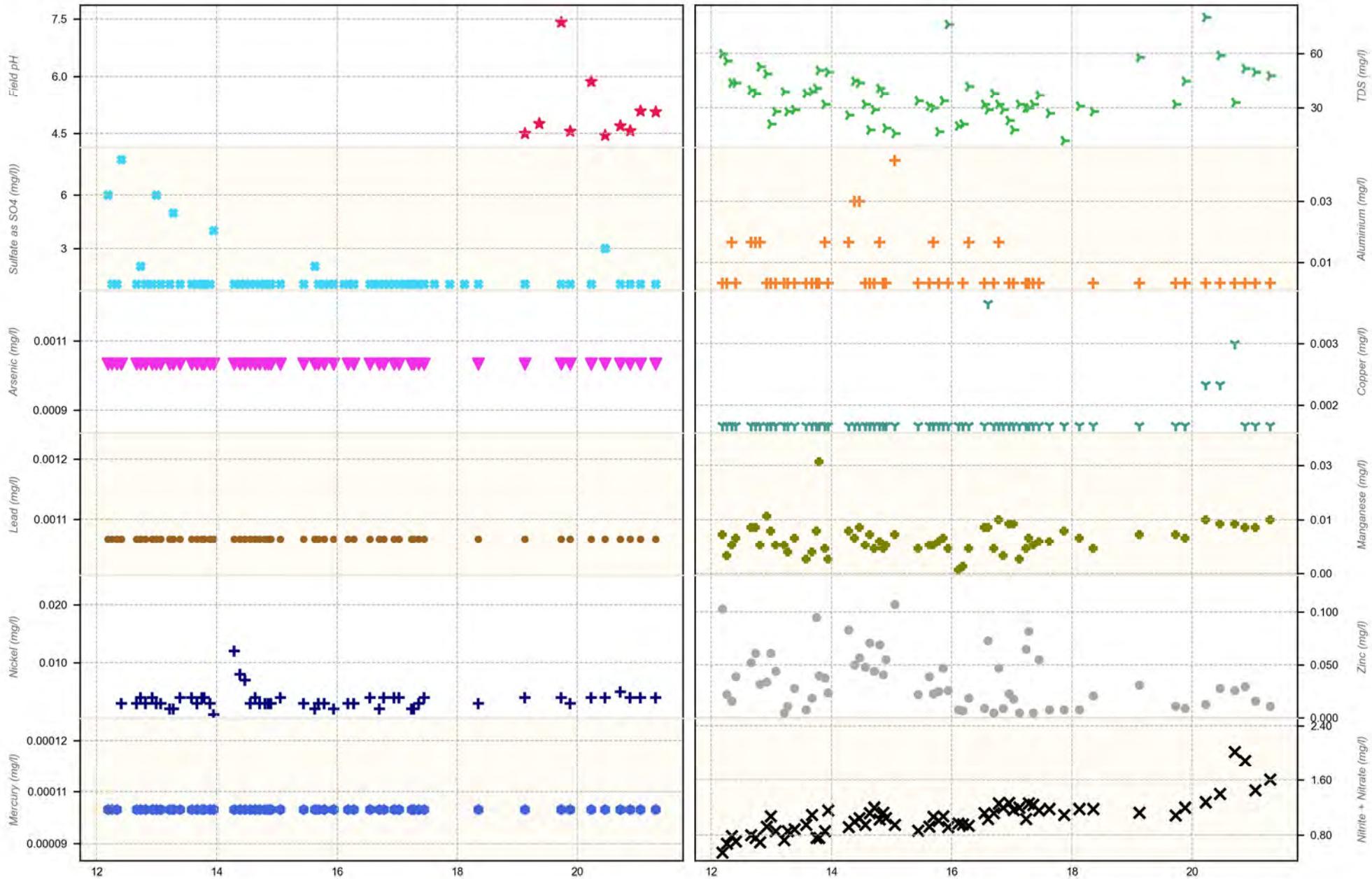
MB55 (Tertiary Basalt, Scrn: 6-9 m, NoSites)



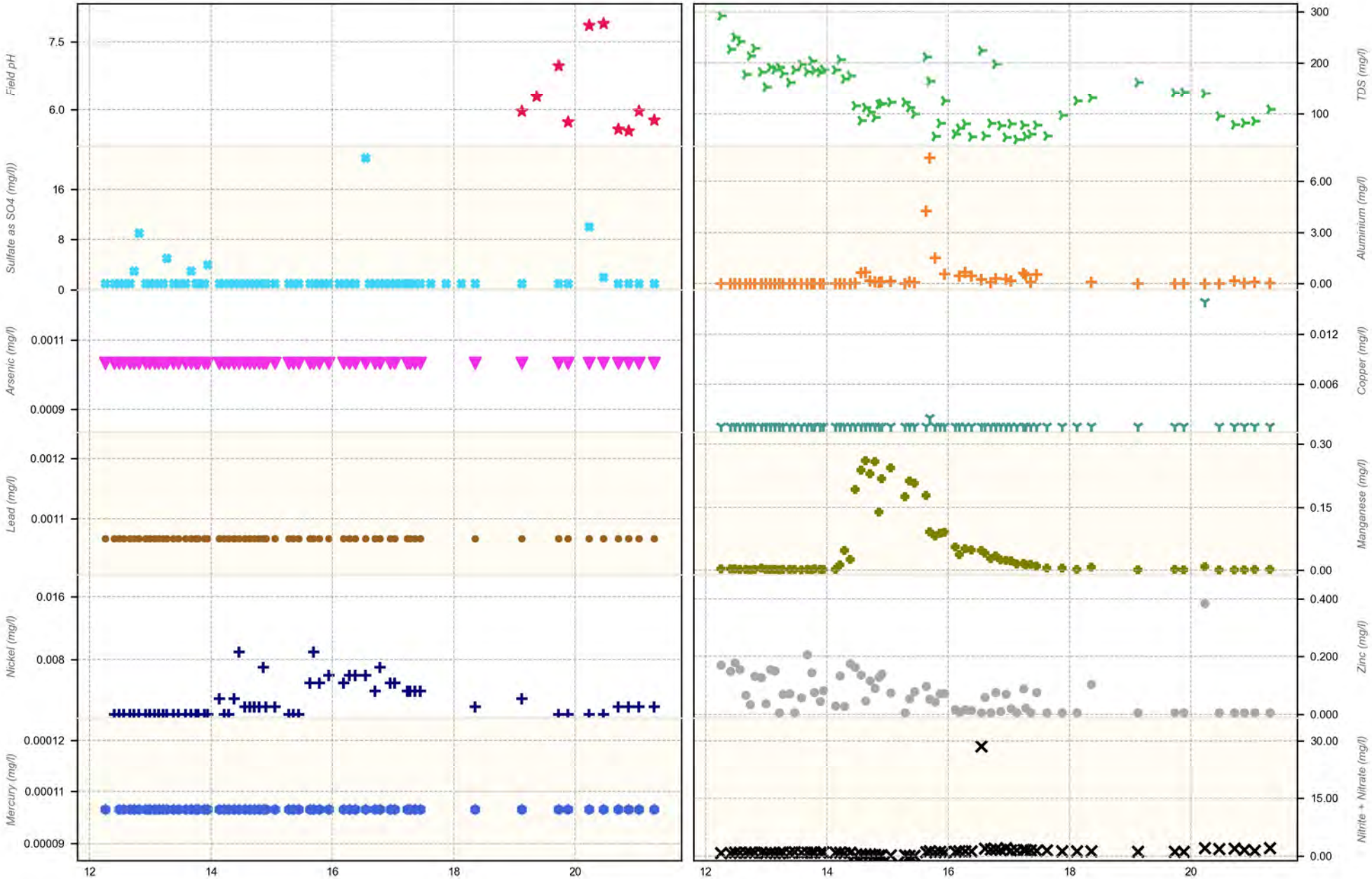
MB56 (Tertiary Basalt, Scrn: 23-30 m, NoSites)



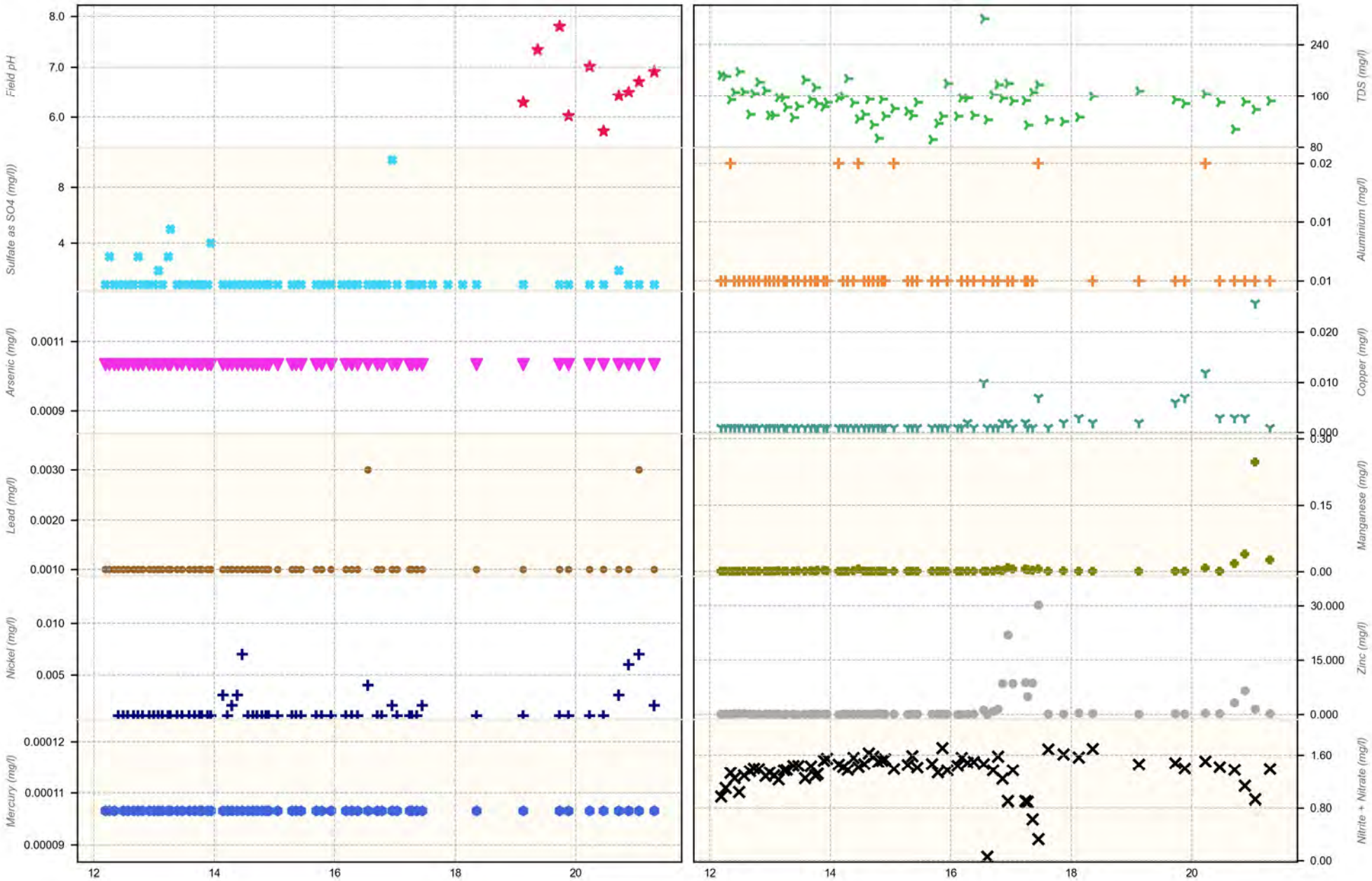
MB63 (Tertiary Basalt, Scrn: 10-16 m, NoSites)



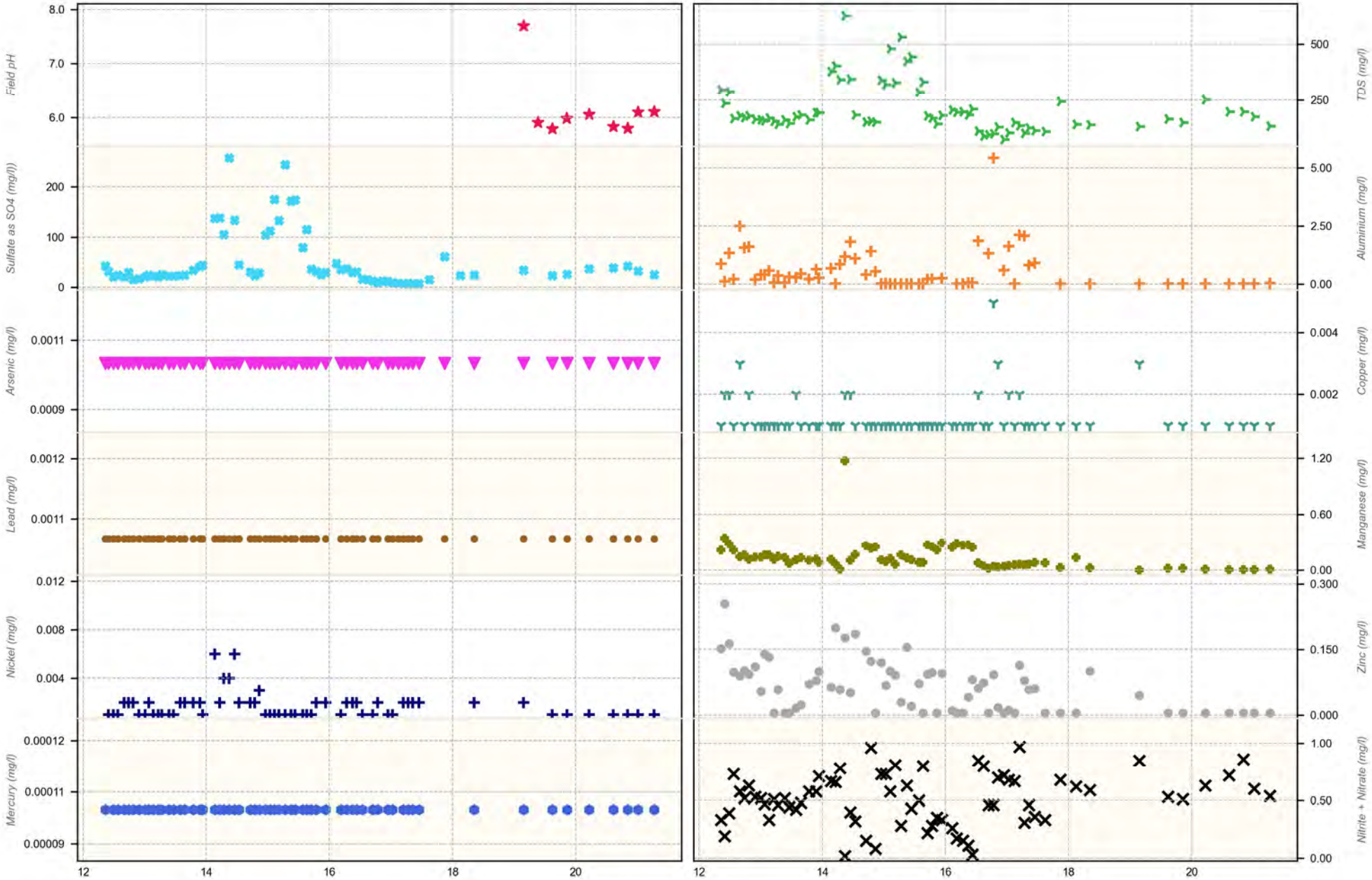
MB64 (Tertiary Basalt, Scrn: 25-62 m, NoSites)



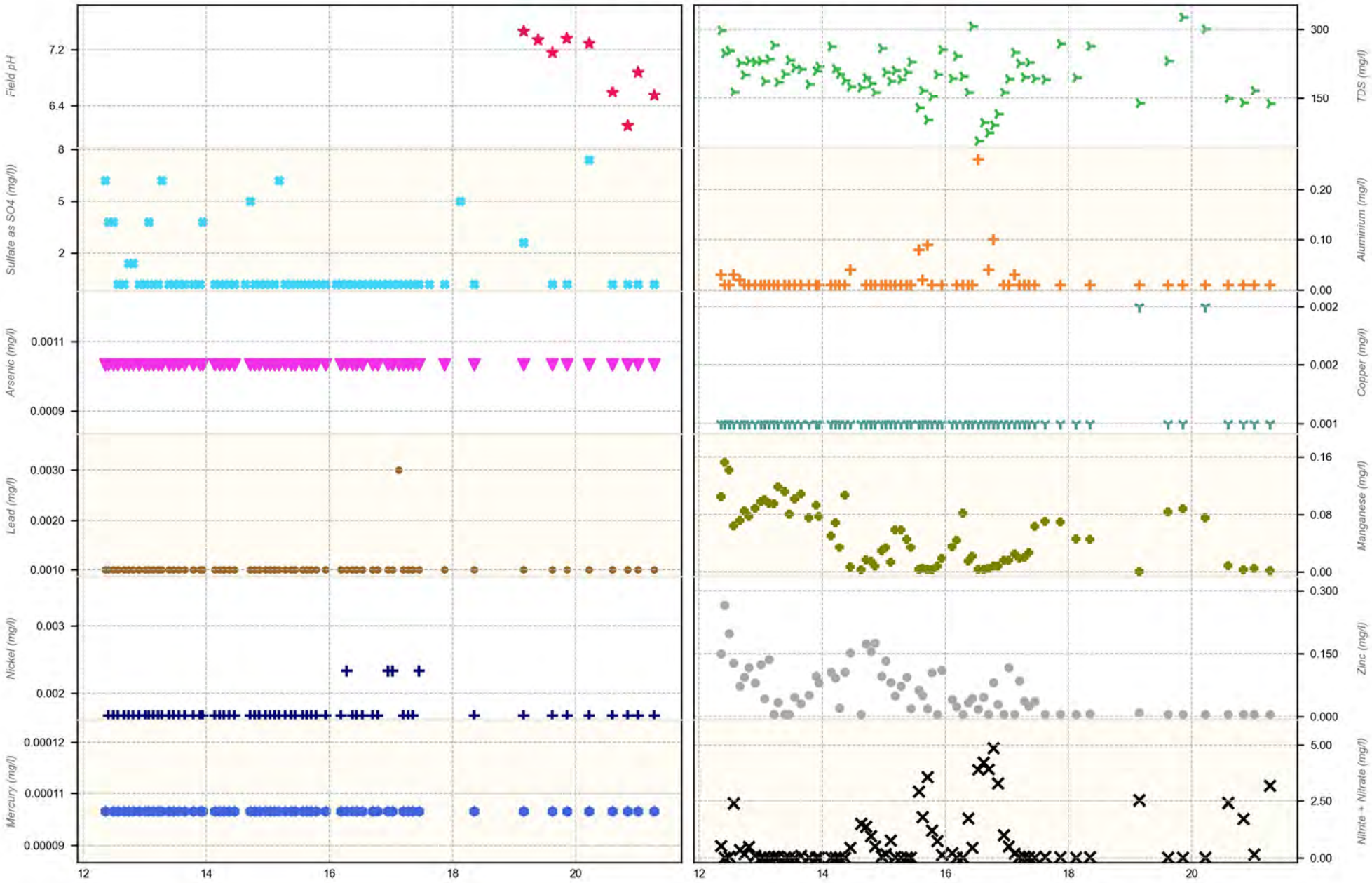
MB65 (Silurian Sediments, Scrn: 26-62 m, NoSites)



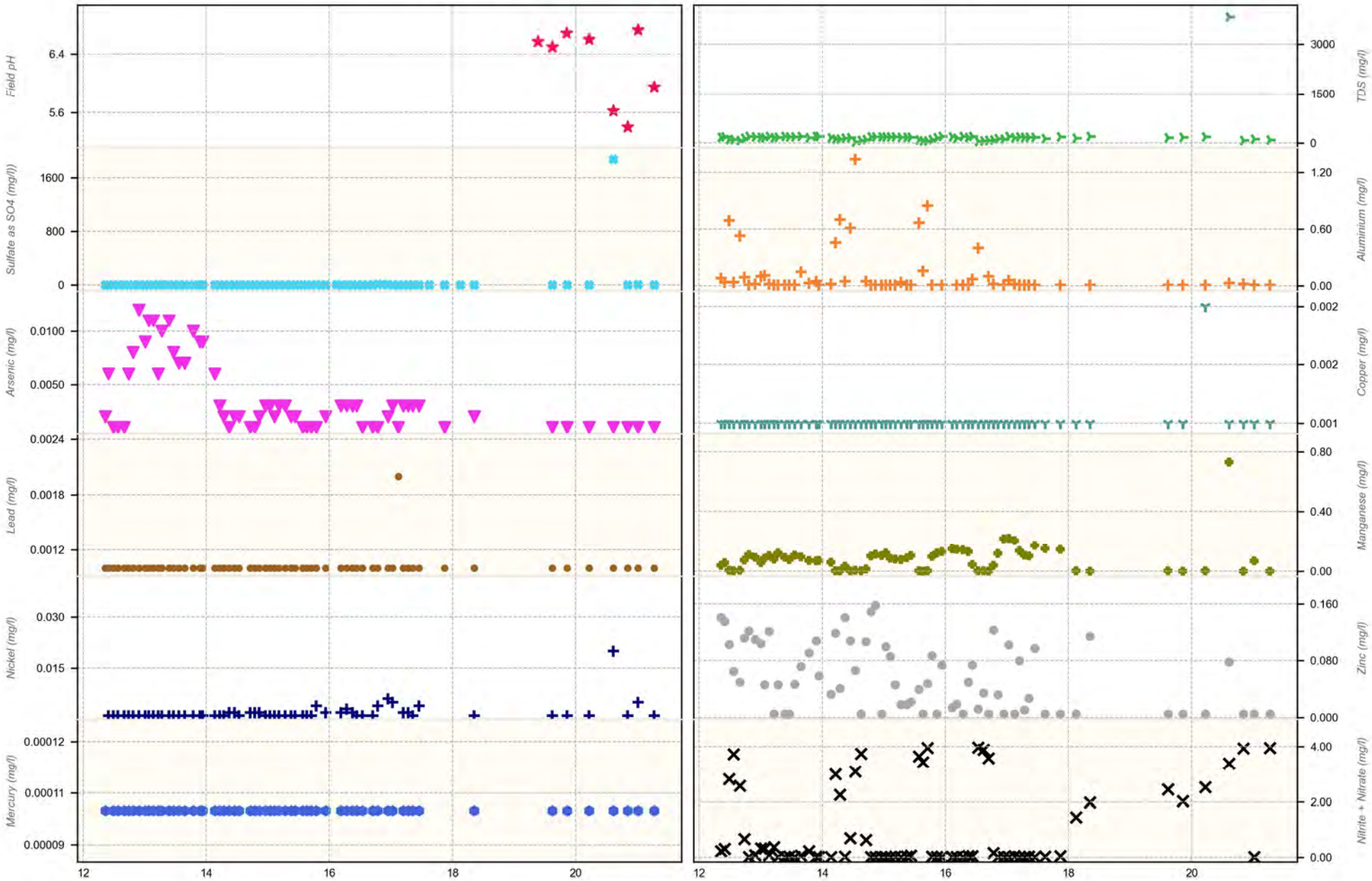
MB71 (Ordovician Volcanics, Scrn: 21.8-33.8 m, NoSites)



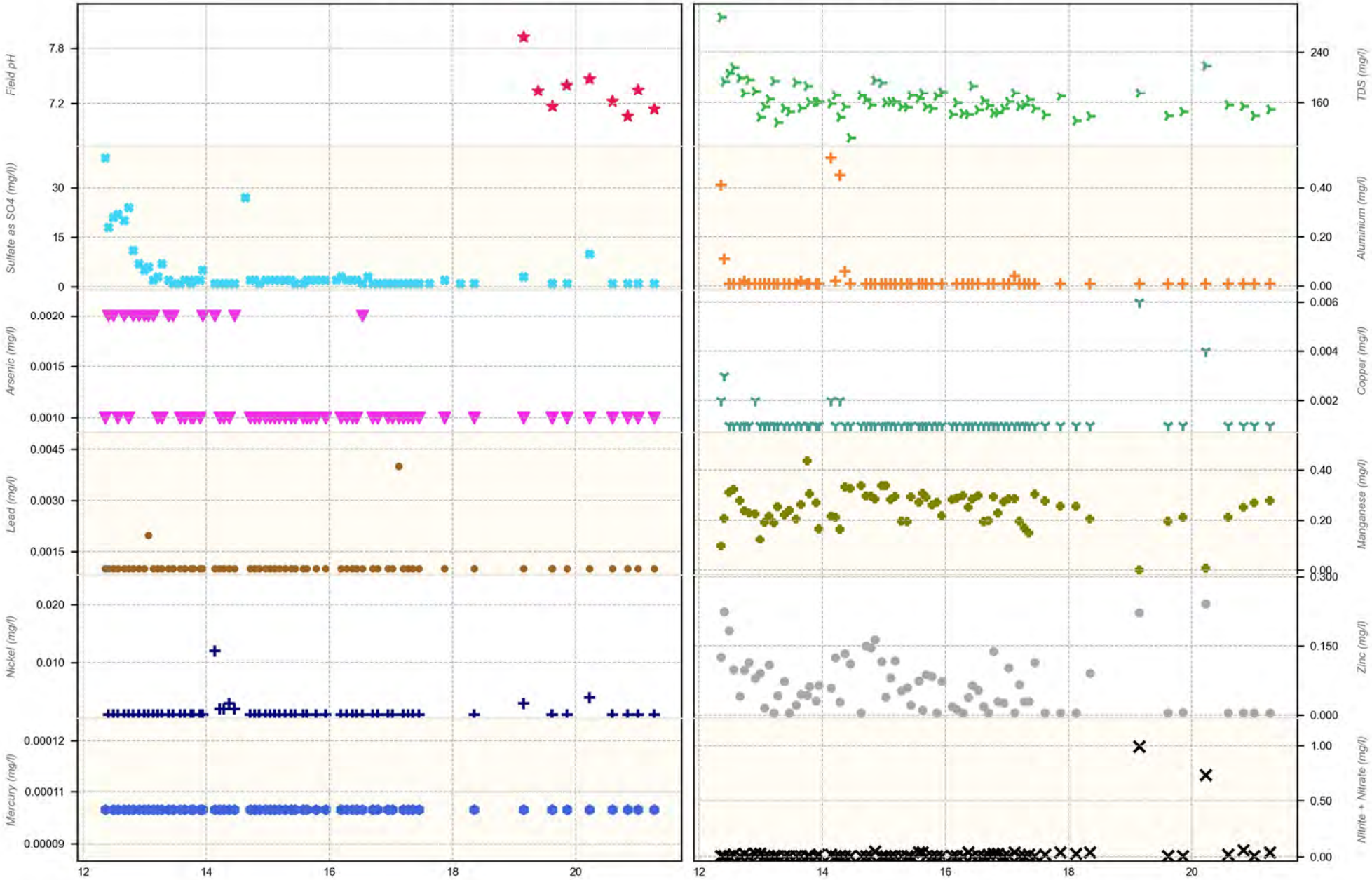
MB72 (Tertiary Basalt, Scrn: 29.2-41.2 m, NoSites)



MB74 (Tertiary Basalt, Scrn: 6.6-24.6 m, NoSites)

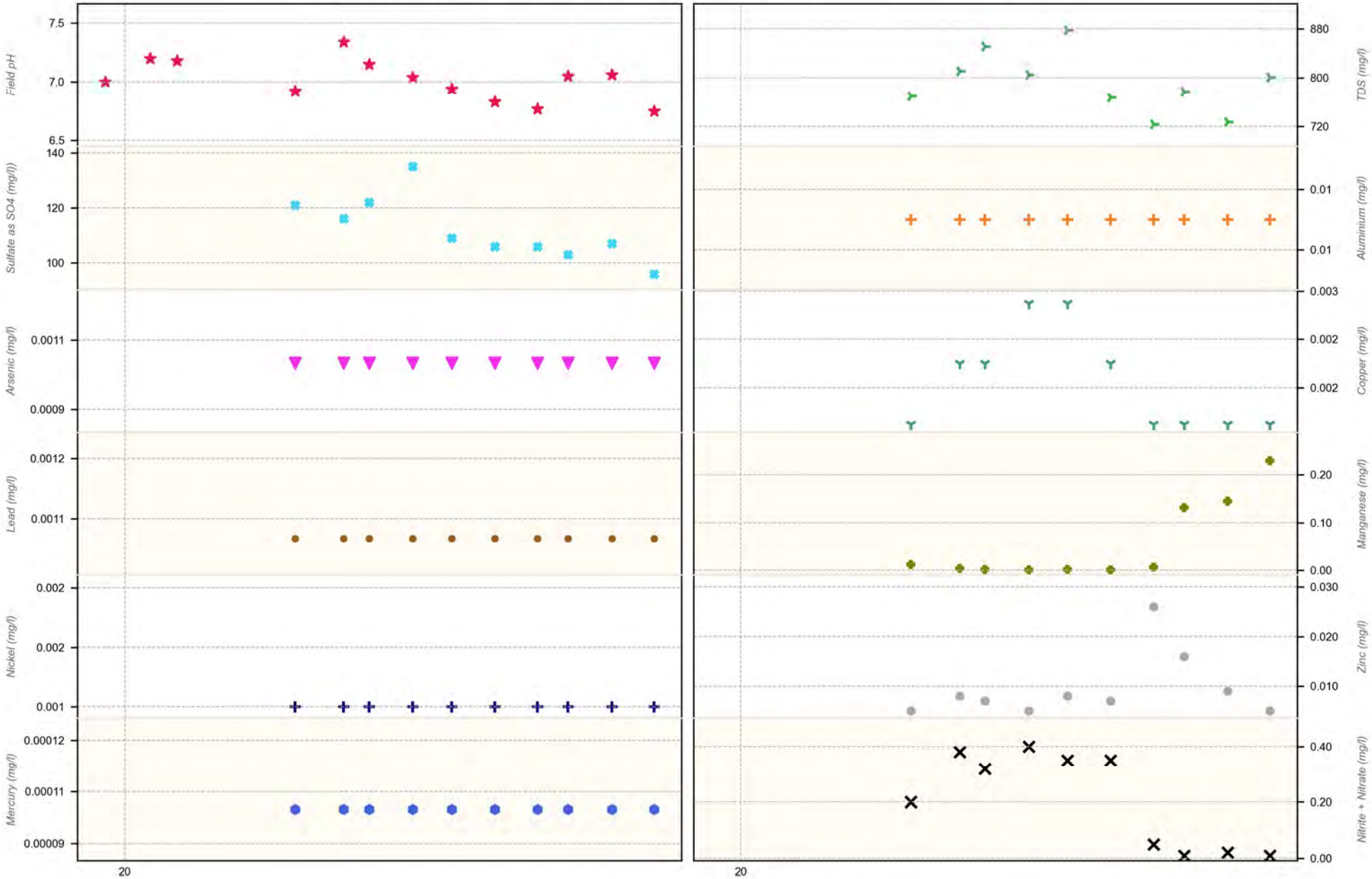


MB75 (Ordovician Volcanics, Scrn: 43.9-58.9 m, NoSites)

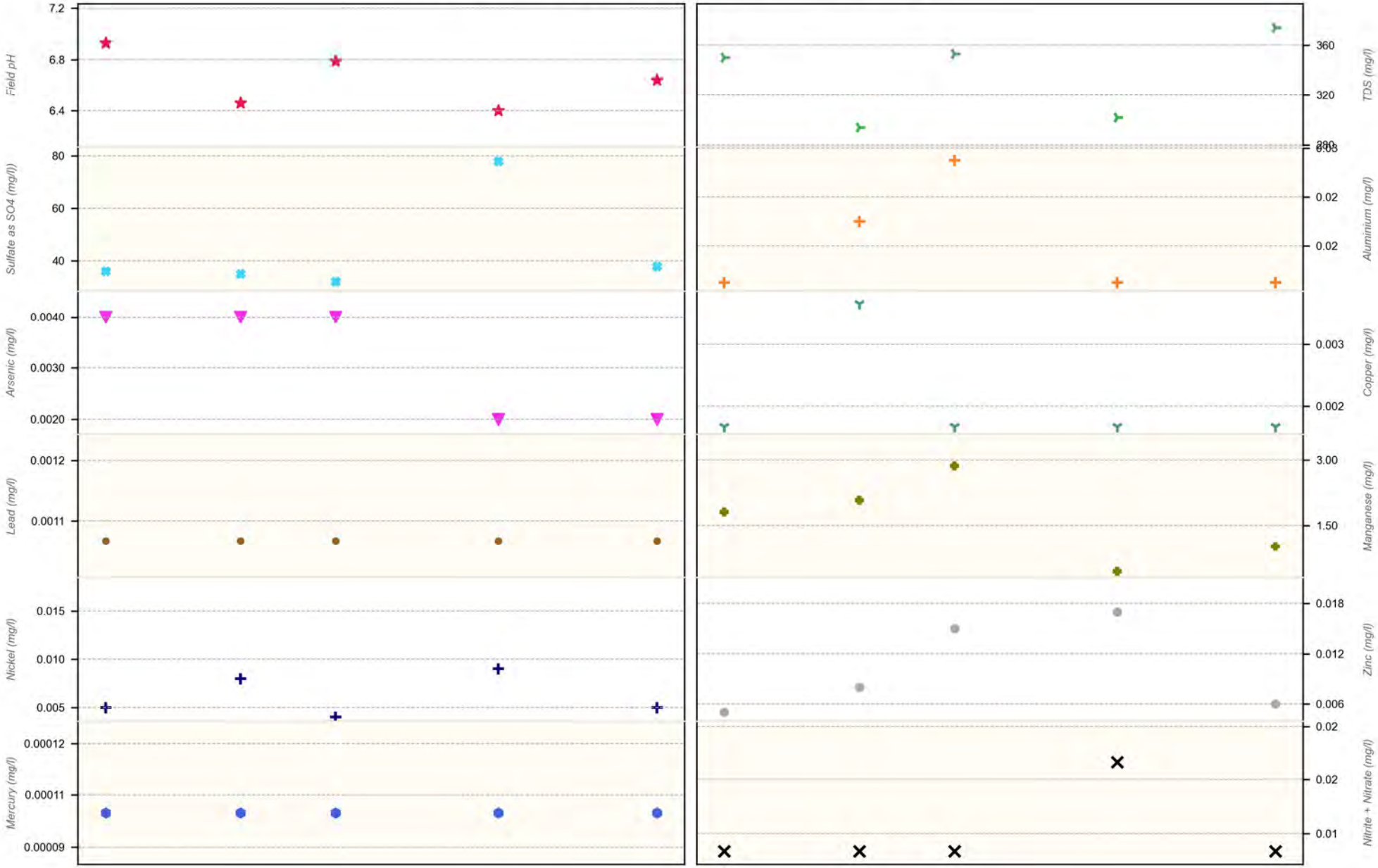


RB01 (Tertiary Basalt, Scrn: 14-50 m, NoSites)

MB98 (No Aquifer formation data, Scrn: NoData, NoSites)

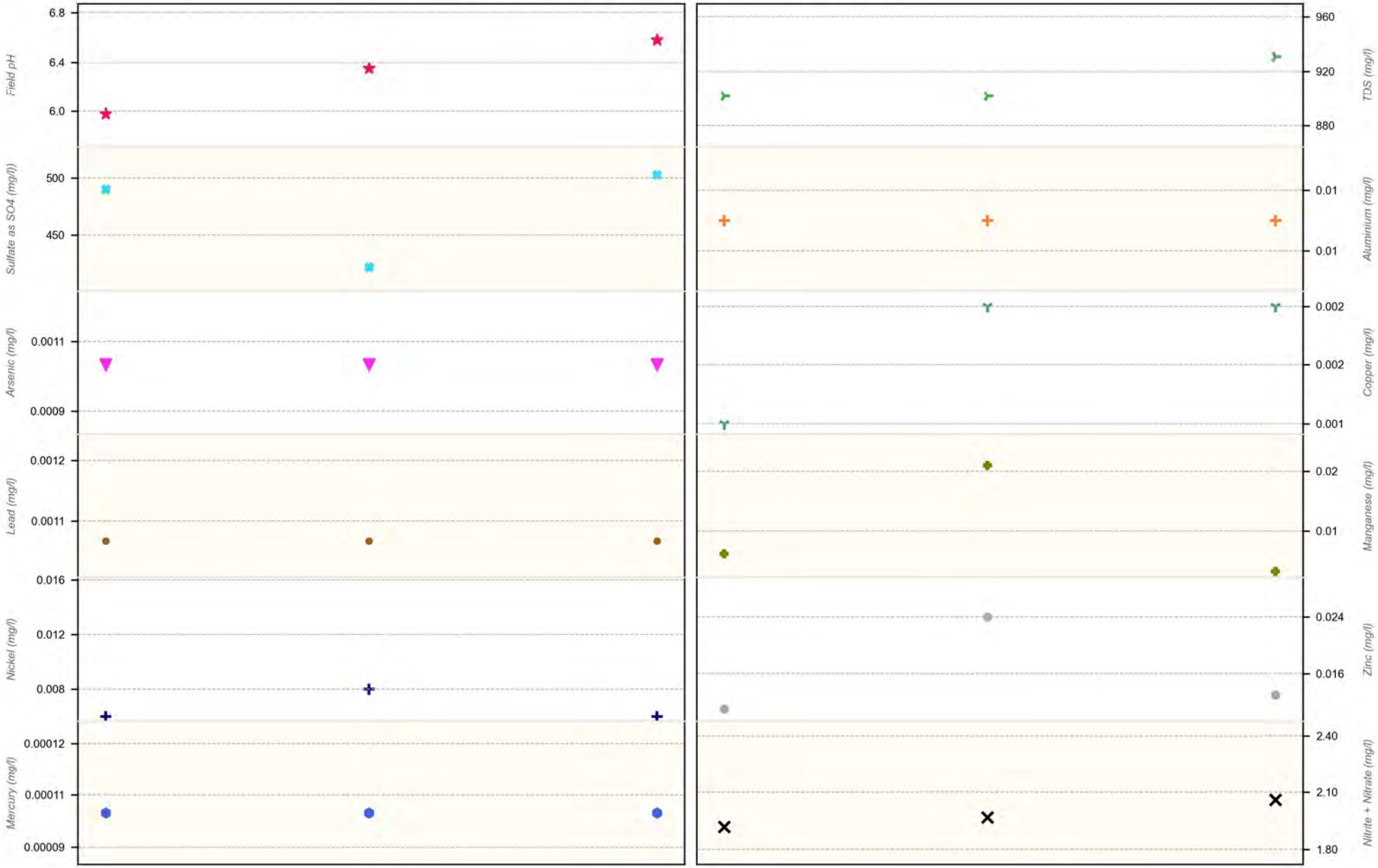


MW1 (Soil/Clay, Scrn: 2.5-7.5 m, NoSites)



MW3 (Soil/Clay, Scrn: 2.5-6 m, NoSites)

MW4 (Soil/Clay, Scrn: 3-9 m, NoSites)



CX1 (No Data)

Field pH
8.0
7.2
6.4
Sulfate as SO4 (mg/l)
2250
2000
1750
Arsenic (mg/l)
0.0011
0.0009
Lead (mg/l)
0.0012
0.0011
0.010
Nickel (mg/l)
0.007
0.005
Mercury (mg/l)
0.00012
0.00011
0.00009
20
TDS (mg/l)
3500
3250
Aluminium (mg/l)
0.01
0.01
Copper (mg/l)
0.020
0.018
0.015
Manganese (mg/l)
1.40
1.20
0.012
Zinc (mg/l)
0.010
0.008
Nitrite + Nitrate (mg/l)
20.00
17.50
15.00
20

RB06 (No Data)

Field pH
0.0
0.0
-0.0
TDS (mg/l)
0
0
-0
Sulfate as SO4 (mg/l)
750
700
Aluminium (mg/l)
0.04
0.00
-0.04
Arsenic (mg/l)
0.0400
0.0000
-0.0400
Copper (mg/l)
0.040
0.000
-0.040
Lead (mg/l)
0.0400
0.0000
-0.0400
Manganese (mg/l)
0.04
0.00
-0.04
Nickel (mg/l)
0.060
0.000
Zinc (mg/l)
0.040
0.000
-0.040
Mercury (mg/l)
0.04000
0.00000
-0.04000
Nitrite + Nitrate (mg/l)
0.04
0.00
-0.04
96
98
00
02
04
06
08
10

Cadia 2020 Independent Compliance Audit - Recommendations

Condition Number (ID)	Compliance Requirement	Independent Audit Finding	Independent Audit Recommendation	Cadia's Proposed Action / Action Taken / Response (as Applicable)	Proposed Action Due Date	Status as at 31 August 2021
S2. C1	**OBLIGATION TO MINIMISE HARM TO THE ENVIRONMENT** The Proponent shall implement all reasonable and feasible measures to prevent and/or minimise any harm to the environment that may result from the construction, operation, or rehabilitation of the project.	**Non-compliance No. 1** – During the audit period Cadia has not adequately implemented 'all' reasonable and feasible measures to prevent and/or minimise any harm to the environment that may result from the operation of the project, specifically in relation to the minimisation of dust emissions from the surface of Tailings Storage Facilities and from ore processing activities (refer to Schedule 3, Conditions 17 and 19 in this audit report).	**Recommendation No. 1** – As defined against Project Approval Schedule 3, Conditions 17 and 19 in this audit report.	No Action Required. Refer to findings and response for : -Schedule 3, Conditions 17 and 19	N/A	N/A
S2. C4	**TERMS OF APPROVAL** The Proponent shall comply with any reasonable requirement/s of the Secretary arising from the Department's assessment of: (a)any reports, strategies, plans, programs, reviews, audits or correspondence that are submitted in accordance with this approval; and (b)the implementation of any actions or measures contained in these documents.	Cadia was mostly compliant with any direction or request for information / action from the Department, however on two occasions Cadia could not fully demonstrate compliance with Project Approval Schedule 2, Condition 4. **Non-compliance No. 2** – As of November 2020: •in relation to the Independent Environmental Audit in 2017, Cadia was not able to comply with the reasonable requirement of the Secretary to respond to a request regarding the 2017 Independent Environmental Audit by 25 January 2018; and •in relation to the Official Caution of 28 February 2020 regarding the Cadiangullong Dam Water Extraction, it is acknowledged that work has commenced and technical challenges have been experienced, however, Cadia had not implemented the action to link the level sensor to the site's central process control system by 20 April 2020 as committed to by Cadia.	**Recommendation No. 2** – Cadia should ensure a system is in place to be able to comply with the timeframes of reasonable requirements of the Secretary.	Accepted. 1. Cadia is developing a reporting schedule to ensure all required reporting / responses to regulator requirements are completed on time. 2. Cadia will complete the linkages between the Cadiangullong Dam level sensor and the DCS System.	30-Jun-21	1. Complete. Cadia uses the CHESS system to manage responses to the regulator and a reporting calendar has been developed. 2. Complete.

Cadia 2020 Independent Compliance Audit - Recommendations

Condition Number (ID)	Compliance Requirement	Independent Audit Finding	Independent Audit Recommendation	Cadia's Proposed Action / Action Taken / Response (as Applicable)	Proposed Action Due Date	Status as at 31 August 2021
S2. C14	**STAGED SUBMISSION OF STRATEGIES, PLANS OR PROGRAMS** With the approval of the Secretary, the Proponent may: (a)submit any strategy, plan or program required by this consent on a progressive basis; and (b)combine any strategy, plan or program required by this consent with any similar strategy, plan or program required for the Cadia East Project. To ensure these strategies, plans or programs are updated on a regular basis, the Proponent may at any time submit revised strategies, plans or programs to the Secretary for approval. With the agreement of the Secretary, the Proponent may prepare any revised strategy, plan or program without undertaking consultation with all parties under the applicable condition of this consent. *Notes:* *•While any strategy, plan or program may be submitted on a progressive basis, the Proponent will need to ensure that the existing operations on site are covered by suitable strategies, plans or programs at all times.* *•If the submission of any strategy, plan or program is to be staged, then the relevant strategy, plan or program must clearly describe the specific stage to which the strategy, plan or program applies, the relationship of this stage to any future stages, and the trigger for updating the strategy, plan or program*	Evidence was sighted (DPIE letter dated 25/06/2020) confirming the Secretary's agreement with the consultation approach Cadia undertook in relation to the revised Rehabilitation Strategy (Revision 3, dated 12 June 2020). **Non-compliance No. 3** – No evidence was obtained to verify that Cadia sought or obtained agreement of the Secretary during the audit period, to prepare management plan revisions without undertaking consultation with all parties under the applicable condition of this consent.	**Recommendation No. 3** – Cadia should formalise existing processes to ensure that environmental management plan revisions are conducted in consultation with all parties under the applicable condition of this Project Approval and that any consultation undertaken be stated in each plan. Similarly, if agreement was obtained from the Secretary not to undertake consultation with all parties, then this should also be included in the plan.	The existing procedure for Reviewing and Updating Management Plans (710-005-EN-PRO-0024) will be reviewed and updated to include consultation with all parties as per the Project Approval.	30-Apr-21	Complete. Procedure updated to Revision 2 and approved for use 21/03/2021
S3. C2	**NOISE** **Impact Assessment Criteria** The Proponent shall ensure that the noise generated by the project does not exceed the noise impact assessment criteria in Table 2 at any residence on privately-owned land or on more than 25 per cent of any privately-owned land. *[Refer to Table 2 in PA06_0295]*	On all occasions during the audit period, Cadia was unable to demonstrate full compliance with criteria defined in Project Approval Schedule 3, Table 2: Noise Impact Assessment Criteria dB(A) LAeq (15min). **Non-compliance No. 4 –** During the audit period, even though mitigation was offered and completed at affected properties and no noise complaints were received, Cadia exceeded the noise impact assessment criteria defined in Project Approval Schedule 3, Table 2: Noise Impact Assessment Criteria dB(A) LAeq (15min) as follows: •on 38 occasions from August 2019 to May 2020; •on 21 occasions from July 2018 to June 2019; •on 86 occasions from July 2017 to June 2018, relating to either aircraft noise during aerial dust suppression activities (x82) or trains in the vicinity of the CVO Dewatering Facility (x4); and •in June 2019, relating to container handling activities contributing noise levels above the LA1,1 minute criteria during the night period at the 247 Newbridge Road monitoring location, resulting in a marginal exceedance of the Sleep Disturbance criteria.	**Recommendation No. 4** – Where reasonable and feasible, Cadia should continue to implement additional noise abatement projects and controls to improve levels of compliance with Project Approval Schedule 3, Table 2: Noise Impact Assessment Criteria dB(A) LAeq (15min). and/or have this condition reassessed within a future Project Approval Modification.	Cadia accepts the recommendation and will continue to investigate and where appropriate mitigate operational noise affected properties. Updates will be provided to DPIE via the reporting of non-compliances, actions taken and provide annual updates via the Annual Review.	Ongoing as required. Reported in Annual Reviews.	Complete. Refer to Section 6.4 of FY21 AEMR

Cadia 2020 Independent Compliance Audit - Recommendations

Condition Number (ID)	Compliance Requirement	Independent Audit Finding	Independent Audit Recommendation	Cadia's Proposed Action / Action Taken / Response (as Applicable)	Proposed Action Due Date	Status as at 31 August 2021
S3. C5	**NOISE** **Traffic Noise Impact Assessment Criteria** The Proponent shall take all reasonable and feasible measures to ensure that the traffic noise generated by the project does not exceed the traffic noise impact assessment criteria in Table 5. *[Refer to Table 5 PA 06_0295*]	No official or valid traffic related noise complaints were received by Cadia during the audit period. **Non-compliance No. 5** – During the audit period, CVO was unable to demonstrate compliance with the required Project Approval Schedule 3, Table 5: Traffic Noise Impact Assessment Criteria dB(A) during 2019/20 on both monitoring occasions, during 2018/19 on one occasion, and during 2017/18 on one occasion. It is acknowledged that during the audit period, Cadia investigated, discussed mitigation options and completed several mitigation measures and initiatives with some affected landowners. Three properties that have not had mitigation works are a result of the landowners not proceeding with the recommended works and discussions are ongoing.	**Recommendation No. 5** – It is acknowledged that few additional opportunities exist to reduce traffic noise generated by the project. Mitigation of traffic noise affected properties is the most favourable solution and is required when requested by affected landowners.	Cadia accepts the recommendation and will continue to investigate and where appropriate mitigate traffic noise affected properties. Updates will be provided to DPIE via the reporting of non-compliances and annual updates via the Annual review.	Ongoing as required. Reported in Annual Reviews.	Complete. Refer to Section 6.4 of FY21 AEMR
S3. C17	AIR QUALITY Impact Assessment Criteria Except for the land in Table 1, the Proponent shall ensure that all reasonable and feasible avoidance and mitigation measures are employed so that particulate matter emissions generated by the development do not cause exceedances of the criteria listed in Tables 8, 9 and 10 at any residence on privately owned land, or on more than 25% of any privately-owned land. [Refer to Tables 8, 9 and 10 in PA 06_0295]	During the audit period, Cadia was unable to demonstrate that it met the criteria defined in Table 9: Short term impact assessment criterion for particulate matter (i.e. 24 hour 50 µg/m3 limit for PM10) on all required occasions). **Non-compliance No. 6** – During the audit period (2017-2020), Cadia exceeded the 24 hour 50 µg/m3 for PM10 limit in Project Approval Schedule 3, Table 9: Short term impact assessment criterion for particulate matter, on 15 separate occasions (i.e. these exceedances were attributed to the operation of the CVO mine and related activities).	**Recommendation No. 6** – To comply with limits defined in Project Approval Schedule 3, Tables 8, 9 and 10, and to reduce the number and frequency of complaints from landowners, additional controls should be progressed and completed to minimise fugitive dust emissions from the surface of the TSFs and from ore processing (i.e. crushers, conveyors, ore stockpile etc). This is inclusive of completing the remaining 50% of projects defined in its 24-month dust abatement works for ore processing.	Cadia has formed a Dust Committee to define and prioritise the actions required for dust abatement. The dust emissions from the TSFs were identified as the highest priority and significant work has been completed and is ongoing to minimise this dust source. Mitigation from other dust sources such as the crushes and roads are currently being considered. A written update and detailed schedule for implementation will be provided to DPIE by 30/6/2021	30-Jun-21	Complete. A written update was provided to DPIE in a letter dated 25 June 2021.
S3. C19	**AIR QUALITY** **Operating Conditions** The Proponent shall: (a)ensure any visible air pollution generated by the project is assessed regularly, and that operations are relocated, modified, and/or stopped as far as is reasonable and feasible to minimise air quality impacts on privately-owned land; (b)ensure that the real-time air quality monitoring and meteorological monitoring data are assessed regularly, and that operations are relocated, modified and/or stopped as required to ensure compliance with the relevant air quality criteria; and (c)implement all reasonable and feasible measures to minimise off-site odour and fume emissions generated by the project, to the satisfaction of the Secretary.	Cadia was only partially able to demonstrate compliance with Project Approval Schedule 3, Condition 19 (a) and (b). **Non-compliance No. 7** – During the audit, Cadia was unable to demonstrate that it diligently controls and minimises fugitive dust emissions from ore processing (i.e. crushers, conveyors, ore stockpile etc). There was minimal evidence that: a) operators are reporting excessive dust; b) dust sprays and sprinklers are being used as required to minimise dust emissions; and c) the water sprayed/applied to conveyors and transfer points is sufficient for the volume of dry ore being handled (i.e. as a means of minimising air quality impacts on privately-owned land).	**Recommendation No. 7** – See Recommendation No. 6 against Project Approval Schedule 3, Condition 17 – Air Quality – Impact Assessment Criteria	This finding will be tabled in the Dust Committee and a plan will be developed to address the issues detailed in this non-compliance. A written update and detailed schedule for implementation will be provided to DPIE by 30/6/2021	30-Jun-21	Complete. A written update was provided to DPIE in a letter dated 25 June 2021.

Cadia 2020 Independent Compliance Audit - Recommendations

Condition Number (ID)	Compliance Requirement	Independent Audit Finding	Independent Audit Recommendation	Cadia's Proposed Action / Action Taken / Response (as Applicable)	Proposed Action Due Date	Status as at 31 August 2021
S3. C27	**SOIL AND WATER** **Cadiangullong Creek Flows** The Proponent shall manage water releases from Cadiangullong Dam to provide: (a)flows of at least: •3.4 ML/day, for periods when inflows into the dam are more than 3.4 ML/day and the water level in the dam is at or above the lowest valve level on the multilevel offtake (ie. 773.0 metres AHD); •the volume equal to the inflow into the dam, for periods when inflows into the dam are between 0.4 and 3.4 ML/day and the water level in the dam is at or above the lowest valve level on the multi-level offtake; •0.4 ML/day, for periods when inflows into the dam are less than 0.4 ML/day and the water level in the dam is at or above the lowest valve level on the multi-level offtake; •the volume equal to the inflow into the dam, up to 0.4ML/day, for periods when the water level in the dam is below the lowest valve level on the multi-level offtake and above the level of the scour valve (i.e. 762.8 metres AHD); and •zero, when the water level in the dam is below the level of the scour valve; and (b)releases of up to 4 medium flows (of the order of 12 to 15 ML/day) per year, each for a duration of 1 to 3 days, with timing and frequency of such flows determined by hydrographs of typical medium flows, to the satisfaction of, and unless otherwise approved by, DPIE	Water inflows and outflows from Cadiangullong Dam are monitored to verify compliance with Project Approval Schedule 3, Condition 27. Results of monthly streamflow monitoring continues to be available on the Cadia website. **Non-compliance No. 8** – On three occasions during the audit period, riparian releases/flows from Cadiangullong Dam did not comply with the criteria and water release requirements defined in Project Approval Schedule 3, Condition 27 (a).	**Recommendation No. 8** – More diligent monitoring and provision of flow data is required to be demonstrated by Cadia to ensure that minimum flows within Oaky Creek downstream are maintained at all times. This could be achieved by revising the method of measuring and determining compliance to reduce the effects of the variables that can impact on meeting this condition.	Cadia has already developed a new web-based dashboard showing real-time flow data to improve data accessibility. Cadia will also revise the method for calculating the downstream flow from a 7-day rolling to a 10-day rolling average in the next version of the Water Management Plan. This will provide operational flexibility while still meeting the intent of the PA Condition to maintain riparian habitat and river health. Tha above changes will be documented in the revised Water Management Plan to be submitted to DPIE by 30/6/2021	30-Jun-21	Complete. An EQuIS dashboard has been developed to permit real-time web based access to the data. Alternative methods of determining compliance have been investigated.
S3. C39	**REHABILITATION AND BIODIVERSITY OFFSETS** Within 2 years of the date of this approval, the Proponent shall make suitable arrangements to provide appropriate long term security for the offset areas to the satisfaction of the Secretary.	Due to the excise of land from the Cadia East Offset Area (MOD 7), it is evident that the subsequent processes to survey, subdivide, seek approval to rezone and register the land as well as amend the BSC Local Environmental Plan (LEP) has been lengthy and is continuing. **Non-compliance No. 9** – Notwithstanding continued efforts by Cadia to make suitable arrangements to provide long term security for the offset areas to the satisfaction of the Secretary, these arrangements had not been finalised at the date of this November 2020 audit.	**Recommendation No. 9** – Cadia should continue efforts to make suitable arrangements to provide long term security for the offset areas to the satisfaction of the Secretary.	Cadia is well advanced in establishing long term security for the offset areas including re-zoning with Blayney Shire Council. The proces will be completed in the current calendar year.	31-Dec-21	N/A Not due in this reporting period
S3. C47	**VISUAL** **CVO Dewatering Facility** Prior to the commencement of construction of the CVO Dewatering Facility, the Proponent shall prepare: (a)architectural plans for the facility in a manner that achieves a suitable standard of design; and (b)a Landscape Plan for the facility, including provision for vegetative screening to minimise the visual impacts on adjacent receivers, in consultation with Blayney Shire Council, and to the satisfaction of the Secretary. Following approval, these plans must be implemented to the satisfaction of the Secretary.	It is acknowledged that Cadia has partially implemented the Landscape Plan including the replanting of trees that did not survive the drought. **Non-compliance No. 10** – Based on a site inspection on 10th November 2020, it was evident that the provision for vegetative screening to minimise the visual impacts on adjacent receivers had not been fully implemented according to the approved Landscape Plan (Cadia Valley Operations – Sealink Concentrate Filtration & Handling Facility – Newbridge Road – Blayney Figure 2 – Proposed Landscaping Plan, 2.09.2019) for the CVO Dewatering Facility.	**Recommendation No. 10** – Cadia should fully implement the Landscape Plan for the CVO Dewatering Facility in accordance with Project Approval Schedule 3, Condition 47.	Between July and September 2020, approximately 95% of the required landscape plan was re-implemented (ie planted) followwing initial failure in 2016. At the time of planting in 2020, a small portion of the required area was not accessible due to civil construction works. The remainaing area (along with any required replanting) will be undetrken by 30/8/2021	30-Aug-21	Action extended: Awaiting extra tubestock

Cadia 2020 Independent Compliance Audit - Recommendations

Condition Number (ID)	Compliance Requirement	Independent Audit Finding	Independent Audit Recommendation	Cadia's Proposed Action / Action Taken / Response (as Applicable)	Proposed Action Due Date	Status as at 31 August 2021
S3. C49	**VISUAL** **Visual Amenity and Lighting** The Proponent shall: (a)implement all reasonable and feasible measures to mitigate visual and off site lighting impacts of the project; (b)ensure no outdoor lights shine above the horizontal; and (c)ensure that all external lighting associated with the project complies with Australian Standard AS4282 (INT) 1997 – Control of Obtrusive Effects of Outdoor Lighting, to the satisfaction of the Secretary.	**Non-compliance No. 11** – It was evident that Cadia is implementing measures to mitigate lighting impacts, however: •in relation to paragraph (b) of this condition, Cadia were not able to ensure no outdoor lights shone above the horizontal as Cadia received 4 fugitive lighting complaints during the audit period, the nature of which, suggest this paragraph was not satisfied; and •in relation to paragraph (c) of this condition, no evidence was able to be provided at the time of this audit that all external lighting associated with the project complies with Australian Standard AS4282 (INT) 1997 – Control of Obtrusive Effects of Outdoor Lighting.	**Recommendation No. 11** – Cadia should ensure that the finalised Fugitive Lighting Management Plan is implemented.	Cadia accept the recommendation. The Cadia Fugitive Lighting Management Plan will be finalised and implemented.	31-May-21	Fugitive Lighting Management Plan approved for use 16/08/2021
S3. C50	**WASTE** **Waste Minimisation** The Proponent shall: (a)minimise the waste generated by the project; (b)ensure that the waste generated by the project is appropriately stored, handled and disposed of; (c)manage on-site sewage treatment and disposal in accordance with the requirements of the applicable Council; and (d)report on waste management and minimisation in the Annual Review, to the satisfaction of the Secretary.	Cadia was able to provide evidence that it is effectively managing non mineralised waste generated by the Project, by proactively identifying recycling opportunities and ensuring non mineralised waste (and waste rock) is appropriately stored, handled and disposed of. **Non-compliance No. 12** – In relation to paragraph (b) of this condition, tailings generated by the Project was not appropriately stored with a slump of the southern wall of the NTSF (9th March 2018) constructed to store and hold the tailings.	**Recommendation No. 12** – It is recommended that Cadia appropriately stores the tailings produced by the Project by ensuring the structural integrity of the walls of the tailings dams.	Significant investigation has been undertaken following the partial wall failure in March 2018. TSF embankment construction designs have been revised and have been submitted for approval to DPIE via Modification 14. Mod 14 is expected to be approved by mid 2021.	Pending approval of Modification 14, no further action required.	Modification 14 not yet approved

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Condition Number (ID)	Compliance Requirement	Independent Audit Observation / Opportunity for Improvement	Cadia's Proposed Action or reason to not implement measures / changes	Proposed Action Due Date (if applicable)	Status as at 31 August 2021
S2. C6	**LIMITS ON APPROVAL** The Proponent shall not process more than 32 million tonnes of ore from the project in a calendar year.	**Observation No. 1** – To enable consistency in business reporting and avoidance of errors, Cadia could request that this condition be based on a fiscal year rather than a calendar year in future approval modifications.	Finding accepted. The Cadia Management Team (Senior Leadership Team) will need to determine if this recommendation meets the needs of the business. Should the recommendation be approved to proceed, Cadia will liaise with DPIE during the MOD14 development application process.	28-Apr-21	Not Complete. At the time of completing this report, this finding was being addressed as part of the Mod 14 development application.
		Observation No. 2 – Cadia could ensure that the calendar year processed ore is reported in the AEMRs (omitted from 2019/20 AEMR).	Accepted. Will be included in the next Annual Review / AEMR and on an ongoing basis.	31-Oct-21	Complete. Included in this AEMR
		Observation No. 3 – This condition is currently assigned to the environment department personnel in CHESS. Cadia could consider assigning accountability to the Ore Processing Manager.	Cadia accept the finding. Action to be assigned to the Ore Processing Manager	15-Mar-21	Complete.
		Observation No. 4 – Cadia could review recommendations of the "Metallurgical Accounting Data Validation" report (MIPAC, 2014) and ensure close-out. Cadia could also consider undertaking an update of this assessment.	Will review action close out with Metalurgical Superintendent.	30-Jun-21	Complete.
S2. C8	**SURRENDER OF CONSENTS** Within 12 months of the date of this approval, or as otherwise agreed by the Secretary, the Proponent shall surrender all existing development consents for the project in accordance with sections 75YA and 104A of the EP&A Act, to the satisfaction of the Secretary. Note: *This approval will apply to all components of the Cadia Valley Operations from the date of approval. The existing management and monitoring plans/strategies/programs/protocols for the project will continue to apply until the approval of the comparable plan/strategy/program under this approval*	**Observation No. 5** – On the basis the Secretary is satisfied that this historical condition has been complied with, Cadia could consider requesting this condition be removed in future approval modifications.	Accepted. Cadia will make a request to DPI&E to remove the condition relating to surrendering all existing development consents during the MOD14 development application process.	28-Apr-21	Not Complete. At the time of completing this report, this finding was being addressed as part of the Mod 14 development application.
S2. C10	**DEMOLITION** The Proponent shall ensure that all demolition work is carried out in accordance with AS 2601-2001: The Demolition of Structures, or its latest version.	**Observation No. 6** – The Newcrest Operational Risk Management (NORM) spreadsheet provided (Excel spreadsheet "17-76 DRAW Blayney old plant decommissioning") for the demolition risk assessment did not identify AS 2601 as a reference. In addition, Project Approval compliance was not identified as a risk category and based on attendance records, approvals personnel were not in attendance for the risk assessment workshop. Cadia should include consideration of approvals/legal risks in future demolition projects where relevant.	Accepted. Internal processes and procedures will be reviewed an updated to ensure that all project approval requirements are incorporated into contracts, risk assessments and project design.	31-May-21	Complete
		Observation No. 7 – It was stated that the demolition contract was managed by Newcrest's Melbourne based commercial group. Cadia should ensure a system is in place to record consideration of *AS 2601-2001: The Demolition of Structures* obligations under this Project Approval condition, in future demolition projects.			
S2. C14	**STAGED SUBMISSION OF STRATEGIES, PLANS OR PROGRAMS** With the approval of the Secretary, the Proponent may: (a)submit any strategy, plan or program required by this consent on a progressive basis; and (b)combine any strategy, plan or program required by this consent with any similar strategy, plan or program required for the Cadia East Project. To ensure these strategies, plans or programs are updated on a regular basis, the Proponent may at any time submit revised strategies, plans or programs to the Secretary for approval. With the agreement of the Secretary, the Proponent may prepare any revised strategy, plan or program without undertaking consultation with all parties under the applicable condition of this consent.	**Observation No. 8** – Cadia could consider renaming the following plans: •"Cadia Environmental Strategy" to "Cadia Environmental Management Strategy" to be consistent with the Project Approval condition; •the "Cadia Air Quality Program" to the "Cadia Air Quality Monitoring Program" to be consistent with the Project Approval condition; and •the "Aboriginal Heritage Management Plan" to "Aboriginal Cultural Heritage Management Plan"" to be consistent with the Project Approval condition.	Cadia accepts the observation. These documents are periodically reviewed and updated. Future updates will ensure correct nomenclature is used.	31-Dec-22	Underway. The format and content of management plans and monitoring programs are progesssively being updated to address the findings of the audit
		Observation No. 9 – Table 12-3 in each of the three AEMRs (during the audit period) should read "Aboriginal Cultural Heritage Management Plan".	Cadia accepts this observation. Future AEMRs will ensure correct nomenclature is used.	30-Oct-21	Complete. Included in this AEMR

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Condition Number (ID)	Compliance Requirement	Independent Audit Observation / Opportunity for Improvement	Cadia's Proposed Action or reason to not implement measures / changes	Proposed Action Due Date (if applicable)	Status as at 31 August 2021
	Notes: *•While any strategy, plan or program may be submitted on a progressive basis, the Proponent will need to ensure that the existing operations on site are covered by suitable strategies, plans or programs at all times.* *•If the submission of any strategy, plan or program is to be staged, then the relevant strategy, plan or program must clearly describe the specific stage to which the strategy, plan or program applies, the relationship of this stage to any future stages, and the trigger for updating the strategy, plan or program*	**Observation No. 10** – A number of management plans state that the plan will be "assessed annually following the AEMR process as to whether a formal review is required" (e.g. Section 9.1 of the Water Management Plan). Cadia should expand this to include within 3 months of an incident report, audit under condition 7 or modifications in accordance with Project Approval Schedule 5, Condition 3. Any of these conditions trigger a (mandatory) review of the Strategies, Plans and Programs. Based on the review, a decision is then made whether a revision. needs to be undertaken. In addition, Project Approval Schedule 5, Condition 3 should be included in the relevant Strategies, Plans and Programs (e.g. Table 1-1 of the Water Management Plan).	Cadia accepts this observation. Standardised wording for when a document review is triggered will be aligned with the Project Approval. Amendments will be included with reviews required under Observation No. 8.	31-Dec-22	Underway. The format and content of management plans and monitoring programs are progesssively being updated to address the findings of the audit
S3. C8	**NOISE** **Continuous Improvement** The Proponent shall: (a)implement all reasonable and feasible best practice noise mitigation measures; (b)investigate ways to reduce the noise generated by the project, including off site road (particularly on Forest Road, Orchard Road and Woodville Road during the night and early morning periods) and rail noise and maximum noise levels which may result in sleep disturbance; and (c)report on these investigations and the implementation and effectiveness of these measures in the Annual Review, to the satisfaction of the Secretary.	**Observation No. 11** – For some specific examples, Cadia is incorrectly defining statutory non-compliances in their AEMR as "non-conformances" (e.g. Section 6.4.4 of the 2019/2020 AEMR relating to noise monitoring exceedances).	Accepted. Will be included in the next Annual Review / AEMR and on an ongoing basis.	31-Oct-21	Complete. Included in this AEMR
S3. C10	**BLASTING AND VIBRATION** **Blasting Impact Assessment Criteria** The Proponent shall ensure that blasting at the project does not exceed the criteria in Table 7. *[Refer to Table 7 in PA 02_0295]*	**Observation No. 12** – Cadia is encouraged to revise and reissue its existing agreement with Ecotech, as the current agreement was stated as not being valid in late 2020 (i.e. it was issued to Ecotech in July 2018 for a 12 month period).	Cadia accepts this observation. A new agreement with Ecotech will be established.	31-Dec-21	In progress. On track for completion by due date
S3. C12	**BLASTING AND VIBRATION** **Public Notice** During mining operations on site, the Proponent shall: (a)notify the landowner/occupier of any residence within 2 kilometres of blasting operations who registers an interest in being notified about the blasting schedule at the mine, or any other landowner nominated by the Secretary; (b)operate a Blasting Hotline, or alternate system agreed to by the Secretary, to enable the public to get up-to-date information on the blasting schedule at the project; (c)publish an up-to-date blasting schedule on its website (for open pit and major underground blasting operations); and (d)advertise the blasting hotline number and website information in the mine's regular newsletter, to the satisfaction of the Secretary.	**Observation No. 13** – In conjunction with its Production Managers, Cadia could review the blasting schedule that is advertised on the Cadia website, as it may no longer reflect actual practice in 2020.	Accepted - Cadia to review and update the blasting schedule that is advertised on the Cadia Valley Operations website to ensure that information is current.	01-Mar-21	Complete
		Observation No. 14 – Cadia does not maintain a "blasting hotline", only a "complaints hotline". The next update of the Project Approval should not refer to a Blasting Hotline.	Accepted. Cadia to seek permission from DPI&E to remove the reference of the "blasting hotline" in S3, Condition 12 (b) during the MOD14 development application process.	28-Apr-21	Not Complete. At the time of completing this report, this finding was being addressed as part of the Mod 14 development application.
S3. C14	**BLASTING AND VIBRATION** **Property Inspections** If the Proponent receives a written request for a structural property inspection from any such landowner, the Proponent shall: (a)within 2 months of receiving this request commission a suitably qualified, experienced and independent person, whose appointment has been approved by the Secretary, to inspect the condition of any building or structure on the land (prior to blasting taking place within 2 kilometres of the property, if possible), and recommend measures to mitigate any potential blasting impacts; and (b)give the landowner a copy of the property inspection report.	**Observation No. 15** – Cadia could potentially investigate and verify if any additional baseline structural inspections need to be completed of the landowner residences (i.e. located within a 2 km radius of existing and future blast zones) that potentially could be impacted in the future (i.e. given that the last opportunity was in 2010).	Action accepted - Cadia will investigate and verify if any additional baseline structural inspections need to be completed.	31-Dec-21	In progress. On track for completion by due date

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S3. C17	**AIR QUALITY** **Impact Assessment Criteria** Except for the land in Table 1, the Proponent shall ensure that all reasonable and feasible avoidance and mitigation measures are employed so that particulate matter emissions generated by the development do not cause exceedances of the criteria listed in Tables 8, 9 and 10 at any residence on privately owned land, or on more than 25% of any privately-owned land.	**Observation No. 16** –Cadia's TSP concentrations are inferred from the PM10 monitoring data, by assuming that 40% of the TSP is PM10. This data and assumption are derived from the Hunter Valley coal region and may not be applicable to a base metals operation in central west NSW. This could be reviewed and potentially reassessed by a specialist air consultant.	Observation to be considered in future reviews of the Air Quality Monitoring Program	31-Dec-22	Underway. The format and content of management plans and monitoring programs are progesssively being updated to address the findings of the audit
		Observation No. 17 – Cadia could request confirmation of the data retention processes and data back-up periods retained by Advitech and request that Cadia data is provided by the consultant to Cadia annually.	Cadia accepts this observation and will seek confirmation and implement annual data provision if required.	31-Dec-21	In progress. On track for completion by due date
		Observation No. 18 – Cadia could investigate why TSP data at the control site remains high, as defined in recent monthly Air Quality Monitoring Assessment reports issued by Advitech.	Not Accepted. Dust deposition results are considered in line with predominant wind directions are independently assessed.	N/A	
		Observation No. 19 – Ideally, the reason for not including high/erroneous dust deposition data in the annual averages (i.e. as prepared by Todoski) would be expected to be included as a one-page appendix in the back of the consultant's report.	Cadia accepts this observation and will ensure future reports include, where appropriate, high/erroneous dust deposition data as an Appendix in the consultant's report.	31-Dec-21	In progress. On track for completion by due date
		Observation No. 20 – Cadia is encouraged to include four duplicate QA/QC samples within its dust deposition monitoring program (i.e. one duplicate sample every quarter at one nominated dust deposition site that typically records higher readings).	Cadia accepts this observation and will install a duplicate sample in line with Observation No. 21.	31-Dec-22	In progress. On track for completion by due date
		Observation No. 21 – Cadia is encouraged to investigate and redesign the design of its dust deposition poles/gauges to reduce the contribution of organic matter from birds.	Cadia accepts this observation. Cadia will investigate, and where appropriate, redesign the Dust Deposition Gauges to minimise contribution of organic matter from birds.	31-Dec-22	In progress. On track for completion by due date
S3. C27	**SOIL AND WATER** **Cadiangullong Creek Flows** The Proponent shall manage water releases from Cadiangullong Dam to provide: (a)flows of at least: •3.4 ML/day, for periods when inflows into the dam are more than 3.4 ML/day and the water level in the dam is at or above the lowest valve level on the multilevel offtake (ie. 773.0 metres AHD); •the volume equal to the inflow into the dam, for periods when inflows into the dam are between 0.4 and 3.4 ML/day and the water level in the dam is at or above the lowest valve level on the multi-level offtake; •0.4 ML/day, for periods when inflows into the dam are less than 0.4 ML/day and the water level in the dam is at or above the lowest valve level on the multi-level offtake; •the volume equal to the inflow into the dam, up to 0.4ML/day, for periods when the water level in the dam is below the lowest valve level on the multi-level offtake and above the level of the scour valve (i.e. 762.8 metres AHD); and •zero, when the water level in the dam is below the level of the scour valve; and (b)releases of up to 4 medium flows (of the order of 12 to 15 ML/day) per year, each for a duration of 1 to 3 days, with timing and frequency of such flows determined by hydrographs of typical medium flows, to the satisfaction of, and unless otherwise approved by, DPIE Water.	**Observation No. 22** – In its 2017/18 AEMR (i.e. Section 11.3 – Notifications) Cadia did not include and report the three non-compliances from December 2017, September 2018 and November 2018 relating to minimum flows required to be maintained at the Oaky Creek gauging station.	Accepted, no action required.	N/A	N/A

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Condition Number (ID)	Compliance Requirement	Independent Audit Observation / Opportunity for Improvement	Cadia's Proposed Action or reason to not implement measures / changes	Proposed Action Due Date (if applicable)	Status as at 31 August 2021
S3. C28	**SOIL AND WATER** The Proponent shall not extract any water from Cadiangullong Dam when the volume in the dam drops to 10 percent or less of its total capacity (i.e. 778.8 metres AHD), unless otherwise approved by DPIE Water. Flow releases (see condition 27 above) shall be continued during any such period, except when the level of water in the dam drops below the level of the dam's scour valve (i.e. 762.8 metres AHD).	**Observation No. 23** – For due diligence, records relating to the physical isolation of the Cadiangullong Dam valve should be retained by CVO Environment Department personnel. This would potentially involve requesting and receiving a written verification that the valve is located, supported by a photo of the locked valve from SAOC (and potentially the key lock). In addition, Cadia could confirm which employee retains the key lock and where the lock should reside.	Accept - Cadia will develop a procedure for the Environment Department to physically lock licensed extraction points that are out of use for compliance purposes.	30-Jun-21	Complete
		Observation No. 24 – Cadia could consider ensuring the Cadiangullong Dam level sensor (when connected to the control centre) is alarmed at an appropriate level above the regulatory level enabled with automatic notification.	Accept - Cadia commits to linking the Cadiangullong Dam level to the central control system (DCS) and developing alarm triggers corresponding to the TARP levels for Cadiangullong Dam in the Cadia Water Management Plan.	30-Jun-21	Complete
S3. C31	**SOIL AND WATER** The Site Water Balance must: (a)include details of: •sources and security of water supply; •water use on site; •water management on site; •any off-site water transfers; •reporting procedures; and (b)investigate and implement all reasonable and feasible measures to minimise water use by the project.	**Observation No. 25** – Whilst it is acknowledged that Cadia's November 2019 Water Management Plan is of high quality, considerable differences in content and structure exist between this plan and for example, the May 2019 Cadia Dust Management Plan. Cadia would benefit by increasing the consistency in structure and content across its environmental management plans (i.e. inclusive of defining all existing environmental controls and potentially, planned future controls). If future controls are unsuitable to be defined within individual environmental management plans, then formal annual Environmental Improvement Plans could be developed, disseminated to operational departments and implemented (i.e. defining how improvements will be formally implemented and potentially administered within CHESS).	Cadia accepts this observation. A program will be put in place to align environmental management plans consistency in structure and content. Cadia will investigate the potential for future controls to be addressed in Environmental Improvement Plans, and if appropriate will seek to implement EIPs.	31-Dec-22	Underway. The format and content of management plans and monitoring programs are progesssively being updated to address the findings of the audit
S3. C32	**SOIL AND WATER** The Erosion and Sediment Control Plan must: (a)be consistent with the requirements of Managing Urban Stormwater: Soils and Construction, Volume 1, 4th Edition, 2004 (Landcom); (b)identify activities that could cause soil erosion and generate sediment; (c)describe measures to minimise soil erosion and the potential for the transport of sediment to downstream waters; (d)describe the location, function, and capacity of erosion and sediment control structures; and (e)describe what measures would be implemented to maintain the structures over time.	**Observation No. 26** – Whilst Cadia's November 2019 Water Management Plan references the NSW Government's guidelines for Managing Urban Stormwater: Soils and Construction, Volume 1, 4th Edition, 2004 (Landcom), Cadia has not defined how its Erosion and Sediment Control Plan aligns with requirements defined in the 2004 NSW Government Guidelines (i.e. as a table in the plan).	Cadia will expand on the commentary in the Water Management Plan to describe how the Erosion and Sediment Control Plan aligns with Landcom 2004	30-Dec-21	In progress. On track for completion by due date
S3. C33	**SOIL AND WATER** The Surface Water Monitoring Program must include: (a)detailed baseline data, based on sound statistical analysis, to benchmark the pre-mining natural variation in surface water flows and quality in creeks and other waterbodies that could potentially be affected by the project; (b)surface water and stream health impact assessment criteria; (c)a program to monitor and assess: •impacts on surface water flows and quality; •impacts on water users; •stream health conditions in Swallow Creek, Cadiangullong Creek, Rodds Creek, Flyers Creek and Diggers Creek, including riparian vegetation; •potential acid rock drainage; •potential leakage or spillage from tailings, mineral concentrate and effluent	**Observation No. 27** – CVO's Environmental Monitoring Manual describes monitoring and sampling requirements inclusive of surface water and groundwater. This Manual was last revised and issued in 2016 and requires review and updating in the next 12 months to ensure it reflects leading practice and standardised industry practices in surface and groundwater monitoring (e.g. June 2018 Queensland DES Monitoring and Sampling Manual).	Cadia accepts this observation. Cadia intends for the Environmental Monitoring Manual to be re-developed by aspect. A Surface Water Monitoring Manual and Groundwater Monitoring Manual will be developed and reviewed as part of this re-development.	31-Dec-21	In progress. On track for completion by due date
		Observation No. 28 – To improve CVO's existing quality control program, the number of monthly QA/QC samples collected for surface and groundwater monitoring would be expected to be 5 8% of the total number of samples collected (i.e. comprising blank, duplicate and potentially spiked samples).	Accept - Cadia will review its quality control procedures based on relevant guidelines and define a proportion of QAQC samples to be routinely collected in the site Water Management Plan.	30-Jun-21	Complete

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	pipelines; (d)a program for the ongoing verification and refinement of the surface water model; and (e)reporting procedures for the results of the monitoring program and model verification.	**Observation No. 29** – CVO is encouraged to schedule and complete an environmental monitoring audit to ensure that: a) environmental monitoring is conducted against leading and standardised industry practice prior to the final reissue of CVO's 2016 Environmental Monitoring Manual; and b) to ensure that monitoring personnel are suitably trained and competent.	Cadia will conduct an internal review of water quality monitoring procedures in accordance with relevant guidelines and any identified improvement actions documented in the next verion of the Environmental Monitoring Manual. Cadia commits to internally providing adequate training to monitoring personnel and verifying competency in the field.	31-May-21	Complete
		Observation No. 30 – QC samples, including blank and duplicate samples must not be identifiable/disclosed to the ALS laboratory (i.e. these samples must be submitted as blind samples to ALS).	Cadia will review it's sample naming convention and database system to develop a system whereby QAQC samples are not identifiable to an external laboratory.	30-Jun-21	Complete
		Observation No. 31 – Section 9 of Cadia's November 2019 Water Management Plan currently lists a range of reports relating to water management, but would be expected to more effectively describe requirements applicable to Project Approval Schedule 3, Condition 33 (e) relating to reporting procedures for the results of the monitoring program and model verification	Cadia will review Section 9 of the Water management Plan and link the reporting requirements with the specific requirements from PA06_0295 Schedule 3. Any changes will be made to the next version of the WMP	30-Jun-21	Complete
		Observation No. 32 – Relevant sections of Cadia's November 2019 Water Management Plan will require review and updating to describe the additional water management practices and containment structures in progress at the CVO Dewatering Facility.	Cadia will incorporate the design changes to the Cadia Dewatering Facility water management in the next revision of the Water Management Plan	30-Jun-21	Complete
S3. C34	**SOIL AND WATER** The Groundwater Monitoring Program must include: (a)detailed baseline data, based on sound statistical analysis, to benchmark the pre-mining natural variation in groundwater levels, yield and quality (including privately-owned bores within the maximum predicted 1 metre groundwater drawdown contour, as indicated on the plans in Appendix 5); (b)groundwater impact assessment criteria (including for monitoring bores and privately-owned bores); (c)a program to monitor: •impacts on the groundwater supply of potentially affected landowners; •impacts on springs and groundwater dependent ecosystems; •the volume of groundwater seeping into open pit and underground mine workings; •regional groundwater levels and quality in all potentially affected aquifers; •potential acid rock drainage; •the hydraulic gradient and groundwater quality around the base of the Cadia Hill pit; (d)a program for the ongoing verification and refinement of the groundwater model; and (e)reporting procedures for the results of the monitoring program and model verification.	**Observation No. 33** – As required by Project Approval Schedule 3, Condition 34 (c), Cadia's November 2019 Water Management Plan could more effectively define and include details of the operation's monitoring program to assess the potential for acid rock drainage (i.e. acknowledging that it is based on the monitoring of water quality within the NLD and SLD leachate dams).	Cadia will expand on commentary relating to assessment of the Potential for AMD and make reference to the Waste Rock (incorporating Acid and Metalliferous Drainage) Management Plan where relevant	30-Jun-21	Complete
S3. C36	**REHABILITATION AND BIODIVERSITY OFFSETS** Rehabilitation By the end of 2010, the Proponent shall prepare a Rehabilitation Strategy for the project to the satisfaction of the Secretary. This strategy must: (a)be prepared by a team of suitably qualified and experienced experts whose appointment has been endorsed by the Secretary; (b)be prepared in consultation with relevant stakeholders, including the RR, DRG, BCD, DPIE Water, Councils and the CCC; (c)investigate options for the future use of disturbed areas including voids upon the completion of mining; (d)describe and justify the proposed rehabilitation strategy for the site, including the post-mining landform and use; (e)define the rehabilitation objectives for the site, as well as the proposed	**Observation No. 34** – Cadia could consider requesting the Secretary to correct the text colour of Project Approval Schedule 3, Condition 36 (e) in any future modification of the Project Approval, as this condition was not changed as part of Modification 13 as shown.	Accepted. Cadia will make a request to DPI&E to correct the colour text for modification updates in PA06_0295 during the MOD14 development application process.	28-Apr-21	Not Complete. At the time of completing this report, this finding was being addressed as part of the Mod 14 development application.
		Observation No. 35 – Notwithstanding the above DPIE consultation agreement, there is no evidence that Cadia consulted with the CCC in the review of the Rehabilitation Strategy as per the commitment stated in Section 11.2 of the strategy (in addition, the summary of comments received in Table 11-1 appears to be from previous revisions/original version of the strategy). Cadia should review this aspect of the strategy.	Refer to commitment from Non Compliance 3 / recommendation 3.	N/A	N/A

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	completion criteria for this rehabilitation; and (f)be prepared in accordance with any relevant RR guideline. *Note: The strategy should build on the concept strategy depicted in Appendix 6.*	**Observation No. 36** – Cadia could consider requesting the Secretary to revise Project Approval Schedule 3, Condition 36 (b) in any future modification to the Project Approval in consideration of the Resource Regulator's response in that they will not comment on revisions of the Rehabilitation Strategy.	Accepted. Cadia to request DPI&E to remove RR regarding consultation on changes or updates to the Rehabilitation Strategy as they do not comment on this plan. This is to be requested during the MOD14 development application process.	28-Apr-21	Not Complete. At the time of completing this report, this finding was being addressed as part of the Mod 14 development application.
		Observation No. 37 – In future revisions of the Rehabilitation Strategy, Cadia should consider amending the review of strategy requirements (Section 11.1) of the Rehabilitation Strategy to refer to the requirement of Project Approval Schedule 5, Condition 3.	Accepted. The next revision of the Rehabilitation Strategy will include review requirements as per Schedule 5, Condition 3.	31-Dec-22	Underway. The format and content of management plans and monitoring programs are progesssively being updated to address the findings of the audit
		Observation No. 38 – Notwithstanding the absence of relevant RR guidelines for preparation of the Rehabilitation Strategy, Cadia should consider ensuring that figures in the strategy are consistent with the latest ESG3 Mining Operations Plan (MOP) Guidelines (see Rehabilitation Phases Table 8, section 11.4 and example Plans 3A - 3E).	Accepted. Cadia will review figures to ensure consistency with the guidelines.	31-Dec-22	Underway. The format and content of management plans and monitoring programs are progesssively being updated to address the findings of the audit
		Observation No. 39 – In future revisions of the Rehabilitation Strategy, Cadia should include the note of this condition (Note: The strategy should build on the concept strategy depicted in Appendix 6) in Table 4-1 of the strategy.	Accepted. Full condition, including notes will be included in future revision of the Strategy	31-Dec-22	Underway. The format and content of management plans and monitoring programs are progesssively being updated to address the findings of the audit
S3. C37	**REHABILITATION AND BIODIVERSITY OFFSETS** The Proponent shall: (a)carry out rehabilitation progressively, that is, as soon as reasonably practicable following disturbance; and (b)achieve the rehabilitation objectives in the Rehabilitation Strategy (see condition 36), to the satisfaction of the RR.	**Observation No. 40** – As per Project Approval Schedule 5, Condition 3(d), plans should be reviewed and if necessary revised within 3 months of a modification. The LMBP should be revised in light of the April 2017 modification (new Cadia Warehouse) (e.g. section 2.4 and Figure 2.2).	Refer to commitment arising from Non Compliance 3 / Recommendation 3	N/A	N/A
		Observation No. 41 – Cadia could improve its internal recording of rehabilitation management outcomes. Other than the annual rehabilitation monitoring report undertaken by DnA Environmental and appended to the AEMR each year, Cadia was unable to produce records of internal rehabilitation management records such as routine inspections/monitoring, corrective actions, or action plans with timelines etc.	Accepted, Cadia to implement internal tracking document.	30-Apr-21	Complete
		Observation No. 42 – Cadia could revise Figure 8-4 of the 2019/20 AEMR to ensure all monitoring sites are included (e.g. North Dump 02-03), and consider reporting the percentage of closure criteria met for the reporting year.	Accepted, the legend from the graph was inadvertently removed during import into the AEMR / Annual Review. This will be corrected in future Annual Reviews	31-Oct-21	Complete. Included in this AEMR
		Observation No. 43 – Cadia could include a table in section 1.7 of the LBMP indicating where in the plan each Project Approval condition is described.	The Observation will be considered during the current review of the LBMP and document templates..	09-May-21	Complete
		Observation No. 44 – Cadia could consider improving the graphical spatial representation of the rehabilitation progression (as suggested in the 2017 IEA) by substituting Figure 8-1 (Mine Disturbed Rehabilitation) of future AEMRs with plans similar to Plan 3A of the approved MOP. However, the colour coding of rehabilitation progression should be consistent with the latest ESG3 Mining Operations Plan (MOP) Guidelines (see Rehabilitation Phases Table 8, section 11.4 and example Plans 3A - 3E).	Accept. Where the required content of figures aligns between the MOP (guidelines) and Annual Review (guidelines) they will be consistent where possible.	31-Oct-21	Complete. Included in this AEMR
		Observation No. 45 – To improve clarity of all relevant project approval area plans/figures (including MOP, management and AEMRs plans and figures), Cadia should consider including a single line on the plan/figure and similarly in the legend identifying the project's approved surface development/disturbance area boundary.	Accepted, Cadia will include a single line for disturbance in future plans.	31/12/21	On track for completion

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		Observation No. 46 – Cadia could consider replying to the RR's letter of 13/08/2020 with a response to the observations and recommendations of the TAP and thereby ensure the RR is satisfied.	Accepted. Cadia will provide a written response to the RR TAP.	30-May-21	Complete
S3. C38	**REHABILITATION AND BIODIVERSITY OFFSETS** **Biodiversity Offsets** The Proponent shall: (a)implement the biodiversity offset strategy as described in the EA, and summarised in Table 14 (and shown conceptually in Appendix 6); and (b)investigate ways to salvage and beneficially use resources (including timber, fauna habitat, seed and soil resources) in areas subject to subsidence as far as is reasonable and feasible, in consultation with the BCD, to the satisfaction of the Secretary. *[Refer to Table 14 in PA 06_0295]*	**Observation No. 47** – In relation to the biodiversity offset strategy shown conceptually in Appendix 6 (Figure 6.1 of the Project Approval): •the Figure differs from Figure 3 Existing CVO Rehabilitation and Woodland Enhancement Concept (NEC-14-81 75W Mod-101D) of the EA. Figure 6.1 is (possibly an earlier draft) version NEC-14-81 75W Mod-101A. Cadia should confirm the correct version is included in the Project Approval; •the Figure does not show the East Cadia Subsidence as a waterbody, unlike the MOP; and •the Figure could be included in the body of the Land and Biodiversity Management Plan rather than in the appendix (as MOD 7 EA).	Accepted. Cadia commits to updating the figure Appendix 6 of the PA to reflect correct final landforms and offsets including displaying the Cadia East subsidence zone as a water body. Land and Biodiversity Management Plan will be updated as per observation 43	28-Apr-21	Not Complete. At the time of completing this report, this finding was being addressed as part of the Mod 14 development application.
		Observation No. 48 – There was no evidence of formal tracking of the work being undertaken in the offset areas. Cadia could consider preparing an internal report structure that regularly tracks the actions and timing of the Management Aspects for the offset areas as listed in Section 9.9 of the Land and Biodiversity Management Plan.	Accepted, Cadia to establish and implement an internal tracking process and document of rehabilitation works undertaken.	30-Apr-21	Complete
S3. C39	**REHABILITATION AND BIODIVERSITY OFFSETS** Within 2 years of the date of this approval, the Proponent shall make suitable arrangements to provide appropriate long term security for the offset areas to the satisfaction of the Secretary.	**Observation No. 49** – The BRR offset area shown in the approved management plans (e.g. Figures 9.2 and 9.3, pp 81-82 of the approved LBMP) is not consistent with the approved BRR offset area as shown in Appendix 6 (Figure 6.3) of the project approval.	Accepted, Cadia to review and update plans to ensure consistency.	30-Jun-21	Complete
		Observation No. 50 – Cadia should ensure the Black Rock Range – Cadia East Offset cadastral boundary (Lot 21 DP 1204782) is correctly reflected in all relevant approvals, plans, strategies and agreements as per the surveyed plan (Carpenter, Ref: 10086B dated 12th November 2009).	Accepted, Cadia to review and update plans to ensure consistency.	30-Jun-21	Complete
S3. C40A	**REHABILITATION AND BIODIVERSITY OFFSETS** **Retirement of Credits** Within two years of commencing construction of the MOD 13 Southern Tailings Storage Facility buttressing, unless the Secretary agrees otherwise, the Proponent must retire biodiversity credits of a number and class identified in Tables 14.1 and 14.2 below. The retirement of credits must be carried out in accordance with the Biodiversity Offsets Scheme of the Biodiversity Conservation Act 2016, to the satisfaction of the Biodiversity Conservation Trust. *]Refer to table 14.1 in PA06_0295]*	**Observation No. 51** – With regard to commencing construction of the MOD 13 Southern Tailings Storage Facility buttressing, Cadia could consider notifying the Secretary of the date of commencement so that the start of this condition's timeframe (i.e. within two years) is clear and Cadia will be able to ensure future compliance.	Accepted. Cadia commits to notify DPI&E of the commencement of construction of Mod 13 STSF buttressing.	08-Mar-21	Complete
S3. C41	**REHABILITATION AND BIODIVERSITY OFFSETS** **Land and Biodiversity Management Plan** The Proponent shall prepare and implement a Land and Biodiversity Management Plan for the project to the satisfaction of the Secretary. This plan must: (a) be prepared in consultation with BCD, DPIE Water, RR and the Councils, and be submitted to the Secretary within 18 months of the date of this approval; (b) include: (i)the rehabilitation objectives for the site and offset areas; (ii)a description of the short, medium, and long term measures that would be implemented to: •rehabilitate the site in accordance with the Rehabilitation Strategy (see condition 36); •implement the offset strategy; and •manage the remnant vegetation and habitat on the site and in the offset areas; (iii)detailed performance and completion criteria for the site rehabilitation and implementation of the offset strategy; (iv)a detailed description of the measures that would be implemented over the next 3 years, including the procedures to be implemented for: •progressively rehabilitating disturbed areas; •implementing revegetation and regeneration within the disturbance areas and	**Observation No. 52** – Cadia could consider standardising the Document History and Status to ensure the correct plan is being referred to when approved. The DPIE has approved Revision 3 of a plan dated 15/5/2017. However, the current plan shows a Date Issued of 20/1/2017 with a printed date of 15 May 2017.	Accepted. This will be completed in line with Observation No. 25.	31-Dec-22	Underway. The format and content of management plans and monitoring programs are progesssively being updated to address the findings of the audit
		Observation No. 53 – Cadia could consider referencing all of the relevant approval conditions as listed in section 1.7 of the LBMP to the relevant section in the plan where the condition is addressed.	The Observation will be considered during the current review of the LBMP and document templates..	09-May-21	Complete
		Observation No. 54 – Cadia should ensure the figures of the Cadia East Offset areas are consistent with the Project Approval (Appendix 6).	Accepted, Cadia to review and update plans to ensure consistency.	30-Jun-21	Complete

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	•implementing revegetation and regeneration within the disturbance areas and offset areas, including establishment of canopy, sub-canopy (if relevant), understorey and ground strata; •investigating ways to salvage and beneficially use resources in areas subject to subsidence (including timber, fauna habitat, seed and soil resources); •protecting vegetation and soil outside the disturbance areas; •rehabilitating creeks and drainage lines on the site (both inside and outside the disturbance areas); •managing potential acid forming material (including ensuring effective isolation of potential acid forming material in rock dumps); •managing salinity; •conserving and reusing topsoil; •undertaking pre-clearance surveys; •managing impacts on terrestrial and aquatic fauna (including a Squirrel Glider conservation strategy); •landscaping the site to minimise visual impacts; •collecting and propagating seed for rehabilitation works; •salvaging and reusing material from the site for habitat enhancement; •controlling weeds and feral pests, including terrestrial and aquatic species; •managing grazing and agriculture on site; •controlling access; •bushfire management; •managing and minimising any potential adverse impacts associated with the final voids; and •managing and minimising any adverse socio-economic effects associated with mine closure; (v)a program to monitor the effectiveness of these measures, and progress against the performance and completion criteria; (vi)a description of the potential risks to successful rehabilitation and/or revegetation, and a description of the contingency measures that would be implemented to mitigate these risks; (vii)details of who would be responsible for monitoring, reviewing, and implementing the plan; and (vii)a Threatened Species Management Protocol, which outlines management strategies to protect any threatened flora and fauna species during construction, operation and postmining.	**Observation No. 55** – Cadia could consider reporting the key findings (only) of the annual waste rock dump cover monitoring (e.g. graph of yearly net percolation rate compared to baseline model) and include any relevant recommendations adopted in the "Actions for the next reporting period" section of the AEMR	Accepted - Cadia to include in future Annual Reviews / AEMR's	31-Oct-21	Complete. Included in this AEMR
		Observation No. 56 – To determine whether any proposed disturbance is within the approved project disturbance footprint, Table 2 of the of the Environmental Impact Permit (710-005-EN-PRO-0006) procedure states that reference should be made to Figure 2 4d from the Cadia East Environmental Assessment. The figure is replicated in Appendix A of the procedure. The Auditor considers the scale of this figure (Project General Arrangement) too large to determine the permitted disturbance footprint. Cadia could consider providing the disturbance area electronically on a GIS. In addition, the procedure requires the assessor to consult previous project environmental assessments to retrieve information such as the location of heritage and environmentally sensitive areas. Cadia could consider including this information in a GIS as well.	Accept. Procedure 710-005-EN-PRO-0006 will be updated to require the checking of the current approved disturbance footprint and heritage sites on the Cadia GIS System.	15-Apr-21	Complete
S3. C42	**ABORIGINAL HERITAGE** **Aboriginal Cultural Heritage Management Plan** The Proponent shall prepare and implement an Aboriginal Cultural Heritage Management Plan for the project to the satisfaction of the Secretary. This plan must: (a)be prepared in consultation with BCD and the Aboriginal community, and be submitted to the Secretary for approval within 6 months of the date of this approval; (b)include a: •detailed salvage program and management plan for Aboriginal sites and potential archaeological deposits within the project disturbance area; •detailed description of the measures that would be implemented to protect and monitor Aboriginal sites outside the project disturbance area; •description of the measures that would be implemented if any new Aboriginal objects or skeletal remains are discovered during the project; and •protocol for the ongoing consultation and involvement of the Aboriginal communities in the conservation and management of Aboriginal cultural heritage on the site.	**Observation No. 57** – The current ACHM shows two version dates; Version 2 – 5/09/2010 Page i and Version 2 – 4/07/2012 Page 2.	Accepted, ACHMP) will be reviewed and updated.	31-Dec-22	
		Observation No. 58 – It is recommended that the ACHM be updated after any new ACHA is undertaken. The ACHA can be referenced in the ACHM and any new sites (if any) and findings can be recorded in the ACHM. This removes the requirement, and possibility of omissions, to search through modification documentation for ACHA findings (e.g. when assessing Environmental Impact Permits).	Trigger (AHCA) for requiring an update will be incorporated into the next review of the ACHMP		Underway. The format and content of management plans and monitoring programs are progesssively being updated to address the findings of the audit

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Condition Number (ID)	Compliance Requirement	Independent Audit Observation / Opportunity for Improvement	Cadia's Proposed Action or reason to not implement measures / changes	Proposed Action Due Date (if applicable)	Status as at 31 August 2021
S3. C43	**HISTORICAL HERITAGE** **Historical Heritage Management Plan** The Proponent shall prepare and implement a Historical Heritage Management Plan for the project to the satisfaction of the Secretary. This plan must: (a)be prepared in consultation with the Heritage NSW and be submitted to the Secretary for approval within 6 months of the date of this approval; (b)include: •compilation of archival recording, excavation and/or salvage of heritage items within the project disturbance area, including the Wire Gully Gold Workings and the Little Cadia Copper Mine; •a detailed conservation management strategy for heritage items outside the project disturbance area but within the vicinity of the site, including a: odescription of the measures that would be implemented to protect heritage items from disturbance, including disturbance from blasting activities; oprogram to monitor the effects of blasting on relevant heritage items; and oan Interpretation Plan for the Cadia Village. *Note: The Little Cadia Copper Mine is outside the zone of subsidence for the Cadia East mine but within its zone of influence, and therefore may potentially be subject to impact. It is proposed to conserve the site in-situ, if possible.*	**Observation No. 59** – The document history and status show the currently approved version of the HHMP as Rev.1 dated issue 15/6/2020. However, the DPIE approval refers to a HHMP, Revision 1 dated 29 May 2020. Cadia should ensure that the DPIE approval dates are consistent with the final plan.	Observation accepted. Future revisions will identify the correct approval dates in line with Observation No. 25.	31-Dec-22	Underway. The format and content of management plans and monitoring programs are progesssively being updated to address the findings of the audit
		Observation No. 60 – Cadia could consider ensuring reports, provided to regulators and for public publishing on the Cadia website, are reviewed by multiple reviewers for quality control. Section 6.7.2.1 of the 17/18 and 18/19 both refer to the 2017/18 inspection report undertaken by Mott McDonald.	Not Accepted. These documents are currently reviewed by multiple people. Further care will be taken in the quality of the reviews prior to accepting reports.	Ongoing	Complete
S3. C44	**TRANSPORT** **Road Construction** The Proponent shall: (a)realign the affected sections of Cadia Road, and reconstruct the Cadia Road / Woodville Road intersection, at least 6 months before causing any subsidence of the affected roads; and (b)construct the CVO Dewatering Facility site intersection on Newbridge Road, prior to the commencement of construction of the facility, to the satisfaction of the applicable Council.	**Observation No. 61** – Schedule 3, Condition 44(b) applies to construction of the CVO Dewatering Facility site intersection on Newbridge Road, which has been constructed to the satisfaction of Blayney Shire Council. Cadia could consider requesting paragraph (b) of this condition be removed in a future modification of the Project Approval, as paragraph (b) is now redundant.	Accepted. Cadia to request DPI&E to remove item Schedule 3, Condition 44b. This is to be requested during the MOD14 development application process.	28-Apr-21	Not Complete. At the time of completing this report, this finding was being addressed as part of the Mod 14 development application.
S3. C45	**TRANSPORT** **Road Haulage** The Proponent shall transport all concentrate: (a)to the Blayney Dewatering Facility and CVO Dewatering Facility by pipeline; and (b)from the Blayney Dewatering Facility and CVO Dewatering Facility by rail. If during the life of the project pipeline or rail services are not available to transport the concentrate the Proponent may apply to the Secretary for permission to temporarily use truck facilities until such time as pipeline or rail services are returned to normal service.	**Observation No. 62** – Considering the Blayney Dewatering Facility is now demolished, references to it in this condition are now redundant. Cadia could consider requesting that references to the Blayney Dewatering Facility in this condition be removed in a future modification of the Project Approval.	Accepted. Cadia will make a request to DPI&E for the reference to the BDWF to be removed during the MOD14 development application process.	28-Apr-21	Not Complete. At the time of completing this report, this finding was being addressed as part of the Mod 14 development application.
S3. C46	**TRANSPORT** **Road Haulage** The Proponent shall ensure that all traffic accessing the Blayney Dewatering Facility does so via Marshalls Lane and Gerty Street. Hill Street shall not be used except with the written permission of Blayney Shire Council.	**Observation No. 63** – This condition applies to traffic route restrictions to and from the (now demolished) old Blayney Dewatering Facility. If Hill Street is not intended to be used in the future, Cadia could consider requesting that this potentially redundant condition be removed in a future modification of the Project Approval.	Accepted. Cadia to seek permission from DPI&E that this condition is removed during the MOD14 development application process.	28-Apr-21	Not Complete. At the time of completing this report, this finding was being addressed as part of the Mod 14 development application.
S3. C49	**VISUAL** **Visual Amenity and Lighting** The Proponent shall: (a)implement all reasonable and feasible measures to mitigate visual and off site lighting impacts of the project; (b)ensure no outdoor lights shine above the horizontal; and (c)ensure that all external lighting associated with the project complies with Australian Standard AS4282 (INT) 1997 – Control of Obtrusive Effects of Outdoor Lighting, to the satisfaction of the Secretary.	**Observation No. 64** – Cadia could update the Risk Register (710-000-RI-REG-0001) to include lighting risks at the CVO Dewatering Facility.	Complete. Risk Register line EAI-396 includes Fugitive lighting risks from the Cadia Dewatering Facility. Fugitive Lighting Management Plan also updated to include risk.	Complete	Complete
		Observation No. 65 – Cadia could consider including lighting (e.g. working at night on the southern waste dump) as an Initiating Trigger in Table 2 of the Environmental Impact Permit (Procedure) 710-005-EN-PRO-0006.	Accept. Procedure 710-005-EN-PRO-0006 will be updated as stated in the observation	15-Apr-21	Complete

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S3. C50	**WASTE** **Waste Minimisation** The Proponent shall: (a)minimise the waste generated by the project; (b)ensure that the waste generated by the project is appropriately stored, handled and disposed of; (c)manage on-site sewage treatment and disposal in accordance with the requirements of the applicable Council; and (d)report on waste management and minimisation in the Annual Review, to the satisfaction of the Secretary.	**Observation No. 66** – The general condition (colour coding, labelling etc.) of waste bins was observed to be poor/faded. Cadia could consider requesting the waste contractor to recondition all waste containers (both for external and internal use containers).	Accepted. Remondis directed to update bin condition in line with observation.	30-Jun-21	Complete
		Observation No. 67 – In the next revision of the Non-Mineral Waste Management Plan, Cadia could update Table 1 to include all paragraphs of this condition (i.e. the current plan includes paragraph (b) only).	Accepted. Future revision of the NMWMP will include the full condition.	31-Dec-22	Underway. The format and content of management plans and monitoring programs are progesssively being updated to address the findings of the audit
		Observation No. 68 – Cadia could consider reviewing the Total Waste Management Contract (TWMC) to include Schedule 3 Condition 50 (a) as a KPI, and report on waste minimisation outcomes and initiatives in the AEMR.	Accepted, TWMC to be reviewed mid 2021 so will add to this recommendation for discussion with Contract Manager	30-Jun-21	Complete
		Observation No. 69 – The % recycling value KPI is omitted from the TWMC (shown as TBA) and shown as 55% in the waste contractors monthly reports (e.g. Figure 11 Site Recycling % – YTD of April 2020 report). The AEMRs for the audit period report it as 65%. Cadia should ensure this recycling benchmark is clear and consistent across all plans, contracts and reporting documents.	Accepted. The NMWP will be updated to reflect how the KPIs are calculated.	31-Dec-22	Underway. The format and content of management plans and monitoring programs are progesssively being updated to address the findings of the audit
		Observation No. 70 – Cadia could review and where necessary update the Non-Mineral Waste Management Plan to: •assign single responsibility for waste contractor liaison and accountability for achieving KPIs. It was stated that the Fixed Plant and Maintenance Department Manager has recently been assigned this role. The Areas of Responsibility table in section 13 of the plan currently assigns responsibility of liaison with stakeholders (including contractors, however not verified if the waste contractor is included) to four departments; and •ensure obligations from the TWMC are captured in the plan (including the 22 KPIs).	Cadia will consider this observation when the TWMC is next reviewed.	31-Dec-22	Underway. The format and content of management plans and monitoring programs are progesssively being updated to address the findings of the audit
		Observation No. 71 – Cadia could consider undertaking an audit to ensure compliant waste tracking is undertaken and waste receivers are compliant with legal requirements.	Accept, Cadia will schedule a series of 'waste tracking audits' of high risk waste streams as per the NMWP.	30-Jun-21	Complete
		Observation No. 72 – At the time of this audit, full IBCs containing oils were observed (temporarily) stored on an unbunded concrete pad area beside the CVO Waste Storage Facility. The area appeared to drain to an internal stormwater drain. It was stated that the drainage system had an inline oil interceptor, however, these are not designed to capture large losses. Cadia should ensure all hydrocarbons are stored (including temporary storage) in bunded areas.	Complete. At the time of the audit, wastes were being progressively moved in to an upgraded waste transfer facility. The area will continue to be included in Cadia Environmental Inspection program.	N/A	Complete

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		Observation No. 73 – Paragraph (a) of this condition requires Cadia to "minimise the waste generated by the project". Cadia effectively manages non-mineral waste generated with specific targets for recycling (65%) and reducing waste to landfill (by 5% each year) i.e. the downstream side, once the waste is generated. Cadia could consider reviewing its waste strategy to ensure effort is expended on the "upstream" side of the non-mineral waste in order to minimise that waste being generated in the first place. This may be through elimination, substitution etc. and integrating waste minimisation into procurement contracts for supplies as well as major projects. Cadia could consider reporting this information (in the AEMR) as a simple stacked bar chart showing total waste generated (recycling plus landfill) each year and resulting trends (of all three KPIs, i.e. percentage recycled, percentage waste to landfill and total waste generated).	Accepted. Cadia will consider revising its reporting of waste data in future AEMRs. Cadia will investigate opportunities for improvement to reduce waste in consideration of procurement and supply.	30-Jun-22	On track for completion
		Observation No. 74 – Cadia should ensure the ore processing area OSSMS is being maintained and operated in accordance with the recommendations of the Cadia Valley Operations Report on Sewage Treatment Plan – Performance Review (April 2008).	Accepted, will review with Maintenance Manager (via the Cadia Obligations Register)	30-Jun-21	Complete
S5. C1	**ENVIRONMENTAL MANAGEMENT** **Environmental Management Strategy** The Proponent shall prepare and implement an Environmental Management Strategy for the project to the satisfaction of the Secretary. The strategy must: (a)be submitted to the Secretary for approval within 6 months of the date of this approval; (b)provide the strategic framework for environmental management of the project; (c)identify the statutory approvals that apply to the project; (d)describe the role, responsibility, authority and accountability of all key personnel involved in the environmental management of the project; (e)describe the procedures that would be implemented to: •keep the local community and relevant agencies informed about the operation and environmental performance of the project; •receive, handle, respond to, and record complaints; •resolve any disputes that may arise during the course of the project; •respond to any non-compliance; and •respond to emergencies; (f) include: •copies of the various strategies, plans and programs that are required under the conditions of this approval once they have been approved; and •a clear plan depicting all the monitoring to be carried out in relation to the project.	**Observation No. 75** – Cadia would be expected to improve the document control applied to its environmental management plans (i.e. primarily relating to the approval of these plans and defined approval dates).	Accepted. Will be completed in line with Observation No. 25.	31-Dec-22	Underway. The format and content of management plans and monitoring programs are progesssively being updated to address the findings of the audit
S5. C2	**ENVIRONMENTAL MANAGEMENT** **Annual Review** By the end of 2010, and annually thereafter, the Proponent shall review the environmental performance of the project to the satisfaction of the Secretary. This review must: (a)describe the works that were carried out in the past year, and the works that are proposed to be carried out over the next year; (b)include a comprehensive review of the monitoring results and complaints records of the project over the past year, which includes a comparison of these results against the: •the relevant statutory requirements, limits or performance measures/ criteria; •the monitoring results of previous years; and	**Observation No. 76** – Cadia's AEMR template could include a table in the front of the template that clearly defines and lists how each issued AEMR complies with the requirements of Project Approval Schedule 5, Condition 2 (a) to (f).	Accepted. Cadia will consider summarising the various sections in the AEMR into a succinct table to address Schedule 5, Condition 2 (a) to (f)	31-Dec-21	Complete. Included in this AEMR
		Observation No. 77 –In relation to the improving the environmental performance of the project, Cadia could consider: •ensuring relevant findings, recommendations or any critical information contained in environmental assessments are extracted and presented in a readily accessible and easy to understand format to all relevant personnel; and •in the case of the location of aboriginal relics, Cadia could consider an updated GIS, with locations marked, that is accessible and workable by personnel in all relevant project departments.	Accepted. Relevant established procedures will be reviewed and updated to address the findings.	30-Jun-21	Complete
S5. C3	**ENVIRONMENTAL MANAGEMENT** **Revision of Strategies, Plans and Programs** Within 3 months of: (a)an annual review under condition 2 above; (b)an incident report under condition 5 below; (c)an audit under condition 7 below; or	**Observation No. 78** – CVO could request removal of Project Approval Schedule 5, Condition 3 (d) relating to the revision of CVO Strategies, Plans and Programs within 3 months of any modification to the Project Approval, given that for example, three Project Approval modifications occurred in a 12-month period in March 2018, April 2018 and September 2018. The requirement to revise these documents at intervals less than annually is impractical.	Accepted. Cadia to seek permission from DPI&E to remove reference to 3 (d) during the MOD14 development application process.	28-Apr-21	Not Complete. At the time of completing this report, this finding was being addressed as part of the Mod 14 development application.

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	(d) any modification of this approval, the Proponent shall review, and if necessary revise, the strategies, plans, and programs required under this approval to the satisfaction of the Secretary *Note: This is to ensure the strategies, plans and programs are updated on a regular basis, and incorporate any recommended measures to improve the environmental performance of the project.*	**Observation No. 79** – The Amendments Table provided in the current Cadia Water Management Plan should be standardised across all of Cadia's Environmental Management Plans and Monitoring Plans (as this process demonstrates compliance with Project Approval Schedule 5, Condition 3 (b) and (c)), for those plans that are required to be approved by the regulator).	Accepted. Will be completed in line with Observation No. 25.	31-Dec-22	Underway. The format and content of management plans and monitoring programs are progesssively being updated to address the findings of the audit
		Observation No. 80 – The AEMRs state that a review of the strategies, plans and programs is undertaken as part of the Annual Review process in accordance with Project Approval Schedule 5, Condition 3(c). However, any review should be undertaken as per Project Approval Schedule 5, Condition 3(a). The review (and revision if necessary) of the documents is required to be completed within 3 months of the annual review based on actions, improvements, changes etc. identified in the AEMR. Cadia should identify any required changes and revise the relevant document (include revision date) as required by this condition.	Accepted. Document revisions will reflect Schedule 5, Condition 3 as per Observation No. 10 and recorded in future AEMRs appropriately.	31-Dec-22	Underway. The format and content of management plans and monitoring programs are progesssively being updated to address the findings of the audit
S5. C4	**ENVIRONMENTAL MANAGEMENT** **Community Consultative Committee** Within 6 months of the date of this approval, the Proponent shall establish Community Consultative Committee (CCC) for the project to the satisfaction of the Secretary. This CCC must be established and operated in general accordance with the Guidelines for Establishing and Operating Community Consultative Committees for Mining Projects (Department of Planning, 2007, or its latest version). *Notes:* *•The CCC is an advisory committee. The Department and other relevant agencies are responsible for ensuring that the Proponent complies with this approval. In accordance with the Guideline, the Committee should comprise an independent chair and appropriate representation from the Proponent, affected councils and the general community.* *•In establishing the CCC, the Department will accept the continued representation from existing CCC members, however the Proponent should ensure that adequate representation is achieved for landowners within the area surrounding the Cadia East underground mine.*	**Observation No. 81** – The next issue of the Project Approval could reference the revised January 2019 version of the Guideline for Establishing and Operating Community Consultative Committees for Mining Projects (i.e. not the 2007 version).	Accepted. Cadia to seek permission from DPI&E to request a change to the reference of the current guideline for CCC.	28-Apr-21	Not Complete. At the time of completing this report, this finding was being addressed as part of the Mod 14 development application.
S5. C5	**COMPLIANCE** **Incident Notification** The Proponent must immediately notify the Department and any other relevant agencies immediately after it becomes aware of an incident. The notification must be in writing and identify the development (including the development application number and name) and set out the location and nature of the incident.	**Observation No. 82** – Cadia's February 2020 procedure titled "Reporting of Environmental Exceedances and Incidents" incorrectly utilises "non-conformances" throughout the procedure (i.e. a failure to meet an internal requirement) instead of referring to "non-compliance" (i.e. a failure to meet a statutory or external obligation). These are the correct and standard definitions utilised in Cadia's Project Approval and in the ISO14001:2015 Standard.	Accepted. Procedure 710-005-EN-PRO-0018 will be updated as suggested.	25-Mar-21	Complete

environmental
engineering &
energy

Cadia East Project
Independent Environmental Audit

Cadia Holdings Pty Limited
Project Approval PA 06_0295 (MOD 13)

November 2020

Prepared for

NSW Government
Department of Planning, Industry and Environment

Report Version: Final

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Document Control

Project No.	20217		
Report Type:	Independent Environmental Audit		
Report Title:	Cadia East Project Independent Environmental Audit Report 2020		
Audit Team:	John Hanrahan *B.Eng. (Chem), MIEAust.* – Lead Auditor Kurt Hammerschmid *B.App.Sc. (Chem), M.Sc. MEIANZ* – Auditor Adam Jones *B.Ec/LLB, B.Comm* – Audit Report Reviewer		
	Name	**Signed**	**Date**
Approved	John Hanrahan		8 February 2021

Prepared for:	**Company**
Mr Jeff Burton	Cadia Valley Operations Cadia Holdings Pty Limited 1460 Cadia Road ORANGE NSW 2800

Document Status	Revision Date	Description
Draft Report A	8 January 2021	Draft Report for Cadia's review
Draft Report B	23 January 2021	Second Draft Report incorporating Cadia's feedback and additional audit information
Final Report	8 February 2021	Final Report as issued to Cadia

LIMITATION: This report has been prepared on behalf of and for the exclusive use of 3E Environmental Engineering & Energy's Client and is subject to and issued in connection with the provisions of the agreement between 3E Environmental Engineering & Energy and its Client. 3E Environmental Engineering & Energy accepts no liability or responsibility whatsoever for or in respect of any issue of reliance on this report by a third party.

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Cadia East Project – Independent Environmental Audit – Details

Project Audited:	Cadia East Project
Dates of on-site component of Audit:	9th – 12th November 2020
Newcrest Cadia Audit Contact:	Mr Jeff Burton – Environment Specialist
Lead Auditor:	John Hanrahan *B.Eng. (Chem), MIEAust* Senior Environmental Engineer 3E Environmental Engineering & Energy PO Box 1893, Armidale, NSW 2350
Auditor:	Kurt Hammerschmid *B.App.Sc. (Chem), M.Sc. MEIANZ* Principal Environmental Auditor Integrated Environmental Systems Pty Ltd PO Box 662, Paddington NSW 2021
Independent Legal Review and Audit Report Reviewer:	Adam Jones *B.Ec/LLB, B.Comm* Lawyer Suite 503, 9-13 Bronte Road Bondi Junction, NSW 2022
Scope of the 2020 Audit:	1. The scope of the audit was to conduct an independent environmental audit and provide a subsequent report of findings as required by Schedule 5, Condition 7 of the Project Approval PA 06_0295 (MOD 13). 2. The scope of the audit included all relevant conditions (but excluding Definitions and Appendices unless otherwise specified in this report) specified in Project Approval PA 06_0295 (MOD 13) approved by the delegate of the NSW Minister for Planning. 3. The scope of the audit was limited to the site of the Cadia East Operations, consisting of: a) Cadia East underground mine; b) Cadia Hill open cut mine; c) Ridgeway underground mine; d) CVO Dewatering Facility; and e) ancillary infrastructure, together known as the Cadia Valley Operations. 4. The audit period for this audit was from 21st September 2017 (the day following the date of completion of the last three-yearly audit) to 12th November 2020 (the last day of the auditors' on-site attendance at this audit).
Cadia personnel interviewed during the Audit:	• Mr Jeff Burton – Specialist – Environment • Ms Vicki Hood – Superintendent – Environment • Ms Jane Chung – Approvals Superintendent • Mr Brandon Akerstrom – Manager – Ore Processing • Mr Nicolas Bourgeot – Senior Specialist – Water • Mr John Ford – Senior Environmental Advisor • Mr Martin Englert – Environmental Advisor • Ms Kara Hatch – Senior Environmental Advisor • Mr Peter Lord – Senior Mining Engineer – Surface • Mr Matthew Armstrong – Senior Social Performance Specialist • Mr Liam Franklyn – Fixed Plant Maintenance Manager • Mr Jon Fisher – Heavy Mobile Equipment Reliability Engineer • Mr James Lett – Superintendent – Geotechnical Engineer Operations (Surface, TSF, PC1, PC2) • Ms Kendra Campbell – Graduate – Environment • Mr Michael Shaw – Manager – CVO Dewatering Facility (Blayney) • Mr Adrian Bush – Manager – Cadia East Production (Mobile Surface Plant Workshop) • Mr Michael Power – Supply and Logistics • Mr John Barrie – Company Representative REMONDIS Australia (Waste Contractor)

Cadia Operational Areas visited/ inspected between 9th and 12th November 2020 (underground operations were not inspected):	• Northern Tailings Storage Facility (NTSF)
	• Southern Tailings Storage Facility (STSF)
	• New Cadia Warehouse
	• South Waste Rock Dump (SWRD)
	• North Waste Rock Dump (NWRD) (rehabilitation and ramp)
	• Cadia East Subsidence Zone
	• Ridgeway Subsidence Zone
	• Upper Rodds Creek Dam
	• Cadiangullong Creek Dam
	• Cadia Hill Open Pit
	• Cadia Extended
	• Former site of the Blayney Dewatering Facility (remediated site)
	• CVO Dewatering Facility (Blayney)
	• CVO concentrate pipeline route (section of)
	• CVO Site Asset and Operations Centre (SAOC)
	• CVO Waste Storage Facility
	• STSF buttressing
	• STSF seepage reclaim pond
	• Flyers Creek weir and gauging station
	• Cadiangullong Creek gauging stations
	  ○ Four Mile Creek
	  ○ Dam gauging station
	• CVO Forestry gauging station
	• Process Plant (surrounds)
	• Meteorological Station
	• CVO noise monitoring trailer
	• Cadia Cornish Engine House and Chimney Precinct

1 Executive Summary

This independent environmental audit of the Newcrest Cadia East Project's compliance with the conditions of Project Approval PA 06_0295 (MOD 13) was conducted in November 2020 by 3E Environmental Engineering & Energy.

The overall findings of this audit of the Cadia East Project in November 2020 are as follows:

- A total of 82 conditions across the Project Approval were audited. As recorded in this audit report, this audit identified 66 'compliant' findings, 12 'non-compliant' findings, and 4 'not triggered' findings.
- Cadia was compliant with 66 of the 78 applicable conditions (i.e. all conditions except those which were 'not triggered').
- This audit report includes 12 recommendations, against each of the non-compliance findings identified.

No major or systemic non-compliances were identified during this audit.

This audit report includes 82 observations. Observations are provided for Cadia's consideration as opportunities for improvement, enabling continual improvement to be demonstrated in statutory compliance, environmental management and environmental practices across the operation.

In terms of overall environmental performance, the Cadia East Project as assessed in this audit was considered to be managed to high environmental standards, in accordance with appropriate environmental management plans, monitoring programs and procedures.

2 Introduction

2.1 Background

The Cadia East Project is a gold and copper producing mine which is 100% owned by Newcrest Mining Limited. The Project is located approximately 25 kilometres south-west of Orange, NSW.

This independent environmental audit is intended to satisfy Schedule 5, Condition 7 of the Project Approval PA 06_0295 (MOD 13), which requires Cadia to commission and pay the full cost of an independent environmental audit of the Project "by the end of December 2011, and every 3 years thereafter".

This audit report is the fourth (4th) independent environmental audit report completed at the Cadia East Project (since the granting of the Project Approval on the 6th January 2010) and submitted to the NSW Department of Planning, Industry and Environment (DPIE), to demonstrate the operation's level of statutory environmental compliance.

2.2 Audit Team

3E Environmental Engineering & Energy (based in Armidale, NSW) provides professional independent auditing and consultancy services in a number of specialised areas of environmental management within the resource, chemical, oil and gas and utilities industries. John Hanrahan (3E's Principal) has more than 18 years' direct experience in the mining and environmental industries and more than 12 years' experience in auditing and agricultural related positions.

Kurt Hammerschmid (Director and Principal Auditor) of Integrated Environmental Systems Pty Ltd (based in Sydney) was engaged by 3E Environmental Engineering & Energy to assist with the compliance audit and provide specialist technical input on water related matters. Kurt Hammerschmid provides second and third party compliance and OHS and environmental auditing and consulting services. Since 1997, Kurt Hammerschmid has completed over 650 audits for a wide range of resource industry, power generation, oil and gas, chemical and water/waste treatment industry clients in Australia and overseas.

Adam Jones (an independent lawyer based in Sydney) was engaged by 3E Environmental Engineering & Energy to conduct a legal review of the draft audit report. Adam Jones has more than 20 years' legal experience across a variety of industry sectors. Since 2012, Adam Jones has built extensive experience in the resource industry via contract work (including conducting on-site audits and audit report reviews).

2.3 Audit Objectives

This independent environmental audit focused on completed works and on-site field practices associated with the Cadia East Project within the last three years (i.e. since the previous independent environmental audit). The objective of this audit was to assess the status of compliance of the Project against the conditions of the Project Approval.

2.4 Audit Scope

The scope of this independent environmental audit included all relevant conditions (but excluding definitions and appendices unless otherwise specified in this report) specified in Project Approval PA 06_0295 (MOD 13) as approved on 20th December 2019.

2.5 Audit Period

The period covered by this independent environmental audit ('audit period') is from 21st September 2017 (the day following the date of completion of the previous three-yearly independent environmental audit by Environmental Resources Management Australia Pty Ltd) to 12th November 2020 (the last day of the on-site attendance component of this audit).

2.6 Audit Report Submission

Section 4.5 of the NSW Government's *Independent Audit Post Approval Requirements* (IPAR) (DPIE, May 2020) requires the submission of the final Independent Audit Report and the proponent's response to audit findings within 2 months of undertaking the independent audit site inspection, unless otherwise agreed with the DPIE. The on-site inspection component of this audit commenced on 9th November 2020 and concluded on 12th November 2020.

Project Approval Schedule 5, Condition 8 permits a timeframe of 3 months from the commencement of the audit (unless otherwise agreed with the DPIE) for submission of the audit report, together with a response to any recommendation contained in the audit report, and a timetable for the implementation of the recommendations.

The Auditors consider that the audit commenced on 9th November 2020 (i.e. the first day of the Auditors' on-site attendance and inspections). On-site attendance and inspections ended on 12th November 2020.

In relation to the applicable timeframe for submission of this audit report, the Auditors consider that Schedule 5, Condition 8 of the Project Approval takes precedence over Section 4.5 of the IPAR.

3 Audit Methodology

3.1 Selection and Endorsement of Audit Team

Cadia selected 3E Environmental Engineering & Energy to conduct the audit, after reviewing proposals received from environmental audit service providers. The Secretary of the DPIE endorsed the appointment of the Audit Team by letter of 17th August 2020, which is reproduced in Appendix D of this audit report.

3.2 Independent Audit Scope Development

The audit scope was determined by Project Approval Schedule 5, Condition 7, which (as of MOD 13) requires that the independent environmental audit must "be prepared in accordance with the relevant *Independent Audit Post Approval requirements* (DPE 2018)".

In consultation with the Proponent and as approved by the DPIE, the Auditors have prepared this audit report in accordance with the current *Independent Audit Post Approval Requirements* (IPAR) issued by the DPIE in May 2020.

In developing the audit scope, 3E Environmental Engineering & Energy consulted the Proponent and considered responses from the relevant agencies arising from pre-audit consultations. The consultation letters and the agency responses received are reproduced in Appendix C of this audit report.

The Detailed Compliance Status table in Appendix A of this audit report was prepared by 3E Environmental Engineering & Energy.

3.3 Compliance Evaluation

This independent environmental audit was conducted by: a) direct verification of compliance against relevant conditions in the field (except underground operations); and b) 'sampling' a range of the documents, records and data associated with the Project and related activities. The nature of sampling during any form of compliance audit is such that it may not necessarily identify everything that the operation is, or is not doing, in relation to an individual condition of the Project Approval.

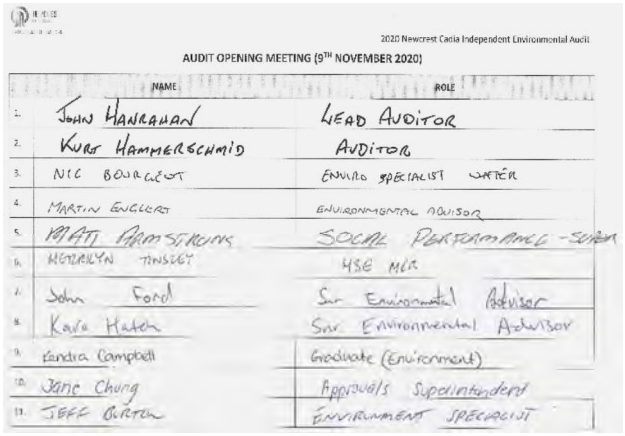
The Lead Auditor's Independent Audit Declaration in respect of the conduct of this independent environmental audit is set out in Appendix E of this audit report.

3.4 Site Interviews

The Lead Auditor and Auditor attended the Project site on each day from 9th to 12th November 2020 (4 days). Interviews were conducted both in person and remotely. The "Cadia East Project – Independent Environmental Audit – Details" page in this audit report lists the names of Cadia personnel who were interviewed during this audit.

An on-site opening meeting for the audit was held on 9th November 2020 and an on-site closing meeting was held on 12th November 2020.

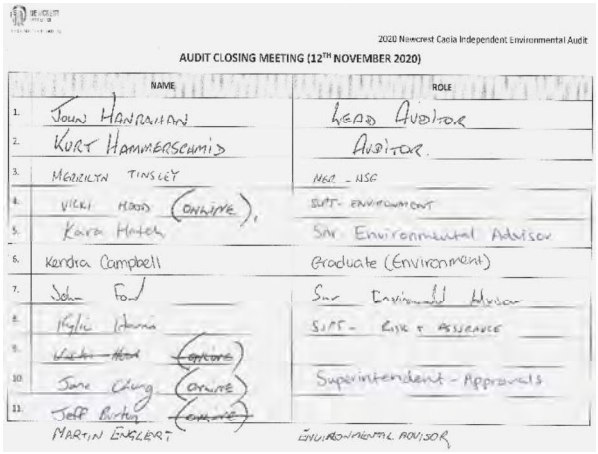
The attendees at the opening and closing meetings are listed in the attendance sheets reproduced below.



2020 Newcrest Cadia Independent Environmental Audit

AUDIT OPENING MEETING (9TH NOVEMBER 2020)

	NAME	ROLE
1.	JOHN HANRAHAN	LEAD AUDITOR
2.	KURT HAMMERSCHMID	AUDITOR
3.	NIC BOURCHIER	ENVIRO SPECIALIST WATER
4.	MARTIN ENGLERT	ENVIRONMENTAL ADVISOR
5.	MATT ARMSTRONG	SOCIAL PERFORMANCE - SCREEN
6.	MEGANLYN TINSLEY	HSE MGR
7.	John Ford	Snr Environmental Advisor
8.	Kara Hatch	Snr Environmental Advisor
9.	Kendra Campbell	Graduate (Environment)
10.	Jane Chung	Approvals Superintendent
11.	JEFF BURTON	ENVIRONMENT SPECIALIST



2020 Newcrest Cadia Independent Environmental Audit

AUDIT CLOSING MEETING (12TH NOVEMBER 2020)

	NAME	ROLE
1.	JOHN HANRAHAN	LEAD AUDITOR
2.	KURT HAMMERSCHMID	AUDITOR
3.	MEGANLYN TINSLEY	HEA - HSC
4.	VICKI HOOD (ONLINE)	SUPT- ENVIRONMENT
5.	Kara Hatch	Snr Environmental Advisor
6.	Kendra Campbell	Graduate (Environment)
7.	John Ford	Snr Environmental Advisor
8.	Kylie Hanna	SUPT - RISK & ASSURANCE
9.	~~Katie Head~~ (online)	
10.	Jane Chung (online)	Superintendent - Approvals
11.	Jeff Burton (online)	
	MARTIN ENGLERT	ENVIRONMENTAL ADVISOR

At the opening meeting, the objectives of the audit, the scope of the audit, the resources required and methodology to be applied were discussed. At the closing meeting, preliminary audit findings were presented, recommendations were made, and post-audit actions and timing for preparation of this audit report were confirmed.

3.5 Site Inspections

The Lead Auditor and Auditor conducted site inspections on each day of the audit (i.e. on the 9th, 10th, 11th and 12th November 2020). The "Cadia East Project – Independent Environmental Audit – Details" page of this audit report lists the operational areas which the Auditors inspected during their on-site attendance.

3.6 Consultation

In preparation for on-site audit attendance, the Lead Auditor consulted the agencies and the Community Consultative Committee (CCC) as indicated in the letters reproduced in Appendix C of this audit report.

Several agencies and the CCC did not respond to the consultation letters.

The agencies which responded to the Lead Auditor's consultation letters were:

- NSW Department of Planning, Industry and Environment
- NSW Resources Regulator
- NSW Department of Planning, Industry and Environment – Biodiversity, Conservation and Science Directorate
- Blayney Shire Council
- NSW Environment Protection Authority.

3.7 Compliance Status Descriptors

The Auditors assessed compliance with each condition of the Project Approval in accordance with the following 'audit finding' compliance status descriptors, as required in Section 3.8 (Table 2) of the NSW Government's *Independent Audit Post Approval Requirements* (DPIE, May 2020).

Status	Description
Compliant	The auditor has collected sufficient verifiable evidence to demonstrate that all elements of the requirement have been complied with within the scope of the audit.
Non-compliant	The auditor has determined that one or more specific elements of the conditions or requirements have not been complied with within the scope of the audit.
Not triggered	A requirement has an activation or timing trigger that has not been met during the temporal scope of the audit being undertaken (may be a retrospective or future requirement), therefore an assessment of compliance is not relevant.

3.8 Observations

As noted in Section 3.8 of the NSW Government's *Independent Audit Post Approval Requirements* (DPIE, May 2020): "The auditor may make observations, including identifying any opportunities for improvement in relation to any compliance requirement or any other aspect of the project."

The 82 observations in this audit report are in addition to the compliance status descriptors in Section 3.7 of this audit report.

4 Audit Findings

4.1 Approvals and Documents Audited

Project Approval PA 06_0295 (MOD 13), Schedule 5, Conditions 7 (a) and (d), required this independent environmental audit to:

"(a) be prepared in accordance with the relevant Independent Audit Post Approval requirements (DPE 2018);"

"(d) assess whether the development complies with the relevant requirements in this consent, and any strategy, plan or program required under this consent;"

The Project Approval is the "consent" referred to in Schedule 5, Condition 7(d) and is the only approval instrument that was required to be directly audited.

As part of this independent environmental audit, the Auditors reviewed the Strategies, Plans and Programs listed in Section 4.6 of this audit report.

Each Project Approval condition in the Detailed Compliance Status table in Appendix A of this audit report also identifies additional documents that were reviewed (for example, Annual Environmental Management Reports) during this independent environment audit.

The Auditors also had regard to Section 3.2 of the NSW Government's *Independent Audit Post Approval Requirements* (DPIE, May 2020) and investigated environmental issues which were raised by agencies during the audit consultation process.

The Auditors' investigations of these environmental issues are recorded in the Consultation Comments tables within Appendix B of this audit report. Where relevant, the outcomes of the Auditors' investigations have also been incorporated into the Audit Findings and Recommendations within the Detailed Compliance Status table in Appendix A of this audit report.

4.2 Compliance Performance

The Summary of Compliance Status table below summarises Cadia's performance against the conditions of the Project Approval as identified in this November 2020 audit. Cadia was compliant with 66 out of 78 conditions which had been triggered as of November 2020.

Summary of Compliance Status
as identified in the November 2020 Independent Environmental Audit

Condition and Audit Finding	Compliant	Non-compliant	Not triggered as at November 2020
Project Approval PA 06_0295 (Mod 13) Schedule 2 – Administrative Conditions (14 conditions)	**11**	**3**	**0**
Project Approval PA 06_0295 (Mod 13) Schedule 3 – Environmental Performance Conditions (51 conditions)	**39**	**9**	**3**
Project Approval PA 06_0295 (Mod 13) Schedule 4 – Additional Procedures (7 conditions)	**6**	**0**	**1**
Project Approval PA 06_0295 (Mod 13) Schedule 5 – Environmental Management, Reporting and Auditing (10 conditions)	**10**	**0**	**0**
Total (82 Conditions)	**66**	**12**	**4**

4.3 Summary of Agency Notices, Orders, Penalty Notices or Prosecutions

During the audit period, Cadia received one "Official Caution" and one "Penalty Infringement Notice".

The DPIE issued an Official Caution to Cadia on the 28th February 2020 in response to Cadia's self-reporting of a non-compliance against Project Approval Schedule 3, Conditions 28 and 30. Refer to Project Approval Schedule 2, Condition 4 in the Detailed Compliance Status table within Appendix A of this audit report for details of the Official Caution.

The NSW Environment Protection Authority (EPA) issued Cadia with a Penalty Infringement Notice (PIN) in relation to dust management in July 2020. Refer to the NSW EPA Consultation Comments table within Appendix B of this audit report for details of the PIN.

4.4 Non-compliances

Appendix A of this audit report contains a Detailed Compliance Status table for the assessment of Cadia's compliance against each Condition of Consent in Schedules 2, 3, 4 and 5 of the Project Approval.

A summary of non-compliances is provided in Section 4.2 of this audit report. Details of these non-compliances are provided with the respective Conditions of Consent in the Detailed Compliance Status table in Appendix A of this audit report.

The Auditors did not identify any major or systemic (i.e. related) non-compliance findings during this audit.

4.5 Previous Audit Recommendations

Cadia's actions (including details regarding status, progress and outcomes) in response to non-compliances and recommendations identified in the previous independent environmental audit (report issued by Environmental Resources Management Australia Pty Ltd (ERM) on 16th January 2018) are recorded in Appendix F of this audit report.

The Auditors comment that the 16th January 2018 audit report was prepared under the NSW Government's *Independent Audit Guideline* (issued in October 2015) and covered the Project Approval, Environment Protection Licence (number 5590) and Mining Leases. The different scope of this audit is due to the amendment of Project Approval Schedule 5, Condition 7 (regarding independent environmental audits) as part of the MOD 13 approval on 20th December 2019.

4.6 Strategies, Plans and Programs

The Project Approval requires Cadia to implement the following strategies, plans and programs:

- Planning Agreements with the relevant Councils (Schedule 2, Condition 13)
- Noise Monitoring Program (Schedule 3, Condition 9)
- Blast Monitoring Program (Schedule 3, Condition 16)
- Air Quality Monitoring Program (Schedule 3, Condition 20)
- Water Management Plan, inclusive of a Site Water Balance, Erosion and Sediment Control Plan, Surface Water Monitoring Program, Groundwater Monitoring Program, and Surface and Groundwater Contingency Plan (Schedule 3, Conditions 30 to 35)
- Rehabilitation Strategy (Schedule 3 Condition 36)
- Biodiversity Offset Strategy (Schedule 3, Condition 38)
- Land and Biodiversity Management Plan (Schedule 3, Condition 41)
- Aboriginal Cultural Heritage Management Plan (Schedule 3, Condition 42)
- Historical Heritage Management Plan (Schedule 3, Condition 43)
- Landscape Plan (Schedule 3, Condition 47)
- Environmental Management Strategy (Schedule 5, Condition 1)
- Annual Review (Schedule 5, Condition 2).

The Auditors assessed the adequacy and implementation of each of Cadia's strategies, plans and programs during this audit, and audit findings and recommendations are included in Appendix A of this audit report for the relevant Project Approval conditions listed above. Opportunities for improvement are identified in the numbered observations set out in Appendix A of this audit report.

4.7 Environmental Performance

In terms of overall environmental performance, the Cadia East Project as assessed in this audit was considered to be managed to high environmental standards, in accordance with appropriate environmental management plans, monitoring programs and procedures.

Appendix A of this audit report contains a Detailed Compliance Status table for the assessment of Cadia's compliance against each Condition of Consent in Schedules 2, 3, 4 and 5 of the Project Approval.

A summary of Cadia's environmental performance as assessed in this November 2020 audit is provided in Section 4.2 of this audit report.

4.8 Consultation Outcomes

During this November 2020 audit the Auditors investigated the environmental issues raised by the agencies identified in Section 3.6 of this audit report as respondents to the Lead Auditor's consultation letters.

The Auditors' investigations of the environmental issues raised in the agency responses are included in the Consultation Comments tables within Appendix B of this audit report.

The Auditors' investigation of each environmental issue in Appendix B formed part of their assessment of compliance with the relevant Project Approval condition. In Appendix B, each relevant environmental issue is cross-referenced to the relevant Audit Finding and Recommendation in the Detailed Compliance Status table within Appendix A of this audit report.

4.9 Complaints

During the audit period, Cadia recorded community complaints in its Community Complaints Register. A summary of the number of complaints received were:

- during the November 2017/2018 Financial Year, a total of 40 complaints were received (inclusive of 14 for dust, six for noise, five for visual amenity and one for blasting);
- during the 2018/2019 Financial Year, a total of 52 community complaints were received (i.e. of these, 37 related to dust emissions and one to traffic noise);
- during the 2019/2020 Financial Year, a total of 40 community complaints were received, inclusive of dust, noise, visual amenity, contractor driving behaviour (i.e. of these, 35 related to dust emissions and one to noise); and
- during the 2020/2021 Financial Year to 30th September 2020, a total of 2 complaints were received, inclusive of one related to dust and one related to noise.

4.10 Incidents

During the audit period, reported incidents and notifications from Cadia Valley Operations (as defined in the CVO AEMRs) to the EPA, DPE or other regulatory body included:

- during the November 2017/2018 Financial Year, a total of two incidents and two notifications;
- during the 2018/2019 Financial Year, a total of one incident and two notifications; and
- during the 2019/2020 Financial Year, no incidents and one notification.

4.11 Actual versus Predicted Environmental Impacts

During the audit period, the actual environmental impacts of the Project were generally consistent with the predicted impacts as described in the relevant Environmental Assessments. However, exceedances of defined noise limits and air quality limits, attributable to the Cadia Valley Operations, were recorded as identified in the evidence collected for the relevant Project Approval conditions in Appendix A of this audit report.

The Project Approval addresses the predicted environmental impacts of the Project via:

- inclusion of 'acquisition upon request' for the property at 247 Newbridge Road (Schedule 3, Condition 1, *Table 1: Land subject to acquisition on request*);
- inclusion of 'land acquisition' criteria' for specified exceedances of noise criteria (Schedule 3, Condition 3);
- inclusion of 'land acquisition criteria' for specified exceedances of particulate matter emissions criteria (Schedule 3, Condition 18);
- the ability of affected landowners to request noise mitigation measures resulting from road traffic or train noise, inclusive of the properties at the Eastburn property, 84 Newbridge Road, 247 Newbridge Road, 331 Newbridge Road, 365a and 365b Cadia Road, 676 and 677 Cadia Road, 1214 Cadia Road, 56 Orchard Road, 324 Orchard Road (Schedule 3, Condition 7);
- the ability of affected landowners to request compensatory water supplies if their water entitlements are impacted (other than an impact that is negligible) as a result of the Project (Schedule 3, Condition 24); and
- the ability of affected landowners with significant direct views of a residence to the mining operations to request additional visual impact mitigation measures (Schedule 3, Condition 48).

During the audit period, Cadia did not acquire any private properties under the conditions of the Project Approval.

4.12 Key Strengths

The Auditors identified that during the audit period, the key strengths of the Project were:

- No major or systemic non-compliances were identified during this audit;
- Cadia was able to demonstrate a high level of commitment to achieving and maintaining environmental compliance and addressing landowner concerns;
- Cadia was able to demonstrate a high level of commitment to progressive rehabilitation of mine disturbed areas and revegetation of offset areas including responding to adverse monitoring results. However, more frequent recording and documenting of rehabilitation actions undertaken is required by Cadia;
- Cadia was able to demonstrate a responsible level of understanding, commitment and capital expenditure to address exceedances in EPL and Project Approval limits and minimise adverse environmental impact applicable to noise, air and water. Nevertheless, more attention and completion of planned dust emission minimisation works is required at the CVO ore processing facility;
- Extensive operating and staff resources are made available by management to enable responsible levels of environmental compliance to be maintained;
- During the audit period, Cadia closely monitored dust emissions from the northern and southern TSFs and is fully aware of the concerns expressed by relevant landowners. Cadia continues to investigate and progress improved and extended methods of reducing dust emissions from the surface of the TSFs.

5 Recommendations

5.1 Non-compliances

For the non-compliances identified in this audit, the Auditors have recommended actions for Cadia to address those non-compliances which Cadia had not already addressed. These recommendations are included in the Independent Audit Findings and Recommendations column for the relevant Project Approval conditions in the Detailed Compliance Status table within Appendix A of this audit report.

5.2 Observations

The Detailed Compliance Status table in Appendix A of this audit report includes individually numbered observations. Observations have been provided by the Auditors as opportunities for improvement, for Cadia's consideration to enable continual improvement to be demonstrated in statutory compliance, environmental management and environmental practices across the operation.

6 Cadia Response to Audit Findings

6.1 Non-compliances

Cadia will record its responses to the identified 'non-compliant' audit findings and recommendations in a 'non-compliance audit findings action plan' document, having regard to the table example in Appendix D of the *Independent Audit Post Approval Requirements* (DPIE, May 2020).

6.2 Observations

Cadia will record its responses to the observations in this audit report in an 'audit observations response' document, having regard to the table example in Appendix D of the *Independent Audit Post Approval Requirements* (DPIE, May 2020).

7 Limitations of Audit

The scope of this independent environmental audit was limited to reviewing how the Proponent (Cadia Holdings Pty Limited) at its Cadia East Project is maintaining environmental compliance against applicable conditions specified in Project Approval PA 06_0295 (MOD 13) as approved on 20th December 2019 by the delegate of the NSW Minister for Planning, for the NSW Department of Planning, Industry and Environment (DPIE).

The period covered by this independent environmental audit ('audit period') is from 21st September 2017 (the day following the date of completion of the previous three-yearly independent environmental audit) to 12th November 2020 (the last day of the on-site component of this audit).

Unless otherwise indicated, in this audit report a reference to 'Cadia', 'Cadia Valley Operations', 'CVO' or 'Cadia East Project", is a reference to the Proponent (as defined in the Project Approval).

This independent environmental audit was conducted by: a) direct verification of compliance against relevant conditions in the field (except underground operations); and b) 'sampling' a range of the documents, records and data associated with the Project and related activities. The nature of sampling during any form of compliance audit is such that it may not necessarily identify everything that the operation is, or is not doing, in relation to an individual condition of the Project Approval.

This independent environmental audit and associated audit report was commissioned by Cadia to comply with Schedule 5, Condition 7 of the Project Approval. No other warranty, expressed or implied, is made as to the professional advice indicated in this report. Note that this report may not contain sufficient information for the purposes of other parties or for other uses.

The content of this report applies only to matters which were available to and/or evident to the auditors at the time of this independent environmental audit and within the scope of the audit. The status of environmental compliance can change in a limited time, which may be important if the report is used after any protracted delay.

The content of this report is based on the observations made during field inspections (excluding underground operations) and the associated documents and records reviewed, that were provided by Cadia during the audit. Field inspection locations were selected by the auditors to ensure that a representative sample of field activities could be inspected/audited against relevant conditions. Field inspections were completed at various locations and infrastructure associated with the Project and applicable to conditions within the Project Approval, except for conducting a formal underground inspection.

Environmental compliance audits such as this independent environment audit are typically based on the selective testing of the information and data being examined. Non-compliances may exist and not be detected. An environmental compliance audit is not designed to identify and detect all instances of non-compliance against the Project Approval, as it is not performed continuously throughout the audit period. The findings and comments expressed in this audit report have been formed and are based on the above limitations.

No analytical samples were collected during this audit to verify any former or current monitoring programs in place or data collected.

This audit report does not, and does not purport to, give legal advice on the actual or potential liabilities of the operation, or draw conclusions as to whether any particular circumstances constitute a breach of relevant legislation. Only qualified legal practitioners who are retained to provide legal advice can provide this advice.

8 Conclusion

This independent environmental audit of the Newcrest Cadia East Project's compliance with the conditions of Project Approval PA 06_0295 (MOD 13) was conducted in November 2020 by 3E Environmental Engineering & Energy.

This audit report is the fourth (4th) independent environmental audit report completed at the Cadia East Project (since the granting of the Project Approval on the 6th January 2010) and submitted to the NSW Department of Planning, Industry and Environment (DPIE), to demonstrate the operation's level of statutory environmental compliance.

A total of 82 conditions across the Project Approval were audited. As recorded in this audit report, this audit identified 66 'compliant' findings, 12 'non-compliant' findings, and 4 'not triggered' findings.

No major or systemic non-compliances were identified during this audit.

This audit report includes 82 observations. Observations are provided for Cadia's consideration as opportunities for improvement, enabling continual improvement to be demonstrated in statutory compliance, environmental management and environmental practices across the operation.

In terms of overall environmental performance, the Cadia East Project as assessed in this audit was considered to be managed to high environmental standards, in accordance with appropriate environmental management plans, monitoring programs and procedures.

Appendix A:
Detailed Compliance Status of the Cadia East Project

The Detailed Compliance Status table below provides information regarding the findings identified in this November 2020 audit against the Project Approval conditions. Observations are provided as opportunities for improvement, for Cadia's consideration to improve levels of compliance and enable continual improvement to be demonstrated in statutory compliance, environmental management and environmental practices across the operation.

In relation to the Project Approval conditions as reproduced in the Detailed Compliance Status table below:

- Blue type represents September 2010 modification – MOD 1
- Red type represents October 2010 modification – MOD 2
- Green type represents August 2011 modification – MOD 3
- Light blue type represents May 2014 modification – MOD 4
- Orange represents August 2014 modification – MOD 5
- Pink type represents August 2015 modification – MOD 6
- Purple type represents August 2015 modification – MOD 7
- Grey type represents April 2016 modification – MOD 8
- Orange type represents April 2017 modification – MOD 9
- Lime type represents March 2018 modification – MOD 10
- Mustard type represents April 2018 modification – MOD 11
- Lilac type represents September 2018 modification – MOD 12
- Blue (Accent 1, 25% Darker) represents December 2019 modification – MOD 13

Detailed Compliance Status

Cadia Project Approval 06_0295 (as modified on 20 December 2019)					
Schedule 2 – Administrative Conditions					
Condition of Consent	**Condition Requirement**	**Evidence collected**	**Independent Audit Findings and Recommendations**	**Compliance Status**	**Unique ID for non-compliance**
1.	**OBLIGATION TO MINIMISE HARM TO THE ENVIRONMENT** The Proponent shall implement all reasonable and feasible measures to prevent and/or minimise any harm to the environment that may result from the construction, operation, or rehabilitation of the project.	During this November 2020 audit, in carrying out mining and related activities, Cadia as the principal holder of the Project Approval, was able to demonstrate that the operation has implemented a range of reasonable and feasible measures to prevent and/or minimise the likelihood of any harm to the environment that may result from the operation of the project. Nevertheless, there was evidence during this audit that Cadia has not adequately implemented 'all' reasonable and feasible measures to prevent and/or minimise any harm to the environment that may result	**Non-compliance No. 1 –** During the audit period Cadia has not adequately implemented 'all' reasonable and feasible measures to prevent and/or minimise any harm to the environment that may result from the operation of the project, specifically in relation to the minimisation of dust emissions from the surface of Tailings Storage Facilities and from ore processing activities (refer to Schedule 3, Conditions 17 and 19 in this audit report). **Recommendation No. 1 –** As defined against Project Approval Schedule 3,	**Non-compliant**	**NC1**

Cadia Project Approval 06_0295 (as modified on 20 December 2019)					
Schedule 2 – Administrative Conditions					
Condition of Consent	**Condition Requirement**	**Evidence collected**	**Independent Audit Findings and Recommendations**	**Compliance Status**	**Unique ID for non-compliance**
		from the operation of the project, specifically in relation to the minimisation of dust emissions from the surface of Tailings Storage Facilities (TSFs) and from ore processing activities (refer to Schedule 3, Conditions 17 and 19 in this audit report). In relation to dust emissions from the surface of the TSFs, it is acknowledged that during the audit period, Cadia closely monitored dust emissions from the northern and southern TSFs and is fully aware of the concerns expressed by relevant landowners. Cadia continues to investigate and progress improved and extended methods of reducing dust emissions from the surface of the TSFs. It is noted that "harm to the environment" is not defined in the Project Approval or in the *Environmental Planning and Assessment Act 1979* (NSW). In this audit the Auditors have interpreted "harm to the environment" as defined in the *Protection of the Environment Operations Act 1997* (NSW): "harm to the environment includes any direct or indirect alteration of the environment that has the effect of degrading the environment and, without limiting the generality of the above, includes any act or omission that results in pollution".	Conditions 17 and 19 in this audit report.		

Cadia Project Approval 06_0295 (as modified on 20 December 2019)					
Schedule 2 – Administrative Conditions					
Condition of Consent	**Condition Requirement**	**Evidence collected**	**Independent Audit Findings and Recommendations**	**Compliance Status**	**Unique ID for non-compliance**
2.	**TERMS OF APPROVAL** The Proponent shall carry out the project: (a) generally in accordance with the EA; and (b) in accordance with the conditions of this approval. *Note: The general layout of the project is shown in Appendix 2.*	During this November 2020 audit the Auditors conducted field inspections of the CVO site (excluding underground operations) and sighted a selection of documents relating to Project Approval conditions. The relevant strategy, plan and program documents are listed in Section 4.6 of this audit report and in the 'evidence collected' column entry for each Project Approval condition. As defined in Section 4.11 of this audit report, during the audit period, the actual environmental impacts of the Cadia East Project were generally consistent with the predicted impacts as described in the 2009 Environmental Assessment (EA). However, exceedances of defined noise limits and air quality limits, attributable to the Cadia Valley Operations, were recorded at several private properties. Despite these exceedances, as noted in Section 4.12 of this audit report, no major or systemic non-compliances were identified during this audit.	Subject to the non-compliances identified in this audit report (none of which were major or systemic), there was evidence during this November 2020 audit that Cadia is carrying out the Cadia East Project generally in accordance with the EA and in accordance with the conditions of the Project Approval.	**Compliant**	
3.	**TERMS OF APPROVAL** If there is any inconsistency between the above documents, the most recent document shall prevail to the extent of the inconsistency. However, the conditions of this approval shall prevail to the extent of any inconsistency.	Relevant CVO personnel acknowledged and understood this condition.	Relevant CVO personnel acknowledged and understood this condition.	**Compliant**	

Cadia Project Approval 06_0295 (as modified on 20 December 2019)					
Schedule 2 – Administrative Conditions					
Condition of Consent	**Condition Requirement**	**Evidence collected**	**Independent Audit Findings and Recommendations**	**Compliance Status**	**Unique ID for non-compliance**
4.	**TERMS OF APPROVAL** The Proponent shall comply with any reasonable requirement/s of the Secretary arising from the Department's assessment of: (a) any reports, strategies, plans, programs, reviews, audits or correspondence that are submitted in accordance with this approval; and (b) the implementation of any actions or measures contained in these documents.	Independent Environmental Audit 2017 The DPIE requested Cadia to update and resubmit the response to recommendations document (0420483_IEA Report CVO Final_Table 3.2_01.12.2017) to the Department by 25 January 2018 to include the outstanding actions from the previous audit and to include dates by which all recommended actions were to be completed and to provide reasons to the Department as to why the full team of experts was not utilised in the audit. Cadia responded to the DPIE request with a letter dated 18 August 2018. Cadiangullong Dam Water Extraction The DPIE issued an Official Caution (correspondence) to Cadia on the 28th February 2020 in response to Cadia's self-reporting of a non-compliance (refer to Schedule 3, Conditions 28 and 30). The DPIE's response (Official Caution) considered Cadia's commitment to implement improvement measures, including a commitment to install a level sensor in the Cadiangullong Dam and the site's central process control system, with an automatic notification alarm when the Dam levels reach the TARP trigger thresholds in the WMP, by 20 April 2020. The Official Caution was uploaded into CHESS. An action (sighted) was created	Cadia was mostly compliant with any direction or request for information/ action from the Department, however on two occasions Cadia could not fully demonstrate compliance with Project Approval Schedule 2, Condition 4. **Non-compliance No. 2 –** As of November 2020: • in relation to the Independent Environmental Audit in 2017, Cadia was not able to comply with the reasonable requirement of the Secretary to respond to a request regarding the 2017 Independent Environmental Audit by 25 January 2018; and • in relation to the Official Caution of 28 February 2020 regarding the Cadiangullong Dam Water Extraction, it is acknowledged that work has commenced and technical challenges have been experienced, however, Cadia had not implemented the action to link the level sensor to the site's central process control system by 20 April 2020 as committed to by Cadia. **Recommendation No. 2 –** Cadia should ensure a system is in place to be able to comply with the timeframes of reasonable requirements of the Secretary.	**Non-compliant**	**NC2**

Cadia Project Approval 06_0295 (as modified on 20 December 2019)					
Schedule 2 – Administrative Conditions					
Condition of Consent	**Condition Requirement**	**Evidence collected**	**Independent Audit Findings and Recommendations**	**Compliance Status**	**Unique ID for non-compliance**
		in CHESS (ACT-013674) to install telemetry from the sensor to the Site Asset Operation Centre (SAOC). The action was assigned with highest priority (HIGH) but has been deferred twice to 30/6/20 and again to 30/6/21. It was stated that the delay in completing the work was due to technical challenges in linking communications between two separate data collection systems. Although the level sensor was already existing, and work has commenced, the connection to the site's central process control system had not been implemented by 20 April 2020 as committed to the DPIE or at the time of this November 2020 audit.			
5.	**LIMITS ON APPROVAL** Mining operations may take place until 30 June 2031. *Note: Under this approval, the Proponent is required to rehabilitate the site and perform additional undertakings to the satisfaction of the Secretary and DRG. Consequently this approval will continue to apply in all other respects other than the right to conduct mining operations until the site has been properly rehabilitated.*	This condition is included in the approved Mining Operations Plan (Rev. K, 5/3/2020) and the approved Land and Biodiversity Management Plan (Rev. 3, 20/01/2017). Site rehabilitation requirements to be undertaken by Cadia are also described in the MOP which has been approved by the Resources Regulator (RR).	Relevant Cadia personnel acknowledged and understood that under this condition, mining operations on the site must cease by 30 June 2031. This limit was also included in the approved Mining Operations Plan and the Land and Biodiversity Management Plan.	**Compliant**	

Cadia Project Approval 06_0295 (as modified on 20 December 2019)					
Schedule 2 – Administrative Conditions					
Condition of Consent	**Condition Requirement**	**Evidence collected**	**Independent Audit Findings and Recommendations**	**Compliance Status**	**Unique ID for non-compliance**
6.	**LIMITS ON APPROVAL** The Proponent shall not process more than 32 million tonnes of ore from the project in a calendar year.	Metallurgical accounting data (collected using PI system) of monthly conveyor weight (dry mass) totals for concentrator 1 (SAG Mill) and concentrator 2 (Reclaim Mill) for Dec-17 to Oct-20 (CY2017 data not verified from conveyor weight records) were reviewed (excel spreadsheet "FY18+ Reconciled summary"). Totals for processed ore were calculated as: • CY2018 25.033 MT • CY2019 28.511 MT • CY2020 25.811 MT (YTD – end of October 2020). Weightometer calibration reports (March and July 2020) for mill feed conveyor (CV2012 – SAG Mill) undertaken by SRO Technology were provided. The "Metallurgical Accounting Data Validation" report (MIPAC, 2014) was also sighted.	Data and reports reviewed showed no exceedances of the 32 Mt/calendar year limit during the audit period. Results for processing of ore verified as: • CY2017: 21.804 MT (as per AEMR) • CY2018: 25.033 MT • CY2019: 28.511 MT • CY2020: 25.811 MT (YTD – end of October). **Observation No. 1 –** To enable consistency in business reporting and avoidance of errors, Cadia could request that this condition be based on a fiscal year rather than a calendar year in future approval modifications. **Observation No. 2 –** Cadia could ensure that the calendar year processed ore is reported in the AEMRs (omitted from 2019/20 AEMR). **Observation No. 3 –** This condition is currently assigned to the environment department personnel in CHESS. Cadia could consider assigning accountability to the Ore Processing Manager. **Observation No. 4 –** Cadia could review recommendations of the "Metallurgical Accounting Data Validation" report (MIPAC, 2014) and ensure close-out. Cadia could also	**Compliant** **Observation** **Observation** **Observation** **Observation**	

Cadia Project Approval 06_0295 (as modified on 20 December 2019)					
Schedule 2 – Administrative Conditions					
Condition of Consent	**Condition Requirement**	**Evidence collected**	**Independent Audit Findings and Recommendations**	**Compliance Status**	**Unique ID for non-compliance**
			consider undertaking an update of this assessment.		
7.	**LIMITS ON APPROVAL** The Proponent shall not use any cyanide or mercury to process or extract gold/copper from the project.	It was stated that Cadia produces gold doré from a flash/float gravity circuit and gold-rich copper concentrates from a conventional flotation circuit. A current list of chemicals used on site (extracted from the ChemAlert system) was sighted. Neither mercury nor cyanide were listed. There was no evidence of cyanide leaching (heap or vat) of ore during the site inspection. *Note: A walk through of the flotation circuit or gold room was not undertaken as part of this audit.*	There was no evidence of cyanide or mercury being used in the processing or extraction of gold or copper from the project.	**Compliant**	
8.	**SURRENDER OF CONSENTS** Within 12 months of the date of this approval, or as otherwise agreed by the Secretary, the Proponent shall surrender all existing development consents for the project in accordance with sections 75YA and 104A of the EP&A Act, to the satisfaction of the Secretary. *Note: This approval will apply to all components of the Cadia Valley Operations from the date of approval. The existing management and monitoring plans/strategies/programs/protocols for the project will continue to apply until the approval of the comparable plan/strategy/program under this approval.*	Verified by interview and a review of previous independent environmental audits and as evidenced in the cited letter dated 14/12/2010.	This is a historical condition and outside the audit period of this November 2020 audit. **Observation No. 5 –** On the basis the Secretary is satisfied that this historical condition has been complied with, Cadia could consider requesting this condition be removed in future approval modifications.	**Compliant** **Observation**	

Cadia Project Approval 06_0295 (as modified on 20 December 2019)					
Schedule 2 – Administrative Conditions					
Condition of Consent	**Condition Requirement**	**Evidence collected**	**Independent Audit Findings and Recommendations**	**Compliance Status**	**Unique ID for non-compliance**
9.	**STRUCTURAL ADEQUACY** The Proponent shall ensure that all new buildings and structures, and any alterations or additions to existing buildings and structures, are constructed in accordance with the relevant requirements of the BCA. *Notes:* • *Under Part 4A of the EP&A Act, the Proponent is required to obtain construction and occupation certificates for the proposed building works;* • *Part 8 of the EP&A Regulation sets out the requirements for the certification of the project.*	It was stated that the new on-site warehouse (Modification 5; approved 5/6/2017) for the storage of consumables used by Cadia Valley Operations was the only new building or structure (completely) constructed during the audit period and that no alterations or additions to existing buildings and structures was undertaken during the audit period. **Photo No. 1 –** New on-site warehouse (looking north west) (12th November 2020) The following Construction Certificates for the new on-site warehouse, endorsed by McKenzie Group Consulting Pty Ltd (private certifying authority), were sighted: • No. 18/124598-1 (BCA Classification 7a) (endorsed 6 March 2018); • No. 18/124598-2 (BCA Classification 7b) (endorsed 21 May 2018);	Cadia was able to demonstrate that the new on-site warehouse was constructed in accordance with the relevant requirements of the BCA, as evidenced by the certifying certificates including an Occupation Certificate for the new warehouse building. At the time of this November 2020 audit, the new molybdenum process plant was under construction.	**Compliant**	

Cadia Project Approval 06_0295 (as modified on 20 December 2019)					
Schedule 2 – Administrative Conditions					
Condition of Consent	**Condition Requirement**	**Evidence collected**	**Independent Audit Findings and Recommendations**	**Compliance Status**	**Unique ID for non-compliance**
		• No. 18/124598-3 (BCA Classification 7b) (endorsed 21 August 2018); • Occupation Certificate No. 18/124598-4 for the Warehouse endorsed by McKenzie Group Consulting Pty Ltd (8 November 2018). It was stated that construction of the new molybdenum process plant also commenced during this audit period. An inspection of the partially constructed molybdenum process plant was undertaken by Blayney Shire Council during the audit period on 25/09/2020 and a Building Information Certificate issued (18 November 2020 – post audit). A Construction Certificate (No. 201207/01) determined on the 16th December 2020 (outside this audit period) for the 'Construction of the Cadia Molybdenum processing facility and associated services and utilities' was also sighted (post audit).			
10.	**DEMOLITION** The Proponent shall ensure that all demolition work is carried out in accordance with *AS 2601-2001: The Demolition of Structures*, or its latest version.	It was stated that the old Blayney dewatering plant was the only demolition work conducted during this audit period. Cadia was able to produce a copy of *AS 2601-2001: The Demolition of Structures*. Section 1 of the standard describes aspects such as health and safety, plant and equipment and protection, while Section 2 describes	Cadia was able to demonstrate that the old Blayney dewatering plant was demolished in accordance with *AS 2601-2001: The Demolition of Structures*. **Observation No. 6 –** The Newcrest Operational Risk Management (NORM) spreadsheet provided (Excel spreadsheet "17-76 DRAW Blayney old plant decommissioning") for the	**Compliant** **Observation** **Observation**	

Cadia Project Approval 06_0295 (as modified on 20 December 2019)					
Schedule 2 – Administrative Conditions					
Condition of Consent	**Condition Requirement**	**Evidence collected**	**Independent Audit Findings and Recommendations**	**Compliance Status**	**Unique ID for non-compliance**
		planning and execution, and Section 3 describes methods of demolition. It was stated that the demolition works were undertaken by DEMEX. DEMEX is a licensed demolition contractor (holds an unrestricted NSW demolition licence No. AD211676). DEMEX's demolition proposal dated 7 August 2019 titled "17-76-PQ-CNP-0007 – 17-76 Blayney Dewatering Improvements" was sighted. Section 7 (p8) of the proposal states that "All demolition works will be conducted in accordance with *AS2601(2001) – The Demolition of Structures, Code of Practice: Demolition Works* and the DEMEX Demolition Plan". Cadia issued a Purchase Order for the work to be carried out as per the proposal.	demolition risk assessment did not identify AS 2601 as a reference. In addition, Project Approval compliance was not identified as a risk category and based on attendance records, approvals personnel were not in attendance for the risk assessment workshop. Cadia should include consideration of approvals/legal risks in future demolition projects where relevant. **Observation No. 7 –** It was stated that the demolition contract was managed by Newcrest's Melbourne based commercial group. Cadia should ensure a system is in place to record consideration of *AS 2601-2001: The Demolition of Structures* obligations under this Project Approval condition, in future demolition projects.		

Cadia Project Approval 06_0295 (as modified on 20 December 2019)					
Schedule 2 – Administrative Conditions					
Condition of Consent	**Condition Requirement**	**Evidence collected**	**Independent Audit Findings and Recommendations**	**Compliance Status**	**Unique ID for non-compliance**
		Photo No. 2 – Remediated site of the now demolished old Blayney dewatering plant (10th November 2020)			
11.	**PROTECTION OF PUBLIC INFRASTRUCTURE** The Proponent shall: (a) repair, or pay the full costs associated with repairing, any publicly-owned infrastructure that is damaged by the project; and (b) relocate, or pay the full costs associated with relocating, any publicly-owned infrastructure that needs to be relocated as a result of the project, except where such works have been compensated through the planning agreement referred to in condition 13 below.	Publicly-owned infrastructure in the vicinity of the project primarily includes roads and utilities. It was stated that during the audit period: (a) no publicly-owned infrastructure was damaged by the project; and (b) no publicly-owned infrastructure was required to be relocated as a result of the project, and therefore no compensation through the planning agreement in Schedule 2, Condition 13 was required.	Based on the evidence collected during this audit, Cadia was compliant with this condition during the audit period.	**Compliant**	

Cadia Project Approval 06_0295 (as modified on 20 December 2019)					
Schedule 2 – Administrative Conditions					
Condition of Consent	**Condition Requirement**	**Evidence collected**	**Independent Audit Findings and Recommendations**	**Compliance Status**	**Unique ID for non-compliance**
12.	**OPERATION OF PLANT AND EQUIPMENT** The Proponent shall ensure that all plant and equipment used at the site is: (a) maintained in a proper and efficient condition; and (b) operated in a proper and efficient manner.	During this audit, the auditor reviewed a random sample of maintenance planning and scheduling applicable to fixed and mobile plant. This is inclusive of targeting equipment, plant and infrastructure with the potential for environmental risk or harm if not correctly maintained, inclusive of: <u>Fixed Plant</u> • clean-out of stormwater drains; • removal of sediment from on-site sediment basins; • sediment basins (diesel and electric pumps); • leachate dam pumps; • dust extraction units/baghouses; and • dust sprays on conveyors/crushers/ transfer points. <u>Mobile Plant</u> • exhaust emissions (i.e. particulates, SOx, NOx) from underground loaders/underground vents; • failure of hydraulic lines on underground loaders; and • concentrate containers (i.e. shipping containers transported by rail).	Relevant to equipment, plant and infrastructure with the potential for environmental risk or harm, Cadia was able to demonstrate diligent and effective maintenance and operation systems for fixed and mobile plant across the operation.	**Compliant**	

Cadia Project Approval 06_0295 (as modified on 20 December 2019)					
Schedule 2 – Administrative Conditions					
Condition of Consent	**Condition Requirement**	**Evidence collected**	**Independent Audit Findings and Recommendations**	**Compliance Status**	**Unique ID for non-compliance**
		 Photo No. 3 – Copper concentrate and container loading facilities at the CVO Dewatering Facility (10th November 2020) Except for fugitive dust from the Cadia process plant, the site inspection during the audit did not identify any examples of any unmaintained or inappropriately operated equipment. <u>Cadia Maintenance Systems</u> During the audit period, Cadia's preventative and break-down maintenance systems were observed to be effectively administered within SAP. The use of SAP for scheduling, tracking and retaining records in SAP was assessed in detail during this audit for underground loaders, inclusive of the testing of exhaust emissions. In addition, Cadia utilises InfoTrack for some mobile equipment, with data			

Cadia Project Approval 06_0295 (as modified on 20 December 2019)					
Schedule 2 – Administrative Conditions					
Condition of Consent	**Condition Requirement**	**Evidence collected**	**Independent Audit Findings and Recommendations**	**Compliance Status**	**Unique ID for non-compliance**
		displayed, for example, on the Loader Reliability Dashboard. Cadia was able to demonstrate that compliance related maintenance within SAP is scheduled as a Priority 1 activity in SAP (i.e. these maintenance activities are not allowed to exceed scheduled intervals and were stated to take precedence over break-down maintenance). It was stated that Cadia can outsource some scheduled or breakdown maintenance to specialist contractors as and when required. It was stated that the clean-out/desilting of on-site stormwater/sediment basins and major drains is the responsibility of surface operations. This is inclusive of those utilised at the CVO dewatering facility. <u>Dust Extraction Systems/Water Sprays</u> In the 6 months to November 2020, Cadia's dust extraction systems/water sprays on crushers, conveyors and conveyor transfer points were subject to a formal reliability program. Cadia maintains a Dust Reduction Committee to reduce ambient dust levels on the surface and underground (i.e. this committee is separate to the committee that is maintained for tailings storage facility dust). It was stated that reducing			

Cadia Project Approval 06_0295 (as modified on 20 December 2019)					
Schedule 2 – Administrative Conditions					
Condition of Consent	**Condition Requirement**	**Evidence collected**	**Independent Audit Findings and Recommendations**	**Compliance Status**	**Unique ID for non-compliance**
		the presence of silica is a focus of the dust reduction program (i.e. this is also a compliance risk). It was stated that exposure limits underground are now compliant and have been compliant in the 12 months to November 2020. A program of works is in place to further reduce occupational dust levels underground. It was stated that over $1 million in capital has been committed towards dust control in the process plant in the 18 months to November 2020 (i.e. involving multiple capital projects since March 2020, which is ongoing). It was stated that Cadia's reliability team is now involved in operating and maintenance of plant, enabling operational and reliability strategies to improve. Cadia personnel are confident they can manage and improve occupational and environmental dust effectively in the future (i.e. after the completion of scheduled work over the next 6 – 12 months). For example, some dust sprays are scheduled to be replaced/upgraded in 2021. Four baghouses/dust extraction units were installed in the Cadia process plant from 2013 to 2015. Specialist engineering consultants have reviewed these dust extraction systems and confirmed that they were correctly sized. It was stated that of these four			

Cadia Project Approval 06_0295 (as modified on 20 December 2019)					
Schedule 2 – Administrative Conditions					
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		baghouses, three were performing well and one unit was not performing in accordance with design/manufacturer's specifications. It was stated that the baghouses are operated until their efficiency reduces to limits defined by Cadia, requiring replacement bags to be installed. **Photo No. 4 –** Baghouse in use at the Cadia Ore Processing Facility (9th November 2020) It was stated that operator errors have been identified in the plant, in not turning dust sprays on when this is clearly required. Cadia's supervisors report the presence of excessive dust to relevant operators, but not all operators have the required awareness to report and investigate the reasons for excessive dust. It was stated that equipment such as conveyors can be shut down if excessive dust exists, but there was no evidence of			

Cadia Project Approval 06_0295 (as modified on 20 December 2019)					
Schedule 2 – Administrative Conditions					
Condition of Consent	**Condition Requirement**	**Evidence collected**	**Independent Audit Findings and Recommendations**	**Compliance Status**	**Unique ID for non-compliance**
		this during site inspections conducted during the audit. <u>Mobile Maintenance</u> It was stated that the average age of Cadia's underground heavy equipment/ loader fleet was 3.5 years, with the oldest loader operating being 5 years old. Exhaust emission data for underground mobile equipment is retained in InfoTrack and displayed on the Loader Reliability Dashboard (LRD) for each equipment. Emission limits for heavy vehicles are defined in an external guideline (i.e. MDG29) and Cadia is aware that mobile equipment is unable to be put back into service if defined emission limits are exceeded. It was stated that exhaust emissions testing occurs for all 70 units of heavy equipment (i.e. loaders, trucks, drills etc) that are operated underground. It was stated that to date, the dashboard (LRD) is only available for underground loaders. Vehicle emissions testing on underground loaders (i.e. for NOx, particulates) is scheduled and completed every 500 hrs and the work is completed in accordance with a Cadia work instruction/form. In addition to the above scheduled testing, it was stated that the underground loader fleet is also			

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		monitored in real time for emissions (i.e. for 20 loaders). Alarms exist on these loaders, which can be trended and detected prior to an alarm being triggered. It was stated that emission failures are alarmed on the screen in the LRD. <u>Sulphur Levels in Diesel</u> It was stated that Cadia is purchasing and utilising low sulphur diesel from one supplier. As a result, SOx emissions were stated to not be a concern. <u>Hydraulics Spills Underground</u> Relevant Cadia personnel stated that they closely monitor hydraulic hose usage and have a formal program in place to replace hoses on mobile equipment prior to failure (i.e. based on the usage hours of the equipment). This is also based on historical data, enabling Cadia to determine when hydraulic hoses are required to be changed. These processes are now well established and have been proactively utilised since 2017. It was stated that this program has reduced downtime and increased availability of underground mobile equipment. It was stated that failure analysis is conducted by external service provider, BPI technologies, on all failed hydraulic hoses.			

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		It was stated that no significant quantities of hydraulic fluid are lost underground (i.e. worst-case scenario would be approximately 200L per week). Dewatering from underground is pumped to the surface and then reused in the process plant. It was stated that underground workshops utilise fuel bays that are fitted with oil/water separators (i.e. these are also in SAP as a work order for scheduled servicing and maintenance). <u>Environmental Monitoring Equipment</u> Formal programs are in place and service contracts have been awarded to specialist service providers for the calibration, servicing, maintenance and repairs of the environmental monitoring equipment utilised by Cadia, inclusive of: • streamflow gauging/monitoring equipment; • TEOMs; • QuattroSound Directional Noise Monitor; and • meteorological stations.			
13.	**PLANNING AGREEMENT** Within 12 months of the date of this approval, unless otherwise agreed by the Secretary, the Proponent shall enter into a planning agreement with the Councils in accordance with Division 6 of Part 4 of the	A Planning Agreement dated 9 July 2013 between Orange City, Blayney Shire and Cabonne Shire Councils was sighted. Annexure B of the Planning Agreement provides details of a one-off contribution to be used for upgrade of Council's road	Based on the evidence collected during this audit, Cadia was compliant with this condition during the audit period.	**Compliant**	

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	EP&A Act, that provide for contributions to the Councils for: • upgrade of Council's road infrastructure affected by the project; and • general community enhancement to address social amenity and community infrastructure requirements arising from the project. The contributions shall be generally consistent with the terms of the offer made in the Proponent's letter dated 17 December 2009 and summarised in Appendix 7. If there is any dispute between the Proponent and any of the Councils during the formal drafting of the planning agreement, then any of the parties involved may refer the matter to the Secretary for resolution.	infrastructure as described in Annexure C of the Planning Agreement. Annexure B of the Planning Agreement provides details of annual payments to Councils for general community enhancement to address social amenity and community infrastructure requirements arising from the project as described in Annexure C of the Planning Agreement. Records of contribution payments to Councils were sighted. This included an Excel spreadsheet listing Purchase Document numbers and payments to Orange City Council and Blayney Shire Council for four (4) annual payments during the audit period.			
14.	**STAGED SUBMISSION OF STRATEGIES, PLANS OR PROGRAMS** With the approval of the Secretary, the Proponent may: (a) submit any strategy, plan or program required by this consent on a progressive basis; and (b) combine any strategy, plan or program required by this consent with any similar strategy, plan or program required for the Cadia East Project.	In relation to paragraphs (a) and (b) of this condition, it was stated that during the audit period: (a) Cadia made no request to the DPIE to submit any strategy, plan or program required by this consent on a progressive basis. (b) Cadia made no request to the DPIE to combine any strategy, plan or program required by this consent with any similar strategy, plan or	Evidence was sighted (DPIE letter dated 25/06/2020) confirming the Secretary's agreement with the consultation approach Cadia undertook in relation to the revised Rehabilitation Strategy (Revision 3, dated 12 June 2020). **Non-compliance No. 3 –** No evidence was obtained to verify that Cadia sought or obtained agreement of the Secretary during the audit period, to prepare management plan revisions without undertaking consultation with all	**Non-compliant** **Observation** **Observation** **Observation**	**NC3**

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	To ensure these strategies, plans or programs are updated on a regular basis, the Proponent may at any time submit revised strategies, plans or programs to the Secretary for approval. With the agreement of the Secretary, the Proponent may prepare any revised strategy, plan or program without undertaking consultation with all parties under the applicable condition of this consent. *Notes:* • *While any strategy, plan or program may be submitted on a progressive basis, the Proponent will need to ensure that the existing operations on site are covered by suitable strategies, plans or programs at all times.* • *If the submission of any strategy, plan or program is to be staged, then the relevant strategy, plan or program must clearly describe the specific stage to which the strategy, plan or program applies, the relationship of this stage to any future stages, and the trigger for updating the strategy, plan or program.*	program required for the Cadia East Project. Cadia stated that it intends to request the Secretary to consider combining the Rehabilitation Strategy and Land and Biodiversity Management Plan in the future. Table 12-3 of each AEMR issued during the audit period, which summarises changes proposed to strategy, plans and programs, was reviewed. The Secretary's agreement of consultation approach (DPIE approval letter dated 25/06/2020) for revised Rehabilitation Strategy was sighted. Evidence was sighted that Cadia met the consultation requirements with DPIE – Water for the two revisions of the WMP during the audit period (WMP v6 approved December 2018: Letter from NRAR dated 26 July 2018 confirming consultation and WMP v7 approved 26 November 2019: DPIE response (email dated 15/10/19) stating that the Department was "*Satisfied – minor updates which do not require to be consulted on.")* However, regarding consultation undertaken for other plans: • It was stated that the EPA have previously advised Cadia that they do not review management plans,	parties under the applicable condition of this consent. **Recommendation No. 3 –** Cadia should formalise existing processes to ensure that environmental management plan revisions are conducted in consultation with all parties under the applicable condition of this Project Approval and that any consultation undertaken be stated in each plan. Similarly, if agreement was obtained from the Secretary not to undertake consultation with all parties, then this should also be included in the plan. **Observation No. 8 –** Cadia could consider renaming the following plans: • "Cadia Environmental Strategy" to "Cadia Environmental Management Strategy" to be consistent with the Project Approval condition; • the "Cadia Air Quality Program" to the "Cadia Air Quality Monitoring Program" to be consistent with the Project Approval condition; and • the "Aboriginal Heritage Management Plan" to "Aboriginal Cultural Heritage Management Plan"" to be consistent with the Project Approval condition. **Observation No. 9 –** Table 12-3 in each of the three AEMRs (during the		

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		notwithstanding, no evidence was obtained to verify that Cadia consulted with the EPA for the revision of the AQMP (dated June 2018), NMP (v4, approved 21/12/18), BMP (Rev. 4, approved 4/08/20) or WMP (v6, approved December 2018). • The current approved HHMP (Rev 1, approved 4 Aug 2020) is the first approved HHMP for the project. Evidence of previous (initial) consultation with the Heritage Branch of the Department of Planning regarding the draft HHMP was provided (letter dated 18 June 2010). However, there were subsequent amendments made to the (same) draft in the ten years following the initial consultation. No evidence was obtained to verify that Cadia consulted with Heritage NSW in regard to the amended draft of the HHMP during the audit period, prior to the plans (Rev 1) approval.	audit period) should read "Aboriginal Cultural Heritage Management Plan". **Observation No. 10 –** A number of management plans state that the plan will be "*assessed annually following the AEMR process as to whether a formal review is required*" (e.g. Section 9.1 of the Water Management Plan). Cadia should expand this to include within 3 months of an incident report, audit under condition 7 or modifications in accordance with Project Approval Schedule 5, Condition 3. Any of these conditions trigger a (mandatory) review of the Strategies, Plans and Programs. Based on the review, a decision is then made whether a revision. needs to be undertaken. In addition, Project Approval Schedule 5, Condition 3 should be included in the relevant Strategies, Plans and Programs (e.g. Table 1-1 of the Water Management Plan).		

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Condition of Consent	**Condition Requirement**	**Evidence collected**	**Independent Audit Findings and Recommendations**	**Compliance Status**	**Unique ID for non-compliance**
1.	**ACQUISITION OF AFFECTED PROPERTIES** **Acquisition Upon Request** Upon receiving a written request for acquisition from the owner of the land listed in Table 1, the Proponent shall acquire the land in accordance with the procedures in conditions 5-7 of schedule 4. *Table 1: Land subject to acquisition upon request* MC & PA Ewens *Note: To interpret the location referred to in Table 1, see the applicable figure in Appendix 2.*	CVO Dewatering Facility Relevant Cadia personnel were able to demonstrate that they are aware of the Project Approval condition that requires Cadia to acquire the land located at MC & PA Ewens (located at 247 Newbridge Road, near the CVO Dewatering Facility) if this resident provides a written request for the land to be purchased. It was stated that during the audit period, no such written requested was received from this landowner. It was stated that this landowner is fully aware of the available acquisition and complaints process under this condition. It was stated that as of November 2020, good relations existed between this landowner and Cadia. It is acknowledged that a standing order exists if requested, to potentially purchase the Ewens property at 247 Newbridge Road. It was stated by Cadia that this property is not required for any operational reasons. Noise Monitoring Unattended noise monitoring is conducted at the Ewen's residence at six-monthly intervals, utilising the Cadia noise monitoring trailer. Attended noise monitoring is also conducted at this	No request for the acquisition of land (as identified in Project Approval, Schedule 3, *Table 1: Land subject to acquisition on request*) was received by Cadia during the audit period from MC & PA Ewens (located at 247 Newbridge Road, near the CVO Dewatering Facility).	**Compliant**	

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		location. Noise monitoring is conducted in accordance with and at intervals defined in the DPIE approved Cadia monitoring schedule. It was stated that the most recent unattended noise monitoring at 247 Newbridge Road was completed on the 1st May 2020 and monitoring is scheduled to be completed again in November 2020. No requests have been received from this landowner for additional noise monitoring to be completed outside of the existing -six-monthly schedule. For noise monitoring completed during the audit period, exceedances above limits defined in the Project Approval and EPL were recorded at this property. During the audit period, no complaints were received by Cadia from this property, relating to noise from the construction and operation of the dewatering facility or from rail related activities. Mitigation works have also been undertaken at this property.			
2.	**NOISE** **Impact Assessment Criteria** The Proponent shall ensure that the noise generated by the project does not exceed the noise impact assessment criteria in Table 2 at any residence on privately-	<u>Directional (Unattended) Noise Monitoring (for operational noise)</u> Unattended noise monitoring is conducted continuously over a minimum seven-day period using a directional noise monitor (e.g. QuattroSound monitor on a mobile trailer) (Photo No. 5). At designated monitoring locations, noise	On all occasions during the audit period, Cadia was unable to demonstrate full compliance with criteria defined in Project Approval Schedule 3, *Table 2: Noise Impact Assessment Criteria dB(A) $L_{Aeq\ (15min)}$*. **Non-compliance No. 4 –** During the audit period, even though mitigation	**Non-compliant**	**NC4**

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	owned land or on more than 25 per cent of any privately-owned land. *Table 2: Noise Impact Assessment Criteria dB(A) $L_{Aeq\ (15min)}$* Table 2: Noise Impact Assessment Criteria dB(A) $L_{Aeq\ (15min)}$ **Location** / **Day** / **Evening** / **Night** / **Night ($L_{A1\ (1\ min)}$)** ***Mining Operations*** 41-CW Knox ('Meribah'), 43-CJ Healey ('Triangle Park'), 138-AC & A Bailey ('Mayburies'), 45-CC Colman ('Mirrabooka'), 246-CK Channell and KP & DV Donkin ('Eastburn'), 209-JI McLennan ('Northwest'), 171-GA Knox ('South Log') — 43 / 38 / 38 / 45 1-GT & JA Christou ('Cowabbi'), 137-MP & LA Ellis ('Argyle'), 169-RL & SL Chamberlain ('Weemalla') — 43 / 38 / 37 / 45 44-AR Colman ('Triangle Flat'), 105-KA Hughes ('Barton Park'), 133-LC & LR Baker ('Bonnie Glen') — 43 / 38 / 35 / 45 Other privately owned land — 43 / 38 / 35 / 45 ***Elsyney Dewatering Facility*** Location 1 — 50 / 50 / 37 / 49 Location 2 — 50 / 50 / 38 / 48 Location 3 — 46 / 46 / 37 / 47 Location 4 — 46 / 46 / 36 / 46 Location 5 — 58 / 58 / 45 / 58 ***CVO Dewatering Facility*** MC & PA Ewens — 50 / 42 / 42 / 45 GP Nixon & Sons — 43 / 35 / 35 / 45 D Palmer — 40 / 39 / 35 / 45 H Tellaw — 40 / 36 / 35 / 45 ML Gardner — 40 / 35 / 35 / 45 GJ Keen — 39 / 35 / 35 / 45 D Somervaille — 38 / 38 / 35 / 45 *Notes:* • *To interpret the locations referred to Tables 2-5, see the applicable figures in Appendices 2 and 4.*	monitoring is conducted biannually at each location or on request if a complaint is received. All noise monitoring data is independently reviewed by a qualified noise consultant. During the audit period, Cadia exceeded the unattended noise assessment impact criteria defined in Project Approval Schedule 3, *Table 2: Noise Impact Assessment Criteria dB(A) $L_{Aeq\ (15min)}$* on: a) 38 occasions from August 2019 – May 2020 (attributed to both operational noise contributions from activities within the Cadia Mine, specifically engine noise from the mobile plant and train movements on the CVO Dewatering Facility rail siding); b) 21 occasions between July 2018 and June 2019 (attributed to both operational noise contributions from activities within the Cadia Mine, specifically engine noise from the mobile plant and train movements on the CVO Dewatering Facility rail siding); and c) 86 occasions from July 2017 to June 2018 (attributed to either aircraft noise during aerial dust suppression activities (x82) or trains in the vicinity of the CVO Dewatering Facility (x4).	was offered and completed at affected properties and no noise complaints were received, Cadia exceeded the noise impact assessment criteria defined in Project Approval Schedule 3, *Table 2: Noise Impact Assessment Criteria dB(A) $L_{Aeq\ (15min)}$* as follows: • on 38 occasions from August 2019 to May 2020; • on 21 occasions from July 2018 to June 2019; • on 86 occasions from July 2017 to June 2018, relating to either aircraft noise during aerial dust suppression activities (x82) or trains in the vicinity of the CVO Dewatering Facility (x4); and • in June 2019, relating to container handling activities contributing noise levels above the LA1,1 minute criteria during the night period at the 247 Newbridge Road monitoring location, resulting in a marginal exceedance of the Sleep Disturbance criteria. **Recommendation No. 4 –** Where reasonable and feasible, Cadia should continue to implement additional noise abatement projects and controls to improve levels of compliance with Project Approval Schedule 3, *Table 2: Noise Impact Assessment Criteria dB(A) $L_{Aeq\ (15min)}$.* and/or have this		

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	• *Noise generated by the project is to be measured in accordance with the relevant requirements, and exemptions (including certain meteorological conditions), of the NSW Industrial Noise Policy.* • *The noise limits do not apply if the Proponent has an agreement with the relevant owner/s of these residences/land to generate higher noise levels, and the Proponent has advised the Department in writing of the terms of this agreement.* • *Noise associated with the mining operations may exceed the night time limits in Table 2 at Property 22 – JL Gill by 1 decibel during construction of the Cadia East mine.* • *Noise associated with the construction of the upgrade to the Blayney Dewatering Facility may exceed the noise impact assessment criteria in Table 2 by up to 3 decibels at all locations except Location 4, and is to be measured in accordance with the relevant procedures in the EPA's Interim Construction Noise Guideline.*	 **Photo No. 5 –** QuattroSound® Directional Noise Monitor (i.e. unattended noise monitoring instrumentation) in use at landowner (10th November 2020) <u>Attended Noise Monitoring</u> Attended noise monitoring is conducted by Cadia to assess operational noise from mining operations and the CVO dewatering facility. This noise monitoring involves the use of an attended noise monitor (e.g. a Bruel and Kjaer Sound Level Analyser) and is conducted by Cadia's noise consultant at designated locations in two 15 minute intervals during daytime, evening and night time periods (i.e. as specified by Cadia's Project Approval and EPL). This noise monitoring is scheduled and conducted twice annually at each location and noise monitoring data is independently reviewed by a qualified noise consultant.	condition reassessed within a future Project Approval modification.		

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		During the audit period, Cadia complied with the attended noise assessment impact criteria defined in Project Approval Schedule 3, *Table 2: Noise Impact Assessment Criteria dB(A) $L_{Aeq\ (15min)}$* during: a) December 2019 and March 2020 monitoring; b) October/ November 2018 monitoring; and c) during the two monitoring periods in 2017/18. During the audit period, Cadia exceeded the attended noise assessment impact criteria defined in Project Approval Schedule 3, *Table 2: Noise Impact Assessment Criteria dB(A) $L_{Aeq\ (15min)}$* in June 2019, relating to container handling activities contributing levels above the L_{A1},1 minute criteria during the night period at the 247 Newbridge Road monitoring location, resulting in a marginal exceedance of the Sleep Disturbance criteria. At the completion of unattended and attended noise monitoring, data is analysed, exceedances identified, and monthly reports collated and issued by an external consultant from Advitech. The Cadia website provides public access to copies of Cadia noise assessment/ survey reports completed by Advitech during the audit period.			

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Condition of Consent	**Condition Requirement**	**Evidence collected**	**Independent Audit Findings and Recommendations**	**Compliance Status**	**Unique ID for non-compliance**
3.	**NOISE** **Land Acquisition Criteria** If the noise generated by the project exceeds the criteria in Table 3 at any residence on privately-owned land or on more than 25 per cent of any privately-owned land, the Proponent shall, upon receiving a written request for acquisition from the landowner, acquire the land in accordance with the procedures in conditions 5-7 of schedule 4. *Table 3: Land acquisition criteria dB(A) $L_{Aeq\ (15min)}$* *Note: Noise generated by the project is to be measured and evaluated in accordance with the relevant requirements, and exemptions (including certain meteorological conditions), of the NSW Industrial Noise Policy.*	In relation to operational noise from Cadia's mining and dewatering facilities, no requests for acquisitions of privately owned land were received during the audit period from any landowners. It was stated that no significant changes are planned in the near future that could potentially increase operational noise which could increase the potential for noise complaints to be received from landowners. The Environmental Assessment of the new Cadia molybdenum plant identified that there would be no noise increases as a result of the plant relocation (Mod 10). **Photo No. 6 –** CVO Molybdenum Plant under construction (9th November 2020)	In relation to noise emitted during the audit period, Cadia did not receive any written requests for acquisition of land from any landowners (i.e. based on the land acquisition criteria dB(A) $L_{Aeq\ (15min)}$ defined in Project Approval Schedule 3, *Table 3: Land acquisition criteria dB(A) $L_{Aeq\ (15min)}$*.	**Compliant**	

Location	*Day*	*Evening*	*Night*
Mining Operations			
All privately-owned land	43	43	40
CVO Dewatering Facility			
D Palmer	45	44	40
H Tetlaw	45	41	40
GP Nixon & Sons, ML Gardner, GJ Keen	44	40	40
D Somervaille	43	43	40

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		Whilst Cadia acknowledges that noise exceedances against the Project Approval and EPL occurred during the audit period, no noise complaints were received from landowners. It was stated that Cadia continues to work closely with Advitech to define improved triggers to enable mine related noise to be better detected during noise monitoring. Once developed and able to be determined, this can potentially be used to alert Cadia prior to a noise exceedance occurring.			
4.	**NOISE** **Cumulative Noise Criteria** The Proponent shall implement all reasonable and feasible measures to ensure that the noise generated by the project combined with the noise generated by other mines and industries does not exceed the amenity criteria in Table 4 at any residence on privately-owned land or on more than 25 per cent of any privately-owned land, to the satisfaction of the Secretary.	It was stated that during the audit period, only one landowner was impacted by noise emissions from Cadia mining operations (i.e. based on communications received from this landowner). It was stated that ongoing discussions are being held with this landowner (i.e. Nixon residence) relating to nuisance noise. It was stated that no other landowners in the vicinity of existing mining or dewatering facilities were significantly impacted by noise from Cadia. It was stated that relevant Cadia environmental personnel are now able to listen to noise monitoring data/files after the completion of scheduled or requested noise monitoring. At Cadia's request, Advitech plans to reconfigure Cadia's	The attended and unattended monthly reports from Advitech confirm that there were no cumulative noise criteria exceedances during the audit period.	**Compliant**	

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Condition of Consent	**Condition Requirement**	**Evidence collected**	**Independent Audit Findings and Recommendations**	**Compliance Status**	**Unique ID for non-compliance**
	Table 4: Cumulative noise criteria dB(A) L_{Aeq} (period) **Location** / **Day** / **Evening** / **Night** ***Mining Operations*** All privately-owned land: 50 / 45 / 40 ***CVO Dewatering Facility*** D Palmer: 55 / 45 / 40 H Tellaw, GP Nixon & Sons, ML Gardner, GJ Keen, D Somerville: 50 / 45 / 40 *Note: Cumulative noise is to be measured in accordance with the relevant requirements, and exemptions (including certain meteorological conditions), of the NSW Industrial Noise Policy.*	noise monitoring program to enable noise to be monitored and assessed in real time (i.e. to detect operational noise and potentially avoid future noise exceedances).			
5.	**NOISE** **Traffic Noise Impact Assessment Criteria** The Proponent shall take all reasonable and feasible measures to ensure that the traffic noise generated by the project does not exceed the traffic noise impact assessment criteria in Table 5. *Table 5: Traffic noise impact assessment criteria dB(A)* **Road** / **Day/Evening** / **Night** Forest Road, Orange Road: 60 $L_{A(1)hour}$ / 55 $L_{A(9)hour}$ Cadia Road, Orchard Road, Four Mile Creek Road, Woodville Road, Panuara Road: 55 $L_{Aeq(1)hour}$ / 50 $L_{Aeq(9)hour}$ *Note: Traffic noise generated by the project is to be measured in accordance with the relevant procedures in the EPA's Environmental Criteria for Road Traffic Noise.*	<u>Directional Unattended Noise Monitoring (Traffic Noise)</u> Unattended noise monitoring is conducted to assess noise from mine related traffic using a directional noise monitor (e.g. QuattroSound monitor on a mobile trailer). This monitoring is also completed continuously over a minimum seven-day period twice annually at residences on either Cadia, Orchard or Woodville roads (including Long Swamp road). This noise monitoring data is independently reviewed by a qualified noise consultant, Advitech. In the audit period, Cadia exceeded the unattended noise assessment impact criteria defined in Project Approval Schedule 3, *Table 5: Traffic Noise Impact Assessment Criteria dB(A)* during:	No official or valid traffic related noise complaints were received by Cadia during the audit period. **Non-compliance No. 5 –** During the audit period, CVO was unable to demonstrate compliance with the required Project Approval Schedule 3, *Table 5: Traffic Noise Impact Assessment Criteria dB(A)* during 2019/20 on both monitoring occasions, during 2018/19 on one occasion, and during 2017/18 on one occasion. It is acknowledged that during the audit period, Cadia investigated, discussed mitigation options and completed several mitigation measures and initiatives with some affected landowners.	**Non-compliant**	**NC5**

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		• 2019/20 where noise monitoring data showed that traffic noise criteria were exceeded at the two dwellings that were monitored. It is acknowledged that mitigation options are being developed in conjunction with the landowners; • 2018/19 where noise monitoring data showed that traffic noise criteria was compliant at one dwelling and exceeded at the second dwelling that was monitored; and • 2017/18 where noise monitoring data showed that traffic noise criteria was compliant at one dwelling and exceeded at the second dwelling that was monitored. No official or valid traffic related noise complaints were received by Cadia during the audit period. To assess the impact of traffic noise, two properties are strategically selected (i.e. within close proximity to main feeder roads) every year for noise monitoring. It was stated that historically, the properties selected for traffic related noise monitoring was based on the complaint history of impacted residents. As of November 2020, traffic related noise monitoring is conducted at select targeted properties (i.e. based on access approval by the landowner and close	Three properties that have not had mitigation works are a result of the landowners not proceeding with the recommended works and discussions are ongoing. **Recommendation No. 5 –** It is acknowledged that few additional opportunities exist to reduce traffic noise generated by the project. Mitigation of traffic noise affected properties is the most favourable solution and is required when requested by affected landowners.		

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		proximity to main feeder roads such as Cadia Road). As of November 2020, it was stated that Cadia maintains a suitable noise monitoring data set relating to traffic noise (i.e. inclusive of six data sets collected during the audit period for the measurement and recording of road traffic noise). To minimise traffic noise impacts, Cadia identified and completed several initiatives inclusive of: • the use of buses for the transport of contract personnel during construction projects and shutdowns (i.e. this requirement is included in relevant contracts); and • promoting car-pooling by Cadia employees.			
6.	**NOISE** **Operating Hours** The Proponent shall comply with the operating hours in Table 6.	<u>Construction</u> It was stated that during the audit period, no construction works are known to have occurred outside of the construction times and days defined in Project Approval Schedule 3, Condition 6. If construction works were needed, the type and nature of the construction works, and potential noise emissions would be discussed between Cadia and the relevant contractor.	During the audit period, no construction works are known to have occurred outside of the construction times and days defined in Project Approval Schedule 3, Condition 6.	**Compliant**	

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	Table 6: Operating Hours **Activity** / **Day** / **Time** ***Construction*** Bodallo Creek water holding dam raise; tailings storage facilities raises; new pipelines — Any day — Day Cadia East underground mine development; upgrade of ore processing facilities — Any day — Any time Dewatering facilities — Monday – Friday — 7.00am to 6.00pm Dewatering facilities — Saturday — 8.00am to 1.00pm Dewatering facilities — Sunday and Public Holidays — None ***Operation*** Mine complex operations; Dewatering facilities — Any day — Any time Blayney Dewatering Facility – train loading — Any day — 7.00am to 7.00pm CVO Dewatering Facility – train loading — Any day — Day *Note: Construction and maintenance activities may be conducted outside the hours in Table 6 provided that the activities are not audible at any residence beyond the boundary of the site.*	It was stated that this Project Approval condition is included in construction contracts that are approved and issued by Cadia to the contractor. <u>Operations</u> Cadia's Project Approval conditions authorises the shunting of rail cars 24 hrs a day. It was stated that because of existing NSW rail schedules, rail shunting at the CVO Dewatering Facility typically occurs from 4 am to 5 am. This activity potentially impacts three landowners that are in the vicinity of this rail siding/CVO's Dewatering Facility. As of November 2020, an available acquisition existed on one property and noise abatement/ remedial works have been completed on the remaining three properties. **Photo No. 7 –** CVO Dewatering Facility Container/Rail Load-out Area (10th November 2020)			

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		<u>Decommissioning and Remediation</u> The CVO Blayney Dewatering Facility was decommissioned and remediated between February and September 2020. No work is known to have occurred outside of the approved days and times defined in Project Approval Schedule 3, *Table 6: Operating Hours*. The land was leased (i.e. with lease expiry occurring on the 6th December 2020) and will be returned to the owner in a suitable state for industrial use (Blayney Shire Council LEP zoning). **Photo No. 8 –** Site of the former CVO Blayney Dewatering Facility – Rehabilitation completed (10th November 2020)			
7.	**NOISE** **Additional Noise Mitigation Measures** Upon receiving a written request from:	During the audit period, Cadia did not receive any written requests for noise mitigation measures to be completed at any residential properties.	During the audit period, Cadia did not receive any written requests for noise mitigation measures to be completed at any residential properties (i.e. relating to traffic noise and noise emanating	**Compliant**	

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	• the landowner of the properties identified as:
	  ○ MC & PA Ewens (unless the landowner has requested acquisition); or
	  ○ GP Nixon & Sons; or
	• the landowner of privately-owned land where subsequent operational noise monitoring shows the noise generated by the project exceeds the noise limits in Table 2 by more than:
	  ○ 1 dB(A), in the case of daytime noise levels at the location identified as ML Gardner; or
	  ○ 2 dB(A), in the case of all other locations; or
	• the landowner of the residences on Forest Road, Orchard Road, Woodville Road or other road listed in Table 5 where subsequent noise monitoring shows traffic noise levels generated by the project exceed the traffic noise criteria in Table 5,
	
	the Proponent shall implement additional noise mitigation measures such as double glazing, insulation, and/or air conditioning at any residence on the land in consultation with the landowner.
	
	These additional mitigation measures must be reasonable and feasible.
	
	If within 3 months of receiving this request from the landowner, the Proponent and the
		Cadia's June 2018 Noise Monitoring Procedure requires that if an identified noise exceedance occurs during attended monitoring at a residence (i.e. that triggers the offering of mitigation), Cadia proceeds with the assessment and an offer of mitigation works.
		
		<u>Traffic Noise Mitigation</u>
		
		As of November 2020, Cadia was able to demonstrate that suitable traffic noise mitigation measures were proactively discussed, agreed and completed at 676 and 677 Cadia Road.
		
		In addition, as of November 2020, noise mitigation works at 365a and 365b Cadia Road were currently under negotiation/offer/planning works, with no works completed to date.
		
		Finally, mitigation offers on properties prior to the audit period, were being progressed during the current audit period. These included:
		• 56 Orchard Road, where mitigation works have been offered and accepted;
		• 324 Orchard Road, where mitigation works have been offered but not accepted; and
		• 1214 Cadia Road, where mitigation works have been offered but not accepted.
			from the CVO Dewatering Facility/rail shunting activities).
			
			It is acknowledged that Cadia offered and conducted mitigation works at several properties along Cadia Road (i.e., relating to traffic noise) and in the vicinity of the Cadia Dewatering facility.
			
			With regards traffic noise, mitigation measures remain outstanding at three affected properties, including 56 Orchard Road, 324 Orchard Road and 1214 Cadia Road.
			
			Noise mitigation as required by Project Approval Schedule 3; Condition 7 has been implemented as required at three residential properties in the vicinity of the CVO Dewatering Facility and at 676 and 677 Cadia Road.		

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	landowner cannot agree on the measures to be implemented, or there is a dispute about the implementation of these measures, then either party may refer the matter to the Secretary for resolution. Within 3 months of this approval, the Proponent shall notify all applicable landowners that they are entitled to receive additional noise mitigation measures, to the satisfaction of the Secretary.	<u>Noise Mitigation at the CVO Dewatering Facility</u> Prior to and during the audit period, Cadia was able to demonstrate that noise mitigation works were progressed and completed on three residential properties located in the vicinity of the CVO Dewatering Facility. These properties included: • 84 Newbridge Road; • 247 Newbridge Road; and • 331 Newbridge Road.			
8.	**NOISE** **Continuous Improvement** The Proponent shall: (a) implement all reasonable and feasible best practice noise mitigation measures; (b) investigate ways to reduce the noise generated by the project, including off-site road (particularly on Forest Road, Orchard Road and Woodville Road during the night and early morning periods) and rail noise and maximum noise levels which may result in sleep disturbance; and (c) report on these investigations and the implementation and effectiveness of these measures in the Annual Review, to the satisfaction of the Secretary.	Generally, apart from specific activities at the CVO Dewatering Facility, noise emanating from the Cadia mining operations and related infrastructure, does not result in any significant adverse impact or nuisance to landowners (i.e. in comparison to other impacts from dust etc). Noise minimisation and improvement initiatives that were completed by Cadia during the audit period included, but were not limited to: • after the completion of an investigation, execution of a "winter strategy" for load and haul to reduce noise output (i.e. via a noise reduction strategy, which determines how material movements are planned on a shift by shift basis);	During the audit period, Cadia was able to demonstrate that it has investigated and completed a range of specific noise mitigation measures and are in discussions with potentially impacted landowners to investigate ways to reduce the noise generated by the project. **Observation No. 11 –** For some specific examples, Cadia is incorrectly defining statutory non-compliances in their AEMR as "non-conformances" (e.g. Section 6.4.4 of the 2019/2020 AEMR relating to noise monitoring exceedances).	**Compliant** **Observation**	

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		• the use of lagging on pipes and motors, and installation of sonic curtains; • external noise consultants utilised by CVO are progressing the use of real time alarm triggering to identify potential mine related exceedances prior to the exceedance level being breached; • a commitment to increase the use of buses to transport contractors to reduce road traffic noise; • a review of and potentially staggering shift times to potentially reduce traffic noise impacts; • traffic noise monitoring at landowner properties along Orchard Road, Cadia Road and Woodville Road; and • noise abatement/remedial works at 676 and 677 Cadia Road and also three residences impacted by noise from the CVO Dewatering Facility during the audit period. Cadia most recently reported on completed noise investigations and noise initiatives in: a) Section 6.4.4.6 (mitigation measures); and b) Section 6.4.4.8 (proposed improvements) within the 2019/2020 AEMR.			

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9.	**NOISE** **Noise Monitoring** The Proponent shall prepare and implement a detailed Noise Monitoring Program for the project to the satisfaction of the Secretary. This program must: (a) be prepared in consultation with EPA, and be submitted to the Secretary for approval within 3 months of the date of this approval; and (b) include: • a combination of unattended and attended monitoring measures; and • a noise monitoring protocol for evaluating compliance with the relevant noise impact assessment and land acquisition criteria in this approval.	Cadia was able to demonstrate that the requirements defined within its June 2018 Noise Monitoring Program meets the requirements of Project Approval Schedule 3, Condition 9 (a) and (b). Cadia's Noise Monitoring Program (Version 4) was issued on the 11th June 2018. This Noise Monitoring Program was formally approved by the DPIE on the 21st December 2018. Cadia's June 2018 Noise Monitoring Program includes: • a combination of unattended and attended monitoring measures (Section 4); and • a noise monitoring protocol for evaluating compliance with the relevant noise impact assessment and land acquisition criteria in this approval (Section 5.1). It was stated that if a noise exceedance occurs, Cadia's noise consultant assesses and determines the influence of background noise and makes a judgement on the extent that background noise has contributed to the recorded exceedance.	During the audit period, Cadia was able to demonstrate that its June 2018 Noise Monitoring Program meets the requirements of Project Approval Schedule 3, Condition 9 (a) and (b).	**Compliant**	

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		It was stated that if the noise exceedance was mining related, relevant Cadia environmental personnel would also listen to the recorded audio to determine its source. At the completion of noise monitoring, all noise exceedances are reviewed and investigated by the consultant and relevant Cadia personnel to identify if the exceedance is mining related. It was stated that if the noise source is contested, then it can be determined and reported as being "inclusive". External service provider, Novecom is contracted to calibrate the trailer mounted noise unit at quarterly intervals. It was stated that the noise monitor currently fitted to this trailer is relatively new.			
10.	**BLASTING AND VIBRATION** **Blasting Impact Assessment Criteria** The Proponent shall ensure that blasting at the project does not exceed the criteria in Table 7.	During the audit period, no blast related events exceeded the (95th percentile) assessment criteria for blast vibration (at a residence on privately owned land). In addition, the percentage of blasts exceeding criteria defined in Project Approval Schedule 3, *Table 7: Blasting impact assessment criteria*, consistently remains below the allowable 5% over a 12 month period. Cadia utilises and maintains a total of 7 ground vibration and overpressure monitors in the field, surrounding the	During the audit period, no blast related events exceeded the (95th percentile) assessment criteria for blast vibration (at a residence on privately owned land). **Observation No. 12 –** Cadia is encouraged to revise and reissue its existing agreement with Ecotech, as the current agreement was stated as not being valid in late 2020 (i.e. it was issued to Ecotech in July 2018 for a 12 month period).	**Compliant** **Observation**	

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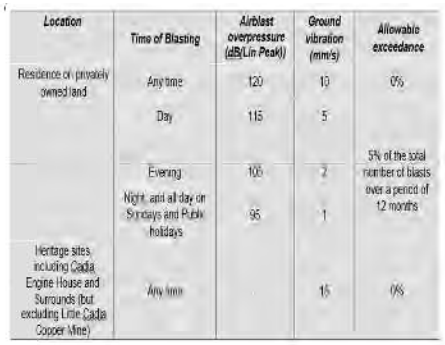
	Table 7: Blasting impact assessment criteria  *Note: The impact assessment criteria for Cadia Engine House and Surrounds apply in the absence of any antivibration strengthening. Alternative criteria may be approved under the Historical Heritage Management Plan (see condition 43) if anti-vibration strengthening works are implemented.*	mine. Given the location of these, it was stated that if a blast vibration event occurred, then all 7 monitors will detect the blast vibration. Given that daily blasting of the underground Cadia East mine is conducted approximately 1 km below the ground surface, the criteria defined in Project Approval Schedule 3, *Table 7: Blasting impact assessment criteria*, were met during the audit period. During the audit period, external service provider, Ecotech Pty Ltd was engaged by Cadia to undertake the assessment and reporting of blasting (ground vibration and overpressure) and calibration of monitoring instrumentation. At monthly intervals, ground vibration and overpressure data are forwarded to Ecotech. This service provider is responsible for analysing and interpreting the data and providing a monthly blast report to Cadia. In addition to the above, no landowner complaints were received during the audit period relating to ground vibration (i.e. as a result of landowners not experiencing blast vibration levels above the maximum vibration criteria).			

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11.	**BLASTING AND VIBRATION** **Operating Conditions** During mining operations on site, the Proponent shall implement best blasting practice to: (a) protect the safety of people, property, public infrastructure, and livestock; (b) protect items of Aboriginal and non-indigenous cultural heritage significance; and (c) minimise the dust and fume emissions from blasting at the project, to the satisfaction of the Secretary.	During the audit period, it was stated in the 2019/2020 AEMR that the primary blast and reporting controls utilised by Cadia to minimise adverse blasting impacts included: • managing the magnitude of blast events and pre-conditioning of the ore body; • controlling the timing of blasts to minimise potential disturbance of residents; • ongoing monitoring and publishing of results; • ongoing reporting to the community; and • ongoing reporting and liaising with blast planning engineers regarding any elevated results. It is acknowledged that there were no landowner complaints relating to ground vibration received by Cadia in 2019/20 and 2018/19, but two community complaints relating to ground vibration were received by CVO in 2017/18.	During this audit, there was no evidence that Cadia's ongoing underground blasting program is: (a) having an adverse impact on the safety of landowners, landowner property, public infrastructure, and/or livestock; (b) having an adverse impact on items of Aboriginal and non-indigenous cultural heritage significance; or (c) measurably increasing the dust and fume emissions from the project.	**Compliant**	
12.	**BLASTING AND VIBRATION** **Public Notice** During mining operations on site, the Proponent shall: (a) notify the landowner/occupier of any residence within 2 kilometres of	Scheduled generic blasting times utilised by Cadia are provided on the Cadia website. Cadia continues to advertise and maintain a Community Hotline (phone 1800 063 043) for the receipt of any community/landowner complaints,	During the audit period, Cadia was able to demonstrate compliance with the requirements of Project Approval Schedule 3, Condition 12 (a) to (d). **Observation No. 13 –** In conjunction with its Production Managers, Cadia could review the blasting schedule that	**Compliant** **Observation** **Observation**	

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	blasting operations who registers an interest in being notified about the blasting schedule at the mine, or any other landowner nominated by the Secretary; (b) operate a Blasting Hotline, or alternate system agreed to by the Secretary, to enable the public to get up-to-date information on the blasting schedule at the project; (c) publish an up-to-date blasting schedule on its website (for open pit and major underground blasting operations); and (d) advertise the blasting hotline number and website information in the mine's regular newsletter, to the satisfaction of the Secretary.	inclusive of any blasting or blast vibration related complaints. Relevant monthly blasting data and blast reports are available on the Cadia website.	is advertised on the Cadia website, as it may no longer reflect actual practice in 2020. **Observation No. 14 –** Cadia does not maintain a "blasting hotline", only a "complaints hotline". The next update of the Project Approval should not refer to a Blasting Hotline.		
13.	**BLASTING AND VIBRATION** **Property Inspections** The Proponent shall advise the owners of privately-owned land that they are entitled to a structural property inspection to establish the baseline condition of buildings and other structures on the property: (a) within 2 months of the date of this approval, for properties within 2 kilometers of blasting operations	It was stated that Cadia advised landowners of their entitlement for a baseline structural property inspection during the Environmental Assessment (EA) process that was conducted in 2010. During the audit period, no structural property inspections have occurred or were requested from landowners. This is inclusive for the period after the natural seismic event that occurred in the region in 2018.	In 2010, Cadia advised landowners of their entitlement for a baseline structural property inspection. During the audit period: a) no structural property inspections occurred or were requested from landowners; and b) no structural complaints were received by Cadia from landowners.	**Compliant**	

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	occurring at the date of this approval; and (b) at least 2 months prior to blasting within 2 kilometers of additional properties.	No structural complaints were received by Cadia from landowners during the audit period.			
14.	**BLASTING AND VIBRATION** **Property Inspections** If the Proponent receives a written request for a structural property inspection from any such landowner, the Proponent shall: (a) within 2 months of receiving this request commission a suitably qualified, experienced and independent person, whose appointment has been approved by the Secretary, to inspect the condition of any building or structure on the land (prior to blasting taking place within 2 kilometres of the property, if possible), and recommend measures to mitigate any potential blasting impacts; and (b) give the landowner a copy of the property inspection report.	It was stated that Cadia advised landowners of their entitlement for a baseline structural property inspection during the EA process that was conducted in 2010. It was stated that the last request for a property inspection by a landowner was received by Cadia in 2013.	No requests were received during the audit period from any landowners for a structural property inspection to be completed on their property. **Observation No. 15 –** Cadia could potentially investigate and verify if any additional baseline structural inspections need to be completed of the landowner residences (i.e. located within a 2 km radius of existing and future blast zones) that potentially could be impacted in the future (i.e. given that the last opportunity was in 2010).	**Compliant** **Observation**	
15.	**BLASTING AND VIBRATION** If any landowner of privately-owned land within 2 kilometres of blasting operations, or any other landowner nominated by the Secretary, claims that buildings and/or structures on his/her land have been	During the audit period, no structural property inspections have occurred or were requested from landowners. This is inclusive for the period after the natural seismic event that occurred in the region in 2018.	During the audit period, no claims were received by Cadia from any landowners relating to their buildings and/or structures being damaged because of blasting conducted by Cadia.	**Compliant**	

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	damaged as a result of blasting at the project, the Proponent shall within 3 months of receiving this request: (a) commission a suitably qualified, experienced and independent person, whose appointment has been approved by the Secretary, to investigate the claim; and (b) give the landowner a copy of the property investigation report. If this independent property investigation confirms the landowner's claim, and both parties agree with these findings, then the Proponent shall repair the damages to the satisfaction of the Secretary. If the Proponent or landowner disagrees with the findings of the independent property investigation, then either party may refer the matter to the Secretary for resolution. If the matter cannot be resolved within 21 days, the Secretary shall refer the matter to an Independent Dispute Resolution Process (see Appendix 8).	As a result, no independent property investigations were required to be completed.			
16.	**Blast Monitoring Program** The Proponent shall prepare and implement a Blast Monitoring Program for the project to the satisfaction of the Secretary. This program must:	Cadia's Blast Monitoring Program (Doc. No. 710-005-EN-PLA-0002) – Revision 4 was last issued on the 16th July 2020.	Cadia's Blast Monitoring Program (Doc. No. 710-005-EN-PLA-0002) – Revision 4, last issued on the 16th July 2020, meets the requirements defined in Project Approval Schedule 3, Condition 16 (a) and (b).	**Compliant**	

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	(a) be prepared in consultation with EPA, and be submitted to the Secretary for approval within 3 months of the date of this approval; and (b) include a protocol for evaluating blast-related impacts (including blast-induced seismic activity) on, and demonstrating compliance with the blasting criteria in this approval for: • privately-owned residences and structures; • items of Aboriginal and non-indigenous cultural heritage significance (including the Cadia Engine House and Surrounds); and • publicly-owned infrastructure.	The review and approval of this Blast Monitoring Program was completed by DPIE on the 4th of August 2020. Cadia's July 2020 Blast Monitoring Program includes the following content required by this condition of the Project Approval: (a) be prepared in consultation with EPA, and be submitted to the Secretary for approval within 3 months of the date of this approval (Section 1.1); and (b) include a protocol for evaluating blast-related impacts (including blast-induced seismic activity) on, and demonstrating compliance with the blasting criteria in this approval for (Section 4.1): • privately-owned residences and structures (Section 4.0); • items of Aboriginal and non-indigenous cultural heritage significance (including the Cadia Engine House and Surrounds) (Section 4.0); and • publicly owned infrastructure (Section 4.0).			

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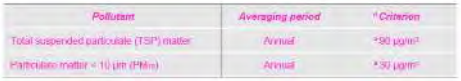
17.	**AIR QUALITY** **Impact Assessment Criteria** Except for the land in Table 1, the Proponent shall ensure that all reasonable and feasible avoidance and mitigation measures are employed so that particulate matter emissions generated by the development do not cause exceedances of the criteria listed in Tables 8, 9 and 10 at any residence on privately owned land, or on more than 25% of any privately-owned land. *Table 8: Long term impact assessment criteria for particulate matter*  *Table 9: Short term impact assessment criterion for particulate matter* *Table 10: Long term impact assessment criteria for deposited dust* *Notes to Tables 8-10:* *a Total impact (i.e. incremental increase in concentrations due to the development plus background concentrations due to all other sources);*	Air Quality Monitoring PM_{10} Monitoring In total, Cadia operates a total of: a) four TEOMs for the determination of PM_{10}; and b) eleven dust deposition gauges, including those located at the CVO Dewatering Facility. TEOMs are utilised by Cadia to measure particulate concentration continuously, provided as a five-minute average to Cadia's real time monitoring network (i.e. assessed over a 4 hour period from midnight to midnight to determine compliance against criteria defined in Project Approval Schedule 3, Table 9). TEOMs are located and operated at the following locations: • TEOM 1 – Bundarra; • TEOM 2 – Flyers Creek; • TEOM 3 – Triangle Flat; and • TEOM 4 – Meribah.	During the audit period, Cadia was unable to demonstrate that it met the criteria defined in *Table 9: Short term impact assessment criterion for particulate matter* (i.e. 24 hour 50 µg/m^3 limit for PM_{10}) on all required occasions). **Non-compliance No. 6 –** During the audit period (2017-2020), Cadia exceeded the 24 hour 50 µg/m^3 for PM_{10} limit in Project Approval Schedule 3, *Table 9: Short term impact assessment criterion for particulate matter*, on 15 separate occasions (i.e. these exceedances were attributed to the operation of the CVO mine and related activities). **Recommendation No. 6 –** To comply with limits defined in Project Approval Schedule 3, Tables 8, 9 and 10, and to reduce the number and frequency of complaints from landowners, additional controls should be progressed and completed to minimise fugitive dust emissions from the surface of the TSFs and from ore processing (i.e. crushers, conveyors, ore stockpile etc). This is inclusive of completing the remaining 50% of projects defined in its 24-month dust abatement works for ore processing.	**Non-compliant** **Observation** **Observation** **Observation** **Observation** **Observation** **Observation**	**NC6**

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	b Incremental impact (i.e. incremental increase in concentrations due to the development on its own); *c Deposited dust is to be assessed as insoluble solids as defined by Standards Australia, AS/NZS 3580.10.1:2003: Methods for Sampling and Analysis of Ambient Air – Determination of Particulate Matter – Deposited Matter – Gravimetric Method; and* *d Excludes extraordinary events such as bushfires, prescribed burning, dust storms, sea fog, fire incidents or any other activity agreed by the Secretary.*	 **Photo No. 9 –** TEOM Air Quality Monitor in use at a landowner property (10^{th} November 2020) Advitech is responsible for the operation and maintenance of Cadia's TEOMs, inclusive of quarterly calibrations. Since installation of these units, there has been no changing out or shifting of the locations of these units. The above four TEOMs report to a SentineX remote communication unit which provides near-real time data accessed via a dedicated website.	**Observation No. 16 –** Cadia's TSP concentrations are inferred from the PM_{10} monitoring data, by assuming that 40% of the TSP is PM_{10}. This data and assumption are derived from the Hunter Valley coal region and may not be applicable to a base metals operation in central west NSW. This could be reviewed and potentially reassessed by a specialist air consultant. **Observation No. 17 –** Cadia could request confirmation of the data retention processes and data back-up periods retained by Advitech and request that Cadia data is provided by the consultant to Cadia annually. **Observation No. 18 –** Cadia could investigate why TSP data at the control site remains high, as defined in recent monthly Air Quality Monitoring Assessment reports issued by Advitech. **Observation No. 19 –** Ideally, the reason for not including high/erroneous dust deposition data in the annual averages (i.e. as prepared by Todoski) would be expected to be included as a one-page appendix in the back of the consultant's report.		

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		Dust Alarms on the TEOMs TEOMs are utilised over a 24 period. Alarms on these units read instantaneous high particulates and are communicated via phone, text or email, to relevant environment and operations personnel. All TEOM alarms are required to be investigated. It was stated that 10 years of PM_{10} data exists from these four TEOM monitoring sites, inclusive of baseline data in the Cadia East Environmental Assessment, when these four sites were originally selected. It was stated that power interruptions can reduce data availability (for a 24 hour monitoring period). Cadia is considering applying for capital to install four generators to reduce/eliminate power failures. Non-operational time of the TEOMs is listed in Cadia's Air Quality Monitoring Assessment reports issued by Advitech. PM_{10} Monitoring Exceedances 2019/20 PM_{10} levels exceeded the 24 hr PM_{10} short-term impact assessment criteria of 50 µg/m3 on 28 occasions throughout FY 2019/20.	**Observation No. 20 –** Cadia is encouraged to include four duplicate QA/QC samples within its dust deposition monitoring program (i.e. one duplicate sample every quarter at one nominated dust deposition site that typically records higher readings). **Observation No. 21 –** Cadia is encouraged to investigate and redesign the design of its dust deposition poles/gauges to reduce the contribution of organic matter from birds.		

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		After the analysis of this data by a specialist consultant, Advitech and removal of data attributed to catastrophic summer bushfires and regional dust storms, only four events included a mine related contribution, and exceeded the 24 hr PM_{10} short-term impact assessment criterion of 50 µg/m^3. For the 12 month period in 2019/20, Cadia was compliant with the long-term PM_{10} impact assessment criterion and remained below the 30 µg/m^3 criterion in Project Approval Schedule 3, Table 8 for the duration of the reporting period (i.e. after allowing for impacts associated with the bushfire events of 2019/20). <u>2018/19</u> PM_{10} levels exceeded the short-term impact assessment criteria (50 µg/m^3) on eight occasions in 2018/19. An assessment undertaken by a specialist consultant, Advitech concluded that six of these were mine related. For the 12 month period in 2018/19, Cadia was compliant with the long-term PM_{10} impact assessment criterion and remained below the 30 µg/m^3 criterion for the duration of the reporting period.			

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		2017/18 PM_{10} levels exceeded the short-term impact assessment criteria (50 µg/m^3) on eight occasions in 2017/18. An assessment undertaken by a specialist consultant, Advitech concluded five of these events were mine related. For the 12 month period in 2017/18, Cadia was compliant with the long-term PM_{10} impact assessment criterion and remained below the 30 µg/m^3 criterion for the duration of the reporting period. Summary of PM_{10} Monitoring Exceedances During the audit period (2017-2020), Cadia exceeded the 24 hour 50 µg/m^3 for PM_{10} limit in Project Approval Schedule 3, Table 9 on 15 separate occasions (i.e. these exceedances were attributed to the operation of the Cadia mine and related activities). Total Suspended Particulates (TSP) At Cadia, TSP concentrations are inferred from the PM_{10} monitoring data, by assuming that 40% of the TSP is PM_{10}.			

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		TSP Monitoring Exceedances 2019/20 The long-term criteria for total suspended particulate (TSP) were below the annual criterion values of 90 µg/m^3, after allowing for impacts associated with the bushfire events of 2019/20. 2018/19 The long-term criteria for total suspended particulate (TSP) were below the annual criterion values of 90 µg/m^3. 2017/18 The long-term criteria for total suspended particulate (TSP) were below the annual criterion values of 90 µg/m^3. Dust Deposition Monitoring Since the Cadia East Environmental Assessment, dust deposition monitoring has been conducted by Cadia to determine the dust generated by the project that does not remain suspended in the ambient atmosphere. A total of 11 dust deposition gauges are utilised and sampled monthly and these samples are analysed by ALS for: a) total solids; b) insoluble solids; c) ash content; d) combustible material; e) soluble particulates; and f) total copper.			

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		Of the 11 dust deposition gauges in use, 8 of these are in the vicinity of the mine and 3 are in the close vicinity of the dewatering plant. Location DG17 is utilised as the control/reference site. Compliance against Project Approval Schedule 3, Conditions 17 and 18 is assessed using the insoluble solids fraction (i.e. ash content) of each deposited dust sample. <u>Dust Deposition Monitoring Exceedances</u> <u>2019/20</u> During 2019/20, the maximum annual average estimated contributions calculated were compliant with Project Approval requirements (of 2 g/m^2/month) at each of the dust deposition gauges. The ash content for these dust gauges (except DG29A) were below the 4 g/m^2/month criteria (all sources). As the elevated measurements comprised a proportion of organic matter, the results were considered compliant with the 4 g/m^2/month criteria specified in Project Approval Schedule 3, Table 10. <u>2018/19</u> During 2018/19, based on ash content, dust gauges DG9A, DG15A, DG17, DG18, DG29A and DGL8 were above the 2 g/m^2/month criteria specified in Project Approval Schedule 3, Table 10.			

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		Cadia was compliant with the 4 g/m^2/month criteria for maximum total deposited dust specified in Project Approval Schedule 3, Table 10. 2017/18 All dust gauges were below the annual (monthly) average of 4 g/m^2/month and 2 g/m^2/month, inclusive of dust gauge 18 (based on elevated sample results being composed of organic matter). As of November 2020, PM_{10} data is held in a database by the service provider. Dust deposition data is being transferred into EQuIS. All historical dust deposition data will be uploaded into EQuIS in the future. Depositional dust data is analysed once annually (i.e. not at monthly frequencies). Dust Management/Abatement at Cadia Airborne dust at Cadia is managed in accordance with the practices and controls defined in Cadia's Dust Management Plan (Doc. No. 710-000-EN-PLA-0001) last issued in July 2019. The above plan provides an assessment of each of the main mining operations areas, outlines key strategic measures, an assessment of possible control mechanisms and commentary on the effectiveness of each control option.			

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		A total of 20 Management Actions (including timelines and responsibilities) applicable to dust abatement are listed in Section 10 of this plan. As of late November 2020, Cadia claimed that 14 of these actions were complete. Of these 20 actions, eight actions are applicable to the northern and southern TSFs and four of these relate to actions within ore processing. <u>Dust Impacts and Community Complaints</u> Primarily because of the northern TSF wall slump on 9th March 2018, community complaints relating to dust increased significantly in the 20 months to November 2020. A total of 86 dust complaints were received by Cadia from local landowners during the audit period. For the 2020 calendar year to the end of October 2020, a total of 16 dust complaints were received by Cadia. It was stated that >80% of dust complaints are valid. The above relates to dust lift-off from the TSFs and is partially attributed to: a) at least 12 landowners being located in a corridor SE of the TSFs and downwind of the prevailing wind; and b) the period of drought that was incurred during 2018/19, with drought breaking rain commencing in Orange in February 2020.			

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		It was stated that property acquisitions have not been raised or discussed to date by these landowners. Any acquisition process would only commence if it was formally triggered. Cadia primarily discusses the collected TEOM data with landowners (i.e. not dust deposition data). Both TEOM 3 and TEOM 4 monitoring stations are located downwind of the TSFs. It was stated that Cadia plans to update its air quality monitoring program in 2021. Since June 2018, with the support of dust management specialists, Cadia was able to demonstrate extensive investigations, trials and expenditure on dust abatement measures on the TSFs. It was stated that local landowners understand the broader Cadia Project Approval and EPL requirements and the actual remedial works and additional controls that have and continue to be implemented by Cadia. It was stated that Cadia plans to utilise the existing Cadia Hill open cut Pit (Photo No. 10 and Photo No. 11) for tailings deposition for the next 7 years until it is filled. Once completed, Cadia plans to resume tailings deposition into the northern and southern TSFs until potentially 2031.			

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		 Photo No. 10 – Tailings being discharged into the Cadia Hill open cut Pit (CHP) (11th November 2020) **Photo No. 11 –** Cadia Hill open cut Pit (11th November 2020) Cadia was able to confirm that its existing air quality consultant, Advitech retains current ISO9001:2015 Quality Management Systems certification.			

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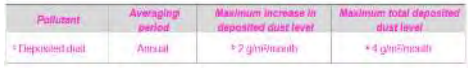
18.	**AIR QUALITY** **Land Acquisition Criteria** If particulate matter emissions generated by the development exceed the criteria, or contribute to exceedances of the relevant cumulative criteria, in Tables 11, 12 and 13 at any residence on privately owned land then upon receiving a written request for acquisition from the landowner, the Proponent shall acquire the land in accordance with the procedures in conditions 5 and 6 of schedule 4. *Table 11: Long term land acquisition criteria for particulate matter* *Table 12: Short term land acquisition criteria for particulate matter* *Table 13: Long term land acquisition criteria for deposited dust*  *Notes to Tables 11-13:* *a Total impact (i.e. incremental increase in concentrations due to the development plus*	In February 2019, a property to the west of Cadia (i.e. Eastburn) was subject to dust/particulate matter levels exceeding the Project Approval short term land acquisition criteria. As required, a valuation and offer for acquiring the land were made by Cadia. The property owners elected not to accept the offer and to consider a range of mitigation options which are currently being progressed in November 2020. Refer to Project Approval Schedule 4, Conditions 1 to 5. During the audit period, one landowner requested a replacement air quality monitor (i.e. a Dustrack unit may potentially be replaced by a TEOM in December 2020). It was stated that this request arose from a community meeting with the residents and has been recorded as a meeting action.	Due to an air quality exceedance, one offer was made by Cadia during the audit period for land acquisition, but the landowners did not accept the offer and it was not progressed.	**Compliant**	

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	background concentrations due to other sources); *b Incremental impact (i.e. incremental increase in concentrations due to the development on its own);* *c Deposited dust is to be assessed as insoluble solids as defined by Standards Australia, AS/NZS 3580.10.1:2003: Methods for Sampling and Analysis of Ambient Air - Determination of Particulate Matter - Deposited Matter - Gravimetric Method; and* *d Excludes extraordinary events such as bushfires, prescribed burning, dust storms, sea fog, fire incidents, illegal activities or any other activity agreed to by the Secretary.*				
19.	**AIR QUALITY** **Operating Conditions** The Proponent shall: (a) ensure any visible air pollution generated by the project is assessed regularly, and that operations are relocated, modified, and/or stopped as far as is reasonable and feasible to minimise air quality impacts on privately-owned land; (b) ensure that the real-time air quality monitoring and meteorological monitoring data are assessed regularly, and that operations are relocated, modified and/or stopped as required to ensure compliance with the relevant air quality criteria; and	Cadia was only partially able to demonstrate compliance with Project Approval Schedule 3, Condition 19 (a) to (c). In relation to each paragraph of this condition: (a) During the audit, Cadia was unable to demonstrate that it minimises fugitive dust emissions from ore processing (i.e. crushers, conveyors, ore stockpile etc). It is acknowledged that forms of dust control are in use and were observed to be either effective or partially effective in minimising the generation of fugitive dust. These controls include: • dust control via the application of hydromulching (by an	Cadia was only partially able to demonstrate compliance with Project Approval Schedule 3, Condition 19 (a) and (b). **Non-compliance No. 7 –** During the audit, Cadia was unable to demonstrate that it diligently controls and minimises fugitive dust emissions from ore processing (i.e. crushers, conveyors, ore stockpile etc). There was minimal evidence that: a) operators are reporting excessive dust; b) dust sprays and sprinklers are being used as required to minimise dust emissions; and c) the water sprayed/applied to conveyors and transfer points is sufficient for the volume of dry ore being handled (i.e. as a means of	**Non-compliant**	**NC7**

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	(c) implement all reasonable and feasible measures to minimise off-site odour and fume emissions generated by the project, to the satisfaction of the Secretary.	independent third-party contractor, Erizon) on the Northern Tailings Storage Facility, and dust suppression products (using Cadia's Panther to apply a combination of Erizons' Suppress X and Rainstorm Gluon RM600) on the Southern Tailings Storage Facility); **Photo No. 12 –** Hydromulched section of the Northern Tailings Storage Facility (NTSF) (9th November 2020)	minimising air quality impacts on privately-owned land). **Recommendation No. 7 –** See Recommendation No. 6 against Project Approval Schedule 3, Condition 17 – Air Quality – Impact Assessment Criteria. **Photo No. 18 –** Dust emissions observed from the CVO processing plant during the audit (12th November 2020)		

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		 Photo No. 13 – Surface of a section of the Northern Tailings Storage Facility (9th November 2020) **Photo No. 14 –** Close-up of the hydromulched surface of the Northern Tailings Storage Facility (9th November 2020)			

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		 Photo No. 15 – Erizons' Suppress X and Rainstorm Gluon RM600 product on the CVO Southern Tailings Storage Facility (9th November 2020) • the use of water trucks on unsealed roads within and around the ore processing plant; **Photo No. 16 –** Evidence of water trucks in use on roadways within the Ore Processing Facility (9th November 2020)			

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		• use of water trucks on haul roads; **Photo No. 17 –** Evidence of water trucks in use on CVO haul roads (9th November 2020) • progressive rehabilitation of inactive and completed sections of the northern and southern waste rock dumps; • the effective use of three of four baghouses within the process plant; and • partial, but potentially ineffective use of some dust sprays within the process plant. (b) Cadia was able to demonstrate that real-time air quality monitoring and meteorological monitoring data are collected and are assessed on a monthly frequency. These monthly			

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		reports are uploaded and made available on the Cadia website. (c) Minimal opportunities or sources exist at Cadia for the operation to generate off-site odour and/or fume emissions that would result in nuisance or harm to landowners. As a result, few controls or measures are required in this regard. In addition to the above, dust controls, mitigation measures and initiatives that were established during the audit period include: • offering rainwater tank cleans to several residents, • installation of some rainwater first flush systems for some landowners; • investigation into the potential use of a baghouse on CVO Crusher no. 2; • an understanding of the advantages of keeping ore stockpiles high; and • the completion of some air modelling and low volume sampling of vents (i.e. VR1 – VR4).			
20.	**AIR QUALITY** Air Quality Monitoring The Proponent shall prepare and implement a detailed Air Quality Monitoring Program for the project to the satisfaction of the Secretary. This program must:	Cadia's Air Monitoring Program (Revision 4) was last issued on the 11th June 2018. The review and approval of this Air Monitoring Program was completed by DPIE on the 21st December 2018.	Cadia was able to demonstrate that its Air Monitoring Program, issued on the 11th June 2018, meets the requirements of Project Approval Schedule 3, Condition 20 (a) and (b).	**Compliant**	

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	(a) be prepared in consultation with EPA, and be submitted to the Secretary for approval within 3 months of the date of this approval; and (b) include: • a combination of real-time monitors, high volume samplers and dust deposition gauges to monitor the dust emissions of the project; and • an air quality monitoring protocol for evaluating compliance with the relevant air quality impact assessment and land acquisition criteria in this approval.	Cadia's June 2018 Air Monitoring Program includes the following content required by this condition of the Project Approval: (a) be prepared in consultation with EPA, and be submitted to the Secretary for approval within 3 months of the date of this approval (Section 4); and (b) include: • a combination of real-time monitors, high volume samplers and dust deposition gauges to monitor the dust emissions of the project (Section 5); and • an air quality monitoring protocol for evaluating compliance with the relevant air quality impact assessment and land acquisition criteria in this approval (Section 5).			
21.	**METEOROLOGICAL MONITORING** During the life of the project, the Proponent shall ensure that there is a suitable meteorological station in the vicinity of the site that complies with the requirements in the *Approved Methods for Sampling of Air Pollutants in New South Wales* guideline.	Cadia utilises and maintains two meteorological stations that are located on the CVO site at: a) Ridgeway; and b) the Southern Lease Boundary.	Cadia was able to demonstrate that it operates, maintains and calibrates two meteorological stations on the CVO site that comply with the requirements of Project Approval Schedule 3, Condition 21.	**Compliant**	

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		 Photo No. 19 – Cadia Ridgeway meteorological station (11th November 2020) Both of Cadia's existing meteorological stations generate data for: a) rainfall; b) temperature; c) wind direction/ degrees; d) wind speed; and e) humidity. There was no evidence that Cadia determines and records evaporation data at either the Ridgeway or Southern Lease Boundary Meteorological Station. The nearest Bureau of Meteorology (BOM) meteorological station is located at Orange airport, a distance of 12 kms to the CVO site boundary. At the time of this audit, both of Cadia's meteorological stations were not linked (i.e. by telemetry) or displayed in real time. It was stated that the Cadia Control Room has access to the internal Cadia meteorological station page (i.e. for the			

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		determination of former and current conditions). Cadia provides monthly reports on its website that provide a summary display of the meteorological conditions for the previous month (i.e. for temperature, rainfall, wind direction and wind speed). Both meteorological stations utilised by Cadia are calibrated, serviced and maintained by technicians employed at ALS Hydrographics, based in Canberra. Cadia was able to demonstrate that both meteorological stations comply with the requirements in the *Approved Methods for Sampling of Air Pollutants in New South Wales* guideline.			
22.	**SOIL AND WATER** **Water Supply** The Proponent shall ensure that it has sufficient water for all stages of the project, and if necessary, adjust the scale of mining operations to match its licensed water entitlements, to the satisfaction of the Secretary. *Note: The Proponent is required to obtain all necessary water licences and approvals for the project under the Water Act 1912 and/or Water Management Act 2000.*	It was stated that sufficient water inventory was available during the audit period to maintain full production within both mining and ore processing. This included January 2020 (i.e. prior to the end of the drought), when current production rates were maintained. Water demand across the CVO site is based on and determined utilising the operation's GoldSIM water balance model, which is run at frequencies that range from monthly to quarterly. Cadia's GoldSIM model is operated and maintained by an external consultant,	Sufficient water inventory was available during the audit period to meet current production rates. Cadia regularly assesses and models its water availability and reliability to enable this condition to be met.	**Compliant**	

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		with Cadia responsible for managing the model inputs and scenarios.			
23.	**SOIL AND WATER** **Discharge Limits** The Proponent shall not discharge any water from the site except as may be expressly provided by an EPL, or in accordance with section 120 of the *Protection of the Environment Operations Act 1997*.	During the audit period, no off-site water discharges occurred from the CVO site. During the audit period, no exceedances occurred against discharge limits defined in Cadia's current EPL. It was stated that the discharge of any water from the CVO site would be contentious, as water in local streams is utilised by landowners for irrigation and stock and domestic purposes. CVO's sediment dams continue to be rated against EPL criteria (i.e. with individual sediment dams having different criteria). Specifically, relating to the existing discharge points across CVO: • CVO's sediment dam network (i.e. Points 1 and 3) was able to be effectively managed to ensure that it did not discharge during the audit period; • Point 19 – CVO's gauging weir below CVO's southern TSF collection pond (i.e. flows of approximately 0.1 ML/day at CAWS63, which is site EPL19). Cadia has operated this station since October 2017, which was recently incorporated into the EPL. Water	During the audit period, no off-site water discharges occurred from the CVO site and no exceedances occurred against discharge limits defined in Cadia's EPL.	**Compliant**	

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		quality within the collection pond was stated to be acceptable, with moderate salinity (i.e. this water is derived from groundwater via a natural seep). This monitoring site continues to be used to detect any potential decrease in water quality from the collection pond; • Since 1996 and 1998, Cadia has retained both a northern and southern leachate dam respectively, from which no discharges were incurred during the audit period. Both facilities are clay lined and installed for the life of mine. Both dams include a marker peg that displays the minimum freeboard requirements as defined in the EPL. These facilities are inspected and recorded within inspection logs by a CVO surface operation technician; • If required, any controlled discharges are required to be undertaken in accordance with the EPL conditions and the Cadia Stormwater Trigger Action Response Plan (TARP). CVO stores and maintains several mobile diesel pumps that can be deployed as and when needed. Under existing EPL conditions, it was stated that CVO's sediment dams are authorised to overflow under adverse weather conditions, but this requires water sampling/monitoring to occur. It			

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		was stated that this potentially occurred in 2012 but did not occur within the audit period.			
24.	**Compensatory Water Supplies** The Proponent shall provide compensatory water supplies to any landowner of privately-owned land whose water entitlements are impacted (other than an impact that is negligible) as a result of the project, in consultation with DPIE Water and to the satisfaction of the Secretary. The compensatory water supply measures must provide an alternative long-term supply of water that is equivalent to the loss attributed to the project. Equivalent water supply must be provided (at least on an interim basis) within 24 hours of the loss being identified. If the Proponent and the landowner cannot agree on the measures to be implemented, or there is a dispute about the implementation of these measures, then either party may refer the matter to the Secretary for resolution. If the Proponent is not able to provide an alternative long-term supply of water, the Proponent shall provide alternative compensation to the satisfaction of the Secretary, which may involve acquisition in accordance with the procedures in conditions 5-7 of schedule 4.	During the audit period, no landowners water entitlements were impacted and therefore no requests were received from landowners relating to provision of compensatory water supplies. As a result no compensatory water supplies were required to be provided to landholders during this audit period. It was stated that during the audit period, one landowner requested more information in relation to one ephemeral stream drying up during the 2019 drought. Cadia responded to this inquiry, which was stated as not being contested by the landowner. One compensatory water supply system agreement was signed prior to the audit period with one landowner on the 12th September 2017 (i.e. in relation to the installation of a bore pump at "Parkhaven").	During the audit period, no loss in water entitlements for private land was identified. No compensatory water supplies were required to be provided to any landowners during the audit period.	**Compliant**	

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	Notes: • *For the purposes of this condition:* - *privately-owned land means any privately-owned land with direct water dependency on Swallow Creek, Cadiangullong Creek, Rodds Creek, Flyers Creek or Diggers Creek/Panuara Rivulet, and any land within the maximum predicted 1 metre groundwater drawdown contour as indicated on the plans in Appendix 5, or any other privately-owned land as notified by the Secretary;* - *a water entitlement includes an accessible riparian water right or licensable quantity;* - *a water entitlement is considered to be impacted if the project results in a loss in pumping yield in bores or pumps, or impacts the quality of the water such that its use is materially affected. (These impact assessment criteria are required to be further quantified in the Site Water Management Plan – see conditions 30-35 below).* • *Compensatory water supplies may be achieved through provision of baseflow offsets within the applicable catchment (see condition 25 below), or through measures on privately-owned land such as lowering or duplicating pumps, deepening or replacing bores, and/or provision of interim water supplies.* • *The Proponent is not required to provide additional compensatory water supplies where such long-term compensation has already been provided under previous consents for the project.*				

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	• *In resolving any dispute under this condition, the Secretary will consult closely with DPIE Water.*				
25.	**SOIL AND WATER** **Baseflow Offsets** The Proponent shall offset the loss of baseflow to the Belubula River and associated creeks caused by the project, in consultation with DPIE Water, and to the satisfaction of the Secretary. The offsets shall be provided either incrementally or on one occasion: (a) prior to the baseflow loss being realised, or within 12 months of the date of this approval for any existing realised baseflow losses that have not previously been offset; and (b) within the catchments where the baseflow loss is realised, as far as is reasonable and feasible, unless otherwise approved by the Secretary. *Notes:* • *The offsets should be provided via the retirement of adequate water entitlements to account for the loss attributable to the project.* • *Relevant compensatory water supplies implemented under condition 24 may be subtracted from the offsets required under this condition.*	The Belubula River is a 200 km long tributary of the Lachlan River, with its headwaters located in the Blayney region. The CVO mine is located north of the Belubula River on Cadiangullong Creek, with Rodds Creek also flowing into Cadiangullong Creek. Rodds Creek is located downgradient of the mine site and is primarily fed by a small catchment, natural springs and water sourced from external sources. Cadia's water monitoring program requires periodic water samples to be collected on Rodds Creek, prior to its confluence with Cadiangullong Creek. During the audit period, Cadia and its consultant GHD, did not detect any issues relating to water quality in Rodds Creek. It was stated that Cadia is not required to complete any water quality monitoring in the Belubula River. It was stated that local landowners and Cadia purchase water from the Belubula River. Cadia owns 20% of the water entitlement within the Belubula River, with 80% of the entitlement owned by local irrigators and vineyards. Water entitlement/allocation trading occurred	During the audit period, Cadia was not required to offset any loss of baseflow. In addition, no formal requests were received from landowners for any water related compensation.	**Compliant**	

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	• *The Proponent is not required to provide additional baseflow offsets where such offsets have already been provided under previous consents for the project. These existing offsets are to be described and evaluated in the Surface and Ground Water Contingency Plan (see condition 35 below).*	during the audit period, with Cadia only purchasing water and not selling any of its allocated water entitlement. <u>Baseflow Offsets</u> Annual baseflow assessments were completed in associated creeks in 2019, but not within the Belubula River. Baseflow calculations were determined by personnel employed by ALS Water Resources Group – Monitoring and Technical Services (i.e. within the Hydstra program). The data was supplied by ALS and plotted by CVO Environment personnel within EQuIS (i.e. to enable this to be visually assessed). It was stated that the baseflow index varies due to natural fluctuations in climatic conditions. Information relating to CVO baseflows was provided in Section 7.6 of Cadia's FY20 AEMR. During the audit period, Cadia was not required to offset any loss of baseflow. In addition, no formal requests were received from landowners for any water related compensation. It was stated that a baseflow offset would only be required if a valid adverse environmental impact was detected or if a valid request for compensation was received from an affected landowner.			

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		It was stated that prior to the current audit period (i.e. in 2013-2015) an additional dam and bore were pre-emptively installed by Cadia to shore up water supplies on two neighbouring landowner properties.			
26.	**SOIL AND WATER** **Baseflow Offsets** At least 6 months prior to the cessation of mining operations, the Proponent shall demonstrate that it has made adequate provision to provide long-term offsets to account for the permanent baseflow loss caused by the project, in consultation with DPIE Water, and to the satisfaction of the Secretary. *Note: The long-term offsets may be provided via the retiring of adequate water entitlements to account for the permanent loss attributable to the project.*	Refer to the 'not triggered' audit finding for this condition.	**Not triggered –** This Project Approval Condition is not triggered, because as of November 2020, mining operations are predicted to continue until 30 June 2031 as approved in the Project Approval and the approved MOP.	**Not triggered**	
27.	**SOIL AND WATER** **Cadiangullong Creek Flows** The Proponent shall manage water releases from Cadiangullong Dam to provide: (a) flows of at least: • 3.4 ML/day, for periods when inflows into the dam are more than 3.4 ML/day and the water	As of the 12th November 2020, Cadia has set the volume of water release from Cadiangullong Dam into Cadiangullong Creek at 3,000 m^3/day (i.e. for required riparian releases/environmental flows). It was stated that the required flows within Cadiangullong Creek (i.e. those released from the dam) are dependent on the flows incurred within Oaky Creek flows.	Water inflows and outflows from Cadiangullong Dam are monitored to verify compliance with Project Approval Schedule 3, Condition 27. Results of monthly streamflow monitoring continues to be available on the Cadia website. **Non-compliance No. 8 –** On three occasions during the audit period, riparian releases/flows from Cadiangullong Dam did not comply with	**Non-compliant** **Observation**	**NC8**

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	level in the dam is at or above the lowest valve level on the multilevel offtake (ie. 773.0 metres AHD); • the volume equal to the inflow into the dam, for periods when inflows into the dam are between 0.4 and 3.4 ML/day and the water level in the dam is at or above the lowest valve level on the multi-level offtake; • 0.4 ML/day, for periods when inflows into the dam are less than 0.4 ML/day and the water level in the dam is at or above the lowest valve level on the multi-level offtake; • the volume equal to the inflow into the dam, up to 0.4ML/day, for periods when the water level in the dam is below the lowest valve level on the multi-level offtake and above the level of the scour valve (i.e. 762.8 metres AHD); and • zero, when the water level in the dam is below the level of the scour valve; and (b) releases of up to 4 medium flows (of the order of 12 to 15 ML/day) per year, each for a duration of 1 to 3 days, with timing and frequency of such flows	Flow readings at the Oaky Creek gauging station are checked daily by CVO environment personnel. An automated valve exists on the Cadiangullong Dam outflow, to allow personnel within the CVO Site Asset Operations Centre (i.e. Control Room) to make necessary adjustments to outflow volumes. Email confirmations are sent from the Control Room to verify that the necessary adjustment has been completed, enabling CVO environment personnel to check that requested adjustments were correctly completed. During the audit period, three non-compliances were reported to the DPIE regarding riparian release requirements from Cadiangullong Dam. These included: • 10th to 17th December 2017 – during this period, riparian flow releases, as measured at the Oaky Creek Gauging Station 12 km downstream, were below the required flow of 3.4 ML/day (i.e. resulting from a technical fault in the logic and control of the Cadiangullong Dam release valve); • 8th to 11th September 2018, riparian flow releases, as measured at the Oaky Creek Gauging Station, were below the required flow of 2.9 to 3.4 ML/day (required to match	the criteria and water release requirements defined in Project Approval Schedule 3, Condition 27 (a). **Recommendation No. 8 –** More diligent monitoring and provision of flow data is required to be demonstrated by Cadia to ensure that minimum flows within Oaky Creek downstream are maintained at all times. This could be achieved by revising the method of measuring and determining compliance to reduce the effects of the variables that can impact on meeting this condition. **Observation No. 22 –** In its 2017/18 AEMR (i.e. Section 11.3 – Notifications) Cadia did not include and report the three non-compliances from December 2017, September 2018 and November 2018 relating to minimum flows required to be maintained at the Oaky Creek gauging station.		

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	determined by hydrographs of typical medium flows, to the satisfaction of, and unless otherwise approved by, DPIE Water.	Cadiangullong Dam inflows at Forestry Gauging Station). This resulted from an unusual rainfall spatial distribution in the Cadiangullong Creek catchment following rainfall on the 6th and 7th September 2018; • On 28th November 2018, the averaged downstream flow, as measured at the Oaky Creek Gauging Station was 3.00 ML/day, which was 0.12 ML/day lower than the calculated required flow of 3.12 ML/day. This resulted from insufficient release of water prior to the rainfall event of 28th – 29th November, combined with lower than expected rainfall runoff from the catchments between Cadiangullong Dam and Oaky Creek gauging station. The above three events were reported in writing to the DPIE as non-compliances within required reporting timeframes and records of these have been retained. It was stated that these water management/processes are unable to be automated as too many variables exist that are outside of Cadia's control including spatial rainfall distribution. It was stated that a period of between 1.5 – 2.5 days exists between a discharge from Cadiangullong Dam to when that			

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		discharge reaches the Oaky Creek gauging station. It was stated that Cadia is reviewing the management of riparian releases and will apply to the DPIE-Water via the next revision of the WMP to manage riparian release using a 10-day rolling average rather than 7-day. This will provide greater operational flexibility and prevent reoccurrence of two of the reported non-compliances, while still meeting the intent of the Condition to maintain riparian habitat.			
28.	**SOIL AND WATER** The Proponent shall not extract any water from Cadiangullong Dam when the volume in the dam drops to 10 percent or less of its total capacity (i.e. 778.8 metres AHD), unless otherwise approved by DPIE Water. Flow releases (see condition 27 above) shall be continued during any such period, except when the level of water in the dam drops below the level of the dam's scour valve (i.e. 762.8 metres AHD).	Cadia received a show-cause letter from the DPIE on the 29th January 2020 for extracting water and reducing the volume/height of Cadiangullong Dam to less that the "internal" 12% depth defined in its approved Water Management Plan. As a result of this, Cadia received an Official Caution from the DPIE on the 28th February 2020. Specifically, the above involved Cadia reducing water levels in the dam below its internal limit of 12% capacity, but not below the 10% capacity limit (i.e. 420 ML) defined in Project Approval Schedule 3, Condition 28. To prevent a non-compliance against this condition, it was stated that the pipeline was physically isolated as instructed by Cadia's Environment Department to	On one occasion during the audit period, Cadia reduced water levels in Cadiangullong Dam below the 12% level defined in CVO's Water Management Plan. Water levels remained above the 10% limit (i.e. 420 ML) defined in Project Approval Schedule 3, Condition 28, by physically isolating the pipeline valve. **Observation No. 23 –** For due diligence, records relating to the physical isolation of the Cadiangullong Dam valve should be retained by CVO Environment Department personnel. This would potentially involve requesting and receiving a written verification that the valve is located, supported by a photo of the locked valve from SAOC (and potentially the key lock). In addition, Cadia could	**Compliant** **Observation** **Observation**	

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		ensure that dam levels did not fall below 10% capacity. It was stated that Cadia plans to remove the internally assigned minimum 12% capacity level defined within its Water Management Plan. In addition, in 2021 Cadia plans to make relevant adjustments within its water management TARPs and Water Management Plan to increase the freeboard within the dam as a means of capturing and retaining additional water from flood events within the dam (i.e. by maintaining water levels in the dam lower than in previous years). Former and current practices involve utilising the dam as water storage (i.e. retain high water levels) with the revised approach focusing on reducing water levels in the dam to facilitate water harvesting during wet weather. It was acknowledged by relevant Cadia personnel that the revised Cadia Water Management Plan will require approval by the DPIE.	confirm which employee retains the key lock and where the lock should reside. **Observation No. 24 –** Cadia could consider ensuring the Cadiangullong Dam level sensor (when connected to the control centre) is alarmed at an appropriate level above the regulatory level enabled with automatic notification.		

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		 Photo No. 20 – Cadiangullong Dam (11th November 2020) **Photo No. 21 –** Cadiangullong Dam Wall (11th November 2020)			

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		Photo No. 22 – Controlled discharge from the Cadiangullong Dam (11th November 2020)			
29.	**SOIL AND WATER** **Flyers Creek Flows** The Proponent shall ensure that natural environmental flows of up to 3.5 ML/day into Flyers Creek weir are allowed to pass uninterrupted downstream, and any approved water extraction is limited to medium and high flows, to the satisfaction of DPIE Water.	This condition of the Project Approval was stated to be based on local landowners' right to access water from Flyers Creek. The Flyers Creek weir is located within a forestry land-use area to the east of the CVO mine. The catchment of Flyers Creek does not drain into any active mine area. The Flyer Creek weir is fitted with a pump, which was stated to have been in use for >10 years.	During the audit period, Cadia was able to demonstrate that the extraction of water from Flyers Creek weir occurred in compliance with the requirements of Project Approval Schedule 3, Condition 29.	**Compliant**	

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		 Photo No. 23 – Flyers Creek pumping station (10th November 2020) **Photo No. 24 –** Flyers Creek weir (10th November 2020) Cadia is authorised to pump between 4,200 and 8,400 ML/annum of water from Flyers Creek and other sources. It was stated that water is extracted from this creek if: a) water is available within Flyers Creek during medium to high			

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		flows; b) Cadia remains below the annual cap of 4,200 ML; and c) available storage exists within mine water storage facilities (i.e. primarily to Rodds Creek Dam via a 2km pipeline). A flow meter exists at Flyers Creek weir to record the total extraction volume. **Photo No. 25 –** Rodds Creek Dam (9th November 2020) It was stated that Cadia pumps from Flyers Creek weir at a rate of 11.2 ML/day (i.e. this is the pump rating, which is fixed and is also automated with the flow downstream to allow for pumping to only occur when flows are >3.5 ML/day). Cadia maintains a downstream flow meter located 1.2 km from the Flyers Creek weir pump station to measure and record the required 3.5 ML/day environment flow that needs to be maintained.			

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		Water extraction volumes are published monthly on Cadia's website within the Cadia monthly water report. A sample of 2019/2020 CVO Streamflow Monitoring Reports was sighted. The flowmeters utilised on Flyers Creek are calibrated by relevant personnel from CVO's Maintenance Department. It was stated that a new metering policy (i.e. the NSW non-urban water metering framework) is being implemented by the DPIE which will require that all flow meters be calibrated at 5-yearly intervals. To comply with these requirements Cadia is developing a project charter for implementation between June 2021 to December 2021. The new DPIE metering policy relates to: a) the type of flow meter used; b) logging and telemetry systems to the DPIE; c) requirements for flow meters to be installed by a certified technician; and d) calibration of flow meters by a certified technician at 5-yearly intervals. It was stated that Cadia may not need to replace existing flow meters, but these will need to be certified.			
30.	**SOIL AND WATER** **Site Water Management Plan** The Proponent shall prepare and implement a Water Management Plan for	As of November 2020, Cadia's Water Management Plan (Doc No. 710-005-EN-PLA-0004 – Version 7) that was last issued on the 26th November 2019 is under review. It was stated that the updated version of the plan will be ready	Cadia was able to demonstrate that its November 2019 version of the Water Management Plan includes the relevant requirements defined in Project	**Compliant**	

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	the project to the satisfaction of the Secretary. This plan must: (a) be prepared in consultation with DPIE Water and EPA, and be submitted to the Secretary for approval within 6 months of the date of this approval; and (b) include a: • Site Water Balance; • Erosion and Sediment Control Plan; • Surface Water Monitoring Program; • Groundwater Monitoring Program; and • Surface and Ground Water Contingency Plan.	for DPIE and NSW EPA review and approval in early 2021. The November 2019 version of Cadia's Water Management Plan was formally approved by the DPIE on the 26th November 2019. The November 2019 version of the plan is available for viewing and download on the Cadia website. It was stated that Cadia is progressing the development of a separate Operational Water Management Plan to define specific requirements not included in the November 2019 Water Management Plan. On the 28th February 2020, the DPIE issued Cadia with an Official Caution for not meeting an internal operational requirement/criterion specified within the Water Management Plan (refer to evidence collected for Project Approval Schedule 3, Condition 28 in this audit report). It was stated that specific operational requirements are likely to be included within the forthcoming Cadia Operational Water Management Plan, and to limit the DPIE approved Water Management Plan to compliance requirements only. The November 2019 version of Cadia's Water Management Plan includes the	Approval Schedule 3, Condition 30 (a) and (b). Overall, with some minor exceptions relating to TARPs defined in Section 7.0 – Surface and Ground Water Contingency Plan, Cadia was able to demonstrate that it has implemented most of the requirements defined in its November 2019 Water Management Plan.		

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		following requirements defined in Project Approval Schedule 3, Condition 30: • Site Water Balance (Section 3.0); • Erosion and Sediment Control Plan (Section 4.0); • Surface Water Monitoring Program (Section 5.0); • Groundwater Monitoring Program (Section 6.0); and • Surface and Ground Water Contingency Plan (Section 7.0).			
31.	**SOIL AND WATER** The Site Water Balance must: (a) include details of: • sources and security of water supply; • water use on site; • water management on site; • any off-site water transfers; • reporting procedures; and (b) investigate and implement all reasonable and feasible measures to minimise water use by the project.	Requirements specific to Cadia's Site Water Balance have been included within the November 2019 Water Management Plan (Section 3.0). The requirements of this condition are defined in the following sections of this plan. • sources and security of water supply (Sections 3.2, 3.3 and 7.3); • water use on site (Section 3.4); • water management on site (Section 2.0); • any off-site water transfers (Section 2.3.1); • reporting procedures (Sections 5.3 and 9.0); and • investigate and implement all reasonable and feasible measures to minimise water use by the project (Sections 3.4 and 3.5).	Cadia was able to demonstrate that the relevant requirements specific to Cadia's Site Water Balance (as required under Project Approval Schedule 3, Condition 31 (a) and (b)) were included within Section 3 of the November 2019 Water Management Plan. **Observation No. 25 –** Whilst it is acknowledged that Cadia's November 2019 Water Management Plan is of high quality, considerable differences in content and structure exist between this plan and for example, the May 2019 Cadia Dust Management Plan. Cadia would benefit by increasing the consistency in structure and content across its environmental management plans (i.e. inclusive of defining all existing environmental controls and potentially, planned future controls). If	**Compliant** **Observation**	

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		It was stated that water related metrics and reporting requirements utilised by Cadia are guided by the 2014 Australian Minerals Council Water Accounting Framework, and Cadia's water balance is reported against these requirements (i.e. as defined in Cadia's AEMR). During the audit period, Cadia continued to utilise GoldSIM to formally track water transfers, inventory, storage and use tracking on a fortnightly frequency. Cadia utilises GoldSIM for annual water forecasting and water accounting/ reporting requirements. Data tracked in GoldSIM is also utilised to estimate related requirements within the site water balance model to enable reporting in accordance with 2014 Australian Minerals Council Water Accounting Framework. It was stated that these requirements will be included in Cadia's planned Operational Water Management Plan by December 2021. It was stated that Cadia's site water balance model assisted the operation in managing water inventories during the 2019 drought (i.e. enabling improved water efficiency and reuse measures to be implemented) and will assist the operation in future periods of low rainfall (i.e. as there is a history of drought in the region).	future controls are unsuitable to be defined within individual environmental management plans, then formal annual Environmental Improvement Plans could be developed, disseminated to operational departments and implemented (i.e. defining how improvements will be formally implemented and potentially administered within CHESS).		

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		To assist in the planning and implementation of programs to minimise water use, Cadia is progressing the development of a Site Water Efficiency Management Plan (draft) which is expected to be issued internally in January 2021. To effectively schedule and administer water transfer and efficiency across the operation, Cadia maintains and utilises a water committee that meets at weekly or fortnightly intervals, with minuted meetings.			
32.	**SOIL AND WATER** The Erosion and Sediment Control Plan must: (a) be consistent with the requirements of *Managing Urban Stormwater: Soils and Construction, Volume 1, 4th Edition, 2004* (Landcom); (b) identify activities that could cause soil erosion and generate sediment; (c) describe measures to minimise soil erosion and the potential for the transport of sediment to downstream waters; (d) describe the location, function, and capacity of erosion and sediment control structures; and	Cadia's current November 2019 Water Management Plan (Section 4) includes the operation's requirements that are applicable to erosion and sediment control. The above is also supported by Cadia's Sediment Control TARP. It is acknowledged that Cadia is obliged to manage erosion and sediment control on site in accordance with EPL5590 (Operating Condition O4). Cadia's November 2019 Water Management Plan (Section 4) includes the following content applicable to Project Approval Schedule 3, Condition 32 (a) to (e): (a) be consistent with the requirements of *Managing Urban Stormwater: Soils and Construction, Volume 1,*	Generally, Cadia was able to demonstrate that its November 2019 Water Management Plan, incorporating the operation's Erosion and Sediment Control Plan, complies with the requirements of Project Approval, Schedule 3, Condition 32 (a) to (d). **Observation No. 26 –** Whilst Cadia's November 2019 Water Management Plan references the NSW Government's guidelines for *Managing Urban Stormwater: Soils and Construction, Volume 1, 4th Edition, 2004* (Landcom), Cadia has not defined how its Erosion and Sediment Control Plan aligns with requirements defined in the 2004 NSW Government Guidelines (i.e. as a table in the plan).	**Compliant** **Observation**	

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	(e) describe what measures would be implemented to maintain the structures over time.	*4th Edition, 2004* (Landcom) (referenced, but not defined); (b) identify activities that could cause soil erosion and generate sediment (Section 4); (c) describe measures to minimise soil erosion and the potential for the transport of sediment to downstream waters (Section 4); (d) describe the location, function, and capacity of erosion and sediment control structures (Section 4, Table 4.1 and Appendix C); and (e) describe what measures would be implemented to maintain the structures over time (Section 4). <u>Management of CVO Sediment Dams</u> The required removal of silt from within CVO's sediment dams is determined by the level of silt against a marker peg within each dam. If nearly reached, this defines that sediment within the dam requires removal. Sediment levels are assessed annually in June via a visual inspection. It was stated that the main runoff pond was desilted in the 12 months to November 2020. Material that is removed is deposited within the PAF cell of the South Waste Rock Dump. Generally, large quantities of suspended solids did not enter CVO's sediment			

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		dams during the audit period. It was stated that all sediment dams are clay lined and were designed with excess capacity. It was stated that all sediment dams have a spillway. It was stated that some sediment dams have electric pumps, some have permanent diesel pumps, and the remainder have infrastructure to place a mobile diesel pump as needed. Cadia employs an individual designated to CVO's TSF/Sediment Dams, that also retains responsibility for CVO's leachate dams and site runoff pond. Neither the leachate dams nor site runoff pond are classified as a prescribed structure (i.e. a declared dam under the NSW Dams Safety Act 2015). As a result of the presence and use of CVO's sediment dams, the CVO site does not contribute any significant sediment loads to local receiving waters. CVO's Oaky Creek gauging station (located in Cadiangullong Creek downstream of all mine area sub-catchments) is required to achieve a TSS concentration of <50 mg/L (i.e. this is a site-specific internal guideline value). Water quality at this location is sampled monthly, inclusive of TSS (i.e. with the baseline TSS of this creek well understood).			

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		It is acknowledged that the upstream site for Oaky Creek recorded a TSS result of 154 mg/L on the 22nd January 2019. The investigation identified that the monitoring event occurred the day after a high intensity rainfall event, so the elevated TSS concentration was associated with residual sediment in the creek.			
33.	**SOIL AND WATER** The Surface Water Monitoring Program must include: (a) detailed baseline data, based on sound statistical analysis, to benchmark the pre-mining natural variation in surface water flows and quality in creeks and other waterbodies that could potentially be affected by the project; (b) surface water and stream health impact assessment criteria; (c) a program to monitor and assess: • impacts on surface water flows and quality; • impacts on water users; • stream health conditions in Swallow Creek, Cadiangullong Creek, Rodds Creek, Flyers Creek and Diggers Creek, including riparian vegetation;	Cadia was able to demonstrate that it maintains a suitable surface water monitoring program to ensure that any actual or potential adverse impacts on the receiving environment can be detected at an early stage. The Cadia East operation continues to operate as a no mine-affected water release site (i.e. mine-affected water on site is retained and reused to prevent off-site discharges of mine-affected water). During the audit period, Cadia was able to demonstrate that its surface water monitoring program (as described in Section 5 of the current November 2019 Water Management Plan) incorporates the following: (a) detailed baseline data, based on sound statistical analysis, to benchmark the pre-mining natural variation in surface water flows and quality in creeks and other waterbodies that could potentially be	During the audit period, Cadia was able to demonstrate that it maintains a suitable surface water monitoring program. Some opportunities for improvement were identified during this audit that are listed below and within other relevant sections of this audit report. **Observation No. 27 –** CVO's Environmental Monitoring Manual describes monitoring and sampling requirements inclusive of surface water and groundwater. This Manual was last revised and issued in 2016 and requires review and updating in the next 12 months to ensure it reflects leading practice and standardised industry practices in surface and groundwater monitoring (e.g. June 2018 Queensland DES Monitoring and Sampling Manual). **Observation No. 28 –** To improve CVO's existing quality control program, the number of monthly QA/QC samples collected for surface and groundwater	**Compliant** **Observation** **Observation** **Observation** **Observation** **Observation** **Observation**	

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	• potential acid rock drainage; • potential leakage or spillage from tailings, mineral concentrate and effluent pipelines; (d) a program for the ongoing verification and refinement of the surface water model; and (e) reporting procedures for the results of the monitoring program and model verification.	affected by the project (Section 5.1 and the original Cadia East EA); (b) surface water and stream health impact assessment criteria (Section 5.2); (c) a program to monitor and assess (Section 5.3): • impacts on surface water flows and quality; • impacts on water users; • stream health conditions in Swallow Creek, Cadiangullong Creek, Rodds Creek, Flyers Creek and Diggers Creek, including riparian vegetation; • potential acid rock drainage; • potential leakage or spillage from tailings, mineral concentrate and effluent pipelines; (d) a program for the ongoing verification and refinement of the surface water model (Section 3.1); and (e) reporting procedures for the results of the monitoring program and model verification (Section 9). To support the above, Cadia maintains an Environmental Monitoring Manual	monitoring would be expected to be 5-8% of the total number of samples collected (i.e. comprising blank, duplicate and potentially spiked samples). **Observation No. 29 –** CVO is encouraged to schedule and complete an environmental monitoring audit to ensure that: a) environmental monitoring is conducted against leading and standardised industry practice prior to the final reissue of CVO's 2016 Environmental Monitoring Manual; and b) to ensure that monitoring personnel are suitably trained and competent. **Observation No. 30 –** QC samples, including blank and duplicate samples must not be identifiable/disclosed to the ALS laboratory (i.e. these samples must be submitted as blind samples to ALS). **Observation No. 31 –** Section 9 of Cadia's November 2019 Water Management Plan currently lists a range of reports relating to water management, but would be expected to more effectively describe requirements applicable to Project Approval Schedule 3, Condition 33 (e) relating to reporting procedures for the results of the monitoring program and model verification.		

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		(105 pages) that was last revised and issued in 2016. It was stated that a Cadia employee has been internally transferred to commence in early 2021 as CVO's Environmental Monitoring Technician. It was stated that during the audit period, Cadia's existing QA/QC program for surface and groundwater sampling involves the collection of four QA/QC samples per month (i.e. two surface water and two groundwater samples per month). Based on the total number of monthly samples collected, this is equivalent to 3%, which is below normal industry standards. During the audit period, there was no evidence that Cadia has conducted a formal internal or external independent environmental monitoring audit to ensure that: a) environmental monitoring is conducted against leading and standardised industry practice prior to review, update and reissue of Cadia's 2016 Environmental Monitoring Manual; and b) to ensure that monitoring personnel are suitably trained and competent. For the past 14 years, at six-monthly intervals, the health of downstream receiving waters has been assessed (i.e. via aquatic ecology surveys conducted by external consultant, GHD).	**Observation No. 32 –** Relevant sections of Cadia's November 2019 Water Management Plan will require review and updating to describe the additional water management practices and containment structures in progress at the CVO Dewatering Facility. **Photo No. 26 –** CVO Dewatering Facility Stormwater/Storage Dams (10^{th} November 2020)		

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		Cadia does not monitor the volumes or water quality within natural springs in the vicinity of the operation. Water entering the Cadia open pit is determined by Cadia's site water balance. A flow meter exists to determine the volume of mine dewatering. Finally, Cadia operates several gauging stations around the Cadia East mining operations to determine upstream and downstream flows within receiving waters. The equipment and instrumentation within these stations are maintained under contract by ALS Hydrographics (i.e. inclusive of equipment calibration and maintenance, stream gauging, operation and maintenance of a web-portal and the servicing and maintenance of CVO's meteorological stations).			
34.	**SOIL AND WATER** The Groundwater Monitoring Program must include: (a) detailed baseline data, based on sound statistical analysis, to benchmark the pre-mining natural variation in groundwater levels, yield and quality (including privately-owned bores within the maximum predicted 1 metre groundwater drawdown contour, as indicated on the plans in Appendix 5);	Cadia's current November 2019 Water Management Plan (Section 6) includes the operation's requirements applicable to CVO's Groundwater Monitoring Program. As required by Project Approval Schedule 3, Condition 34, Cadia's Groundwater Monitoring Program includes: (a) detailed baseline data, based on sound statistical analysis, to benchmark the pre-mining natural variation in groundwater levels, yield	With the one minor exception described below, Cadia was able to demonstrate that its November 2019 Water Management Plan (Section 6) includes most of the operation's requirements applicable to Cadia's Groundwater Monitoring Program, as required by Project Approval Schedule 3, Condition 34 (a) to (e). **Observation No. 33 –** As required by Project Approval Schedule 3, Condition 34 (c), Cadia's November 2019 Water Management Plan could	**Compliant** **Observation**	

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	(b) groundwater impact assessment criteria (including for monitoring bores and privately-owned bores); (c) a program to monitor: • impacts on the groundwater supply of potentially affected landowners; • impacts on springs and groundwater dependent ecosystems; • the volume of groundwater seeping into open pit and underground mine workings; • regional groundwater levels and quality in all potentially affected aquifers; • potential acid rock drainage; • the hydraulic gradient and groundwater quality around the base of the Cadia Hill pit; (d) a program for the ongoing verification and refinement of the groundwater model; and (e) reporting procedures for the results of the monitoring program and model verification.	and quality (including privately-owned bores within the maximum predicted 1 metre groundwater drawdown contour, as indicated on the plans in Appendix 5) (Section 6.1 and Appendix H); (b) groundwater impact assessment criteria (including for monitoring bores and privately-owned bores) (Section 6.2); (c) a program to monitor (Section 6.3): • impacts on the groundwater supply of potentially affected landowners (Section 6.2); • impacts on springs and groundwater dependent ecosystems (Section 6.3.3); • the volume of groundwater seeping into open pit and underground mine workings (Section 6.3.2 and Table 6.9); • regional groundwater levels and quality in all potentially affected aquifers (Section 6.3); • potential acid rock drainage (not included); • the hydraulic gradient and groundwater quality around the base of the Cadia Hill pit (Section 6.3.2 and Tables 6.8 and 6.9);	more effectively define and include details of the operation's monitoring program to assess the potential for acid rock drainage (i.e. acknowledging that it is based on the monitoring of water quality within the NLD and SLD leachate dams).		

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		(d) a program for the ongoing verification and refinement of the groundwater model (Section 6.4); and (e) reporting procedures for the results of the monitoring program and model verification (Sections 6.4 and 6.6). <u>Groundwater Monitoring and Management</u> The NSW EPA stated in its 8th October 2020 stakeholder communication that "dust emissions and groundwater quality impacts remain the key issues of concern for the EPA for this premises". The most recent issue of the EPL (11th June 2020) required some additional monitoring stations in the vicinity of the southern tailings dam (i.e. Nos. 23 to 37 monitoring points that relate to surface and groundwater monitoring points). It was stated that the these were pre-existing monitoring locations that were incorporated into the EPL in June 2020 (i.e. mandating the monitoring to be completed for an addition 5 groundwater bores and 3 surface water monitoring sites). Monthly samples are collected at these locations and reported monthly, with availability on the Cadia website. It was stated that these additional monitoring sites were added to assess any adverse seepage from the southern			

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		TSF (i.e. into Rodds Creek). Seepage collection occurs from the southern TSF within the ST14 pond (i.e. CAWS31) and is pumped to the process water pond. This pond (ST14) is fed by a spring, with limited evidence of seepage from the southern TSF to date (i.e. with the exception of increased detectable molybdenum concentrations in 2019/2020, which does not currently pose a further risk to downstream receiving waters) as identified by external consultant, GHD within its September 2020 CVO AEMR – Surface and Groundwater Assessment Report. 			

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		 Photos No. 27 & 28 – ST14 pond below the southern TSF (9th November 2020) This report was forwarded to the NSW EPA with the annual submission of Cadia's 2019/20 AEMR on the 27th October 2020. Cadia is also obliged to report water quality results for CAWS63 (EPL Point 19) and MB27 (EPL Point 23) against compliance criteria at monthly intervals. CAWS55 is the next downstream water monitoring location. Within these annual assessment reports during the audit period, GHD has not detected any adverse environmental impacts at these locations. <u>Groundwater Monitoring</u> Cadia's existing groundwater monitoring program involves the determination of groundwater level and groundwater			

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		sampling of approximately 50 groundwater bores at monthly intervals. Additional groundwater samples are collected at quarterly intervals for internal requirements. It was stated that as recommended by external consultant AGE, an additional six monitoring bores are scheduled to be installed in late 2020 around the south western side of the Cadia open pit (i.e. between the Cadiangullong Creek diversion and the access road) to observe any potential impacts from higher elevation fractures in the Cadia Hill open cut pit (i.e. as the level of tailings rises). It was stated that these bores will be drilled to variable depths between 10 m to 100 m. Once commissioned, these monitoring bores will be sampled monthly to establish a baseline and will continue to be monitored for the life of the operation.			

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		 Photo No. 29 – Location of higher elevation fractures in the Cadia Hill open cut Pit (11th November 2020) The above is scheduled to be included within the next revision of Cadia's Water Management Plan, requiring approval by the DPIE. During the audit period, Cadia was able to demonstrate that the water quality within 10 landowner bores is sampled and analysed at quarterly intervals. From 2010 to 2020, potential groundwater drawdown has been modelled at three yearly intervals by external consultant AGE. The most recent September 2020 CVO AEMR – Surface and Groundwater Assessment Report did not identify any drawdown of groundwater within any neighbouring landowner properties			

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		(i.e. at levels greater than the 3 m drawdown guideline), inclusive of the closest landowner at Parkhaven.			
35.	**SOIL AND WATER** The Surface and Ground Water Contingency Plan must include: (a) a protocol for the investigation, notification and mitigation of any exceedances of the surface water, stream health and groundwater impact assessment criteria; (b) a procedure for investigating monitoring and minimising leakage from the Cadia Hill open cut pit towards Cadiangullong creek; (c) measures to mitigate and/or compensate potentially affected landowners in accordance with the compensatory water supply requirements in condition 24 above; (d) a protocol for providing advance warning and water supply measures for landowners of privately owned land that are predicted to exceed the surface or ground water impact assessment criteria at some stage during the project life; (e) a protocol for investigating, evaluating and providing the baseflow offsets required under condition 25 above, including a detailed evaluation (in the	Cadia's Surface and Ground Water Contingency Plans are primarily described as Trigger Action Response Plans (TARPs) and other related content within Section 7.0 of Cadia's November 2019 Water Management Plan. A total of six TARPs are defined within this plan, inclusive of: 1. TARP for Cadiangullong Dam; 2. TARP for Rodds Creek Dam; 3. TARP for Tailings Storage Facilities; 4. TARP for Surface and Groundwater quality; 5. TARP for Surface water flow/ extraction; and 6. TARP for Groundwater extraction. It was stated that Cadia expects some of the above TARPs will require review and update prior to the next issue of the Cadia Water Management Plan. Section 7.0 of Cadia's November 2019 Water Management Plan includes the following requirements: (a) a protocol for the investigation, notification and mitigation of any exceedances of the surface water, stream health and groundwater	Cadia's Surface and Ground Water Contingency Plans are primarily described as Trigger Action Response Plans (TARPs) and other related content within Section 7.0 of Cadia's November 2019 Water Management Plan meet the requirements of Project Approval Schedule 3, Condition 35 (a) to (f).	**Compliant**	

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	initial plan) of offsets provided under previous consents for the project; and (f) the procedures that would be followed if any significant unforeseen impacts on surface or ground water are detected during the project.	impact assessment criteria (Section 7.2); (b) a procedure for investigating monitoring and minimising leakage from the Cadia Hill open cut pit towards Cadiangullong creek (Section 7.2); (c) measures to mitigate and/or compensate potentially affected landowners in accordance with the compensatory water supply requirements in condition 24 above (Section 7.4); (d) a protocol for providing advance warning and water supply measures for landowners of privately owned land that are predicted to exceed the surface or ground water impact assessment criteria at some stage during the project life (Section 7.2 and Table 7.4); (e) a protocol for investigating, evaluating and providing the baseflow offsets required under condition 25 above, including a detailed evaluation (in the initial plan) of offsets provided under previous consents for the project (Section 7.3); and (f) the procedures that would be followed if any significant unforeseen impacts on surface or ground water are detected during the project (Section 7.4).			

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		It was stated that currently, determination of water levels within the Cadiangullong Dam requires a manual check by Cadia operators, but telemetry is expected to be installed and alarmed in the near future (i.e. inclusive of an internal alarm which is activated when compliance level limits are approached). It was stated that during the audit period, some water related concerns have been expressed by local landowners, but none of these are known to have submitted a formal/valid complaint.			
36.	**REHABILITATION AND BIODIVERSITY OFFSETS** **Rehabilitation** By the end of 2010, the Proponent shall prepare a Rehabilitation Strategy for the project to the satisfaction of the Secretary. This strategy must: (a) be prepared by a team of suitably qualified and experienced experts whose appointment has been endorsed by the Secretary; (b) be prepared in consultation with relevant stakeholders, including the RR, DRG, BCD, DPIE Water, Councils and the CCC;	The date of this condition predates this audit period however, previous IEAs verified that the Rehabilitation Strategy was prepared and submitted by the end of 2010 (17/12/10). The latest revision of the Rehabilitation Strategy (Rev 3; 12/06/2020) and an approval letter from the Secretary dated 25/06/2020 confirming satisfaction with the Rehabilitation Strategy was sighted. The Secretary also noted that consultation on this version of the Rehabilitation Strategy had only been undertaken with the Environment Protection Authority and Blayney Shire Council, specific to the BDF and agreed with this consultation approach. In relation to paragraphs (a) to (f) of this condition:	Evidence collected during this audit indicates that Cadia was compliant with this condition during the audit period. **Observation No. 34 –** Cadia could consider requesting the Secretary to correct the text colour of Project Approval Schedule 3, Condition 36 (e) in any future modification of the Project Approval, as this condition was not changed as part of Modification 13 as shown. **Observation No. 35 –** Notwithstanding the above DPIE consultation agreement, there is no evidence that Cadia consulted with the CCC in the review of the Rehabilitation Strategy as per the commitment stated in Section 11.2 of the strategy (in addition, the summary of comments received in Table 11-1 appears to be from previous	**Compliant** **Observation** **Observation** **Observation** **Observation** **Observation** **Observation**	

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	(c) investigate options for the future use of disturbed areas including voids upon the completion of mining; (d) describe and justify the proposed rehabilitation strategy for the site, including the post-mining landform and use; (e) define the rehabilitation objectives for the site, as well as the proposed completion criteria for this rehabilitation; and (f) be prepared in accordance with any relevant RR guideline. *Note: The strategy should build on the concept strategy depicted in Appendix 6.*	(a) Section 5.2 states that the strategy and commitments have been developed by an approved panel (approved by NSW DoPI 28/10/2010); (b) the Secretary noted (letter dated 26/06/2020) that consultation on this version of the Rehabilitation Strategy had only been undertaken with the Environment Protection Authority and Blayney Shire Council, specific to the BDF and agreed with this consultation approach; (c) Section 5.2 discusses options for future use of disturbed areas and section 9 specifically discusses options for the voids; (d) Section 5.2 of the strategy describes the proposed rehabilitation strategy for the site; (e) a broad statement of rehabilitation objectives is described in Section 5.1 and is further defined in Table 5-1 (commitments) including completion criteria (performance indicators); and (f) Cadia was not aware of any relevant RR guidelines.	revisions/original version of the strategy). Cadia should review this aspect of the strategy. **Observation No. 36 –** Cadia could consider requesting the Secretary to revise Project Approval Schedule 3, Condition 36 (b) in any future modification to the Project Approval in consideration of the Resource Regulator's response in that they will not comment on revisions of the Rehabilitation Strategy. **Observation No. 37 –** In future revisions of the Rehabilitation Strategy, Cadia should consider amending the review of strategy requirements (Section 11.1) of the Rehabilitation Strategy to refer to the requirement of Project Approval Schedule 5, Condition 3. **Observation No. 38 –** Notwithstanding the absence of relevant RR guidelines for preparation of the Rehabilitation Strategy, Cadia should consider ensuring that figures in the strategy are consistent with the latest ESG3 Mining Operations Plan (MOP) Guidelines (see Rehabilitation Phases Table 8, section 11.4 and example Plans 3A - 3E). **Observation No. 39 –** In future revisions of the Rehabilitation Strategy, Cadia should include the note of this		

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			condition (*Note: The strategy should build on the concept strategy depicted in Appendix 6)* in Table 4-1 of the strategy.		
37.	**REHABILITATION AND BIODIVERSITY OFFSETS** The Proponent shall: (a) carry out rehabilitation progressively, that is, as soon as reasonably practicable following disturbance; and (b) achieve the rehabilitation objectives in the Rehabilitation Strategy (see condition 36), to the satisfaction of the RR.	Rehabilitation Monitoring Reports (DnA Environmental May 2018; 2019; 2020). In relation to paragraphs (a) and (b) of this condition: (a) Cadia was able to provide evidence that rehabilitation is being carried out progressively which was verified by site inspection. Mine site rehabilitation undertaken during the audit period included: • 2017/18: 19 ha on the western side of the South Waste Rock Dump (SWRD) completed prior to the end of December 2017; • 2018/19: 0 ha (the originally planned rehabilitation area of 30 ha was withdrawn due to the decision to the locate the new Cadia Warehouse in this area); and • 2019/20: 0.9 ha Ridgeway laydown yards.	Evidence collected during this audit indicates that Cadia was compliant with this condition during the audit period. **Observation No. 40 –** As per Project Approval Schedule 5, Condition 3(d), plans should be reviewed and if necessary revised within 3 months of a modification. The LMBP should be revised in light of the April 2017 modification (new Cadia Warehouse) (e.g. section 2.4 and Figure 2.2). **Observation No. 41 –** Cadia could improve its internal recording of rehabilitation management outcomes. Other than the annual rehabilitation monitoring report undertaken by DnA Environmental and appended to the AEMR each year, Cadia was unable to produce records of internal rehabilitation management records such as routine inspections/monitoring, corrective actions, or action plans with timelines etc. **Observation No. 42 –** Cadia could revise Figure 8-4 of the 2019/20 AEMR to ensure all monitoring sites are included (e.g. North Dump 02-03), and consider reporting the percentage of	**Compliant** **Observation** **Observation** **Observation** **Observation** **Observation** **Observation** **Observation**	

		 Photo No. 30 – Rehabilitation in progress – Ridgeway laydown yard (11th November 2020) The North Waste Rock Dump (NWRD) Ramp (9.0 ha) is proposed to be rehabilitated and completed by 30 June 2022 (MOP, 5/3/2020). It was stated that the Cadia Extended area is not planned for rehabilitation in the current MOP term due to underlying resources. A site inspection of rehabilitation areas in progress and planned was undertaken at the time of the site visit. (b) Cadia reports on progress of the rehabilitation objectives in the Rehabilitation Strategy on an annual basis to the RR as part of the AEMRs. Evidence that the RR was satisfied with the AEMRs (Annual Review) was sighted as per below: • "Cadia Valley Operations Annual Environmental Management Report 2017/18" prepared by Newcrest Mining Limited and dated 24 October 2018 and covering the period from 1 July 2017 to 30 June	closure criteria met for the reporting year. **Observation No. 43 –** Cadia could include a table in section 1.7 of the LBMP indicating where in the plan each Project Approval condition is described. **Observation No. 44 –** Cadia could consider improving the graphical spatial representation of the rehabilitation progression (as suggested in the 2017 IEA) by substituting Figure 8-1 (Mine Disturbed Rehabilitation) of future AEMRs with plans similar to Plan 3A of the approved MOP. However, the colour coding of rehabilitation progression should be consistent with the latest ESG3 Mining Operations Plan (MOP) Guidelines (see Rehabilitation Phases Table 8, section 11.4 and example Plans 3A - 3E). **Observation No. 45 –** To improve clarity of all relevant project approval area plans/figures (including MOP, management and AEMRs plans and figures), Cadia should consider including a single line on the plan/figure and similarly in the legend identifying the project's approved surface development/disturbance area boundary. **Observation No. 46 –** Cadia could consider replying to the RR's letter of 13/08/2020 with a response to the observations and recommendations of the TAP and thereby ensure the RR is satisfied.		

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		2018. 2017/18 AEMR: Letter dated 19 December 2018 from the RR confirming RR is satisfied. • Email dated 31 October 2019 from the RR confirming receipt of AEMR dated 29 October 2019. It was stated that no comments were received from the RR. • It was stated that at the date of this November 2020 audit, the RR had not responded to the submission of the 2019/20 AEMR. 			

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		 Photos No. 31 & 32 – 2017/18 rehabilitation; west side of SWRD (lower half of bottom photo) (looking east) (11th November 2020) **Photo No. 33 –** NWRD ramp shown in left foreground with NWRD rehabilitation in background (looking east) (11th November 2020) The auditors noted that on the 8th July 2020, a targeted assessment program (TAP) was conducted at Cadia by the RR. The assessment focused on			

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		progressive rehabilitation obligations as outlined in the Mining Operations Plan (MOP) and how materials and soils on site were being managed to achieve sustainable rehabilitation outcomes. A letter (Targeted Assessment Program – Soils and Materials Management letter from the RR dated 13/08/2020) received included the following recommendations: 1. The mine should undertake a specific rehabilitation risk assessment to identify the range of risks and associated controls throughout the life of mine to achieve sustainable rehabilitation outcomes. 2. The mine should identify and implement ongoing tailings characterisation of geochemical properties to confirm EIS findings are relevant and address potential constraints for rehabilitation. 3. The mine should establish an inventory of materials (e.g. inert capping material.) to ensure there is enough material available for emplacement and or capping to achieve nominated final landform and sustainable rehabilitation outcomes. 4. The mine should ensure that control measures validated via monitoring are recorded to ensure that risks are appropriately addressed. The mine			

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		should develop a formalised quality assurance process throughout the life cycle of rehabilitation, which includes the verification of execution of procedures by responsible personnel as well as the recording of key data at each rehabilitation phase (e.g. actual methodologies undertaken, weather conditions etc.). 5. The mine should develop a remediation plan to address the failure of revegetation on the NWRD with proposed actions and timeframes. The RR's letter did not include a request for Cadia to provide a response to the recommendations of the TAP or deadline.			
38.	**REHABILITATION AND BIODIVERSITY OFFSETS** **Biodiversity Offsets** The Proponent shall: (a) implement the biodiversity offset strategy as described in the EA, and summarised in Table 14 (and shown conceptually in Appendix 6); and (b) investigate ways to salvage and beneficially use resources (including timber, fauna habitat, seed and soil resources) in areas subject to subsidence as far as is reasonable	In relation to paragraphs (a) and (b) of this condition: *(a) Biodiversity Offset Strategy* The biodiversity offset strategy is described in Section 4 (pp 4-80 to 4-83) of the Cadia Project EA (Cadia, 2009). The extent of the offset areas was subsequently modified in August 2015 (MOD 7) as summarised in Table 14 and shown conceptually in Appendix 6 of the Project Approval. For the purposes of this condition the auditor has defined the	Cadia was able to demonstrate that it is generally implementing the biodiversity offset strategy as described in the EA and salvaging and beneficially using resources as required by Project Approval Schedule 3, Condition 38 (b). **Observation No. 47 –** In relation to the biodiversity offset strategy shown conceptually in Appendix 6 (Figure 6.1 of the Project Approval): • the Figure differs from Figure 3 *Existing CVO Rehabilitation and Woodland Enhancement Concept* (NEC-14-81 75W Mod-101D) of	**Compliant** **Observation** **Observation**	

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	and feasible, in consultation with the BCD, to the satisfaction of the Secretary. *Table 14: Biodiversity Offset Strategy* **Subject to final survey constraints*	EA as the combination of the 2009 EA and the 2015 MOD 7 EA. The EA described the integrated approach of the strategy which included: • rehabilitation of post-mining landforms; • provision of a Squirrel Glider monitoring program; and • enhancement and conservation of vegetation and habitat within an offset area. Evidence of implementation of this approach to the strategy is described below: <u>Rehabilitation of post-mining landforms</u> It was evident that Cadia are progressively rehabilitating mine disturbed areas as verified in Schedule 3, Condition 37 above. <u>Provision of a Squirrel Glider monitoring program</u> The EA considered the presence of the Squirrel Glider in the Cadia Valley to appear to be significant (p 4-90) and a monitoring program was to be prepared within 6 months of Project Approval (p 4-97) for the Southern Remnant area located south of the SWRD. Monitoring was undertaken in August – September 2009 (Cenwest Environmental Services, March 2011) and concluded that it was	the EA. Figure 6.1 is (possibly an earlier draft) version NEC-14-81 75W Mod-101A. Cadia should confirm the correct version is included in the Project Approval; • the Figure does not show the East Cadia Subsidence as a waterbody, unlike the MOP; and • the Figure could be included in the body of the Land and Biodiversity Management Plan rather than in the appendix (as MOD 7 EA). **Observation No. 48 –** There was no evidence of formal tracking of the work being undertaken in the offset areas. Cadia could consider preparing an internal report structure that regularly tracks the actions and timing of the Management Aspects for the offset areas as listed in Section 9.9 of the Land and Biodiversity Management Plan.		

Area	Minimum Size*
Black Rock Range Offset Area – Enhancement Area	647 ha
Black Rock Range Offset Area – Revegetation Area	162 ha
Flyers Creek and Belubula River Offset Area	97 ha
Stratton Vale Offset Area	60 ha
Total	966 ha

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		very unlikely that a Squirrel Glider resided in the Southern Remnant or surrounds. Therefore, the other objectives of the proposed monitoring program as described in the EA were satisfied. <u>Enhancement and conservation of vegetation and habitat within an offset area.</u> Section 9.9 of the Land and Biodiversity Management Plan (LBMP) includes a specific action plan for key operational aspects relating to the offset areas and Section 8.2.2 of each AEMR reports on the status of implementation of the offsite rehabilitation programs. Based on a review of EPBC annual compliance reports (note: submission to the federal department (DAWE) not verified), the following actions (sample) of the strategy were reported to be implemented: 1. <u>Vegetation Corridor Program:</u> Vegetation areas of 7.5 ha, 7.2 ha (replanting) and 0 ha were planted in the General corridors over the audit period with no work undertaken in the Riparian corridors.			

		 Photo No. 34 – Enhanced vegetation corridor on western side of CVO (looking east) (11th November 2020) 2. <u>Black Rock Range:</u> Fire trail maintenance, weed control and aquatic ecosystem monitoring were undertaken over the three reporting years. No ecological burning was undertaken due to drought conditions. Revegetation works with approximately 5,660 tubestock planted over the audit period. **Photo No. 35 –** Cleared agricultural land revegetation underway (Black Rock Range – Cadia East Offset Area) (18 September 2018 – photo courtesy of CVO)		

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		3. <u>Flyers Creek/Stratton Vale:</u> It was stated that no rehabilitation works were undertaken during the audit period. Maintenance activities included weed control, fox baiting, kangaroo reduction programs and fence maintenance. The EA states (p 4-83) that baseline monitoring of the offset areas would be conducted within two years of the Project Approval (i.e. by 2012) and be used to assess change over time. Terrestrial fauna surveys would also be conducted every five years to monitor the use of the offset areas by vertebrate fauna and the offset area would be independently audited at intervals agreed with relevant authorities. It was stated that baseline monitoring at BRR commenced in 2010 (generally conducted biannually) and was again conducted in 2019 for Aquatic ecosystem monitoring as reported in AEMR's. Evidence of BRR survey monitoring (excel spreadsheet "*BRR 2019 data spreadsheet*") was sighted. BRR vegetation monitoring from 2010-2019 was included. *<u>(b) Salvage and beneficial use of resources</u>* Table 2.6 of the LMBP specifically details the (ongoing) actions to salvage available habitat and other resources within the Cadia East Subsidence Zone.			

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		Timber salvage It was stated that native logs have been previously (outside of this audit period) been harvested from the subsidence zone and future salvaging may not be possible as the zone is moving into the pine plantation. Soil resources: It was stated that at the time of this audit a campaign was commencing to harvest pine trees in order to monitor the cracking and recover the topsoil. *Note: Offset areas were not inspected during the site inspection component of this audit.*			
39.	**REHABILITATION AND BIODIVERSITY OFFSETS** Within 2 years of the date of this approval, the Proponent shall make suitable arrangements to provide appropriate long term security for the offset areas to the satisfaction of the Secretary.	The BRR survey plan (Carpenter, Ref: 10086B dated 12th November 2009) was sighted however, survey plans of the Stratton Vale and Belubula River/Flyers Creek Offset Areas were not sighted. It was stated that Contango Agricultural Company Pty Ltd (Cadia's related body corporate), Cadia and the Planning Minister plan to enter into a Voluntary Planning Agreement (VPA) to satisfy this condition. A draft copy of the Cadia East Biodiversity Offset – Planning Agreement was sighted. The VPA was determined to be the appropriate instrument to ensure the long	Due to the excise of land from the Cadia East Offset Area (MOD 7), it is evident that the subsequent processes to survey, subdivide, seek approval to rezone and register the land as well as amend the BSC Local Environmental Plan (LEP) has been lengthy and is continuing. **Non-compliance No. 9 –** Notwithstanding continued efforts by Cadia to make suitable arrangements to provide long term security for the offset areas to the satisfaction of the Secretary, these arrangements had not been finalised at the date of this November 2020 audit.	**Non-compliant** **Observation** **Observation**	**NC9**

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		term security of the biodiversity offsets (DoPI email dated 5/06/2013). On the 2nd May 2018, a Planning Proposal (PP) was accepted by Blayney Shire Council (BSC) to rezone the land parcels (within the offset areas) that were unable to be secured in perpetuity. On the 30th August 2018, a Gateway Determination was made to proceed with the amendment of BSC's LEP 2012 to insert Zone E2 Environmental Conservation (E2) and rezone proposed Lot 202 in the subdivision of Lot 201 DP 1037198 ("Stratton Vale") and proposed Lot 204 in the subdivision of Lot 1422 DP 1168271 (Belubula River/Flyers Creek Offset Area) from zone RU1 Primary production (RU1) to zone E2. CVO advised in October 2018 (email dated 4/10/2018 sighted). The LEP amendment was required to be finalised within 12 months of the week following the determination (i.e. 6/9/2019). The DPIE was provided with a copy of the survey plans (required as Annexure B of the VPA) in August 2018 (email sighted). At the time of this audit, it was not evident what had transpired since the PP determination in 2018 until February 2020. BSC advised Cadia in February 2020 that the subject land required the subdivision to be lodged (Cadia have	**Recommendation No. 9 –** Cadia should continue efforts to make suitable arrangements to provide long term security for the offset areas to the satisfaction of the Secretary. **Observation No. 49 –** The BRR offset area shown in the approved management plans (e.g. Figures 9.2 and 9.3, pp 81-82 of the approved LBMP) is not consistent with the approved BRR offset area as shown in Appendix 6 (Figure 6.3) of the project approval. **Observation No. 50 –** Cadia should ensure the Black Rock Range – Cadia East Offset cadastral boundary (Lot 21 DP 1204782) is correctly reflected in all relevant approvals, plans, strategies and agreements as per the surveyed plan (Carpenter, Ref: 10086B dated 12th November 2009).		

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		stated that this is incorrect), however, it was not clear from subsequent emails whether this related to subdivision of BRR. Post audit, Cadia advised that BSC were awaiting confirmation from the surveyor of registration of the subdivision plans that had been lodged with NSW Land Registry Services (email from BSC to Cadia dated 17 November 2020). With regard to the BRR offset area, land in the southern tip (13.6 ha of the "Ulah" property) along with the Trig Station (2.6 ha) was approved to be excised from the offset area (826 ha) as part of MOD 7 (April 2015). The Project Approval was modified to reflect the BRR offset area reduction as shown in Appendix 6 (Figure 6.3) of the Project Approval. Schedule 3, Condition 38 (Table 14) of the Project Approval was also modified to show a reduced BBR offset area (combined reduction area of 16.5 ha) of 809 ha (minimum size, subject to final survey constraints) due to excise of the land (however, would still include the area of the Crown land ("paper" roads)). The survey area of the BRR offset (ex. Trig Reserve and ex. Roads) is 807.7 ha and does not show the 13.6 ha of the "Ulah" property excised.			

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40.	**REHABILITATION AND BIODIVERSITY OFFSETS** Within 6 months of the approval of the Land and Biodiversity Management Plan (see condition 41 below), the Proponent shall lodge a conservation and biodiversity bond with the Department to ensure that the offset strategy is implemented in accordance with the performance and completion criteria of the Land and Biodiversity Management Plan. The sum of the bond shall be determined by: (a) calculating the full cost of implementing the offset strategy; and (b) employing a suitably qualified quantity surveyor to verify the calculated costs, to the satisfaction of the Secretary. *Notes:* • *If the offset strategy is completed to the satisfaction of the Secretary, the Secretary will release the conservation bond.* • *If the offset strategy is not completed to the satisfaction of the Secretary, the Secretary will call in all or part of the conservation bond, and arrange for the satisfactory completion of the relevant works.* • *If amendments to the Mining Act 1992 allow the Minister for Mineral Resources to require rehabilitation securities under a Mining Lease which apply to the implementation of rehabilitation works outside the boundary of a Mining Lease, the Proponent may transfer the*	A Bank Guarantee issued (dated 1 March 2017) by HSBC Bank Australia in favour of the NSW Department of Planning and Environment (DPE), in connection with an agreement between Cadia and the DPE for implementing the biodiversity offset strategy in accordance with the performance and completion criteria in the Cadia Valley Operations Land and Biodiversity (Landscape) Management Plan relating to the titles, was sighted. Land listed includes: • Black Rock range Lot 21 DP 1204782 • Flyers Creek/Belubula Offset Area proposed Lot 205 in the subdivision of Lot 1422 DP 1168271 • Stratton Vale Offset Area proposed Lot 202 in the subdivision of Lot 201 DP 1037198.	This condition is outside the audit period of this audit however, it has been verified by previous IEAs.	**Compliant**	

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	conservation bond required under this approval to the Minister of Mineral Resources provided the Secretary and DRG agree to the transfer.				
40A.	**REHABILITATION AND BIODIVERSITY OFFSETS** **Retirement of Credits** Within two years of commencing construction of the MOD 13 Southern Tailings Storage Facility buttressing, unless the Secretary agrees otherwise, the Proponent must retire biodiversity credits of a number and class identified in Tables 14.1 and 14.2 below. The retirement of credits must be carried out in accordance with the Biodiversity Offsets Scheme of the Biodiversity Conservation Act 2016, to the satisfaction of the Biodiversity Conservation Trust. *Table 14.1: Ecosystem Credit Requirements* *Table 14.2: Species Credit Requirements*	It was stated that the STSF buttressing work undertaken to date (i.e. as of November 2020) has been undertaken generally in accordance with the project approvals EA (i.e. the Project Approval as existing prior to MOD 13) and therefore commencement of construction of the MOD 13 STSF buttressing has not commenced as at the date of this audit. Cadia intends to make a payment to the NSW Biodiversity Conservation Fund, administered by the NSW Biodiversity Conservation Trust, instead of retiring credits for all of the biodiversity credit requirements. The total cost of the payment has been determined by the BAM Credit Calculator as described in the MOD 13 EA.	**Not triggered –** Construction of the MOD 13 Southern Tailings Storage Facility buttressing has not commenced as of November 2020. Therefore, the timing requirements of Schedule 3, Condition 40A have not been triggered during this audit period. **Observation No. 51 –** With regard to commencing construction of the MOD 13 Southern Tailings Storage Facility buttressing, Cadia could consider notifying the Secretary of the date of commencement so that the start of this condition's timeframe (i.e. within two years) is clear and Cadia will be able to ensure future compliance.	**Not triggered** **Observation**	

Ecosystem Credits	Disturbance Area (hectares)	Credits Required
PCT 296 - White Box grassy woodland in the upper slopes sub-region of the NSW South Western Slopes Bioregion	0.31	8

Threatened Species	Disturbance Area (hectares)	Credits Required
Squirrel Glider - *Petaurus norfolcensis*	0.31	8
Small Purple-pea - *Swainsona recta*	0.31	8
Silky Swainson-pea - *Swainsona sericea*	0.31	8
Pink-tailed Legless Lizard - *Aprasia parapulchella*	0.31	8
Little Eagle - *Hieraaetus morphnoides*	0.31	6
Superb Parrot - *Polytelis swainsonii*	0.31	8
Total Credits	**0.31**	**46**

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41.	**REHABILITATION AND BIODIVERSITY OFFSETS** **Land and Biodiversity Management Plan** The Proponent shall prepare and implement a Land and Biodiversity Management Plan for the project to the satisfaction of the Secretary. This plan must: (a) be prepared in consultation with BCD, DPIE Water, RR and the Councils, and be submitted to the Secretary within 18 months of the date of this approval; (b) include: (i) the rehabilitation objectives for the site and offset areas; (ii) a description of the short, medium, and long term measures that would be implemented to: • rehabilitate the site in accordance with the Rehabilitation Strategy (see condition 36); • implement the offset strategy; and • manage the remnant vegetation and habitat on the site and in the offset areas;	Cadia has prepared a Land and Biodiversity Management Plan (Revision 3, dated 15/5/2017) for the project which was approved by the Secretary (letter dated 30/5/17). (a) This paragraph predated this audit period, however, it has been verified by previous IEAs. (b) Based on a review of the LBMP, the currently approved LBMP includes the requirements in paragraph (b) of this condition. In relation to paragraph (b)(iv) of this condition, Cadia provided examples of implementation of the following aspects of the LMBP: <u>Progressive rehabilitation</u> • Site inspection provided evidence that Cadia is progressively rehabilitating disturbed areas. Rehabilitation progress of the NWRD, western side of the SWRD and Ridgeway laydown areas was sighted during the site inspection (refer to Schedule 3, Condition 37 above).	Cadia was able to sufficiently demonstrate that a Land and Biodiversity Management Plan for the project has been prepared and is being implemented to satisfy Project Approval Schedule 3, Condition 41. **Observation No. 52 –** Cadia could consider standardising the Document History and Status to ensure the correct plan is being referred to when approved. The DPIE has approved Revision 3 of a plan dated 15/5/2017. However, the current plan shows a Date Issued of 20/1/2017 with a printed date of 15 May 2017. **Observation No. 53 –** Cadia could consider referencing all of the relevant approval conditions as listed in section 1.7 of the LBMP to the relevant section in the plan where the condition is addressed. **Observation No. 54 –** Cadia should ensure the figures of the Cadia East Offset areas are consistent with the Project Approval (Appendix 6). **Observation No. 55 –** Cadia could consider reporting the key findings (only) of the annual waste rock dump cover monitoring (e.g. graph of yearly net percolation rate compared to baseline model) and include any relevant recommendations adopted in	**Compliant** **Observation** **Observation** **Observation** **Observation** **Observation**	

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	(iii) detailed performance and completion criteria for the site rehabilitation and implementation of the offset strategy; (iv) a detailed description of the measures that would be implemented over the next 3 years, including the procedures to be implemented for: • progressively rehabilitating disturbed areas; • implementing revegetation and regeneration within the disturbance areas and offset areas, including establishment of canopy, sub-canopy (if relevant), understorey and ground strata; • investigating ways to salvage and beneficially use resources in areas subject to subsidence (including timber, fauna habitat, seed and soil resources); • protecting vegetation and soil outside the disturbance areas; • rehabilitating creeks and drainage lines on the site	<u>Implementing revegetation and regeneration within the disturbance areas and offset areas</u> • Refer to Schedule 3, Condition 38 above. <u>Investigating ways to salvage and beneficially use resources in areas subject to subsidence</u> • Refer to Schedule 3, Condition 38 (b) above. <u>Protecting vegetation and soil outside the disturbance areas</u> • An Environmental Impact Permit (EIP) is required for disturbance of (previously undisturbed) land or clearing or removal of vegetation and an EIP application process has been documented (document number 710-005-EN-PRO-0006 dated 11/03/2020). <u>Rehabilitating creeks and drainage lines on the site</u> • Riparian corridor rehabilitation is undertaken as part of Cadia's vegetation corridor program with progress reported annually in section 8 of the AEMR. It was reported that 311 ha had been completed at the start of this audit period with no additional area completed during the period (partly)	the "Actions for the next reporting period" section of the AEMR. **Observation No. 56 –** To determine whether any proposed disturbance is within the approved project disturbance footprint, Table 2 of the of the Environmental Impact Permit (710-005-EN-PRO-0006) procedure states that reference should be made to Figure 2-4d from the Cadia East Environmental Assessment. The figure is replicated in Appendix A of the procedure. The Auditor considers the scale of this figure (Project General Arrangement) too large to determine the permitted disturbance footprint. Cadia could consider providing the disturbance area electronically on a GIS. In addition, the procedure requires the assessor to consult previous project environmental assessments to retrieve information such as the location of heritage and environmentally sensitive areas. Cadia could consider including this information in a GIS as well.		

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	(both inside and outside the disturbance areas); • managing potential acid forming material (including ensuring effective isolation of potential acid forming material in rock dumps); • managing salinity; • conserving and reusing topsoil; • undertaking pre-clearance surveys; • managing impacts on terrestrial and aquatic fauna (including a Squirrel Glider conservation strategy); • landscaping the site to minimise visual impacts; • collecting and propagating seed for rehabilitation works; • salvaging and reusing material from the site for habitat enhancement; • controlling weeds and feral pests, including terrestrial and aquatic species; • managing grazing and agriculture on site;	due to drought conditions (2018/19 AEMR). • Cadia monitors aquatic health through rehabilitation monitoring and invertebrate sampling programs. An Aquatic ecosystem monitoring program (AEMP) is conducted biannually and reported in the AEMR. Aquatic ecosystem monitoring was conducted on the Panuara Rivulet in Spring 2018 and Autumn 2019. The 2019 AEMP was supplemented by an additional aquatic ecology monitoring program aimed at monitoring and maintaining refuge pools in Cadiangullong Creek. <u>Managing potential acid forming material</u> • Cadia colour codes PAF (pink) waste rock and stores separately to NAF (blue). The respective waste rock dumps are physically segregated and demarcated by the waste rock haul road. O'Kane Consultants conducted modelling in 2008 regarding net percolation rates of the cover system for the PAF in both the NWRD and SWRD and have continued to monitor annually for the audit period. The following monitoring reports for the audit period were sighted: ○ Year 4 monitoring period 1 June 2017 – 31 May 2018;			

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	• controlling access; • bushfire management; • managing and minimising any potential adverse impacts associated with the final voids; and • managing and minimising any adverse socio-economic effects associated with mine closure; (v) a program to monitor the effectiveness of these measures, and progress against the performance and completion criteria; (vi) a description of the potential risks to successful rehabilitation and/or revegetation, and a description of the contingency measures that would be implemented to mitigate these risks; (vii) details of who would be responsible for monitoring, reviewing, and implementing the plan; and (vii) a Threatened Species Management Protocol, which outlines management strategies to protect any threatened flora and fauna species during construction, operation and postmining.	○ Year 5 monitoring period 1 June 2018 – 31 May 2019. • The monitoring is being conducted to verify the specific design objective to limit water infiltration to prevent the production of contaminated leachate in the waste rock dumps. The monitoring includes data collection and interpretation as per the best practice guidelines outlined in the International Network for Acid Prevention (INAP) Global Cover System Guidance Document (INAP 2017). Monitoring results are reported annually in section 8.6.1 of the AEMRs. **Photo No. 36 –** Waste rock haul road separating the PAF and NAF waste rock dumps (9th November 2020)			

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		Managing salinity • It was stated that there are no known salinity issues. Conserving and reusing topsoil • Stable topsoil stockpiles were observed during the site inspection. • Based on data supplied by the senior mine surveyor, CVO is currently forecasting surplus topsoil based on current and forecast topsoil volumes and volumes required for final rehabilitation of mine disturbed areas (refer to DPIE-RR consultation Issue No.11). Undertaking pre-clearance surveys • Cadia stated that a key component of the Vegetation Clearance Protocol is that a pre-clearance survey is undertaken. The STSF Buttress tracks and works (dated 5/10/2018) EIP was sighted. Specific instructions were included stating that a specialist ecologist would be required if vegetation removal was unavoidable. Managing impacts on terrestrial and aquatic fauna • For vegetation clearing, Cadia has developed an Environmental Impact Permit (EIP) system which includes (if required) a Threatened Species			

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		(including the Squirrel Glider) Management Protocol. An EIP (dated 27/07/2018) for early works for the Molybdenum Bulk Earthworks was sighted. <u>Landscaping the site to minimise visual impacts</u> • It was stated that the focus of rehabilitation to date has been on the eastern and southern side of the SWRD as these areas are visible to the public (dwellings, public roads etc.). This was verified during the site inspection. **Photo No. 37 –** View of CVO from public road (looking northeast) with in-progress rehabilitatation southern side of SWRD visible in middle right (11th November 2020)			

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		<u>Collecting and propagating seed for rehabilitation works</u> • Cadia has a seed supply contract with Fields Environmental Solutions (FES) (BioBankSeed) (undated proposal to supply seed for 2018 from FES sighted) and the OLALC. It was stated that drought conditions during the audit period have affected the last few seed collection years. FES have mapped similar bioregions and have collected seeds of indigenous trees and shrubs. OLALC have also undertaken seed collection over the audit period. FES invoices dated 15/11/2018 and 8/07/2019 for seed supply were sighted. <u>Salvaging and reusing material from the site for habitat enhancement</u> • It was stated that there was no salvaging and reusing of material from the site for habitat enhancement during this audit period. <u>Weed and pest control</u> • It was stated that the control of weeds and feral pests was ongoing during the audit period and reported in the AEMRs. Fox baiting is undertaken in conjunction with a Cadia led program to encourage			

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		CVO neighboring property participation as well. <u>Managing grazing and agriculture on site</u> • Cadia has Grazing Rights Agreements (sample agreement sighted) in place in order to manage grazing and agriculture on site. These are properties (grazing areas) outside the operational areas on the MLs mainly to the west of the CVOs within the MLs and then properties outside the MLs to the south of the CVOs. <u>Controlling access</u> • It was stated that CVO access is controlled with boundary fencing and locked gates. CVO security personnel are responsible for the gates and maintenance. Boundary fences on CVO neighboring land agisted by CVO is maintained by the agistees. A fencing contractor is engaged to maintain the integrity of the rehabilitation and offset boundary fencing. Vehicular access to CVO is controlled by swiping ID cards and activation of a boom gate at a manned security gate. <u>Bushfire management</u> • It was stated that during the audit period, mitigation measures such as spraying herbicides on vegetation			

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		surrounding infrastructure, strategic grazing of vegetation around infrastructure on farms and controlled burning to minimise fuel loads to the north of the site had been undertaken. In the case of bushfire, CVO water trucks are available including two Cat 7s and one Cat 1 (in addition to the RFS) as well as CVO volunteer labour. It was stated that the existence of a declared Total Fire ban day is checked prior to the issue of hot work permits. <u>Minimising final voids impacts</u> • To minimise any potential adverse impacts associated with the final voids, it was stated that new fencing has been installed around the Cadia East subsidence zone and more recently a more secure fence around the influence zone. Ridgeway had been fenced prior to this audit period.			

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		 Photo No. 38 – Secure fencing and signage around subsidence zone (11th November 2020) <u>Minimising adverse socio-economic impacts</u> • It was stated that every five years a socio-economic impact study is undertaken. The latest study (CVO Socio-Economic Study, Umwelt, September 2020) was sighted. Section 8 (p 270) of the report specifically addresses Mine Closure Specific Impacts and Opportunities. In relation to paragraphs (b)(v) to (viii) of this condition (note: there is a misprint in the condition; (vii) is duplicated):			

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		(v) Comprehensive monitoring reports are included as appendices in the annual AEMR; e.g. waste dump cover monitoring reports (O'Kane Consulting) and rehabilitation monitoring reports (DnA Environmental). (vi) Section 4 (p 60) of the LBMP outlines the outcomes of the risk assessment undertaken and existing controls and contingency measures identified to mitigate the potential risks to successful rehabilitation. It was stated that the following contingency measures were implemented during this audit period: • Seedlings planted at the CVO dewatering facility in Blayney that died during the drought were replanted; • Monitoring (early detection) of the NWRD rehabilitation has identified a poor strike/germination of a (trial) planting of eucalypts. When seed is available, Cadia intends to infill with eucalypts. (vii) Section 1.3 of the LMBP states that the responsibility for implementing, monitoring and reviewing the Land and Biodiversity (Landscape) Management Plan lies with the CVO Health, Safety, Environment, Social Responsibility and Training			

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		(HSESRT) Manager. It was stated that actions are tracked using verbal reporting in meetings. (viii) Section 2.10 of the LMBP describes Cadia's Threatened Species Management Protocol (TSMP), which outlines management strategies to protect any threatened flora and fauna species during construction, operation and postmining. It was stated that no threatened flora or fauna were identified during the preclearance surveys during the audit period, and therefore the TSMP was not required to be initiated.			
42.	**ABORIGINAL HERITAGE** **Aboriginal Cultural Heritage Management Plan** The Proponent shall prepare and implement an Aboriginal Cultural Heritage Management Plan for the project to the satisfaction of the Secretary. This plan must: (a) be prepared in consultation with BCD and the Aboriginal community, and be submitted to the Secretary for approval within 6 months of the date of this approval; (b) include a:	Cadia has prepared an Aboriginal Cultural Heritage Management Plan (ACHM) (current version: Version 2 – 4/07/2012) for the project. The ACHM was approved by the Secretary in May 2013 (as verified by previous audits). It was stated that no changes have been made since 2013. Aboriginal Cultural Heritage assessments (ACHA) undertaken for project modifications are referred to when assessing Environmental Impact Permit applications; no new aboriginal heritage sites have been identified during the audit period. It is expected that the ACHM will be reviewed considering the new corporate Social Performance	Cadia was able to sufficiently demonstrate that an Aboriginal Cultural Heritage Management Plan for the Project has been prepared and is being implemented to satisfy Project Approval Schedule 3, Condition 42. **Observation No. 57 –** The current ACHM shows two version dates; Version 2 – 5/09/2010 Page i and Version 2 – 4/07/2012 Page 2. **Observation No. 58 –** It is recommended that the ACHM be updated after any new ACHA is undertaken. The ACHA can be referenced in the ACHM and any new sites (if any) and findings can be recorded in the ACHM. This removes	**Compliant** **Observation** **Observation**	

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	• detailed salvage program and management plan for Aboriginal sites and potential archaeological deposits within the project disturbance area; • detailed description of the measures that would be implemented to protect and monitor Aboriginal sites outside the project disturbance area; • description of the measures that would be implemented if any new Aboriginal objects or skeletal remains are discovered during the project; and • protocol for the ongoing consultation and involvement of the Aboriginal communities in the conservation and management of Aboriginal cultural heritage on the site.	Standard (as an ICMM member company). (a) Verified by previous IEAs however, this is outside the scope of this audit. (b) In relation to paragraph (b): • Section 6.1 of the ACHM details the salvage program and management plan for known Aboriginal sites and section 6.2 of the ACHM details the salvage program and management plan for potential archaeological deposits. • Section 6.3 of the ACHM details management measures that would be implemented to protect and monitor Aboriginal sites outside the project disturbance area. • Section 7 of the ACHM details management measures that would be implemented if any new Aboriginal objects or skeletal remains are discovered during the project. It was stated that no new Aboriginal objects or skeletal remains were discovered during the audit period. • Section 9 of the ACHM details the protocol for the ongoing consultation and involvement of the Aboriginal communities in	the requirement, and possibility of omissions, to search through modification documentation for ACHA findings (e.g. when assessing Environmental Impact Permits).		

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		the conservation and management of Aboriginal cultural heritage on the site. Evidence of implementation includes consultation with the OLALC CEO and an OLALC representative participating in the archaeological field assessment for MOD13 ACHA (section 4.2, ACHA, August 2019). There is no keeping place (locked cabinet) as there are currently no salvaged Aboriginal artefacts on site.			
43.	**HISTORICAL HERITAGE** **Historical Heritage Management Plan** The Proponent shall prepare and implement a Historical Heritage Management Plan for the project to the satisfaction of the Secretary. This plan must: (a) be prepared in consultation with the Heritage NSW and be submitted to the Secretary for approval within 6 months of the date of this approval; (b) include: • compilation of archival recording, excavation and/or salvage of heritage items within the project disturbance area, including the Wire Gully Gold Workings and the Little Cadia Copper Mine;	In relation to paragraph (a) of this condition, Cadia prepared a Historical Heritage Management Plan (HHMP) (Rev 1; 15/06/2020) for the project to the satisfaction of the Secretary (DPIE approval letter dated 4/08/2020 sighted). This timeframe of this condition is outside this audit period and is a historical compliance. A previous IEA has verified that Heritage NSW was consulted in the preparation of the HHMP and that it was submitted (email dated 6/07/10) to the Secretary for approval within 6 months of the date of this approval. In relation to the first dot point in paragraph (b) of his condition, the HHMP includes a compilation of archival recording, excavation and salvage of heritage items within the project disturbance area, including the Wire	Cadia was able to provide evidence that a Historical Heritage Management Plan for the project has been prepared and implemented to satisfy Project Approval Schedule 3, Condition 43. **Observation No. 59 –** The document history and status show the currently approved version of the HHMP as Rev.1 dated issue 15/6/2020. However, the DPIE approval refers to a HHMP, Revision 1 dated 29 May 2020. Cadia should ensure that the DPIE approval dates are consistent with the final plan. **Observation No. 60 –** Cadia could consider ensuring reports, provided to regulators and for public publishing on the Cadia website, are reviewed by multiple reviewers for quality control. Section 6.7.2.1 of the 17/18 and 18/19	**Compliant** **Observation** **Observation**	

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	• a detailed conservation management strategy for heritage items outside the project disturbance area but within the vicinity of the site, including a: ○ description of the measures that would be implemented to protect heritage items from disturbance, including disturbance from blasting activities; ○ program to monitor the effects of blasting on relevant heritage items; and ○ an Interpretation Plan for the Cadia Village. *Note: The Little Cadia Copper Mine is outside the zone of subsidence for the Cadia East mine but within its zone of influence, and therefore may potentially be subject to impact. It is proposed to conserve the site in-situ, if possible.*	Gully Gold Workings and the Little Cadia Copper Mine (Section 2.2). In respect of the Wire Gully Gold Workings, it was stated that all management measures recommended by Higginbotham (2009) were completed prior to this audit period and reported in the 2013-14 AEMR. In respect of the Little Cadia Copper Mine (LCCM), the compilation of archival recording, excavation and salvage of heritage items within the LCCM was completed as described is section 2.2.1.2 of the HHMP. Current management measures include the recommendation, Higginbotham (2009), that the remains of the LCCM should be protected from disturbance. LCCM is in the zone of influence (as stated in the note to this condition), however, is not expected to subside. Cadia has updated the CE subsidence zone model in 2020 (Geotechnica, 2020) which shows a retraction of the zone of influence compared to the CE environmental assessment. An overlay of the updated simulated cracking limit over the LCCM precinct was not provided however, based on the current location of the exclusion fence, the LCCM precinct would appear to remain in the zone of influence. It was stated that backfilling of the excavation as recommended by	both refer to the 2017/18 inspection report undertaken by Mott McDonald.		

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		Higginbotham (2009) was completed prior to this audit period. In addition, mitigation measures such as sandbag protection and placement of geotechnical material have been implemented as reported in previous AEMRs (outside of this audit period). In relation to the second dot point in paragraph (b) of this condition, the HHMP includes a detailed conservation management strategy for heritage items outside the project disturbance area but within the vicinity of the site, including: <u>Cadia Cornish Engine House and Chimney Precinct</u> The Cadia Cornish Engine House and Chimney (Photo No. 39) is listed on the NSW State Heritage Register (SHR 00779). Previous conservation works undertaken to date are described in section 2.2.3.2 of the HHMP. Cadia was able to provide evidence of implementation of the management measures listed in section 2.2.3.5 of the HHMP including Annual Inspection Reports (Mott McDonald, 2017, 2018 and 2019) undertaken by a structural engineer; sample of monthly inspection reports (#171, #190, #198 and #206) from 2017 to 2020 undertaken by Cadia environmental personnel, and a sample (2017-2020) of blast monitoring reports			

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		including vibration results for the chimney monitoring station. Minor repairs are ongoing as required and are permitted under an exemption approval as per the Heritage Act (1997). In November 2018, the OEH (Heritage Division) (letter dated 19 November 2018) endorsed a further extension of the exemption until 31 December 2023 which also grants approval to retain the strengthening work on the structure. The original approval was for 5 years. A specific Conservation Management Plan (CMP) was developed (Godden MacKay 1995) for SHR 00779 to address the extensive and complex conservation issues and required actions. An updated draft CMP was completed and submitted by Cadia to OEH on the 18th of October 2018. OEH have provided feedback to Cadia for consideration, amendment and re-submission. It was noted that the draft Conservation Management Plan will be resubmitted by Cadia in FY21 (AEMR 2019/20).			

		 Photo No. 39 – Cadia Cornish Engine House and Chimney (11th November 2020) The HHMP includes the following elements specified in the second dot point in paragraph (b) of this condition. <u>Measures that would be implemented to protect heritage items from disturbance</u> Section 3.1 of the HHMP describes the general conservation and mitigation measures to protect heritage items from disturbance. A sample of measures were verified including: • Archival recording is located on Cadia's website; • The Higginbottom's guidance referred to in the EIP process was sighted; • Sample of EIPs were sighted listing the requirement to consider heritage items. Specifically, with regard to the Te Anau Homestead, it was stated that Cadia will likely undertake the demolition of these buildings during 2020-21 to make way for a possible expansion of the NTSF footprint.		

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		<u>Program to monitor the effects of blasting on relevant heritage items</u> Section 3.2 of the HHMP describes the program (included in the Cadia Blast Management Plan) to monitor the effects of blasting on relevant heritage items. During the audit period, no blast related events exceeded the (95th percentile) assessment criteria for blast vibration (refer to Project Approval Schedule 3, Condition 10 in this audit report). <u>An Interpretation Plan for the Cadia Village</u> Section 3.3 of the HHMP details the Cadia Village Interpretation Plan. Interpretation of the Cadia Engine House and Chimney provided by signage at the Heritage Pavilion (Photo No. 41) was sighted. **Photo No. 40 –** Heritage Pavilion (11th November 2020)			

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		 Photo No. 41 – Interpretative signage located in the Heritage Pavilion (11th November 2020)			
44.	**TRANSPORT** **Road Construction** The Proponent shall: (a) realign the affected sections of Cadia Road, and reconstruct the Cadia Road / Woodville Road intersection, at least 6 months before causing any subsidence of the affected roads; and (b) construct the CVO Dewatering Facility site intersection on Newbridge Road, prior to the commencement of construction of the facility, to the satisfaction of the applicable Council.	An on-site inspection of both the Cadia Road / Woodville Road intersection and CVO Dewatering Facility site intersection on Newbridge Road was undertaken during this audit. In relation to paragraphs (a) and (b) of this condition: (a) It was stated that discussions regarding these realignment and reconstruction works have been initiated with both Blayney Shire and Cabonne Shire Councils, as the intersection straddles the council boundary. Cadia East Subsidence modelling (*Assessment of PC2 and PC2-3 Subsidence Zone of Influence*, Geotechnica, report of 15 January 2020) predicts Cadia Road will be impacted by subsidence	Based on the evidence collected during this audit, Cadia was compliant with this condition during the audit period. **Observation No. 61 –** Schedule 3, Condition 44(b) applies to construction of the CVO Dewatering Facility site intersection on Newbridge Road, which has been constructed to the satisfaction of Blayney Shire Council. Cadia could consider requesting paragraph (b) of this condition be removed in a future modification of the Project Approval, as paragraph (b) is now redundant.	**Compliant** **Observation**	

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		by December 2023. Therefore, to satisfy this condition, these works would need to be completed by June 2023. It was stated that initial design work is commencing in 2021. **Photo No. 42 –** Predicted surface cracking extent by December 2023 (Figure 69, Geotechnica 2020) (b) Construction of the CVO Dewatering Facility site intersection on Newbridge Road prior to the commencement of construction of the Facility, was verified according to previous IEA (letter dated 15/8/14 from Blayney Shire Council and copy of plans for both road works and buildings related to the construction of CVO Dewatering facility on			

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		Newbridge Road. The letter was a Notice of Determination of Construction Certificate Application 83/2014 giving approval).			
45.	**TRANSPORT** **Road Haulage** The Proponent shall transport all concentrate: (a) to the Blayney Dewatering Facility and CVO Dewatering Facility by pipeline; and (b) from the Blayney Dewatering Facility and CVO Dewatering Facility by rail. If during the life of the project pipeline or rail services are not available to transport the concentrate the Proponent may apply to the Secretary for permission to temporarily use truck facilities until such time as pipeline or rail services are returned to normal service.	An on-site inspection was made of the concentrate pipeline route (a section of), site of the (now demolished) Blayney Dewatering Facility and CVO Dewatering Facility. In relation to paragraphs (a) and (b) of this condition: (a) It was stated that, during the audit period, there had been no road transport of concentrate to the CVO Dewatering Facility; all concentrate had been supplied via the concentrate pipeline. The Blayney Dewatering Facility had ceased operating prior to this audit period (in 2016), and therefore no concentrate was delivered by either mode of transport during this audit period. (b) It was stated that, during the audit period, all transport of concentrate from the CVO Dewatering Facility; was by rail. Transport of concentrate by train from the Blayney Dewatering Facility had ceased prior to this audit period (last train in May/June 2016), with	Cadia was able to sufficiently demonstrate that all concentrate was transported to the CVO Dewatering Facility by pipeline and from the facility by rail to satisfy Project Approval Schedule 3, Condition 45. **Observation No. 62 –** Considering the Blayney Dewatering Facility is now demolished, references to it in this condition are now redundant. Cadia could consider requesting that references to the Blayney Dewatering Facility in this condition be removed in a future modification of the Project Approval.	**Compliant** **Observation**	

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		the first train concentrate shipment from the new CVO Dewatering Facility in June/July 2016. It was stated that, during the audit period, no application had been made to the Secretary for permission to temporarily use truck facilities due to unavailability of the concentrate pipeline or rail service.			
46.	**TRANSPORT** **Road Haulage** The Proponent shall ensure that all traffic accessing the Blayney Dewatering Facility does so via Marshalls Lane and Gerty Street. Hill Street shall not be used except with the written permission of Blayney Shire Council.	Marshalls Lane, Gerty Street and Hill Street in the vicinity of the now demolished (old) Blayney Dewatering Facility were inspected. It was reported that the (old) Blayney Dewatering Facility ceased operating in June 2016 (when operation of the new CVO Dewatering Facility commenced). It was then placed in care and maintenance, only pumping return water to the CVO site. Cadia had sought and gained approval from Blayney Shire Council (letter dated 7/9/2012) to use Hill Street (adjacent to St Joseph's Central School) conditional that the vehicles are <3 tonne and not at times that coincide with the school's operating hours. Demolition of the Blayney Dewatering Facility commenced in February 2020. It was stated that all demolition traffic accessed the demolition site via the industrial area (Marshalls Lane/Gerty Street). Demolition was completed in September 2020.	Cadia was able to sufficiently demonstrate compliance with Project Approval Schedule 3, Condition 46. **Observation No. 63 –** This condition applies to traffic route restrictions to and from the (now demolished) old Blayney Dewatering Facility. If Hill Street is not intended to be used in the future, Cadia could consider requesting that this potentially redundant condition be removed in a future modification of the Project Approval.	**Compliant** **Observation**	

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		No traffic related complaints relating to the Blayney Dewatering Facility were recorded in the audit period.			
47.	**VISUAL** **CVO Dewatering Facility** Prior to the commencement of construction of the CVO Dewatering Facility, the Proponent shall prepare: (a) architectural plans for the facility in a manner that achieves a suitable standard of design; and (b) a Landscape Plan for the facility, including provision for vegetative screening to minimise the visual impacts on adjacent receivers, in consultation with Blayney Shire Council, and to the satisfaction of the Secretary. Following approval, these plans must be implemented to the satisfaction of the Secretary.	The commencement of construction of the CVO Dewatering Facility (early May 2015) was outside of this audit period. The CVO Dewatering Facility was (officially) opened on 11 July 2016. (a) Verified by previous audits (NSW Planning & Environment email dated 4 July 2014 indicating approval of Architectural Plans and Landscape Plans for the CVO Dewatering Facility). (b) Verified by previous audits (email dated 4/07/2014 from DPE). At the time of the site inspection on 10th November 2020, it was evident that the Landscape Plan (*Cadia Valley Operations – Sealink Concentrate Filtration & Handling Facility – Newbridge Road – Blayney Figure 2 – Proposed Landscaping Plan, 2.09.2019*) had been partially implemented in the four years since commissioning. Recent (July-September 2020) plantings of tubestock were observed on the recent southern extension of the western bund (Photo No. 43). However, no plantings were observed on the western side of the detention basin (Photo No. 44) as required by the approved Landscape Plan (LP). Current vegetative screening	It is acknowledged that Cadia has partially implemented the Landscape Plan including the replanting of trees that did not survive the drought. **Non-compliance No. 10 –** Based on a site inspection on 10th November 2020, it was evident that the provision for vegetative screening to minimise the visual impacts on adjacent receivers had not been fully implemented according to the approved Landscape Plan (*Cadia Valley Operations – Sealink Concentrate Filtration & Handling Facility – Newbridge Road – Blayney Figure 2 – Proposed Landscaping Plan, 2.09.2019*) for the CVO Dewatering Facility. **Recommendation No. 10 –** Cadia should fully implement the Landscape Plan for the CVO Dewatering Facility in accordance with Project Approval Schedule 3, Condition 47.	**Non-compliant**	**NC10**

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		to minimise visual impacts has not been established and is considered poor. **Photo No. 43 –** Western bund looking west from CVO Dewatering Facility (10th November 2020) **Photo No. 44 –** Detention basin looking north west from CVO Dewatering Facility (10th November 2020) It is noted that the mine site (and Blayney) have recorded below average			

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		rainfall (drought) over the three preceding financial years (2018-2020 FY) as reported in the AEMRs and that a percentage of the initial plantings had died. It was stated, in order to achieve a high percentage of survival rates, replanting had been delayed until more favorable weather conditions. In addition, it was stated that the approved LP required mature plants, however, due to lack of availability, tubestock was substituted, albeit at an increased density of planting. Review of the approved LP indicates that tubestock (Pot Size) is listed as an option.			
48.	**VISUAL** **Mining Operations Additional Visual Impact Mitigation** Upon receiving a written request from an owner of privately-owned land with significant direct views from a residence to the mining operations, the Proponent shall implement additional visual impact mitigation measures (such as landscaping treatments or vegetation screens) in consultation with the landowner, and to the satisfaction of the Secretary. These mitigation measures must be reasonable and feasible and must be	It was stated that no written request from an owner of privately-owned land with significant direct views from a residence to the mining operations was received by Cadia during the audit period. Therefore, no subsequent requirement for implementation of additional visual impact measures was required.	**Not triggered –** No written request under this condition had been received by Cadia during the audit period. Therefore, this condition was not triggered during the audit period.	**Not triggered**	

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	implemented within a reasonable timeframe. If within 3 months of receiving this request from the owner, the Proponent and the owner cannot agree on the measures to be implemented, or there is a dispute about the implementation of these measures, then either party may refer the matter to the Secretary for resolution. *Notes:* • *The additional visual impact mitigation measures must be aimed at reducing the visibility of the mine from significantly affected residences and do not necessarily require measures to reduce visibility of the mine from other locations on the affected properties. The additional visual impact mitigation measures do not necessarily have to include measures on the affected property itself (i.e. the additional measures may consist of measures outside the affected property boundary that provide an effective reduction in visual impacts).* • *Except in exceptional circumstances, the Secretary will not require additional visual impact mitigation to be undertaken for residences that are more than 5 kilometres from the mining operations.*				
49.	**VISUAL** **Visual Amenity and Lighting** The Proponent shall:	In relation to paragraphs (a) to (c) of this condition: (a) Evidence was sighted that Cadia is implementing measures to mitigate lighting impacts including:	**Non-compliance No. 11 –** It was evident that Cadia is implementing measures to mitigate lighting impacts, however: • in relation to paragraph (b) of this condition, Cadia was not able to	**Non-compliant**	**NC11**

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	(a) implement all reasonable and feasible measures to mitigate visual and off-site lighting impacts of the project; (b) ensure no outdoor lights shine above the horizontal; and (c) ensure that all external lighting associated with the project complies with *Australian Standard AS4282 (INT) 1997 – Control of Obtrusive Effects of Outdoor Lighting*, to the satisfaction of the Secretary.	• A draft Fugitive Lighting Management Plan (Fugitive Lighting Management Plan 710-005-EN-PLA-XXXX, Rev 4, 12/11/2020) (note: this plan was approved by Cadia yet not finalised at the time of this audit) has been prepared; • Lighting is identified as a General Requirement (Risk controls) in the recently updated Environment Impact Permit (Procedure) 710-005-EN-PRO-0006 (Rev 1; 11/03/2020) (Table 1; Section 2.1); • Lighting is identified as a risk in the Environmental Impact Application Form (710-005-EN-FRM-0001) as well as the EIP template (710-005-EN-TEM-0001); • Lighting related obligations are included in the Environment and Social Performance Induction; • Lighting is identified as a risk in the Risk Register (710-000-RI-REG-0001). (b) Upon review of the complaints register, four (4) fugitive lighting complaints were received and recorded during the audit period. Two of the complaints were regarding the new warehouse and were received within a month of	ensure no outdoor lights shone above the horizontal, as Cadia received 4 fugitive lighting complaints during the audit period, the nature of which suggest this paragraph was not satisfied; and • in relation to paragraph (c) of this condition, no evidence was able to be provided at the time of this audit that all external lighting associated with the project complies with *Australian Standard AS4282 (INT) 1997 – Control of Obtrusive Effects of Outdoor Lighting*. **Recommendation No. 11 –** Cadia should ensure that the finalised Fugitive Lighting Management Plan is implemented. **Observation No. 64 –** Cadia could update the Risk Register (710-000-RI-REG-0001) to include lighting risks at the CVO Dewatering Facility. **Observation No. 65 –** Cadia could consider including lighting (e.g. working at night on the southern waste dump) as an Initiating Trigger in Table 2 of the Environmental Impact Permit (Procedure) 710-005-EN-PRO-0006.		

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		each other. Corrective actions taken by Cadia included redirection, shrouding and installation of motion sensors. A lighting tower (which was subsequently turned off) on top of a waste rock dump was the source of an earlier complaint and the remaining fugitive lighting complaint was related to the direction of light (subsequently redirected) from CVO. The nature of these complaints suggest that the outdoor lights were shining above the horizontal and therefore not satisfying this paragraph (b) of this condition. (c) No evidence was able to be provided at the time of this audit that all external lighting associated with the project complies with *Australian Standard AS4282 (INT) 1997 – Control of Obtrusive Effects of Outdoor Lighting*.			
50.	**WASTE** **Waste Minimisation** The Proponent shall: (a) minimise the waste generated by the project; (b) ensure that the waste generated by the project is appropriately stored, handled and disposed of;	In relation to paragraphs (a) to (d) of this condition: (a) Evidence was sighted that Cadia is implementing measures to minimise the waste generated by the project including: • Minutes were sighted of Waste Contract meetings which are undertaken regularly (quarterly). Waste contract KPIs are reviewed at these meetings.	Cadia was able to provide evidence that it is effectively managing non mineralised waste generated by the Project, by proactively identifying recycling opportunities and ensuring non mineralised waste (and waste rock) is appropriately stored, handled and disposed of. **Non-compliance No. 12 –** In relation to paragraph (b) of this condition, tailings generated by the Project was	**Non-compliant** **Observation** **Observation** **Observation** **Observation** **Observation** **Observation**	**NC12**

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	(c) manage on-site sewage treatment and disposal in accordance with the requirements of the applicable Council; and (d) report on waste management and minimisation in the Annual Review, to the satisfaction of the Secretary.	• Cadia has prepared a Non-Mineralised Waste Management Plan (Version 2, 27/03/19) which describes how Cadia manages waste. • Cadia CVO Major Services Contract for the provision of Total Waste Management Services (1/4/17-30/3/20). • The waste contractor provides a monthly report to Cadia (Monthly Total Waste Management Report (April - June 2020) sighted). • Waste segregation with 37 skip bins on site for general waste, scrap steel, timber, oil filters etc. • Recycling of waste including re-smelting of scrap mill balls, mill liners, copper cable, offline filtering of HV engine oil to prolong life etc. Cadia has a recycling target (65%) which is reported against in the AEMR. • The warehouse has introduced reusable steel cages for consumables storage in the warehouse to eliminate the use and disposal of wooden pallets. • Cadia employee waste related training is undertaken at least annually on-site by the waste	not appropriately stored with a slump of the southern wall of the NTSF (9th March 2018) constructed to store and hold the tailings. **Recommendation No. 12 –** It is recommended that Cadia appropriately stores the tailings produced by the Project by ensuring the structural integrity of the walls of the tailings dams. **Observation No. 66 –** The general condition (colour coding, labeling etc.) of waste bins was observed to be poor/faded. Cadia could consider requesting the waste contractor to recondition all waste containers (both for external and internal use containers). **Observation No. 67 –** In the next revision of the Non-Mineral Waste Management Plan, Cadia could update Table 1 to include all paragraphs of this condition (i.e. the current plan includes paragraph (b) only). **Observation No. 68 –** Cadia could consider reviewing the Total Waste Management Contract (TWMC) to include Schedule 3 Condition 50 (a) as a KPI, and report on waste minimisation outcomes and initiatives in the AEMR. **Observation No. 69 –** The % recycling value KPI is omitted from the TWMC	**Observation** **Observation** **Observation**	

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		contractor as well as during employee inductions. (b) Cadia was able to demonstrate that waste generated by the project is generally appropriately stored, handled and disposed of. <u>Non-mineralised waste</u> It was stated that a small quantity of solids (sludge) is removed each year by a waste contractor (Polpure Pty Ltd) from the onsite wastewater treatment systems. Polpure is a licensed Transporter of Waste and holds EPL10619 (POEO Public Register). All other waste is disposed of offsite by Remondis Australia Pty Ltd (Remondis). Remondis holds EPL7356 (POEO Public Register) for the transport of Category 1 and 2 trackable waste. It was stated that trackable waste is transported to Environmental Treatment Solutions Pty Ltd (ETS) licensed Transfer Station (EPL13230) at Blayney, and if closed, is directly transported to the ETS waste facility in Minto (EPL20696 for Waste Storage). Samples of completed Transport Certificates (No. 2T01116939 and No. 2T01116941) were sighted, both of which included the required	(shown as TBA) and shown as 55% in the waste contractors monthly reports (e.g. Figure 11 Site Recycling % – YTD of April 2020 report). The AEMRs for the audit period report it as 65%. Cadia should ensure this recycling benchmark is clear and consistent across all plans, contracts and reporting documents. **Observation No. 70 –** Cadia could review and where necessary update the Non-Mineral Waste Management Plan to: • assign single responsibility for waste contractor liaison and accountability for achieving KPIs. It was stated that the Fixed Plant and Maintenance Department Manager has recently been assigned this role. The Areas of Responsibility table in section 13 of the plan currently assigns responsibility of liaison with stakeholders (including contractors, however not verified if the waste contractor is included) to four departments; and • ensure obligations from the TWMC are captured in the plan (including the 22 KPIs). **Observation No. 71 –** Cadia could consider undertaking an audit to ensure compliant waste tracking is undertaken		

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		Consignment Authorisations (CA no.). General waste is transported and disposed at a licensed council waste facility. Waste oils, batteries, grease, oily rags and chemicals awaiting offsite transport are stored in a covered, bunded dedicated Waste Storage Facility with an impermeable concrete floor. Bulk fuel and chemical storage was observed during this audit to be generally well managed. **Photo No. 45 –** CVO Waste Storage Facility (9th November 2020) <u>Waste Rock</u> Waste rock at Cadia is classified into three different waste types depending on its mineralisation and	and waste receivers are compliant with legal requirements. **Observation No. 72 –** At the time of this audit, full IBCs containing oils were observed (temporarily) stored on an unbunded concrete pad area beside the CVO Waste Storage Facility. The area appeared to drain to an internal stormwater drain. It was stated that the drainage system had an inline oil interceptor, however, these are not designed to capture large losses. Cadia should ensure all hydrocarbons are stored (including temporary storage) in bunded areas. **Observation No. 73 –** Paragraph (a) of this condition requires Cadia to "minimise the waste generated by the project". Cadia effectively manages non-mineral waste generated with specific targets for recycling (65%) and reducing waste to landfill (by 5% each year) i.e. the downstream side, once the waste is generated. Cadia could consider reviewing its waste strategy to ensure effort is expended on the "upstream" side of the non-mineral waste in order to minimise that waste being generated in the first place. This may be through elimination, substitution etc. and integrating waste minimisation into procurement contracts for supplies as well as major projects. Cadia could consider reporting this information (in		

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		acid generating potential with each waste type colour coded. The waste classification and management system is detailed in the approved mining operations plan (MOP). It was stated that waste rock produced from the underground workings is deemed potentially acid forming (PAF) and stored in the PAF ("pink") section of the SWRD waste emplacement area. All waste rock material has been going to the PAF section of SWRD since 2011. Non-acid forming waste rock (NAF) is stored in the "blue" section of the SWRD waste emplacement area (see Photo No. 59). The location of the SWRD and general management of waste rock was observed to be consistent with the process described in the MOP. Cadia has also designed a waste rock cover to minimise water ingress into PAF waste bodies (NWRD sighted) with waste rock leachate water quality monitored and the results reported annually in the AEMR. <u>Tailings</u> The tailings management process is described in the approved MOP. Tailing generated by the project is disposed of and stored in two tailings	the AEMR) as a simple stacked bar chart showing total waste generated (recycling plus landfill) each year and resulting trends (of all three KPIs, i.e. percentage recycled, percentage waste to landfill and total waste generated). **Observation No. 74 –** Cadia should ensure the ore processing area OSSMS is being maintained and operated in accordance with the recommendations of the *Cadia Valley Operations Report on Sewage Treatment Plan – Performance Review* (April 2008).		

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		dams (STSF and the NTSF) and more recently (at the time of the site inspection) in the Cadia Hill open cut Pit (CHP). A slump (9th March 2018) of the southern wall of the NTSF, which has been reported to the regulator, was sighted. There was no evidence of environmental harm as the slump was totally contained within the STSF. Other than the slump, no issues of concern were observed during the site inspection regarding tailings management. (c) The on-site sewage management system (OSSMS) for the ore processing infrastructure area and the Ridgeway office area were observed during this audit and appeared to be well managed. The ore processing infrastructure area system (Photo No. 46) is a modular fixed-film, aerobic treatment system. It was stated that treated wastewater is recycled to the process water pond and a small amount of solids is removed periodically be a licensed waste contractor.			

		Photo No. 46 – Modular OSSMS located at the main plant site (11th November 2020) At the time of the site inspection, the sewage treatment method for the Ridgeway Office system was not apparent, however, concrete holding/treatment tanks and lined wastewater ponds were observed. It was stated that, based on consultation with Cabonne Council, no approval document was issued as part of the approval of the Ridgeway OSSMS and that it was potentially considered part of the 'state significant development' approval. An approval (DA 120/2016) issued by Blayney Shire Council (dated 11 January 2017) was sighted granting approval to operate an OSSMS on Lot 101 Cadia Road Orange (assumed to be DP 576778 although not stated) which is the location of the ore processing infrastructure area. The approval was granted subject to the OSSMS being maintained and operated in accordance with recommendations of the *Cadia Valley Operations Report on Sewage Treatment Plan* –		

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		Performance Review (April 2008) (not sighted or verified). (d) Waste management was reported in Section 6.8 in each of the AEMRs during the audit period. Waste minimisation is not specifically addressed, however, performance against a target of "Reduce Waste to Landfill by 5%" is included and results reported as a 10.5% decrease in 2017/18, 27% increase in 2018/19, and not reported in 2019/120.			

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1.	**NOTIFICATION OF LANDOWNERS** Within 1 month of the date of this approval, the Proponent shall notify the owners of the land listed in Table 1 of schedule 3 in writing that they have the right to require the Proponent to acquire their land at any stage during the project.	Cadia stated that it retains historical records from 2010 relating to notifying the owners of land listed in Project Approval, Schedule 3, Table 1 that these landowners have the right to request Cadia to acquire their land at any stage during the project.	Given this was a historical obligation in 2010, compliance with this condition was assessed during previous Project Approval audits. Cadia has notified the owners of land listed in Project Approval, Schedule 3, Table 1 that these landowners have the right to request Cadia to acquire their land at any stage during the project.	**Compliant**	
2.	**NOTIFICATION OF LANDOWNERS** If the results of monitoring required in schedule 3 identify that impacts generated by the project are greater than the relevant impact assessment criteria, except where a negotiated agreement has been entered into in relation to that impact, then the Proponent shall, within 2 weeks of obtaining the monitoring results, notify the Secretary, the affected landowners and tenants (including tenants of mine-owned properties) accordingly, and provide quarterly monitoring results to each of these parties until the results show that the project is complying with the criteria in schedule 3.	2017 In 2017, no requests were received by Cadia in relation to acquiring land from landowners listed in Project Approval Schedule 3, Table 1. 2018 MC & PA Ewens Property It was stated that the original offer to acquire the property was made in 2010 in writing to this landowner. In 2018, a property acquisition right was enabled at the MC & PA Ewens property at 247 Newbridge Road, located in proximity to the CVO Dewatering Facility (i.e. on the basis of adverse noise impacts). A formal standing agreement remains in place to purchase this property whenever the property owners elect to sell (i.e. as of November 2020,	The DPIE and affected landowners were notified in accordance with this condition.	**Compliant**	

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		the property owner had not taken up Cadia's offer for purchase). 2019 and 2020 Eastburn Property On the 15th April 2019, the owners of the Eastburn property were informed by Cadia in writing of a dust exceedance that occurred at this property on the 24th February 2019. This dust exceedance arose from strong easterly winds resulting in elevated dust/particulate matter to the west of the CVO site. These particulate matter levels exceeded the Project Approval short term Land Acquisition criteria specified in Schedule 3, Condition 18, during the February 2019 monitoring period. The completed Dust Investigation/ Modelling Report for the February 2019 dust event was issued by Advitech on the 24th February 2019. In October 2019, an independent property evaluation of the 337 ha Eastburn property was completed by the Opteon Property Group Pty Ltd. In December 2019, an offer to acquire the Eastburn property was made by Cadia. The offer was considered by the landowner, but since early 2020, the landowner has not pursued or agreed on this offer for acquisition. Alternatively,			

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		the landowners are in the process of considering a range of mitigation options which were being progressed with Cadia in November 2020. Cadia was able to demonstrate that no exceedances of the Project Approval short term Land Acquisition criteria specified in Schedule 3, Condition 18 occurred since the February 2019 monitoring period, therefore ongoing quarterly air quality monitoring reports are not required to be provided to this landowner.			
3.	**INDEPENDENT REVIEW** If a landowner of privately-owned land considers the project to be exceeding the impact assessment criteria in schedule 3, then he/she may ask the Secretary in writing for an independent review of the impacts of the project on his/her land. If the Secretary is satisfied that an independent review is warranted, the Proponent shall within 3 months of the Secretary's decision: (a) consult with the landowner to determine his/her concerns; (b) commission a suitably qualified, experienced and independent person, whose appointment has been approved by the Secretary, to conduct monitoring on the land, to:	Apart from those initiated by Cadia under relevant Project Approval conditions, no additional independent monitoring/reviews were completed during the audit period on any landowners' land.	No written requests were received by Cadia from any landowners during the audit period requesting an independent review of the impacts of the project on his/her land.	**Compliant**	

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	• determine whether the project is complying with the relevant impact assessment criteria in schedule 3; and • identify the source(s) and scale of any impact on the land, and the project's contribution to this impact; and (c) give the Secretary and landowner a copy of the independent review.				
4.	**INDEPENDENT REVIEW** If the independent review determines that the project is complying with the relevant impact assessment criteria in schedule 3, then the Proponent may discontinue the independent review with the approval of the Secretary. If the independent review determines that the project is not complying with the relevant impact assessment criteria in schedule 3, then the Proponent shall: (a) implement all reasonable and feasible measures, in consultation with the landowner, to ensure that the project complies with the relevant criteria, and conduct further monitoring to determine whether these measures ensure compliance; or (b) secure a written agreement with the landowner to allow exceedances of the relevant impact assessment	As defined in Project Approval Schedule 4, Condition 3 in this audit report.	No written requests were received by Cadia from any landowners during the audit period requesting an independent review of the impacts of the project on his/her land.	**Compliant**	

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	criteria, to the satisfaction of the Secretary. If the further monitoring referred to under paragraph (a) above determines that the project is complying with the relevant impact assessment criteria, then the Proponent may discontinue the independent review with the approval of the Secretary.				
5.	**LAND ACQUISITION** Within 3 months of receiving a written request from a landowner with acquisition rights, the Proponent shall make a binding written offer to the landowner based on: (a) the current market value of the landowner's interest in the property at the date of this written request, as if the property was unaffected by the project, having regard to the: • existing and permissible use of the land, in accordance with the applicable planning instruments at the date of the written request; and • presence of improvements on the property and/or any approved building or structure which has been physically commenced at the date of the landowner's written request, and is due to be completed subsequent to that	Apart from the MC & PA Ewens property in 2018 and the Eastburn property in 2019/2020, no other binding written offers were made to landowners during the audit period. There was no occasion during the audit period where the acquisition price of the land and/or the terms upon which the land is to be acquired was referred to the DPIE for resolution. The independently valued sum (i.e. the market value of the Eastburn property as determined by independent valuers, the Opteon Property Group Pty Ltd in October 2019) was significantly less than the acquisition (i.e. asking) price determined by the landowner. As a result, the landowner did not proceed with the sale of the property to Cadia.	Binding written offers were made by Cadia for the proposed purchase of: a) the MC & PA Ewens property in 2018; and b) the Eastburn property in 2019/2020. No written correspondence was referred to the DPIE during the audit period to resolve a land acquisition dispute.	**Compliant**	

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	date, but excluding any improvements that have resulted from the implementation of the 'additional noise mitigation measures' in condition 7 of schedule 3 or 'compensatory water supplies' in condition 24 of schedule 3; (b) the reasonable costs associated with: • relocating within the same local government area, or to any other local government area determined by the Secretary; and • obtaining legal advice and expert advice for determining the acquisition price of the land, and the terms upon which it is to be acquired; and (c) reasonable compensation for any disturbance caused by the land acquisition process. However, if at the end of this period, the Proponent and landowner cannot agree on the acquisition price of the land and/or the terms upon which the land is to be acquired, then either party may refer the matter to the Secretary for resolution. Upon receiving such a request, the Secretary shall request the President of the NSW Division of the Australian Property				

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	Institute to appoint a qualified independent valuer to: (a) consider submissions from both parties; (b) determine a fair and reasonable acquisition price for the land and/or the terms upon which the land is to be acquired, having regard to the matters referred to in paragraphs (a)-(c) above; (c) prepare a detailed report setting out the reasons for any determination; and (d) provide a copy of the report to both parties. Within 14 days of receiving the independent valuer's report, the Proponent shall make a binding written offer to the landowner to purchase the land at a price not less than the independent valuer's determination. However, if either party disputes the independent valuer's determination, then within 14 days of receiving the independent valuer's report, they may refer the matter to the Secretary for review. Any request for a review must be accompanied by a detailed report setting out the reasons why the party disputes the independent valuer's determination. Following consultation with the independent valuer and both parties, the Secretary shall determine a fair and reasonable acquisition price for the land,				

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	having regard to the matters referred to in paragraphs (a)-(c) above and the independent valuer's report. Within 14 days of this determination, the Proponent shall make a binding written offer to the landowner to purchase the land at a price not less than the Secretary's determination. If the landowner refuses to accept the Proponent's binding written offer under this condition within 6 months of the offer being made, then the Proponent's obligations to acquire the land shall cease, unless the Secretary determines otherwise.				
6.	**LAND ACQUISITION** The Proponent shall pay all reasonable costs associated with the land acquisition process described in condition 5 above.	Cadia was able to demonstrate that: a) the independent valuation of the Eastburn property in October 2019 by Opteon Property Group Pty Ltd; and b) the legal fees incurred by the landowner's solicitors in 2019 and 2020 (i.e. from Whitely, Ironside and Shillington and Associates), were met and paid for by Cadia.	Cadia has paid all reasonable costs in 2019 and 2020 associated with the proposed land acquisition process for the Eastburn property.	**Compliant**	
7.	**LAND ACQUISITION** If the Proponent and landowner agree that only part of the land shall be acquired, then the Proponent shall also pay all reasonable costs associated with obtaining Council approval for any plan of subdivision (where permissible), and registration of the plan at the Office of the Registrar-General.	The Eastburn property negotiations that occurred in 2019/20 were over the whole of their 337.2 ha property. Negotiations between Cadia and the landowners did not commence or proceed on the basis of part acquisition of the land.	**Not triggered –** This condition was not triggered during the audit period.	**Not triggered**	

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Schedule 5 – Environmental Management, Reporting and Auditing					
Condition of Consent	**Condition Requirement**	**Evidence collected**	**Independent Audit Findings and Recommendations**	**Compliance Status**	**Unique ID for non-compliance**
1.	**ENVIRONMENTAL MANAGEMENT** **Environmental Management Strategy** The Proponent shall prepare and implement an Environmental Management Strategy for the project to the satisfaction of the Secretary. The strategy must: (a) be submitted to the Secretary for approval within 6 months of the date of this approval; (b) provide the strategic framework for environmental management of the project; (c) identify the statutory approvals that apply to the project; (d) describe the role, responsibility, authority and accountability of all key personnel involved in the environmental management of the project; (e) describe the procedures that would be implemented to: • keep the local community and relevant agencies informed about the operation and environmental performance of the project; • receive, handle, respond to, and record complaints;	Cadia's current Environmental Management Strategy (Document No. 710-005-EN-STR-0001) was issued to the DPIE on the 12th June 2020 (Revision 3) and formally approved by the DPIE on the 18th June 2020. The strategy meets the requirements defined in Project Approval Schedule 5, Condition 1 as follows: (a) be submitted to the Secretary for approval within 6 months of the date of this approval (originally approved by the DPIE on the 15th May 2013); (b) provide the strategic framework for environmental management of the project (Section 2); (c) identify the statutory approvals that apply to the project (Section 2.1.1); (d) describe the role, responsibility, authority and accountability of all key personnel involved in the environmental management of the project (Section 6); (e) describe the procedures that would be implemented to: • keep the local community and relevant agencies informed about the operation and environmental performance of the project (Section 3);	Cadia's current Environmental Management Strategy (Document No. 710-005-EN-STR-0001) was issued to the DPIE on the 12th June 2020 (Revision 3) and formally approved by the DPIE on the 18th June 2020. This version of the EMS Strategy complied with the requirements of Project Approval Schedule 5, Condition 1 (a) to (f). **Observation No. 75 –** Cadia would be expected to improve the document control applied to its environmental management plans (i.e. primarily relating to the approval of these plans and defined approval dates).	**Compliant** **Observation**	

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	• resolve any disputes that may arise during the course of the project; • respond to any non-compliance; and • respond to emergencies; (f) include: • copies of the various strategies, plans and programs that are required under the conditions of this approval once they have been approved; and • a clear plan depicting all the monitoring to be carried out in relation to the project.	• receive, handle, respond to, and record complaints (Section 4); • resolve any disputes that may arise during the course of the project (Section 5); • respond to any non-compliance (Section 2.7.4); and • respond to emergencies (Section 2.7); (f) include: • copies of the various strategies, plans and programs that are required under the conditions of this approval once they have been approved (Section 8); and • a clear plan depicting all the monitoring to be carried out in relation to the project (Section 9). To support the above Environmental Management Strategy, Cadia also maintains a number of environmental management plans and monitoring plans (see Requirement No. 3 in the DPIE's Consultation Comments in this audit report). It was stated that the management actions within the environmental management plans and monitoring plans will be entered into the CVO CHESS action management system. It was stated that all actions will be consulted			

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		with the relevant owners prior to inclusion in CHESS. It was stated that statutory compliance related actions are expected to be 70 to 80% of the CHESS actions arising from this process. Cadia also maintains its Statutory Obligations Register within CHESS. Cadia maintains a formal procedure titled "Development, Review and Update of Management Plans and Monitoring Programs (Doc No. 710-005-EN-PRO-0024) issued on the 9th June 2020 that describes how these processes are to be administered on-site.			
2.	**ENVIRONMENTAL MANAGEMENT** **Annual Review** By the end of 2010, and annually thereafter, the Proponent shall review the environmental performance of the project to the satisfaction of the Secretary. This review must: (a) describe the works that were carried out in the past year, and the works that are proposed to be carried out over the next year; (b) include a comprehensive review of the monitoring results and complaints records of the project over the past year, which includes a comparison of these results against the:	Cadia was able to demonstrate that the annual AEMRs issued during the audit period included and complied with the required content defined in Project Approval Schedule 5, Condition 2 (a) to (f), inclusive of: (a) describe the works that were carried out in the past year, and the works that are proposed to be carried out over the next year (Section 4 and throughout the AEMR); (b) include a comprehensive review of the monitoring results and complaints records of the project over the past year, which includes a comparison of these results against: • the relevant statutory requirements, limits or	Cadia was able to demonstrate that the annual AEMRs issued during the audit period included and complied with the required content defined in Project Approval Schedule 5, Condition 2 (a) to (f). **Observation No. 76 –** Cadia's AEMR template could include a table in the front of the template that clearly defines and lists how each issued AEMR complies with the requirements of Project Approval Schedule 5, Condition 2 (a) to (f). **Observation No. 77 –**In relation to the improving the environmental performance of the project, Cadia could consider:	**Compliant** **Observation** **Observation**	

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	• the relevant statutory requirements, limits or performance measures/ criteria; • the monitoring results of previous years; and • the relevant predictions in the EA and previous EAs; (c) identify any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance; (d) identify any trends in the monitoring data over the life of the project; (e) identify any discrepancies between the predicted and actual impacts of the project, and analyse the potential cause of any significant discrepancies; and (f) describe what measures will be implemented over the next year to improve the environmental performance of the project.	performance measures/criteria (Sections 3 and 11); • the monitoring results of previous years (Sections 6 and 7); and • the relevant predictions in the EA and previous EAs (Sections 6 and 7); (c) identify any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance (Section 11); (d) identify any trends in the monitoring data over the life of the project (Sections 6 and 7); (e) identify any discrepancies between the predicted and actual impacts of the project, and analyse the potential cause of any significant discrepancies (Sections 6 and 7); and (f) describe what measures will be implemented over the next year to improve the environmental performance of the project (Section 12). It was stated that CVO plans to upload the current 2019/20 AEMR (issued 27th October 2020) to the Cadia website for public access in mid-November 2020.	• ensuring relevant findings, recommendations or any critical information contained in environmental assessments are extracted and presented in a readily accessible and easy to understand format to all relevant personnel; and • in the case of the location of aboriginal relics, Cadia could consider an updated GIS, with locations marked, that is accessible and workable by personnel in all relevant project departments.		

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Condition of Consent	**Condition Requirement**	**Evidence collected**	**Independent Audit Findings and Recommendations**	**Compliance Status**	**Unique ID for non-compliance**
3.	**ENVIRONMENTAL MANAGEMENT** **Revision of Strategies, Plans and Programs** Within 3 months of: (a) an annual review under condition 2 above; (b) an incident report under condition 5 below; (c) an audit under condition 7 below; or (d) any modification of this approval, the Proponent shall review, and if necessary revise, the strategies, plans, and programs required under this approval to the satisfaction of the Secretary. *Note: This is to ensure the strategies, plans and programs are updated on a regular basis, and incorporate any recommended measures to improve the environmental performance of the project.*	In the 12 months to November 2020, Cadia has operated a formal SharePoint based system (i.e. the Cadia Document Management System) that retains all Cadia documents, enabling the controlled version of each document to be uploaded and accessible via the CVO Intranet page. As of November 2020, it was stated that Cadia's document control process includes a default revision period of two years for Cadia's environmental strategies, management plans, monitoring plans etc. It was stated that as of November 2020, some relevant Cadia documents have not been included in this review cycle to date (e.g. Cadia's Land and Biodiversity Management Plan, which was last issued on 30th May 2017). It was stated that each controlled Cadia document is required to: a) have an owner of the document, either a superintendent or specialist; and b) an approver, that is required to be a Manager. It was stated that in the near future, a Senior Environmental Advisor will be responsible to ensure that effective document management and control processes are maintained within CVO's Environment Department. To facilitate the correct and timely development, review and update of	With some minor exceptions, Cadia was able to demonstrate that relevant environmental strategies, plans and programs are relatively up-to-date and reflect current/required operational practices. **Observation No. 78 –** CVO could request removal of Project Approval Schedule 5, Condition 3 (d) relating to the revision of CVO Strategies, Plans and Programs within 3 months of any modification to the Project Approval, given that for example, three Project Approval modifications occurred in a 12-month period in March 2018, April 2018 and September 2018. The requirement to revise these documents at intervals less than annually is impractical. **Observation No. 79 –** The Amendments Table provided in the current Cadia Water Management Plan should be standardised across all of Cadia's Environmental Management Plans and Monitoring Plans (as this process demonstrates compliance with Project Approval Schedule 5, Condition 3 (b) and (c)), for those plans that are required to be approved by the regulator). **Observation No. 80 –** The AEMRs state that a review of the strategies, plans and programs is undertaken as	**Compliant** **Observation** **Observation** **Observation**	

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		relevant CVO management plans and monitoring programs, CVO's Environment Department issued a procedure in June 2020 relating to the Development, Review and Update of Management Plans and Monitoring Programs (Procedure No. 710-005-EN-PRO-0024). Section 3.1 of this procedure states: "a general review of these plans is undertaken between June and October each year as part of the AEMR process". In Q1 2021, CVO's Environment Department is considering the development and use of a separate Document Register to: a) trigger scheduled updates; and b) stagger the interval of updates to ensure that all CVO environment documents are not required to be reviewed and reissued at the same time each year. It was stated that during the audit period, specific environmental management and monitoring plans were revised and updated as a result of: a) the September 2017 independent audit findings (e.g. vibration monitoring program); and b) relevant incidents (e.g. water related incidents).	part of the Annual Review process in accordance with Project Approval Schedule 5, Condition 3(c). However, any review should be undertaken as per Project Approval Schedule 5, Condition 3(a). The review (and revision if necessary) of the documents is required to be completed within 3 months of the annual review based on actions, improvements, changes etc. identified in the AEMR. Cadia should identify any required changes and revise the relevant document (include revision date) as required by this condition.		

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4.	**ENVIRONMENTAL MANAGEMENT** **Community Consultative Committee** Within 6 months of the date of this approval, the Proponent shall establish Community Consultative Committee (CCC) for the project to the satisfaction of the Secretary. This CCC must be established and operated in general accordance with the Guidelines for Establishing and Operating Community Consultative Committees for Mining Projects (Department of Planning, 2007, or its latest version). *Notes:* • *The CCC is an advisory committee. The Department and other relevant agencies are responsible for ensuring that the Proponent complies with this approval. In accordance with the Guideline, the Committee should comprise an independent chair and appropriate representation from the Proponent, affected councils and the general community.* • *In establishing the CCC, the Department will accept the continued representation from existing CCC members, however the Proponent should ensure that adequate representation is achieved for landowners within the area surrounding the Cadia East underground mine.*	Cadia was able to demonstrate that it has maintained a suitable and effective CCC process during the audit period. Attendees at CCC meetings include: a) an independent chair; b) representatives from three local government departments; c) appointed landowner/community personnel; and d) relevant Cadia personnel (i.e. averaging an attendance rate of approximately 15 personnel at each meeting). The most recent quarterly CCC meeting was held in August 2020, with the next meeting scheduled to be held on the 10th November 2020. Typically, these meetings are of a two-hour- duration and required to be attended by Cadia's General Manager, who is responsible for presenting a suitable presentation that forms the basis for discussions by attendees. At the completion of these meetings, minutes are drafted within two to three weeks of each meeting. These minutes remain in draft format until they are formally ratified at the next meeting and then uploaded to the Cadia website as a final version. A January 2019 version of the CCC guideline exists and has replaced the 2007 version. Cadia has formally	Cadia was able to demonstrate that it has maintained a suitable and effective CCC process during the audit period. **Observation No. 81 –** The next issue of the Project Approval could reference the revised January 2019 version of the Guideline for Establishing and Operating Community Consultative Committees for Mining Projects (i.e. not the 2007 version).	**Compliant** **Observation**	

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		assessed that the current CCC meetings address the requirements of the 2019 guideline.			
5.	**COMPLIANCE** **Incident Notification** The Proponent must immediately notify the Department and any other relevant agencies immediately after it becomes aware of an incident. The notification must be in writing and identify the development (including the development application number and name) and set out the location and nature of the incident.	During the audit period, Cadia utilised its CHESS action management system as the main platform for the uploading and recording of environmental incidents and exceedances against limits defined in the Project Approval and EPL. Internal Notification Cadia has interpreted that "immediate" internal notification of an environmental incident with the potential to cause material harm is 1 hour (i.e. as defined in Section 3.2.2 of the Cadia February 2020 procedure titled "Reporting of Environmental Exceedances and Incidents"). External Notification Section 3.2.4 of the above procedure clearly defines that "written reports are required within 7 days to EPA, DPIE and DPIE-Resource Regulator" (i.e. as it applies to the follow up written report required by the EPL). Cadia's CHESS system records if an environmental incident was reportable to the DPIE and/or NSW EPA, inclusive of a descriptor that records the details. It was stated that Cadia reports environmental incidents to the DPIE	Section 3.2.2 and 3.2.4 of Cadia's February 2020 procedure titled "Reporting of Environmental Exceedances and Incidents" defines the required internal and external reporting obligations for any incident that has or can cause material harm to the environment. **Observation No. 82 –** Cadia's February 2020 procedure titled "Reporting of Environmental Exceedances and Incidents" incorrectly utilises "non-conformances" throughout the procedure (i.e. a failure to meet an internal requirement) instead of referring to "non-compliance" (i.e. a failure to meet a statutory or external obligation). These are the correct and standard definitions utilised in Cadia's Project Approval and in the ISO14001:2015 Standard.	**Compliant** **Observation**	

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		based on the definitions of "incident" and "material harm" in the Project Approval. It was stated that in most cases, the reportable events to the DPIE involved the reporting of exceedances against limits defined in the Project Approval and EPL, rather than actual occurrences of environmental incidents. Since September 2020, it was stated that Cadia utilises a portal for the reporting of incidents to the DPIE. In addition, Cadia understand that all reportable environmental incidents are required to be reported within the annual AEMRs.			
5B.	**COMPLIANCE** **Non-Compliance Notification** Within seven days of becoming aware of a non-compliance, the Proponent must notify the Department of the non-compliance. The notification must be in writing and identify the development (including the development application number and name), set out the condition of this consent that the development is non-compliant with, why it does not comply and the reasons for the non-compliance (if known) and what actions have been, or will be, undertaken to address the non-compliance.	Based on the sample of records which were sighted, for both environmental incidents and exceedances (after the receipt and analysis of relevant environmental monitoring data) against criteria and limits defined in the Project Approval, there was no evidence of Cadia not notifying the DPIE within the seven day timeframe required under Project Approval Schedule 5, Condition 5B. On an annual frequency, environmental incidents and exceedances against Project Approval (and EPL) limits and criteria are collated and reported in Cadia's AEMR and published on the Cadia website.	For both environmental incidents and exceedances, Cadia was able to demonstrate notification to the DPIE within the seven-day timeframe required under Project Approval Schedule 5, Condition 5B, inclusive of supplying the information required within this condition.	**Compliant**	

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	Note: A non-compliance which has been notified as an incident does not need to also be notified as a noncompliance.	The above obligation is effectively described in the Cadia February 2020 procedure titled "Reporting of Environmental Exceedances and Incidents". Section 3.2.4 of this procedure clearly defines that "written reports are required within 7 days to EPA, DPIE and DPIE-Resource Regulator". For each reportable incident or exceedance, the information communicated to the DPIE is in accordance with requirements defined in Project Approval Schedule 5, Condition 5B.			
6.	**COMPLIANCE** **Compliance Reporting** The Applicant must provide regular compliance reporting to the Department on the development in accordance with the relevant Compliance Reporting requirements (DPE 2018).	This Project Approval condition was included within the MOD13 update. It was stated that Cadia inquired to the DPIE relating to the precise requirements and obligations associated with this Project Approval condition (i.e. to determine if further reporting obligations were required in addition to information provided annually by Cadia within its AEMR). This request for additional information was most recently forwarded to the assessments team at the DPIE in July 2020.	It was stated that as of November 2020, Cadia was waiting on a reply and confirmation from the DPIE that existing reporting processes (i.e. Cadia's AEMRs) are adequate to satisfy this Project Approval condition.	**Compliant**	

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Schedule 5 – Environmental Management, Reporting and Auditing					
Condition of Consent	**Condition Requirement**	**Evidence collected**	**Independent Audit Findings and Recommendations**	**Compliance Status**	**Unique ID for non-compliance**
7.	**INDEPENDENT ENVIRONMENTAL AUDIT** By the end of December 2011, and every 3 years thereafter, unless the Secretary directs otherwise, the Proponent shall commission and pay the full cost of an Independent Environmental Audit of the project. This audit must: (a) be prepared in accordance with the relevant Independent Audit Post Approval requirements (DPE 2018); (b) be led and conducted by a suitably qualified, experienced and independent team of experts and include experts in surface water, groundwater and any other fields specified by the Secretary, whose appointment has been endorsed by the Secretary; (c) be carried out in consultation with the relevant agencies; (d) assess whether the development complies with the relevant requirements in this consent, and any strategy, plan or program required under this consent; and (e) recommend appropriate measures or actions to improve the environmental performance of the development and any strategy, plan or program required under this consent.	Cadia was able to demonstrate that it has scheduled, commissioned, completed and paid the full cost of independent three yearly environmental audits of the CVO operation since December 2011. Prior to this audit, Cadia engaged ERM to complete the most recent three-yearly independent environmental audit during the period 18th – 20th September 2017, comprising of a three-person audit team from ERM. The final report (Version C) for the September 2017 audit was submitted to Cadia on the 16th January 2018. Cadia and the independent audit team from ERM were able to demonstrate that the September 2017 audit met the requirements of Project Approval Schedule 5, Condition 7 (a) to (e). Prior to the September 2017 independent environmental audit completed by ERM, previous three-yearly independent on-site environmental audits were completed by: • Grahame Brown and Associates (16th to 20th February 2015); • Umwelt Environmental Consultants (13th to 15th December 2011); and • Matrix+ Consulting (26th to 28th May 2008).	Cadia was able to demonstrate that it has scheduled, commissioned, completed and paid the full cost of independent three-yearly environmental audits of the Cadia Valley Operations since December 2011.	**Compliant**	

Cadia Project Approval 06_0295 (as modified on 20 December 2019)					
Schedule 5 – Environmental Management, Reporting and Auditing					
Condition of Consent	**Condition Requirement**	**Evidence collected**	**Independent Audit Findings and Recommendations**	**Compliance Status**	**Unique ID for non-compliance**
8.	**INDEPENDENT ENVIRONMENTAL AUDIT** Within 3 months of commencing an Independent Environmental Audit, or unless otherwise agreed by the Secretary, a copy of the audit report must be submitted to the Secretary, and any other NSW agency that requests it, together with a response to any recommendations contained in the audit report, and a timetable for the implementation of the recommendations. The recommendations of the Independent Environmental Audit must be implemented to the satisfaction of the Secretary.	A copy of Final Version B (dated 20th November 2017) of the ERM audit report was submitted to the DPIE on the 14th December 2017 by CVO's Approvals Manager. Email correspondence dated 14th December 2017 was sighted. This email was accompanied by a separate attachment - Table 3.1 - Summary of Audit Findings. After comments were received from the DPIE on the 11th January 2018, these were considered and incorporated into the report and ERM issued a Final Report C on the 16th January 2018. The Final Version C of the audit report as issued by ERM on the 16th January 2018 listed the audit findings within Table 3.2 (pages 23–39) of the report.	The previous independent compliance audit in 2017 was completed by an audit team from ERM, with the site component of the audit completed at CVO from the 18th to 20th September 2017. ERM submitted a Version B of the audit report to Cadia on the 20th November 2017. Cadia submitted a copy of this audit report to the DPIE on the 14th December 2017 (i.e. within the required 3 month period). As a result of comments received from the DPIE on the 11th January 2018, a Final Version C of the audit report was issued by ERM on the 16th January 2018.	**Compliant**	
9.	**ACCESS TO INFORMATION** From the end of June 2010, the Proponent shall make the following information publicly available on its website: (a) a copy of all current statutory approvals for the project; (b) a copy of the current environmental management strategy and associated plans and programs; (c) a summary of the monitoring results of the project, which have been reported in accordance with the various plans	As of November 2020, Cadia was able to demonstrate that the following required content was available on its website: (a) a copy of all current statutory approvals for the project (under Statutory Approvals); (b) a copy of the current environmental management strategy and associated plans and programs (under Environmental Overview and Environmental Monitoring webpages); (c) a summary of the monitoring results of the project, which have been	As of November 2020, Cadia was able to demonstrate that all relevant documents required by Project Approval Schedule 5, Condition 9 were available on the Cadia website.	**Compliant**	

Cadia Project Approval 06_0295 (as modified on 20 December 2019)					
Schedule 5 – Environmental Management, Reporting and Auditing					
Condition of Consent	**Condition Requirement**	**Evidence collected**	**Independent Audit Findings and Recommendations**	**Compliance Status**	**Unique ID for non-compliance**
	and programs approved under the conditions of this approval; (d) a complaints register, which is to be updated on a monthly basis; (e) a copy of the minutes of CCC meetings; (f) a copy of any Annual Reviews (over the last 5 years); (g) a copy of any Independent Environmental Audit, and the Proponent's response to the recommendations in any audit; and (h) any other matter required by the Secretary.	reported in accordance with the various plans and programs approved under the conditions of this approval (under Environmental Monitoring); (d) a complaints register, which is to be updated on a monthly basis (since 2013 and up to September 2020, under Community – Stakeholder Communications); (e) a copy of the minutes of CCC meetings (since 2003 and until August 2020, under Community – Stakeholder Communications); (f) a copy of any Annual Reviews (over the last 5 years) (since 2010, under Performance Reporting); (g) a copy of any Independent Environmental Audit, and the Proponent's response to the recommendations in any audit (since 2008, under Performance Reporting); and (h) any other matter required by the Secretary.			

Appendix B:
Agency Consultation Comments and Auditor Investigations

The following Consultation Comments tables set out the environmental issues raised by the agencies which responded to the Lead Auditor's consultation letters as reproduced in Appendix C, and the Auditors' investigations of these issues. The Auditors' investigations are cross-referenced to the relevant Audit Findings and Recommendations within the Detailed Compliance Status table in Appendix A of this audit report.

Cadia Project Approval 06_0295 (as modified on 20 December 2019)			
DPIE Consultation Comments (9th September 2020 (by letter))			
Issue No.	**Environmental issue raised**	**Investigation of issue**	**Independent Audit Findings and Recommendations Appendix A Reference**
1.	All the requirements outlined in Schedule 5 Condition 7 of the Consent.	Refer to evidence collected in Appendix A of this audit report for Schedule 5, Condition 7.	Project Approval Schedule 5, Condition 7.
2.	Whether works associated with Mod 13 have commenced (include date) and what activities have been undertaken to date.	Modification 13 (Cadia Hill Tailings Completion) was granted approval on 20/12/2019 and is essentially comprised of three changes to the Project Approval: 1. <u>Additional deposition of tailings in the Cadia Hill open cut Pit (CHP)</u> Approval was granted to increase the CHP tailings level from the previously approved level of 560 mAHD to the full capacity of 713 mAHD. At the time of this audit it was stated that the CHP level was at approx. 24% of the 713 mAHD level (approx. 509 mAHD), therefore, the tailings level has not reached the previously approved level of 560 mAHD. Infill of the CHP by tailings was sighted during the site inspection (Photo No. 47).	Project Approval Schedule 3, Condition 40A.

Cadia Project Approval 06_0295 (as modified on 20 December 2019)			
DPIE Consultation Comments (9th September 2020 (by letter))			
Issue No.	**Environmental issue raised**	**Investigation of issue**	**Independent Audit Findings and Recommendations Appendix A Reference**
		 Photo No. 47 – Deposition of tailings underway in the CHP (11th November 2020) Consistent with the approval, additional groundwater monitoring is required to be installed adjacent to the south-western corner of the CHP. It was stated that works (drilling) commenced in July 2020. In-pit bores MB94 and MB96 were installed to a depth below the level of the previous bore MB95 (already inundated at a level of approx. 477 mAHD; decommissioned and sealed prior). These in-pit bores have been sampled. In addition, drilling preparation work has been completed for the out-of-pit bores (6 in total; MB97a&b; MB99a&b; MB100 and MB101 where a&b refers to nested bores) adjacent to CHP and Cadiangullong Creek. Drilling of the bores between the CHP and Cadiangullong Creek is expected to	

Cadia Project Approval 06_0295 (as modified on 20 December 2019)			
DPIE Consultation Comments (9th September 2020 (by letter))			
Issue No.	**Environmental issue raised**	**Investigation of issue**	**Independent Audit Findings and Recommendations Appendix A Reference**
		commence 30 November 2020 with expected completion by mid December 2020. Decommissioning and closure of adit VR101, located at 600 mAHD) (Photo No. 48) has not commenced as the tailings level is not expected to reach this level for another two years. **Photo No. 48 –** Adit VR101 located at 600 mAHD in the CHP wall (11th November 2020) AGE consultants have been engaged to commence work on the location and treatment of possible faults and cracks in the south-west corner of the Cadia Hill pit, between 694 mAHD and 713 mAHD. It was stated that the drilling program is 80% complete and includes coring to determine fracturing. In addition, the pit water level is not anticipated to reach	

Cadia Project Approval 06_0295 (as modified on 20 December 2019)			
DPIE Consultation Comments (9th September 2020 (by letter))			
Issue No.	**Environmental issue raised**	**Investigation of issue**	**Independent Audit Findings and Recommendations Appendix A Reference**
		713 mAHD level for approximately 4-8 years, depending on tailings deposition scheduling. 2. <u>Installation of a new ventilation adit to replace VR101 within the CHP</u> Decommissioning and closure of adit VR101 (located at 600 mAHD in the CHP) has not commenced as the tailings level is not expected to reach this level for another two years. It is expected the adit will be sealed during 2022 or 2023 (MOP, 5/3/2020). 3. <u>Construction of additional downstream buttressing of the STSF embankment to cater for future approved lifts</u> It was stated that construction of the buttressing (the works) commenced 1 January 2019, prior to MOD13 approval (20/12/2019). West and east (saddle dam section) buttressing was undertaken and completed (Photo No. 49). Cadia stated that the works completed to date is intermediate buttressing with further work awaiting final STSF lift design.	

Cadia Project Approval 06_0295 (as modified on 20 December 2019)			
DPIE Consultation Comments (9th September 2020 (by letter))			
Issue No.	**Environmental issue raised**	**Investigation of issue**	**Independent Audit Findings and Recommendations Appendix A Reference**
		 Photo No. 49 – STSF buttressing works to date (looking west along outer southern wall of STSF (10th November 2020) Cadia considers the works to date to be consistent with Schedule 2, Condition 2 of the Project Approval in that it is 'generally in accordance' with the EA and entirely within the Part 3A Approval Area (pre-MOD 13), as noted in legal advice received by Cadia (email 25 June 2018). However, based on the approved mine infrastructure area in Figure 1-2 (and Figure ES-4) of the EA 2009, it is considered by the auditors that the works to date were outside the approved CVO disturbance footprint (pre-MOD 13). Notwithstanding, Cadia's verbal communication with DPIE (28 June 2018) confirmed that, based on Cadia's legal advice, DPIE did not disagree with the opinion that a s4.55 Mod of the Part 3A Approval was not required. However, Cadia subsequently applied (9 September 2019) to modify the Project	

Cadia Project Approval 06_0295 (as modified on 20 December 2019)			
DPIE Consultation Comments (9th September 2020 (by letter))			
Issue No.	**Environmental issue raised**	**Investigation of issue**	**Independent Audit Findings and Recommendations Appendix A Reference**
		Approval (MOD 13) under s4.55(1A) of the EP&A Act to expand the approved CVO disturbance footprint to accommodate the proposed construction of the STSF buttressing.	
3.	The status of the review and any revisions of management plans.	Generally, Cadia was able to demonstrate that it revises, updates and reissues its environmental management plans within three-yearly intervals (i.e. as a means of ensuring that these plans describe current and required practices). Some exceptions were noted relating to Cadia completing the review and revision of some management plans during the audit period (e.g. Cadia's Land and Biodiversity Management Plan (Version 3), which was last issued on 30th May 2017, was not reviewed and issued during the audit period). During the audit period, Cadia completed the following revisions of relevant Environmental "Management" Plans: • CVO Dust Management Plan (9th July 2019) – Version 3.0; • CVO Water Management Plan (26th November 2019) – Version 7.0; • CVO Historical Heritage Management Plan (15th June 2020) – Revision 1; • Social Performance Management Plan (12th June 2019) – No.3 (endorsed); • Fugitive Lighting Management Plan (Approval Date – 12th November 2020) – Revision 4; • CVO Hydrocarbon and Chemical Management Plan (23rd January 2019) – Version 1.0;	Project Approval Schedule 5, Condition 3.

Cadia Project Approval 06_0295 (as modified on 20 December 2019)			
DPIE Consultation Comments (9th September 2020 (by letter))			
Issue No.	**Environmental issue raised**	**Investigation of issue**	**Independent Audit Findings and Recommendations Appendix A Reference**
		• CVO Non-Mineral Waste Management Plan (9th May 2019) – Version 2.0. During the audit period, Cadia completed the following revisions of relevant Environmental "Monitoring" Plans: • CVO Air Quality Monitoring Program (11th June 2018) – Version 4.0; • CVO Noise Monitoring Program (11th June 2018) – Version 4.0; • CVO Blast Monitoring Program (7th August 2020) – Version 4.0. It was stated that Cadia is progressing the development and issue of additional environmental management plans over the next 12 months, inclusive of: • CVO Noise Management Plan, • CVO Acid Mine Drainage Management Plan; • CVO Blast Management Plan; and • CVO Operational Water Management Plan. All environmental management and monitoring plans are required to be reviewed and updated in accordance with the workflow and requirements specified in the CVO Development, Review and Update of Management Plans and Monitoring Programs (17th June 2020) – Version 1.0.	
4.	The number of complaints that have been received, whether they have been adequately investigated and actioned by the proponent, particularly in relation to noise and air quality impacts.	During the audit period, Cadia received the following number of external complaints: <u>November 2017/2018 Financial Year</u> • 40 complaints (inclusive of 14 for dust, six for noise, five visual amenity and one for blasting).	Project Approval Schedule 3, Conditions 2, 4 and 5 (regarding noise impacts). Project Approval Schedule 3, Condition 17 (regarding air quality impacts).

Cadia Project Approval 06_0295 (as modified on 20 December 2019)			
DPIE Consultation Comments (9th September 2020 (by letter))			
Issue No.	**Environmental issue raised**	**Investigation of issue**	**Independent Audit Findings and Recommendations Appendix A Reference**
		2018/2019 Financial Year • 52 community complaints (i.e. of these, 37 related to dust emissions and one to traffic noise). 2019/2020 Financial Year • 40 community complaints, inclusive of dust, noise, visual amenity, contractor driving behaviour (i.e. of these, 35 related to dust emissions and one to noise). 2020/2021 Financial Year to 30th September 2020 • 2 complaints, inclusive of one related to dust and one related to noise. During the audit period, Cadia was able to demonstrate that it investigated all valid community complaints and identified and recorded suitable corrective and preventative actions. Cadia was able to demonstrate that all community complaints received during the audit period have been tabulated and are available on the Cadia website (i.e. as the Community Complaints Register). As assessed on a sampling basis and except for surface dust from the northern and southern TSFs (which is being progressed), Cadia was able to demonstrate that it adequately investigated and actioned community complaints received during the audit period. It is acknowledged by the auditors that significant investigations, effort, expenditure and community liaison occurred during the audit period in relation to noise (i.e. traffic noise and noise from the CVO Dewatering Facility) and air quality/dust impacts from the TSFs. Remedial work and capital expenditure continue to be	Project Approval Schedule 3, Condition 49 (regarding visual impacts). Project Approval Schedule 5, Conditions 1, 2 and 9 (regarding recording of complaints).

Cadia Project Approval 06_0295 (as modified on 20 December 2019)			
DPIE Consultation Comments (9th September 2020 (by letter))			
Issue No.	**Environmental issue raised**	**Investigation of issue**	**Independent Audit Findings and Recommendations Appendix A Reference**
		progressed/incurred by CVO to address surface dust emissions from the TSFs, which is expected to continue for the next 12 to 24 months.	
5.	Subsidence between the Cadia Hill Pit (CHP) and Cadia East underground mining.	The Cadia East Project EA predicted that the Cadia East underground mining subsidence zone (Photo No. 50) would extend to the CHP (EA, Figure 2-4d). However, MOD13's geotechnical assessment found that the subsidence zone would not extend to the CHP. That is, at the end of the mine life there will be two pits with no breakthrough or connectivity. **Photo No. 50 –** Cadia East underground mining subsidence in background and CHP in foreground (looking east) (11th November 2020). At the time of the audit, it was stated that the subsidence model had been recently updated (*Assessment of PC2 and PC2-3 Subsidence Zone of Influence*, Geotechnical, 15 January 2020). The results confirmed previous	Project Approval Schedule 3, Condition 43 (regarding historical heritage). Project Approval Schedule 3, Condition 44 (regarding road construction).

Cadia Project Approval 06_0295 (as modified on 20 December 2019)			
DPIE Consultation Comments (9th September 2020 (by letter))			
Issue No.	**Environmental issue raised**	**Investigation of issue**	**Independent Audit Findings and Recommendations Appendix A Reference**
		findings that the Cadia East underground mining subsidence zone would not extend to the CHP (Photo No. 51). Simulated surface cracking limits at June 2037 **Photo No. 51 –** Simulated surface cracking at June 2037 (Geotechnica, 2020) Results (Photo No. 52) indicate that the subsidence zone extent may be smaller than previously modelled.	

Cadia Project Approval 06_0295 (as modified on 20 December 2019)			
DPIE Consultation Comments (9th September 2020 (by letter))			
Issue No.	**Environmental issue raised**	**Investigation of issue**	**Independent Audit Findings and Recommendations Appendix A Reference**
		 Photo No. 52 – Updated subsidence model output: contracted extent (white dashed line) (Geotechnica, 2020)	
6.	Details on the water balance model and surface water discharge.	Cadia was able to demonstrate that during the audit period, its operational water balance is used to effectively quantify flows and water movements within the CVO site. Cadia's site water balance incorporates all primary water sources, consumption, reuse and recycling, change in water storage and losses across the site. The site water balance was completed using metered and measured inputs into a calibrated GoldSIM water model to estimate unmetered inflows and transfers. There was no evidence during this audit of any mismanagement or failure to internally reuse and recycle water as much as practicable during the audit period. Water use and transfers were observed to be managed in a practical and responsible manner in accordance with required operational and water storage demands on-site. No measurable or adverse environmental impacts are known to have occurred (or water related concerns from local landowners) during the audit period from externally	Project Approval Schedule 3, Conditions 23 and 31.

Cadia Project Approval 06_0295 (as modified on 20 December 2019)			
DPIE Consultation Comments (9th September 2020 (by letter))			
Issue No.	**Environmental issue raised**	**Investigation of issue**	**Independent Audit Findings and Recommendations Appendix A Reference**
		sourced/extracted water (e.g. Cadiangullong Dam, Flyers Creek, Belubula River). During the audit period, no off-site mine-affected water discharges occurred from the CVO site and no exceedances occurred against discharge limits defined in Cadia's EPL. The 2014 Minerals Council of Australia Water Accounting Framework (WAF) is used by Cadia as the reporting framework.	
7.	Surface and groundwater, particularly the monitoring program (including the hydraulic gradient, surface and groundwater quality around the base of the CHP, and monitoring and minimising leakage from the CHP towards Cadiangullong Creek), potential leakage or spillage from tailings and the Surface and Ground Water Contingency Plan.	An extensive review and assessment of surface water quality, groundwater quality and groundwater levels were completed in September 2020 by specialist consultant GHD. A 205 page report was issued by the consultant on the 4th September 2020. As part of GHD's review of surface water and groundwater monitoring results for the 2019-2020 reporting period, the GHD report of 4th September 2020 identified the following key performance/ management issues: • The deposition of tailings in the Cadia Hill Pit is potentially influencing groundwater levels and quality in the immediate vicinity of the pit. It is likely that seepage from the pit is influencing localised groundwater at this elevation, however since there is a strong hydraulic gradient towards the pit it is unlikely that decant water is migrating away from the pit. As such, there is no indication of impact on nearby surface water environments. • The WRDs and the TSFs appear to have localised influences of mine related chemistry on surface water quality and groundwater levels and quality. However, based on results from the 2019-20	Project Approval Schedule 3, Conditions 23, 25, 27, 28, 30 and 33 (regarding surface water monitoring program). Project Approval Schedule 3, Condition 34 (regarding groundwater monitoring program). Project Approval Schedule 3, Condition 35 (surface and groundwater contingency plan).

Cadia Project Approval 06_0295 (as modified on 20 December 2019)			
DPIE Consultation Comments (9th September 2020 (by letter))			
Issue No.	**Environmental issue raised**	**Investigation of issue**	**Independent Audit Findings and Recommendations Appendix A Reference**
		reporting period there is no evidence of increased impact to receiving environments in these zones. • Exceedances of a number of groundwater quality trigger values are due to parameters being naturally elevated at some monitoring locations. This potentially includes sulfate at MB84, MB86 and MB87, pH at MB83, MB84 and MB86, and manganese and nickel at MB83. It is acknowledged that site specific guideline values are currently under review as part of the current revision and update of Cadia's Water Management Plan. In September 2020, GHD recommended the installation of additional monitoring bores within the Cadia Hill Pit area. Two additional bores in the Cadia Hill Pit were completed in July 2020 and four additional bores in between the pit and Cadiangullong Creek are planned for installation in December 2020. The auditors direct the DPIE to the above 4th September 2020 report (and the previous September 2019 report) by GHD for all required information relating to CVO's performance applicable to surface water and groundwater.	
8.	Biodiversity impacts associated with the additional downstream buttressing of the Southern Tailings Storage Facility (TSF), as well as closure of Adit VR101 and construction of a replacement adit (bat scats were found in one of the seven side passages of adit VR101 in Oct 2018).	<u>STSF Buttressing Biodiversity Impacts:</u> MOD13 EA assessed biodiversity impacts of the STSF buttressing as requiring clearing of 3.9 ha of exotic grassland and 0.31 ha of Box-Gum Woodland. Intermediate buttressing is now complete (sighted) with further work awaiting final STSF lift design. Some clearing of the 3.9 ha of exotic grassland has been undertaken, however, it was stated that no clearing of the	Project Approval Schedule 3, Condition 40A.

Cadia Project Approval 06_0295 (as modified on 20 December 2019)			
DPIE Consultation Comments (9th September 2020 (by letter))			
Issue No.	**Environmental issue raised**	**Investigation of issue**	**Independent Audit Findings and Recommendations Appendix A Reference**
		0.31 ha of Box-Gum Woodland (verified during site inspection) has been undertaken as of November 2020. <u>Closure of existing adit VR101</u> Cadia have previously decommissioned and closed an adit (an exploration drive (the Cadia Hill Underground or CHUG adit)) located in the CHP prior to inundation by tailings. At that time, an Eastern Bentwing Bat Management Strategy (ERM, April 2018) was prepared (sighted). Sections 3 and 4 of the plan detail the management measures and monitoring required. It was stated that Cadia intend to use the same process (including bat surveys) for closure of adit VR1010 in addition to the obligations in the MOD13 EA. The adit is not expected to be closed for another two years (i.e. dependent on tailings levels). It was stated that construction of a replacement adit has not commenced. **Photo No. 53 –** Existing adit VR101 (11th November 2020)	

Cadia Project Approval 06_0295 (as modified on 20 December 2019)			
DPIE Consultation Comments (9th September 2020 (by letter))			
Issue No.	**Environmental issue raised**	**Investigation of issue**	**Independent Audit Findings and Recommendations Appendix A Reference**
9.	Rehabilitation activities.	Refer to evidence collected and audit findings in Appendix A for Schedule 3, Conditions 36 to 41.	Project Approval Schedule 3, Conditions 36 to 41.
10.	Incident reporting and notification associated with exceedances of water, noise and air quality criteria. Assess whether these notifications were adequately investigated, notifications provided to affected receivers and mitigation/improvement measures were actioned by the proponent. Specifically, in relation to: a. Noise criteria exceedances as a result of traffic movements and the CVO Dewatering Facility, and b. Air quality criteria exceedances as a result of elevated dust from the TSF's.	During the audit period, Cadia was able to demonstrate to the auditors: • a committed and responsible level of investigation of environmental incidents and exceedances against criteria and limits defined in the Project Approval and EPL; • the use of an extensive network of environmental monitoring equipment, utilised to measure off-site noise and dust emissions and on-site surface water and groundwater quality; • improvement programs and commitment of capital expenditure to improve the environmental performance of the operation and to reduce adverse environmental and nuisance impacts to local landowners; • proactive, transparent and responsive communications with affected landowners and relevant community/stakeholder personnel, inclusive of those that attend the Community Consultative Committee meetings, facilitated by an independent chair; • suitable noise monitoring programs have been established and are maintained at affected properties located in the vicinity of the CVO Dewatering Facility. Noise mitigation works have been completed or offered on properties affected by traffic noise, and acquisition rights exist on properties impacted by noise from the CVO Dewatering Facility or associated rail activities; and	Project Approval Schedule 5, Conditions 5, 5B and 6.

Cadia Project Approval 06_0295 (as modified on 20 December 2019)			
DPIE Consultation Comments (9th September 2020 (by letter))			
Issue No.	**Environmental issue raised**	**Investigation of issue**	**Independent Audit Findings and Recommendations Appendix A Reference**
		• responsible commitment and progress were demonstrated by Cadia relating to programs associated with the reduction of surface dust from the Northern and Southern Tailings Storage Facilities.	
11.	On 28 February 2020, the Department issued an Official Caution for non-compliance with Schedule 3 Condition 30. As a result of the non-compliance the proponent made a commitment to install a level sensor in the Cadiangullong Dam and sites central process control system, with an automatic notification alarm when the Dam levels reach the TARP trigger thresholds in the WMP, by 20 April 2020. Provide details as to whether the improvement measures have been installed and their effectiveness.	It was stated that the improvement measures had commenced but, at the date of the audit, had not been fully implemented. It was stated that the water level sensor in Cadiangullong Dam was pre-existing (Photo No. 54), however, the required (telemetry) communication connection between the sensor and the Site Asset Operation Centre (SAOC) has not yet been installed. **Photo No. 54 –** Existing level sensor location (eastern side of Cadiangullong Dam) (11th November 2020)	Project Approval Schedule 2, Condition 4. Project Approval Schedule 3, Condition 28.

Cadia Project Approval 06_0295 (as modified on 20 December 2019)			
DPIE Consultation Comments (9th September 2020 (by letter))			
Issue No.	**Environmental issue raised**	**Investigation of issue**	**Independent Audit Findings and Recommendations Appendix A Reference**
		 Photo No. 55 – Outflow from Cadiangullong Dam to maintain regulatory flows (11th November 2020) The Official Caution of 28 February 2020 was uploaded into CHESS. An action (sighted) was created in CHESS (Act-013674) to install telemetry from the sensor to the Site Asset Operation Centre (SAOC). The action was assigned with highest priority (HIGH) but has been deferred twice to 30/6/20 and again to 30/6/21.	

Cadia Project Approval 06_0295 (as modified on 20 December 2019)			
NSW Resources Regulator Consultation Comments (15th October 2020 (by letter))			
Issue No.	**Environmental issue raised**	**Investigation of issue**	**Independent Audit Findings and Recommendations Appendix A Reference**
1.	Review relevant mining leases and exploration licences as agreed with Resources Regulator	The following six (6) mining leases held by Cadia Holdings Pty Ltd are consistent with the Project Approval (Project Layout Plans – Appendix 2) and with the currently approved MOP (Mining Operations Plan 710-005-EN-PLA-0008 (Rev. K, dated 5/03/2020)). The mining leases as detailed below are the subject of the MOP approval by the Resources Regulator (letter dated 12 March 2020 sighted). MINING LEASE 1405 (Act 1992) MINING LEASE 1449 (Act 1992) MINING LEASE 1472 (Act 1992) MINING LEASE 1481 (Act 1992) MINING LEASE 1689 (Act 1992) MINING LEASE 1690 (Act 1992) In addition, Cadia Holdings Pty Ltd holds two Mining Lease Applications (MLA 505 and MLA 506) as shown in the Project Approval (Project Layout Plans – Appendix 2). A review of the MOP, Mining Leases and Exploration Licences was not included in the audit scope of this independent environmental audit of Project Approval PA_06_0295 (MOD 13).	Project Approval Schedule 5, Condition 7(d) (not included in audit scope).
2.	Undertake an assessment of compliance against the conditions of title related to environmental management	An assessment of compliance against the conditions of title (in the Mining Leases) related to environmental management was not included in the audit scope of this independent environmental audit of Project Approval PA_06_0295 (MOD 13).	Project Approval Schedule 5, Condition 7(d) (not included in audit scope).
3.	Verify that there is a current Mining Operations Plan (MOP) in place and it has been approved	The currently approved Mining Operations Plan 710-005-EN-PLA-0008 (MOP) (Rev. K, dated 5/03/2020) was	Project Approval Schedule 2, Condition 5 (regarding end date of mining operations).

Cadia Project Approval 06_0295 (as modified on 20 December 2019)			
NSW Resources Regulator Consultation Comments (15th October 2020 (by letter))			
Issue No.	**Environmental issue raised**	**Investigation of issue**	**Independent Audit Findings and Recommendations Appendix A Reference**
	by the Regulator – review compliance against any conditions of approval of the MOP;	sighted. The MOP period is from the 1st February 2020 to the 30th June 2022. The MOP was approved by the Resources Regulator (RR-DPIE) which confirmed the MOP approval period is until the 30th June 2022 (letter dated 12th March 2020 sighted). In addition, the MOP 2016-2019 (Rev J) was amended three times during the audit period and then revised (Rev K) which is the current approved MOP (2020-2022). The amendments were approved by the Resources Regulator with the following approval letters sighted: • Amendment B – letter dated 24/04/2018; • Amendment C – letter dated 30/07/2018; • Amendment D – letter dated 01/02/2019.	Project Approval Schedule 3, Conditions 36 and 37 (regarding rehabilitation).
4.	Undertake a critical review of the MOP, including an assessment of its compatibility with the description of operations contained in the planning approval. In particular • Review the rehabilitation strategy as outlined in the MOP to determine if it is consistent with the Project Approval in terms of progressive rehabilitation schedule; and proposed final land use(s); • Review the rehabilitation objectives and completion criteria as outlined in the MOP to determine if they have been developed in accordance with the proposed final land use(s) as outlined in the Project Approval;	A critical review of the MOP was not included in the audit scope of this independent environmental audit of Project Approval PA_06_0295 (MOD 13). In relation to the MOP's description of operations and rehabilitation provisions, the MOP is considered to be compatible with the Project Approval. The rehabilitation schedule for the term of the MOP is described in section 2.3.9 (p 67) and shown in Figure 38 (p 68) of the MOP. Comparison of the progressive rehabilitation schedule compared to the MOP is reported annually by Cadia in the AEMRs (AEMR, Section 8.3). Planned rehabilitation during the term of the current MOP is consistent with the forecast in the 2019/20 AEMR. Progressive rehabilitation is undertaken in accordance with the Cadia Rehabilitation Strategy (Cadia, 2019) and	Project Approval Schedule 3, Conditions 36 to 41. Project Approval Schedule 5, Condition 7(d) (not included in audit scope).

Cadia Project Approval 06_0295 (as modified on 20 December 2019)			
NSW Resources Regulator Consultation Comments (15th October 2020 (by letter))			
Issue No.	**Environmental issue raised**	**Investigation of issue**	**Independent Audit Findings and Recommendations Appendix A Reference**
		the Cadia Land and Biodiversity Management Plan (Cadia, 2017).	
5.	Review the development and implementation of any rehabilitation monitoring programs to assess performance against the nominated objectives and completion criteria – verified by reviewing monitoring reports and rehabilitation inspection records;	Refer to evidence collected and audit findings in Appendix A for Schedule 3, Conditions 36 to 41.	Project Approval Schedule 3, Conditions 36 to 41.
6.	Determine if a rehabilitation care and maintenance program has been developed and implemented based on the outcomes of monitoring program – verified by reviewing Annual Rehabilitation Programs or similar documentation;	Refer to evidence collected and audit findings in Appendix A for Schedule 3, Conditions 36 to 41.	Project Approval Schedule 3, Conditions 36 to 41.
7.	Confirm that mining operations are being conducted in accordance with the approved MOP (production, mining sequence etc.), including within the designated MOP approval boundary – to be verified by site plans and site inspection;	The amount of ore produced as shown in the material production schedule (Table 2-7) is consistent (albeit FY basis) with the Limits on Approval of the Project Approval (refer to Schedule 2, Condition 6 in Appendix A of this audit report). An underground mine inspection was not included in the scope of this audit and therefore the mining sequence could not be verified. However, the mine boundary perimeter was viewed during the site inspection and the mining operations were confirmed to be within the project approval boundaries which is consistent with the MOP.	Project Approval Schedule 2, Condition 2 (regarding carrying out the project generally in accordance with the EA). Project Approval Schedule 2, Condition 6 (regarding calendar year limit on processing of ore).
8.	Confirm that rehabilitation progress is consistent with the approved MOP as verified by site plans and a site inspection. This should include an evaluation against rehabilitation targets and whether the final landform is being	The rehabilitation progress is consistent with the approved MOP (see Issue Number 3 above). This was verified by a site inspection (from a distance) of the western portion of the SWRD (19.5 ha completed December 2017), commencement of the rehabilitation of	Project Approval Schedule 3, Conditions 36 to 41.

Cadia Project Approval 06_0295 (as modified on 20 December 2019)			
NSW Resources Regulator Consultation Comments (15th October 2020 (by letter))			
Issue No.	**Environmental issue raised**	**Investigation of issue**	**Independent Audit Findings and Recommendations Appendix A Reference**
	developed in accordance with conceptual final landform in the Project Approval; and	the laydown yards (scheduled 2019-20) and the Cadia extended and NWRD ramp (scheduled 2020-2022). Rehabilitation of the Laydown Yards was not complete at the time of this audit (MOP forecast completion by 30 June 2020), however, land had been prepared for rehabilitation as reported in the 2019/20 AEMR.	
9.	Based on a visual inspection, determine if there are any rehabilitation areas that appear to have failed or that have incurred an issue that may result in a delay in achieving the successful rehabilitation outcomes	The lower bench area of the NWRD rehabilitation area was inspected as part of this audit. Based on the visual inspection, there was evidence of a good composition of shrubs and grasses but an absence of trees. This was picked up early by Cadia's own monitoring and confirmed with the annual independent monitoring results of the three NWRD monitoring sites (DnA, 2020). It was stated that the lack of trees was due to a poor strike. Cadia plans to correct by infilling with eucalypts when seed becomes available. **Photo No. 56 –** NWRD rehabilitation (11th November 2020)	Project Approval Schedule 3, Conditions 36 to 41.

Cadia Project Approval 06_0295 (as modified on 20 December 2019)			
NSW Resources Regulator Consultation Comments (15th October 2020 (by letter))			
Issue No.	**Environmental issue raised**	**Investigation of issue**	**Independent Audit Findings and Recommendations Appendix A Reference**
10.	Assess progress in the development and implementation of a remediation plan to address the failure of revegetation on the northern waste rock dump.	Refer to the investigation comments for Issue Number 9 above.	Project Approval Schedule 3, Conditions 36 to 41.
11.	Assess progress in the development of an inventory of materials (eg suitable inert capping material) to ensure there is enough material available for emplacement and/or capping to achieve the nominated final landform and sustainable rehabilitation outcomes. This will need to be developed based on the capping design of the tailings dams, particularly to ensure there is sufficient material to address potential long term differential settlement	Topsoil: The topsoil balance is shown is Section 3.2.1.6 of the approved MOP. Based on current stockpiles (as at 30 June 2019) and projected topsoil stripping volumes, a surplus of 542,000 m^3 is forecast. A reconciliation spreadsheet of topsoil volumes supplied by the senior mine surveyor during the audit showed total topsoil stockpile volume as follows: • June 2018: 4,128,369 m^3 • June 2019: 4,237,079 m^3 • June 2020: 4,250,692 m^3 The June 2020 total slightly exceeds the 4,210,879 m^3 reported in the 2019/20 AEMR for the same date and the June 2019 total slightly exceeds the 4,200,000 m^3 in the MOP. However, either way, the current inventory and projection would achieve the required 0.2 m coverage of topsoil for the 2,092 ha (see MOP table 7-2; total disturbed area of 2,033 ha minus 274 ha of open voids) of disturbed area at mine closure (note: mine lease disturbed area of 2,494 ha in Table 7-2 appears to be incorrect). Inert Capping Material (NAF – Blue Dump): A reconciliation spreadsheet of NAF volumes (as at July 2020) supplied by the senior mine surveyor during the audit showed total NAF volume as 79,966,444 m^3. The reconciliation assumed approx. 100 ha @ 2m depth for PAF rehabilitation and approx. 100 ha @ 1m depth for TSF decant cover, therefore requiring 3,000,000 m^3 of capping material leaving a current surplus of	Project Approval Schedule 3, Conditions 36 to 41.

Cadia Project Approval 06_0295 (as modified on 20 December 2019)			
NSW Resources Regulator Consultation Comments (15th October 2020 (by letter))			
Issue No.	**Environmental issue raised**	**Investigation of issue**	**Independent Audit Findings and Recommendations Appendix A Reference**
		76,966,444 m^3. Cadia noted that NAF will be required for STSF buttressing and NTSF repair however, volumes were not known at the date of this audit. It was observed that the Benign Rock (NAF) currently stored as at June 2020 was not reported in the 2019/20 AEMR. **Photo No. 57 –** Plan of Blue Dump (benign waste rock – NAF) stockpile extent (blue line) (email dated 13th November 2020)	

Cadia Project Approval 06_0295 (as modified on 20 December 2019)			
NSW Resources Regulator Consultation Comments (15th October 2020 (by letter))			
Issue No.	**Environmental issue raised**	**Investigation of issue**	**Independent Audit Findings and Recommendations Appendix A Reference**
12.	In addition to the above, the audit should note observations where rehabilitation procedures, practices and outcomes represent best industry practice.	Cadia is following the ESG3: Mining Operations Plan (MOP) Guidelines, September 2013 (ESG3) which details a process for monitoring and managing progression towards successful rehabilitation outcomes. In addition, annual monitoring of both waste rock dump cover systems by external consultants, O'Kane Consultants, includes data collection and interpretation as per the best practice guidelines outlined in the International Network for Acid Prevention (INAP) Global Cover System Guidance Document (INAP 2017).	Project Approval Schedule 3, Conditions 36 to 41.

Cadia Project Approval 06_0295 (as modified on 20 December 2019)			
NSW DPIE – Biodiversity, Conservation and Science Directorate Consultation Comments (20th October 2020 (by email))			
Issue No.	**Environmental issue raised**	**Investigation of issue**	**Independent Audit Findings and Recommendations Appendix A Reference**
1.	Assess the adequacy and effectiveness of the implementation of the Rehabilitation Strategy (Schedule 3 Condition 37).	Refer to evidence collected and audit findings in Appendix A for Schedule 3, Conditions 36 to 41.	Project Approval Schedule 3, Conditions 36 to 41.
2.	Determine whether the biodiversity credits associated with Mod 13 have been retired (Schedule 3 Condition 40A).	It was stated that Cadia's understanding is that the STSF buttressing works under MOD 13 have not commenced, and that work undertaken to date has been in accordance with Project Approval Schedule 2, Condition 2 (a) (i.e. generally in accordance with the EA). This understanding was supported by legal advice (letter, 25 June 2018) and general informal discussions with the DPIE. In addition, the class of the ecosystem (PCT 266) and species (listed in Table 14.2) has not yet been impacted (i.e. the White Box grassy woodland (Photo No. 58) has not been cleared as of the date of this audit). **Photo No. 58 –** PCT 266 (undisturbed) near outer southern wall of the STSF (10th November 2020)	Project Approval Schedule 3, Conditions 36 to 41.

Cadia Project Approval 06_0295 (as modified on 20 December 2019)			
NSW DPIE – Biodiversity, Conservation and Science Directorate Consultation Comments (20th October 2020 (by email))			
Issue No.	**Environmental issue raised**	**Investigation of issue**	**Independent Audit Findings and Recommendations Appendix A Reference**
		Refer to evidence collected and audit finding in Appendix A for Schedule 3, Conditions 40A. Relevant Cadia personnel are aware of the obligations of Schedule 3 Condition 40A requiring the retirement of credits. The biodiversity credits must be retired within two years of commencing construction of MOD 13, however, as understood by Cadia, construction of the STSF buttressing works under MOD 13 has not yet commenced, therefore, the commencement of the timeframe has not been triggered.	
3.	Assess the adequacy and effectiveness of the implementation of the Land and Biodiversity Management Plan (Schedule 3 Condition 41), in particular regarding: a. delivery of the proposed management and monitoring actions, and performance and completion criteria b. whether any of the trigger points in the TARP have been exceeded and whether the corresponding response was adequate c. determine whether an updated version of the Land and Biodiversity Management Plan is required to incorporate the recommendations of the Microbat Management Strategy (the last available version of the LBMP is dated 30/05/2017. The LMBP is not available on the CVO website).	Refer to evidence collected and audit finding in Appendix A for Schedule 3, Condition 41, and the investigation comments for the DPIE Consultation Comments, Issue Number 8.	Project Approval Schedule 3, Condition 41.
4.	Update on IEA recommendations from the 2017 audit (Table 3.2 in the 2017 IEA) and whether	In relation to each paragraph of this issue:	Project Approval Schedule 3, Conditions 37, 38 and 39 (regarding this Issue Number 4).

Cadia Project Approval 06_0295 (as modified on 20 December 2019)			
NSW DPIE – Biodiversity, Conservation and Science Directorate Consultation Comments (20th October 2020 (by email))			
Issue No.	**Environmental issue raised**	**Investigation of issue**	**Independent Audit Findings and Recommendations Appendix A Reference**
	findings and recommendations have been implemented by the proponent, including: a. 3.37 – spatial representation of rehabilitation provided as requested b. 3.38 – reporting to include all biodiversity offset areas c. 3.39 – appropriate long term security for offset areas is in place	(a) Item No. 3.37 of the 2017 IEA suggested that CVO provides a graphical or spatial representation of rehabilitation progression through stages of the rehabilitation cycle. Cadia stated it has recently requested GIS (.dxf) files from its approvals consultant to be loaded on the GIS (MapInfo). This will include details of vegetation mapping, potential archaeological deposits etc. Cadia is currently transitioning to another GIS (ArcGIS). The GIS layers of both past and future rehabilitation, as shown in the currently approved MOP, are available in MapInfo. A limited number of the environmental team have access to the GIS. (b) Item No. 3.38 of the 2017 IEA recommended that all areas to be reported on in AEMRs to make it clear what actions are being undertaken and where. (c) Item No. 3.39 of the 2017 IEA was an action to confirm appropriate long term security for offset areas is in place. Cadia stated that the VPA is still in progress (as reported in the last IEA). Subdivision of Black Rock Range (biodiversity offset) and amendment to the Blayney Shire Council LEP (rezoning of land to E2 Environmental Conservation Zone) was required. At the time of the audit the subdivision plan had been submitted to NSW Land and Registry Services, and Blayney Shire Council was awaiting registration. Changes since the last IEA include the Molybdenum plant relocation where no credits were required and the MOD 13 STSF buttressing which will require credits.	Project Approval Schedule 3, Condition 40A (regarding the MOD 13 STSF buttressing).

Cadia Project Approval 06_0295 (as modified on 20 December 2019)			
Blayney Shire Council Consultation Comments (23rd October 2020 (by email))			
Issue No.	**Environmental issue raised**	**Investigation of issue**	**Independent Audit Findings and Recommendations Appendix A Reference**
1.	Comment: Council acknowledges the significant community concern regarding air quality impacts associated with the drying of the tailing's dams, particularly across spring/summer of 2019.	In the 24 months to November 2020, Cadia was able to demonstrate the expenditure of millions of dollars towards investigations into dust abatement options and large-scale trials on the northern and southern TSFs. Extensive large-scale trials were progressed during the audit period, with the most effective form of mulching being utilised on the northern TSF, and dust suppression products being utilised on the southern TSF. As of November 2020, Cadia was able to demonstrate that the hydro-mulching of large sections of the northern TSF has been largely successful in reducing dust emissions from surfaces that have been treated. Less success has been achieved on the southern TSF with the application of dust suppression chemicals. Subsequently, the southern TSF remains a source of fugitive dust to landowners downwind of the facility during adverse weather conditions. Dust emissions from the surface of the northern and southern TSFs remains a source of community complaints in November 2020 (i.e. 16 community complaints were received relating to dust from the TSFs in 2020 YTD). Refer to evidence collected and audit findings in Appendix A for Schedule 3, Conditions 17 and 19.	Project Approval Schedule 3, Conditions 17 and 19.

Cadia Project Approval 06_0295 (as modified on 20 December 2019)			
NSW EPA Consultation Comments (7th October 2020 (by email))			
Issue No.	**Environmental issue raised**	**Investigation of issue**	**Independent Audit Findings and Recommendations Appendix A Reference**
1.	The EPA issued Cadia a Penalty Infringement Notice (PIN) in relation to dust management in July 2020. The source of the dust was the tailings storage facility. Dust emissions and groundwater quality impacts remain as the key issues of concern for the EPA for this premises.	<u>Dust Emissions from the CVO TSFs</u> The PIN issued by the EPA in July 2020 is acknowledged by the auditors. During this audit, Cadia was able to demonstrate that: • it has committed significant expenditure in the 20 months to November 2020, towards investigations into dust abatement options from the northern and southern TSFs; • these investigations enabled extensive trials to be progressed, with the most effective form of a mulch cover being utilised on the northern TSF, and dust suppression products being utilised on the southern TSF; • it continues to closely monitor dust emissions from the northern and southern TSFs; and • is fully aware of the concerns expressed by relevant landowners in relation to dust from the TSFs. <u>Groundwater Impacts</u> The auditors direct the NSW EPA to the extensive review and assessment of surface water quality, groundwater quality and groundwater levels at the CVO site that was completed in September 2020 by specialist consultant GHD (i.e. GHD issued a 205 page report on 4th September 2020, including required information relating to Cadia's performance applicable to surface water and groundwater). GHD's detailed report of 4th September 2020 identified that it is likely that seepage from the Cadia Hill pit is influencing localised groundwater. In this report, GHD concluded that since the hydraulic gradient is generally towards the pit, it is unlikely that decant water is influencing groundwater at greater distances from the pit.	Project Approval Schedule 3, Conditions 17 and 19 (regarding dust emissions). Project Approval Schedule 3, Conditions 30 and 34 (regarding groundwater quality).

Appendix C:
Consultation letters and Agency responses

In accordance with Condition 7(c) in Schedule 5 of the Project Approval PA 06_0295 (MOD 13) and section 3.2 of the NSW Government's *Independent Audit Post Approval Requirements* (DPIE, May 2020), consultation letters were sent by email to the relevant agencies and the Community Consultative Committee for the Project. These consultation letters are reproduced in this Appendix. Agency comments received in response to the consultation letters are reproduced in this Appendix, and form the issues which are recorded with investigation outcomes in Appendix B.

environmental engineering & energy

PO Box 1693
ARMIDALE NSW 2350
Telephone: 0447-172-010

ABN 57 542 567 124

Email: admin@3eenvironmental.com.au

Project Number: 20217

8th October 2020

Ms Renee Shepherd
Senior Team Leader
Biodiversity Conservation Division (BCD)
Department of Planning and Environment
PO BOX 2111
DUBBO NSW 2830

By email: renee.shepherd@environment.nsw.gov.au

Dear Renee

Re: Cadia East Project (PA 06_0295) – Independent Environmental Audit

3E Environmental Engineering & Energy (3E) has been engaged by Cadia Holdings Pty Ltd to undertake an Independent Environmental Audit (audit) of the Cadia East Project as required by Schedule 5, condition 7 of Project Approval 06_0295.

3E will conduct the on-site component of the audit from 9th to 11th November 2020.

The scope of this audit will include all relevant conditions specified in Project Approval 06_0295 (as modified on 20 December 2019) granted by the NSW Minister for Planning on 6 January 2010 and cover the three-year period from September 2017 (previous audit) to November 2020 (this audit).

Schedule 5, condition 7 of Project Approval 06_0295 (as modified on 20 December 2019) requires that the audit must be carried out in consultation with the relevant agencies.

In compliance with this condition, we request the BCD provide any feedback regarding the environmental operations and/or environmental management of the Cadia East Project and any key issues which the BCD would like us to consider within the scope of the audit.

If you wish to respond to this request please email your written response to: jhanrahan@3eenvironmental.com.au, before 23 October 2020.

Your written response (if any) and this letter will be included as an appendix in the final audit report.

Yours sincerely,
3E ENVIRONMENTAL ENGINEERING & ENERGY

JOHN HANRAHAN *BEng (Chem), MIEAust, MAusIMM*
LEAD AUDITOR

Cc: Mr Jeff Burton – Environment Specialist – Cadia Valley Operations

environmental engineering & energy

PO Box 1693
ARMIDALE NSW 2350
Telephone: 0447-172-010

ABN 57 542 567 124

Email: admin@3eenvironmental.com.au

Project Number: 20217

8th October 2020

Mr Mark Dicker
Director Planning and Environmental Services
Blayney Shire Council
PO BOX 62
BLAYNEY NSW 2799

By email: MDicker@blayney.nsw.gov.au

Dear Mark

Re: Cadia East Project (PA 06_0295) – Independent Environmental Audit

3E Environmental Engineering & Energy (3E) has been engaged by Cadia Holdings Pty Ltd to undertake an Independent Environmental Audit (audit) of the Cadia East Project as required by Schedule 5, condition 7 of Project Approval 06_0295.

3E will conduct the on-site component of the audit from 9th to 11th November 2020.

The scope of this audit will include all relevant conditions specified in Project Approval 06_0295 (as modified on 20 December 2019) granted by the NSW Minister for Planning on 6 January 2010 and cover the three-year period from September 2017 (previous audit) to November 2020 (this audit).

Schedule 5, condition 7 of Project Approval 06_0295 (as modified on 20 December 2019) requires that the audit must be carried out in consultation with the relevant agencies.

In compliance with this condition, we request Blayney Shire Council (BSC) provide any feedback regarding the environmental operations and/or environmental management of the Cadia East Project and any key issues which BSC would like us to consider within the scope of the audit.

If you wish to respond to this request please email your written response to: jhanrahan@3eenvironmental.com.au, before 23 October 2020.

Your written response (if any) and this letter will be included as an appendix in the final audit report.

Yours sincerely,
3E ENVIRONMENTAL ENGINEERING & ENERGY

JOHN HANRAHAN *BEng (Chem), MIEAust, MAusIMM*
LEAD AUDITOR

Cc: Mr Jeff Burton – Environment Specialist – Cadia Valley Operations

environmental engineering & energy

PO Box 1693
ARMIDALE NSW 2350
Telephone: 0447-172-010

ABN 57 542 567 124

Email: admin@3eenvironmental.com.au

Project Number: 20217

8th October 2020

Ms Heather Nicholls
Deputy General Manager Cabonne Services
Cabonne Council
PO Box 17
MOLONG NSW 2866

By email: heather.nicholls@cabonne.nsw.gov.au

Dear Heather

Re: Cadia East Project (PA 06_0295) – Independent Environmental Audit

3E Environmental Engineering & Energy (3E) has been engaged by Cadia Holdings Pty Ltd to undertake an Independent Environmental Audit (audit) of the Cadia East Project as required by Schedule 5, condition 7 of Project Approval 06_0295.

3E will conduct the on-site component of the audit from 9th to 11th November 2020.

The scope of this audit will include all relevant conditions specified in Project Approval 06_0295 (as modified on 20 December 2019) granted by the NSW Minister for Planning on 6 January 2010 and cover the three-year period from September 2017 (previous audit) to November 2020 (this audit).

Schedule 5, condition 7 of Project Approval 06_0295 (as modified on 20 December 2019) requires that the audit must be carried out in consultation with the relevant agencies.

In compliance with this condition, we request Cabonne Council provide any feedback regarding the environmental operations and/or environmental management of the Cadia East Project and any key issues which Cabonne Council would like us to consider within the scope of the audit.

If you wish to respond to this request please email your written response to: jhanrahan@3eenvironmental.com.au, before 23 October 2020.

Your written response (if any) and this letter will be included as an appendix in the final audit report.

Yours sincerely,
3E ENVIRONMENTAL ENGINEERING & ENERGY

JOHN HANRAHAN *BEng (Chem), MIEAust, MAusIMM*
LEAD AUDITOR

Cc: Mr Jeff Burton – Environment Specialist – Cadia Valley Operations

environmental engineering & energy

PO Box 1693
ARMIDALE NSW 2350
Telephone: 0447-172-010

ABN 57 542 567 124

Email: admin@3eenvironmental.com.au

Project Number: 20217

8th October 2020

Mr David Johnson
Chairperson
Community Consultative Committee (CCC)

By email: johnsons08@iinet.net.au

Dear David

Re: Cadia East Project (PA 06_0295) – Independent Environmental Audit

3E Environmental Engineering & Energy (3E) has been engaged by Cadia Holdings Pty Ltd to undertake an Independent Environmental Audit (audit) of the Cadia East Project as required by Schedule 5, condition 7 of Project Approval 06_0295.

3E will conduct the on-site component of the audit from 9th to 11th November 2020.

The scope of this audit will include all relevant conditions specified in Project Approval 06_0295 (as modified on 20 December 2019) granted by the NSW Minister for Planning on 6 January 2010 and cover the three-year period from September 2017 (previous audit) to November 2020 (this audit).

Schedule 5, condition 7 of Project Approval 06_0295 (as modified on 20 December 2019) requires that the audit must be carried out in consultation with the relevant agencies.

In compliance with this condition, we request the CCC provide any feedback regarding the environmental operations and/or environmental management of the Cadia East Project and any key issues which the CCC would like us to consider within the scope of the audit.

If you wish to respond to this request please email your written response to: jhanrahan@3eenvironmental.com.au, before 23 October 2020.

Your written response (if any) and this letter will be included as an appendix in the final audit report.

Yours sincerely,
3E ENVIRONMENTAL ENGINEERING & ENERGY

JOHN HANRAHAN *BEng (Chem), MIEAust, MAusIMM*
LEAD AUDITOR

Cc: Mr Jeff Burton – Environment Specialist – Cadia Valley Operations

environmental engineering & energy

PO Box 1893
ARMIDALE NSW 2350
Telephone: 0447-172-010

ABN 57 542 567 124

Email: admin@3eenvironmental.com.au

Project Number: 20217

8th October 2020

Ms Kate Unitt
Crown Lands – Department of Planning, Industry and Environment
PO Box 2215
DANGAR NSW 2309

By email: kate.unitt@crownland.nsw.gov.au

Dear Kate

Re: Cadia East Project (PA 06_0295) – Independent Environmental Audit

3E Environmental Engineering & Energy (3E) has been engaged by Cadia Holdings Pty Ltd to undertake an Independent Environmental Audit (audit) of the Cadia East Project as required by Schedule 5, condition 7 of Project Approval 06_0295.

3E will conduct the on-site component of the audit from 9th to 11th November 2020.

The scope of this audit will include all relevant conditions specified in Project Approval 06_0295 (as modified on 20 December 2019) granted by the NSW Minister for Planning on 6 January 2010 and cover the three-year period from September 2017 (previous audit) to November 2020 (this audit).

Schedule 5, condition 7 of Project Approval 06_0295 (as modified on 20 December 2019) requires that the audit must be carried out in consultation with the relevant agencies.

In compliance with this condition, we request Crown Lands provide any feedback regarding the environmental operations and/or environmental management of the Cadia East Project and any key issues which Crown Lands would like us to consider within the scope of the audit.

If you wish to respond to this request please email your written response to: jhanrahan@3eenvironmental.com.au, before 23 October 2020.

Your written response (if any) and this letter will be included as an appendix in the final audit report.

Yours sincerely,
3E ENVIRONMENTAL ENGINEERING & ENERGY

JOHN HANRAHAN *BEng (Chem), MIEAust, MAusIMM*
LEAD AUDITOR

Cc: Mr Jeff Burton – Environment Specialist – Cadia Valley Operations

environmental engineering & energy

PO Box 1893
ARMIDALE NSW 2350
Telephone: 0447-172-010

ABN 57 542 567 124

Email: admin@3eenvironmental.com.au

Project Number: 20217

8th October 2020

Ms Sheridan Ledger
Head Regional Operations Unit - Central West
NSW Environmental Protection Authority
PO BOX 1388
BATHURST NSW 2795

By email: Sheridan.Ledger@epa.nsw.gov.au

Dear Sheridan

Re: Cadia East Project (PA 06_0295) – Independent Environmental Audit

3E Environmental Engineering & Energy (3E) has been engaged by Cadia Holdings Pty Ltd to undertake an Independent Environmental Audit (audit) of the Cadia East Project as required by Schedule 5, condition 7 of Project Approval 06_0295.

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The scope of this audit will include all relevant conditions specified in Project Approval 06_0295 (as modified on 20 December 2019) granted by the NSW Minister for Planning on 6 January 2010 and cover the three-year period from September 2017 (previous audit) to November 2020 (this audit).

Schedule 5, condition 7 of Project Approval 06_0295 (as modified on 20 December 2019) requires that the audit must be carried out in consultation with the relevant agencies.

In compliance with this condition, we request the NSW EPA provide any feedback regarding the environmental operations and/or environmental management of the Cadia East Project and any key issues which the NSW EPA would like us to consider within the scope of the audit.

If you wish to respond to this request please email your written response to: jhanrahan@3eenvironmental.com.au, before 23 October 2020.

Your written response (if any) and this letter will be included as an appendix in the final audit report.

Yours sincerely,
3E ENVIRONMENTAL ENGINEERING & ENERGY

JOHN HANRAHAN *BEng (Chem), MIEAust, MAusIMM*
LEAD AUDITOR

Cc: Mr Jeff Burton – Environment Specialist – Cadia Valley Operations

environmental engineering & energy

PO Box 1893
ARMIDALE NSW 2350
Telephone: 0447-172-010

ABN 57 542 587 124

Email: admin@3eenvironmental.com.au

Project Number: 20217

8th October 2020

Ms Katrina Stankowski
Senior Team Leader
Heritage Division – Department of Planning, Industry and Environment
Locked Bag 5022
PARRAMATTA NSW 2124

By email: Katrina.Stankowski@environment.nsw.gov.au

Dear Katrina

Re: Cadia East Project (PA 06_0295) – Independent Environmental Audit

3E Environmental Engineering & Energy (3E) has been engaged by Cadia Holdings Pty Ltd to undertake an Independent Environmental Audit (audit) of the Cadia East Project as required by Schedule 5, condition 7 of Project Approval 06_0295.

3E will conduct the on-site component of the audit from 9th to 11th November 2020.

The scope of this audit will include all relevant conditions specified in Project Approval 06_0295 (as modified on 20 December 2019) granted by the NSW Minister for Planning on 6 January 2010 and cover the three-year period from September 2017 (previous audit) to November 2020 (this audit).

Schedule 5, condition 7 of Project Approval 06_0295 (as modified on 20 December 2019) requires that the audit must be carried out in consultation with the relevant agencies.

In compliance with this condition, we request the Heritage Division provide any feedback regarding the environmental operations and/or environmental management of the Cadia East Project and any key issues which the Heritage Division would like us to consider within the scope of the audit.

If you wish to respond to this request please email your written response to: jhanrahan@3eenvironmental.com.au, before 23 October 2020.

Your written response (if any) and this letter will be included as an appendix in the final audit report.

Yours sincerely,
3E ENVIRONMENTAL ENGINEERING & ENERGY

JOHN HANRAHAN *BEng (Chem), MIEAust, MAusIMM*
LEAD AUDITOR

Cc: Mr Jeff Burton – Environment Specialist – Cadia Valley Operations

environmental engineering & energy

PO Box 1893
ARMIDALE NSW 2350
Telephone: 0447-172-010

ABN 57 542 587 124

Email: admin@3eenvironmental.com.au

Project Number: 20217

8th October 2020

Mr Mark Hodges
Manager Building and Environment
Orange City Council
PO BOX 35
ORANGE NSW 2800

By email: MHodges@orange.nsw.gov.au

Dear Mark

Re: Cadia East Project (PA 06_0295) – Independent Environmental Audit

3E Environmental Engineering & Energy (3E) has been engaged by Cadia Holdings Pty Ltd to undertake an Independent Environmental Audit (audit) of the Cadia East Project as required by Schedule 5, condition 7 of Project Approval 06_0295.

3E will conduct the on-site component of the audit from 9th to 11th November 2020.

The scope of this audit will include all relevant conditions specified in Project Approval 06_0295 (as modified on 20 December 2019) granted by the NSW Minister for Planning on 6 January 2010 and cover the three-year period from September 2017 (previous audit) to November 2020 (this audit).

Schedule 5, condition 7 of Project Approval 06_0295 (as modified on 20 December 2019) requires that the audit must be carried out in consultation with the relevant agencies.

In compliance with this condition, we request the Orange City Council (Council) provide any feedback regarding the environmental operations and/or environmental management of the Cadia East Project and any key issues which the Council would like us to consider within the scope of the audit.

If you wish to respond to this request please email your written response to: jhanrahan@3eenvironmental.com.au, before 23 October 2020.

Your written response (if any) and this letter will be included as an appendix in the final audit report.

Yours sincerely,
3E ENVIRONMENTAL ENGINEERING & ENERGY

JOHN HANRAHAN *BEng (Chem), MIEAust, MAusIMM*
LEAD AUDITOR

Cc: Mr Jeff Burton – Environment Specialist – Cadia Valley Operations

environmental engineering & energy

PO Box 1893
ARMIDALE NSW 2350
Telephone: 0447-172-010

ABN 57 542 587 124

Email: admin@3eenvironmental.com.au

Project Number: 20217

8th October 2020

Ms Christine Fawcett
Manager Environmental Operations – Central/West
Resources Regulator – Department of Planning, Industry and Environment
Locked Bag 21
ORANGE NSW 2800

By email: christine.fawcett@planning.nsw.gov.au

Dear Christine

Re: Cadia East Project (PA 06_0295) – Independent Environmental Audit

3E Environmental Engineering & Energy (3E) has been engaged by Cadia Holdings Pty Ltd to undertake an Independent Environmental Audit (audit) of the Cadia East Project as required by Schedule 5, condition 7 of Project Approval 06_0295.

3E will conduct the on-site component of the audit from 9th to 11th November 2020.

The scope of this audit will include all relevant conditions specified in Project Approval 06_0295 (as modified on 20 December 2019) granted by the NSW Minister for Planning on 6 January 2010 and cover the three-year period from September 2017 (previous audit) to November 2020 (this audit).

Schedule 5, condition 7 of Project Approval 06_0295 (as modified on 20 December 2019) requires that the audit must be carried out in consultation with the relevant agencies.

In compliance with this condition, we request the Resources Regulator (RR) provide any feedback regarding the environmental operations and/or environmental management of the Cadia East Project and any key issues which the RR would like us to consider within the scope of the audit.

If you wish to respond to this request please email your written response to: jhanrahan@3eenvironmental.com.au, before 23 October 2020.

Your written response (if any) and this letter will be included as an appendix in the final audit report.

Yours sincerely,
3E ENVIRONMENTAL ENGINEERING & ENERGY

JOHN HANRAHAN *BEng (Chem), MIEAust, MAusIMM*
LEAD AUDITOR

Cc: Mr Jeff Burton – Environment Specialist – Cadia Valley Operations

environmental engineering & energy

PO Box 1893
ARMIDALE NSW 2350
Telephone: 0447-172-010

ABN 57 542 587 124

Email: admin@3eenvironmental.com.au

Project Number: 20217

6th October 2020

Mr Tim Baker
Senior Water Regulation Officer
Water – Department of Planning, Industry and Environment
209 Cobra Street
DUBBO NSW 2830

By email: Tim.Baker@dpi.nsw.gov.au

Dear Tim

Re: Cadia East Project (PA 06_0295) – Independent Environmental Audit

3E Environmental Engineering & Energy (3E) has been engaged by Cadia Holdings Pty Ltd to undertake an Independent Environmental Audit (audit) of the Cadia East Project as required by Schedule 5, condition 7 of Project Approval 06_0295.

3E will conduct the on-site component of the audit from 9th to 11th November 2020.

The scope of this audit will include all relevant conditions specified in Project Approval 06_0295 (as modified on 20 December 2019) granted by the NSW Minister for Planning on 6 January 2010 and cover the three-year period from September 2017 (previous audit) to November 2020 (this audit).

Schedule 5, condition 7 of Project Approval 06_0295 (as modified on 20 December 2019) requires that the audit must be carried out in consultation with the relevant agencies.

In compliance with this condition, we request the DPI&E-Water provide any feedback regarding the environmental operations and/or environmental management of the Cadia East Project and any key issues which the DPI&E-Water would like us to consider within the scope of the audit.

If you wish to respond to this request please email your written response to: jhanrahan@3eenvironmental.com.au, before 23 October 2020.

Your written response (if any) and this letter will be included as an appendix in the final audit report.

Yours sincerely,
3E ENVIRONMENTAL ENGINEERING & ENERGY

JOHN HANRAHAN *BEng (Chem), MIEAust, MAusIMM*
LEAD AUDITOR

Cc: Mr Jeff Burton – Environment Specialist – Cadia Valley Operations

environmental engineering & energy

PO Box 1893
ARMIDALE NSW 2350
Telephone: 0447-172-010

ABN 57 542 587 124

Email: admin@3eenvironmental.com.au

Project Number: 20217

3 September 2020

Ms. Katrina O'Reilly
Team Leader - Compliance
NSW Department of Planning, Industry & Environment (DPIE)
Level 2, 84 Crown Street
WOLLONGONG NSW 2500

Via email: katrina.o'reilly@planning.nsw.gov.au

Dear Katrina,

RE: CADIA EAST PROJECT (PA 06_0295) – INDEPENDENT ENVIRONMENTAL AUDIT 2020_AUDIT SCOPE PREPARATION

3E Environmental Engineering & Energy has been commissioned to conduct an Independent Environmental Audit (audit) of the Cadia East Project PA 06_0295 (the Approval) in November 2020.

The audit will be undertaken in accordance with Condition 7 of Schedule 5 of the Approval and in accordance with the *Independent Audit Post Approval Requirements* (PAR).

The Independent Audit PAR (2020) requires the auditor to prepare the audit scope and the Department (DPIE) to provide input into the scope of the audit. The purpose of this letter is to seek the DPIE's confirmation of the scope of the audit; i.e. whether the audit should assess compliance with the Approval only, or whether the audit should assess compliance with the Approval and the Mining Leases for the Project.

Condition 7(a) of Schedule 5 of the Approval relates to preparation of the audit in accordance with the relevant Independent Audit PAR. Section 3.3 1. c. of the Independent Audit PAR (2020) states that the audit must include:

"*…all environmental licences and approvals applicable to the development excluding environment protection licences issued under the Protection of the Environment Operations Act 1997;*"

Condition 7(d) of Schedule 5 of the Approval relates to the assessment of compliance and only refers to "this consent" (which we interpret as the Approval).

The Glossary in the Independent Audit PAR (2020) defines "Approval" as: *A regulatory approval instrument.* If we interpret the word "approval" in section 3.3 1.c. of the Independent Audit PAR (2020) separately from "environmental licences" (which means "approval" does not have to be an "environmental approval") then technically a Mining Lease would be included in the audit scope due to Independent Audit PAR (2020) Glossary definition of "Approval".

However, the introduction of the Independent Audit PAR (2020) states: *If there is any inconsistency between the requirements in conditions of consent and the requirements in this document, the conditions of consent prevail.* Condition 7(d) of Schedule 5 of the Approval states: "*assess whether the development complies with the relevant requirements in this consent, and any strategy, plan or program required under this consent*".

There are two alternative interpretations regarding the scope of this audit in relation to the Mining Leases:

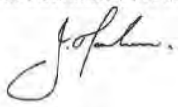
1. We could interpret Condition 7(d) of Schedule 5 of the Approval as a standalone provision (because this is the only paragraph in the condition that relates to "assess"), in which case it is inconsistent with the Independent Audit PAR (2020), and therefore we exclude assessment of compliance with the Mining Leases; or

2. We could interpret Condition 7(d) of Schedule 5 of the Approval as being a more detailed explanation of the general requirement regarding audit preparation in Condition 7(a) of Schedule 5 of the Approval, and therefore we include assessment of compliance with the Mining Leases pursuant to Condition 7(a).

We request the DPIE to confirm whether the scope of this audit should be limited to an assessment of the operation's compliance with the Approval only (alternative 1 above), or expanded to an assessment of the operation's compliance with the Approval and the Mining Leases (alternative 2 above).

Please call should you have any questions.

Yours sincerely,
3E ENVIRONMENTAL ENGINEERING & ENERGY



John Hanrahan
Lead Auditor

cc: Mr Jeff Burton - Environment Specialist - Cadia Valley Operations

Enclosure 1 CADIA EAST PROJECT PA 06_0295 – INDEPENDENT ENVIRONMENTAL AUDIT CONDITION 7 SCHEDULE 5

ENCLOSURE 1

CADIA EAST PROJECT PA 06_0295 – INDEPENDENT ENVIRONMENTAL AUDIT
CONDITION 7 SCHEDULE 5

INDEPENDENT ENVIRONMENTAL AUDIT

7. By the end of December 2011, and every 3 years thereafter, unless the Secretary directs otherwise, the Proponent shall commission and pay the full cost of an Independent Environmental Audit of the project. This audit must:
   (a) be prepared in accordance with the relevant *Independent Audit Post Approval requirements* (DPE 2018);
   (b) be led and conducted by a suitably qualified, experienced and independent team of experts and include experts in surface water, groundwater and any other fields specified by the Secretary, whose appointment has been endorsed by the Secretary;
   (c) be carried out in consultation with the relevant agencies;
   (d) assess whether the development complies with the relevant requirements in this consent, and any strategy, plan or program required under this consent; and
   (e) recommend appropriate measures or actions to improve the environmental performance of the development and any strategy, plan or program required under this consent.

NSW GOVERNMENT | Planning, Industry & Environment

Mr John Hanrahan
Principal Auditor
3E Environmental Engineering & Environment
COPNOR 146 NORDEN ROAD
BLACK MOUNTAIN, NSW 2365

09/09/2020

Dear Mr Hanrahan

Cadia East Project (PA 06_0295)
IEA Audit Scope & Consultation

I refer to your letter submitted to the Department Planning Industry and Environment (**Department**) dated 3 September 2020, seeking clarification in relation to the audit scope and preparation for the Independent Environmental Audit (**Audit**) required for the Cadia East Project, PA06_0295 (**Consent**).

Audit Scope

The Department has carefully reviewed your letter and provides the following in response:

I. In this circumstance the requirements of the Independent Audit Post Approval Requirement (2020) (IA PAR) do appear to be inconsistent with the Conditions of Consent.
II. With this said, the Conditions of Consent do prevail the requirements of the IA PAR.
III. Therefore, the Audit is required to assess whether the development complies with the relevant requirements in this Consent, being PA 06_0295 including any strategy, plan or program required under this Consent.
IV. If any program, plan or strategy required under the Consent, refers to specific requirements in an environmental licence and/or lease, then those requirements will be required to be assessed for compliance as part of the Audit. For example, the approved water management plan notes that Cadia extracts water in accordance with the Water Access Licences (**WALs**), therefore as part of the Audit process the requirements of the WALs would need to be assessed to ensure compliance with their entitlements. This would be the same in relation to the mining lease, if it has been specified within a program, plan or strategy required under the Consent, then those components would need to be audited.

DPIE Consultation Comments

Furthermore, in relation to the Audit the Department requests that it address the following points:

1. All the requirements outlined in Schedule 5 Condition 7 of the Consent.
2. Whether works associated with Mod 13 have commenced (include date) and what activities have been undertaken to date.
3. The status of the review and any revisions of management plans.
4. The number of complaints that have been received, whether they have been adequately investigated and actioned by the proponent, particularly in relation to noise and air quality impacts.
5. Subsidence between the Cadia Hill Pit (**CHP**) and Cadia East underground mining.
6. Details on the water balance model and surface water discharge.
7. Surface and groundwater, particularly the monitoring program (including the hydraulic gradient, surface and groundwater quality around the base of the CHP, and monitoring and minimising leakage from the CHP towards Cadiangullong Creek), potential leakage or spillage from tailings and the Surface and Ground Water Contingency Plan.
8. Biodiversity impacts associated with the additional downstream buttressing of the Southern Tailings Storage Facility (**TSF**), as well as closure of Adit VR101 and construction of a replacement adit (bat scats were found in one of the seven side passages of adit VR101 in Oct 2018).
9. Rehabilitation activities.
10. Incident reporting and notification associated with exceedances of water, noise and air quality criteria. Assess whether these notifications were adequately investigated, notifications provided to affected receivers and mitigation/improvement measures were actioned by the proponent. Specifically, in relation to:
    a. Noise criteria exceedances as a result of traffic movements and the CVO Dewatering Facility, and
    b. Air quality criteria exceedances as a result of elevated dust from the TSF's.
11. On 28 February 2020, the Department issued an Official Caution for non-compliance with Schedule 3 Condition 30. As a result of the non-compliance the proponent made a commitment to install a level sensor in the Cadiangullong Dam and sites central process control system, with an automatic notification alarm when the Dam levels reach the TARP trigger thresholds in the WMP, by 20 April 2020. Provide details as to whether the improvement measures have been installed and their effectiveness.

Agency Consultation

Lastly, in accordance with Schedule 5 Condition 7(c) in relation to agency consultation, the Department requests that as part of the Audit you consult with the following agencies:

- DPIE - Division of Resource and Geosciences
- DPIE – Biodiversity and Conservation Division (BCD)
- DPIE – Natural Resource Access Regulator (NRAR)
- DPIE – Resources Regulator (RR)
- Environment Protection Authority (EPA)
- Department of Primary Industries (DI-Water)
- Councils – Orange City Council, Blayney Shire Council and Cabonne Shire Council

If you wish to discuss the matter further, please contact Jennifer Rowe on (02) 4247 1851.

Yours sincerely

Katrina O'Reilly
Team Leader - Compliance
Compliance

As nominee of the Planning Secretary

NSW Regional NSW

AREQ0012929

Mr John Hanrahan
3E Environmental Engineering & Energy
PO Box 1893
Armidale NSW 2350
By email: jhanrahan@3eenvironmental.com.au

Dear Mr Hanrahan

Subject: Cadia East Project – Independent Environmental Audit

Thank you for your email and letter dated 8 October 2020 requesting consultation on the independent audit to be undertaken of the Cadia East Project.

The Cadia Valley Operations are covered by the titles listed below.

- ML1405 (1992)
- ML1449 (1992)
- ML1472 (1992)
- ML1481 (1992)
- ML1689 (1992)
- ML1690 (1992)

The Resources Regulator requires that the following issues be addressed in independent environmental audits undertaken in accordance with a planning consent condition.

- Review relevant mining leases and exploration licences as agreed with Resources Regulator;
- Undertake an assessment of compliance against the conditions of title related to environmental management;
- Verify that there is a current Mining Operations Plan (MOP) in place and it has been approved by the Regulator – review compliance against any conditions of approval of the MOP;
- Undertake a critical review of the MOP, including an assessment of its compatibility with the description of operations contained in the planning approval. In particular:
    - Review the rehabilitation strategy as outlined in the MOP to determine if it is consistent with the Project Approval in terms of progressive rehabilitation schedule; and proposed final land use(s);

NSW Resources Regulator
516 High Street Maitland NSW 2320 | PO Box 344 HRMC NSW 2310 | Tel: 1300 814 609 |
resourcesregulator.nsw.gov.au

    - Review the rehabilitation objectives and completion criteria as outlined in the MOP to determine if they have been developed in accordance with the proposed final land use(s) as outlined in the Project Approval;
- Review the development and implementation of any rehabilitation monitoring programs to assess performance against the nominated objectives and completion criteria – verified by reviewing monitoring reports and rehabilitation inspection records;
- Determine if a rehabilitation care and maintenance program has been developed and implemented based on the outcomes of monitoring program – verified by reviewing Annual Rehabilitation Programs or similar documentation;
- Confirm that mining operations are being conducted in accordance with the approved MOP (production, mining sequence etc.), including within the designated MOP approval boundary – to be verified by site plans and site inspection;
- Confirm that rehabilitation progress is consistent with the approved MOP as verified by site plans and a site inspection. This should include an evaluation against rehabilitation targets and whether the final landform is being developed in accordance with conceptual final landform in the Project Approval; and
- Based on a visual inspection, determine if there are any rehabilitation areas that appear to have failed or that have incurred an issue that may result in a delay in achieving the successful rehabilitation outcomes.
- Assess progress in the development and implementation of a remediation plan to address the failure of revegetation on the northern waste rock dump.
- Assess progress in the development of an inventory of materials (eg suitable inert capping material) to ensure there is enough material available for emplacement and/or capping to achieve the nominated final landform and sustainable rehabilitation outcomes. This will need to be developed based on the capping design of the tailings dams, particularly to ensure there is sufficient material to address potential long term differential settlement.

In addition to the above, the audit should note observations where rehabilitation procedures, practices and outcomes represent best industry practice.

Yours sincerely

Jenny Ehmsen
Principal Compliance Auditor

15 October 2020

From: David Geering <David.Geering@environment.nsw.gov.au>
Sent: Wednesday, 21 October 2020 8:09 AM
To: John Hanrahan
Subject: RE: Cadia East Project (PA 06_0295) - Independent Environmental Audit: Consultation

Hi John,

Thank you for providing us with the opportunity to contribute to the Independent Environmental Audit and Biodiversity Audit for the Cadia East Project

Given that Aboriginal cultural heritage responsibilities have transferred to Heritage NSW, BCS's main area of interest centres around biodiversity. As such, the items we request to be considered in the audit are:

1. Assess the adequacy and effectiveness of the implementation of the Rehabilitation Strategy (Schedule 3 Condition 37)
2. Determine whether the biodiversity credits associated with Mod 13 have been retired (Schedule 3 Condition 40A).
3. Assess the adequacy and effectiveness of the implementation of the Land and Biodiversity Management Plan (Schedule 3 Condition 41), in particular regarding:
    a. delivery of the proposed management and monitoring actions, and performance and completion criteria
    b. whether any of the trigger points in the TARP have been exceeded and whether the corresponding response was adequate
    c. determine whether an updated version of the Land and Biodiversity Management Plan is required to incorporate the recommendations of the Microbat Management Strategy (the last available version of the LBMP is dated 30/05/2017. The LMBP is not available on the CVO website).
4. Update on IEA recommendations from the 2017 audit (Table 3.2 in the 2017 IEA) and whether findings and recommendations have been implemented by the proponent, including:
    a. 3.37 – spatial representation of rehabilitation provided as requested
    b. 3.38 – reporting to include all biodiversity offset areas
    c. 3.39 – appropriate long term security for offset areas is in place

Regards

David

David Geering
Senior Conservation Planning Officer, North West
Biodiversity, Conservation and Science Directorate | Department of Planning, Industry and Environment

49-53 Wingewarra Street, Dubbo 2830
PO Box 2111 Dubbo NSW 2830
T: 02-6883-5335 | E david.geering@environment.nsw.gov.au
49-53 Wingewarra Street, Dubbo NSW 2830
www.dpie.nsw.gov.au

Planning, Industry & Environment

Our Vision: Together, we create thriving environments, communities and economies

From: Mark Dicker <MDicker@blayney.nsw.gov.au>
Sent: Friday, 23 October 2020 11:22 AM
To: jhanrahan@3eenvironmental.com.au
Cc: Planning
Subject: RE: Cadia East Project (PA 06_0295) - Independent Environmental Audit - Consultation

Hi John,

The only comment to make is that Council acknowledges the significant community concern regarding air quality impacts associated with the drying of the tailings dams, particularly across spring / summer of 2019.

Thanks Mark

Mark Dicker
Director Planning and Environmental Services
Blayney Shire Council

From: jhanrahan@3eenvironmental.com.au <jhanrahan@3eenvironmental.com.au>
Sent: Thursday, 8 October 2020 8:03 AM
To: Mark Dicker <MDicker@blayney.nsw.gov.au>
Subject: Cadia East Project (PA 06_0295) - Independent Environmental Audit - Consultation

Dear Mark,

Please find a request attached seeking any feedback regarding the environmental management at the Cadia East Project.

We will conduct an independent environmental audit from the 9-11 November and would welcome any feedback by the 23 October 2020.

Please feel free to contact me should you have any queries or require further information.

Kind regards,

John Hanrahan *BEng(Chem), MIEAust., MAusIMM*
Lead Auditor

ENVIRONMENTAL | ENGINEERING | ENERGY

PO Box 1893 Armidale NSW 2350
m: 0447-172-010
e: jhanrahan@3eenvironmental.com.au

From: Sheridan Ledger <Sheridan.Ledger@epa.nsw.gov.au>
Sent: Thursday, 8 October 2020 9:44 AM
To: jhanrahan@3eenvironmental.com.au
Cc: EPA RSD Central West Mailbox
Subject: RE: Cadia East Project (PA 06_0295) - Independent Environmental Audit - Consultation

Hello John,

Thank you for your correspondence.

Please be aware the EPA issued Cadia a Penalty Infringement Notice (PIN) in relation to dust management in July 2020. The source of the dust was the tailings storage facility. Dust emissions and groundwater quality impacts remain as the key issues of concern for the EPA for this premises. I trust this assists with the scope of your audit.

Kind regards

Sheridan

From: jhanrahan@3eenvironmental.com.au <jhanrahan@3eenvironmental.com.au>
Sent: Thursday, 8 October 2020 8:01 AM
To: Sheridan Ledger <Sheridan.Ledger@epa.nsw.gov.au>
Subject: Cadia East Project (PA 06_0295) - Independent Environmental Audit - Consultation

Dear Sheridan,

Please find a request attached seeking any feedback regarding the environmental management at the Cadia East Project.

We will conduct an independent environmental audit from the 9-11 November and would welcome any feedback by the 23 October 2020.

Please feel free to contact me should you have any queries or require further information.

Kind regards,

John Hanrahan *BEng(Chem), MIEAust., MAusIMM*
Lead Auditor

ENVIRONMENTAL | ENGINEERING | ENERGY

PO Box 1893 Armidale NSW 2350
m: 0447-172-010
e: jhanrahan@3eenvironmental.com.au

Appendix D:
Endorsement of November 2020 Audit Team

In accordance with Condition 7 (b) in Schedule 5 of Project Approval PA 06_0295 (MOD 13), on 17th August 2020 the Secretary's nominee of the Department of Planning, Industry and Environment (DPIE) endorsed the appointment of the Audit Team for this November 2020 audit. The nominee's letter of 17th August 2020 is reproduced below.

NSW GOVERNMENT | Planning, Industry & Environment

Ms Merrilyn Tinsley
Manger- Health, Safety, Environment, Social Performance and Approvals
Cadia Valley Operations
1460 Cadia Road
Orange, NSW, 2800
17/08/2020

Dear Ms Tinsley

Cadia East project (PA 06_0295)
Endorsement of Auditor

I refer to your letter, dated 13 August 2020, seeking the Secretary's endorsement for an auditor to undertake the Independent Environmental Audit (audit) under Project Approval PA 06_0295 (the Approval) for the Cadia East Project.

Having considered the qualifications and experience of the 3E Environmental, Engineering & Energy audit team, namely;

- John Hanrahan as Lead Auditor,
- Kurt Hammerschmid (an environmental compliance auditor and technical specialist in water) as Auditor, and
- Adam Jones as independent legal and Audit Report Reviewer

the Secretary endorses the appointment of this team to undertake the audit in accordance with Condition 7(b) of Schedule 5 of the Approval. This approval is conditional on the audit team being independent of the development.

Please ensure this correspondence is appended to the Independent Audit Report.

The Independent Audit must be prepared in accordance with the requirements of the Approval and consideration and finalised in accordance with the *Independent Audit Post Approval Requirements*. Failure to meet these requirements will require revision and resubmission.

The Department reserves the right to request an alternate auditor or audit team for future audits.

Notwithstanding the agreement for the above listed audit team for this Project, each respective project approval or consent requires a request for the agreement to the auditor or audit team be submitted to the Department, for consideration of the Secretary. Each request is reviewed and depending on the complexity of future projects, the suitability of a proposed auditor or audit team will be considered.
If you wish to discuss the matter further, please contact Jennifer Rowe on (02) 42471851.

Yours sincerely

Katrina O'Reilly
Team Leader - Compliance
Compliance
As nominee of the Planning Secretary

4 Parramatta Square | 12 Darcy Street, Parramatta 2150 | dpie.nsw.gov.au | 1

Appendix E:
Independent Audit Declaration

Project Name	Cadia East Project
Consent Number	Project Approval PA 06_0295 (MOD 13)
Description of Project	Cadia East Project, including the: • Cadia East underground mine; • Cadia Hill open cut mine; • Ridgeway underground mine; • Blayney and CVO Dewatering Facilities; and • ancillary infrastructure, together known as the Cadia Valley Operations.
Project Address	1460 Cadia Road, Orange NSW 2800
Proponent	Cadia Holdings Pty Limited
Title of Audit	Cadia East Project Independent Environmental Audit Report 2020
Date	8 February 2021

I declare that I have undertaken the Independent Audit and prepared the contents of the attached Independent Audit Report and to the best of my knowledge:

i. the audit has been undertaken in accordance with relevant condition(s) of consent and the Independent Audit Compliance Requirements (Department 2020);
ii. the findings of the audit are reported truthfully, accurately and completely;
iii. I have exercised due diligence and professional judgement in conducting the audit;
iv. I have acted professionally, objectively and in an unbiased manner;
v. I am not related to any proponent, owner or operator of the project neither as an employer, business partner, employee, or by sharing a common employer, having a contractual arrangement outside the audit, or by relationship as spouse, partner, sibling, parent, or child;
vi. I do not have any pecuniary interest in the audited project, including where there is a reasonable likelihood or expectation of financial gain or loss to me or spouse, partner, sibling, parent, or child;
vii. neither I nor my employer have provided consultancy services for the audited project that were subject to this audit except as otherwise declared to the Department prior to the audit; and
viii. I have not accepted, nor intend to accept any inducement, commission, gift or any other benefit (apart from payment for auditing services) from any proponent, owner or operator of the project, their employees or any interested party. I have not knowingly allowed, nor intend to allow my colleagues to do so.

Notes:

a) Under section 10.6 of the Environmental Planning and Assessment Act 1979 a person must not include false or misleading information (or provide information for inclusion in) in a report of monitoring data or an audit report produced to the Minister in connection with an audit if the person knows that the information is false or misleading in a material respect. The proponent of an approved project must not fail to include information in (or provide information for inclusion in) a report of monitoring data or an audit report produced to the Minister in connection with an audit if the person knows that the information is materially relevant to the monitoring or audit. The maximum penalty is, in the case of a corporation, $1 million and for an individual, $250,000; and
b) The Crimes Act 1900 contains other offences relating to false and misleading information: section 307B (giving false or misleading information – maximum penalty 2 years imprisonment or 200 penalty units, or both).

Name of Auditor	John Hanrahan
Signature	
Qualification	B.Eng. (Chem), MIEAust. – Lead Auditor
Company	3E Environmental Engineering & Energy
Company Address	PO Box 1893 Armidale NSW 2850

Appendix F:
Cadia's Response to Independent Audit Report of 16th January 2018

The following tables from the independent environmental audit report of 16th January 2018 (ERM) are available on the Cadia website under the file name, "Cadia Independent Environmental Audit Findings Summary 2018" at: https://www.cadiavalley.com.au/site/performance-reporting.

During this November 2020 audit, Cadia advised it had closed out (i.e. completed) all required actions in the 'CVO Response' and 'Cadia Response 2017' columns of the following tables.

The Audit Classifications referred to in the following 'Summary of Audit Findings' table are:

O = observation;

NC = non-compliant; and

ANC = administrative non-compliance.

Summary of Audit Findings

Item No	Assessment Requirement	Comment	Audit Classification	Response/ Action	CVO Response
EPL 3509					
P1.1	The points referred to in the table detailed in Annex B P1.1 are identified in the EPL for the purposes of monitoring and/or the setting of limits for the emission of pollutants to the air from the point.	Monitoring is conducted in-line with requirements and reported annually (AEMR). Relocation of blast monitoring, noise locations - included in updated Vibration Management Plan (VMP) sent to DP&E in August 2016. Documents are yet to be approved; therefore at this stage the EPL has not been not updated.	O	Update EPL once VMP approved.	Accepted. Pending approval of the VMP (submitted 11/8/2016)
L1.1	Except as may be expressly provided in any other condition of this licence, the licensee must comply with section 120 of the Protection of the Environment Operations Act 1997.	Section 120 of the Protection of the Environment Operations (POEO) Act 1997 prohibits the pollution of water. Localised instances of seepage to groundwater from the southern waste rock dump leachate dams and the southern tailings storage facility has been identified as described in the 2015/16 AEMR. Characterisation work is ongoing in consultation with the EPA and DPI Water to further define the extent of identified seepage influence on groundwater. Future actions include an assessment of potential seepage mitigation measures (as per the pollution reduction program including tailings seepage management section in the EPL updated July 2017). The EPL has further been updated to include Licenced Discharge Point 19 on Rodds Creek at the boundary of the premises with associated discharge concentration limits. To date no significant impact to groundwater users or creeks have been identified, and the identified seepage to groundwater is not considered to have resulted in material harm during the audit period. Management has further confirmed that no fines or notices have been issued by the environmental authorities during the audit period and that on this basis CVO have not been found to contravene Section 120 of the POEO Act.	O	To maintain ongoing compliance continue characterisation work in consultation with the EPA and DPI Water to further assess the nature and extent of identified seepage influence to groundwater and appropriate mitigation measures.	Accepted - Pollution Reduction Program studies are being undertaken as per conditions in EPL 3590. To be submitted to EPA by 28 February 2018.
L4.1	Noise generated at the Blayney dewatering facility and the CVO Dewatering Facility must not exceed the noise limits in the table below. The locations referred to in the table below are indicated by location name. Location / Day / Ev / Night / Night 'Meribah': 43 / 38 / 36 / 45 'Triangle Park': 'Coorabin': 43 / 38 / 37 / 45 'Argyle': 'Weemalla' 'Triangle Flat': 43 / 38 / 36 / 45 Barton Park': 'Bonnie Glen' 'Chesterfield' 43 / 38 / 35 / 45 'Warrengong': 'Willow Creek' Other privately 43 / 38 / 35 / 45	A 1dB exceedance was recorded at Warrengong property. The source was investigated and found that short stockpile movements and haulage following recent Seismic event was the cause. This work has now ceased. Controls will be required if work is re-commenced in the area. An action out of the investigation also includes a TARP that is currently in production.	NC	Implement controls as required if and when work area is again operational.	Accepted. TARP to be developed by 30/6/2017

Item No	Assessment Requirement	Comment	Audit Classification	Response / Action	CVO Response
L4.2	Noise generated at the Blayney dewatering facility and the CVO Dewatering Facility must not exceed the noise limits in the table below. The locations referred to in the table below are indicated by location name. Locality and location / Day - LAeq (15 minute) / Evening - LAeq (15 minute) / Night - LAeq (15 minute) / Night - LA1 (1 minute) 85 Carcoar Street Blayney (Location 1): 50 / 50 / 39 / 49 15 Railway Lane Blayney (Location 2): 50 / 50 / 36 / 46 0 Hill Street Blayney (Location 3): 46 / 46 / 37 / 47 Blayney Primary School (Location 4): 46 / 46 / 36 / 46 Blayney Pre-School (Location 5): 38 / 38 / 42 / 20 84 Newbridge Road Blayney (Athol Gardens): 38 / 38 / 35 / 45 247 Newbridge Road Blayney: 43 / 38 / 35 / 45 331 Newbridge Road Blayney (Hollwood): 43 / 35 / 35 / 45	Train movements off and on siding at CDF have resulted in exceedance on the noise criteria. Three landholders are affected with mitigation required for two. The third landholder thus has triggered the acquisition criteria, but landholder does not want to action acquisition. A review of mitigation options for the property has identified that this mitigation would not be feasible due to the current structure. The auditor understands that discussions are ongoing with the landholder and DP&E in relation to options for mitigation.	NC	Continue to monitor situation, consult with DP&E and landholder, and implement appropriate mitigations as required.	Accepted. Mitigation to be completed following exceedance as required by PA To be applied following identified exceedances.
O1.1	Licensed activities must be carried out in a competent manner. This includes: a) the processing, handling, movement and storage of materials and substances used to carry out the activity; and b) the treatment, storage, processing, reprocessing, transport and disposal of waste generated by the activity.	The auditors observed rubbish disposed in spill kit at the Oil/Waste Oil decanting area. Bins for the disposal of oily rags and spill response bins at the workshop are the same colour (yellow), and in places they are located side by side along with general waste bins. Oil containers and drums were also observed stored in workshop without secondary containment. Further an instance of small oil cans stored on a pallet outside of bunded area was observed in the waste oil storage compound.	O	CVO should review the storage and handling of workshop waste materials to ensure appropriate waste segregation for disposal. All stored hydrocarbon containers should have secondary containment.	Cadia will undertake ongoing inspections that focus on workshop wastes and hydrocarbon storage. Inspections to be undertaken on a 6-monthly basis commencing 1 January 2018.

Item No	Assessment Requirement	Comment	Audit Classification	Response / Action	CVO Response
O2.1	All plant and equipment installed at the premises or used in connection with the licensed activity: a) must be maintained in a proper and efficient condition; and b) must be operated in a proper and efficient manner.	Review of the maintenance work planning and scheduling process, and information management system. This included tracking a sample of maintenance activities for scheduled vehicle maintenance. During the site inspection no observations were made of unmaintained or inappropriately operated equipment. However, minor leaks from breather valves on return water pipeline identified 2015 – 2016. Response detailed in AMERs and not considered a non-compliance	O	No further action required.	
O3.3	All dust control equipment must be operable at all times with the exception of shutdowns required for maintenance	FY15/16 AEMR reported that a water cart was reported to not be in operation during a dry period due to breakdown.	NC	Continue ongoing preventative maintenance to ensure water carts remain in active service.	Accepted Conduct check to ensure planned maintenance is in place for water carts. Checks completed by 31 December 2018.
O4.1	The stormwater control structures (sediment basins) identified at EPA identification point 1 must be drained or pumped out as necessary to maintain each basins design storage capacity within 5 days following rainfall.	Inspections of sediment basins are undertaken following > 10mm of rainfall in a 24 hour period (with an automated inspection alarm set up within CVO's environmental monitoring database). During the audit period capacity was restored within 5 days of rainfall for structures that had sufficient design capacity. However, during the 2014/15 AEMR reporting period three sediment basins were out of compliance with design volumes (sediment basins CD HT, SB15 and CP1A). These basins were reported (AEMR, FY14/15) to rarely accumulate sufficient water to require pumping with the inspection and pumping regime expected to control risk. Maintenance to reinstate storage capacity was undertaken in 2015. During the 2015/16 AEMR reporting period two basins were considered to remain undersized for their estimated catchment (CD HT and AR2-5). Based on on-site communications ERM understands that the catchment for CD HT and AR2-5 has recently been split, and following survey works, sediment basin CD HT and AR2-5 have now been found to be compliant and the current EPL is being updated to reflect this change.	NC	No further action required.	
O4.5	The licensee must undertake maintenance as necessary to desilt any storage basin identified at EPA identification points 1 and 3 in order to retain each storage basins design storage capacity.	Storage basins regularly surveyed to confirm compliance with design specification. As noted for O4.1, a subset of Point 1 sediment basins was found to be non-compliant with design specifications within the audit period. Potential risk to the environment associated with these non-compliances was considered to be low (with no uncontrolled discharges) and rectifying actions have occurred as per the comments provided for O4.1.	NC	No further action required.	
M2.2	Air Monitoring Requirements: Points 4,5,6,7,8,9,10,11 Pollutant / Unit of measure / Frequency / Sampling Method Particulates – Deposited Matter / Grams per square metre per month / Monthly / Australian Standard 3580.10.1-2003	FY14/15: Air quality monitoring was not conducted for 6 days due to electricity supply failure at TEOM units.	AOC	Continue to monitor and maintain equipment as required.	Accepted Regular calibration and scheduled maintenance has been checked and confirmed as being in place for TEOM units.

Item No	Assessment Requirement	Comment	Audit Classification	Response / Action	CVO Response
	Points: 12,13,14,15 Pollutant: PM10; Unit of measure: Micrograms per cubic metre; Frequency: Special Frequency 1; Sampling Method: Australian Standard 3580.9.7 - 2001	FY15/16: Air quality monitoring not conducted for several 24hr periods at MP12, 13, 14 & 15 due to electricity supply failure and instrument faults at TEOM units.	ANC	Continue to monitor and maintain equipment as required.	As Above
R2.2	The licensee must provide written details of the notification to the EPA within 7 days of the date on which the incident occurred.	Incident on 8 July 2015 (pit dewatering line breach) was not reported until 28 July 2015. Delay in reporting due to delay in receiving water quality results. Have since altered approach to send interim letter to avoid missing condition deadline.	ANC	Since 2015 incident systems updated to ensure reporting deadlines are met. No further action required.	
Ministers Conditions of Approval PA 06-0295 (Modification 9)					
3.2.	The Proponent shall ensure that the noise generated by the project does not exceed the noise impact assessment criteria at any residence on privately-owned land or on more than 25 per cent of any privately-owned land. For assessment criteria refer to Annex A Table 2: Noise Impact Assessment Criteria dB(A) LAeq (15min)	CVO has reported noise exceedance during the FY16/17 reporting period in relation to train movements at the CDF rail siding. The impacted resident has been advised of their rights for property acquisition as required. The auditor understands that this matter forms part of ongoing discussion with DP&E, and a review of the noise modelling for the CDF are underway. CVO reports that there have been no community complaints received regarding train noise at the CDF. CVO reported an exceedance of operational noise criteria during the FY16/17 reporting period pertaining to surface stockpile movements. These operations have since ceased, while CVO notes that if recommenced, noise mitigation measures will be required.	NC	CVO should continue to undertake noise mitigation where possible. CVO should complete its review of the CDF noise model and continue to explore options to address noise impacts at this location. If stockpile movement activities re-commence, the CVO's suggested mitigation measures should be enacted in order to reduce noise and potential impacts of this operation.	Accepted. Mitigation to be completed following exceedance as required by PA. To be applied following identified exceedances See previous action L4.1
3.5.	The Proponent shall take all reasonable and feasible measures to ensure that the traffic noise generated by the project does not exceed the traffic noise impact assessment criteria in Table 5. *Table 5: Traffic noise impact assessment criteria dB(A)* Road: Forest Road, Orange Road; Day/Evening: 60 LAeq (15 hours); Night: 55 LAeq (15 hours) Road: Cadia Road, Orchard Road, Four Mile Creek Road, Woodville Road, Panuara Road; Day/Evening: 55 LAeq (15 hours); Night: 50 LAeq (15 hours)	CVO have reported a number of traffic noise exceedances for residences on Long Swamp Road and Cadia Road during the audit period. CVO has contacted the informed the residents as required and provided mitigation measures to houses reportedly to the satisfaction of the landholders. CVO has also undertaken a number of initiatives to minimise traffic noise impacts.	NC	CVO should continue to monitor and where possible seek to minimise traffic noise impacts through ongoing traffic management measures where necessary. Where possible review consent limits in consultation with DPE.	Accepted. Re-vamp the Cadia car-pooling program by 31/12/18. Attempts to modify consents has been unsuccessful. Consideration will be given with future modifications.

Item No	Assessment Requirement	Comment	Audit Classification	Response / Action	CVO Response
	Except for the land in Table 1, the Proponent shall ensure that all reasonable and feasible avoidance and mitigation measures are employed so that particulate matter emissions generated by the development do not cause exceedances of the criteria listed in Tables 8, 9 and 10 at any residence on privately owned land, or on more than 25% of any privately-owned land. *Table8: Long term impact assessment criteria for particulate matter* Pollutant: Total suspended particulate (TSP) matter; Averaging period: Annual; dCriterion: a90 µg/m3 Pollutant: Particulate matter < µm (PM10); Averaging period: Annual; dCriterion: a30 µg/m3 *Table 9: Short term impact assessment criterion for particulate matter* Pollutant: Particular matter < 10 µm (PM10); Averaging period: 24 hour; dCriterion: a50 µg/m3 Table 10: Long term criteria for deposited dust Pollutant: cDeposited dust; Averaging period: Annual; Maximum increase in deposited dust levels: b 2 g/m2/month; Maximum total deposited dust level: a 4 g/m2/month	FY2015/2016 – one recorded PM10 exceedance at TEOM 4 considered likely caused by dust from the tailing dam. Other reported exceedances are attributed to external factors and as such not attributed to CVO operations.	NC	No further action required.	

Item No	Assessment Requirement	Comment	Audit Classification	Response / Action	CVO Response
3.23	The Proponent shall not discharge any water from the site except as may be expressly provided by an EPL or in accordance with section 120 of the Protection of the Environment Operations Act 1997.	Uncontrolled discharges have been limited to the following events: 1. Limited accidental release (<50 L) from pit dewatering line adjacent to Cadiangullong Creek. Leak noticed at 5pm on the 8th of July 2015 and incident reported to the EPA at 7am on the 9th of July. Samples taken upstream and downstream of release as well as suspected mixing zone of released water and water within Cadiangullong Creek. Samples analysed for pH, major ions and trace metals. Letter report with results issued to EPA on the 24th of July concluding that the release had no significant impact on water quality within the Cadiangullong Creek. 2. Limited accidental release (<50 L) from leaking pit dewatering line adjacent to Cadiangullong Creek. Leak noticed and reported to the EPA on the 14th of January 2017. Samples taken upstream and downstream of release as well as suspected mixing zone of released water and water within Cadiangullong Creek. Samples analysed for pH, major ions and trace metals. Letter report with results issued to EPA on the 25th of January concluding that the release had no significant impact on water quality within the Cadiangullong Creek. 3. A number of mostly minor leaks were observed at air release valves on the Blayney return water line between June 2015 and November 2015. The most significant leak occurred on the 27th of July 2015 when an estimated volume of 5 000 L was released. The released water entered private property via a culvert with surface water in the area ultimately draining to a farm dam. Water samples were collected and private landholders notified on the day. Landowners were provided with a written summary of the incident as well as water quality results (with CVO reporting that water quality in the obtained samples met the ANZECC guidelines for livestock and irrigation and that the reported concentrations were mostly consistent with water quality sampling results from Flyers Creek). A report was provided to the EPA on 4 August 2015. Reason for leaks from air release valves investigated and corrective action implemented. Based on the above the incidents noted are not considered to have resulted in significant harm.	NC	No further action required.	
3.37.	The Proponent shall: a) carry out rehabilitation progressively, that is, as soon as reasonably practicable following disturbance; and b) achieve the rehabilitation objectives in the Rehabilitation Strategy (see condition 36), to the satisfaction of the Minister for Mineral Resources.	Field observation confirmed progressive rehabilitation was occurring. AEMRs FY14/15 & FY15/16 include details of the progressive rehabilitation undertaken during reporting periods and states that it is consistent with the MOP. The auditor notes discrepancies in the areas stated as completed rehabilitation and proposed future rehabilitation between the MOP (2016-2019) and the AEMRs FY14/15 & FY 15/16. Interview with Environment and Community Superintendent identified that AEMR-reported proposed future rehabilitation area in the western part of the mine area was pushed further into the future and not completed for operational reasons. The MOP (2016-2019) identifies that area as proposed for rehabilitation in FY17 although the DP&E MOP Amendment A approval letter to CVO (2 May 2017, ref: OUT17/17149) confirms the DP&E acceptance of an amended MOP which delays that area's rehabilitation further into the future.	O	Notwithstanding the finding a suggested improvement is to provide a graphical or spatial representation of rehabilitation rogression through stages of the rehabilitation cycle.	Accepted: Cadia will provide clearer reporting including mapping for indicating rehabilitation progression in future annual reports (commencing with 2017/18 AEMR).

Item No	Assessment Requirement	Comment	Audit Classification	Response / Action	CVO Response
3.38.	The Proponent shall: a) implement the biodiversity offset strategy as described in the EA, and summarised in Table 14 (and shown conceptually in Appendix 6); and b) investigate ways to salvage and beneficially use resources (including timber, fauna habitat, seed and soil resources) in areas subject to subsidence as far as is reasonable and feasible, to the satisfaction of the Secretary.	a. The LMP (CVO 2017) contains descriptions regarding the timing of securing land for the offsets (section 9.6). AEMR FY14/15 & 15/16 both describe ongoing works in the woodland corridors required by Appendix 6 (section 5.5.1) and that monitoring has been occurring in Black Rock Range offset area, and rehabilitation works are progressing in the Flyers Creek and Belubula River offset areas. No reporting of any activities in the Stratton Vale offset area. No evidence is available of the above activities to allow assessment of implementation of offset strategy.	O	All biodiversity offset strategy areas to be reported on in AEMRs to make it clear what actions are being undertaken and where.	Accepted. To be included with the 2017/18 AEMR
3.39.	Within 2 years of the date of this approval, the Proponent shall make suitable arrangements to provide appropriate long term security for the offset areas to the satisfaction of the Secretary.	Section 9.6 of the LMP (CVO 2017) identifies the original condition was dated 6 January 2010 which meets the offset land security requirement due on 6 January 2012. No evidence is available to demonstrate that long term security was obtained prior to this date except for a decision that a VPA should be used. This is an ANC despite the subsequent detail of CVO conversations. Section 9.6 of the LMP contains detail of correspondence with the NSW DP&I (then) (now DP&E) in amongst liaison detail with the DoEE (not relevant to this condition). The (then) DP&I were involved in liaison with CVO regarding offset land security and CVO quote an unreferenced approval from DP&I confirming agreement. A VPA was submitted in 2012. A modification application was made after considering appropriate additional areas in May 2015 and approved. An updated VPA was then prepared following subdivision plans for the new areas and submitted to DPE on 20 June 2017. A VPA which is the chosen land security for the Black Rock Range offset area is reported in both FY14/15, FY 15/16 and FY16/17 AEMRs as being 'in progress'.	ANC	Confirm appropriate long term security for the offset areas to the satisfaction of the Secretary is in place.	Accepted. Cadia has contacted DP&E regarding status of the draft VPA submitted in June 2017
3.43.	The Proponent shall prepare and implement a Historical Heritage Management Plan for the project to the satisfaction of the Secretary. This plan must: a. be prepared in consultation with the OEH and be submitted to the Secretary for approval within 6 months of the date of this approval; b. include: • compilation of archival recording, excavation and/or salvage of heritage items within the project disturbance area, including the Wire Gully Gold Workings and the Little Cadia Copper Mine; • a detailed conservation management strategy for heritage items outside the project disturbance area but within the vicinity of the site, including a: ◦ description of the measures that would be implemented to protect heritage items from disturbance, including disturbance from blasting activities; ◦ program to monitor the effects of blasting on relevant heritage items; and ◦ an Interpretation Plan for the Cadia Village.	HHMP has been under review since 2011. It was initially submitted to the Department of Planning in 2011 but approval has not been received. A revised approach is being drafted and resubmitted to DP&E.	ANC	Follow up approval of HHMP.	Cadia is completing a conservation management plan for SHR779. The Plan will be appended to the HHMP submitted to DP&E and the Heritage Council. The Conservation Management Plan will be submitted for approval during 2018.
5.5.	The Proponent shall notify the Secretary and any other relevant agencies immediately of any incident. Within 7 days of the date of the incident, the Proponent shall provide the Secretary and any relevant agencies with a detailed report on the incident, and such further reports as may be requested.	The FY2015/2016 AEMR reports that following an incident the written report required to be submitted to EPA with 7 days was provided to EPA one day late.	ANC	CVO to ensure in future that reporting deadlines are met.	Accepted. To be applied on an ongoing basis following the reporting of incidents.

Mining Leases 1405, 1449, 1472, 1481 1689 and 1690

Item No	Assessment Requirement	Comment	Audit Classification	Response / Action	CVO Response
ML1405ML1449 8	As soon as any drill hole ceases to be used it must be filled or plugged to the satisfaction of the Regional Inspector of Mines and the land in its immediate vicinity left in a clean, tidy and stable condition	CVO has indicated that it has a number of legacy boreholes that have not been filled or plugged. The auditor was advised that CVO has an ongoing program of works to address the issue of borehole completion.	NC	Continue to identify and make safe legacy boreholes	This condition has been removed from the renewed ML 1405 effective from 5 October 2017
All MLs 11	Operations must not be carried out in a manner that endangers the safety of any persons and stock in the vicinity of the operations. In particular, all shafts and excavations are to be appropriately protected, to the satisfaction of the Regional Inspector of Mines, to ensure that access to them by persons arid stock is restricted. Abandoned shafts and excavations opened up or used by the lease holder are to be filled in or otherwise rendered safe to a standard acceptable to the Regional Inspector of Mines.	Refer ML1405, ML1449, Condition 8 above.	O	Refer ML1405, ML1449, Condition 8 above.	This condition has been removed from the renewed ML 1405 effective from 5 October 2017
ML1405ML1449 37a.	Operations must be carried out in a manner which avoids pollution of the Lachlan River Catchment Area.	Potential pollution to the Lachlan River Catchment is controlled through the EPL and the 2014 Water Management Plan which include requirements for surface and groundwater quality monitoring (which include trigger values for further actions). Water quality monitoring data reported in AEMRs and monitoring results are available online. Localised instances of seepage to groundwater from the southern waste rock dump leachate dams and the southern tailings storage facility has been identified as described in the 2015/16 AEMR. Characterisation work is ongoing in consultation with the EPA and DPI Water to further define the extent of identified seepage influence on groundwater and to identify appropriate mitigation measures. Refer to L1.1 in EPL compliance table for further details.	O	See recommendations for Item L1.1 in EPL compliance table.	This condition has been removed from the renewed ML 1405 effective from 5 October 2017 / Addressed in EPL 5590
37c.	The lease holder must comply with any regulations in force for the protection from pollution of the said Catchment Area	The requirements of the EPL (EPL # 5590) and Section 120 of the Protection of the Environment Operations Act 1997 refers. Localised instances of seepage to groundwater from the southern waste rock dump leachate dams and the southern tailings storage facility has been identified as described in the 2015/16 AEMR. Characterisation work is ongoing in consultation with the EPA and DPI Water to further define the extent of identified seepage influence on groundwater and to identify appropriate mitigation measures. Refer to L1.1 in EPL compliance table for further details.	O	See recommendations for Items L1.1 in EPL compliance table.	This condition has been removed from the renewed ML 1405 effective from 5 October 2017 / Addressed in EPL 5590
40.	Operations must be carried out in a manner that avoids the pollution or siltation of any watercourse or waterbody.	See Item 37a.	O	See recommendations for Items L1.1 in EPL compliance table.	This condition has been removed from the renewed ML 1405 effective from 5 October 2017 / Addressed in EPL 5590

Previous Audit (2014) – Outstanding Recommendations and Response

Clause	Requirement	Compliance	Recommendation	CVO Response	Proposed Action	2017 Audit Finding	Cadia Response 2017
Recommendations - Project Approval dated 6 January 2010							
S3.25	**Baseflow Offsets** The Proponent shall offset the loss of baseflow to the Belubula River and associated creeks caused by the project, in consultation with NOW, and to the satisfaction of the Secretary. The offsets shall be provided either incrementally or on one occasion:(a) prior to the baseflow loss being realised, or within 12 months of the date of this approval for any existing realised baseflow losses that have not previously been offset; and(b) within the catchments where the baseflow loss is realised, as far as is reasonable and feasible, unless otherwise approved by the Secretary. *Notes:- The offsets should be provided via the retirement of adequate water entitlements to account for the loss attributable to the project.- Relevant compensatory water supplies implemented under condition 24 may be subtracted from the offsets required under this condition. The Proponent is not required to provide additional baseflow offsets where such offsets have already been provided under previous consents for the project. These existing offsets are to be described and evaluated in the Surface and Ground Water Contingency Plan (see condition 35 below).*	NA	**S3.25.1** It is recommended by the technical expert reviewing surface water management that CVO update the Water Management Plan to reflect the approach to calculation and offsetting of baseflow losses. **Ranking: N**	The Water Management Plan (WMP) approved by DP&E on 5 December 2014 includes an action to formalise the approach for calculation and offset of baseflow loss with NSW Office of Water."	Action to be completed as per WMP. CVO to seek further advice from NOW on alternative approaches to determining baseflow losses.	Matter raised with NoW.. To be followed up again.	The next revision of the Water Management plan will contain triggers for the loss of baseflow in tributaries to the Belubula River. Following the initiation of a trigger an investigation will be undertaken as described in the WMP. WMP to be submitted by 31 August 2018.

2021 Cadia Valley Operations Rehabilitation Monitoring Report

for
Newcrest Mining Limited

Prepared by
DnA Environmental
May 2021

Disclaimer

This is a report of work carried out by DnA Environmental on behalf of Newcrest Mining Limited Cadia Valley Operations (CVO), Orange and has been prepared according to the brief provided by the client. The information contained herein is complete and correct to the best of my knowledge. The representations, statements, opinions and advice expressed or implied in this report are for the benefit of the Client only.

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Signed:

Dr Donna Johnston
Restoration Ecologist
PhD, BAppSc (Hons) MEIANZ

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Reviewed by: John Ford - Environmental Scientist CVO.
Final report submitted: 8th September 2021.

DnA Environmental
417 Mandurama Rd
Mandurama, NSW 2792

Ph/Fax: (02) 63 675 251
Mobile: 0408 221 922
donna@dnaenviro.com.au
ABN 19 607 392 634

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Field work and associated reports have been undertaken by Dr Donna Johnston and Andrew Johnston from DnA Environmental. In 2021, field surveys were undertaken by Andrew Johnston (DnA Environmental) and Ray Mjadwesch (Mjadwesch Environmental Service Support). John Ford (CVO Environmental Scientist – Land & Biodiversity) provided comments on the report.

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Executive summary

Cadia Valley Operations (CVO) is one of Australia's largest gold mining operations and is 100 per cent owned by Newcrest. It is located approximately 25 kilometres from the city of Orange in central west New South Wales. Rehabilitation activities at the Cadia Valley Operations aim to generate safe and sustainable landforms at the mine site and on CHPL-owned land.

Final land use goals are broadly based on the pre-existing land uses within the Cadiangullong Creek Valley, with these being agriculture (predominantly grazing) with scattered paddock trees and woodland conservation. The pre-existing landform of undulating hills would be replicated through mine rehabilitation landforms so that these landforms are typical of the surrounding topography. Specific future post mining land use goals include:

- High quality agriculture (Grazing) areas where there is a low risk of erosion, degradation and damage by grazing livestock using a species composition and carrying capacity similar to the surrounding agricultural areas.
- Woodland (conservation) to establish similar vegetation communities to the surrounding remnant woodlands and to increase the extent and connectivity of woodlands in the local area.

Other post-miming rehabilitation objectives will allow for future needs of the community through retaining key infrastructure where appropriate (pending future negotiations with regulatory bodies / community. Progressive rehabilitation of mining disturbed lands would be undertaken throughout the life of the Project, where practicable.

The 2021 rehabilitation monitoring program was undertaken by DnA Environmental on behalf of Newcrest Mining Limited, Cadia Valley Operations (CVO). The purpose of this report is to present the results of the ongoing annual rehabilitation monitoring program that first commenced in 2008. The monitoring program compares the progress of rehabilitated landforms towards fulfilling long-term land use objectives by comparing a selection of ecological performance targets or completion criteria against areas of remnant vegetation not impacted by mining activities that are representative of the final land use and vegetation assemblage (reference sites). It also aims to comply and be consistent with conditions specified within a range of approval documents and associated Management Plans and align with the regulatory guidelines whilst addressing the range of technical issues associated with mine rehabilitation.

The CVO monitoring project aimed to establish clearly defined, repeatable and consistent methodologies for monitoring changes in various aspects of ecosystem function, succession and long-term sustainability. Part of the process includes:

- Establishing a range of relevant reference sites to compare and track the progress and inherent ecosystem function of rehabilitation areas;
- Selecting a range of suitable reference sites that reflect the desired final land use, biodiversity targets, historical disturbances and local community expectations; and
- Undertaking a monitoring program that provides simple but informative and reliable information that indicates positive recovery trends or rapid detection of rehabilitation failure.

In September 2013 NSW Department of Planning, Industry & Environment, (formerly NSW Trade and Investment - Division of Resources and Energy) or the "Department", released the revised ESG3 MOP guidelines (T& I 2013) which detailed a process for monitoring and managing progression towards successful rehabilitation outcomes quantified by completion criteria. The ESG3 MOP is used by the Department to monitor the progress of mining and rehabilitation activities across the life of a mine. The ESG3 MOP guidelines detailed a process for monitoring and managing progression towards successful rehabilitation outcomes quantified by completion criteria, which are applicable to each of the similar land management units within the mine site. Rehabilitation Phases where the post mining land use is a native plant ecosystem according to the MOP guidelines include:

- Decommissioning;
- Landform establishment and stability;
- Growth medium development;
- Ecosystem and land use establishment; and
- Ecosystem and land use sustainability.

Reference sites provide a range of ecological performance indicators or completion criteria against which rehabilitation progress can be compared and provide the ability to monitor ecological indicators of an existing natural ecosystem and changes in that ecosystem as a result of climatic variations and disturbance events (such as drought, fire, flood etc.). The reference sites are used as a benchmark for the final rehabilitated landscape and provide a time series record of ecosystem change and development. Since its inception the CVO monitoring program has adopted this process of comparing rehabilitation areas against reference sites in logical successional phases and has adapted the methodology with the various revisions of the Departments regulatory guidelines.

CVO Rehabilitation monitoring program

At CVO, the agreed post mining land use aims to establish a combination of grazing land and endemic woodland on final landforms and add value to the current vegetation corridor program of CVO farmland. Three main vegetation communities form the basis of the rehabilitation objectives and these include woodland (open woodland with grassy understorey), riparian woodlands and perennial pastures (exotic grassland suitable for grazing). Replicated sites representing each of these main community types (reference sites) were established to provide a range of ecological performance targets or completion criteria. Reference sites were spread out where possible to maximise the spatial distribution and subsequent variations in community composition across the local landscape and all are now situated on Cadia owned land.

At CVO, rehabilitation has been progressive since the inception of the monitoring program and subsequently the number of rehabilitation monitoring sites has typically grown over the years. A review of the monitoring program has been undertaken on numerous occasions prompting the need to simplify and refine the methodology without losing the heterogeneity of the local ecology and to align more adequately with the various changes in the MOP reporting guidelines. Major rehabilitation has been undertaken on the main Waste Emplacements in 2008 (South Dump) and in 2014/2015 and 2018 (North and South Dump). Subsequently there have been some changes in the quantity, locations and frequency of monitoring of the rehabilitation sites.

This year the monitoring program included monitoring of:

- Three woodland reference sites;
- Nine woodland rehabilitation sites including:
    - South Dump 04 – 10 (excluding 06);
    - North Dump 01 – 03.

Some of the older, more stable woodland and riparian rehabilitation sites and farmland revegetation areas are now monitored on a three-year rotation in an attempt to keep the number of monitoring sites to a manageable level. The three farmland revegetation sites (Willunga DS 01 – 02 and Ashleigh Park) and two riparian rehabilitation sites (Creek Diversion, Cadiangullong Creek) and the riparian reference sites were last assessed 2019.

The monitoring methodology is consistent with that used in previous years and includes a combination of Landscape Function Analyses (LFA) and an assessment of ecosystem characteristics using an adaptation of methodologies derived by the Biometric Model. Soil analyses and permanent transects and photo-points have been established to record changes in these attributes over time.

Data obtained from replicated reference sites are used to provide upper and lower ecological performance indicator limits or "completion criteria targets". Primary completion performance indicators are those chosen as completion criteria targets and rehabilitation sites should equal, exceed, or show positive trends towards those attributes of the reference sites. When these primary completion performance indicators have been met or are trending in the right direction, the sites should therefore theoretically be eligible for closure sign off. The range values of each ecological performance indicator are adapted annually to reflect climatic variations and local disturbance events. Ecological monitoring has been undertaken in autumn in all monitoring years and this year occurred from 12th -14th April. This year, field surveys were undertaken by Andrew Johnston (DnA Environmental) and Ray Mjadwesch (Mjadwesch Environment Service Support).

Rainfall

The long-term annual average rainfall recorded at Orange Airport is 846mm however below average annual rainfall has been experienced since 2014, except in 2016 and 2020. In 2016, above average rainfall events from May through to September occurred which collectively caused extensive flooding throughout the Central Western Region. This flood event was the result of 610mm or close to 70% of the annual average of rainfall over five consecutive winter months.

Since October 2016, the lowest annual rainfall was recorded for three consecutive years during 2017 to 2019 with only just over half of the expected annual rainfall being received in 2017 and 2018, while in 2019 only 417mm was recorded. In January and February 2020, some rainfall was experienced but these were lower than average, however expected rainfall was received in March and above average rainfall was recorded in April with 147mm being recorded. During the remainder of 2020, monthly averages were slightly low in most months, except in October, resulting in a total of 821mm being recorded for the year. During January, February and March this year, rainfall was similar to or above the expected averages.

Subsequently there have been extremes in climatic conditions, with floods in 2016 followed by three consecutive years of drought which has typically been reflected in the monitoring data. Over the last year there have been improved growing conditions resulting in a reduction in grazing and disturbance by animals, and extensive plant growth and increased levels of ground cover.

Progress of the woodland rehabilitation sites

The improved seasonal conditions this year has resulted in a significant increase in the growth, diversity and abundance of the vegetation, especially ground covers and subsequently, improved ecological function was recorded in all monitoring sites. South Dump 10 and the three rehabilitation sites on the North Dump had levels of ground cover and functional patch areas that were similar to the local woodlands this year. All sites on the South Dump (except South Dump 10) continued to have low levels of ground cover and functional patch areas compared to the woodland reference sites, but numerous sites were close to reaching this target. Despite this, all rehabilitation sites had acceptable levels of perennial ground cover, except South Dump 10 which was dominated by annual exotic weeds.

The woodland reference sites continued to be the most ecologically functional sites with the sum of LFA scores (stability + infiltration + nutrient recycling indices) ranging from 177 – 202, out of a possible score of 300. These sites contained high patch areas, mature tree canopies and high abundance of protective perennial ground covers. Most importantly, they also had a well-developed and decomposing litter layer which had developed a spongy humus layer with little to no soil surface crusting. Sites North Dump 02, South Dump 05 and South Dump 08 were functionally similar to each other with scores of 172, 161 and 158 respectively, closely followed by North Dump 01 with a sum of 152.

Sites South Dump 10, North Dump 03 and South Dump 09 were functionally very similar to each other with a sum of scores ranging from 145 - 149, with South Dump 10 having the highest function of these sites. Sites South Dump 04 and South Dump 07 were the least functional communities and appear to be developing more slowly but at similar rates to each other with scores of 133 and 127 respectively.

There continues to be a decline in tree and/or shrub densities in most rehabilitation areas, however these have typically been species of acacia (and volunteer *Cassinia arcuata* (Chinese Shrub)) which presently occur in much higher numbers than would be expected in the local woodlands. The high densities of acacias are a crucial part of the successional development of the rehabilitation areas, especially in the development of the soil profile as their stems assist in accumulating mobilised resources (alive or dead), their roots improve soil characteristics and the extensive addition of dead leaves and spent pods add nutrients and improve the extent and decomposition of the litter layers.

There was a low abundance of eucalypts within some rehabilitation areas, especially near South Dump 04 and none have been recorded in the North Dump monitoring sites. Native non-endemic species to the CVO area were *A. decurrens* (Early black Wattle) and *A. filicifolia* (Fern-leaved Wattle) which were recorded in low densities in several sites. It is also questionable if *A. spectabilis* should be included as endemic to the CVO area. While they are non-endemic, they are native to NSW, limited in number and are not seen to represent any environmental risk.

There has been no consistent change in total species diversity across the range of monitoring sites however the level of diversity has tended to fluctuate with the seasonal conditions and degree of grazing intensity. In the rehabilitation areas floristic diversity may also be associated with the successional development and/or management intervention of the area. An increase in species diversity was also recorded in the rehabilitation areas this year, and all sites had a higher diversity than were recorded in the reference sites. The highest diversity was recorded in South Dump 08 with 58 species, while the lowest number was recorded in South Dump 10 with 25 species. All rehabilitation sites had a diversity of native species containing at least the minimum threshold, except South Dump 10.

Similarly to one of the farmland woodland reference sites, exotic pasture species such as *Phalaris aquatica* (Phalaris), *Vulpia* sp. (Rat's-tail Fescue) and *Trifolium subterraneum* (Subterraneum Clover) often provided the most ground cover in South Dump 05 and South Dump 08. Low growing native shrubs such as *Acacia buxifolia, Acacia filicifolia* and *Cassinia arcuata* were also providing important ground covers in some sites, while *Oxalis perennans* (Yellow Wood-sorrel) was becoming relatively abundant in South Dump 08. Site South Dump 10 was heavily dominated by the exotic annual weeds *Silybum marianum* (Variegated Thistle) and *Chenopodium album* (Fat Hen). On the North Dump, the native *Geranium solanderi* (Geranium solanderi) was abundant, while in North Dump 03, *Modiola caroliniana* (Red-flowered Mallow) and *Petrorhagia nanteuilii* (Proliferous Pink) were the most abundant ground covers.

Exotic annual weeds which have voluntarily and successfully colonised large areas of rehabilitation are playing a particularly important role in the ecological development, function and stability of the sites. This is largely due to the provision of protective ground cover and development of the litter layers which lead to increased stability and coherency of the soil profile. Many annual weeds have become naturalised within the local area, and some of the annual ground covers were clovers or medics which can be useful pasture species. The level of weediness will also be dependent of the degree of disturbance and overgrazing, which is implicated with extremes in environmental conditions. Thus in some cases, exotic species may always be persistent, but not necessarily problematic. This year all rehabilitation sites, except for the newest rehabilitation area South Dump 10, had a level of exotic plant cover comparable to the reference sites.

The drought conditions over three consecutive years have not been conducive to significant developments in the rehabilitation areas, however many areas have maintained or even slightly improved in ecological function during the drought, largely due to the establishment of exotic annual plants. Establishing tree and shrub seedlings have also provided critical surface protection, especially when they were small. More vulnerable rehabilitation areas, such as those occurring on the steeper slopes (South Dump 04, 07 and 09, and North Dump 01) have tended to have a higher degree of erosion resulting in a more unstable environment where ground cover plants and cryptogams have been slower to establish.

Weeds of National Significance and Priority weeds of the Central Tablelands that were recorded in the woodland monitoring sites this year included *Hypericum perforatum* (St. John's Wort), *Rubus fruticosus* (Blackberry), *Solanum sisymbriifolium* (Sticky Nightshade) and *Nassella trichotoma* (Serrated Tussock). There were several other species that are listed under the general NSW biosecurity duty.

No soil analyses were undertaken this year however there have been some differences in soil chemistry between the soils applied onto rehabilitation areas and the soils occurring in the local woodlands in previous years. Copper was recorded in high concentrations in many rehabilitation sites in 2020, especially those on the North Dump. In the rehabilitation areas on the South Dump, the soils were acidic and there were also high concentrations of Sulfur, especially in South Dump 04, 05, 07 and 08. These concentrations were far in excess of the guidelines and had increased during 2019 and 2020. In the newest site South Dump 10, the soils were also saline.

Much of the minor rilling recorded in previous years has declined as ground covers have become more established. Some rilling continued to be recorded in the steeper rehabilitation slopes including South Dump 07, 09 and North Dump 01.

Performance of the woodland rehabilitation sites against primary completion performance indicators

The table below presents the performance of the woodland biodiversity and rehabilitation monitoring sites against “Primary performance indicators” for woodland monitoring sites this year. The selection of criteria has been presented in order of ecosystem successional processes, beginning with landform establishment and stability (orange) and ending with indicators of ecosystem sustainability (blue) as per NSW T&I ESG3 guidelines (2013). Primary performance targets are considered to be met when they fall within the specified target ranges and these have been represented by a coloured box. A striped coloured box indicates that the soil characteristics may not necessarily be similar to the local soils but fall within agricultural industry guidelines.

Performance of the woodland rehabilitation sites against primary completion performance indicators in 2021.

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Unit of measurement	2021 Woodland ecosystem range		South Dump 04	South Dump 05	South Dump 07	South Dump 08	South Dump 09	South Dump 10	North Dump 01	North Dump 02	North Dump 03
Performance indicators are quantified by the range of values obtained from replicated reference sites assessed in 2021					Lower KPI	Upper KPI	2021								
Phase 2: Landform establishment and stability	Landform slope, gradient	Landform suitable for final land use and generally compatible with surrounding topography and final landform design	Slope	Degrees (<18°)	10	14	18	18	16	0	16	17	14	15	2
	Active erosion	Areas of active erosion are limited	No. Rills/Gullies	No.	0	0	0	0	5	0	5	0	2	0	0
Phase 3: Growth medium development	Soil chemical, physical properties and amelioration	Soil properties are suitable for the establishment and maintenance of selected vegetation species	pH	pH (5.6-7.3)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Organic Matter	% (>4.5)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Phosphorous	mg/kg (50)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Phase 4: Ecosystem & Land Use Establishment	Landscape Function Analysis (LFA): Landform stability and organisation	Landform is stable and performing as it was designed to do	LFA Stability	%	65.1	80.0	64.9	67.1	63.7	74.1	67.7	67.5	68.0	72.5	67.5
			LFA Landscape organisation	%	100	100	67	94	55	89	98	100	100	100	100

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Unit of measurement	2021 Woodland ecosystem range		South Dump 04	South Dump 05	South Dump 07	South Dump 08	South Dump 09	South Dump 10	North Dump 01	North Dump 02	North Dump 03
	Vegetation diversity	Vegetation contains a diversity of species comparable to that of the local remnant vegetation	Diversity of shrubs and juvenile trees	% population	0	100	100	98	100	100	100	100	100	100	100
			Total species richness	No./area	26	60	36	38	35	58	28	25	44	44	39
	Vegetation density	Vegetation contains a density of species comparable to that of the local remnant vegetation	Density of shrubs and juvenile trees	No./area	0	108	106	346	334	420	364	6	152	336	300
	Ecosystem composition	The vegetation is comprised by a range of growth forms comparable to that of the local remnant vegetation	Trees	No./area	1	4	0	1	3	4	3	1	0	0	0
			Shrubs	No./area	0	6	4	10	13	13	10	2	4	5	4
			Grasses	No./area	6	10	11	7	7	8	10	4	9	11	6
Phase 5: Ecosystem & Land Use Sustainability	Landscape Function Analysis (LFA): Landform function and ecological performance	Landform is ecologically functional and performing as it was designed to do	LFA Infiltration	%	56.1	66.0	33.7	46.4	31.6	38.8	37.2	41.2	43.8	49.3	40.9
			LFA Nutrient recycling	%	54.0	64.1	34.8	47.8	31.6	44.6	40.0	39.9	40.6	49.9	37.8

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Unit of measurement	2021 Woodland ecosystem range		South Dump 04	South Dump 05	South Dump 07	South Dump 08	South Dump 09	South Dump 10	North Dump 01	North Dump 02	North Dump 03
	Protective ground cover	Ground layer contains protective ground cover and habitat structure comparable with the local remnant vegetation	Perennial plant cover (< 0.5m)	%	11	64	19	23	32	45	15	0	55	70	66
			Total Ground Cover	%	94	100	64	84	50	93	78	100	100	100	96
	Ground cover diversity	Vegetation contains a diversity of species per square meter comparable to that of the local remnant vegetation	Native understorey abundance	> species/m^2	1.2	5.0	2.6	2.2	3.2	3.2	2.2	0.2	2.2	1.8	2
	Native ground cover abundance	Native ground cover abundance is comparable to that of the local remnant vegetation	Percent ground cover provided by native vegetation <0.5m tall	%	17.6	75.0	45.2	58.9	88.1	50	78	6.8	35.4	27.9	26.9
	Ecosystem growth and natural recruitment	The vegetation is maturing and/or natural recruitment is occurring at rates similar to those of the local remnant vegetation	shrubs and juvenile trees 0 - 0.5m in height	No./area	0	93	8	10	4	22	8	3	0	8	272
			shrubs and juvenile trees 1.5 - 2m in height	No./area	0	0	38	40	114	82	138	1	54	130	12

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Unit of measurement	2021 Woodland ecosystem range		South Dump 04	South Dump 05	South Dump 07	South Dump 08	South Dump 09	South Dump 10	North Dump 01	North Dump 02	North Dump 03
	Ecosystem structure	The vegetation is developing in structure and complexity comparable to that of the local remnant vegetation	Foliage cover 0.5 - 2 m	% cover	0	3.0	9	47	32.6	14	40	0	15	20	3
			Foliage cover 2 - 4m	% cover	0	3.0	0	20	2.5	0.5	4.5	0	2	6	0
			Foliage cover >6m	% cover	17.5	38.0	0	0	0	0	0	0	0	0	0
	Tree diversity	Vegetation contains a diversity of maturing tree and shrubs species comparable to that of the local remnant vegetation	Tree diversity	% endemic	100	100	100	100	100	100	100	0	100	100	100
	Tree density	Vegetation contains a density of maturing tree and shrubs species comparable to that of the local remnant vegetation	Tree density	No./area	9	43	2	38	16	2	5	0	3	22	1
	Ecosystem health	The vegetation is in a condition comparable to that of the local remnant vegetation.	Healthy trees	% population	30	52	100	21	87.5	0	100	0	66.667	9	0

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Unit of measurement	2021 Woodland ecosystem range		South Dump 04	South Dump 05	South Dump 07	South Dump 08	South Dump 09	South Dump 10	North Dump 01	North Dump 02	North Dump 03
			Flowers/fruit: Trees	% population	**42**	**78**	**100**	**0**	**0**	**0**	**0**	**0**	**67**	**9**	**100**

Conclusion

While no rehabilitation sites yet met all primary completion criteria, many sites had been demonstrating a significant increase in ecological function up until the drought conditions that were experienced for three consecutive years during 2017 - 2019. During the drought, there tended to be a declining trend in ecological function as a result of the prolonged dry seasonal conditions and simultaneous increase in grazing and disturbance by animals, with a decline in many performance indicators also being reflected in the range of woodland reference sites. This year, the improved seasonal conditions resulted in a significant increase in the diversity and abundance of the ground covers in all of the rehabilitation and woodland reference sites, therefore increased ecological function was recorded in all sites.

The density of shrubs and/or juvenile trees (<5cm dbh) recorded in the woodland rehabilitation sites was highly variable between sites. In sites on the South Dump and North Dump 01 and 02, shrub densities have continued to decline in all sites. While in some cases, some individuals may have grown and were now recorded as mature trees (>5 cm dbh), the majority were drought mortalities and/or had reached the end of their life span (natural senescence). In North Dump 03, however, many volunteer *Cassinia arcuata* (Chinese Shrub) were establishing.

The potential for the ongoing decline in mature acacia densities, may have implications for the rehabilitation sites to meet completion targets into the future, particularly when there is an absence of or low density of long-lived eucalypt species. Sites without or with low densities of eucalypts are likely to require rehabilitation intervention via reseeding or tubestock planting to ensure appropriate eucalypt densities become established in the longer-term.

Testing of waste rock materials and topsoils prior to application on rehabilitation areas should be regularly undertaken to ensure suitable substrates are used prior to spreading onto rehabilitation areas. These should continue to be monitored, as increasing concentrations of some heavy metals and/or salts may inhibit the establishment of protective ground cover and have an adverse effect of the development and sustainability of wider rehabilitation areas. In some areas, ongoing active rilling may require intervention.

While no formal survey for fauna is undertaken by DnA Environmental, a range of wildlife have been or were observed within the rehabilitation areas. Increased habitat such as large logs and fallen trees would further enhance rehabilitation sites. Additional perching sites could also be made available by erecting mature eucalypts that have been cleared for mining, upside down (i.e. tree roots provide the new dead tree canopy) in appropriate locations across the rehabilitation areas. Large rocky outcrops could also be constructed. These practices have been undertaken with very successful outcomes in the Hunter Valley. Birds using the perching sites assist rehabilitation outcomes by introducing native plant seed (especially those with fleshy drupes) that may not otherwise colonise large rehabilitation areas. A range of other wildlife may also assist with the natural dispersal of seeds, create germination niches and micro-sites and assist with nutrient recycling across the wider rehabilitation areas. They may however also distribute weeds and harbour pest animals.

Follow up surveillance and control of priority weeds will continue to be required as part of the CVO land management plans and care should be undertaken to avoid spraying of non-target species. While grazing pressure has significant declined after the drought, feral and pest animal populations will require ongoing monitoring.

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1 Introduction: 2021 CVO Rehabilitation monitoring report

1.1 Background

Cadia Valley Operations (CVO) is one of Australia's largest gold mining operations and is 100 per cent owned by Newcrest. It is located approximately 25 kilometres from the city of Orange in central west New South Wales and is 250 kilometres west of Sydney (http://www.newcrest.com.au/our-business/operations/cadia-nsw/).

CVO comprises three mines - the Cadia East underground panel cave mine which commenced commercial production on 1 January 2013, the Ridgeway underground mine (currently in care and maintenance) and the Cadia Hill open pit mine (currently in care and maintenance).

On 15 October 2019, Newcrest announced the approval of the first stage of the Cadia Expansion Project to Execution phase. The first stage comprises commencement of the next cave development (PC2-3) and, subject to regulatory approvals, an increase in the nameplate capacity of the process plant to 33mtpa. The second stage, which is in Feasibility Study, is focused on a further increase in processing capacity to 35mtpa and recovery rate improvement projects. The Cadia Molybdenum Plant Feasibility Study has an estimated capital cost of $95m, with commissioning of the plant expected in FY22 (https://www.newcrest.com/our-assets/cadia; accessed 12/5/2021).

Cadia produces gold doré from a gravity circuit and gold-rich copper concentrates from a flotation circuit at Cadia. The gold dore is then refined at the Perth Mint and concentrates are piped to a dewatering plant at nearby Blayney and sent by rail to Port Kembla in New South Wales for export. The Molybdenum Plant is expected to deliver an additional revenue stream in the form of a molybdenum concentrate which will be a by-product credit to AISC per ounce.

1.2 CVO Post mining land use objectives

Final land use goals are broadly based on the pre-existing land uses within the Cadiangullong Creek Valley being agriculture (predominantly grazing) with scattered paddock trees and woodland conservation (Newcrest 2013a, 2013b; Newcrest Mining Limited, 2020). The pre-existing landform of undulating hills would be replicated through mine rehabilitation landforms so that these landforms generally / reasonably blend in with surrounding topography. Specific future post mining land use goals include:

- High quality agriculture (Grazing) areas were deemed to be sustainable and low risk of erosion, degradation, damage. Similar species composition and carrying capacity to surrounding areas.
- Woodland (conservation). Increasing the amount of conserved woodland in the district for future flora and fauna protection. Replacing / replicating Endangered Ecological Communities where applicable. Similar vegetation types / composition to surrounding / local remnant vegetation.
- Allowing for future needs of the community through retaining key infrastructure where appropriate (pending future negotiations with regulatory bodies / community). Considerations may include regional
- water reticulation network, future industrial use of the site, landfill (within Cadia Hill Pit), roads, power assets etc.

The overall rehabilitation goal is to generate enduring land value, including both ecological value (e.g. biological diversity and other environmental values) and agricultural value (i.e. the ability to produce agricultural goods).

Rehabilitation activities at Cadia aim to generate safe and sustainable landforms at the mine site, CHPL-owned land and the region as a whole, by rehabilitating mine disturbed lands to:

- add value to the current vegetation corridor programme (ecological value);
- allow for the future land use of grazing, where appropriate and sustainable (agricultural value);
- retain areas that may be important for future industry and infrastructure needs; and
- provide safe and stable landforms and minimise any adverse potential impacts so that there is no future liability for Newcrest or the community.

1.3 Rehabilitation and land management strategy

The primary objectives of rehabilitation and revegetation of post-mining disturbance areas at Cadia are summarised in the following points:

- If possible, allow for future industrial use of site infrastructure and resources.
- Create safe and stable, sustainable and productive landforms which conform to the natural topography of the Cadia area.
- Ensure there is no future or residual liability from the site (e.g. from soil or water contamination) for Newcrest or the wider community;
- Create sustainable ecological and if applicable, production (agricultural) ecosystems which are comparable to local reference / analogue sites (Mine Closure Criteria) or similar vegetation associations.
- Increase areas (compared to pre-mining) of native woodland with a long term land use of conservation to increase overall habitat availability for native fauna.
- Rigorously assess any mine disturbed areas with a future land use for agriculture / grazing to ensure it remains a sustainable land use and will not be subject to degradation (erosion).
- Incorporate ‘chain of ponds’ concepts into riparian system restoration.
- Protect the wider environment from potential long-term environmental impacts (e.g. impacts from Acid and Metalliferous Drainage AMD) via best practice design and rehabilitation.
- Consult with future user groups and other stakeholders regarding post mining land use and rehabilitation objectives.
- Control weeds and pests to meet mine closure criteria.
- Prevent, control and repair areas of erosion.
- Manage bushfire fuels and plan for emergencies, taking into consideration conservation objectives.
- Maximise the harvesting of topsoil and clay resources.

CHPL would aim to provide a balanced rehabilitation outcome, recognising the alternative land uses that exist in the region and aiming to establish a combination of grazing land and indigenous woodland on final landforms.

Rehabilitation programmes would be adjusted over the life of the Project as necessary, based on the outcomes of research trials, community and regulatory consultation, regional infrastructure requirements and industry knowledge. Progressive rehabilitation would be undertaken throughout the life of the Project, where practicable.

1.4 CVO rehabilitation commitments

1.4.1 Primary mine disturbed areas

The following section provides a brief overview of the rehabilitation and mine closure considerations for the primary mine disturbed areas that are being progressively rehabilitated at CVO according to CVO Land and Biodiversity Management Plan (Newcrest 2013a, 2013b, 2020). Presently two major areas of rehabilitation are progressively being rehabilitated including areas situated on the North and South Waste Rock Dumps. A map showing the conceptual final land use for these areas is provided in Figure 1-1. A map showing the various phases of the progressive mine rehabilitation is provided in Figure 1-2, including areas that have already been rehabilitated (Newcrest 2013a, 2013b).

1.4.1.1 North Waste Rock Dump

- The North Waste Rock Dump would have maximum batter slopes of 1:3, with 15 to 20 metre (m) wide, step-back, reverse graded berms and rock lined drains;
- PAF material contained in the dump would be encapsulated by covering with 0.5 m of compacted clay followed by 2 to 3 m of non-acid forming (NAF) material;
- This would be covered by 20 to 30 centimetres (cm) of topsoil. Where possible topsoil will be used that has been stripped from an area with a consistent final land use;
- Drainage control structures would be installed where necessary, utilising 'chain of ponds' concepts where appropriate; and
- The North Waste Rock Dump would be revegetated with indigenous bushland species with a final land use of conservation.

1.4.1.2 South Waste Rock Dump (SWRD)

- The revegetation objective for the South Waste Rock Dump is to provide woodland across the dump surface and batters with a final land use of conservation;
- Selective encapsulation of PAF waste rock with a low permeability seal followed by NAF material and topsoil;
- 20 to 30 centimetres (cm) of topsoil will be placed as the surface substrate. Where possible topsoil will be used that has been stripped from an area with a consistent final land use;
- Grading the final surface of the dump to blend in with the natural topography of the area, with an overall outer batter slope of 1:4 comprising 1:3 outer slopes and 15 to 20 m wide, step-back, reverse graded berms;
- Installation of rock lined drains and detention ponds to channel runoff safely to constructed outlet areas;
- Creation of additional habitat using trees cleared from disturbance areas supplemented with additional habitat structures targeting threatened and declining woodland species (e.g. nesting boxes, bat boxes, salvaged hollows etc);
- The woodland areas will be linked to other conservation areas in the Cadia Valley through the vegetation corridor programme;
- Rehabilitation trials would be conducted by CHPL to determine the best combination of techniques for the establishment of native woodland species (including soil treatments, seed mixes, sowing methods etc).

1.4.1.3 SWRD Water Management

- The top surface of the South Waste Rock Dump would be designed with a slight dish shape that would generally drain towards the north. Rock lined channels would be installed along the northern edge of the top surface to provide a stable means for surface water runoff to drain from the top of the SWRD;
- On the batters of the dump, surface water runoff would flow perpendicularly down the slope to the toe of each batter where it would be re-directed by the 15 to 20 m wide reverse graded berms. The water would gradually flow short distances along the berms to rock lined channels which would be constructed at regular intervals down the faces of the batters. These channels would enable water from one berm to be channelled in a controlled manner down the face of the batter to the next berm and ultimately to the base of the dump;
- Rock lined channels would be used at the base of the dump to direct runoff into natural creek lines, the surface of the NTSF, or the Rodds Creek Water Holding Dam;
- Drainage control structures would utilise 'chain of ponds' concepts where appropriate; and
- The existing sediment ponds and leachate collection ponds downstream of the dump would be retained until the revegetated surface of the dump is stable and the runoff water quality is acceptable.

1.4.2 **Guiding principles**

The following guiding principles will be implemented for the Mine Disturbed Landscape (Newcrest 2013a, 2013b).

- Rehabilitation for the post mining land use of woodland, forest or native communities to use:
    - A range of indigenous species (trees, shrubs, grasses, forbs (and aquatic species where applicable);
    - Seed that has been locally collected; and
    - A range of species to provide diversity (including structural diversity) consistent with the target vegetation association (based on soil type, aspect, slope and adjacent (or pre-existing) communities).
- Rehabilitation for the post mining land use of agriculture / grazing to use:
    - Predominantly perennial species (supplemented with annual species as required such as legumes etc);
    - Ranges of native and / or introduced pasture species where suitable; and
    - Scattered paddock trees to match the surrounding agricultural landscape.
- Species will be selected based on the target vegetation community and derived from vegetation survey species lists from a similar community type or monitoring reference site. (Refer to Appendix B Cadia East Environmental Assessment (CHPL 2009));
- Where possible attempt to re-create communities consistent with local Endangered Ecological Communities (EEC);
- The recovery and use of habitat and rehabilitation resources from remnant areas destined for clearance / subsidence should be maximised to enhance the success and colonisation of rehabilitated sites;
- Locally uncommon species from remnant areas or species that are difficult to propagate should be re-located / re-planted prior to approved clearing;
- Native seed to be collected from within 20km of mine lease boundary or within an acceptable distribution radius;
- Where possible immediately re-spread harvested topsoil to take advantage of seed banks and soil biota and to reduce damage to soil structure through rehandling;

- Utilise topsoil from areas with a similar post mining land use to take advantage of available seed banks; and
- Undertake annual monitoring of rehabilitation sites and compare a range of parameters against selected reference sites.

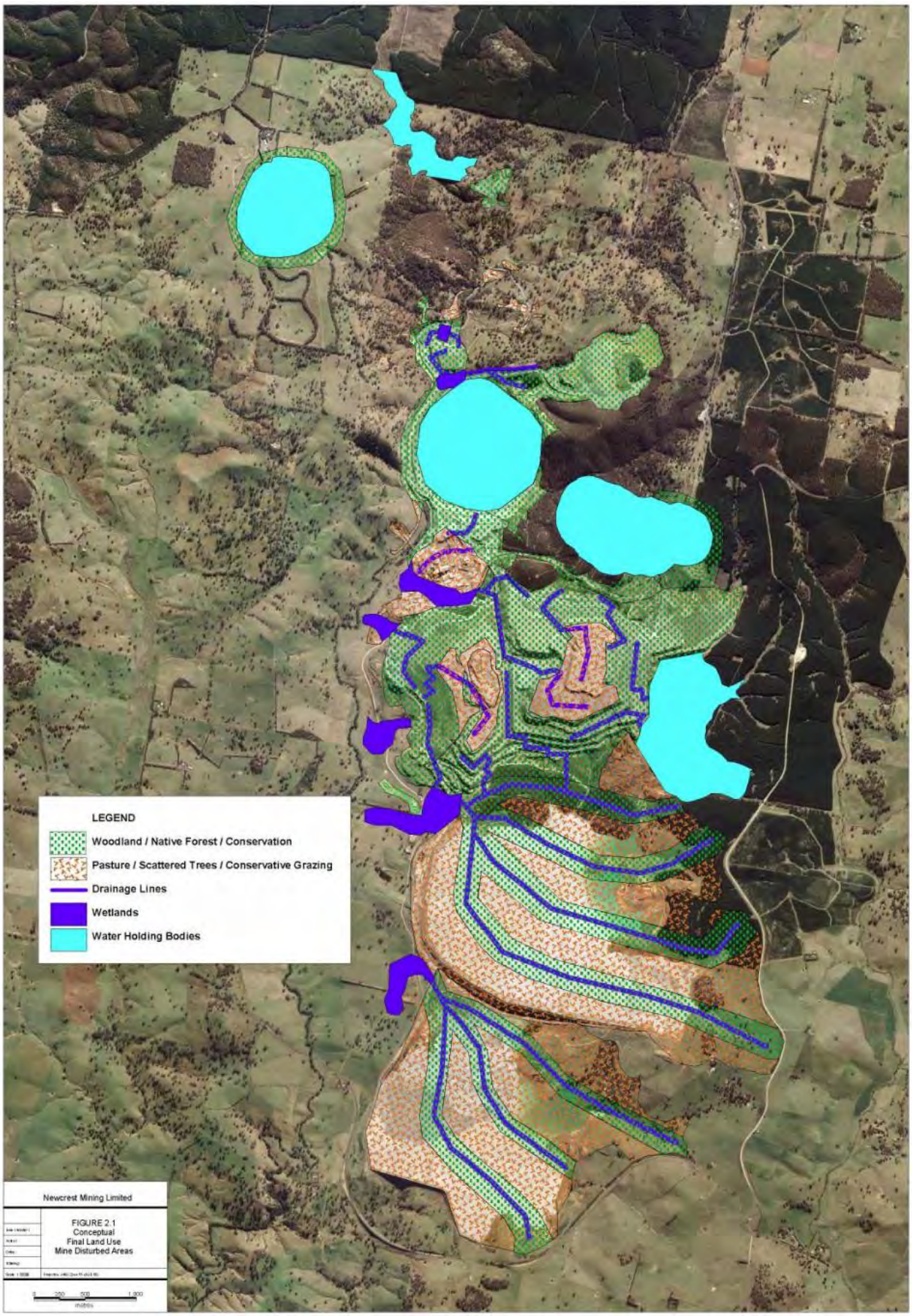


Figure 1-1. Conceptual final land use of mine disturbed areas (Newcrest 2013b).

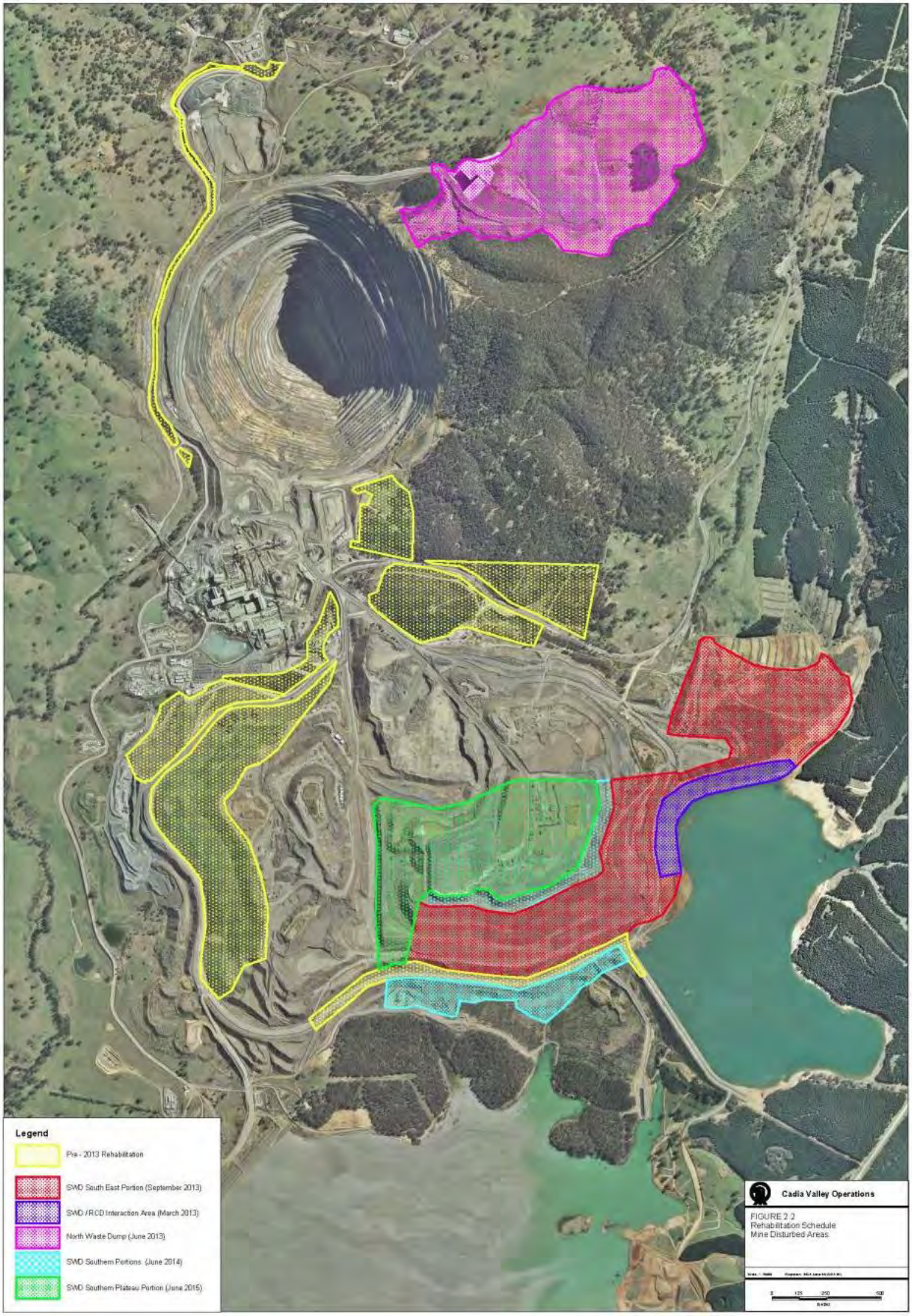


Figure 1-2. Rehabilitation schedule of mine disturbed areas (Newcrest 2013a).

1.4.3 Vegetation corridor program.

1.4.3.1 Aim of CVO Vegetation Corridor Program

The aim of the CVO Vegetation Corridor Program is to generate enduring land value, including both ecological and agricultural value. This aim will be achieved through meeting the following objectives throughout the life of the plan (Newcrest 2013b):

- Conserve and enhance areas of isolated remnant vegetation;
- Link significant areas of remnant vegetation;
- Provide habitat for native fauna;
- Allow the movement of genetic material between flora and fauna populations; and
- Increase the sustainability and biodiversity of CVO farms and environs.

1.4.3.2 Considerations for Vegetation Corridors

The following considerations will be taken into account when planning and implementing the Vegetation Corridor Program. Figure 1-3 shows the status of the Vegetation Corridor Program (Newcrest 2013b). Figure 1-4 shows how the Vegetation Corridor Program aligns with the proposed mine site rehabilitation concepts to extend corridor linkages across Newcrest owned land (Newcrest 2013b).

- Existing viable remnants should be protected wherever possible;
- Protection is to extend to all strata and native life forms including trees, shrubs, grasses, other herbs and forbs, ground litter, fungi, logs etc;
- Existing remnants should be enlarged or connected by revegetating with the appropriate indigenous species in the landscape;
- Ensure revegetation areas are of sufficient size (nominally >5ha or > 100m wide) where possible to maximise sustainability and biodiversity outcomes;
- Revegetation areas should provide a wide range of habitat features and provide specific habitat for threatened and locally significant fauna species;
- Rehabilitation planning should recognise that physiographic and topographic controls as well as land use objectives may make some areas better suited to pasture and agriculture;
- Rehabilitation planning would be conducted in consultation with the Community Consultative Committee (CCC) and key government stakeholder agencies (e.g. NSW Office of Environment and Heritage (OEH) (Formally NSW Department of Environment, Climate Change and Water), NSW Department of Trade and Investment, Regional Infrastructure and Services (formally Industry & Investment (I&I NSW) and NSW Office of Water (NOW)), and Councils through the AEMR process;
- Rehabilitation planning should be recognised as a dynamic activity requiring stakeholder consultation, the conduct of trials and design studies and the preparation of appropriate management plans prior to implementation;
- Allow for the protection and enhancement of threatened species, communities and locally significant species; and
- Planning for rehabilitation works will take into consideration livestock movement, stock water access, farm operational needs and future mining projects.

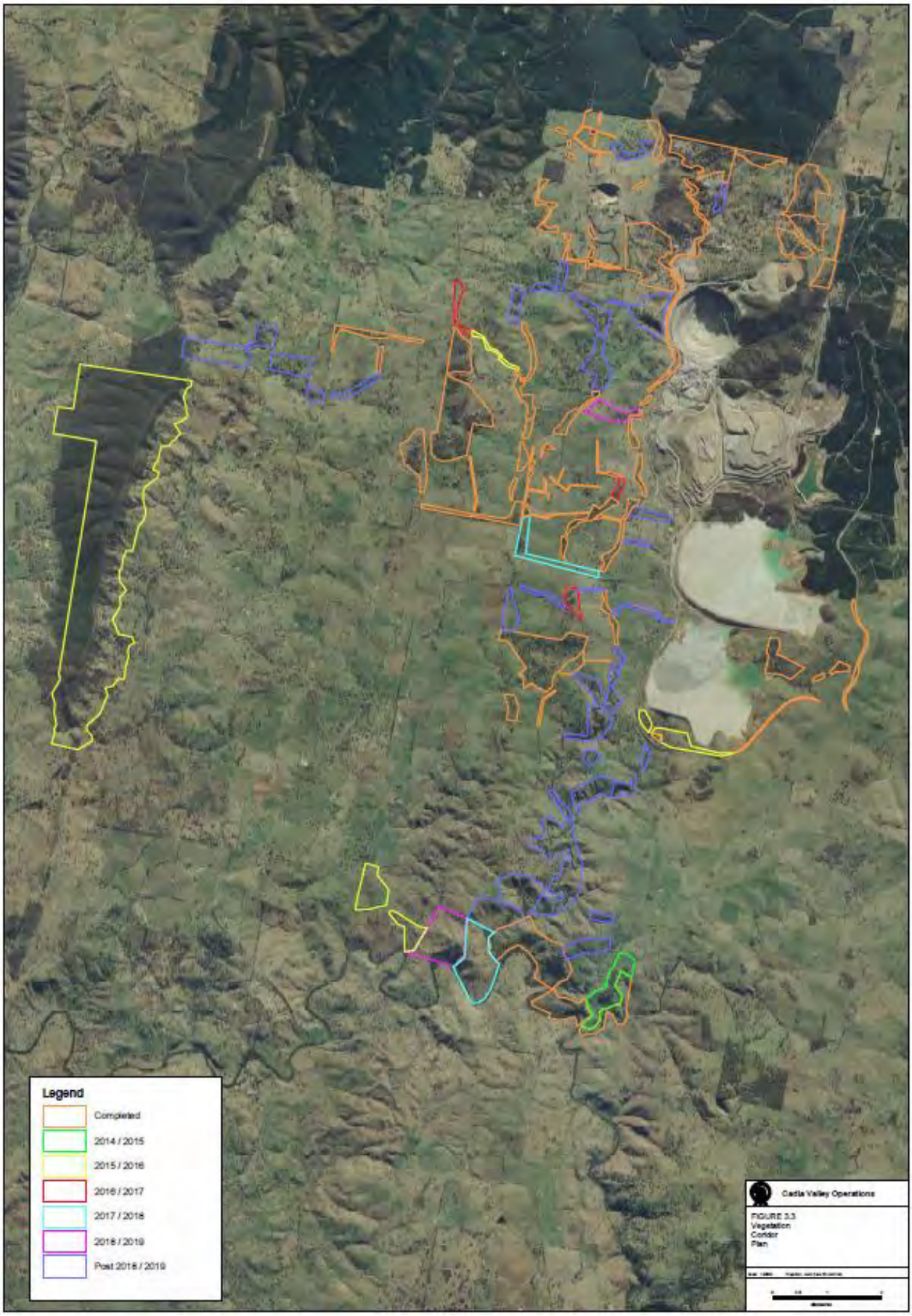


Figure 1-3. Vegetation Corridor Program (Newcrest 2013 b).

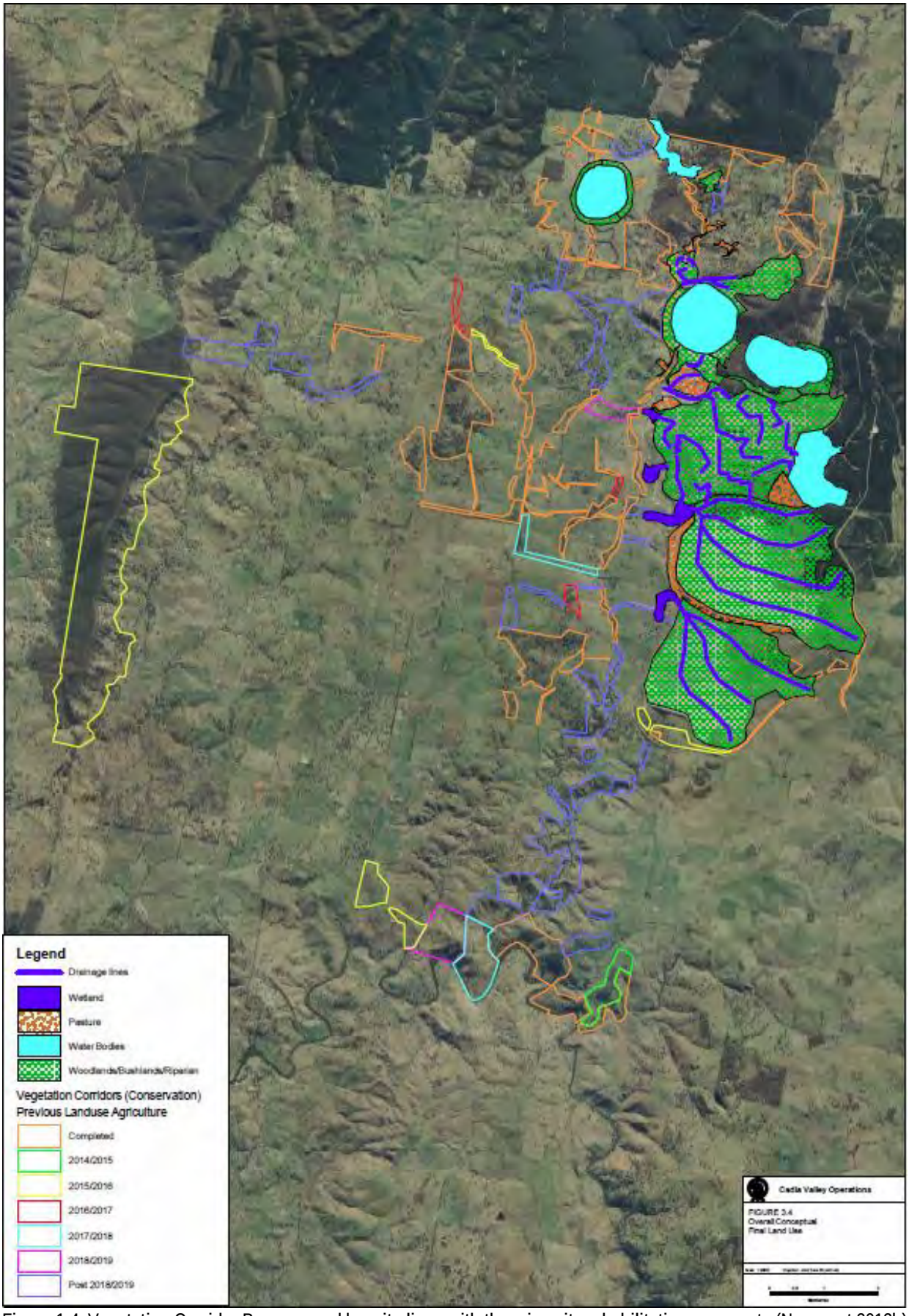


Figure 1-4. Vegetation Corridor Program and how it aligns with the mine site rehabilitations concepts (Newcrest 2013b).

1.5 ESG3 MOP Guidelines

In NSW, mining operations must be carried out in accordance with a Mining Operations Plan (MOP) that has been approved by the NSW Department of Planning, Industry & Environment (the Department) (formerly NSW Trade and Investment - Division of Resources and Energy. The Mining Operations Plan (MOP) is a tool used by the Department to monitor the progress of mining and rehabilitation activities across the life of a mine (NSW T&I 2013). The MOP is intended to fulfil the function of both a rehabilitation plan and a mine closure plan. It should document the long-term mine closure principles and outcomes whilst outlining the proposed rehabilitation activities during the MOP term (NSW T&I 2013).

ESG3: Mining Operations Plan (MOP) Guidelines, September 2013 (ESG3) detailed a process for monitoring and managing progression towards successful rehabilitation outcomes (NSW T&I 2013). The Guideline requires industry to identify and provide measurable data and demonstrate that proposed rehabilitation outcomes are achievable and realistic within a given timeframe. The requirement for more targeted information strengthens the capacity of the Department to regulate rehabilitation and environmental performance and more accurately determine rehabilitation security liabilities (NSW T&I 2013). These guidelines have been superseded by the Rehabilitation Management Plan and Associated Annual rehabilitation Report and Forward Program for large mines Codes of Practice (NSW Department of Planning 2018).

1.5.1 Rehabilitation phases

Successful rehabilitation of a mine site can be conceptually described in terms of logical steps or phases and these should be made applicable to each of the similar land management units or domains. It is likely that most domains will require a different rehabilitation methodology to achieve the intended post-mining land use (NSW T&I 2013). Rehabilitation Phases where the post mining land use is a native plant ecosystem according to the new MOP guidelines include:

1. Decommissioning;
2. Landform Establishment;
3. Growth Medium Development;
4. Ecosystem and Land Use Establishment;
5. Ecosystem and Land Use Sustainability; and
6. Relinquished Lands.

1.5.2 Performance Indicators

To satisfy regulatory conditions, performance measures, indicators and associated performance/completion criteria that are appropriate to the location and relevant to the stated rehabilitation goals and objectives must be presented for each land management unit or domain (NSW T&I 2013). The application of the ecological performance data during the Decommissioning phase (Phase 1) are not considered applicable within the presentation of the ecological data obtained within the CGO rehabilitation monitoring program. Subsequently the ecological performance criteria which are consolidated into Key Performance Indicator (KPI) tables are only represented within Rehabilitation Phases 2 (Landform establishment) to Phase 5 (Ecosystem and Land Use Sustainability).

Data from reference sites provide suitable target values of key biophysical parameters, vegetation structures and diversity, and habitat complexity. It provides the ability to monitor both success against true values of an existing ecosystem and the effects of climatic variations and disturbance events (such as fire, flooding, drought etc.). The reference site can be used as the target outcome of the final rehabilitated landscape and a time series record of

ecosystem change or development can be obtained. By comparing data with reference sites, it is possible to see if the rehabilitation or disturbed site is developing adequately. All completion criteria at a given site should be within critical threshold values if ecosystem rehabilitation is to be judged successful (NSW T&I 2013).

1.6 Completion criteria and key performance indicators

At CVO, a range of Key Performance Indicators (KPI's) have been determined and are quantified by data obtained from replicated reference sites which are representative of the agreed final land use. All ecological performance indicators are quantified by range values measured annually (or three-year monitoring cycle) from these reference sites which form an *upper* and *lower* KPI target. The same ecological performance indicators are measured in the rehabilitation sites and these should equal or exceed these values or demonstrate an increasing trend.

These Key Performance Indicators have been further separated into "*Primary performance indicators*" and "*Secondary performance indicators"*. Primary performance indicators are those chosen as essential completion criteria targets and have been identified as those that will satisfy requirements specifically identified within the EIS, MOP and relevant Management Plans and in particular the final land use and any relevant conditions of consent relating to vegetation type, specific use of species and condition for example.

Secondary performance indicators are those that would be desirable to achieve but will not necessarily have an influence on relinquishment requirements. Therefore, please note that not all Performance Indicators are set as primary completion criteria targets.

2 CVO rehabilitation monitoring program

2.1 Primary objectives

The primary objective of the CVO rehabilitation monitoring program was to compare the progress of rehabilitated landforms and revegetated conservation areas towards fulfilling long-term land use objectives by comparing a selection of ecological targets or completion criteria against unmined areas of remnant vegetation (reference sites) that are representative of the final land use and vegetation assemblage. This involved developing a set of completion criteria consistent with CVOs Landscape Management Plan (CPHL 2009), Rehabilitation Strategy (Newcrest Mining Ltd 2013a), Land and Biodiversity – Landscape Management Plan (Newcrest 2013b), community expectations as well as relevant NSW legislation, policies and best practice guidelines (NSW I&I 2010, NSW T&I 2012, NSW T&I 2013).

The primary objectives in establishing completion criteria is to establish clearly defined, repeatable and consistent methodologies for monitoring changes in various aspects of ecosystem stability, recovery and long-term sustainability. Part of this process includes:

- Establishing a range of relevant reference sites to compare and track the progress of rehabilitation areas and inherent ecosystem function;
- Selecting a range of suitable reference sites that reflect the desired final land use, biodiversity targets and local community expectations; and
- Undertaking monitoring programs that provide simple but informative and reliable information that indicates positive recovery trends or rapid detection of rehabilitation failure.

2.2 Establishing suitable reference sites

Three main vegetation community types were identified as being rehabilitated onto mining disturbed areas or CVO farmland areas and included:

- Grassy woodland;
- Introduced pastures; and
- Riparian woodlands.

All reference sites have been subjected to some form of prior disturbance, in particular clearing for agriculture and livestock grazing and all woodland sites were regrowth, with some invasion from introduced species. These sites, despite their disturbance history were typical of the local area and help set realistic rehabilitation targets and provide a benchmark for transitional processes that can be expected or that are presently occurring in the rehabilitation areas.

Data obtained from these reference sites quantified the range of key ecological performance indicators and resulting completion criteria. The reference sites were spread out where possible to maximise the spatial distribution and subsequent variations in community composition across the local landscape and all are now situated on Cadia owned land.

Since 2016, the number of reference sites has included:

- Four grassy woodland;
- Two riparian woodland; and
- Two exotic pastures.

2.3 General description of the reference sites

2.3.1 Grassy woodland reference sites

The grassy woodlands were comprised of low various densities of *E. albens* (White Box) or *E. melliodora* trees but *E. blakelyi* (Blakely's Red Gum), *E. macrorhyncha* (Red Stringybark), *E. bridgesiana* (Apple Box) and/or or *E. goniocalyx* (Bundy Box) may also have been present. Scattered old growth trees were present as well as younger regrowth and some relatively recent natural eucalypt recruitment was present in all sites. There was an absence of a shrub layer in two sites however in the other woodland site, there were some scattered *Acacia dealbata* (Silver Wattle) and *A. implexa* (Hickory) and eucalypt regeneration was present. There may also have been occasional exotic shrubs in some woodland areas *(i.e. Rubus fruticosus* (Blackberry), *Rosa rubiginosa* (Sweet Briar). The understoreys were usually dominated by native perennial grasses and common native forbs and all sites contained a high cover of leaf litter. There were also scattered exotic annuals and pockets of exotic grasses or weeds especially in old stockcamp areas.

2.3.2 Riparian woodland reference sites

The two riparian woodland sites were quite different to each other, but both were characteristically open grassy woodland. One site was comprised of scattered old growth trees of *E. camaldulensis* (River Red Gum), *E. melliodora* and *E. bridgesiana* (Apple Box) and had an understorey dominated by *Phalaris aquatica* (*Phalaris*) and *Dactylis glomerata (Cocksfoot)* with patches of introduced annual grasses and native grass and herbs. The second site was also comprised of scattered old growth trees dominated by *E. viminalis* (Ribbon Gum), *E. melliodora* and *E. bridgesiana* and a relatively intact and diverse native grassy understorey and contained some patches of shrubs including *Acacia melanoxylon* (Blackwood) and *A. dealbata*. Both sites however contained various noxious weeds and floods waters continue to alter the stream morphology.

2.3.3 Introduced pasture reference sites

The two introduced pasture sites were dominated by *Phalaris aquatica* and contained various combinations of other pasture species such as *Dactylis glomerata* (Cocksfoot), *Lolium* sp. (Ryegrass) and *Trifolium* species (Clovers). At RfPast03, *Puccinellia stricta* (Australian Saltmarsh Grass) was also very abundant. These sites are intermittently grazed by sheep and cattle but both sites contained very high ground cover levels and had very few weeds.

2.4 CVO Rehabilitation monitoring sites

At CVO, rehabilitation has been progressive since the inception of the monitoring program and subsequently the number of rehabilitation monitoring sites has typically grown over the years. Major rehabilitation was undertaken on the main Waste Emplacements in 2008 (South Dump) and in 2014/2015 (North and South Dump).

In 2008, seven rehabilitation sites were first established and were a combination of bushland, woodland and riparian communities. In 2010, one additional woodland site (SouthDump03) was established on the Southern waste rock emplacement. The rehabilitation monitoring sites were considered to be representative of the rehabilitation area as a whole or were similar to and representative of other areas of rehabilitation.

In 2014 - 2015, large areas of rehabilitation had been completed on the Northern and Southern Waste Rock emplacements and three new rehabilitation monitoring sites were established in both rehabilitation areas to provide a representation of the progress of the rehabilitation on the various batters and time of rehabilitation.

"Ashleigh Park" the direct seeded rehabilitation site and "Cadiangullong Creek" and "Creek Diversion", both riparian woodland corridor rehabilitation projects were not monitored in 2014 or 2015 in an attempt to keep the number of monitoring sites to a manageable number. While these sites may have fell short in meeting some completion targets, previous monitoring has indicated that both of these rehabilitation sites were very stable and were establishing well with changes in ecological condition usually occurring as a response to seasonal conditions and grazing pressure. These sites will continue to be monitored at three yearly intervals and thus they were included in the 2016 and 2019 monitoring events. There are presently no exotic pasture rehabilitation areas, therefore there has been no further requirement to monitoring the exotic pasture reference sites again this year.

In 2015 a new grassy woodland reference site was established to replace a reference site situated on a reserve but leased by a local landholder which was rapidly being degraded by invasive weeds. The new reference site was dominated by *E. melliodora – E. macrorhyncha* and has a similar sloping topography and ecotonal transition as the rehabilitation areas and is located on CVO property adjacent to the main access road. RWood04 was considered to be a more suitable analogue for the woodland rehabilitation areas.

A significant area (~60ha) of additional rehabilitation had been undertaken on the South Dump in February 2015 with new rehabilitation monitoring sites being established in 2016 to provide a representation of the progress of the rehabilitation on the various batters. In 2019 one more monitoring site (South Dump 10), which was seeded in February 2018, was established on the western batter of the South Dump.

The reference site RWood04 and rehabilitation site South Dump 06 are now unable to be accessed due to closure of the surrounding area due to mine subsidence and are no longer able to be part of the monitoring program.

2.5 Summary and location of the monitoring sites

Table 2-1 shows a summary of the monitoring sites assessed as part of the CVO monitoring program, including the general locality, year of establishment, community type and frequency of monitoring. Figure 2-1 shows the location of the reference and rehabilitation monitoring sites. GPS coordinates and other site-specific information is provided in Appendix 1.

Table 2-1. Summary of the monitoring sites.

Site type	Vegetation community	Site name	Rehabilitation method	Year established	3 year monitoring rotation	Monitored in 2016	Monitored in 2017	Monitored in 2018	Monitored in 2019	Monitored in 2020	Monitored in 2021
Reference site	Woodland - Ashleigh Park	RfWood01	-	2008		1	1	1	1	1	1
	Woodland - Bundarra	RfWood02	-	2008		1	1	1	1	1	1
	~~Woodland - CVO Access Rd~~	~~RWood04~~	-	~~2015~~		~~1~~	~~1~~	~~1~~	~~subsidence~~	~~subsidence~~	~~subsidence~~
	Woodland - Cadiangullong Dam	RWood05	-	2008		1	1	1	1	1	1
	Pasture - Bundarra	RfPast01	-	2008	☑ 2019	1			1		
	Pasture - Willunga	RfPast03	-	2008	☑ 2019	1			1		
	Riparian - Bakers Shaft	RrRip02	-	2008	☑ 2019	1			1		
	Riparian - Cadiangullong Ck CVO	RrRip03	-	2008	☑ 2019	1			1		
	Total reference sites					8	4	4	8	3	3
Rehabilitation sites	Woodland	Ashleigh Park	Direct Seeded Farmland	2008	☑ 2019	1			1		
	Woodland	South Dump 01	Aerial seeding + tubestock planting	2008	☑ 2019	1		1	1		
	Woodland	South Dump 02	Aerial seeding + tubestock planting	2008	☑ 2019	1		1	1		
	Woodland	South Dump 03	Aerial seeding + tubestock planting	2010	☑ 2019	1		1	1		
	Woodland	WillungaDS01	Direct seeded farmland	2008	☑ 2019	1			1		
	Woodland	WillungaDS02	Direct seeded farmland	2008	☑ 2019	1			1		
	Riparian woodland	Cadiangullong Creek	Direct seeded farmland	2008	☑ 2016	1			1		
	Riparian woodland	Creek Diversion	Tubestock planting	2008	☑ 2019	1			1		
	Woodland	North Dump 01	Aerial seeding	2014		1	1	1	1	1	1
	Woodland	North Dump 02	Aerial seeding	2014		1	1	1	1	1	1
	Woodland	North Dump 03	Aerial seeding	2014		1	1	1	1	1	1
	Woodland	South Dump 04	Aerial seeding	2014		1	1	1	1	1	1
	Woodland	South Dump 05	Aerial seeding	2014		1	1	1	1	1	1
	~~Woodland~~	~~South Dump 06~~	~~Aerial seeding~~	~~2014~~		~~1~~	~~1~~	~~1~~	~~subsidence~~	~~Subsidence~~	~~Subsidence~~
	Woodland	South Dump 07	Aerial seeding	2016		1	1	1	1	1	1
	Woodland	South Dump 08	Aerial seeding	2016		1	1	1	1	1	1
	Woodland	South Dump 09	Aerial seeding	2016		1	1	1	1	1	1
	Woodland	South Dump 10	Seeded	2018					1	1	1
	Total rehabilitation monitoring sites					17	9	16	17	9	9
Total No sites						25	13	16	25	12	12

Figure 2-1. Map of the CVO monitoring sites.

3 Rehabilitation monitoring methodology

The primary objective of the CVO rehabilitation monitoring program was to establish an annual rehabilitation monitoring program and develop set of completion criteria that complies and is consistent with conditions specified within a range of approval documents and conditions and associated CVO Management Plans including the CVO Rehabilitation Strategy (CVO 2013) and CVO Land and Biodiversity – Landscape Management Plan (CVO 2013). It has also been amended to align with the Rehabilitation and Environmental Management Plan (REMP) Guidelines (NSW I&I 2010) and the Departments ESG3 MOP guidelines (NSW T&I 2012, 2013), whilst addressing the range of technical issues identified in the ACARP project (Nichols 2005).

The monitoring methods adopted to obtain completion targets included a combination Landscape Function Analyses (LFA; CSIRO Tongway & Hindley 1996), accredited soil analyses and an assessment of ecosystem diversity and habitat values using an adaptation of methodologies derived from the Biometric Manual (Gibbons *et al* 2005, DECCW 2011). The methodology used for undertaking the monitoring has been provided in "Rehabilitation monitoring methodology and determination of completion criteria" (DnA Environmental 2011) and have been referenced in previous monitoring reports.

Ecological monitoring has been undertaken in autumn in all monitoring years. Field work and associated reports have been undertaken by Dr Donna Johnston and Andrew Johnston from DnA Environmental. In 2021, field surveys were undertaken by Andrew Johnston (DnA Environmental) and Ray Mjadwesch (Mjadwesch Environment Service Support) during 12th -14th April.

3.1 Limitations

3.1.1 Species identification

In some cases there may have been a lack of critical features and/or reproductive structures (due to heavy grazing or browsing, new germinants etc) that may be required for the positive identification of some plant genera, and therefore some species may have only been identified to the genera level.

4 Rainfall

Total annual and monthly rainfall averages recorded at CVO from 2014 to the end of April 2021 compared to long term monthly averages recorded at Orange Airport are provided in Figure 4-1 and Figure 4-2. The long term annual average rainfall recorded at Orange Airport is 857mm. The graph indicates that, with the exception of 2016 and 2020, below average annual rainfall has been experienced since 2014, with the lowest annual rainfall occurring during three consecutives of 2017 to 2019, with annual total rainfall ranging from 417 - 496mm respectively, with these being less than or only slightly more than half the expected rainfall.

Despite the apparently low rainfall activity in most years, the monthly averages indicate there has been high variability and erratic rainfall activity over these years. In 2015, there was below average rainfall during September and October and in February 2016 almost no rainfall was recorded at all, and only 19mm was received in March, thus providing very dry conditions preceding the 2016 monitoring event.

Relief from hot dry conditions during 2014 and 2015 occurred in April 2016 with above average rainfall events from May through to September which collectively caused extensive flooding throughout the Central Western Region. This flood event was the result of 610mm or close to 70% of the annual average of rainfall over five consecutive winter months. In 2016, a total of 927mm was recorded. Since November 2016, rainfall was typically well below the monthly averages with only 3mm being recorded in February 2017. In March 2017 however, there was a much-needed 110mm of rain which was well above the monthly average, followed by the monthly average of 45mm in April.

From October 2017 to January 2018 rainfall conditions were close to the expected monthly averages, however very dry conditions continued to be experienced throughout most of 2018, until November, where 97mm of rain fell. Above average rainfall was also recorded in January and March 2019 as a result of extreme storm activity, but in April, only 0.5mm of rain was recorded, with very limited rainfall being recorded for the remainder of the year.

In January and February 2020, some rain was experienced but these were lower than average, however expected rainfall was received in March and above average rainfall was recorded in April with a total of 147mm that month. During the remainder of 2020, monthly averages were slightly low in most months, except in October where 125mm was recorded, resulting in a total of 821mm being recorded for the year. During January, February and March this year, rainfall was similar to or above the expected averages.

Subsequently there have been extremes in climatic conditions, with floods in 2016 followed by three consecutive years of drought which has typically been reflected in the monitoring data. Over the last year there have been improved growing conditions resulting in a reduction in grazing and disturbance by animals, and extensive plant growth and increased levels of ground cover.

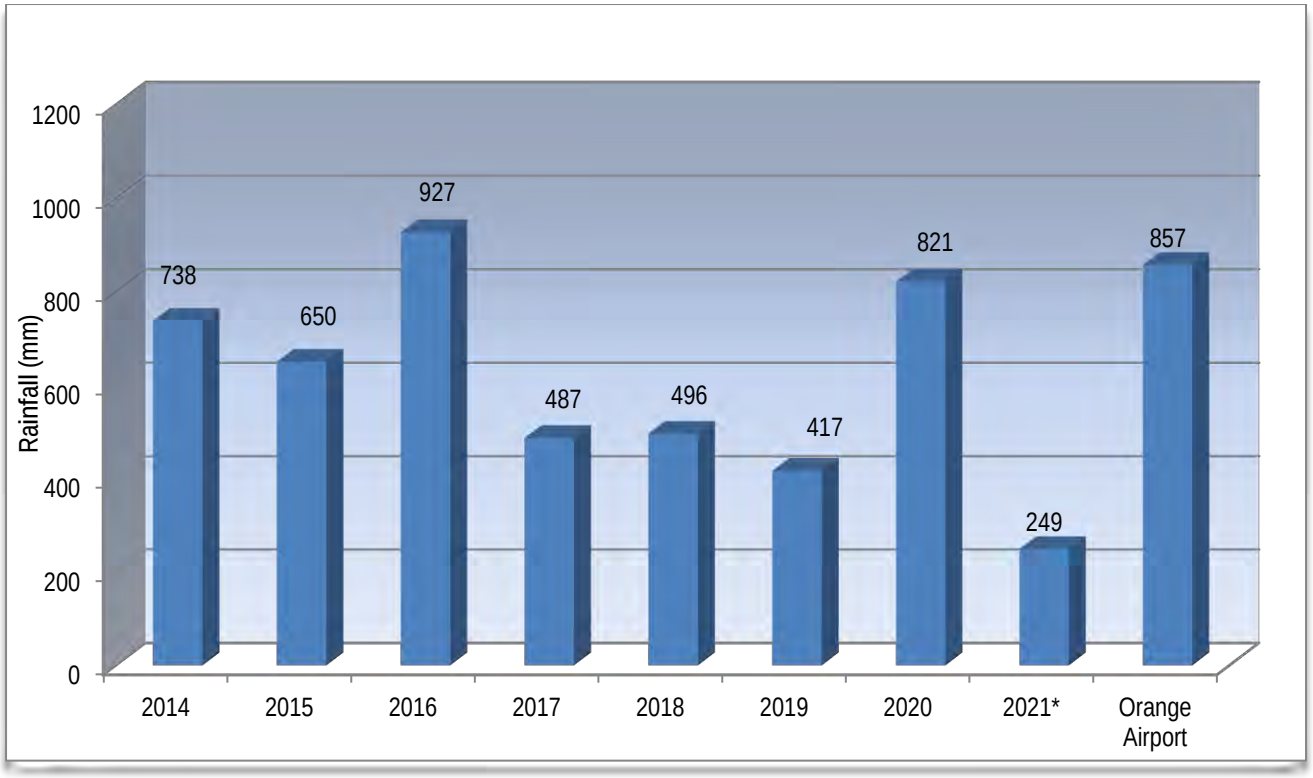


Figure 4-1. Annual average rainfall recorded at Cadia Valley Operations 2014 - April 2021 compared to long term monthly averages recorded at Orange Airport. (*2021 Jan – April ranfall)

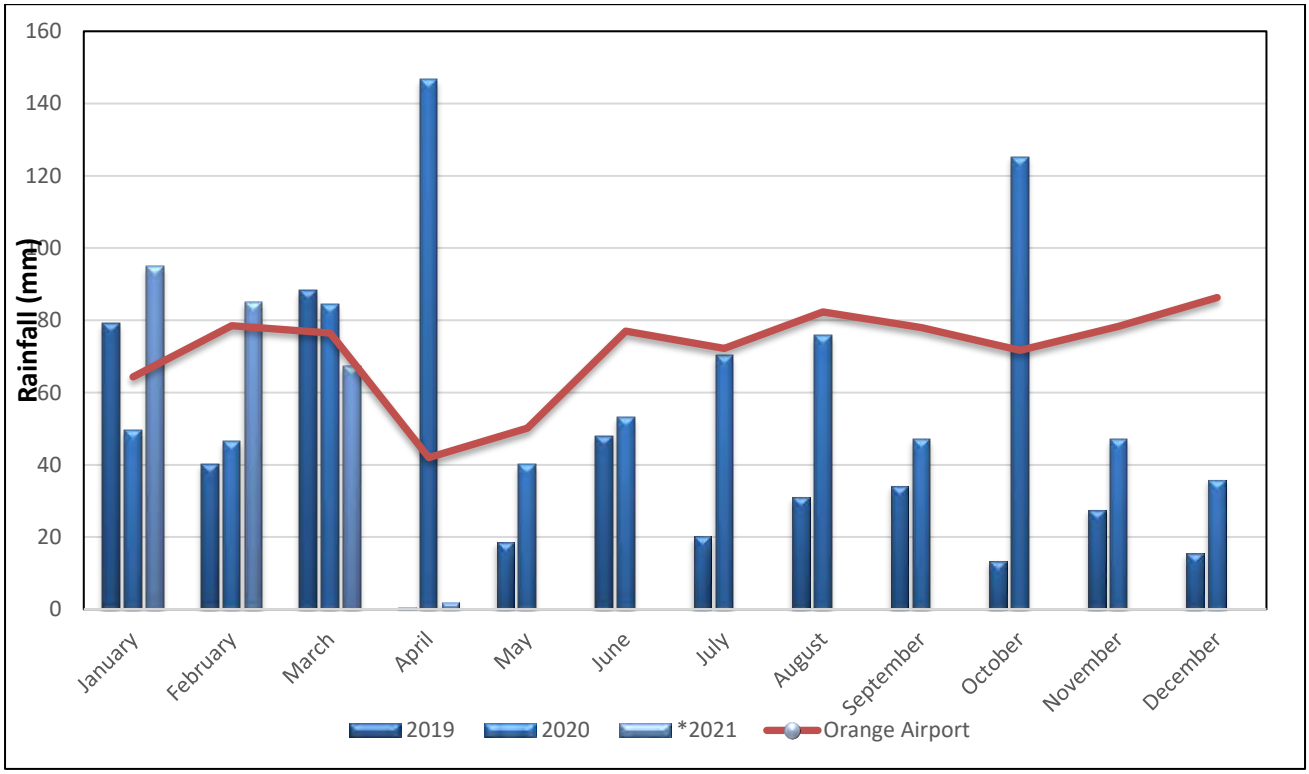


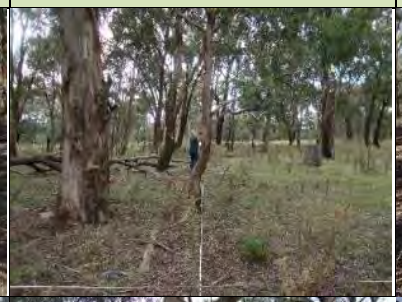
Figure 4-2. Average monthly rainfall recorded at Cadia Valley Operations January 2017 – April *2021 compared to long term monthly mean rainfall recorded at Orange Airport.

5 Results: Woodland monitoring sites

5.1 Descriptions and photo-points of the woodland reference sites

Table 5-1 provides a series of photographs taken from a permanent photo-point along the vegetation transect 2008 – 2021. Photos from numerous years have been excluded for ease of presentation of the increasing quantity of data. The GPS co-ordinates and other site-specific information of the reference sites are provided in Appendix 1.

Table 5-1. General description and permanent photo-point along the vegetation transect in the reference monitoring sites 2008 - 2021.

Site name	2008	2012	2016	2020	2021
RfWood01: "Ashleigh Park"					
RfWood02: "Bundarra"					
RWood05: Cadiang-ullong Dam					

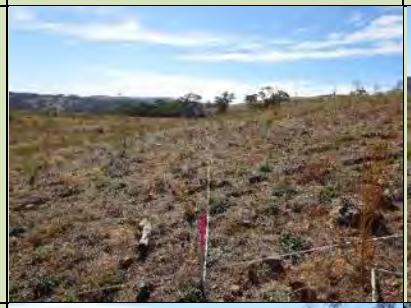
5.2 Descriptions and photo-points of rehabilitation areas on the south and north dumps

Table 5-2 provides a photograph taken from the permanent monitoring point along the vegetation transect of rehabilitation sites established on the South and North Dumps from 2014 to 2021. North Dump 03 and South Dump 08 are relatively flat, while the remainder are on slopes. Sites South Dump 04 and 05 and North Dump 01, 02 and 03 were aerial seeded during November 2013 with a blend of native trees and shrubs and exotic pasture species. Sites on the North Dump were over sown with Japanese Millet while sites on the South Dump were over sown with Cereal Rye, Couch, Cocksfoot, Phalaris, Subterranean Clover, Perennial Ryegrass and the native grass *Bothriochloa macra* (Redgrass). In October 2015, sites South Dump 04 and 05 were cross ripped and re-seeded to reduce the compaction layer. Sites South Dump07, 08 and 09 were also aerial sown in February 2015 with a mix of endemic native, shrubs and ground cover species. South Dump10 was sown in February 2018. GPS co-ordinates and other site specific information of the rehabilitation sites are provided in Appendix 1.

Table 5-2. Permanent photo-point of the rehabilitation monitoring sites on the south and north dumps 2014 - 2021.

Site name	2014	2016	2018	2020	2021
South Dump 04					
South Dump 05					

Site name	2014	2016	2018	2020	2021
South Dump 07	N/A				
South Dump 08	N/A				
South Dump 09	N/A				
South Dump 10	N/A	N/A			

Site name	2014	2016	2018	2020	2021
North Dump 01					
North Dump 02					
North Dump 03					

5.3 Ecological trends and performance against a selection of ecological performance indicators

The following section provides a summary of the ecological trends and performance of woodland rehabilitation sites against a selection of performance indicators obtained from the three woodland reference sites. As the rehabilitation monitoring program has been undertaken annually since 2008 many of the original sites (pre 2010) have reached a stable and functional state and are now being assessed every three years. These sites were not assessed this year.

In terms of data analyses, the majority of young rehabilitation sites were established and first assessed in 2014. Data obtained prior to 2014 from the older sites has been omitted from the report for ease of presentation. For early reference of data obtained from these older rehabilitation sites please refer to 2009 – 2016 CVO annual rehabilitation monitoring reports (DnA Environmental 2009 – 2016).

5.3.1 **Landscape Function Analyses**

5.3.1.1 Landscape Organisation Index

A patch is an area within an ecosystem where resources such as soil and litter tend to accumulate, while areas where resources are mobilised and transported away are referred to as interpatches. Landscape Organisation Indices (LOI) are calculated by the length of the patches divided by the length of the transect to provide an index or percent of the transect which is occupied by functional patch areas (Tongway and Hindley 2004).

The woodland reference sites were characterised by having a mature tree canopy and in two sites, there was a well-developed, decomposing leaf litter layer and a sparse cover of native perennial forbs and grasses. The other sites tended to have much more dominant perennial grass cover. The extended dry conditions during 2017 - 2019 caused a reduction in perennial ground covers and increased disturbances by animals has created some bare interpatch areas in RfWood01 and RfWood02, thus lowering LOIs in these sites. This year, the improved seasonal conditions resulted in a significant increase in the diversity and abundance of the ground covers, with 100% functional patch area in the woodland reference sites (Figure 5-1).

All rehabilitation sites established on the South Dump and North Dump had previously demonstrated a significant increase in functional patch area (Figure 5-1). Despite the loss of many of the original troughs and banks due to erosive processes in numerous sites, there tended to be a concurrent increase in plant and litter covers. During 2017 - 2019 however, prolonged dry conditions and increased grazing and disturbance by animals resulted in a deterioration of functional patch area in all rehabilitation sites.

In 2020, the continuing drought conditions, heavy grazing and increased erosion was recorded in several rehabilitation areas including South Dump 04 and South Dump 09, and a minor decrease was also recorded in North Dump 01. In the remaining sites, increased patch area was recorded largely due to the relatively recent germination of annual plant covers.

As for the reference sites, improved seasonal conditions also resulted in an increase in ground covers and resultant functional patch areas in all rehabilitation sites this year. LOIs or functional patch areas were highly variable over the South Dump rehabilitation area and ranged from a low of 55% in South Dump 07 to a high of 100% in South Dump 10. All three sites on the North Dump had 100% functional patch area this year.

This year, South Dump 10 and all three sites on the North Dump had an LOI comparable to the woodland reference sites (Figure 5-1), while they were very close to achieving this target in South Dump 05 and South Dump 09.

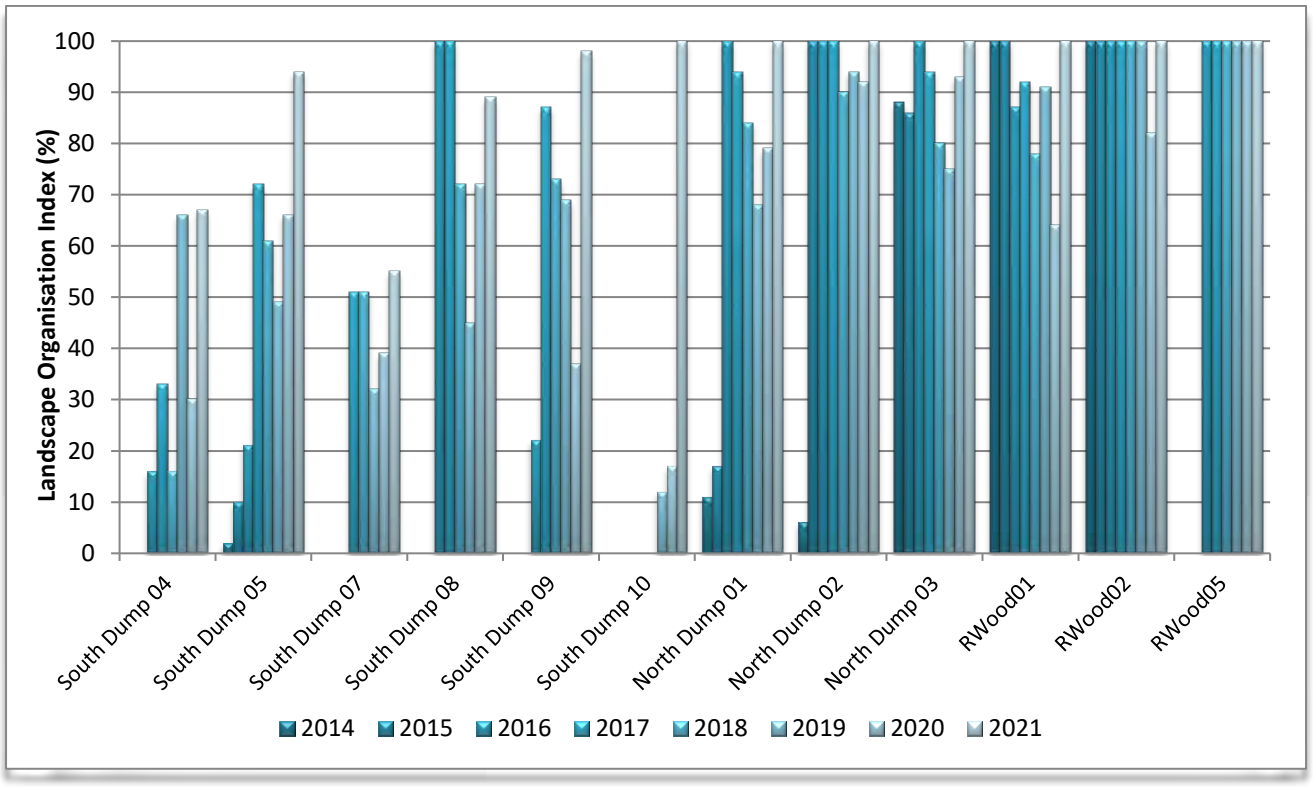


Figure 5-1. Landscape Organisation Indices recorded in the woodland monitoring sites.

5.3.1.2 Soil surface assessments

5.3.1.2.1 Stability

Changes in stability in the various woodland reference sites have tended to fluctuate according to seasonal conditions and total grazing pressure and these have been variable between sites. In 2016, there was an increase in stability in most of the monitoring sites as a result of the improved seasonal conditions, which typically promoted live annual and perennial plant cover. During 2017 - 2020, extended dry conditions and increased grazing and disturbance caused by animals has typically resulted in a reduction in the stability of the woodland reference site. This year, improved conditions resulted in increased stability in all three sites, with indices of 65.1 – 80.0 (Figure 5-2).

Last year, the stability of the rehabilitation areas on the South Dump were variable, with a marginal decline also being recorded in South Dump 04, 05, and 09. South Dump 05 continued to be subjected by heavy disturbance by macropods, while active rilling and sheet erosion created unstable conditions for the establishment of cryptogam and ground cover vegetation in South Dump 04 and South Dump 09. Stability in the remaining sites on the South Dump last year tended to have an increase in litter and ground cover vegetation, and in some sites, there had been an increase in shrub cover and/or cryptogams were abundant despite the drought. This year, increased stability was recorded in all rehabilitation sites on the South Dump with indices that ranged from a low of 63.7 in South Dump 07, to a high of 74.1 at South Dump 08.

On the North Dump rehabilitation area, annual weeds had become well colonised and due to the litter accumulation, all three sites had a well-developed and mostly stable annual plant/litter layer. Overgrazing by herbivores was prevalent in all three sites resulting in the exposure of small bare patches mostly on the top of old rip lines where some isolated erosion may have occurred, and sheeting had become more evident in North Dump 01 last year. This year stability on the North Dump also increased and ranged from 67.5 – 72.5.

All rehabilitation sites except South Dump 04 and South Dump 07 had stability indices comparable to the woodland reference sites this year.

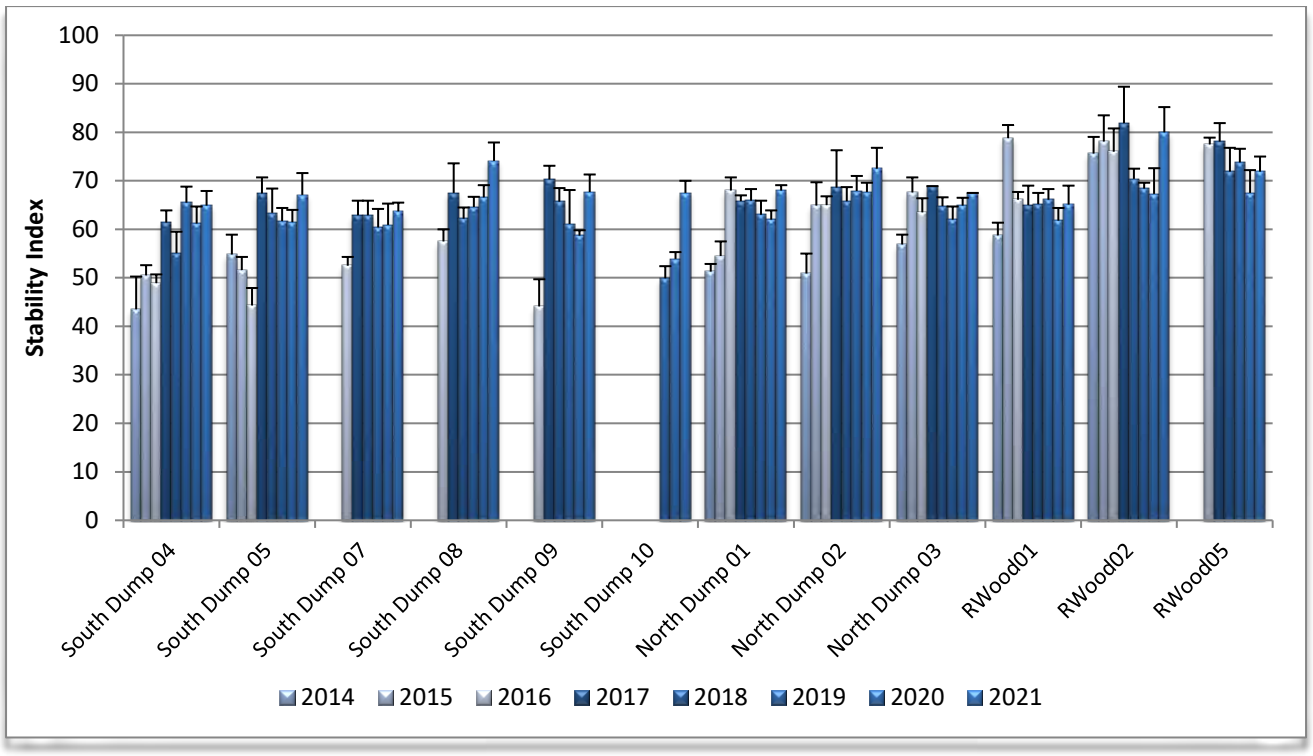


Figure 5-2 LFA stability indices recorded in the woodland monitoring sites.

5.3.1.2.2 Infiltration

The LFA infiltration indices recorded in the woodland reference sites have increased this year as a result of the improved seasonal conditions, with these ranging from 56.1 – 66.0 (Figure 5-3). In the rehabilitation sites, an increase in infiltration capacity was also recorded in all monitoring sites. Infiltration capacity of rehabilitation sites on the South Dump ranged from a low of 31.6 at South Dump 07 to a high of 46.4 at South Dump 05. On the North Dump, infiltration indices ranged from 40.9 at North Dump 03 to 49.3 at North Dump 02.

Despite the improved infiltration in the rehabilitation sites, they did not yet have an infiltration capacity comparable to the woodland reference sites again this year.

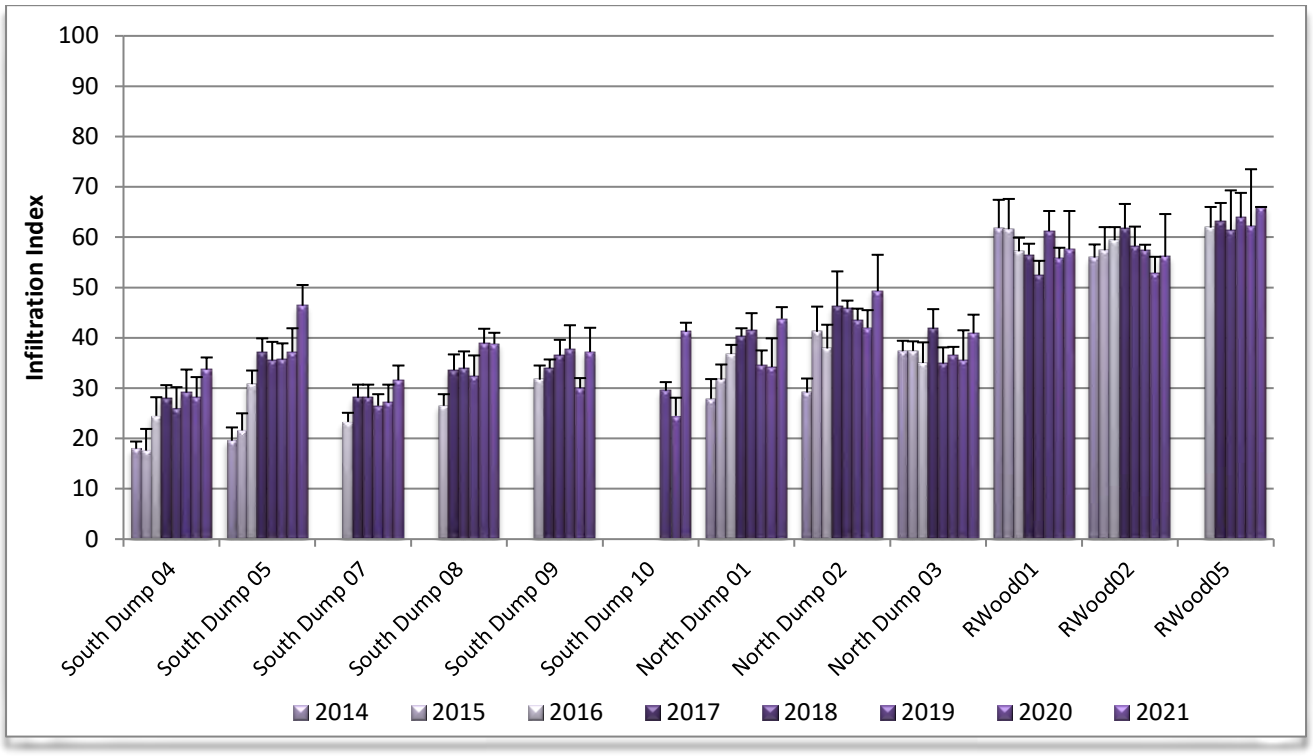


Figure 5-3. LFA infiltration indices recorded in the woodland monitoring sites.

5.3.1.2.3 Nutrient recycling

The nutrient recycling indices followed similar trends as infiltration capacity of the sites. They also tended to be influenced by the increase levels of perennial canopy and ground cover, litter cover and decomposition as well as cover provided by cryptogams. The LFA nutrient recycling indices for the woodland reference sites ranged from 54.0 – 64.1 (Figure 5-4).

Increased nutrient recycling was also recorded in the rehabilitation monitoring sites. Nutrient recycling indices for rehabilitation sites on the South Dump ranged from a low of 34.8 on South Dump 04 to a high of 47.8 at South Dump 05. On the North Dump, nutrient recycling ranged from a low of 37.8 (North Dump 03) to a high of 49.9 (North Dump 02). No rehabilitation site had a nutrient recycling capacity that was comparable to the woodland reference sites again this year.

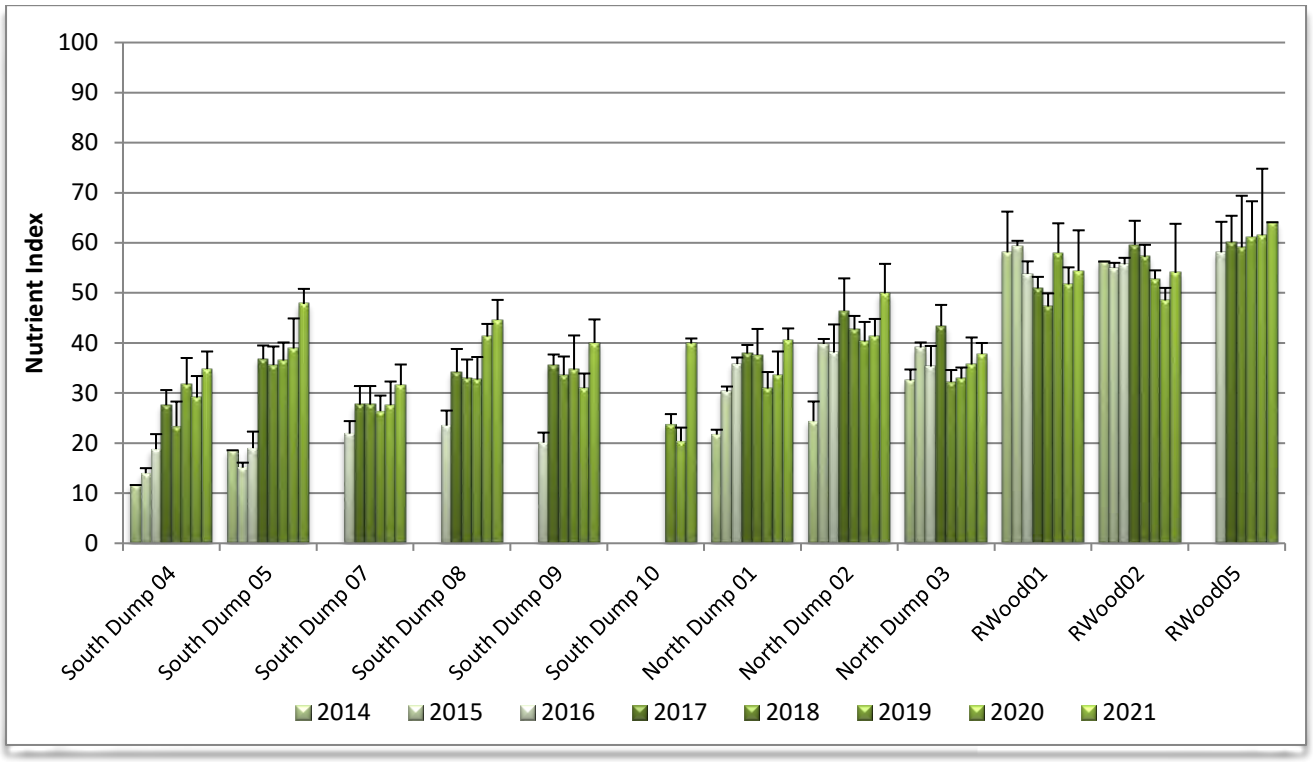


Figure 5-4 LFA nutrient recycling indices recorded in the woodland monitoring sites.

5.3.1.2.4 Most functional sites

The sum of the LFA stability, infiltration and nutrient recycling components provides an indication of the most functional to least functional monitoring site recorded in 2021 (Figure 5-5). The maximum score possible is 300.

The woodland reference sites continued to be the most ecologically functional sites with total scores ranging from 177 – 202, with RWood05 being the most functionally woodland community. These sites contained high patch areas, mature tree canopies, high abundance of protective perennial ground covers. Most importantly, they also had a well-developed and decomposing litter layer which had developed a spongy humus layer with little to no soil surface crusting. Sites North Dump 02, South Dump 05 and South Dump 08 were functionally similar to each other with scores of 172, 161 and 158 respectively, closely followed by North Dump 01 with a sum of 152.

Sites South Dump 10, North Dump 03 and South Dump 09 were functionally very similar to each other with a sum of scores ranging from 145 - 149, with South Dump 10 having the highest function of these sites. Sites South Dump 04 and 07 were the least functional communities and appear to be developing more slowly but at similar rates to each other with scores of 133 and 127 respectively. Examples of the substrates and vegetation covers in the woodland monitoring sites this year have been illustrated in Table 5-3.

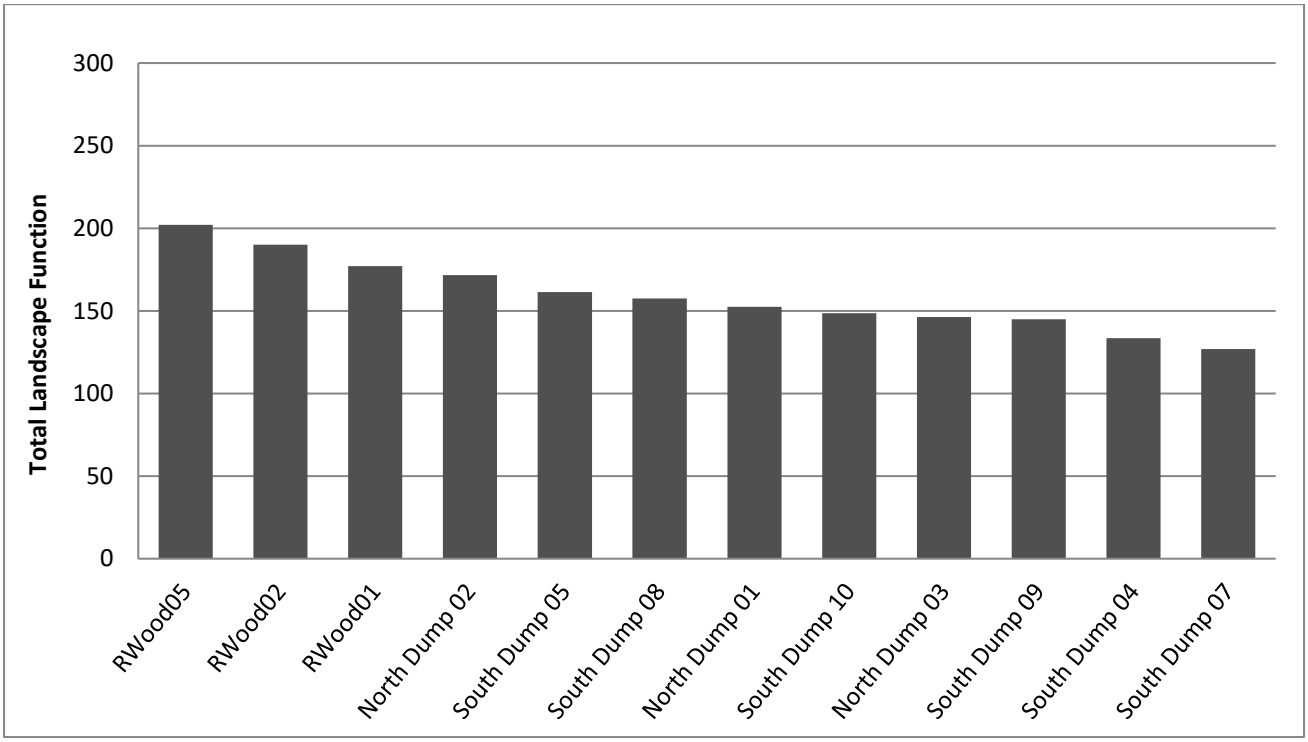
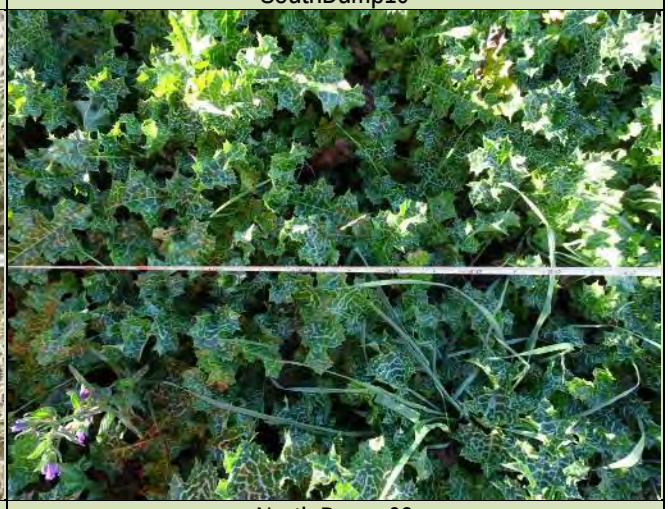


Figure 5-5. Sum of the LFA stability, infiltration and nutrient recycling components indicating the most functional to least functional monitoring site recorded in 2021.

Table 5-3. Examples of the different ground covers in the woodland monitoring sites in 2021.

South Dump 04	South Dump 05
SouthDump07	**SouthDump08**

SouthDump09	SouthDump10
	
North Dump 01	North Dump 02
North Dump 03	RfWood01

RfWood02	RWood05

5.3.2 Tree and mature shrub populations

5.3.2.1 Density

The density of live mature trees (>5cm dbh) recorded in the woodland reference sites was highly variable with a further decrease in density recorded in RWood05 this year, as several mature acacias have died. The resultant tree densities were 8 – 35 trees per 50 x 20m (0.1 ha) plot, equating to a stem density of 80 – 350 trees per hectare (Figure 5-6).

In the younger rehabilitation sites, young trees and mature shrubs had established in several areas of rehabilitation, with significant increases in densities in South Dump 05 and North Dump 02 up until 2020, where significant acacia mortality was recorded. While additional acacias have matured in North Dump 02, continued mortality was recorded in South Dump 05. In South Dump 07, many eucalypts had now developed into trees, and three of these sites continued to have a density comparable to the reference sites.

There were two to four individuals in South Dump 04, South Dump 08 and South Dump 09 while none yet had > 5 cm dbh in South Dump 10. On the North Dump there were three and one individuals recorded at North Dump 01 and 03 respectively. Despite quite significant losses of mature acacias over the past few years, sites South Dump 05 and North Dump 02 continued to have a tree and mature shrub density comparable to the reference sites, and this year so did South Dump 07.

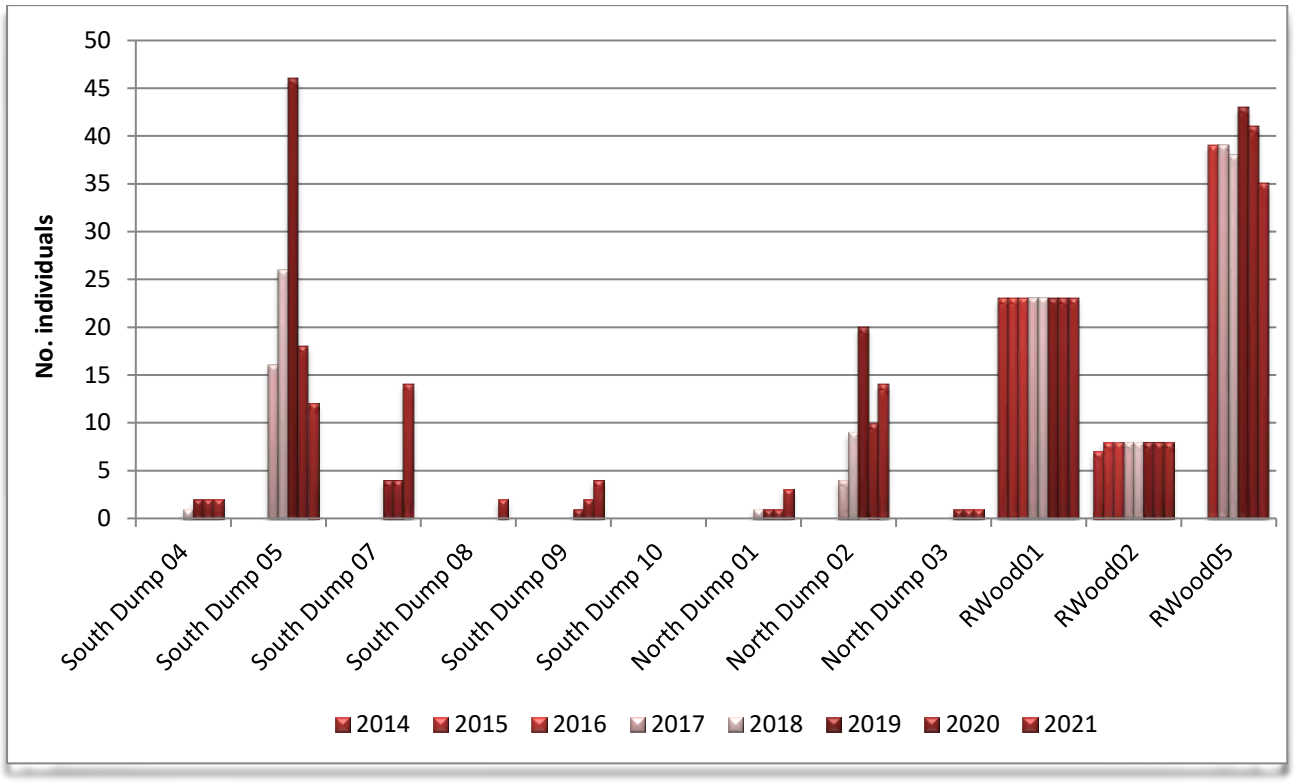


Figure 5-6. Tree and mature shrub densities (>5cm dbh) in the woodland monitoring sites.

5.3.2.2 Diameter at breast height

The average dbh recorded in the reference sites ranged from 26 – 68 cm with the smallest being 7 cm and the largest 95 cm. The average trunk diameter in rehabilitation sites on the South and North Dump ranged from 7 – 15 cm, with the maximum diameter being recorded in South Dump 04 with two acacias having a dbh of 15 cm (Table 5-4). On the North Dump the average dbh was 5 – 7cm, with the maximum dbh being 11cm at North Dump 02.

5.3.2.3 Condition

Trees and mature shrubs in the woodland reference sites were predominantly in good to moderate health this year however, a small number were stressed in RfWood01 and RWood05, and 8 – 19% were stags [dead]. In the reference sites 42 – 78% of the tree population contained reproductive structures such as buds, flowers or fruits (Table 5-4). RfWood02 and RWood05 contained tree hollows (>5cm) with 44% and 5% of the tree populations bearing suitable habitat hollows respectively, however mistletoe was not recorded in any site.

In South Dump 05 and North Dump 02, 68% and 36% were dead as the mature acacias become senescent, and there were 13% dead in South Dump 07 this year. No other site had dead individuals but 27% had advanced dieback in North Dump 02. In the remaining sites, most other individuals were in healthy to moderate condition. In South Dump 04 and North Dump 03 all individuals were bearing reproductive structures, while flowers were also recorded in 9 – 67% of individuals in North Dump 01 and 02. Rehabilitation areas were still too young to provide hollows and no mistletoe was observed.

5.3.2.4 Species Composition

In the reference sites, the tree populations were comprised of 1 – 4 species of tree and mature shrubs (Table 5-4). The most dominant species were *Eucalyptus melliodora* (Yellow Box), *E. albens* (White Box) and *E.*

goniocalyx (Bundy Box), with *E. macrorhyncha* (Red Stringybark), *E. bridgesiana* (Apple Box), *Acacia dealbata* (Silver Wattle) and *A. implexa* (Hickory) typically occurring in fewer numbers.

The rehabilitation sites on the South and North Dump typically had tree populations comprised only of mature *A. dealbata.* The exceptions included South Dump 07 which had an increasing number of *Eucalyptus goniocalyx and E. albens* trees. In South Dump 09 there were *E. goniocalyx* and *E. viminalis* saplings as well as *Acacia penninervis* (Mountain Hickory) and non-endemic *Acacia decurrens* (Early black Wattle).

Table 5-4. Trunk diameters and condition of the trees and mature shrubs in the woodland monitoring sites in 2021.

Site Name	No species	Average dbh (Cm)	Max dbh (cm)	Min dbh (cm)	Total trees	No. with multiple limbs	% Live trees	% Healthy	% Medium Health	% Advanced Dieback	% Dead	% Mistletoe	% Flowers / fruit	%. Trees with hollows
South Dump 04	1	15	15	15	2	0	100	100	0	0	0	0	100	0
South Dump 05	2	8	11	5	38	2	32	21	11	0	68	0	0	0
South Dump 07	2	8	11	6	16	0	88	88	0	0	13	0	0	0
South Dump 08	1	7	7	7	2	0	100	0	100	0	0	0	0	0
South Dump 09	4	8	13	5	5	0	100	100	0	0	0	0	0	0
South Dump 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
North Dump 01	1	7	10	5	3	2	100	67	33	0	0	0	67	0
North Dump 02	1	7	11	5	22	6	64	9	27	27	36	0	9	0
North Dump 03	1	7	7	7	1	0	100	0	100	0	0	0	100	0
RWood01	2	32	89	7	25	10	92	52	36	4	8	0	52	0
RWood02	1	68	95	31	9	1	89	33	56	0	11	0	78	44
RWood05	4	26	77	7	43	12	81	30	42	9	19	0	42	5

5.3.3 Shrubs and juvenile trees

5.3.3.1 Density

The density of shrubs and/or juvenile trees (<5cm dbh) recorded in the woodland reference sites was highly variable with none recorded in RfWood01 while many more seedlings were recorded in RWood05 this year with 116 seedlings.

The density of shrubs and/or juvenile trees (<5cm dbh) recorded in the woodland rehabilitation sites was also highly variable between sites. In sites on the South Dump and North Dump 01 and 02, shrub densities have continued to decline in all sites largely due to drought mortality and or natural senescence. In some cases, some individuals may have grown and were now recorded a mature tree (>5 cm dbh). It was noted that numerous relatively tall *A. dealbata* individuals were very stressed or had recently died in pockets throughout several of the rehabilitation areas. In North Dump 03, many volunteer *Cassinia arcuata* (Chinese Shrub) were establishing.

All of the woodland rehabilitation sites on the South Dump, except South Dump 10 continued to have a high density of shrubs compared to the reference sites, which ranged from 106 individuals in South Dump 04 to 420 individuals in South Dump 08. The newest site South Dump 10 continued to have only 6 individuals. Shrub densities on the North Dump ranged from 152 - 336 (Figure 5-7, Table 5-5).

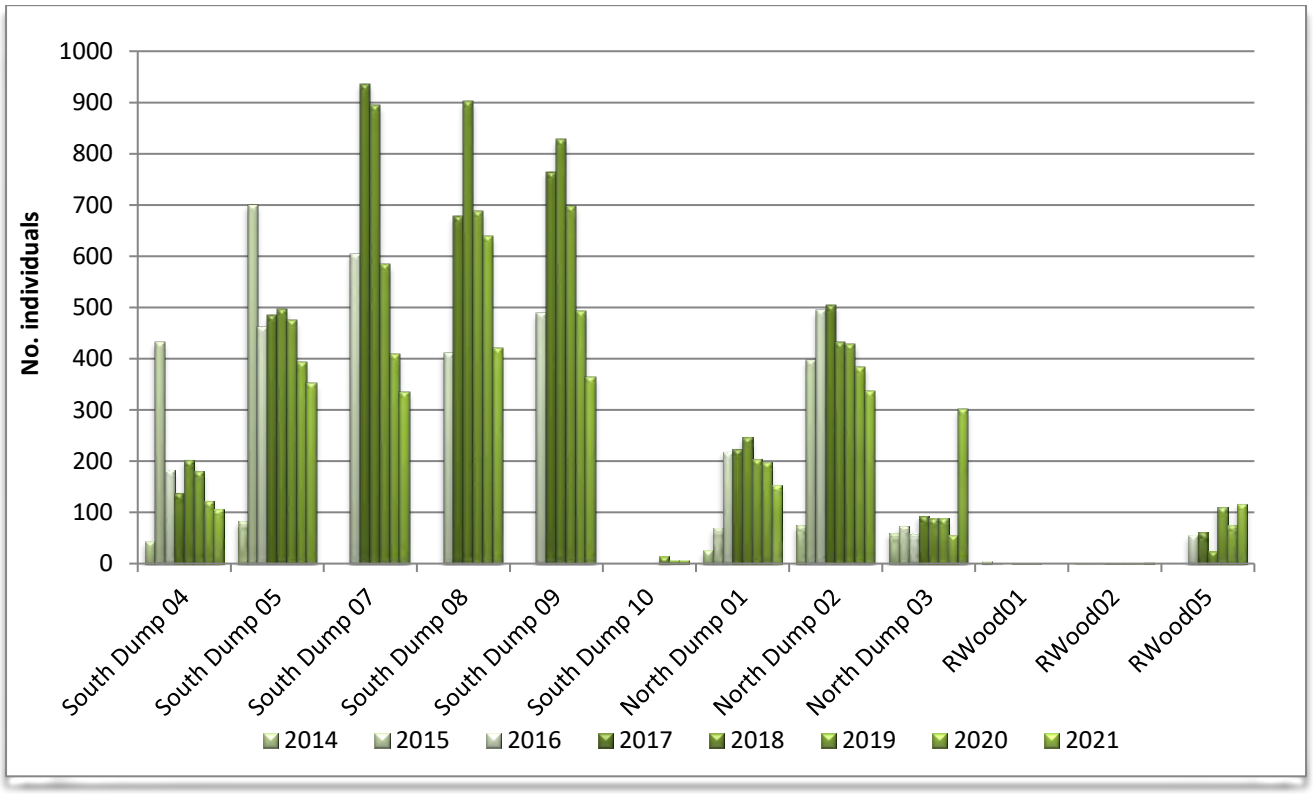


Figure 5-7. Population densities of shrubs and juvenile trees recorded in the woodland monitoring sites.

Table 5-5. Shrubs and juvenile trees recorded in each height class in the woodland monitoring sites in 2021.

Site Name	0-0.5m	0.5-1.0m	1.0-1.5m	1.5-2.0m	>2.0m	Total	No. species	% endemic
South Dump 04	8	12	26	38	22	106	3	100
South Dump 05	10	20	34	40	248	352	10	98
South Dump 07	4	38	110	114	68	334	13	100
South Dump 08	22	110	172	82	34	420	16	100
South Dump 09	8	34	94	138	90	364	8	100
South Dump 10	3	2	0	1	0	6	3	100
North Dump 01	0	18	50	54	30	152	3	100
North Dump 02	8	24	76	130	98	336	4	100
North Dump 03	272	6	9	12	1	300	4	100
RfWood01	0	0	0	0	0	0	0	0
RfWood02	1	1	0	0	0	2	1	100
RWood05	93	22	0	0	1	116	8	93

5.3.3.2 Diversity

In the two reference sites with juvenile trees and shrubs there were 1 – 8 species. The most common shrubs and juvenile tree species in the woodland reference site RWood05 were *A. dealbata*, with one or two juvenile *E. goniocalyx, Cassinia arcuata, A. implexa* and *Brachychiton populneus* (Kurrajong). There were numerous exotic shrubs including *Crataegus monogyna* (Hawthorn), *Rubus fruticosus* (Blackberry) and *Rosa rubiginosa* (Sweet Briar) which comprised 7% of the shrub population. In RfWood02, there were two juvenile *E. albens*.

The rehabilitation sites on the South and North Dump had a relatively high diversity of shrubs and juvenile trees with 3 - 16 different species with these typically containing a proportionately high density and diversity of acacias. The lowest diversity was recorded in South Dump 04 and South Dump 10 with three different species, while at South Dump 08 there were 16 different species.

A. buxifolia tended to be the most abundant species followed by *A. dealbata* and *A. vestita*. Other occasional species may have included *A. spectabilis* (Mudgee Wattle), *A. genistifolia* (Early Wattle), *A. verniciflua* (Varnish Wattle), *A. penninervis* (Mountain Hickory), *A. decora* (Western Golden Wattle), *A. filicifolia* (Fern leaved Wattle) and *A. paradoxa* (Kangaroo Thorn). Volunteer *Cassinia arcuata* (Chinese Shrub) was often abundant and was recorded in most some sites. Other occasional species may have included *Hakea sp., Pultenaea sp.* and the native vine *Hardenbergia violacea* (Happy Wanderer).

In South Dump 07, 08 and 09, eucalypts were recorded more frequently with common species being juvenile *Eucalyptus albens, E. blakelyi*, *E. bridgesiana, E. goniocalyx, E. viminalis* (Ribbon Gum), *E. dives* (Broad-leaved Peppermint), *E. melliodora, E. polyanthemos* (Red Box) and *E. macrorhyncha.* Sites that did not presently contain eucalypts included South Dump 04 and 05 and North Dump 01, 02 and 03.

Native non endemic species to the CVO area were *A. decurrens* (Early black Wattle) and *A. filicifolia* (Fern-leaved Wattle) which were recorded in low densities in several sites. It is also questionable if *A. spectabilis* should be included as endemic to the CVO area.

5.3.3.3 Height class

In the reference site which contained a good shrub population (RWood05) most seedlings tended to be less than 0.5m in height, and almost all were less than 1.0m. In the rehabilitation areas, most individuals tended to be taller than 1.0m tall however there was also a large and increasing number of individuals > 2.0m. Site South Dump 05 had the highest density of large individuals with 248 individuals > 2.0 m, while South Dump 10 had none (Table 5-5, Figure 5-8).

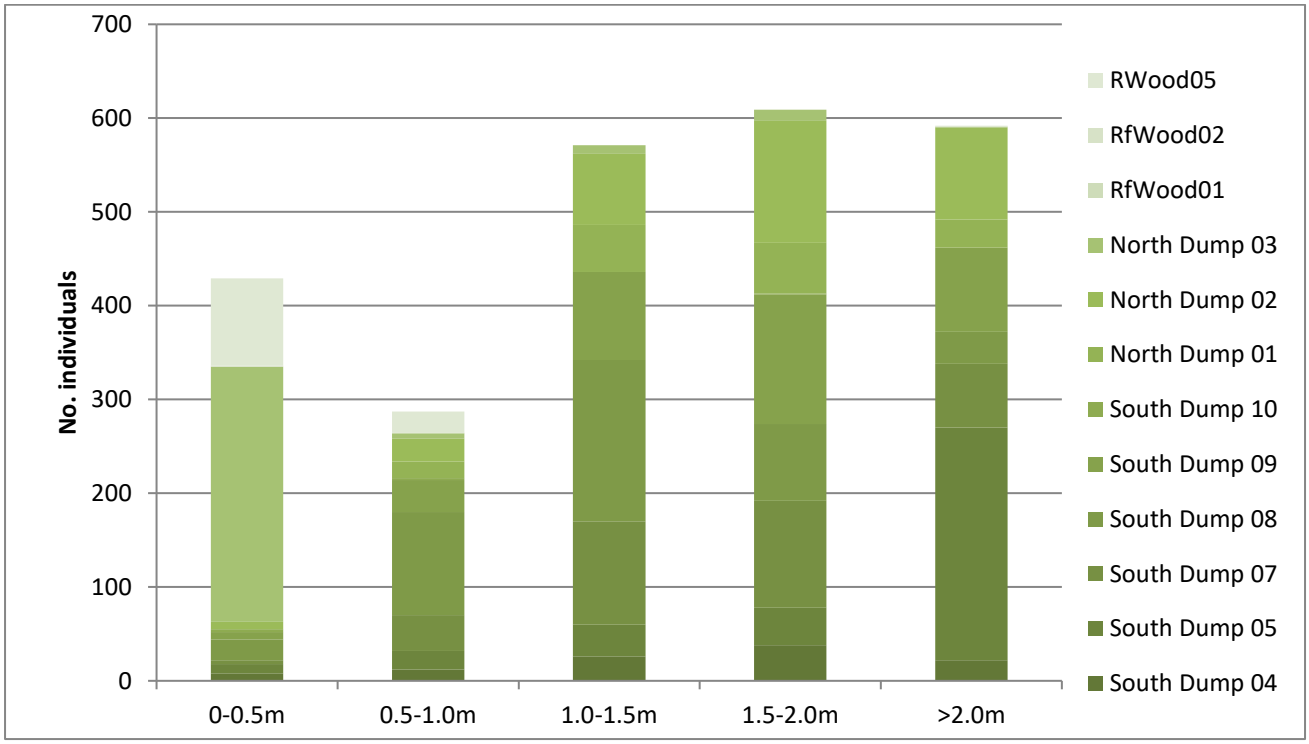


Figure 5-8. Number of individuals within the five height classes.

5.3.4 Total ground cover

Total ground cover is a combination of leaf litter, annual plants, cryptogams, rocks, logs and live perennial plants (<0.5m in height). In the woodland reference sites, there was a marginal increase in two sites however a minor decrease was recorded in RWood05 due to ongoing disturbance of animal tracks and camps, with 94 – 100% ground cover along the vegetation transects this year (Figure 5-9).

In 2017 improved seasonal conditions resulted in a significant increase in ground cover in all rehabilitation areas, however in 2018 and 2019 many rehabilitation areas were affected by the prolonged dry conditions with some also being heavily impacted on by macropods. As a result, total ground cover tended to decline in numerous sites, however, some rainfall events caused a flush of annual plant growth, with increased cover recorded in all rehabilitation sites except South Dump 04 and South Dump 10 in 2020. This year improved seasonal conditions resulted in increased levels of ground cover in all rehabilitation sites, except South Dump 07 which continued to have some rilling and active sheet erosion.

On the South Dump, total ground cover ranged from a low of 50% in South Dump 07 to a high of 100% at South Dump 10. On the North Dump, total ground cover ranged from 96 – 100%. This year, sites South Dump 10 and all three sites on the North Dump had a total ground cover that was comparable to the woodland reference sites.

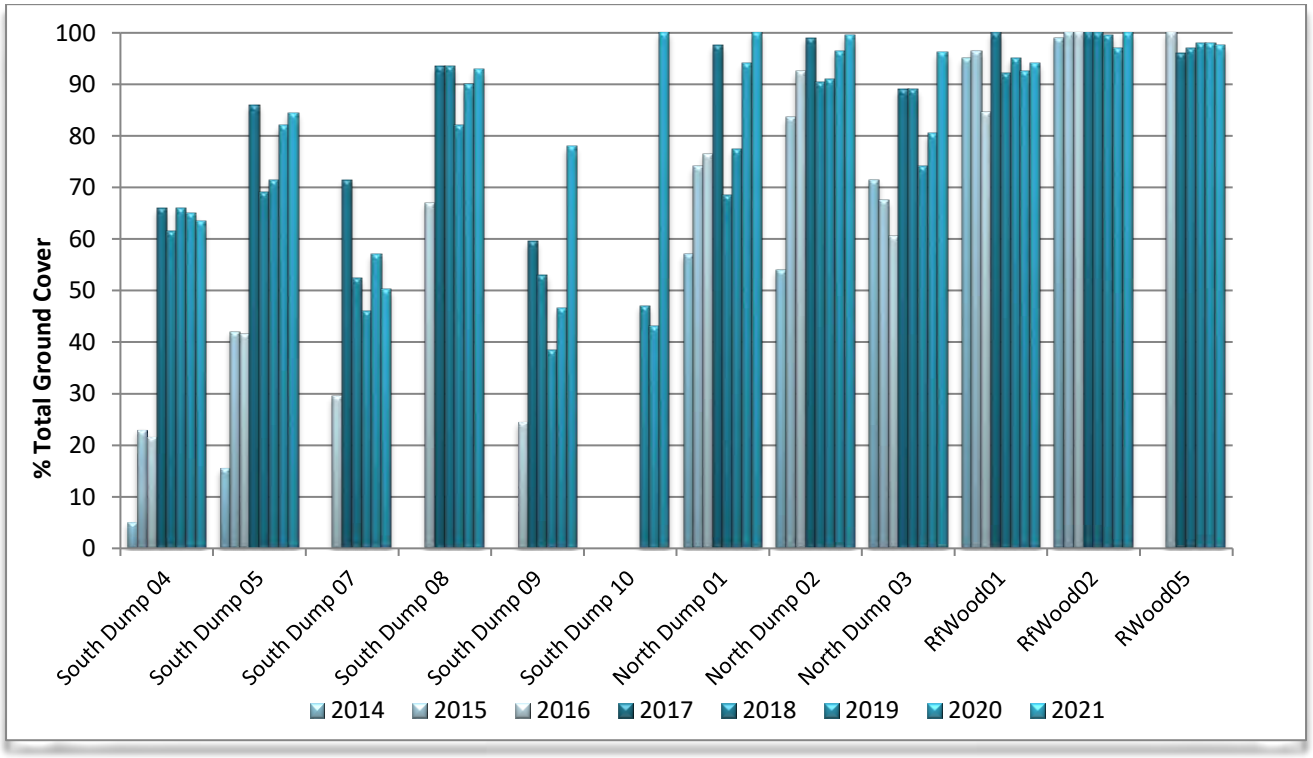


Figure 5-9. Total ground cover recorded in the woodland monitoring sites.

5.3.5 Structural composition

This year only two reference sites were dominated by dead leaf litter that provided 74 – 78% cover and in these sites annual (2 – 8%) and perennial ground (11 – 16%) cover plants were sparse. In RfWood02 however, perennial plants had again become dominant and provided 64% of the total cover, while there was 18% annual plants and 5% dead litter cover. There may have been a small amount of cover from fallen branches and some rock cover was recorded in RfWood02 due to a rocky granite outcrop. Cryptogam cover was absent due to the high levels of plant and litter covers (Figure 5-10).

This year there was also an increase in annual and perennial plant cover ground cover in most rehabilitation monitoring sites. All sites except South Dump 10 had an acceptable cover of perennial plants which ranged from 15% (South Dump09) to 70% in North Dump 02. South Dump 10 was almost entirely dominated by annual weeds.

The three woodland reference sites contained a mature canopy cover (>6.0 m) but typically there was limited foliage cover recorded in the lower height classes, a characteristic feature of open grassy woodland communities. In the rehabilitation areas on the South and North Dump the establishing tree and shrub seedlings provided some foliage cover 0.5 – 2.0 m in height in all sites except South Dump 10.

All rehabilitation sites except South Dump 04, 10 and North Dump 02 and 03 had some vertical foliage cover 2.0 - 4.0 m in height. In some sites such as South Dump 05 there was previously also some canopy cover 4.0 – 6.0 m and >6.0 m in height provided by the maturing acacias, however these individuals have since died.

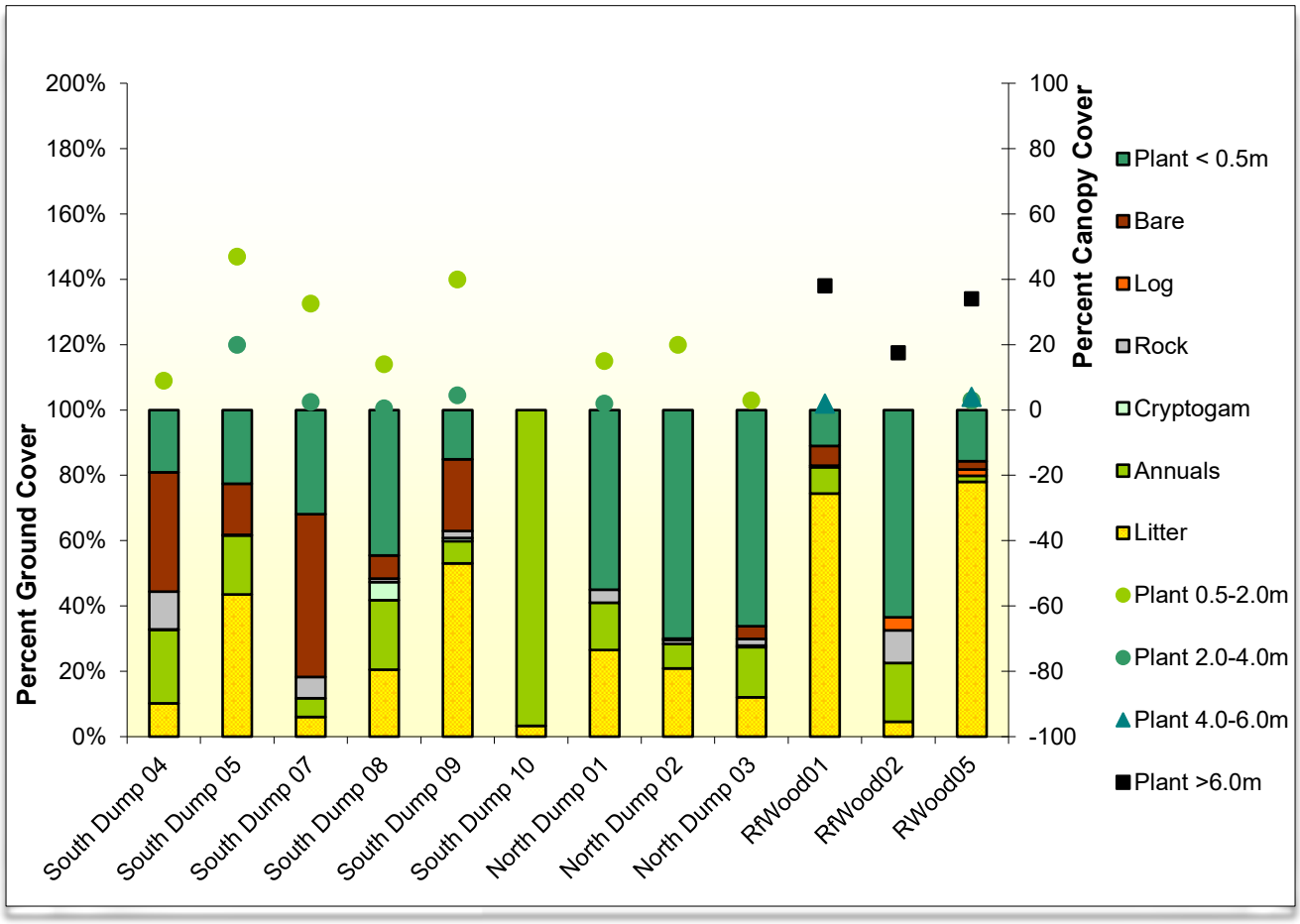


Figure 5-10. Average percent ground cover and projected foliage cover recorded in the woodland monitoring sites in 2021.

5.3.6 Floristic Diversity

There has been no consistent change in total species diversity across the range of monitoring sites however the level of diversity has tended to fluctuate with the seasonal conditions and degree of grazing intensity. In the rehabilitation areas floristic diversity may also be associated with the successional development and/or management intervention of the area. This year the improved seasonal conditions has resulted in an increase in total species diversity with a total of 26 – 60 plant species recorded in the 0.1 ha woodland reference site monitoring quadrats (Figure 5-11).

An increase in species diversity was also recorded in the rehabilitation areas and all had a higher diversity than were recorded in the reference sites. The highest diversity was recorded in South Dump 08 with 58 species, while the lowest diversity was recorded in South Dump 10 with 25 species.

The diversity of native species followed similar trends and this year there were 10 – 36 native species recorded in the reference sites with all rehabilitation sites containing at least the minimum threshold, except South Dump 10 (Figure 5-12). The most native species were recorded in South Dump 08 with 37 species, while the lowest number was recorded in South Dump 10 with eight native species.

In the reference sites there were 16 – 24 exotic species with all rehabilitation sites on the South Dump containing an acceptable diversity of exotic species with 9 – 21 exotic species. On the North Dump there were 26 – 30 exotic species with these sites having a higher diversity of exotics than desired (Figure 5-13).

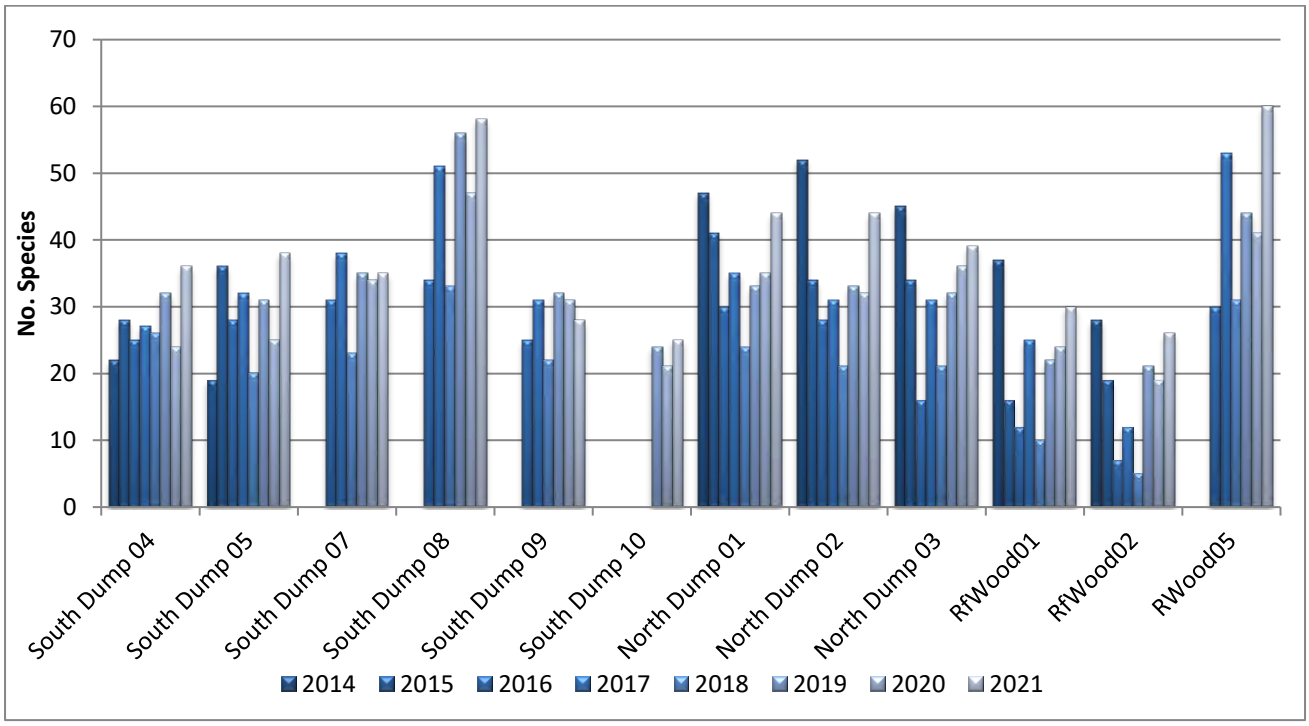


Figure 5-11. Total species diversity recorded in the woodland sites.

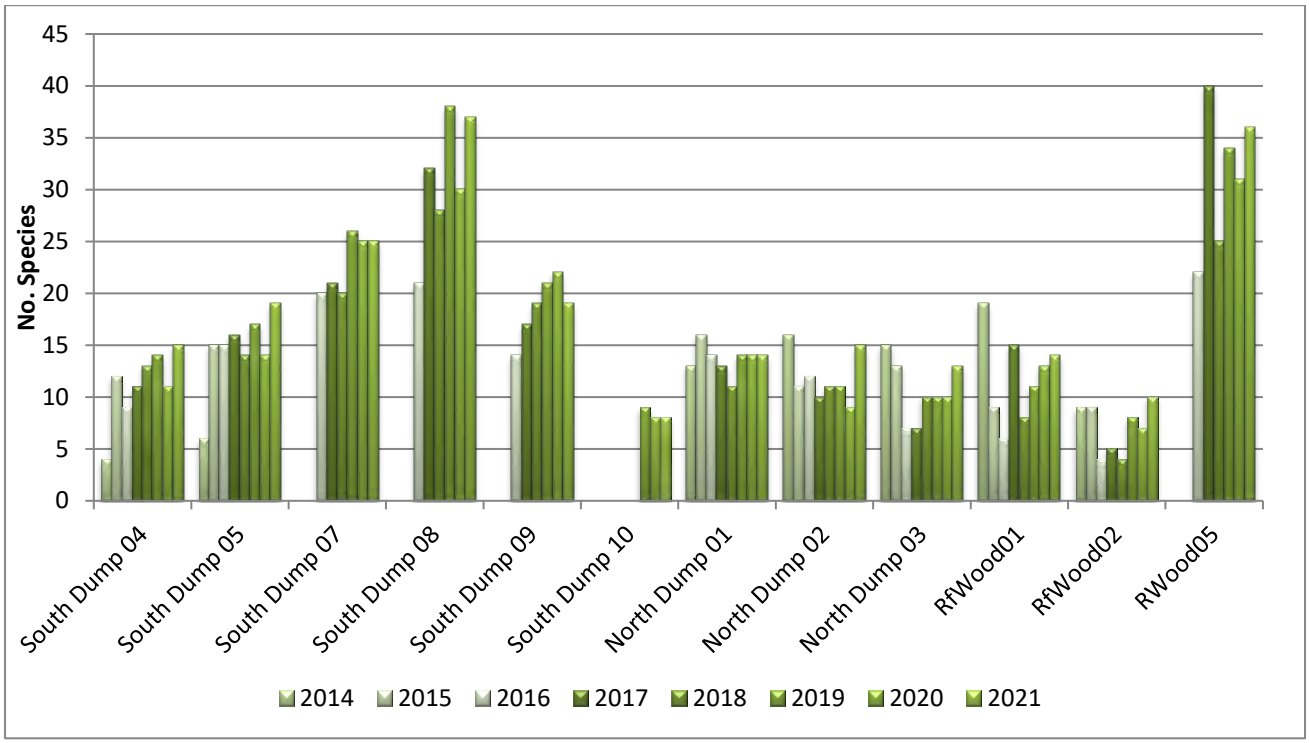


Figure 5-12. Native species diversity recorded in the woodland monitoring sites.

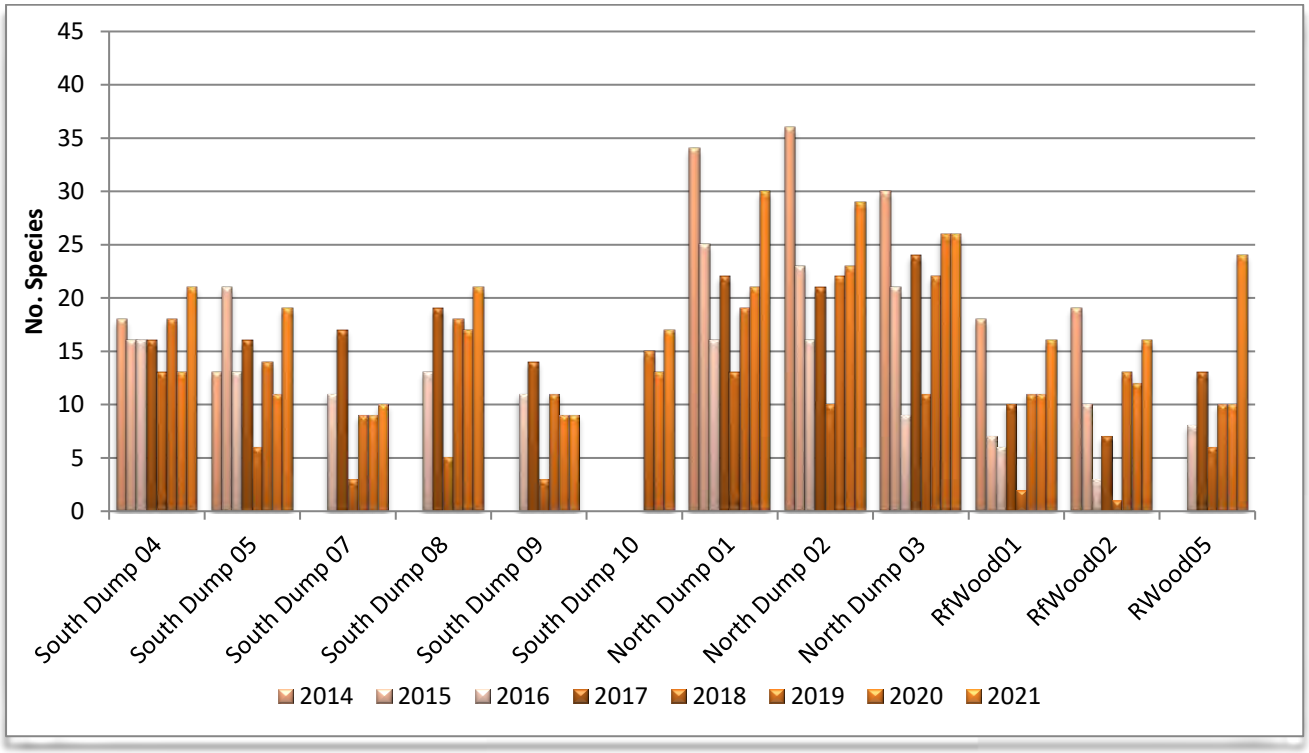


Figure 5-13. Exotic species diversity recorded in the woodland monitoring sites.

5.3.7 Native ground cover abundance

Native ground cover abundance is an additional ecological indicator which provides a measure of the cover abundance of the native vegetation and an indication of the overall weediness of the sites (Figure 5-14). Similarly, to the floristic diversity data, the proportionate ground cover provided by native plants has also been strongly influenced by the seasonal conditions and degree of grazing pressure. Dry conditions usually result in the lower abundance of exotic annual plants thus tending to increase the cover provided by live native perennial species.

This year, there continued to be sparse plant cover in RfWood01 and RWood05 and exotic pastures species had increased in RfWood02. Subsequently endemic ground cover targets were highly variable between the woodland reference sites and native plants provided 18 – 75% of the live plant cover this year.

Native ground cover was also highly variable within the rehabilitation areas and this year there was a significant increase in the percent cover provided by native plant in all rehabilitation sites. Apart from the new area of rehabilitation at South Dump 10 with only 7% native plant cover, native plants provided 45 – 88% of the live plant covers on the South Dump. On the North Dump native plant cover was less and provided 27 – 35% of the live plant cover.

All rehabilitation sites, except South Dump 10 had an acceptable cover of native plants, compared to the reference sites this year.

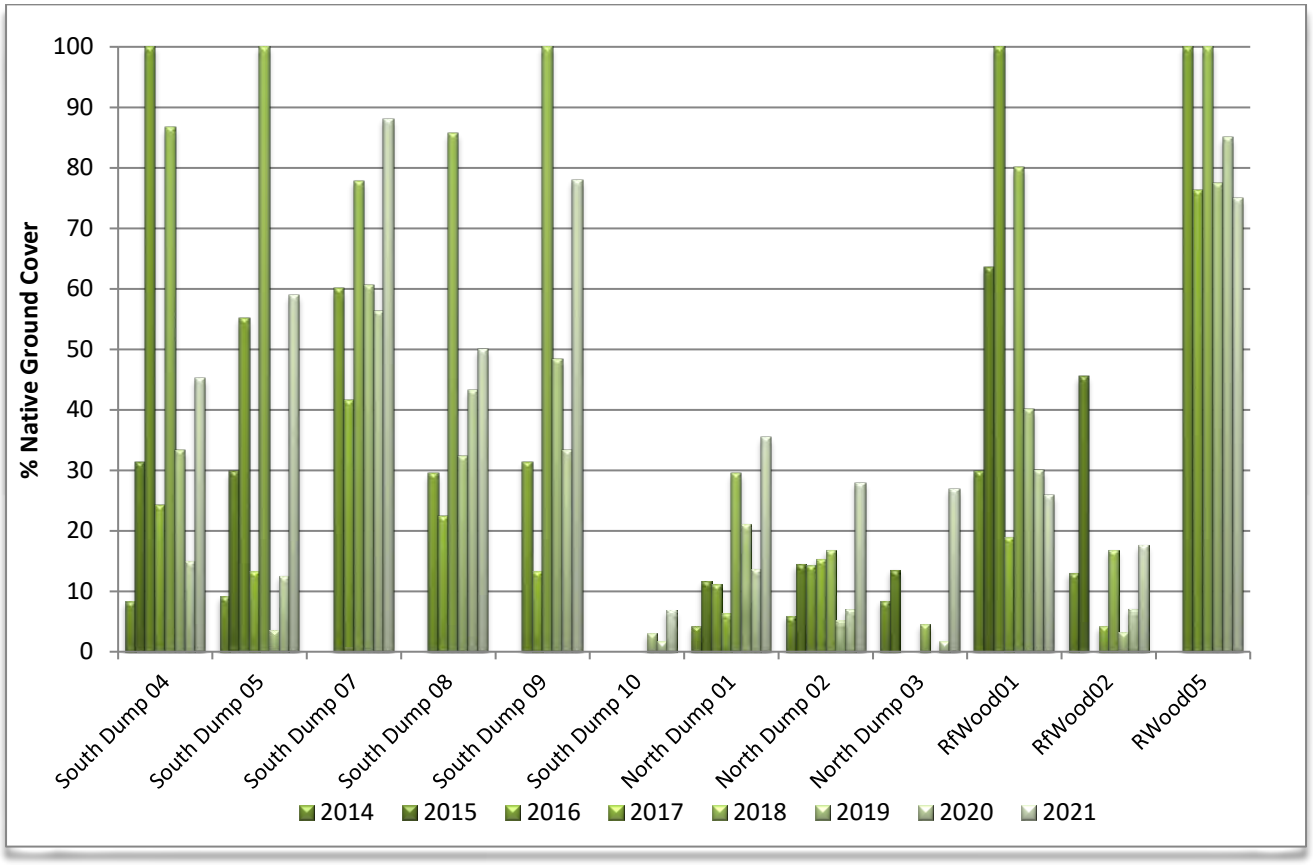


Figure 5-14. Native cover abundance recorded in the woodland monitoring sites.

5.3.8 **Most common species**

The most common species, those that were recorded in at least seven woodland rehabilitation sites in 2021 is given in Table 5-6. The exotic pasture species *Phalaris aquatica* (Phalaris) and *Trifolium subterraneum* (Subterraneum Clover) which were sown as part of the rehabilitation were common to all rehabilitation sites, with the native ground cover *Oxalis perennans* (Yellow Wood-sorrel) also common in all sites this year.

The native shrubs *A. vestita, A. buxifolia and Cassinia arcuata* (Chinese Shrub*)* and the native ground covers *Rytidosperma* spp. (Wallaby Grass) and *Senecio quadridentatus* (Cotton Fireweed) were also very common and recorded in at least seven rehabilitation sites. There were also a variety of common exotic species including *Lolium sp.* (Ryegrass), *Modiola caroliniana* (Red-flowered Mallow), *Sonchus oleraceus* (Milk Thistle), *Conyza bonariensis* (Fleabane) and *Echium plantagineum* (Paterson's Curse).

In numerous cases, species recorded in the rehabilitation areas were sown as part of the rehabilitation program or were volunteer species. In many cases, these common species were also recorded one or more of the woodland reference sites, reflecting their natural distribution within the local area. A comprehensive list of species recorded in all woodland monitoring sites in 2021 has been included in Appendix 4.

Table 5-6. The most common species recorded in the woodland rehabilitation sites in 2021 and their occurrence in the woodland reference sites.

exotic	*Scientific Name*	Common Name	Habit	North Dump 01	North Dump 02	North Dump 03	South Dump 04	South Dump 05	South Dump 07	South Dump 08	South Dump 09	South Dump 10	Total	RfWood01	RfWood02	RWood05
	Oxalis perennans	Yellow Wood-sorrel	h	1	1	1	1	1	1	1	1	1	9	1	1	1
*	*Phalaris aquatica*	Phalaris	g	1	1	1	1	1	1	1	1	1	9		1	
*	*Trifolium subterraneum*	Subterraneum Clover	h	1	1	1	1	1	1	1	1	1	9	1	1	1
	Acacia buxifolia	Box-leaved Wattle	s	1	1	1	1	1	1	1	1		8			
	Acacia vestita	Boree	s	1	1	1	1	1	1	1	1		8			
*	*Lolium spp.*	A Ryegrass	g	1	1	1	1	1		1	1	1	8	1	1	
*	*Modiola caroliniana*	Red-flowered Mallow	h	1	1	1	1	1	1	1		1	8			
*	*Sonchus oleraceus*	Milk Thistle	h	1	1	1	1	1		1	1	1	8	1	1	1
	Cassinia arcuata	Chinese Shrub	s	1		1		1	1	1	1	1	7			1
*	*Conyza bonariensis*	Fleabane	h	1		1	1	1	1	1	1		7	1	1	1
*	*Echium plantagineum*	Paterson's Curse	h	1	1		1	1	1	1		1	7	1		
*	*Polygonum aviculare*	Wireweed	h	1	1	1		1	1	1		1	7			
	Rytidosperma racemosum	Wallaby Grass	g	1	1	1	1	1		1	1		7	1	1	1
	Senecio quadridentatus	Cotton Fireweed	h	1	1	1	1	1		1		1	7		1	1

5.3.9 **Most abundant species**

The most abundant species recorded in each of the rehabilitation monitoring sites this year are provided in Table 5-7. The most abundant species were those that collectively summed to a Braun-Blanquet total of 10 or more from the five replicated samples along the vegetation transect. The maximum score that can be obtained by any one species is 30.

The composition of the grassy understorey has remained variable between the woodland reference sites and this year only *Phalaris aquatica* (Phalaris) and *Lolium* sp. (Ryegrass) were the only species to occur in any abundance that meets the minimum abundance criteria in the reference site RfWood02.

In the rehabilitation areas, exotic species also often provided the most ground cover, with the annual pasture species *Phalaris aquatica* (Phalaris), Vulpia sp. (Rat's-tail Fescue) and *Trifolium subterraneum* (Subterraneum Clover) providing the most ground cover in South Dump 05 and South Dump 08 respectively. Low growing native shrubs such as *Acacia buxifolia, Acacia filicifolia* and *Cassinia arcuata* were also providing important ground covers in some sites, while *Oxalis perennans* was becoming relatively abundant in South Dump 08.

Site South Dump 10 was heavily dominated by the exotic annual weeds *Silybum marianum* (Variegated Thistle) and *Chenopodium album* (Fat Hen). On the North Dump, the native *Geranium solanderi* was abundant, while in North Dump 03, *Modiola caroliniana* (Red-flowered Mallow) and *Petrorhagia nanteuilii* (Proliferous Pink) were the most abundant ground covers.

Table 5-7. The most abundant species recorded in the woodland monitoring sites in 2021.

exotic	Scientific Name	Common Name	South Dump 04	South Dump 05	South Dump 07	South Dump 08	South Dump 09	South Dump 10	North Dump 01	North Dump 02	North Dump 03	RfWood01	RfWood02	RWood05
*	*Phalaris aquatica*	Phalaris		13						17			17	
	Acacia buxifolia	Box-leaved Wattle		17										
*	*Trifolium subterraneum.*	Subterraneum Clover				11			12		11			
*	*Vulpia spp.*					14								
	Acacia filicifolia	Fern-leaved Wattle				10								
	Oxalis perennans	Yellow Wood-sorrel				11								
	Cassinia arcuata	Chinese Shrub					12							
*	*Chenopodium album*	Fat Hen						13						
*	*Silybum marianum*	Variegated Thistle						25	11					
	Geranium solanderi	Native Geranium							14					
*	*Modiola caroliniana*	Red-flowered Mallow									14			
*	*Petrorhagia nanteuilii*	Proliferous Pink									15			
*	*Lolium sp.*	Ryegrass											16	

5.3.10 **Vegetation composition**

The composition of the vegetation as categorised by eight different growth forms is given in Figure 5-15, with these being highly variable between the sites. The reference sites were comprised by a high diversity of herbs with 19 - 34 species followed by grasses with 8 – 10 species. There were 1 – 4 species of tree and while two sites had no shrubs, there were six different shrubs in RWood05. Up to two reed species may have been present. There were no sub-shrubs or vines however one fern was recorded year.

In the rehabilitation sites, most sites had a composition that was comparable to the reference sites however there continued to be an absence of tree species in South Dump 04 and all three areas on the North Dump. Some sites including South Dump 07, 09 and 10 also had a low diversity of herbs and South Dump 10 also had a low diversity of grasses.

Compared to the reference sites, there was also a high diversity of shrubs, especially in South Dump 05, 07, 08 and 09 as a result of the seeding program with up to 13 species recorded in South Dump 07 and 08. Some sites contained a reed and in South Dump 08, the native vine *Hardenbergia violacea* (Happy Wanderer) continued to be recorded.

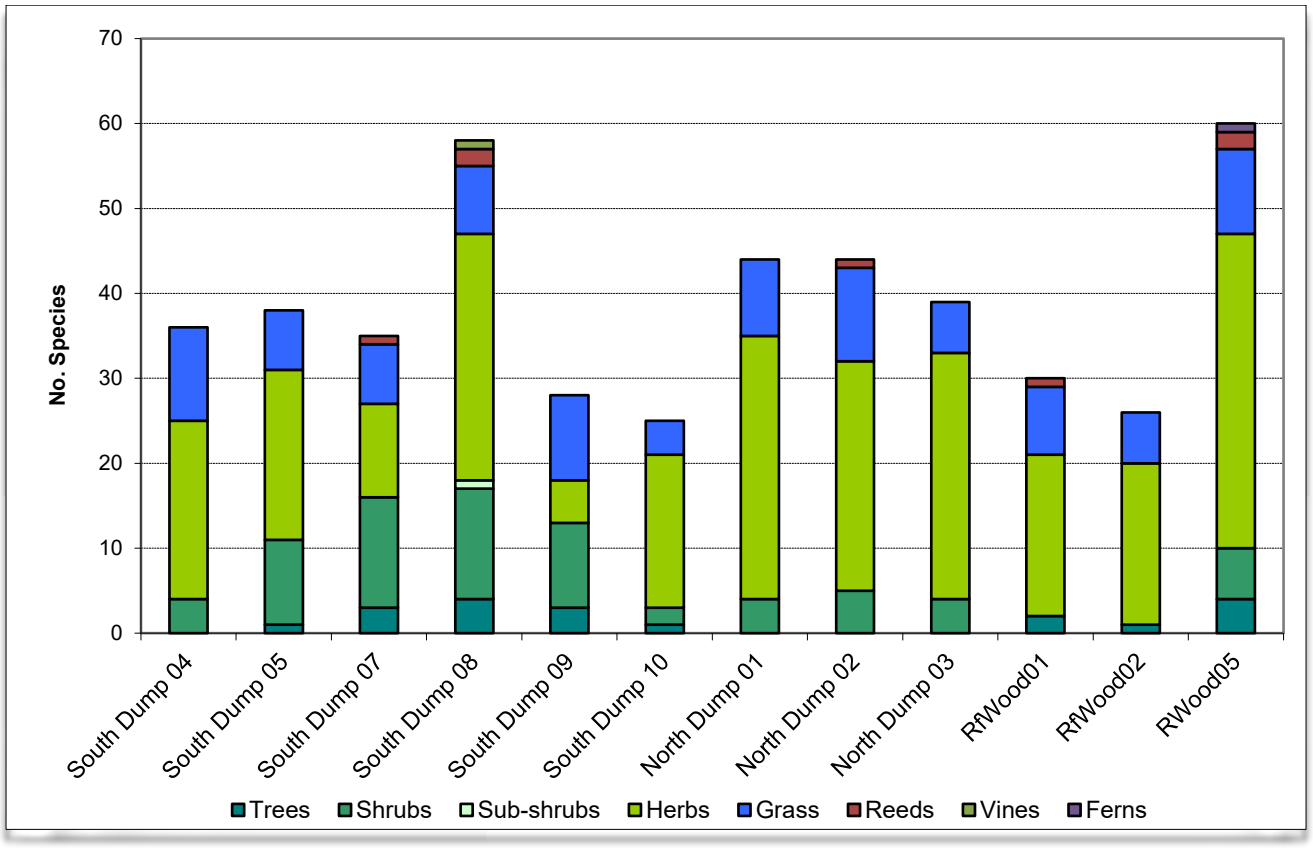


Figure 5-15. Vegetation composition of the woodland monitoring sites in 2021.

5.3.11 **Rill Assessment**

Much of the minor rilling recorded in previous years has declined as ground covers have become more established, however minor rilling continued to be recorded in South Dump 07 and 09 and North Dump 01 this year. In South Dump 07 and 09 the extent of rilling appears to be declining as the vegetation becomes more established, however there continued to be five large rills with a total cross-sectional of 0.245 – 0.300 m^2 respectively (Figure 5-16). At North Dump 01, there was some tunnelling and sheet erosion, and two large rills continued to be active and have been increasing in size, with a total cross-sectional of 0.330 m^2 this year.

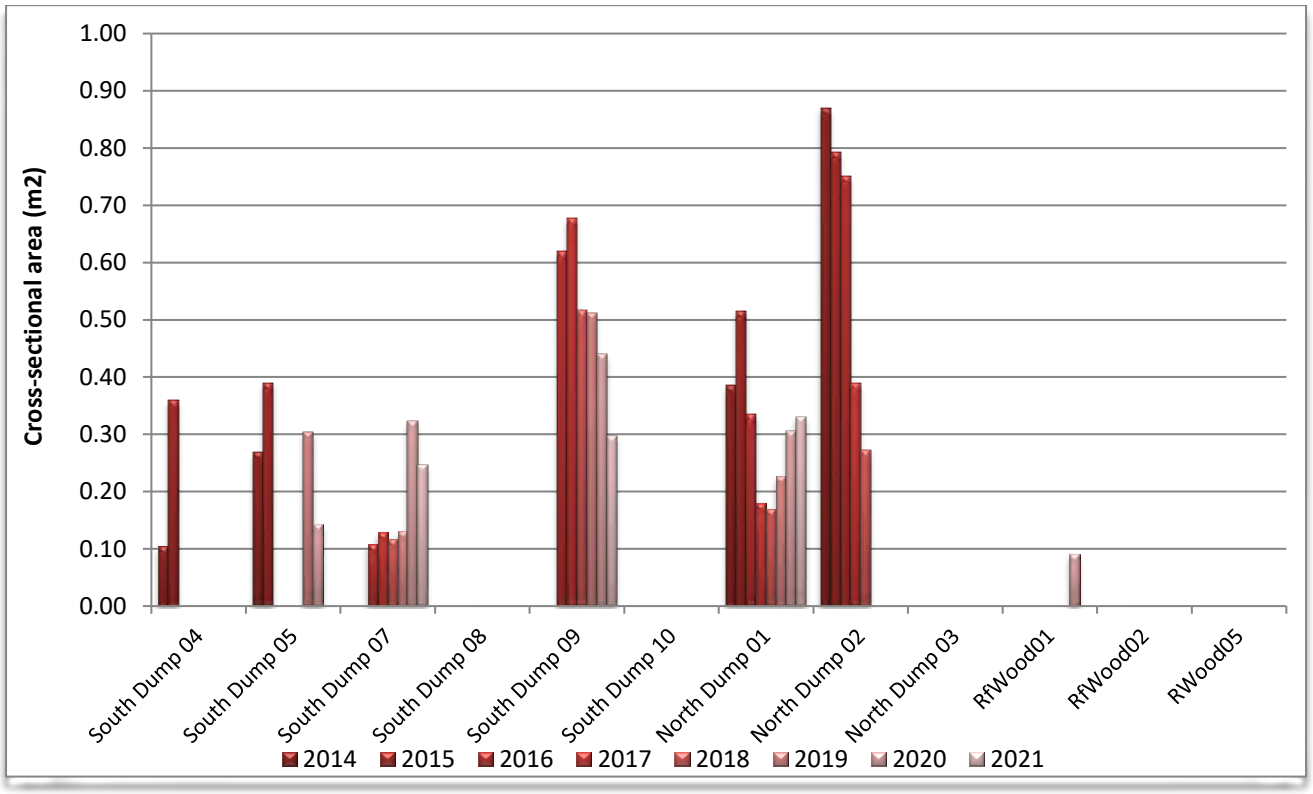


Figure 5-16. Sum of the cross-sectional area of the rills recorded in the woodland monitoring sites.

5.3.12 **Soil Analyses**

No soil analyses were taken this year.

5.4 Woodland rehabilitation site performance towards meeting ecological performance indicators

Table 5-8 indicates the performance of the rehabilitation monitoring sites against the range of primary and secondary ecological performance indicators recorded in the woodland reference sites in 2021. The performance indicators have been presented in order of rehabilitation phases and ecosystem succession, beginning with Phase 2 Landform establishment and stability (Orange) followed by Phase 3 Growth Medium Development (Brown), Phase 4 Ecosystem & Land Use Establishment (Green) and ending with Phase 5 Ecosystem & Land Use Sustainability (Blue).

Rehabilitation sites meeting or exceeding the range values of the reference sites have been identified with a shaded colour box and have therefore been deemed to meet the ecological targets. In the case of "growth medium development", upper and lower soil property indicators are also based on results obtained from the respective reference sites. In some cases, the site may not fall within ranges based on these data but may be within "desirable" levels as prescribed by the agricultural industry. If this scenario occurs, the rehabilitation site has been identified using a striped shaded box to indicate that it falls within "desirable agricultural" ranges but does not fall within specified completion criteria targets using the adopted methodology.

Table 5-8. Performance of the woodland rehabilitation monitoring sites against primary and secondary ecological performance indicators in 2021.

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators	Secondary Performance Indicators	Unit of measurement	2021 Woodland ecosystem range		South Dump 04	South Dump 05	South Dump 07	South Dump 08	South Dump 09	South Dump 10	North Dump 01	North Dump 02	North Dump 03
Performance indicators are quantified by the range of values obtained from replicated reference sites assessed in 2021							Lower KPI	Upper KPI	2021								
Phase 2: Landform establishment and stability	Landform slope, gradient	Landform suitable for final land use and generally compatible with surrounding topography and final landform design	Slope	Landform is generally compatible within the context of the local topography and final landform design.		Degrees (<18°)	10	14	18	18	16	0	16	17	14	15	2
	Active erosion	Areas of active erosion are limited	No. Rills/Gullies	Number of gullies or rills >0.3m in width or depth in a 50m transect are limited and stabilising		No.	0	0	0	0	5	0	5	0	2	0	0
			Cross-sectional area of rills		Provides an assessment of the extent of soil loss due to gully and rill erosion and that it is limited and/or is stabilising	m^2	0	0	0	0	0.245	0	0.297	0	0.330	0	0
Phase 3: Growth medium development	Soil chemical, physical properties and amelioration	Soil properties are suitable for the establishment and maintenance of selected vegetation species	pH	pH is typical of that of the surrounding landscape or falls within desirable ranges provided by the agricultural industry		pH (5.6-7.3)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			EC		Electrical Conductivity is typical of that of the surrounding landscape or fall within desirable ranges provided by the agricultural industry	< dS/m (<0.150)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Organic Matter	Organic Matter levels are typical of that of the surrounding landscape, increasing or fall within desirable ranges provided by the agricultural industry		% (>4.5)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Phosphorous	Available Phosphorus is typical of that of the surrounding landscape or fall within desirable ranges provided by the agricultural industry		mg/kg (50)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators	Secondary Performance Indicators	Unit of measurement	2021 Woodland ecosystem range		South Dump 04	South Dump 05	South Dump 07	South Dump 08	South Dump 09	South Dump 10	North Dump 01	North Dump 02	North Dump 03
			Nitrate		Nitrate levels are typical of that of the surrounding landscape or fall within desirable ranges provided by the agricultural industry	mg/kg (>12.5)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			CEC		Cation Exchange Capacity is typical of that of the surrounding landscape or fall within desirable ranges provided by the agricultural industry	Cmol+/kg (>14)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			ESP		Exchangeable Sodium Percentage (a measure of sodicity) is typical of that of the surrounding landscape or fall within desirable ranges provided by the agricultural industry	% (<5)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Phase 4: Ecosystem & Land Use Establishment	Landscape Function Analysis (LFA): Landform stability and organisation	Landform is stable and performing as it was designed to do	LFA Stability	The LFA stability index provides an indication of the sites stability and is comparable to or trending towards that of the local remnant vegetation		%	65.1	80.0	64.9	67.1	63.7	74.1	67.7	67.5	68.0	72.5	67.5
			LFA Landscape organisation	The Landscape Organisation Index provides a measure of the ability of the site to retain resources and is comparable to that of the local remnant vegetation		%	100	100	67	94	55	89	98	100	100	100	100
	Vegetation diversity	Vegetation contains a diversity of species comparable to that	Diversity of shrubs and juvenile trees		The diversity of shrubs and juvenile trees with a stem diameter < 5cm is comparable to that of the local remnant vegetation.	species/area	0	8	3	10	13	16	8	3	3	4	4

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators	Secondary Performance Indicators	Unit of measurement	2021 Woodland ecosystem range		South Dump 04	South Dump 05	South Dump 07	South Dump 08	South Dump 09	South Dump 10	North Dump 01	North Dump 02	North Dump 03
		of the local remnant vegetation		The percentage of shrubs and juvenile trees with a stem diameter < 5cm dbh which are local endemic species, and these percentages are comparable to the local remnant vegetation		% population	0	100	100	98	100	100	100	100	100	100	100
			Total species richness	The total number of live plant species provides an indication of the floristic diversity of the site and is comparable to the local remnant vegetation		No./area	26	60	36	38	35	58	28	25	44	44	39
			Native species richness		The total number of live native plant species provides an indication of the native plant diversity of the site and that it is greater than or comparable to the local remnant vegetation	>No./area	10	36	15	19	25	37	19	8	14	15	13
			Exotic species richness		The total number of live exotic plant species provides an indication of the exotic plant diversity of the site and that it is less than or comparable to the local remnant vegetation	<No./area	16	24	21	19	10	21	9	17	30	29	26
			Ratio of native to exotic species		The ratio of live native species compared to live exotic plant species provides an indication of the relative native species richness of the site and that it is more than or comparable to the local remnant vegetation	>	1	2	0.7	1.0	2.5	1.8	2.1	0.5	0.5	0.5	0.5
	Vegetation density	Vegetation contains a density of species comparable to that of the local remnant vegetation	Density of shrubs and juvenile trees		The total density of shrubs or juvenile trees with a stem diameter < 5cm is comparable to that of the local remnant vegetation	No./area	0	116	106	352	334	420	364	6	152	336	300

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators	Secondary Performance Indicators	Unit of measurement	2021 Woodland ecosystem range		South Dump 04	South Dump 05	South Dump 07	South Dump 08	South Dump 09	South Dump 10	North Dump 01	North Dump 02	North Dump 03
				The density of endemic shrubs or juvenile trees with a stem diameter < 5cm is comparable to that of the local remnant vegetation		No./area	0	108	106	346	334	420	364	6	152	336	300
	Ecosystem composition	The vegetation is comprised by a range of growth forms comparable to that of the local remnant vegetation	Trees	The number of tree species regardless of age comprising the vegetation community is comparable to that of the local remnant vegetation		No./area	1	4	0	1	3	4	3	1	0	0	0
			Shrubs	The number of shrub species regardless of age comprising the vegetation community is comparable to that of the local remnant vegetation		No./area	0	6	4	10	13	13	10	2	4	5	4
			Sub-shrubs		The number of sub-shrub species comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	0	0	0	0	0	1	0	0	0	0	0
			Herbs		The number of herbs or forb species comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	19	37	21	20	11	29	5	18	31	27	29
			Grasses	The number of grass species comprising the vegetation community is comparable to that of the local remnant vegetation		No./area	6	10	11	7	7	8	10	4	9	11	6
			Reeds		The number of reed, sedge or rush species comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	0	2	0	0	1	2	0	0	0	1	0
			Vines		The number of vines or climbing species comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	0	0	0	0	0	1	0	0	0	0	0

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators	Secondary Performance Indicators	Unit of measurement	2021 Woodland ecosystem range		South Dump 04	South Dump 05	South Dump 07	South Dump 08	South Dump 09	South Dump 10	North Dump 01	North Dump 02	North Dump 03
			Ferns		The number of ferns comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	0	1	0	0	0	0	0	0	0	0	0
			Aquatic		The number of aquatic plants comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	0	0	0	0	0	0	0	0	0	0	0
Phase 5: Ecosystem & Land Use Sustainability	Landscape Function Analysis (LFA): Landform function and ecological performance	Landform is ecologically functional and performing as it was designed to do	LFA Infiltration	LFA infiltration index provides an indication of the sites infiltration capacity and is comparable to or trending towards that of the local remnant vegetation		%	56.1	66.0	33.7	46.4	31.6	38.8	37.2	41.2	43.8	49.3	40.9
			LFA Nutrient recycling	LFA nutrient recycling index provides an indication of the sites ability to recycle nutrient and is comparable to or trending towards that of the local remnant vegetation		%	54.0	64.1	34.8	47.8	31.6	44.6	40.0	39.9	40.6	49.9	37.8
	Protective ground cover	Ground layer contains protective ground cover and habitat structure comparable with the local remnant vegetation	Litter cover		Percent ground cover provided by dead plant material is comparable to that of the local remnant vegetation	%	5	78.0	10	44	6	21	53	3	27	21	12
			Annual plants		Percent ground cover provided by live annual plants is comparable to that of the local remnant vegetation	<%	2	18	23	18	6	21	7	97	15	8	15
			Cryptogam cover		Percent ground cover provided by cryptogams (e.g. mosses, lichens) is comparable to that of the local remnant vegetation	%	0	0	0	0	0	6	1	0	0	0	1
			Rock		Percent ground cover provided by stones or rocks (> 5cm diameter) is comparable to that of the local remnant vegetation	%	0	10	12	0	7	1	2	0	4	1	2

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators	Secondary Performance Indicators	Unit of measurement	2021 Woodland ecosystem range		South Dump 04	South Dump 05	South Dump 07	South Dump 08	South Dump 09	South Dump 10	North Dump 01	North Dump 02	North Dump 03
			Log		Percent ground cover provided by fallen branches and logs (>5cm) is comparable to that of the local remnant vegetation	%	1	4	0	0	0	0	0	0	0	0	0
			Bare ground		Percentage of bare ground is less than or comparable to that of the local remnant vegetation	< %	0	6	37	16	50	7	22	0	0	1	4
			Perennial plant cover (< 0.5m)	Percent ground cover provided by live perennial vegetation (<0.5m in height) is comparable to that of the local remnant vegetation		%	11	64	19	23	32	45	15	0	55	70	66
			Total Ground Cover	Total groundcover is the sum of protective ground cover components (as described above) and that it is comparable to that of the local remnant vegetation		%	94	100	64	84	50	93	78	100	100	100	96
	Ground cover diversity	Vegetation contains a diversity of species per square meter comparable to that of the local remnant vegetation	Native understorey abundance	The abundance of native species per square metre averaged across the site provides an indication of the heterogeneity of the site and that it is has more than or an equal number of native species as the local remnant vegetation		> species/m^2	1.2	5.0	2.6	2.2	3.2	3.2	2.2	0.2	2.2	1.8	2
			Exotic understorey abundance		The abundance of exotic species per square metre averaged across the site provides an indication of the heterogeneity of the site and that it is has less than or an equal number of exotic species as the local remnant vegetation	< species/m^2	2.0	4.0	3	2.8	0.8	3	1.4	2.4	5.6	4.4	5.6

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators	Secondary Performance Indicators	Unit of measurement	2021 Woodland ecosystem range		South Dump 04	South Dump 05	South Dump 07	South Dump 08	South Dump 09	South Dump 10	North Dump 01	North Dump 02	North Dump 03
	Native ground cover abundance	Native ground cover abundance is comparable to that of the local remnant vegetation	Percent ground cover provided by native vegetation <0.5m tall	The percent ground cover abundance of native species (<0.5m) compared to exotic species is comparable to that of the local remnant vegetation		%	17.6	75.0	45.2	58.9	88.1	50	78	6.8	35.4	27.9	26.9
	Ecosystem growth and natural recruitment	The vegetation is maturing and/or natural recruitment is occurring at rates similar to those of the local remnant vegetation	shrubs and juvenile trees 0 - 0.5m in height	The number of shrubs or juvenile trees <0.5m in height provides an indication of establishment success and/or natural ecosystem recruitment and that it is comparable to that of the local remnant vegetation		No./area	0	93	8	10	4	22	8	3	0	8	272
			shrubs and juvenile trees 0.5 - 1m in height		The number of shrubs or juvenile trees 0.5-1m in height provides an indication of establishment success, growth and/or natural ecosystem recruitment and that it is comparable to that of the local remnant vegetation	No./area	0	22	12	20	38	110	34	2	18	24	6
			shrubs and juvenile trees 1 - 1.5m in height		The number of shrubs or juvenile trees 1-1.5m in height provides an indication of establishment success, growth and/or natural ecosystem recruitment and that it is comparable to that of the local remnant vegetation	No./area	0	0	26	34	110	172	94	0	50	76	9
			shrubs and juvenile trees 1.5 - 2m in height	The number of shrubs or juvenile trees 1.5-2m in height provides an indication of establishment success, growth and/or natural ecosystem recruitment and that it is comparable to that of the local remnant vegetation		No./area	0	0	38	40	114	82	138	1	54	130	12

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators	Secondary Performance Indicators	Unit of measurement	2021 Woodland ecosystem range		South Dump 04	South Dump 05	South Dump 07	South Dump 08	South Dump 09	South Dump 10	North Dump 01	North Dump 02	North Dump 03
			shrubs and juvenile trees >2m in height		The number of shrubs or juvenile trees >2m in height provides an indication of establishment success, growth and/or natural ecosystem recruitment and that it is comparable to that of the local remnant vegetation	No./area	0	1	22	248	68	34	90	0	30	98	1
	Ecosystem structure	The vegetation is developing in structure and complexity comparable to that of the local remnant vegetation	Foliage cover 0.5 - 2 m	Projected foliage cover provided by perennial plants in the 0.5 - 2m vertical height stratum indicates the community structure is comparable to that of the local remnant vegetation		% cover	0	3.0	9	47	32.6	14	40	0	15	20	3
			Foliage cover 2 - 4m	Projected foliage cover provided by perennial plants in the 2 - 4m vertical height stratum indicates the community structure is comparable to that of the local remnant vegetation		% cover	0	3.0	0	20	2.5	0.5	4.5	0	2	6	0
			Foliage cover 4 - 6m		Projected foliage cover provided by perennial plants in the 4 -6m vertical height stratum indicates the community structure is comparable to that of the local remnant vegetation	% cover	0.0	4.0	0	0	0	0	0	0	0	0	0
			Foliage cover >6m	Projected foliage cover provided by perennial plants >6m vertical height stratum indicates the community structure is comparable to that of the local remnant vegetation		% cover	17.5	38.0	0	0	0	0	0	0	0	0	0

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators	Secondary Performance Indicators	Unit of measurement	2021 Woodland ecosystem range		South Dump 04	South Dump 05	South Dump 07	South Dump 08	South Dump 09	South Dump 10	North Dump 01	North Dump 02	North Dump 03
	Tree diversity	Vegetation contains a diversity of maturing tree and shrubs species comparable to that of the local remnant vegetation	Tree diversity		The diversity of trees or shrubs with a stem diameter >5cm is comparable to the local remnant vegetation	species/area	1	4	1	2	2	1	4	0	1	1	1
				The percentage of maturing trees and shrubs with a stem diameter >5cm dbh which are local endemic species, and these percentages are comparable to the local remnant vegetation		% endemic	100	100	100	100	100	100	100	0	100	100	100
	Tree density	Vegetation contains a density of maturing tree and shrubs species comparable to that of the local remnant vegetation	Tree density	The density of shrubs or trees with a stem diameter > 5cm is comparable to that of the local remnant vegetation		No./area	9	43	2	38	16	2	5	0	3	22	1
			Average dbh		Average tree diameter of the tree population provides a measure of age, (height) and growth rate and that it is trending towards that of the local remnant vegetation.	cm	26	68	15	8	8	7	8	0	7	7	7
	Ecosystem health	The vegetation is in a condition comparable to that of the local remnant vegetation.	Live trees		The percentage of the tree population which are live individuals, and that the percentage is comparable to the local remnant vegetation	% population	81	92	100	32	87.5	100	100	0	100	64	100
			Healthy trees	The percentage of the tree population which are in healthy condition and that the percentage is comparable to the local remnant vegetation		% population	30	52	100	21	87.5	0	100	0	66.667	9	0
			Medium health		The percentage of the tree population which are in a medium health condition and that the percentage is comparable to the local remnant vegetation	% population	36	56	0	11	0	100	0	0	33	27	100

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators	Secondary Performance Indicators	Unit of measurement	2021 Woodland ecosystem range		South Dump 04	South Dump 05	South Dump 07	South Dump 08	South Dump 09	South Dump 10	North Dump 01	North Dump 02	North Dump 03
			Advanced dieback		The percentage of the tree population which are in a state of advanced dieback and that the percentage is comparable to the local remnant vegetation	% population	0	9	0	0	0	0	0	0	0	27	0
			Dead Trees		The percentage of the tree population which are dead (stags), and that the percentage is comparable to the local remnant vegetation	% population	8	19	0	68	13	0	0	0	0	36	0
			Mistletoe		The percentage of the tree population which have mistletoe provides an indication of community health and habitat value and that the percentage is comparable to the local remnant vegetation	% population	0	0	0	0	0	0	0	0	0	0	0
			Flowers/fruit: Trees	The presence of reproductive structures such as buds, flowers or fruit provides evidence that the ecosystem is maturing, capable of recruitment and can provide habitat resources comparable to that of the local remnant vegetation		% population	42	78	100	0	0	0	0	0	67	9	100
			Hollows		The presence of hollows provides evidence that the ecosystem is maturing, and can provide habitat resources comparable to that of the local remnant vegetation	% population	0	44	0	0	0	0	0	0	0	0	0

6 Priority weeds

This year, Weeds of National Significance (WONS), listed Priority weeds of the Central Tablelands (NSW DPI 2021) or weeds included under the NSW general biosecurity duty recorded in the woodland monitoring sites are provided in Table 6-1. WONS and Priority weeds of the Central Tablelands have been highlighted green and were recorded in several sites. These included *Hypericum perforatum* (St. John's Wort), *Rubus fruticosus* (Blackberry), *Solanum sisymbriifolium* (Sticky Nightshade) and *Nassella trichotoma* (Serrated Tussock). The remaining species are listed under the general NSW biosecurity duty.

Table 6-1. Priority weeds recorded at CVO.

Scientific Name	Common Name	Habit	RfWood01	RfWood02	RWood05	North Dump 01	North Dump 02	North Dump 03	South Dump 04	South Dump 05	South Dump 07	South Dump 08	South Dump 09	South Dump 10	Total
Carthamus lanatus	Saffron Thistle	h				1		1	1						3
Centaurea solstitialis	St Barnaby's Thistle	h										1			1
Xanthium spinosum	Bathurst Burr	h		1										1	2
Echium plantagineum	Paterson's Curse	h	1			1	1		1	1	1	1		1	8
Echium vulgare	Vipers Bugloss	h				1	1	1	1			1			5
Hypericum perforatum	St. John's Wort	h							1			1			2
Marrubium vulgare	Horehound	h	1	1		1	1	1		1					6
Crataegus monogyna	Hawthorn	s			1										1
Rosa rubiginosa	Sweet Briar	s			1										1
Rubus fruticosus	Blackberry	s			1					1					2
Solanum sisymbriifolium	Sticky Nightshade	h		1											1
Nassella trichotoma	Serrated Tussock	g				1	1		1						3

7 Threatened flora

No threatened species have been identified within the range of woodland monitoring sites

8 Conclusion

While no rehabilitation sites yet met all primary completion criteria, many sites had been demonstrating a significant increase in ecological function up until the drought conditions that were experienced for three consecutive years during 2017 - 2019. During the drought, there tended to be a declining trend in ecological function as a result of the prolonged dry seasonal conditions and simultaneous increase in grazing and disturbance by animals, with a decline in many performance indicators also being reflected in the range of woodland reference sites. This year, the improved seasonal conditions resulted in a significant increase in the diversity and abundance of the ground covers in all of the rehabilitation and woodland reference sites, therefore increased ecological function was recorded in all sites.

The density of shrubs and/or juvenile trees (<5cm dbh) recorded in the woodland rehabilitation sites was highly variable between sites. In sites on the South Dump and North Dump 01 and 02, shrub densities have continued to decline. While in some cases, some individuals may have grown and were now recorded as mature trees (>5 cm dbh), the majority were drought mortalities and/or had reached the end of their life span (natural senescence). In North Dump 03, however, many volunteer *Cassinia arcuata* (Chinese Shrub) were establishing.

The potential for the ongoing decline in mature acacia densities, may have implications for the rehabilitation sites to meet completion targets into the future, particularly when there is an absence of or low density of long-lived eucalypt species. Sites without or with low densities of eucalypts are likely to require rehabilitation intervention via reseeding or tubestock planting to ensure appropriate eucalypt densities become established in the longer-term.

Testing of waste rock materials and topsoils prior to application on rehabilitation areas should be regularly undertaken to ensure suitable substrates are used prior to spreading onto rehabilitation areas. These should continue to be monitored, as increasing concentrations of some heavy metals and/or salts may inhibit the establishment of protective ground cover and have an adverse effect of the development and sustainability of wider rehabilitation areas. In some areas, ongoing active rilling may require intervention.

While no formal survey for fauna is undertaken by DnA Environmental, a range of wildlife have been or were observed within the rehabilitation areas. Increased habitat such as large logs and fallen trees would further enhance rehabilitation sites. Additional perching sites could also be made available by erecting mature eucalypts that have been cleared for mining, upside down (i.e. tree roots provide the new dead tree canopy) in appropriate locations across the rehabilitation areas. Large rocky outcrops could also be constructed. These practices have been undertaken with very successful outcomes in the Hunter Valley. Birds using the perching sites assist rehabilitation outcomes by introducing native plant seed (especially those with fleshy drupes) that may not otherwise colonise large rehabilitation areas. A range of other wildlife may also assist with the natural dispersal of seeds, create germination niches and micro-sites and assist with nutrient recycling across the wider rehabilitation areas. They may however also distribute weeds and harbour pest animals.

Follow up surveillance and control of priority weeds will continue to be required as part of the CVO land management plans and care should be undertaken to avoid spraying of non-target species. While grazing pressure has significant declined after the drought, feral and pest animal populations will require ongoing monitoring.

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Appendix 1. Monitoring site location data

GPS co-ordinates and other site-specific information for the reference sites.

Site Reference	LFA Start	LFA Finish	LFA slope°	LFA bearing°	Veg transect start	Veg transect finish	Veg transect bearing°
RfWood01 (Ashleigh Park)	55680871 6295705	55680880 6295718	10	30 NE	55680875 6295715	55680903 6295677	120 SE
RfWood02 (Bundarra)	55683151 6290452	55683159 6290441	14	145 SE	55683154 6290447	55683114 6290436	236 NW
RWood04 (CVO access) (Right - left transect)	55687596 6296337	55687589 6296351	10	310 W	55687591 6296345	55687554 6296316	220 SW
RWood05 (CVO Cadiangullong Dam)	55 684994 6298928	55 685013 6298922	12	94	55 685005 6298924	55 684987 6298876	184 S
RfPast01 (Bundarra)	55 683406 6290780	55 683423 6290790	10	45 NE	55 683415 6290785	55 683439 6290742	140 SE
RfPast03 (Willunga)	55 687926 6298533	55 687911 6298546	8	300 NW	55 687918 6298540	55 687948 6298579	25 N
RrRip02 (Bakers Shaft)	55 686614 6279287	55 686622 6279263	10	170 S	55 686622 6279272	55 686573 62792710	260 W
RrRip03 (CVO Cadiang Ck)	55 685302 6298471	55 685314 6298478	14	44	55 685306 6298475	55 685327 6298431	140 SE

GPS co-ordinates and other site-specific information for the rehabilitation monitoring sites.

Site	LFA Start	LFA Finish	LFA slope°	LFA bearing°	Veg transect start	Veg transect finish	Veg transect bearing°
Ashleigh Park 01	55 680874 6294881	55 680864 6294899	5	320 NW	55 680887 6294887	55 680873 6294904	320 NW
South Dump 01	55 685304 6294460	55 685308 6294478	22	351 N	55 685307 6294468	55 685353 6294467	79 E
South Dump 02	55 685118 6294354	55 685108 6294369	17	302 NW	55 685113 6294362	55 685146 6294401	33 NE
South Dump 03	55685250 6293838	55685231 6293838	18	245W	55685240 6293838	55685239 6293886	348 NW
South Dump 04	55686455 6293539	55686453 6293524	18	173S	55686454 6293535	686407 6293533	264 W
South Dump 05	55687089 6294032	687108 6294029	18	88E	687100 6294032	687092 6293982	175 S
South Dump 06	687551 6294645	55687570 6294653	1	231SW	55687561 6294649	55687579 6294603	144 SE

Site	LFA Start	LFA Finish	LFA slope°	LFA bearing°	Veg transect start	Veg transect finish	Veg transect bearing°
South Dump 07	55686973 6294252	55686991 6294252	16	76 E	55686983 6294254	55686981 6294200	168 S
South Dump 08	55686632 6293878	55686643 6293860	0	142 SE	55686638 6293868	55686594 6293845	232 SW
South Dump 09	55685920 6294044	55685900 6294046	16	260 W	55685911 6294045	55685915 6294096	350 N
South Dump 10	55684896 6293929	55684878 6293915	17	216 SW	55684888 6293919	55684853 6293957	305 NW
North Dump 01	55686596 6296978	55686582 6296967	14	217SW	55686589 6296973	55686555 6297013	307 NW
North Dump 02	55686375 6296954	55686362 6296942	15	220SW	55686369 6296947	55686339 6296986	309 NW
North Dump 03	55687148 6297228	55687130 6297227	1	260W	55687139 6297226	55687139 6297277	350 N
Willunga DS01	55 687586 6298689	55 687579 6298710	6	320 NW	55 687601 6298700	55 687568 6298737	320 NW
Willunga DS02	55 687266 6208927	55 687260 6298910	10	180 S	55 687248 6298929	55 872473 6298883	182 S
Cadiangullong Creek	55 684249 6294028	55 684242 6294015	5	180 S	55 684244 6294017	55 684199 6294037	275 W
Creek Diversion	55 685350 6297515	55 685346 6297501	8	165 S	55 685346 6297511	55 685296 6297506	257 W

Appendix 2. Descriptions and photo-points of the older woodland and farmland rehabilitation monitoring sites

General description and photo from the permanent photo-point at the rehabilitation monitoring sites 2008 - 2019.

2008	2012	2014	2016	2018	2019
Ashleigh Park 01: Bushland revegetation: The site was direct seeded in 2004. The adjacent remnant vegetation is dominated by *E. macrorhyncha, E. melliodora* and some *E. polyanthemos* with little to no shrubby understorey. Native pasture species are dominant in the grassy understorey but have been heavily grazed in the past. In 2010, the site had recently been heavily grazed but had recovered in 2011 with the understorey dominated by native grasses. The shrubs had grown significantly with the rows starting to join in places and there was some acacia suckers/regeneration. In 2012, there was light grazing by cattle and combined with macropods and rabbits, the grass was very short but retained good ground cover and the tree and shrubs had significantly grown. In 2013 the site has been heavily grazed and there was little active plant growth in the grassy understorey. The trees and shrubs continue to grow but rabbits continue to be a problem. In 2016 there was limited live ground cover, and these were grazed very low by livestock (?), macropods and rabbit grazing, but overgrazing and scratching have caused bare patches to develop. Some acacias had died, and the lower foliage cover had died off as the shrubs grew in height. There were pockets of acacias suckering. In 2019, a track had been graded through the site, to rip and destroy rabbit warrens in the area. The revegetation area was severely overgrazed. Numerous acacias had died, but persisting trees and shrubs were large and the eucalypts were developing mature canopies. Scattered acacia suckers.					
		N/A		N/A	
South Dump 01: Woodland rehabilitation: North facing slope of the southern waste emplacement. This section of the waste emplacement was shaped and covered in 2006 followed by aerial seeding with a range of local native trees and shrub species. It was reseeded in 2007. In 2011, there was increased ground cover and only a few small pockets of bare ground. The site remains weedy but there was higher perennial grass cover. Several acacias had died but others appear very healthy and have grown considerably and there was an echidna hole. In 2012 there was an increase in ground cover and tubestock had grown significantly, but galls were present in some of the acacias. Macropods/rabbits have kept grasses short in patches. Rabbits (and foxes?) require baiting. Small skinks were present. In 2013 there was low ground cover and many of the shrubs had died due to the prolonged dry conditions. In 2014 more shrubs had died but the remaining shrubs had further grown. In 2015 the site was very dry with little active ground cover growth. Rytidosperma and Dactylis glomerata were dominant but very stressed. There has been heavy browsing by macropods and rabbits with some bare patches especially under thicker acacias. Many acacias had further died leaving the site much more open. The persisting shrubs were in bud and mostly healthy, but the A. implexa often had galls. In 2016 there was limited live ground cover, and these were grazed very low by a macropod and rabbit grazing but overgrazing and scratching have caused bare patches to develop. Some acacias had died, and the lower foliage cover had died off as the shrubs grew in height. There were pockets of acacias suckering. In 2018 the site was grazed very low by a macropod and rabbits and there was limited live ground cover. Overgrazing, scratching, tracks and camps have continued to degrade the rehabilitation sites and many more acacias had died. This site was not assessed in 2019.					
					N/A
South Dump 02: Woodland rehabilitation: West facing slope of the southern waste emplacement. This section of the waste emplacement was shaped and covered in 2006 followed by aerial seeding with a range of local native trees and shrub species. It was reseeded in 2007. In 2011 the perennial grasses (Phalaris, Cocksfoot) were scattered but were becoming tall and rank and kangaroo tracks have left a few bare areas. There has been significant growth of the shrubs especially *A. dealbata* and there were relatively few weeds. Old rills have stabilised but there were some small bare areas towards end of veg transect. In 2012 there was an increase in ground cover and tubestock had grown					

2008	2012	2014	2016	2018	2019
significantly. Macropods have kept grasses short in patches and camps and heavy browsing were evident. The site was noticeably very dry with most annual species being dead. There was little evidence of rabbits. In 2013 there was low ground cover and many of the shrubs had died due to the prolonged dry conditions. In 2014 more shrubs had died but the remaining shrubs had further grown. In 2015 the site was very dry with little active ground cover growth. Phalaris tussocks were very stressed and appearing dead. There has been heavy browsing by Macropods and rabbits with some bare patches especially under thicker acacias. Many acacias had further died leaving the site much more open but there was some scattered Acacia suckers. The A buxifolia often suffered from scale. In 2016 there was limited live ground cover, and these were grazed very low by a macropod and rabbit grazing but overgrazing and scratching have caused bare patches to develop. Some acacias had died, and the lower foliage cover had died off as the shrubs grew in height. There were pockets of acacias suckering. In 2018 the site was grazed very low by a macropod and rabbits and there was limited live ground cover. Overgrazing, scratching, tracks and camps have continued to degrade the rehabilitation sites and many more acacias had died. This site was not assessed in 2019.					
					N/A
South Dump 03: Woodland rehabilitation: West facing slope of the southern waste emplacement. This section of the waste emplacement was shaped and covered in 2006 followed by aerial seeding with a range of local native trees and shrub species. It was reseeded in 2007. This site was not monitored until 2010. In 2011 there had been an increased growth of perennial grasses and shrubs and was very stable. There were some roo tracks and camps beneath the shrubs. In 2012 there was an increase in ground cover and tubestock had grown significantly. There were many small wrens and a Grey Fantail. In 2013 there was low ground cover and many of the shrubs had died due to the prolonged dry conditions. In 2014 more shrubs had died but the remaining shrubs had further grown. In 2015 the site was very dry with little active ground cover growth. Phalaris tussocks were very stressed and appearing dead. There has been heavy browsing by Macropods and rabbits with some bare patches especially under thicker acacias. Many acacias had further died leaving the site much more open but there were numerous Acacia suckers. In 2016 there was limited live ground cover, and these were grazed very low by a macropod and rabbit grazing but overgrazing and scratching have caused bare patches to develop. Some acacias had died, and the lower foliage cover had died off as the shrubs grew in height. There were pockets of acacias suckering. In 2018 the site was grazed very low by a macropod and rabbits and there was limited live ground cover. Overgrazing, scratching, tracks and camps have continued to degrade the rehabilitation sites and many more acacias had died. This site was not assessed in 2019.					
N/A					N/A
Willunga DS01: Woodland rehabilitation: Willunga property, southern side of gully behind complex. The area was direct seeded in 2005 and 2006 and had been heavily grazed by sheep and cattle prior to the 2008 monitoring. In 2011, the site had remained ungrazed and there had been a considerable improvement in native and exotic grasses and there were fewer weeds, but there was a large patch of dead *Carthamus lanatus* (Saffron Thistle) at end of veg transect. The trees and shrubs have grown considerably but some subject to insect attack and had been defoliated. Some *E. bridgesiana* now had >5cm dbh. There were a few Blackberries. In 2012 the trees and shrubs had significantly grown, and the site remained ungrazed. The understorey was dominated by exotic perennials but large patches of *Microlaena stipoides* were present. There were fewer weeds and the Saffron Thistles had almost compete disappeared. There was an increase in Blackberries. In 2013, macropods have kept the grass short and their camps have created large bare along the rows of establishing trees. The Blackberries had been sprayed and they were dead. In 2014 the site had not been grazed and the kangaroo camps were recovering. There were many small acacia suckers and numerous small Blackberries. In 2015 and 2016 the site appears to have been heavily grazed but not recently. The ground cover was very low and retains patches of Phalaris, dead litter and Microlaena. There were few other ground cover plants present but numerous Acacia suckers have persisted with many being chewed right back. The old kangaroo camps have persisted beneath the tree line, but the trees appear to be healthy. Most of the Blackberry was dead but a few small seedlings remain. In 2019, the area remains overgrazed and was currently being grazed by cattle, with large bare patches beginning to develop. There was some recent germination of annuals and reshooting of perennial ground covers. A large patch of *Echium vulgare* (Viper's Bugloss) has developed at end of the plot. Some acacias have died outright, however the surviving trees and shrubs had significantly grown and the Acacias were suckering but grazed.					

2008	2012	2014	2016	2018	2019
				N/A	
Willunga DS02: Woodland rehabilitation: Willunga property. Paddock adjacent to Ridgeway access road. It is a rocky knoll with native pastures that has been fenced off to restrict grazing. The area was direct seeded in 2005 and 2006, with sparse scattering of seedlings now present. Some tubestock were planted in the lower section of the monitoring area. The site is largely ungrazed and dominated by tall rank *Bothriochloa macra*, and there appeared to more weeds (Skeleton weed, dead Saffron Thistle and Blackberry). In 2012, the site remained ungrazed, but the large patches of Blackberries had been sprayed. There continued to a dense sward of native grasses with relatively few weeds. The trees and shrubs have continued to grow with a couple of individuals being affected by spray drift. Many small Blackberries were observed so follow up spraying will be essential. In 2013, macropods have kept the grass short and while the Blackberries had been sprayed will continue to require some follow up. In 2014 the site remained ungrazed and there were a scattering of small Blackberries. The site had not been recently grazed and had retained a moderate cover of native grasses and Skeleton weed was abundant. A few Blackberry canes remain, and occasional Blackberry persist. While many acacias have died over the years the remaining trees have grown and appear healthy. There were few annual grasses present this year. In 2016 there was limited live ground cover, and these were grazed very low by a combination of recent strategic stock grazing and macropods. In 2019, the area was being grazed by cattle, but good ground cover was retained. There was some recent germination of annuals and reshooting of perennial ground covers. The surviving trees and shrubs had significantly grown, and the Acacias were suckering.					
				N/A	

Appendix 3. Descriptions and photo-points of the riparian monitoring sites

General description and permanent photo-point along the vegetation transect in the riparian reference monitoring sites 2008 - 2019.

2008	2010	2012	2014	2016	2019
RrRip02 Riparian patch: reserve Bakers Shaft Reserve. Open woodland dominated by *E. camaldulensis, E. melliodora* and *E. bridgesiana*. Understorey dominated by *Phalaris aquatica* and *Dactylis glomerata* with patches of introduced annual grasses and native grasses and herbs. Some *E. camaldulensis* regeneration occurring along the rocky banks. In 2011 the site was ungrazed and was dominated by a dense sward of exotic perennial grasses with thistles beneath the tree canopies. The young saplings had significantly grown. There was evidence of high flood waters. In 2012, the area contained long rank perennial grasses and several "shrubs" had been chopped down by campers. There were many small Blackberry bushes growing. Flood waters have altered the stream morphology with litter and debris evident high amongst tree branches. In 2013 the site was overgrazed by sheep but retained relatively good ground levels. The continued to be many small Blackberries. In 2016 there was limited live ground cover, and these were grazed very low by a combination of recent strategic stock grazing and macropods. A walking track was developing across the site but presently probably had little impact on the vegetation data. In 2019 the site was being grazed by cattle and continued to be dominated by a dense sward of exotic and native perennial grasses. A couple of large tree branches have fallen down. *Nassella neesiana* (Chilean Needlegrass) was spreading and there were scattered Hypericum perforatum (St John's Wort). The river was the lowest observed. The eucalypt saplings had grown.					
RrRip03 Cadiangullong creek CVO. Open woodland dominated by *E. viminalis, E. melliodora* and *E. bridgesiana* and a relatively intact native understorey. Large old growth trees and midstorey shrubs including *Acacia melanoxylon* and *A. dealbata*. Very weedy on the opposing banks and in patches along the sloping banks. Bank drops steeply down to the creek with some erosion occurring on the kangaroo tracks. Willows have been removed further downstream. In 2011 two large trees had fallen down within the site. In 2011 and 2012, high flood waters have continued to alter the stream morphology with loss of aquatic vegetation and pools, with bank slumping and undercutting. In 2013 the creek beds had stabilised and there continued to be good ground cover and some acacia recruitment. No orchids have been sighted since 2010. There were many small noxious shrub species which had been browsed by macropods, despite evidence of active weed control being undertaken. In 2016 there was limited live ground cover, and these were grazed very low by macropods. In 2019, the site was grazed very low by macropods and continued to contain a range of weeds. The creek was very low and reduced to deep pools but remains clear and very slow flowing. A large branch had fallen across the LFA transect and a new transect was established 10m along the veg transect. There was an active wombat hole.					
			N/A		

General description and photo from the permanent photo-point at the riparian rehabilitation monitoring sites 2008 - 2019.

2008	2010	2012	2014	2016	2019
Creek Diversion: Riparian restoration: Start of Cadiangullong Creek diversion (photo from rear). Planted with tubestock in 2005. Heavy grazing by wallabies and kangaroos. In 2011 there was an improvement in ground cover and the Phalaris was tall and rank and the shrubs have grown. The creek bed was densely vegetated with Water Couch, pockets of Cumbungi and some *A. melanoxylon* saplings were establishing on the banks. The bottom remained rocky with occasional rocky pools. The banks remained intact despite intense flooding. Water was clear and flowing. In 2012, the grass was long and rank and there was an improvement in ground cover along the veg transect. There was less evidence of macropod grazing. The Creek itself retains a dense bed of Water Couch with a narrow stream of water flowing through. The banks remained stable despite floods. Some shrubs had died, and the clovers had been frosted. In 2013 and 2014, there continued to be low be low but typically good ground cover but a notable absence of clovers due to the prolonged dry conditions and several more shrubs had died. The creek was well vegetated and gently flowing. In 2016 macropods have trampled and grazed low the grasses leaving scattered dry Phalaris tussocks. Litter cover is good, and cryptogams persist in bare areas, but rabbits scratching were evident. Creek contained a dense sward of Cumbungi and Water Couch, with occasional *A. melanoxylon* and Casuarinas on the creek banks. In 2019, the surviving tubestock were very large. Most of the site was grazed very low by macropods and quite weedy. The creek was very low and reduced to deep pools. Willows have regrown.					
Cadiangullong Creek: Riparian restoration: Below Clark's hardstand. It contains remnant riparian vegetation with an overstorey of *Casuarina cunninghamiana* and a small patch of *A. dealbata* on the creek bank which has some patchy regeneration present. The area was direct seeded in 2006. The understorey remained dominated by Phalaris. Saplings damaged by past grazing (2009) have recovered and grown considerably. In 2011, flood water had spilled onto the floodplain leaving piles of debris scattered across the site. In 2012 the site remains ungrazed with long dense exotic perennial grasses continuing to dominate the site and there continued to be low species diversity. The scattered trees and shrubs continue to grow, but macropods have grazed many small acacia suckers along the creek banks. The creek was fast flowing with changed morphology and loss of bed after floods. Some minor scouring of the banks. Some of the mature casuarina trees continued to be "sick". In 2013 the site had been past grazed and maintained low species diversity. The creek was clear flowing. In 2016 cattle have recently trampled and grazed low the grasses leaving scattered dry Phalaris tussocks. The creek bank had stabilised, and the creek was clear and slow flowing. The trees and shrubs have significantly grown. In 2019, the surviving tubestock had become very large. Most of the site was grazed by cattle/macropods and remained dominated by Phalaris. The creek was dry and reduced to deep pools.					
			N/A		

Appendix 4: Flora species recorded in the woodland monitoring sites 2021

*Note: "1" denotes the presence of that species at a particular site and is not a measure of cover abundance.
Key to habit legend: t = tree; s = shrub; ss =sub-shrub; h = herb; g = grass, r = reed; v = vine; f = fern; p = parasite

Group	Family	exotic	Scientific Name	Common Name	Habit	RfWood01	RfWood02	RWood05	North Dump 01	North Dump 02	North Dump 03	South Dump 04	South Dump 05	South Dump 07	South Dump 08	South Dump 09	South Dump 10
Dicotyledon	Araliaceae		*Hydrocotyle laxiflora*	Stinking Pennywort	h			1									
Dicotyledon	Asteraceae	*	*Arctotheca calendula*	Capeweed	h				1	1			1	1	1		
Dicotyledon	Asteraceae	*	*Bidens subalternans*	Greater Beggars Tick	h							1			1		
Dicotyledon	Asteraceae	*	*Carduus tenuiflorus*	Winged Slender Thistle	h		1										
Dicotyledon	Asteraceae	*	*Carthamus lanatus*	Saffron Thistle	h				1		1	1					
Dicotyledon	Asteraceae		*Cassinia arcuata*	Chinese Shrub	s			1	1		1		1	1	1	1	1
Dicotyledon	Asteraceae		*Cassinia longifolia*	Shiny Cassinia	s											1	
Dicotyledon	Asteraceae	*	*Centaurea solstitialis*	St Barnaby's Thistle	h										1		
Dicotyledon	Asteraceae	*	*Chondrilla juncea*	Skeleton Weed	h	1		1	1	1						1	
Dicotyledon	Asteraceae	*	*Cirsium vulgare*	Spear Thistle	h	1	1	1	1	1			1				1
Dicotyledon	Asteraceae	*	*Conyza bonariensis*	Fleabane	h	1	1	1	1		1	1	1	1	1	1	
Dicotyledon	Asteraceae		*Cymbonotus lawsonianus*	Bear's Ear	h			1									
Dicotyledon	Asteraceae		*Euchiton involucratus*	Star Cudweed	h										1		
Dicotyledon	Asteraceae		*Euchiton sphaericus*	Japanese Cudweed	h			1	1	1	1			1	1		
Dicotyledon	Asteraceae	*	*Hypochaeris glabra*	Smooth Catsear	h	1	1	1					1				
Dicotyledon	Asteraceae	*	*Hypochaeris radicata*	Flatweed	h			1			1	1	1	1	1		
Dicotyledon	Asteraceae	*	*Lactuca serriola*	Prickly Lettuce	h	1	1	1	1		1	1					
Dicotyledon	Asteraceae		*Pseudognaphalium luteoalbum*	Jersey Cudweed	h							1			1		
Dicotyledon	Asteraceae		*Senecio hispidulus*	Hill Fireweed	h			1									
Dicotyledon	Asteraceae		*Senecio prenanthoides*		h			1									
Dicotyledon	Asteraceae		*Senecio quadridentatus*	Cotton Fireweed	h		1	1	1	1	1	1	1		1		1
Dicotyledon	Asteraceae	*	*Silybum marianum*	Variegated Thistle	h		1		1	1			1				1
Dicotyledon	Asteraceae		*Solenogyne bellioides*		h			1									

Group	Family	exotic	Scientific Name	Common Name	Habit	RfWood01	RfWood02	RWood05	North Dump 01	North Dump 02	North Dump 03	South Dump 04	South Dump 05	South Dump 07	South Dump 08	South Dump 09	South Dump 10
Dicotyledon	Asteraceae	*	*Sonchus asper*	Prickly Sowthistle	h				1	1	1	1	1		1		
Dicotyledon	Asteraceae	*	*Sonchus oleraceus*	Milk Thistle	h	1	1	1	1	1	1	1	1		1	1	1
Dicotyledon	Asteraceae		*Vittadinia cuneata*	Fuzzweed	h									1	1		
Dicotyledon	Asteraceae		*Vittadinia cuneata var. cuneata*	Fuzzweed	h							1					
Dicotyledon	Asteraceae		*Vittadinia spp.*	Fuzzweed	h						1						
Dicotyledon	Asteraceae	*	*Xanthium spinosum*	Bathurst Burr	h		1										1
Dicotyledon	Boraginaceae		*Cynoglossum australe*	Australian Hounds Tounge	h			1									
Dicotyledon	Boraginaceae	*	*Echium plantagineum*	Paterson's Curse	h	1			1	1		1	1	1	1		1
Dicotyledon	Boraginaceae	*	*Echium vulgare*	Vipers Bugloss	h				1	1	1	1			1		
Dicotyledon	Boraginaceae		*Hackelia suaveolens*		h			1									
Dicotyledon	Brassicaceae	*	*Lepidium africanum*	Peppercress	h						1						1
Dicotyledon	Brassicaceae		*Lepidium pseudohyssopifolium*	Peppercress	h		1										
Dicotyledon	Brassicaceae	*	*Sisymbrium officinale*	Hedge Mustard	h	1					1						1
Dicotyledon	Campanulaceae		*Wahlenbergia communis*	Tufted Bluebell	h	1									1		
Dicotyledon	Campanulaceae		*Wahlenbergia luteola*	Australian Bluebell	h	1											
Dicotyledon	Caryophyllaceae	*	*Petrorhagia nanteuilii*	Proliferous Pink	h	1		1	1	1	1						
Dicotyledon	Caryophyllaceae	*	*Stellaria media*	Chickweed	h	1											
Dicotyledon	Chenopodiaceae	*	*Chenopodium album*	Fat Hen	h				1		1						1
Dicotyledon	Chenopodiaceae		*Chenopodium pumilio*	Small Crumbweed	h		1		1		1				1		1
Dicotyledon	Chenopodiaceae		*Einadia nutans*	Climbing Saltbush	h												1
Dicotyledon	Chenopodiaceae		*Salsola australis*	Buckbush	ss										1		
Dicotyledon	Convolvulaceae		*Dichondra repens*	Kidney Weed	h			1									
Dicotyledon	Euphorbiaceae	*	*Euphorbia lathyris*	Caper Spurge	h				1								
Dicotyledon	Fabaceae (Faboideae)		*Daviesia leptophylla*	Slender Bitter-Pea	s										1		
Dicotyledon	Fabaceae (Faboideae)		*Desmodium varians*	Slender Tick-trefoil	h			1									
Dicotyledon	Fabaceae (Faboideae)		*Glycine clandestina*	Climbing Glycine	h			1									
Dicotyledon	Fabaceae (Faboideae)		*Hardenbergia violacea*	Happy Wanderer	v										1		

Group	Family	exotic	Scientific Name	Common Name	Habit	RfWood01	RfWood02	RWood05	North Dump 01	North Dump 02	North Dump 03	South Dump 04	South Dump 05	South Dump 07	South Dump 08	South Dump 09	South Dump 10
Dicotyledon	Fabaceae (Faboideae)		*Pultenaea spinosa*	Spiny Bush-pea	s										1		
Dicotyledon	Fabaceae (Faboideae)	*	*Trifolium repens*	White Clover	h		1	1	1	1			1		1		
Dicotyledon	Fabaceae (Faboideae)	*	*Trifolium subterraneum*	Subterraneum Clover	h	1	1	1	1	1	1	1	1	1	1	1	1
Dicotyledon	Fabaceae (Faboideae)	*	*Vicia sativa*	Common Vetch	h			1		1							
Dicotyledon	Fabaceae (Mimosoideae		*Acacia filicifolia*	Fern-leaved Wattle	s								1	1	1	1	
Dicotyledon	Fabaceae (Mimosoideae)		*Acacia buxifolia*	Box-leaved Wattle	s				1	1	1	1	1	1	1	1	
Dicotyledon	Fabaceae (Mimosoideae)		*Acacia dealbata*	Silver Wattle	s			1	1	1	1	1	1	1			
Dicotyledon	Fabaceae (Mimosoideae)		*Acacia decora*	Western Golden Wattle	s							1	1				1
Dicotyledon	Fabaceae (Mimosoideae)		*Acacia decurrens*	Early black Wattle	s									1	1	1	
Dicotyledon	Fabaceae (Mimosoideae)		*Acacia genistifolia*	Early Wattle	s					1			1	1	1		
Dicotyledon	Fabaceae (Mimosoideae)		*Acacia implexa*	Hickory	s			1					1	1	1	1	
Dicotyledon	Fabaceae (Mimosoideae)		*Acacia paradoxa*	Kangaroo Thorn	s								1	1	1	1	
Dicotyledon	Fabaceae (Mimosoideae)		*Acacia penninervis*	Mountain Hickory	s									1	1	1	
Dicotyledon	Fabaceae (Mimosoideae)		*Acacia spectabilis*	Mudgee Wattle	s					1							
Dicotyledon	Fabaceae (Mimosoideae)		*Acacia verniciflua*	Varnish Wattle	s									1	1	1	
Dicotyledon	Fabaceae (Mimosoideae)		*Acacia vestita*	Boree	s				1	1	1	1	1	1	1	1	
Dicotyledon	Geraniaceae	*	*Erodium cicutarium*	Common Crowsfoot	h					1							
Dicotyledon	Geraniaceae	*	*Geranium molle*	Dove's Foot Cranesbill	h								1				
Dicotyledon	Geraniaceae		*Geranium solanderi*	Native Geranium	h	1	1	1	1	1	1	1	1		1		
Dicotyledon	Haloragaceae		*Gonocarpus tetragynus*	Raspwort	h									1	1		
Dicotyledon	Hypericaceae		*Hypericum gramineum*	Small St. John's Wort	h			1									
Dicotyledon	Hypericaceae	*	*Hypericum perforatum*	St. John's Wort	h							1			1		
Dicotyledon	Lamiaceae	*	*Marrubium vulgare*	Horehound	h	1	1		1	1	1		1				
Dicotyledon	Lamiaceae	*	*Salvia verbenaca*	Wild Sage	h			1									
Dicotyledon	Lamiaceae		*Scutellaria humilis*	Dwarf Scullcap	h			1									
Dicotyledon	Lythraceae		*Lythrum hyssopifolia*	Hyssop Loosestrife	h							1	1				
Dicotyledon	Malaceae	*	*Crataegus monogyna*	Hawthorn	s			1									

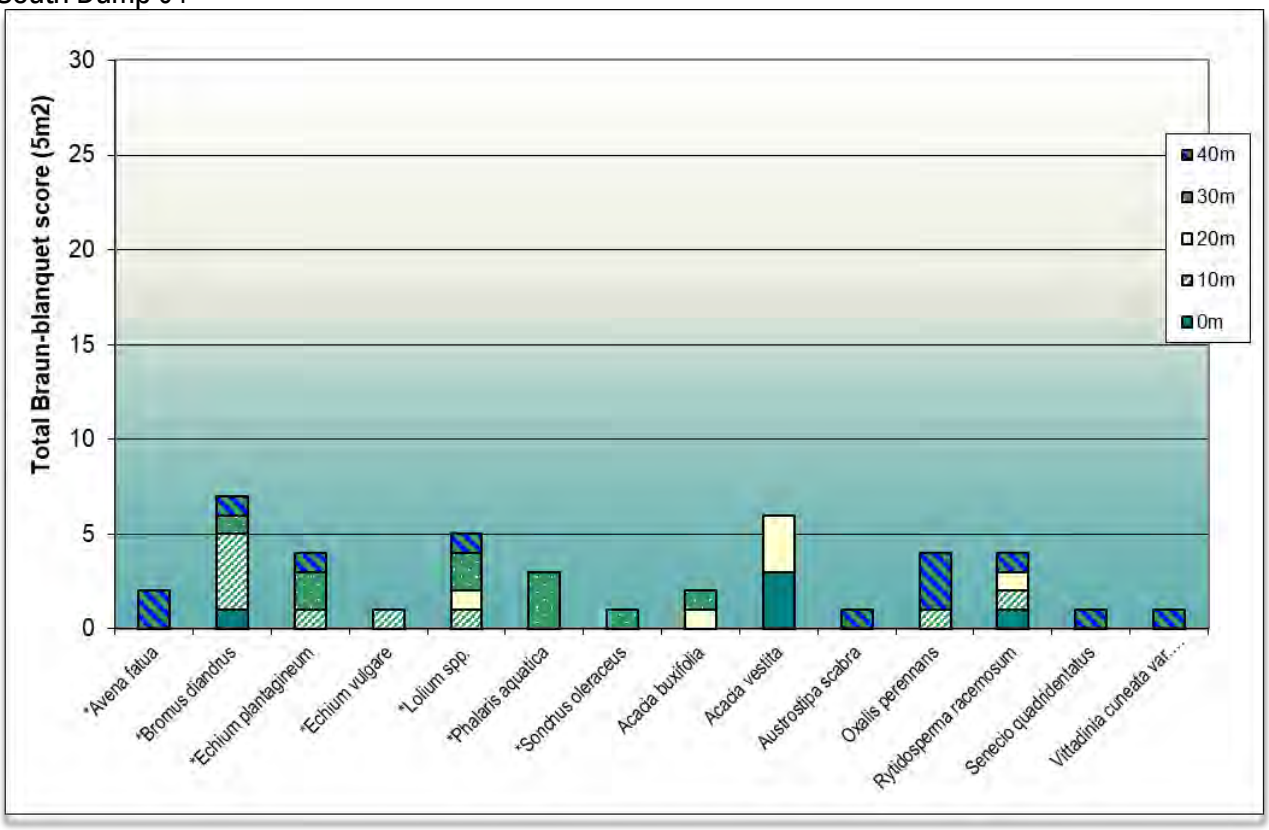
Group	Family	exotic	Scientific Name	Common Name	Habit	RfWood01	RfWood02	RWood05	North Dump 01	North Dump 02	North Dump 03	South Dump 04	South Dump 05	South Dump 07	South Dump 08	South Dump 09	South Dump 10
Dicotyledon	Malvaceae	*	*Modiola caroliniana*	Red-flowered Mallow	h				1	1	1	1	1	1	1		1
Dicotyledon	Myrtaceae		*Eucalyptus albens*	White Box	t		1						1	1	1	1	
Dicotyledon	Myrtaceae		*Eucalyptus blakelyi*	Blakely's Red Gum	t	1											1
Dicotyledon	Myrtaceae		*Eucalyptus goniocalyx*	Bundy Box	t			1						1	1	1	
Dicotyledon	Myrtaceae		*Eucalyptus macrorhyncha*	Red Stringybark	t			1						1			
Dicotyledon	Myrtaceae		*Eucalyptus melliodora*	Yellow Box	t	1		1							1		
Dicotyledon	Myrtaceae		*Eucalyptus polyanthemos*	Red Box	t										1		
Dicotyledon	Myrtaceae		*Eucalyptus viminalis*	Ribbon Gum	t											1	
Dicotyledon	Myrtaceae		*Leptospermum spp.*	Tea-tree	s										1		
Dicotyledon	Onagraceae		*Epilobium billardierianum*	Willow Herb	h					1		1	1		1		
Dicotyledon	Orobanchaceae	*	*Orobanche minor*	Broomrape	h			1									
Dicotyledon	Oxalidaceae		*Oxalis perennans*	Yellow Wood-sorrel	h	1	1	1	1	1	1	1	1	1	1	1	1
Dicotyledon	Papaveraceae	*	*Papaver somniferum*	Opium Poppy	h						1						
Dicotyledon	Plantaginaceae	*	*Plantago lanceolata*	Ribwort	h			1	1		1						1
Dicotyledon	Plantaginaceae		*Veronica plebeia*	Trailing Speedwell	h	1											
Dicotyledon	Polygonaceae	*	*Acetosella vulgaris*	Sheep Sorrel	h				1	1	1				1		
Dicotyledon	Polygonaceae	*	*Polygonum aviculare*	Wireweed	h				1	1	1		1	1	1		1
Dicotyledon	Polygonaceae		*Rumex brownii*	Swamp Dock	h	1	1	1	1	1					1		
Dicotyledon	Polygonaceae	*	*Rumex crispus*	Curled Dock	h				1	1	1						1
Dicotyledon	Primulaceae	*	*Lysimachia arvensis*	Scarlet Pimpernel	h			1			1	1			1		
Dicotyledon	Proteaceae		*Grevillea ramosissima*	Fan Grevillea	s									1			
Dicotyledon	Proteaceae		*Hakea spp.*	Needlewood	s									1			
Dicotyledon	Resedaceae	*	*Reseda luteola*	Weld	h				1		1						
Dicotyledon	Rosaceae		*Acaena ovina*	Sheep's Burr	h			1									
Dicotyledon	Rosaceae		*Acaena sp.*	Sheep's Burr	h					1							
Dicotyledon	Rosaceae	*	*Rosa rubiginosa*	Sweet Briar	s			1									
Dicotyledon	Rosaceae	*	*Rubus fruticosus*	Blackberry	s			1					1				

Group	Family	exotic	Scientific Name	Common Name	Habit	RfWood01	RfWood02	RWood05	North Dump 01	North Dump 02	North Dump 03	South Dump 04	South Dump 05	South Dump 07	South Dump 08	South Dump 09	South Dump 10
Dicotyledon	Rosaceae	*	*Sanguisorba minor*	Sheep's Burnet	h			1									
Dicotyledon	Solanaceae		*Solanum cinereum?*	Narrawa Burr	h				1								
Dicotyledon	Solanaceae	*	*Solanum nigrum*	Blackberry Nightshade	h	1	1	1	1	1	1	1					1
Dicotyledon	Solanaceae	*	*Solanum sisymbriifolium*	Sticky Nightshade	h		1										
Dicotyledon	Sterculiaceae		*Brachychiton populneus*	Kurrajong	t			1									
Dicotyledon	Urticaceae	*	*Urtica urens*	Small Nettle	h					1							
Dicotyledon	Verbenaceae	*	*Verbena bonariensis*	Purpletop	h						1						
Dicotyledon	Verbenaceae	*	*Verbena litoralis*	Coastal Verbena	h										1		
Dicotyledon	Violaceae		*Viola betonicifolia*	Showy Violet	h			1									
Monocotyledon	Cyperaceae		*Carex inversa*	Knob Sedge	r	1		1		1							
Monocotyledon	Juncaceae		*Juncus spp.*	A Rush	r										1		
Monocotyledon	Juncaceae		*Juncus subsecundus*		r			1						1	1		
Monocotyledon	Juncaceae		*Luzula spp.*		h			1									
Monocotyledon	Poaceae		*Austrostipa scabra*	Speargrass	g	1		1			1	1	1	1	1	1	
Monocotyledon	Poaceae		*Austrostipa scabra subsp. falcata*	Speargrass	g											1	
Monocotyledon	Poaceae	*	*Avena fatua*	Wild Oats	g		1	1	1	1		1		1	1	1	
Monocotyledon	Poaceae		*Bothriochloa macra*	Red-leg Grass	g		1		1		1						
Monocotyledon	Poaceae	*	*Bromus cartharticus*	Prairie Grass	g					1		1					
Monocotyledon	Poaceae	*	*Bromus diandrus*	Great Brome	g	1		1		1		1	1	1		1	
Monocotyledon	Poaceae	*	*Bromus rubens*	Red Brome	g			1				1					
Monocotyledon	Poaceae		*Chloris truncata*	Windmill Grass	g				1						1		
Monocotyledon	Poaceae		*Cynodon dactylon*	Couch	g							1	1			1	
Monocotyledon	Poaceae	*	*Dactylis glomerata*	Cocksfoot	g				1	1	1						1
Monocotyledon	Poaceae		*Echinopogon ovatus*	Forest Hedgehog Grass	g			1									
Monocotyledon	Poaceae		*Elymus scaber*	Common Wheatgrass	g	1		1						1		1	
Monocotyledon	Poaceae	*	*Hordeum leporinum*	Barley Grass	g				1	1							
Monocotyledon	Poaceae	*	*Lolium spp.*	A Ryegrass	g	1	1		1	1	1	1	1		1	1	1

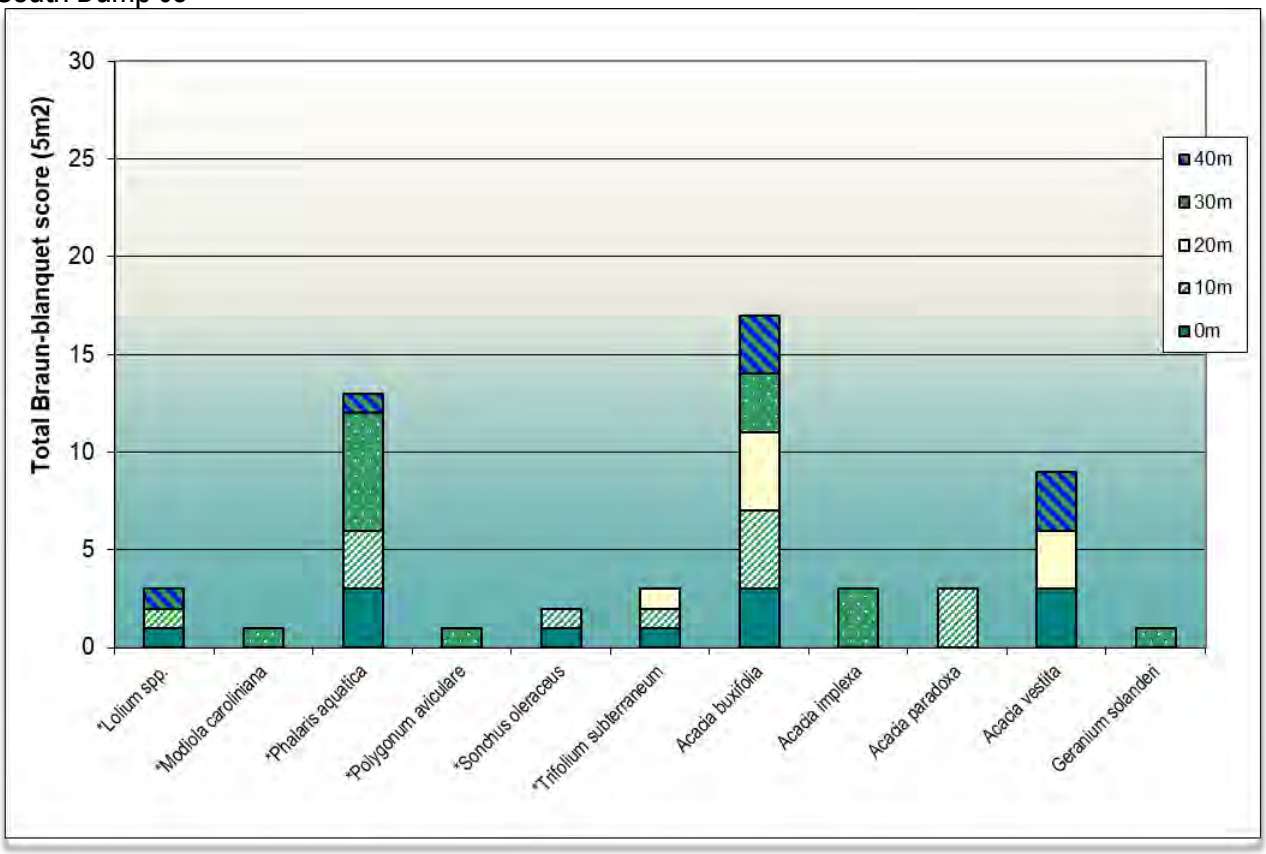
Group	Family	exotic	Scientific Name	Common Name	Habit	RfWood01	RfWood02	RWood05	North Dump 01	North Dump 02	North Dump 03	South Dump 04	South Dump 05	South Dump 07	South Dump 08	South Dump 09	South Dump 10
Monocotyledon	Poaceae		*Microlaena stipoides*	Weeping Rice-grass	g	1	1	1		1							
Monocotyledon	Poaceae	*	*Nassella trichotoma*	Serrated Tussock	g				1	1		1					
Monocotyledon	Poaceae		*Panicum effusum*	Hairy Panic	g	1								1			1
Monocotyledon	Poaceae	*	*Phalaris aquatica*	Phalaris	g		1		1	1	1	1	1	1	1	1	1
Monocotyledon	Poaceae		*Poa sieberiana*	Fine-leaf Tussock	g			1							1		
Monocotyledon	Poaceae		*Rytidosperma racemosum*	Wallaby Grass	g	1	1	1	1	1	1	1	1		1	1	
Monocotyledon	Poaceae		*Rytidosperma richardsonii*	Wallaby Grass	g							1	1				
Monocotyledon	Poaceae		*Rytidosperma setaceum*	Small-flowered Wallaby Grass	g									1			
Monocotyledon	Poaceae	*	*Vulpia bromoides*		g			1		1						1	
Monocotyledon	Poaceae	*	*Vulpia spp.*	Rat's-tail Fescue	g	1									1		
Pteridophyta	Adiantaceae		*Cheilanthes sieberi subsp. sieberi*	Rock Fern	f			1									

Appendix 5: Species cover abundance at individual woodland monitoring sites in 2021

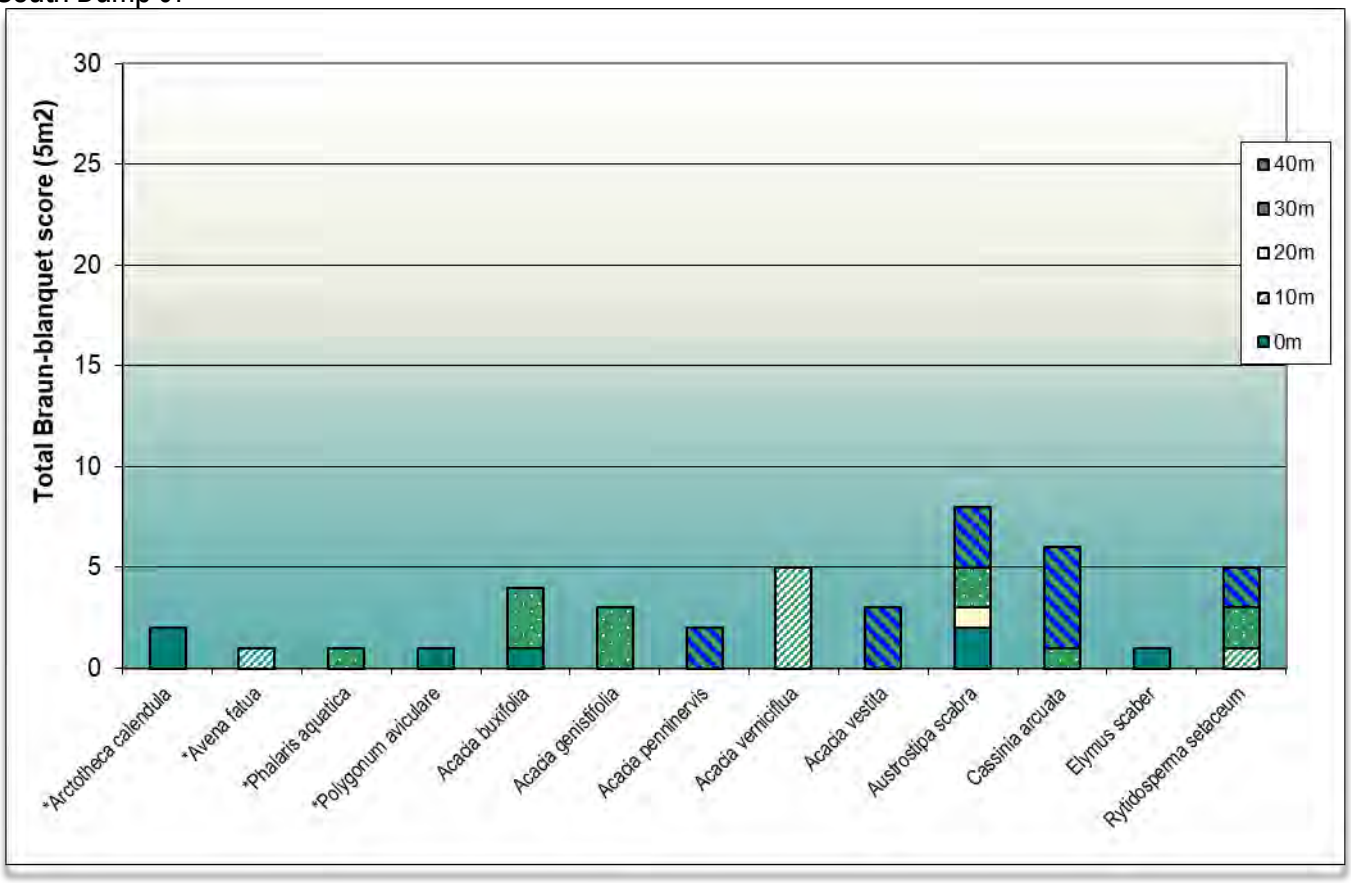
South Dump 04



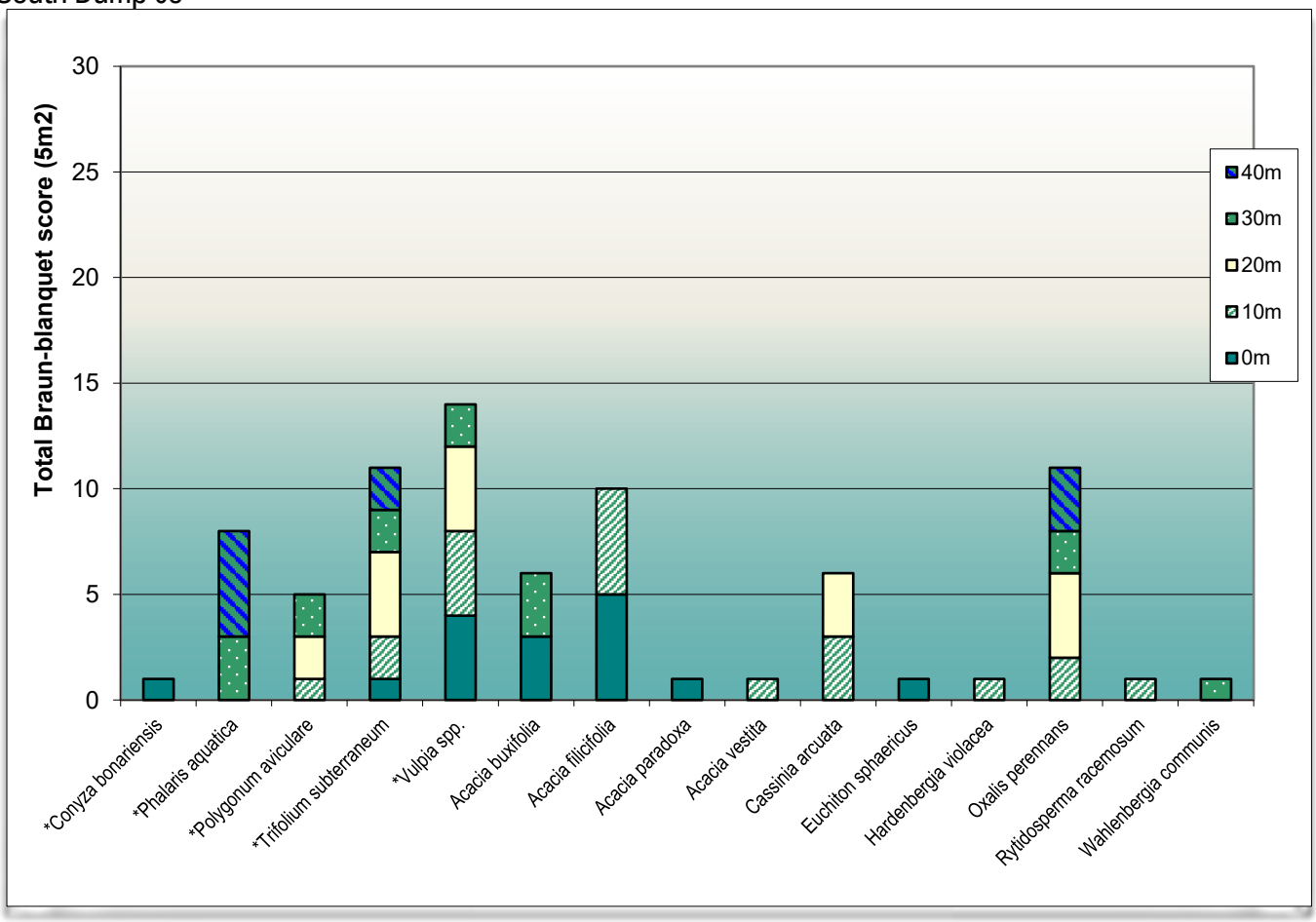
South Dump 05



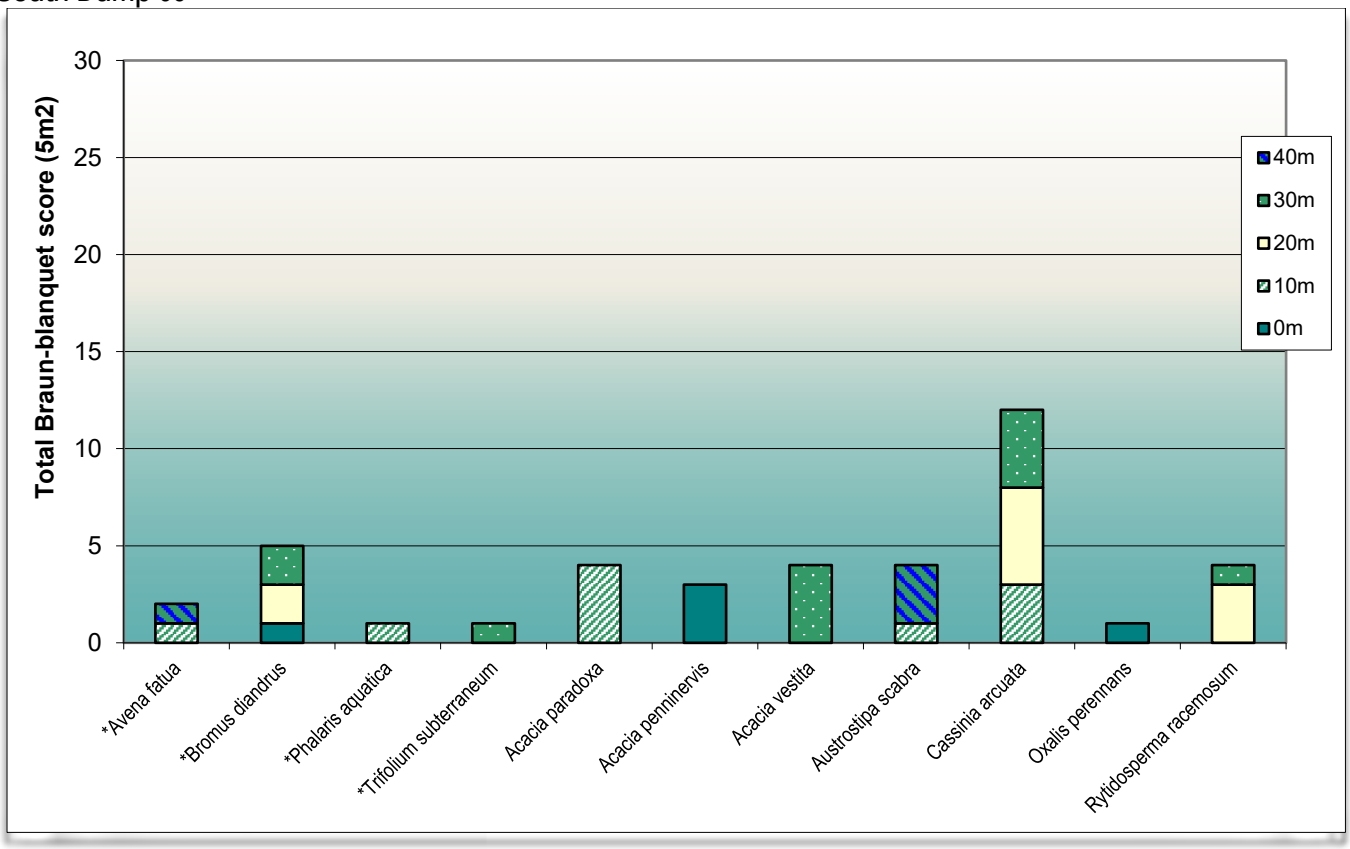
South Dump 07



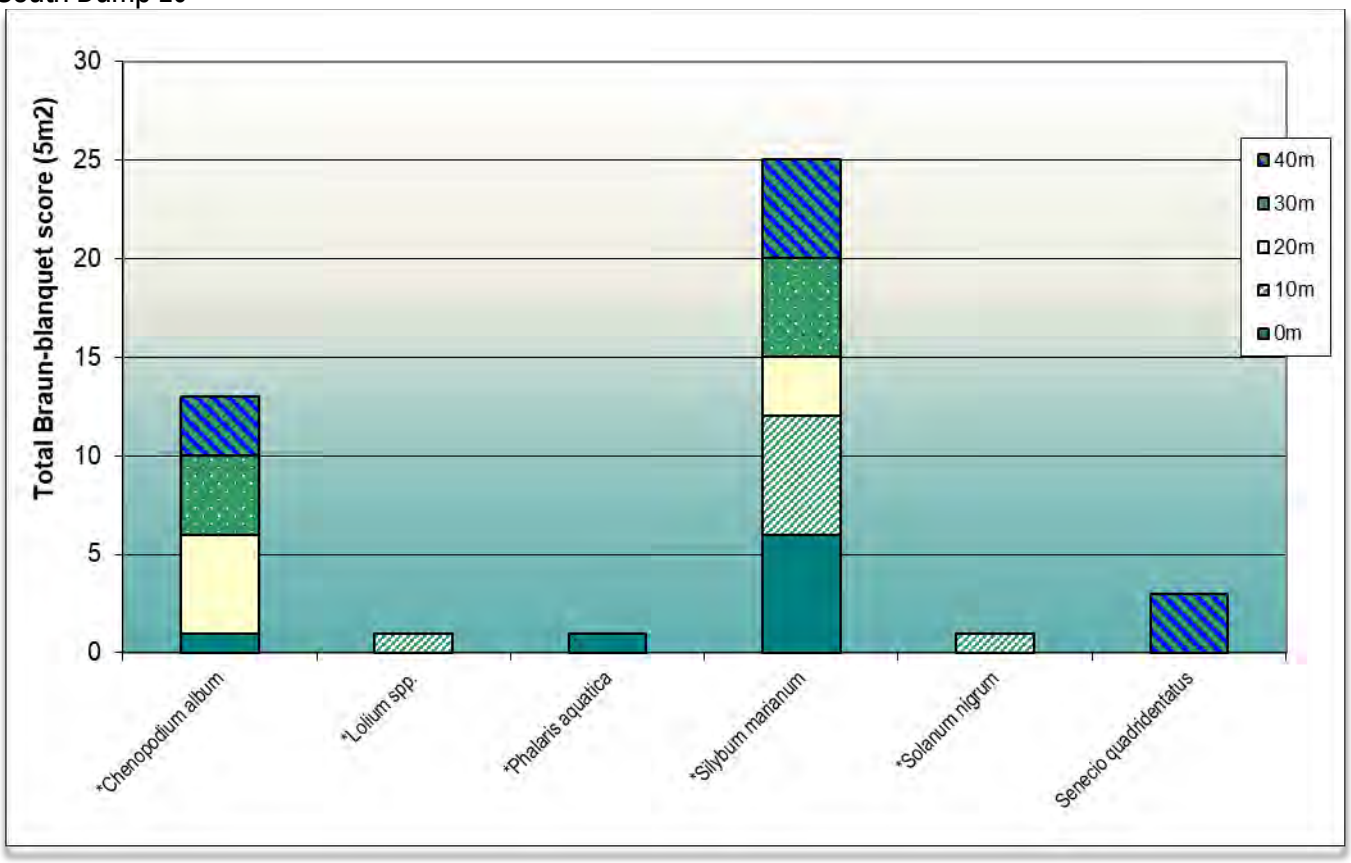
South Dump 08



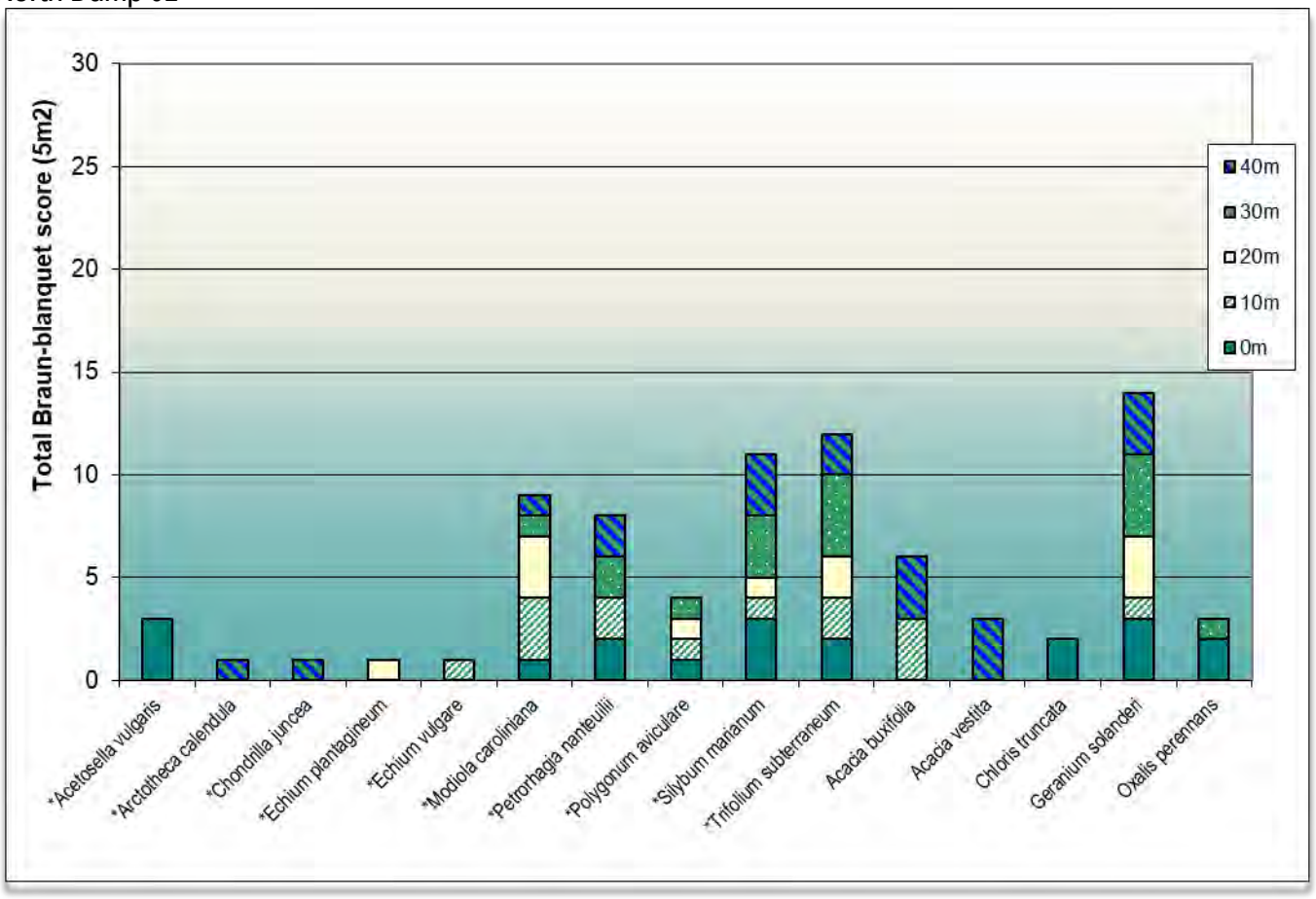
South Dump 09



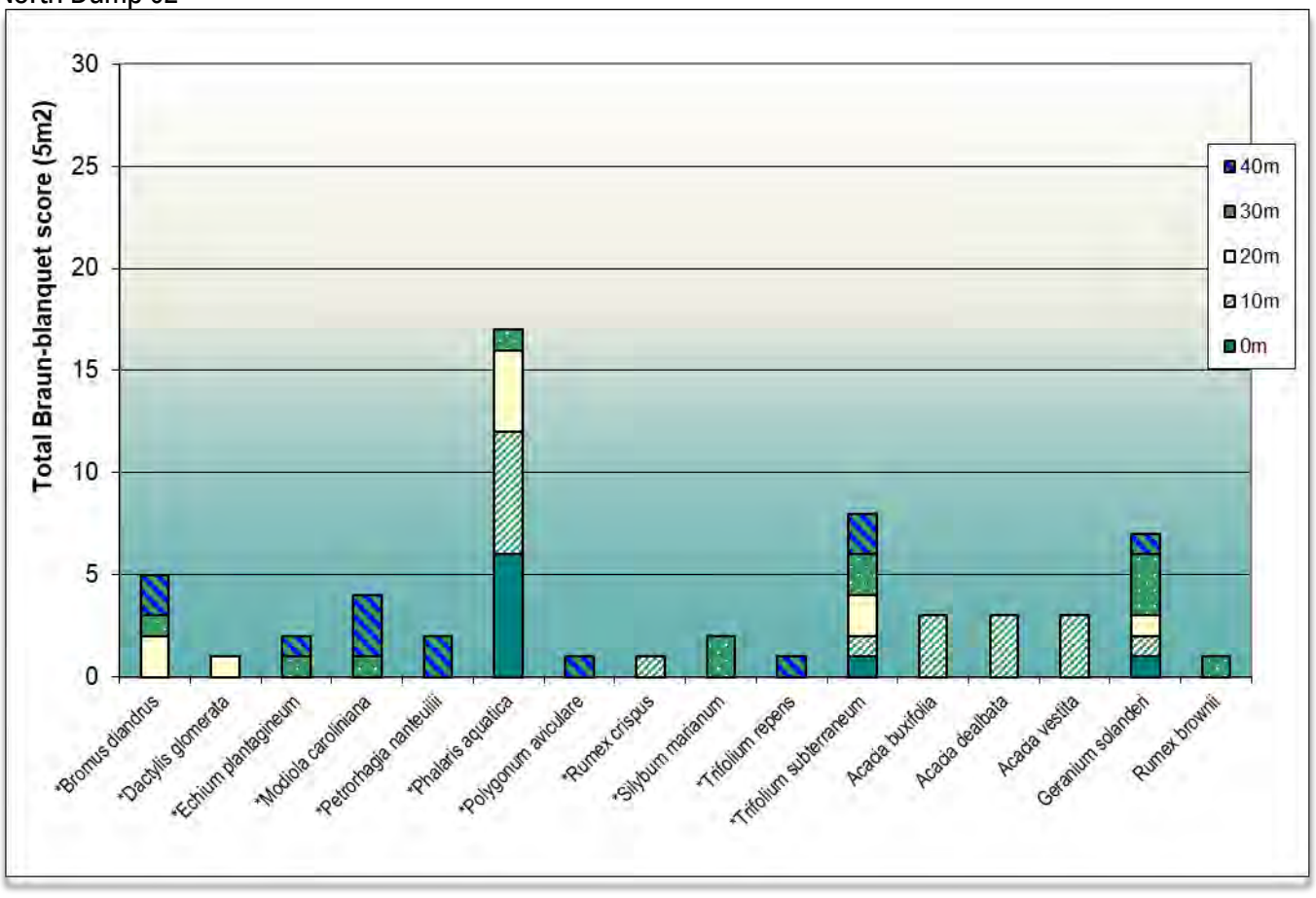
South Dump 10



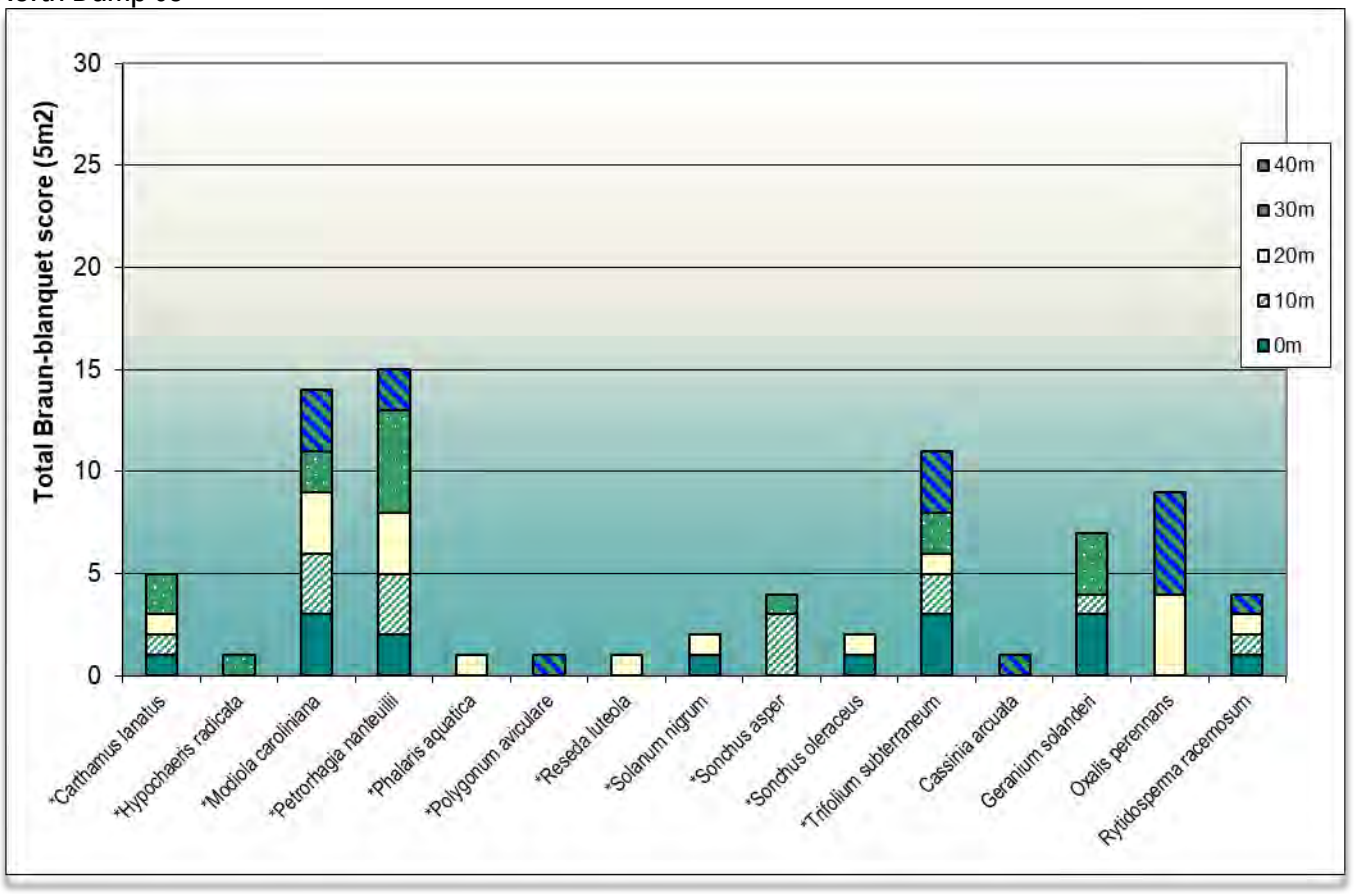
North Dump 01



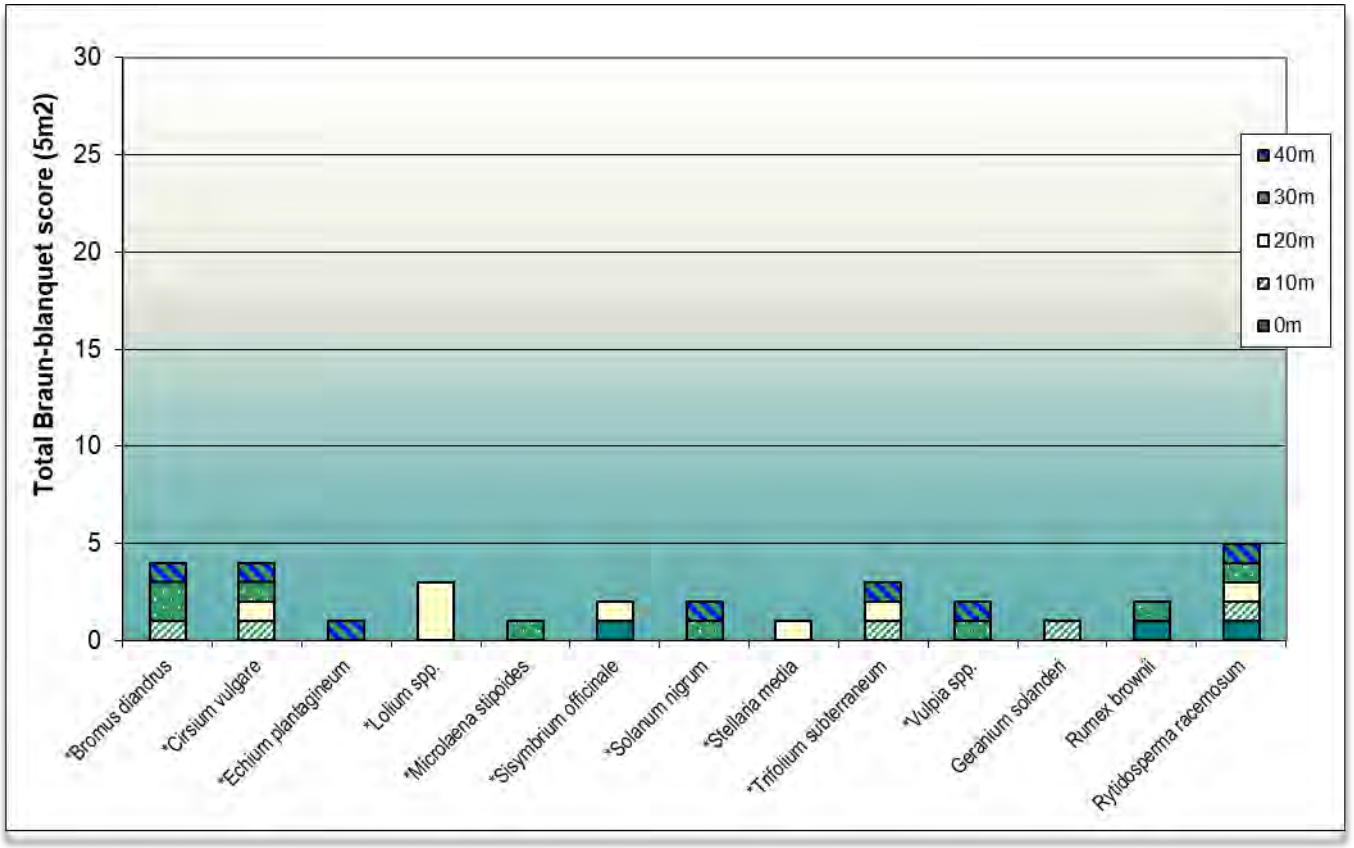
North Dump 02



North Dump 03



RfWood01



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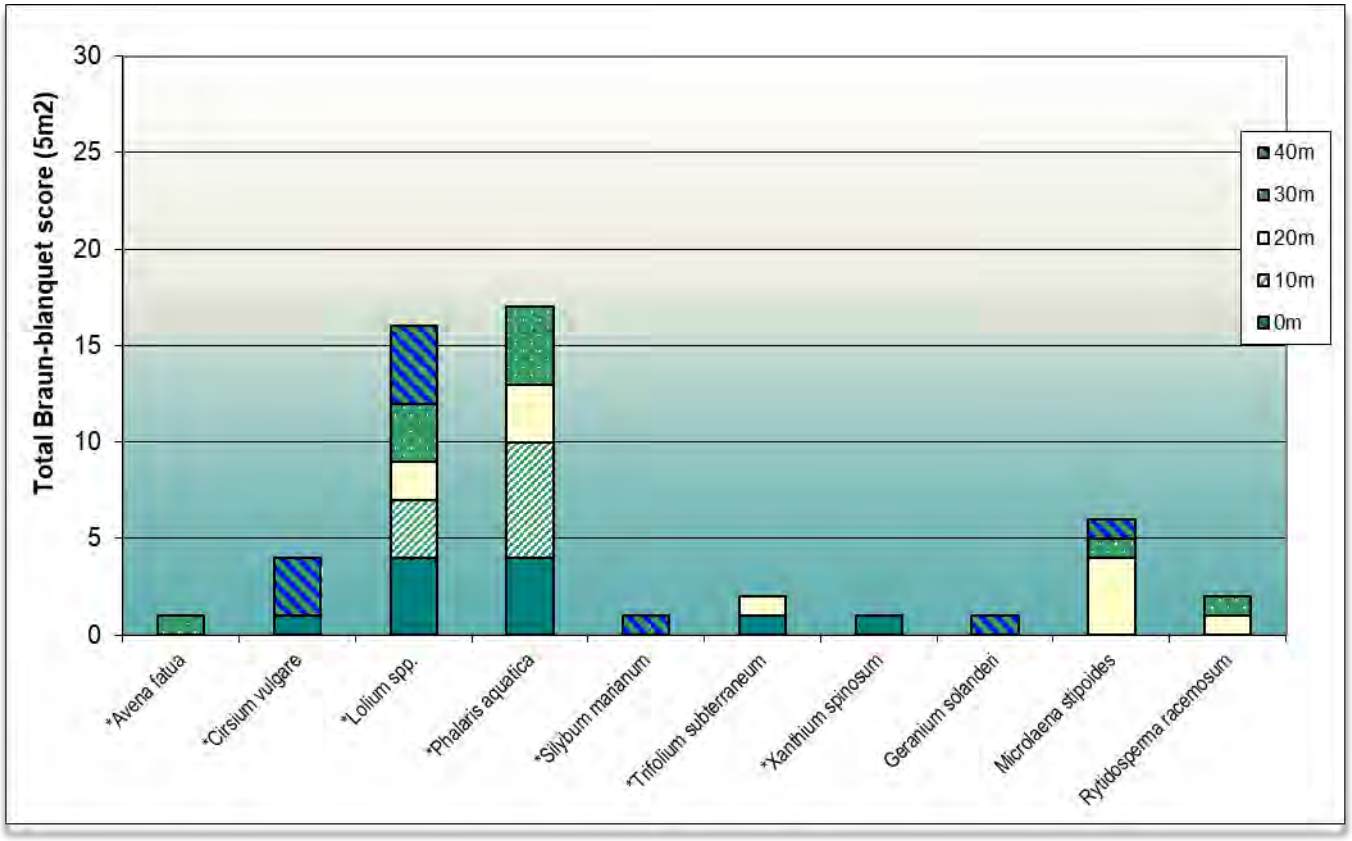

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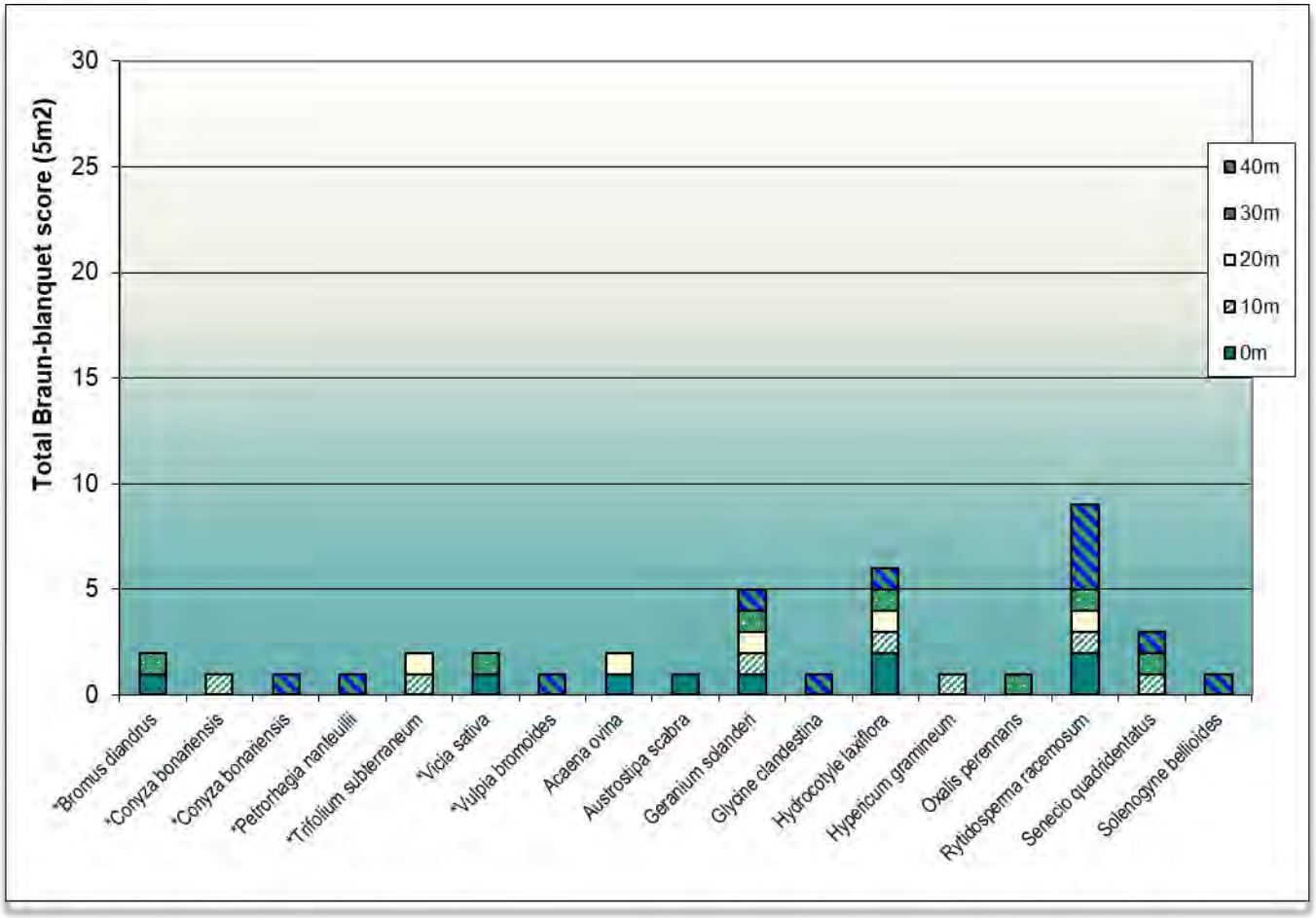

Brisbane

2/14 Heussler Terrace
Milton QLD 4064
Australia
www.okc-sk.com

Our ref: 715-18-02

7 September 2021

John Ford
Environmental Scientist
Cadia Valley Operations
Newcrest Mining
1460 Cadia Road
Orange NSW 2800

By email john.ford@newcrest.com.au

Dear John

Re: CVO Cover System Field Trials - Performance Monitoring Summary Year 7

Okane Consultants Pty Ltd (Okane) were retained by Cadia Valley Operations (CVO) to undertake performance monitoring at the CVO waste rock dump (WRD) cover system field trials. Information reported within this document summarises findings from the Year 7 monitoring period between 1 June 2020 and 31 May 2021.

Background

CVO is a gold mine located in central western New South Wales, 25 km south-west of Orange and is owned by Newcrest Mining Ltd. In 2010/11 Okane was engaged to implement a cover system field monitoring program after preliminary closure planning identified the need for further investigation for suitable options of onsite WRDs. CVO implemented a reclamation plan for closure of its north and south WRDs (NWRD and SWRD respectively) which involved the construction of a multi-layered engineered cover system over both WRDs.

Certain sections of the WRDs were instrumented following construction, of the cover system, to evaluate field performance over time. A natural site located in the vicinity of the NWRD was instrumented for provision of baseline soil conditions as well as a means of comparison with the

disturbed WRDs. Full details of historic studies completed by Okane have been presented to CVO previously and contain comprehensive analysis to date[1,2,3,4,5,6, and 7].

The locations of the NWRD and SWRD cover system field trials are shown in Figure 1. The cover system constructed at both WRDs utilises the moisture store-and-release concept. The NWRD cover system is enhanced with an additional low hydraulic conductivity layer below the non-compacted layer (Figure 2). The low hydraulic conductivity layer is used to 'delay' deep percolation during short-duration seasonal rainfall events in which the storage capacity of a cover system that solely relies on the store-and-release concept might be exceeded. The cover system functions by storing rainfall within the cover profile until evapotranspiration takes place and the moisture returns to the atmosphere. This process is complimented at the WRDs with a surface water management program to take runoff into consideration.

Figure 1: Location of the Cover System Trials and Natural Reference site relative to the CVO mine.

Base imagery adapted from Google (2020)[8]

[1] Okane Consultants. 2010. Closure Planning Support Studies for the Cadia Valley Operations, South Waste Rock Dump. Reference 715-03. February.

[2] Okane Consultants. 2013. Cadia Valley Operations – Record of Construction Report for the North Waste Rock Dump Cover System Field Trials. Reference 715-06. August.

[3] Okane Consultants. 2014. Newcrest Mining – Record of Installation Report for the Cadia Valley Operations South Waste Rock Dump Field Performance Monitoring System. Reference 715-11. May.

[4] Okane Consultants. 2017. Cadia Valley Operations: North and South Waste Rock Dumps Cover System. Reference 715-14. October.

[5] Okane Consultants. 2018. Cadia Valley Operations Performance Monitoring Report for the Year 4 Monitoring Period. 715-15. August.

[6] Okane Consultants. 2019. Cadia Valley Operations Performance Monitoring Report for the Year 5 Monitoring Period. 715-16. July.

[7] Okane Consultants. 2020. Cadia Valley Operations Performance Monitoring Report for the Year 6 Monitoring Period. 715-17. September.

[8] Google (2020) Satellite Imagery CNES/Airbus, Maxar Technologies, accessed at: https://earth.google.com/web/search/cadia+valley+mine/@-33.45700823,149.00222514,827.89564635a,4816.46757558d,35y,0h,0t,0r/data=CigiJgokCYY3DqALoTTAEVPJMwJG-DTAGQ8OoYA5il5AlW5rL4UeW15A , Accessed on 7/7/2020

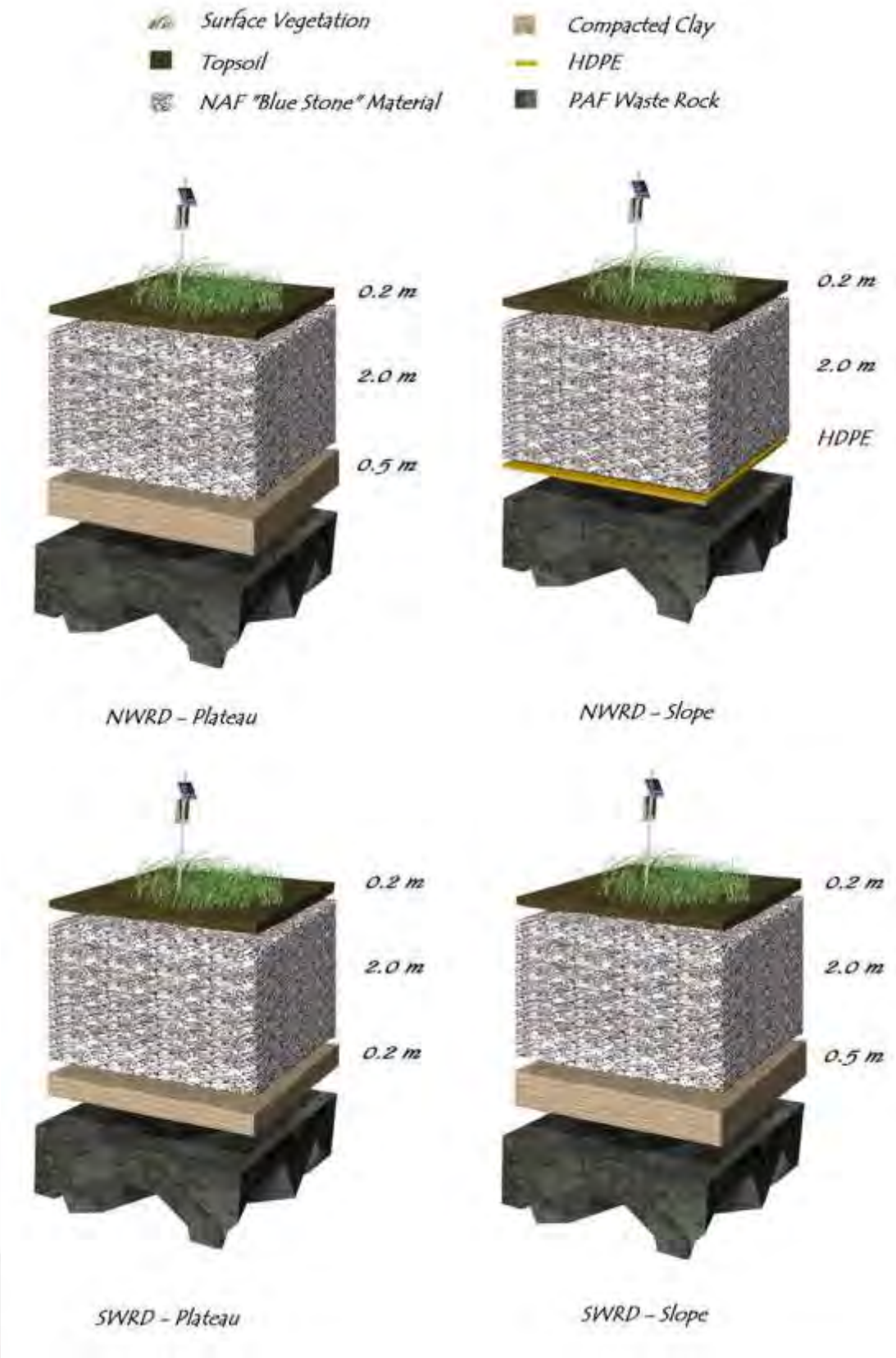

Figure 2: Cover System Profiles at CVO

The primary design objectives of cover systems are to minimise detrimental impacts of the mine waste on the receiving environment in the short term and facilitate recovery of the environment disturbed by mining over the long term. Specific design objectives of the cover systems constructed at CVO include:

- To limit the ingress of meteoric water to the underlying waste rock, thereby reducing contaminant production and potential adverse impact from release to the receiving environment;
- To provide for a stable landform; and
- Providing an adequate layer to support establishment of sustainable vegetation.

A single automated soil monitoring station was installed in a natural soil profile near the NWRD to act as a control plot and point of reference to which the NWRD and SWRD can be compared. Similar to the primary monitoring stations at NWRD and SWRD, sensors installed at the natural site measure *in situ* matric suction, temperature and volumetric water content. However, these provide background soil characteristics for CVO in a non-disturbed area, with all measurements indicative of a natural soil profile which is influenced by established vegetation. The location of the natural site relative to the NWRD and SWRD monitoring areas is shown in Figure 1.

This document focuses on the field data collected from 1 June 2020 to 31 May 2021, referred to herein as Year 7. Field data presented and discussed includes meteorological data and changes in the *in situ* moisture, matric suction and temperature conditions at both cover system field trials. This document has been prepared to provide a high-level summary of key data trends and findings during the Year 7 monitoring period, from both the NWRD and SWRD with respect to the climate conditions experienced at CVO.

Year 7: Data Collection

Data capture rates for automated sensors are based on the number of recorded valid sensor readings compared to the number scheduled. This measure takes into account failed sensors operating and the total operational time for the sensors over the monitoring period. The data collection efficiency is the percentage of valid readings compared to scheduled. Data capture rates for various components of the monitoring systems for the NWRD, SWRD and the natural site during the Year 7 monitoring period are summarised in Table 1 to Table 3 respectively.

Table 1: Summary of NWRD data capture rates for the Year 7 Monitoring Period.

Component	Number of Automated Sensors Installed	Number of Automated Sensors Operating	Percentage of Sensors Operating (%)	Data Collection Efficiency (%)	Data Capture Rate (%)
Primary 1 (Plateau)					
Thermal Conductivity Sensor	12	12	100	100	100
Water Content Sensor	16	16	100	100	100
Primary 2 (Plateau)					
Thermal Conductivity Sensor	12	12	100	100	100
Water Content Sensor	16	16	100	100	100
Net Radiometer	1	1	0	0	0
Tipping Bucket Rain Gauge	1	1	100	100	100
Primary 3 (Plateau)					
Thermal Conductivity Sensor	12	12	100	11	11
Water Content Sensor	16	16	100	6	6
Primary 4 (Slope)					
Thermal Conductivity Sensor	11	11	100	100	100
Water Content Sensor	13	13	100	100	100
Primary 5 (Slope)					
Thermal Conductivity Sensor	11	11	100	100	100
Water Content Sensor	12	12	100	100	100
Net Radiometer	1	0	0	0	0
Primary 6 (Slope)					
Thermal Conductivity Sensor	11	11	73	100	73
Water Content Sensor	13	13	100	99%	99%
Secondary 1(Slope)					

Component	Number of Automated Sensors Installed	Number of Automated Sensors Operating	Percentage of Sensors Operating (%)	Data Collection Efficiency (%)	Data Capture Rate (%)
Thermal Conductivity Sensor	10	10	100	53	53
Water Content Sensor	10	10	100	53	53
Secondary 2 (Slope)					
Thermal Conductivity Sensor	10	10	100	100	100
Water Content Sensor	10	10	100	100	100
Water Level Monitoring					
Hobo Loggers	3	2	66	66	66
Interflow Monitoring					
Tipping Bucket Flow Gauge	1	0	0	0	0
Average Data Capture Rate for the Monitoring Period:					70%

*Denote instances where some of the installed thermal conductivity sensors are no longer giving reliable suction readings but are providing good temperature data.

Table 2: Summary of SWRD data capture rates for the Year 7 Monitoring Period.

Component	Number of Automated Sensors Installed	Number of Automated Sensors Operating	Percentage of Sensors Operating (%)	Data Collection Efficiency (%)	Data Capture Rate (%)
Primary 1 (Slope)					
Thermal Conductivity Sensor	16	16	100	100	100
Water Content Sensor	16	16	100	100	100
Wind Speed Monitor	1	1	100	100	100
Net Radiometer	1	1	100	100	100
Primary 2 (Slope)					
Thermal Conductivity Sensor	16	14*	88	73	73
Water Content Sensor	16	16	100	73	73
Primary 3 (Slope)					
Thermal Conductivity Sensor	16	16*	100	100	100
Water Content Sensor	16	16	100	87	87
Primary 4 (Plateau)					
Thermal Conductivity Sensor	14	14*	100	100	100
Water Content Sensor	14	14	100	70	70
Primary 5 (Plateau)					
Thermal Conductivity Sensor	14	13*	100	56%	56%
Water Content Sensor	14	13	100	56%	56%
Primary 6 (Plateau)					
Thermal Conductivity Sensor	16	16*	100	46%	46%
Water Content Sensor	14	13	93	35%	35%
Meteorological Station					
Air Temperature and RH	1	1	100	100	100

Component	Number of Automated Sensors Installed	Number of Automated Sensors Operating	Percentage of Sensors Operating (%)	Data Collection Efficiency (%)	Data Capture Rate (%)
Tipping Bucket Rain Gauge (TBRG)	1	1	100	100	100
Wind Speed Monitor	1	1	100	100	100
Net Radiometer	1	1	100	100	100
Evapotranspiration Monitoring					
Eddy Covariance System	1	1	0	0	0
Water Level Monitoring					
OTT PLS	3	3	100	0	0
Interflow Monitoring					
Tipping Bucket Flow Gauge (TBFG)	1	0	0	0	0
Average Data Capture Rate for the Monitoring Period:					62%

*Denote instances where some of the installed thermal conductivity sensors are no longer giving reliable suction readings but are providing good temperature data.

Table 3: Summary of Natural site data capture rates for the Year 7 Monitoring Period.

Component	Number of Automated Sensors Installed	Number of Automated Sensors Operating	Percentage of Sensors Operating (%)	Data Collection Efficiency (%)	Data Capture Rate (%)
Primary 1					
Thermal Conductivity Sensor	8	8*	100	100	100
Water Content Sensor	8	8	100	100	100

*Denote instances where some of the installed thermal conductivity sensors are no longer giving reliable suction readings but are providing good temperature data.

Cover Monitoring System Data Collection Issues

NWRD

An average data capture rate of 70% was measured across all sensors at the NWRD for the Year 7 monitoring period, reflecting an 18% decrease since the Year 6 monitoring period[7]. This reduction is primarily related to the reduced function of the CVON Primary 3 which experienced a power supply issue for the majority of the monitoring period. Reduced data capture was also measured at both secondary stations at the NWRD.

Secondary meteorological instrumentation is installed at the NWRD for comparison with conditions at the SWRD, and to allow a more location-specific water balance to be developed. The TBRG installed at the NWRD recorded all data through the monitoring period, and a calibration check was completed during the May 2021 site visit to validate the accuracy of these measurements. 1,181 mm of rainfall was measured at the NWRD during the monitoring period compared with 994 mm at the SWRD, reflecting a variation of 187 mm. Whilst variation between the two WRDs is most significant in March 2021 whereby 163 mm was measured at the NWRD compared with 33 mm at the SWRD, monthly rainfall totals for the remainder of the monitoring period are comparable. This suggests that the rainfall was highly localised during March. Okane will continue to monitor rainfall volumes through quarterly QA/QC to validate the accuracy of these measurements.

CVON-3, located at the NWRD plateau, has failed to record and remotely send data due to impacted power supply since early-August 2020. As described in the site visit memorandum[9], a thorough inspection of this DAS was conducted and a cut in the wires connecting the solar panel with the PS100 charge regulator was observed. The sensors at this station are functioning; however, as the solar panel could not charge and supply power to the datalogger, no measurements were recorded. The damaged wire was repaired, and a replacement battery installed during the site visit. This station is now recording and remotely sending data.

Some CS299 sensors recorded correct temperature readings but erroneous suction readings, as identified in Table 1 to Table 3 during the monitoring period. The issue can likely be attributed to general wear/damage to the sensors over time resulting in the sensors' inability to heat up as required during scheduled suction measurements. However, the data collected from these sensors will continue to be monitored during monthly QA/QC. No additional sensors failed during the Year 7 monitoring period at the NWRD.

The interflow tipping bucket installed on the NWRD slope has been providing unreliable and intermittent measurements, with daily tipping bucket measurements having ceased. A calibration check was completed during the May 2021 site visit; however, as the sensors fail to provide accurate measurements, this calibration check could not be verified. Inspection of the area downgradient of this enclosure suggested that the drainage path had been blocked by sediment causing water to pool inside the enclosure. The drainage channel was cleared and deepened, allowing most water to drain. The majority of sediment and insect waste was removed from within both enclosures. Okane will continue to monitor data collection during the Year 8 monitoring period.

SWRD

SWRD Primary 6 (P6), installed at the plateau, continued to experience issues related to power supply and data capture despite battery and regulator replacement during past site visits. Significant vegetation coverage in the immediate vicinity of the station is believed to have obscured the solar

[9] Okane Consultants Pty Ltd. 2021. CVO Cover System Performance Monitoring – Year 7 Site Maintenance Visit May 2021. May.

panel, hence reducing its charging capacity. A replacement battery was installed during the May 2021 site visit to ensure the power supply is not compromised, and vegetation was trimmed by CVO during the site visit to allow greater exposure to the solar panel. Okane will continue to monitor data capture and power supply at P6 and CVO should continue to inspect and trim vegetation as necessary to ensure full exposure to the solar panel. However, should power supply continue to decline, Okane may recommend replacement of the charge regulator or solar panel associated with this station.

The Eddy Covariance (EC) system recorded data through the monitoring period at a reduced rate, with timesteps missed at regular intervals. The EC system comprises multiple sensors and instruments, all of which were physically in good condition and no damage was identified during the May 2021 site visit. However, low battery voltages from four batteries and into the CR3000 datalogger were measured during the site visit confirming that power supply was insufficient for the system to function correctly. De-ionised water was added to each of the four batteries by CVO, allowing connection to the datalogger to be re-established. Okane will continue to monitor data output by the EC system.

The Net Radiometer located at the NWRD meteorological station has provided out of range values throughout the monitoring period. Wires were checked during the May 2021 site visit and the levelling of the sensor was checked; hence it is likely this issue can be attributed to either damage to the apparatus or wires.

The interflow tipping bucket installed at the SWRD slope have been providing unreliable and intermittent measurements during the monitoring period. As per the NWRD TBFG, a calibration check was completed at during the May 2021 site visit; however, this could not be verified. A general clean of the enclosure was undertaken though any damage to buried wires could not be rectified.

The three OTT PLS Pressure Transducers installed at CVO's SWRD P1, P4 and P6 are largely unresponsive, providing occasional values not indicative of *in situ conditions.* This has been noted in previous monitoring periods. The OTT PLS Transducers are used to measure positive pore water pressure above the Compacted Clay Layer (CCL) on the SWRD slope and above the compacted potentially acid forming (PAF) waste. Erroneous measurements may have been caused by damaged wires buried below the surface, damage to the OTT PLS Pressure Transducers, or moisture within the pressure transducers. As these sensors are buried, they cannot be retrieved during site visits without potentially damaging other buried sensors.

Presentation and Discussion of Field Data

To evaluate the performance of the respective NWRD and SWRD cover systems during the Year 7 monitoring period the collected sensor data is quality controlled and then synthesised with the metrological data. This then allows water balance estimates, and indication of the performance monitoring sites, to be produced.

The principal drivers of cover system performance are evaporative forcing and rainfall quantity. Rainfall is measured by TBRG installed at both the NWRD and SWRD. Potential evaporation (PE) can

be calculated using net radiation measured with a solar radiation sensor (NR-Lite) as well as air temperature, relative humidity, and wind speed using data collected from the meteorological station located at the SWRD plateau. Direct measurements can be used from an EC system such as the one installed at the SWRD plateau. However, due to the unreliability of some EC and net radiation data collected during this monitoring period, PE has been calculated using alternative meteorological data. Okane serviced some aspects of this equipment during the May 2021 site visit[9]; however, data capture will continue to be monitored and Okane will attempt to further troubleshoot malfunctioning instruments.

Rainfall

Total annual rainfall measured at CVO during the Year 7 period varied between 994 mm at the SWRD and 1,181 mm at the NWRD (Figure 3). This variability may be attributed to the isolated nature of rainfall whereby a highly localised storm passed over the NWRD and missed the SWRD, or to declining performance of the TBRG. In consideration that rainfall was similar between the two WRDs for a majority of the monitoring period, isolated rainfall has likely occurred. However, Okane will continue to monitor these trends over the following monitoring period (Year 8) and make recommendations as required.

Rainfall at the Orange Airport Bureau of Meteorology Station, ~15 km north-east of CVO (Station Number 063303[10]), was 1,079 mm for the Year 7 monitoring period. The long term 25-year average yearly rainfall (1996 to 2021) at the Orange Airport BOM station is 895 mm[11]. The largest 12-hour rainfall event measured during the Year 7 monitoring period occurred on 13 March 2021, during which 54 mm was recorded at the NWRD. March 2021 recorded the largest amount of rainfall with 163 mm at the NWRD, the second largest rainfall month being October 2020 with 148 mm at the NWRD and 142 mm at the SWRD. The rainfall for Year 7 was above the BOM long-term average of 895 mm.

[10] Bureau of Meteorology. 2021. Rainfall data from Orange Airport, Station Number #063303

[11] BOM (2021) Daily Rainfall Orange Airport AWS, Accessed at: http://www.bom.gov.au/climate/dwo/202105/html/IDCJDW2105.202105.shtml

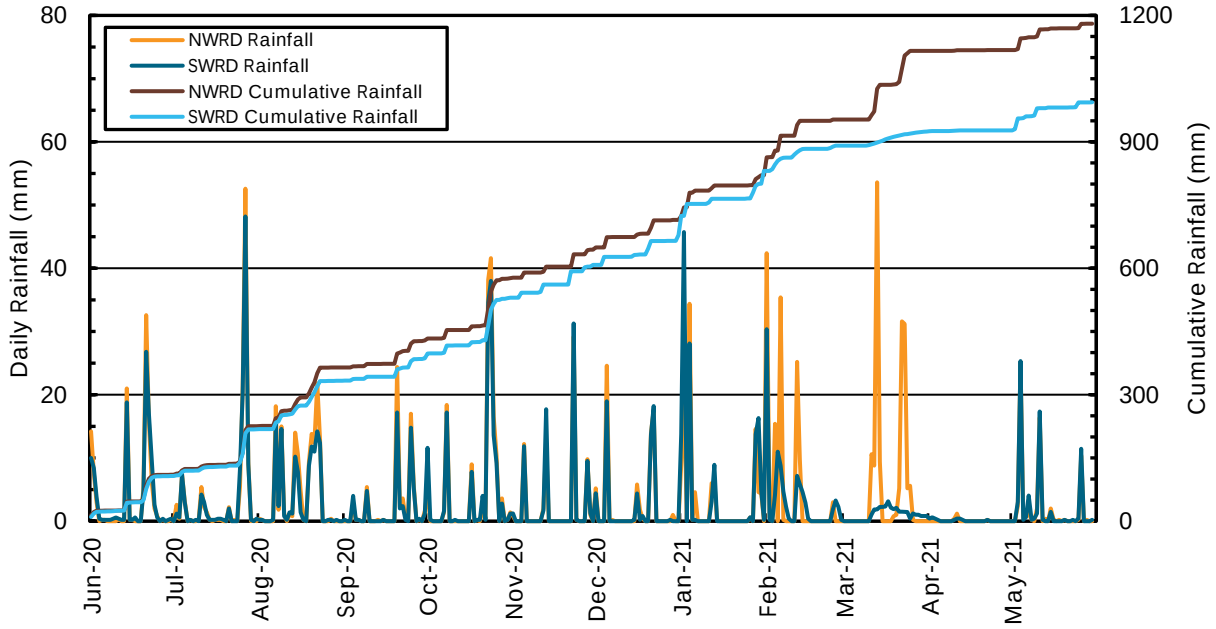

Figure 3: Daily and Cumulative Rainfall totals at the NWRD and SWRD for Monitoring Year 7

Potential Evaporation

Potential Evaporation (PE) was estimated based on the Penman Monteith[12] method using the meteorological data collected during the Year 7 monitoring period. It is defined as the theoretical maximum, assuming free water on the surface at all times. The calculated PE for Year 7 was 1,135 mm, closely aligning with the annual rainfall at the NWRD at approximately 1:1 (Figure 4).

Rainfall exceeded PE during June, July, August, October, March, and May. PE exceeded rainfall during the summer months between November and February; however, the greatest PE:rainfall ratio occurred in April 2021 at 38:1. Although rainfall was low during April, measuring only 6.5 mm, remnant moisture at the surface resulting from heavy rainfall during March likely contributed to this ratio. It should be noted that PE is not a direct measurement of actual evaporation, rather it is an estimate of the maximum energy available for evapotranspiration to occur.

[12] Allen, R.G., L.S Pereira, D. Raes and M. Smith. 1998. Crop Evapotranspiration – Guidelines for Computing Crop Water Requirements. FAO Irrigation and Drainage Paper 56. Food and Agriculture Organization of the United Nations. Rome, Italy

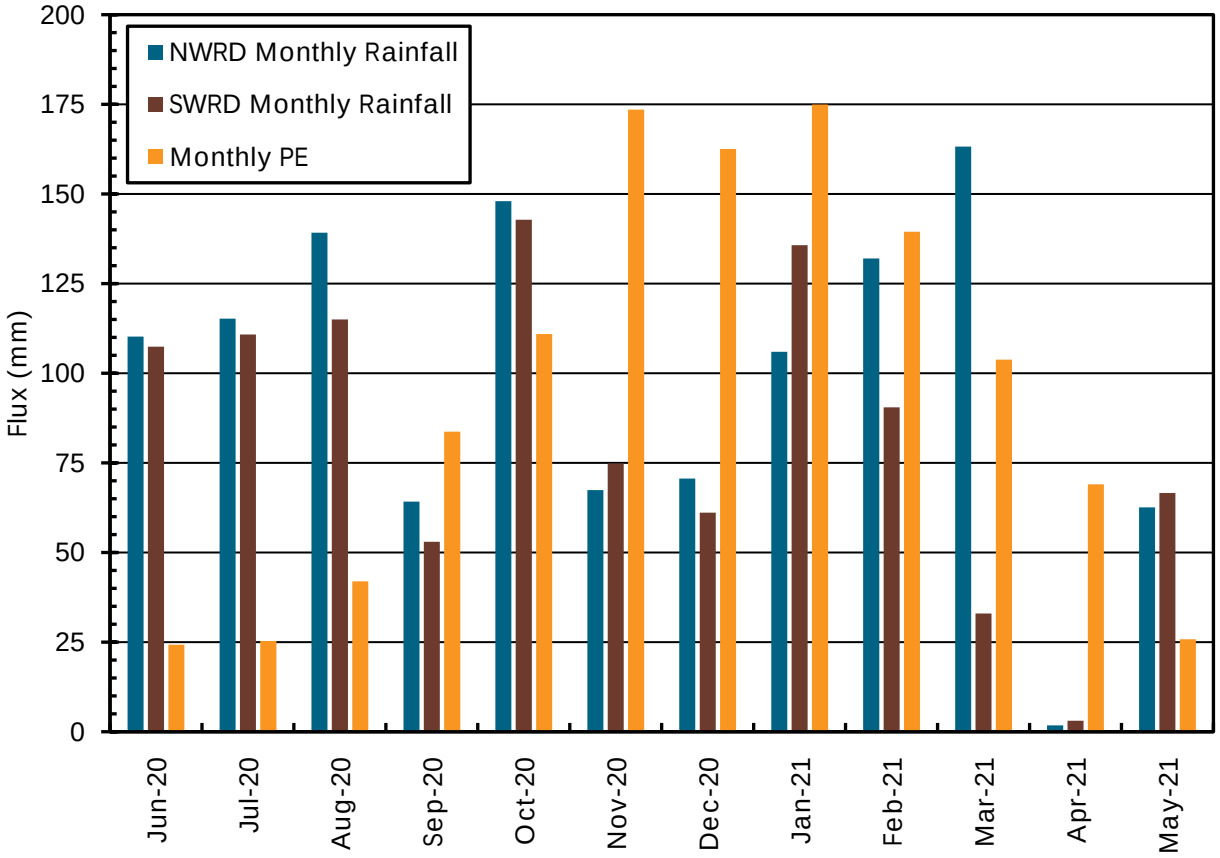

Figure 4: Comparison of Recorded Monthly Rainfall at SWRD and NWRD to calculated Evapotranspiration from the SWRD Meteorological Station.

In situ Temperature Conditions

In situ soil temperatures are continuously monitored throughout the year with a profile of Campbell Scientific Australia (CSA) Model 229 thermal conductivity (TC) sensors. Representative 2D contour temperature profiles for both the plateau area and slope were developed for the NWRD and SWRD during Year 7, shown in Figure 5 to Figure 8.

Seasonal temperature patterns dictate sensor nest readings based on ambient temperatures, with the highest and lowest temperatures recorded in summer and winter, respectively. Temperature effects are most strongly visible in the upper topsoil profile of the cover systems, which respond strongly to daily meteorology/radiative forcing. Deeper cover materials are insulted by the upper cover and contain much greater thermal mass and therefore the fluctuations are present on a longer timescale and generally only indicate seasonal effects.

Rainfall events are visible as significant high frequency cooling events in the upper cover system during the monitoring period. Temperature fluctuations within the PAF waste rock were minimal and did not exceed ambient conditions in either the NWRD or SWRD, indicating that internal heating at depth from oxidation is absent in the upper portions of the landforms monitored. The area blanked out in white in Figure 8 indicates a period with absent data.

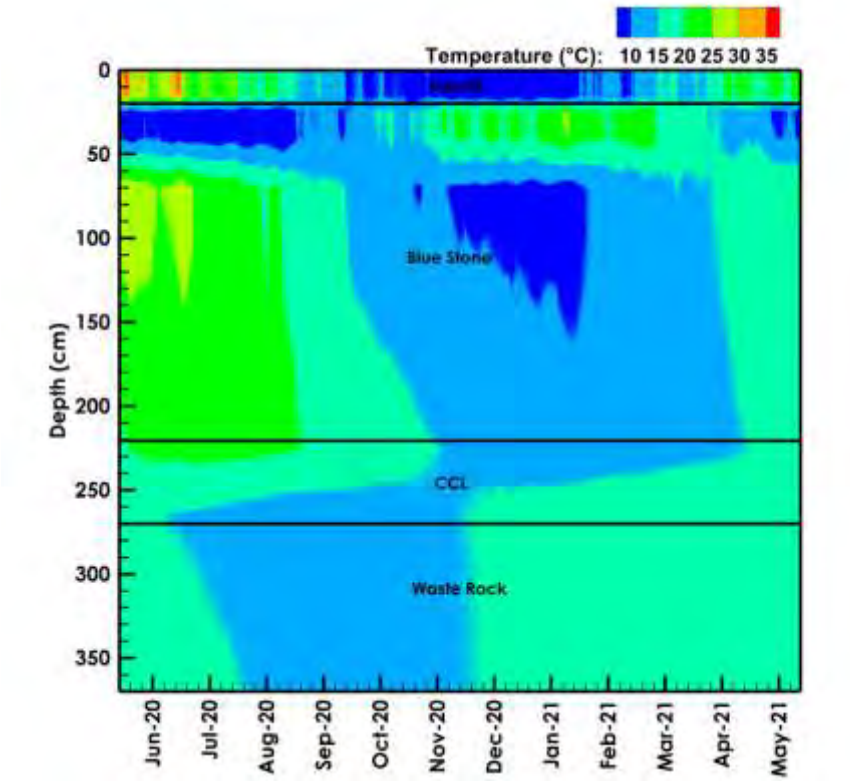

Figure 5: Monitoring Year 7 Temperature Profile at NWRD Primary 1

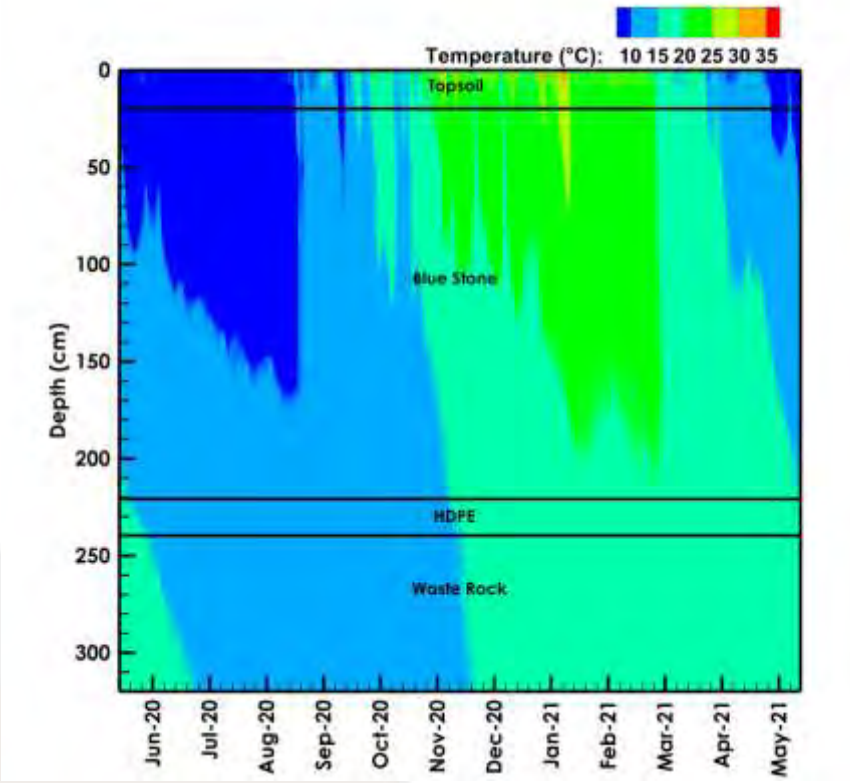

Figure 6: Monitoring Year 7 Temperature Profile at NWRD Primary 4

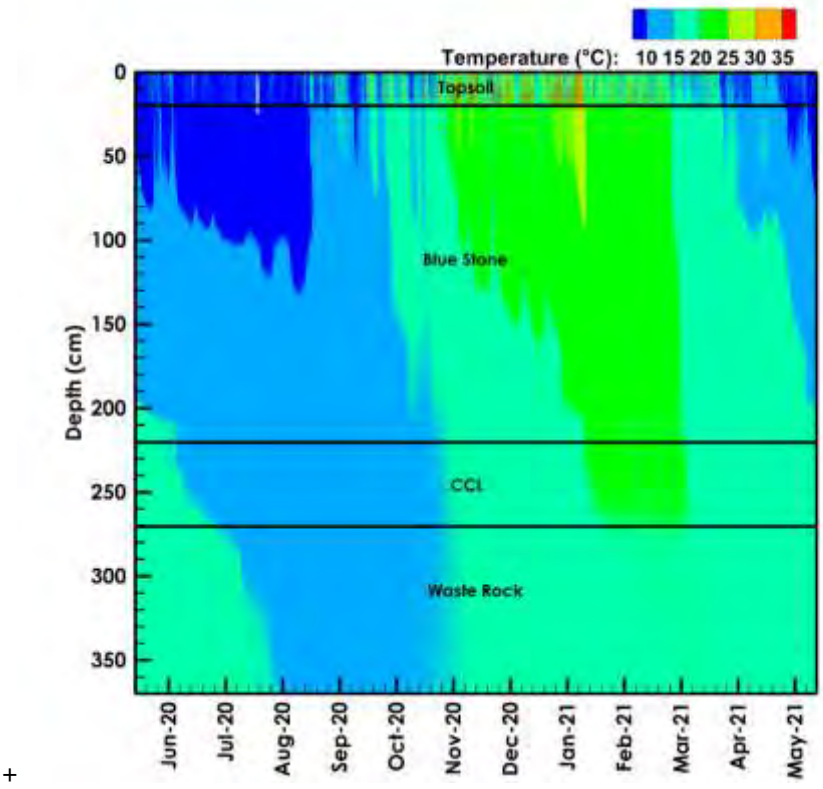

Figure 7: Monitoring Year 7 Temperature Profile at SWRD Primary 3

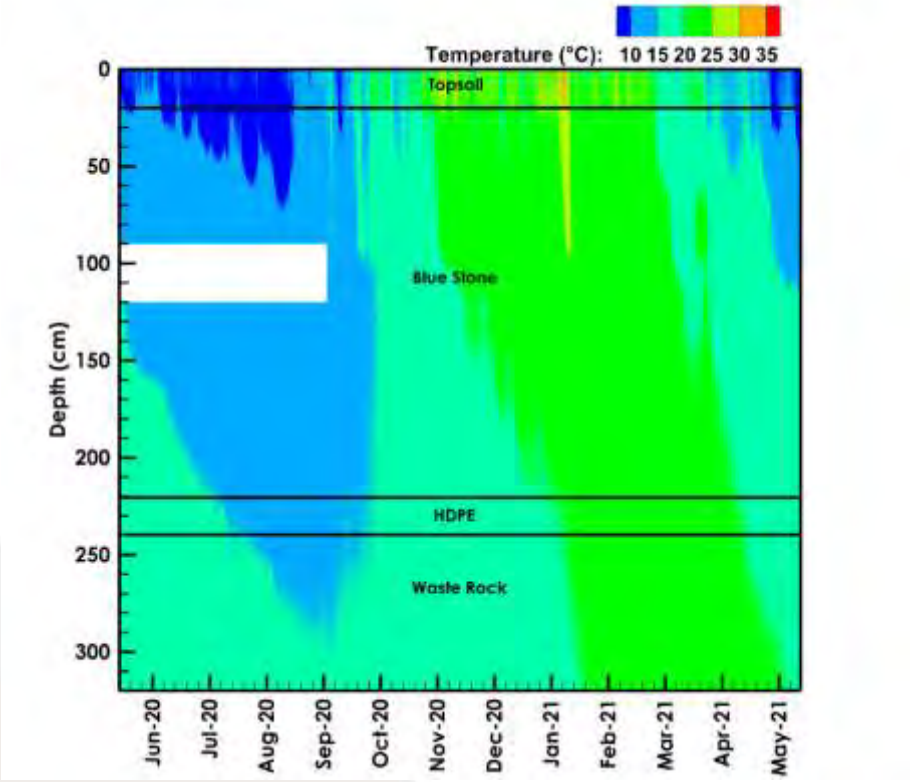

Figure 8: Monitoring Year 7 Temperature Profile at SWRD Primary 4

In situ Moisture Conditions

The *in situ* moisture conditions at each WRD cover system are continuously measured by CSA Model CS616 time domain reflectometry (TDR) and thermal conductivity (TC) sensors (indirect measurement of matric suction). Sensor nests were strategically positioned across the two WRDs to develop a thorough understanding for the cover system moisture regimes on temporal and spatial scale[13],[14]. Additionally, the plant available water capacity (PAWC) is defined as the available water for plants and vegetation in the cover system profile and is described by the following equation:

$$PAWC = FC - PWP$$

Field capacity (FC) can be defined as the volume of water measured at matric suction 33 kPa, and permanent wilting point (PWP), can be defined at the volume of water measured at matric suction 1500 kPa. When the stored moisture within the cover exceeds FC water will drain to the underlying waste rock before it can be fully utilised by vegetation or removed through evapotranspiration. In this scenario water is reported as net percolation (NP). Waterlogging may also result, impacting the success of vegetation growth. The health of vegetation is negatively affected when the PWP is reached. VWC within the bounds of both FC and PWP over the long term is ideal, which for the cover materials at NWRD and SWRD is approximately 91 mm and 175 mm, respectively.

Change in Water Storage

The volume of water stored within the cover profile at each primary monitoring location was estimated by dividing the cover system profile into multiple layers, each having a CS616 sensor at its centre. The total volume of water within the cover profile is calculated by summing the product of the of the VWC and its elemental thickness. The water volume was predominately between the PWP and FC during the summer months and exceeded the FC on occasion at all monitoring locations during the winter months with lower PE.

Fluctuations in stored water were similar across all monitoring sites and the range of fluctuation was also similar, as shown in Figure 9, 10 and 11. Due to the failure of the interflow monitoring system it is difficult to determine the exact impact of the above average rainfall on interflow.

[13] O'Kane Consultants Pty Ltd. 2013. Cadia Valley Operations – Record of Construction Report for the North Waste Rock Dump Cover System Field Trials. Reference 715/6. August.

[14] O'Kane Consultants Pty Ltd. 2014. Newcrest Mining – Record of Installation Report for the Cadia Valley Operations South Waste Rock Dump Field Performance Monitoring System. Reference 715/11. May.

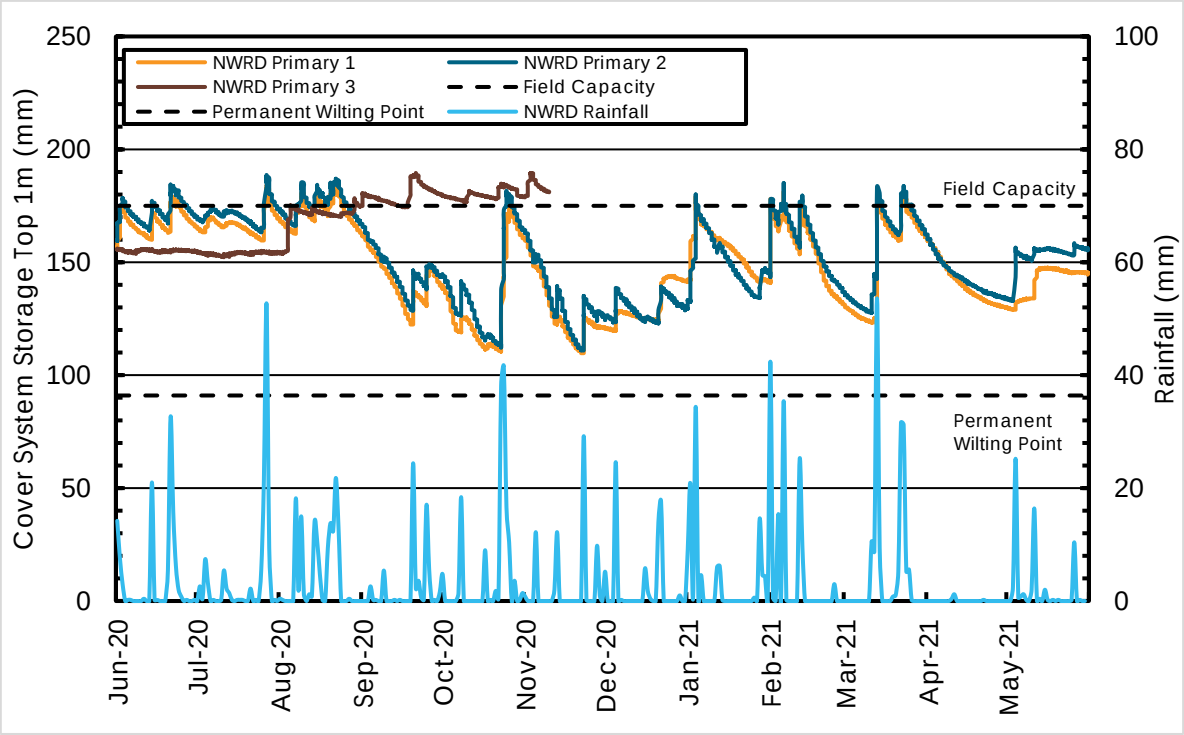

Figure 9: Total Stored Water in Upper 1 m of SWRD Plateau for Year 7

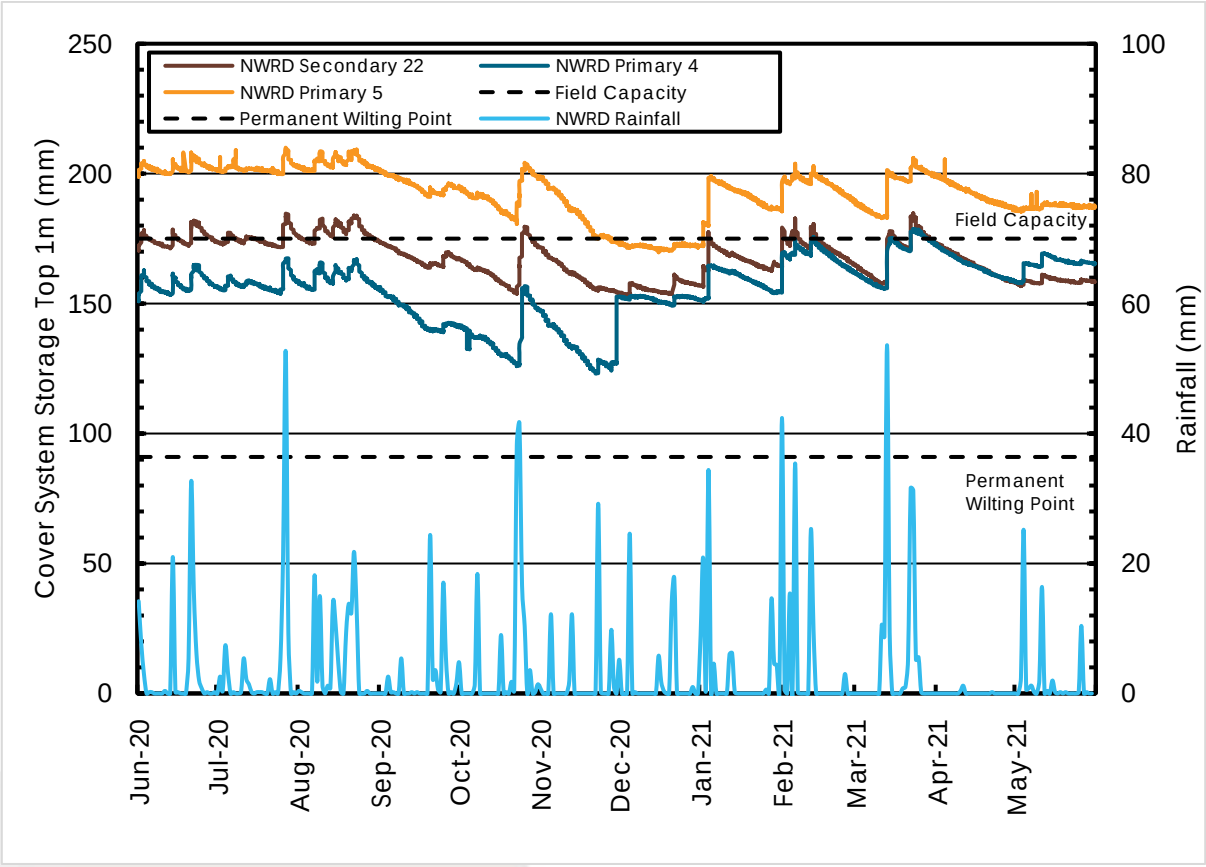

Figure 10: Total Stored Water in Upper 1 m of SWRD Slope for Year 7

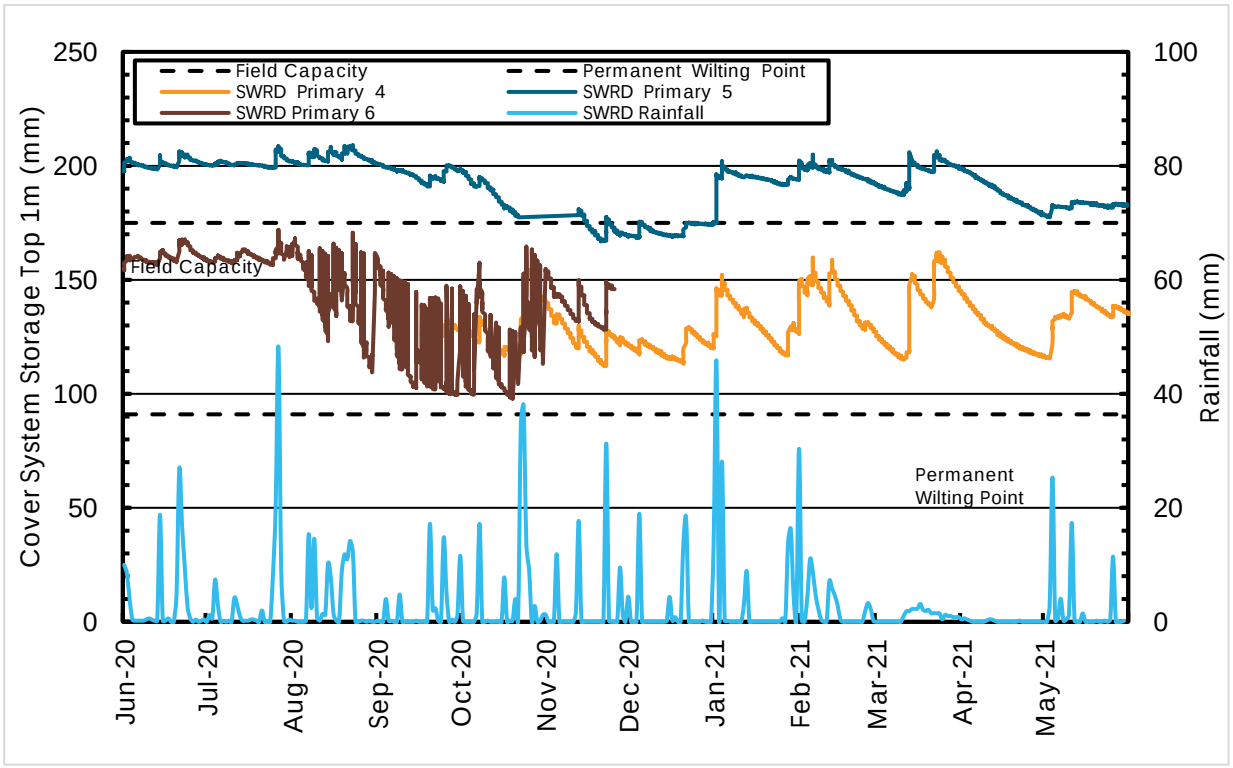

Figure 11: Total Stored Water in Upper 1 m of NWRD Plateau for Year 7

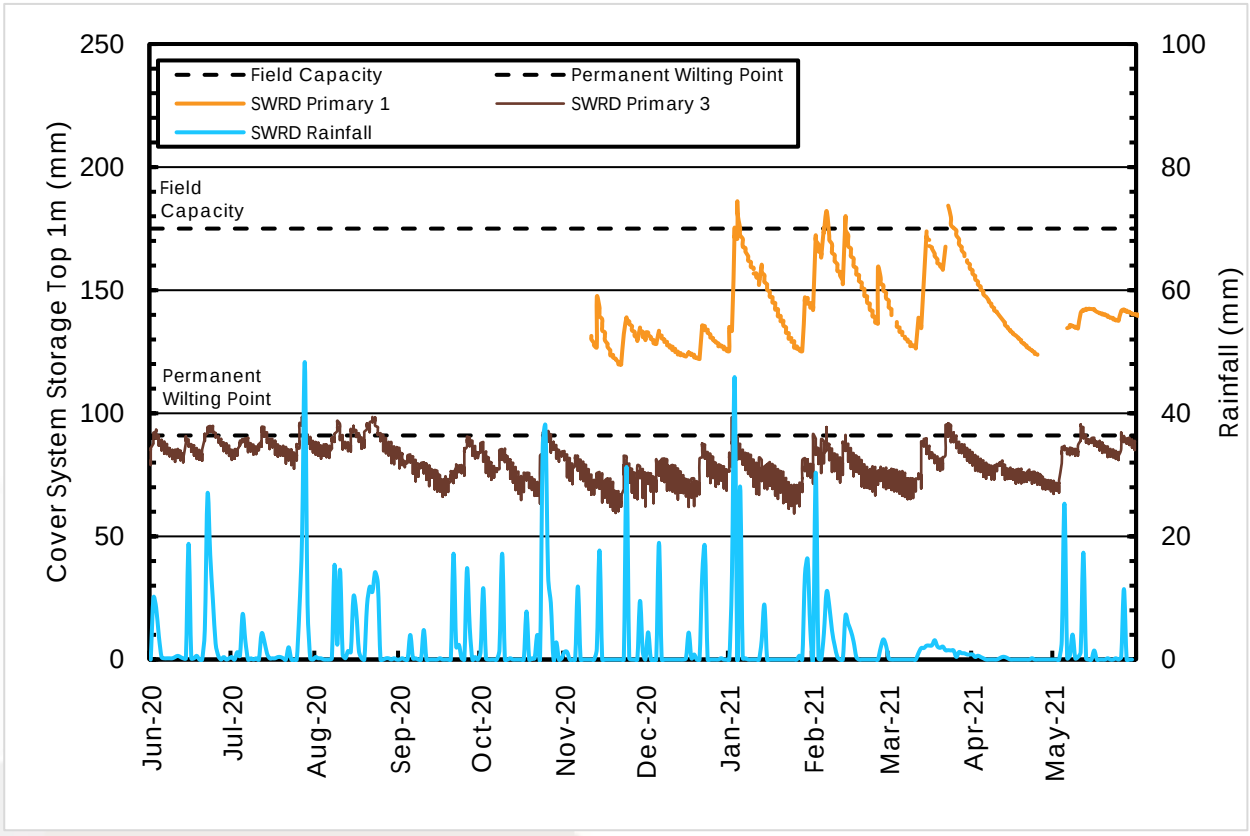

Figure 12: Total Stored Water in Upper 1 m of SWRD Slope for Year 7

Volumetric Water Content

VWC was recorded using CS 616 sensors for the duration of the Year 7 monitoring period. 2D contour plots were constructed using the measured data for both the NWRD and SWRD, shown in Figure 13 to Figure 16. Within the NWRD plateau the driest layer was the bluestone, while the wettest layer, with the greatest VWC was the CCL, as would be expected due to their respective permeabilities. Significant rainfall events are shown to result in increased VWC within the topsoil and shallow sections of the bluestone. Constant high VWC was maintained for the duration of the monitoring period within the CCL, with a constant, though slightly lower VWC also measured in the waste rock. The NWRD slope, which utilises a HDPE liner, recorded a lower VWC than the NWRD plateau in all layers, with only the bluestone layer experiencing a greater degree of seasonal variability between the NWRD plateau and slope.

At the SWRD, the CCL layer had the largest VWC in comparison to the other layers within the cover system for both the plateau and slope. Within the SWRD slope the increased moisture resulting from significant rainfall events can be seen to penetrate up to depths of 1 m, below this depth the VWC is relatively constant through the Year 7 period, with only minor fluctuation in the bluestone material. The thicker CCL layer within the slope may have resulted in lower VWC values in the waste rock. Areas of white in the following figures indicate absent data.

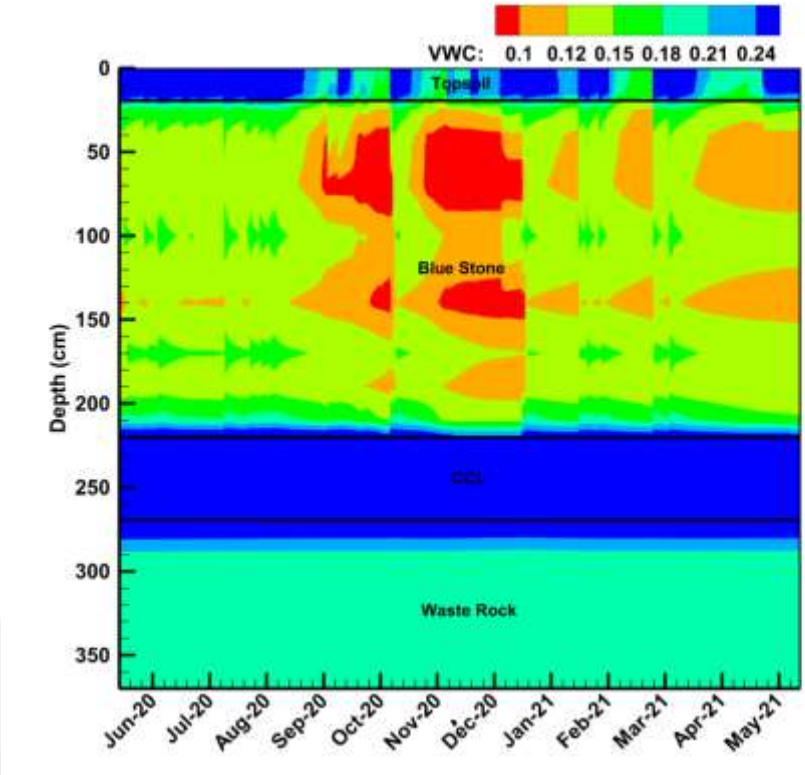

Figure 13: VWC Measured at the NWRD Primary Station 1 for Monitoring Year 7

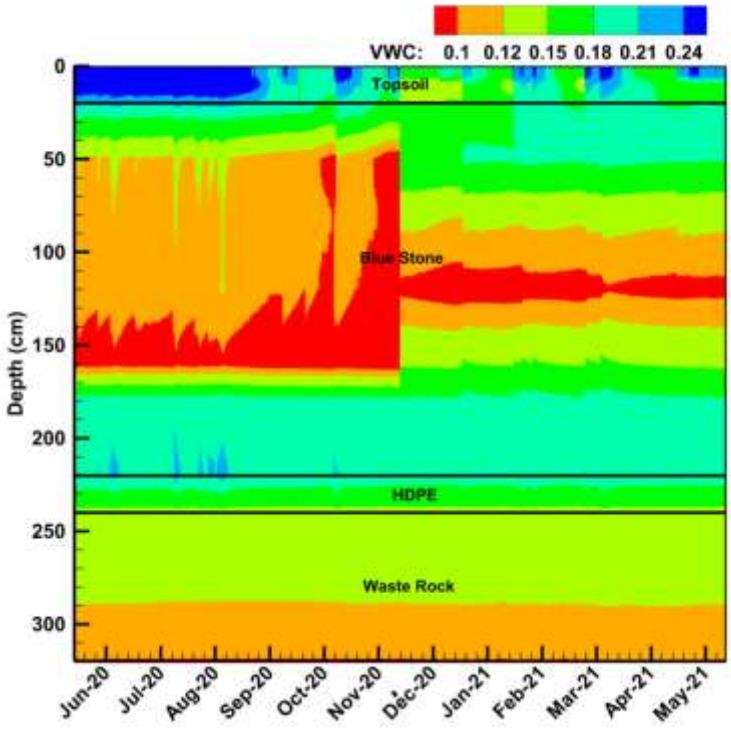

Figure 14: VWC Measured at the NWRD Primary Station 4 for Monitoring Year 7

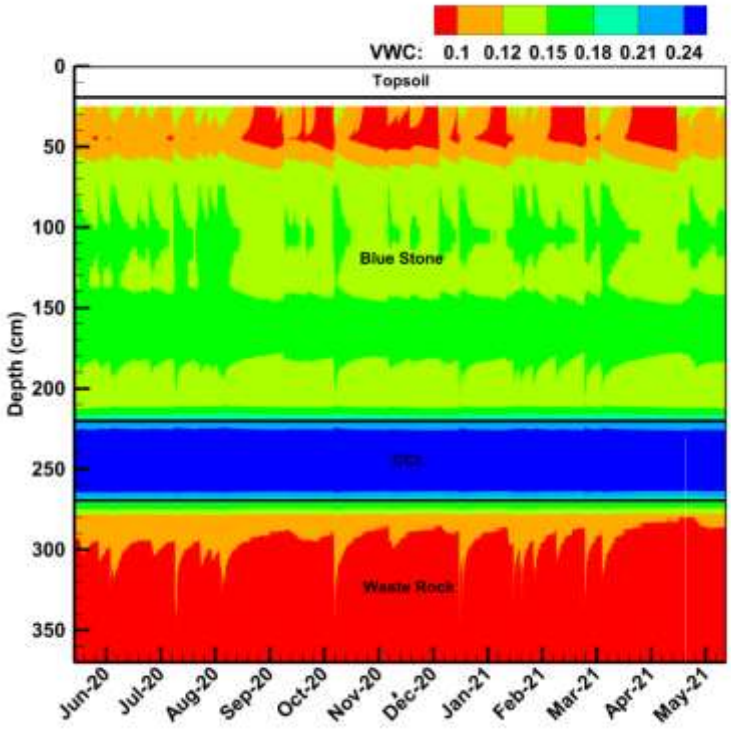

Figure 15: VWC Measured at the SWRD Primary Station 3 for Monitoring Year 7

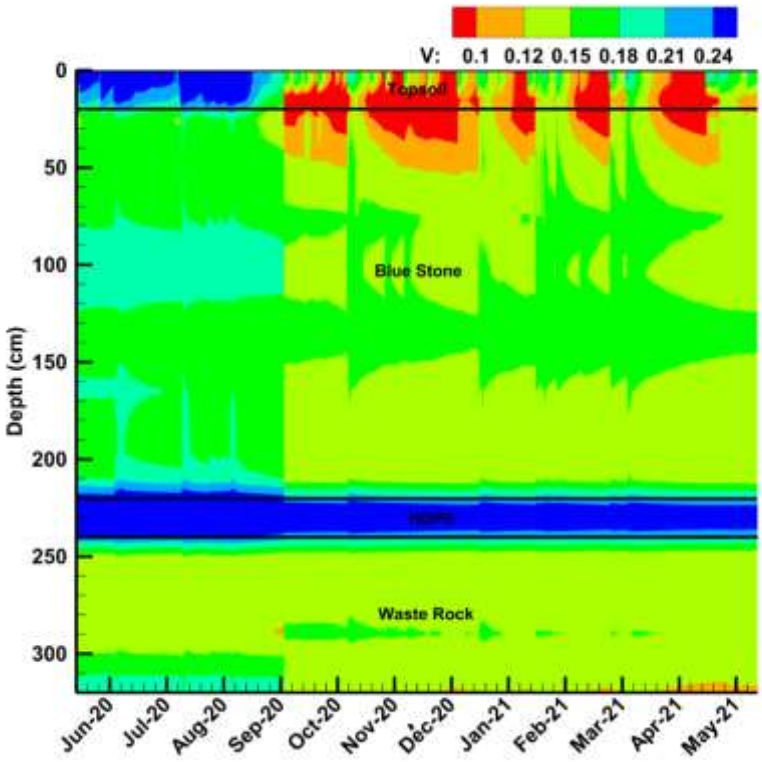

Figure 16: VWC Measured at the SWRD Primary Station 3 for Monitoring Year 7

Matric Suction

Measurement of matric suction is used to assist with monitoring and interpretation of flow patterns within the cover system field trials. The direction and magnitude of flow gradients can be measured with the nests of CS 229 TC sensors installed throughout the profile depth. 2D suction contour plots of the cover system and waste rock for the NWRD and SWRD, plateau and slope are shown in Figure 17 to Figure 20.

Matric suction was most variable and reached the maximum values within the topsoil layer and the upper 0.5 m of the cover system. Strong seasonal drying patterns are reflected in the cover systems with increasing suction to 2. m reported during the warm drier period of September to January at the SWRD and NWRD plateaus. This impact was less pronounced at the slopes where increased suction was generally confined to the active area shallower than 0.5 m.

In Okane's experience where root depth is shallow (<0.5 m) moisture cycling depth is generally 0.5 m to 1.0 m with water stored below this depth reporting as net percolation through the bottom of the cover system.

The matric suction combined with the VWC content results indicate that stored water below approximately 1.5 m will report as net percolation. During the previous monitoring period (Year 6), deep suction decreases were generally not linked to shallower suction decreasing, indicating suction decrease through the loss of water to NP. However, as a result of higher annual rainfall during the

Year 7 monitoring period, this trend was not as noticeable as suction remained low at depth for much of the year.

Within the NWRD slope the impact of the HDPE is evident with increased suction within the waste rock in comparison to the bluestone layer, located above the HDPE. Matric suction results for monitoring Year 7 are consistent with the VWC results, with suction decreasing as volumetric content increases.

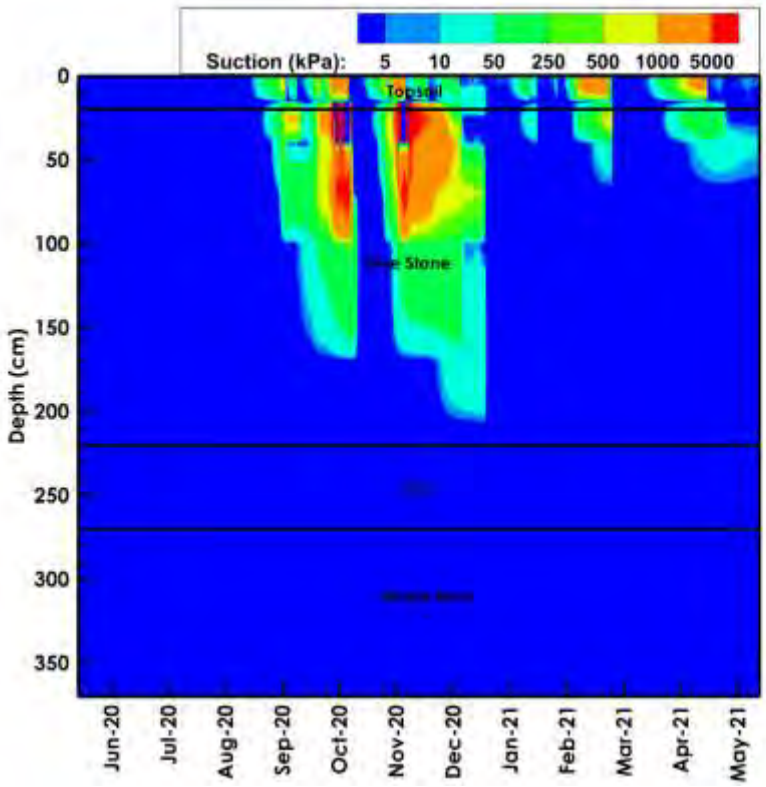

Figure 17: Soil Suction Measured at the NWRD Primary Station 1 for Monitoring Year 7

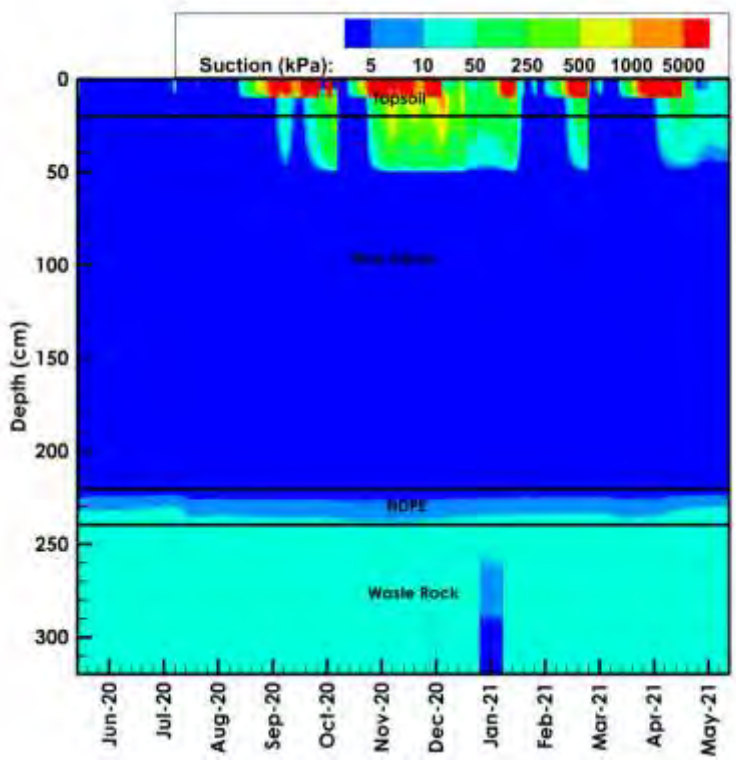

Figure 18: Soil Suction Measured at the NWRD Primary Station 4 for Monitoring Year 7

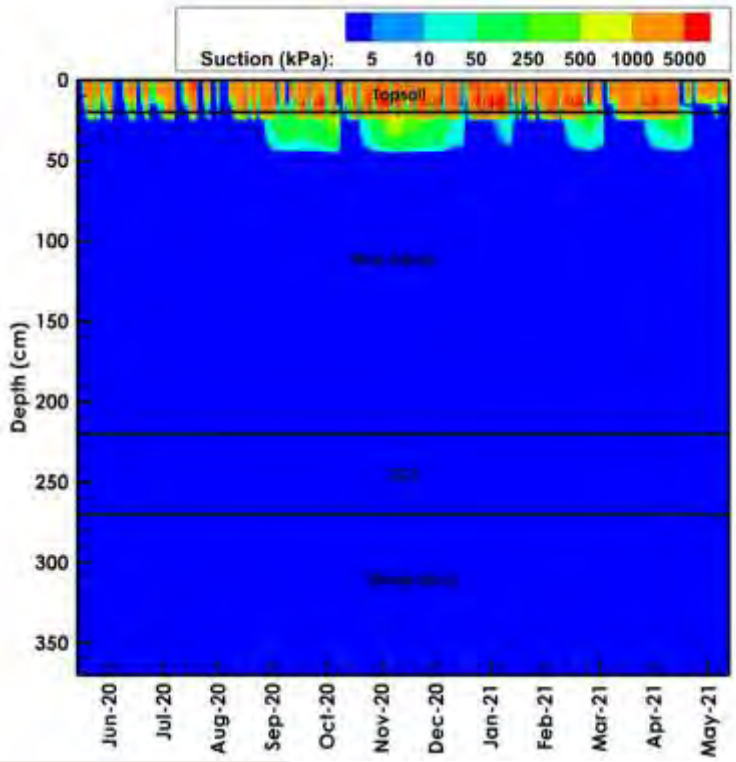

Figure 19: Soil Suction Measured at the SWRD Primary Station 3 for Monitoring Year 7

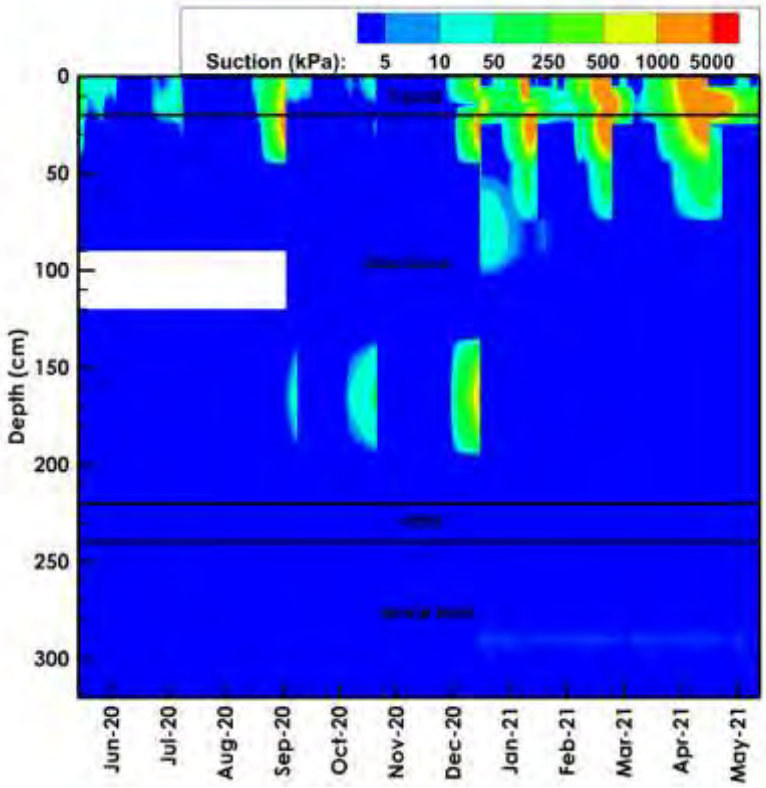

Figure 20: Soil Suction Measured at the SWRD Primary Station 4 for Monitoring Year 7

Water Balance

A water balance was completed for both the NWRD and SWRD at each location within the cover system for the Year 7 monitoring period. This was accomplished using collected performance monitoring data from site. The water balance equation utilised for a cover system comprises the following components:

$$R = RO + AET + NP + \Delta S$$

Whereby R is rainfall (mm), RO is runoff (mm), AET is actual evapotranspiration (mm), NP is net percolation (mm) and ΔS the change in cover water storage (mm). AET was back calculated using measured water storage in the cover system, while NP was calculated through an analytical method and understanding of field capacity developed for the cover system. Ratios of AET versus PE were developed based on water volumes within the cover profile and RO was estimated based on rainfall intensity. The remaining values involved the use of recorded rainfall and matric suction data from on site to determine the change in water storage.

The water balances over the monitoring period Year 7 are shown in Figure 21 and Figure 22 for the NWRD and SWRD plateaus, respectively. Figures 23 and 24 show the NWRD and SWRD slopes, respectively. The results for both the NWRD and SWRD plateau show that the measured change in storage results varied by a small quantity from the calculated change in storage results, with the discrepancies occurring during significant rainfall events.

For both the NWRD and SWRD plateau, water storage was impacted by significant rainfall events, the largest being on 13 March 2021 (54 mm). Over a four-day period between 11 and 14 March, 82 mm of rainfall resulted in a large increase of water storage, the largest of which was 49 mm at the NWRD Primary 1 station in the top 1 m. A gradual decline in water held followed this sharp spike in water storage within the cover profile during the subsequent drier period as moisture was removed through both evapotranspiration and NP.

As previously mentioned, a considerable difference in rainfall of 16% was measured between the NWRD and SWRD TBRGs during the Year 7 monitoring period compared with a 2% difference during Year 6. However, despite this difference trends were similar between both years, albeit with slightly higher percentages in terms of AET, NP, and runoff were measured during year 7. The similarity between the NWRD and SWRD TBRGs was more apparent during the first half of the monitoring period, suggesting that the variation can either be attributed to highly isolated rainfall, or inaccuracies related to either of the TBRG increasing during the second half of the monitoring period. Should this variability continue through the Year 8 monitoring period, Okane would recommend each unit is calibrated to improve accuracy. Hourly rainfall data was compared with daily rainfall to verify that this variation was in-fact being recorded by the TBRG and not simply an issue with the daily download template. A summary of water balance parameters including rainfall is provided in Table 4.

AET was the largest contributor to water balance, ranging between 60% and 66%. Plateau stations ranged between 62% and 66% for the NWRD and SWRD, respectively, and slope stations ranged between 60% and 62% for the SWRD and NWRD, respectively. As expected, the SWRD plateau features the greatest vegetation density, hence measures the greatest AEP. Collectively, AEP was greater at the four stations during the Year 7 monitoring period relative to the Year 6 monitoring period, consistent with the increased vegetation density in Year 7.

NP accounted for approximately 27% at the NWRD plateau and 22% at the SWRD plateau, and 20% and 22% at the NWRD and SWRD slopes, respectively. These values are marginally higher than those measured during the Year 6 monitoring period, though still conform with expected trends. NP is presented herein as a percentage of rainfall for the NWRD and SWRD. Where the HDPE liner has been utilised the 'NP' will likely result in interflow along the surface of the HDPE liner, suction and VWC results do not indicate any changes over the monitoring period below the HDPE liner due to NP effects.

Table 4: Water Balance Parameters

Station	Precipitation	NP	AET	Runoff
NWRD Primary 1	1181 mm	321 mm (27%)	739 mm (62%)	126 mm (11%)
NWRD Primary 5	1181 mm	238 mm (20%)	734 mm (62%)	221 mm (19%)
SWRD Primary 3	994 mm	223 mm (22%)	593 mm (60%)	163 mm (16%)
SWRD Primary 4	651 mm*	144 mm (22%)	429 mm (66%)	71 mm (11%)

*100% of rainfall was recorded at SWRD P4; however, has been adjusted to reflect the incomplete soil monitoring dataset.

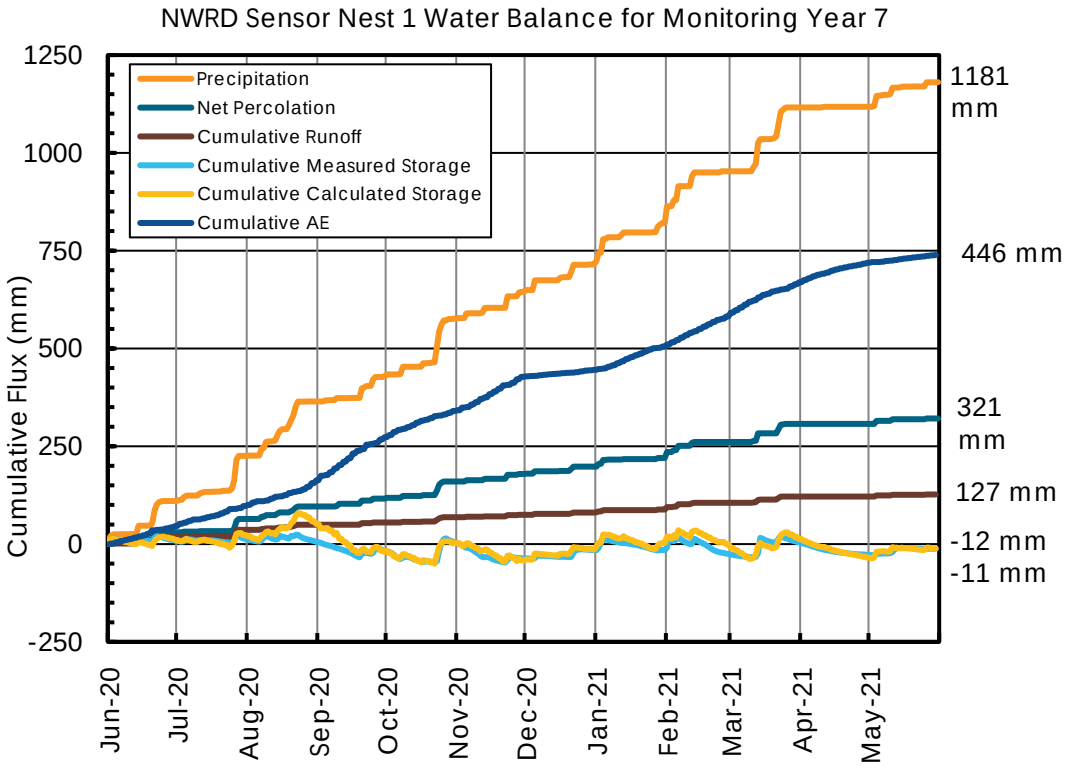

Figure 21: Water Balance for NWRD Primary 1 (Plateau) for Monitoring Year 7.

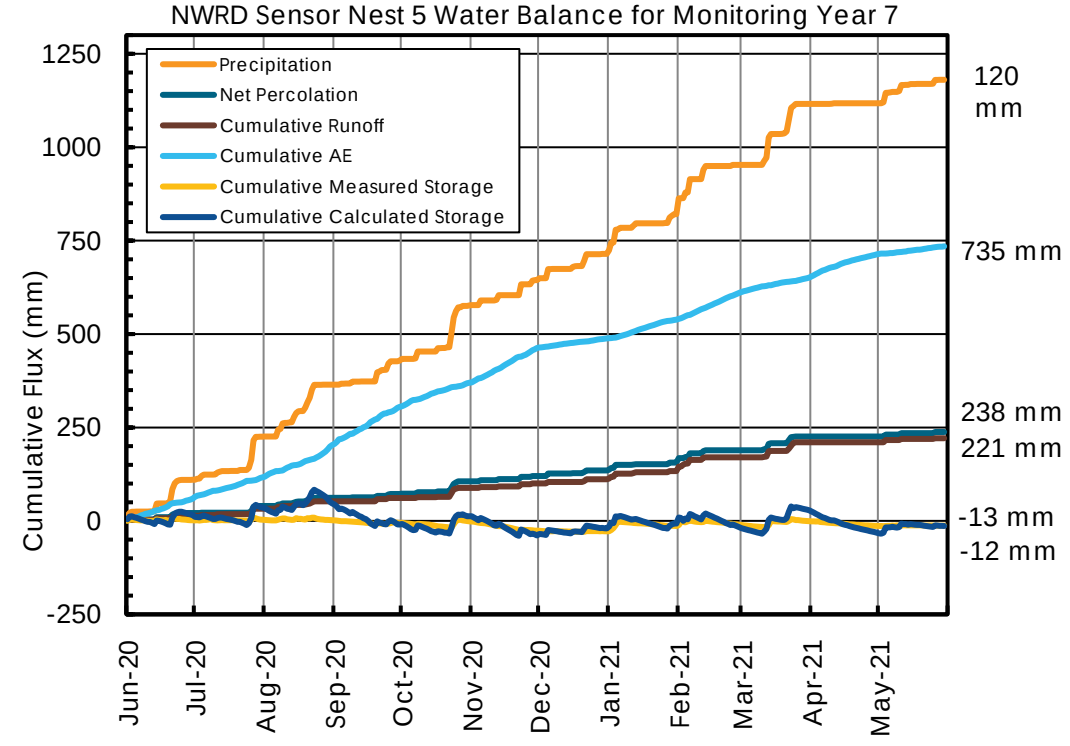

Figure 22: Water Balance for NWRD Primary 5 (Slope) for Monitoring Year 7

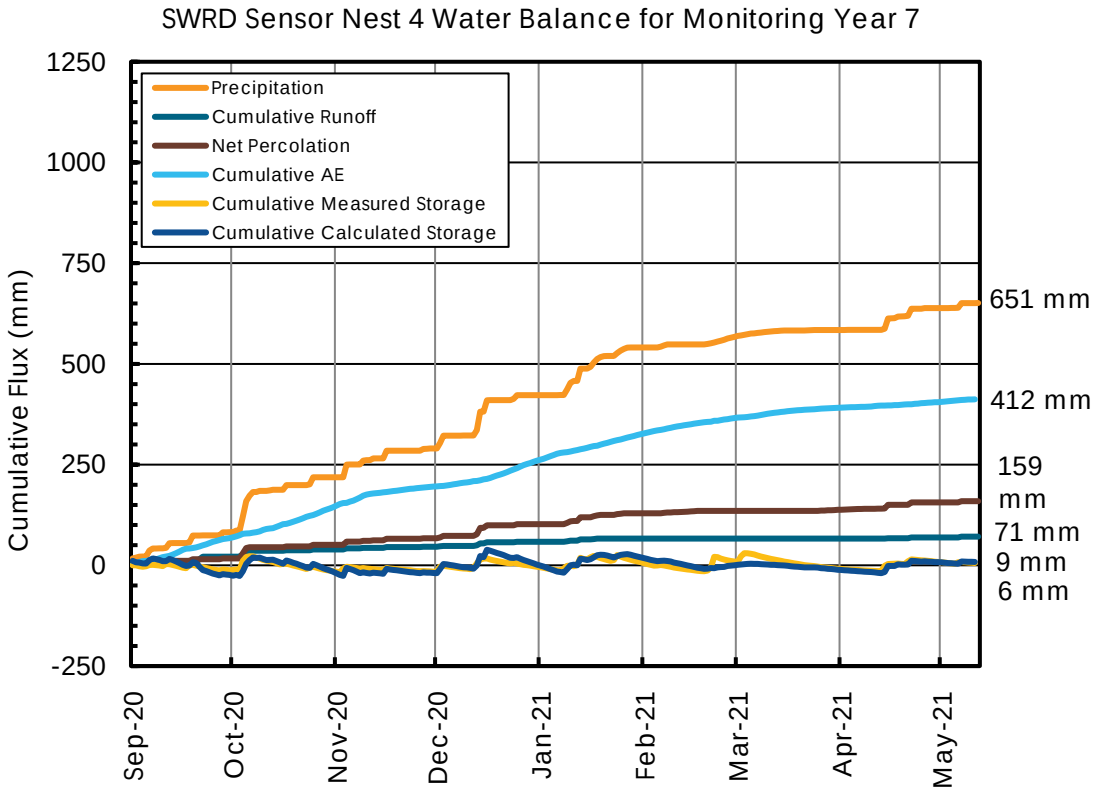

Figure 23: Water Balance for SWRD Primary 4 (Plateau) for Monitoring Year 7

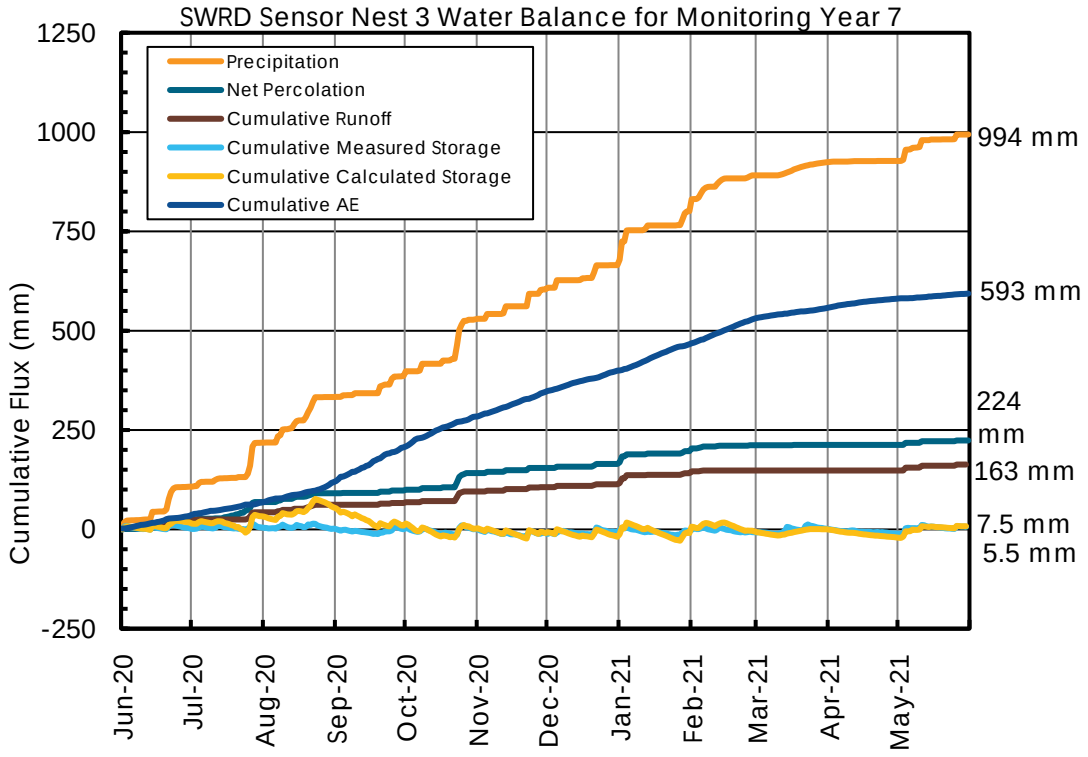

Figure 24: Water Balance for SWRD Primary 3 (Slope) for Monitoring Year 7

Cover System Performance and Recommendations

Over time cover systems are constantly evolving, responding to specific chemical, physical and biological processes that occur and are unique to each system. When evaluating their effectiveness site trials provide invaluable information that can be used to assess performance and ensure that the site-specific criteria are met. Comprehensive quantitative analysis of these processes on cover systems will result in more complete and defensible closure plans that reduce uncertainty related to long-term performance.

Estimated NP was higher during the Year 7 monitoring period relative to the Year 6 monitoring period due to considerably higher rainfall, and some erosion to the NWRD and SWRD slopes likely contributing to increased NP by providing preferential pathways through which moisture can infiltrate the profile.

The maturing plant community successfully contributed to water removal via transpiration and is expected to continue to improve as the cover system matures. Increased vegetation density at the NWRD plateau in particular, during the Year 7 monitoring period, likely positively impact AET in this area. From examination of data collected since the onset of monitoring, performance of the cover system (based on NP rates) is comparable to the predicted results from numerical modelling analysis[15].

The conceptual model for the CVO NWRD and SWRD cover systems remains unchanged from that developed during the numerical modelling program based on its performance over the seven monitoring years. NP values may change in future monitoring years as the cover system continues to evolve, and as plant densities, leaf areas, and sizes continue increasing into a more mature community, responding to climate conditions that naturally vary over time.

Cover System Criteria

The data set measured since the onset of monitoring provides valuable information on cover system performance over varying conditions, including both below and above average rainfall years. Although there are now seven years of data available, Okane recommends continued monitoring to capture long-term abiotic and biotic temporal and spatial variability. Moreover, the development of the plant community could be assessed over time through surveys and monitoring to quantify actual plant cover, density, species and root depths/distributions.

Compliance with implementation of agreed engineering designs or closure plans should not be considered as having met the closure requirements as the design may not necessarily result in the required rehabilitation outcome. Improved understanding of the likely long-term performance for the WRDs will help CVO to determine appropriate closure criteria. Results of a field response

[15] O'Kane Consultants. 2008. Evaluation of Cover Systems Designs and Monitoring Proposed for the North Waste Rock Dump at Cadia Valley Operations. Report No. 715/1-01. Submitted to Newcrest Mining Ltd. June 2008.

modelling program would also be evaluated in the context of meeting appropriate closure criteria, where the design limits NP to appropriate levels.

Recommendations

Both the NWRD and SWRD cover systems performed as anticipated during the Year 7 monitoring period. Okane recommends that data collection and interpretation continue as per the best practice guidelines outlined in the International Network for Acid Prevention (INAP) Global Cover System Guidance Document[16]. This monitoring period will allow for assessment of the cover systems response to climate variations within a broader context, capture more frequent climate cycles, and capture cover material evolution in the years after placement, providing greater confidence in the cover system performance. Following completion and analysis of the data concerning the Year 7 monitoring period Okane has provided the following key recommendations to maximise the potential benefit of the cover system field trials, including the quality and applicability of data generated:

- The EC system should be inspected at least twice yearly to ensure water levels in the four batteries are high enough to maintain functionality of the system. Batteries should be replaced as required.
- Vegetation in close proximity to monitoring stations should be trimmed to prevent solar panels from being obscured. P6 at the SWRD is the most likely station to be impact by vegetation due to the height and density of branches in this section of the SWRD plateau; however, all stations at the SWRD and to a lesser extent the NWRD, may be impacted by encroaching vegetation.
- TBFG enclosures at both the SWRD and NWRD should be inspected following large rainfall events to ensure free drainage is maintained, and to remove sediment and debris as required.
- Qualified Okane personnel should visit the site for a minimum of two days at least annually for the purposes of inspecting the cover system trials and instrumentation. The Year 7 site visit occurred in May 2021, and another site visit is proposed for the Year 8 monitoring period during the Autumn/Winter of 2022. This visit will include yearly servicing and calibration of all relevant sensors and equipment in addition to *in situ* permeability testing.
- Okane continues monitoring the field trials in a similar capacity to build on the large dataset as per INAP 2017 guidelines. Monitoring the cover systems over a larger timeframe will lead to improved data quality and greater confidence, helping to support mine closure decisions and ongoing planning.
- Erosion at the NWRD and SWRD surface was noted during the Year 7 and previous site visits, most notably along the slopes. Erosion should be monitored prior to, during and following prolonged

[16] International Network for Acid Prevention (INAP). 2017. Global Cover System Design – Technical Guidance Document. Prepared by O'Kane Consultants Inc. for INAP. March 2017.

or intense rainfall events to ensure the cover system is not comprised. Furthermore, Okane advises that any activities that could potentially compromise the condition of the cover system should be minimised.

- To increase understanding of actual vegetation effects on performance and further improve establishment success Okane would like to undertake vegetation surveys and implement plant monitoring. Surveys and monitoring would quantify actual plant cover, density, species, root depth/distribution, including aspects of plant ecophysiology. Vegetation parameters could then be used in conjunction with cover monitoring data to accurately assess water movement within the covers, and further partition the water balance by separating evapotranspiration into its respective components (evaporation and transpiration). Using this combined information, the amount of water being removed by vegetation, the depths at which is it removed, and at what soil water pressures (suctions) can be determined.

Please do not hesitate to contact me at (07) 3367 8063 or rbraun@okc-sk.com should you have any questions or comments.

Ryn Braun,
Geoscientist
rbraun@okc-sk.com