Newcrest Mining Limited

CVO AEMR - Surface and Groundwater Assessment Report

September 2020

Executive summary

GHD Pty Ltd were engaged by Cadia Holdings Pty Limited (CHPL) to undertake an assessment of surface water quality, groundwater quality and groundwater levels to meet internal and annual reporting requirements for the 2019-2020 reporting period.

Surface and groundwater quality data and groundwater level data 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.

Ridgeway area

The majority of the groundwater level monitoring bores showed declining trends between May 2019 and November 2019, which were consistent with the Cumulative Rainfall Departure (CRD) curve. Groundwater levels then increased between November 2019 and June 2020 in accordance with the increasing CRD over this period. Water levels at monitoring bores in the Ridgeway area have not reached the trigger levels in the Water Management Plan (WMP), which was last revised in 2019.

Upper Cadiagullong 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, 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 TSS.

The groundwater level at a monitoring bore located in the immediate vicinity of the pit, MB95, showed an increasing trend similar to the pit water level, indicating ongoing connection between pit water and groundwater at the site. Arsenic, molybdenum and nickel concentrations were elevated in the pit decant water and were either elevated or increasing at the nearby bore. The assessment found that it is likely that seepage from the pit is influencing localised groundwater. However, since the hydraulic gradient is generally towards the pit, it is unlikely that decant water is influencing groundwater at greater distances from the pit. Monitoring bore MB95 was inundated by tailings in May 2020. Two replacement monitoring bores are planned for construction in July 2020.

Ore Processing area

Water quality trends at the Site Runoff Pond (SROP) were observed, including an increasing trend in nitrogen oxides, copper and major cation concentrations. These trends were not of concern as the SROP is a zero discharge stormwater runoff dam, where poor water quality is expected. There was no evidence that the ore processing area has influenced water quality in Cadiangullong Creek downstream of the area.

The groundwater levels within the Ore Processing Area showed generally stable trends. Groundwater quality data did not indicate that seepage was occurring from the SROP into the surrounding aquifer.

Waste rock dumps

The assessment indicated that the waste rock dump leachate is becoming more dilute over time, with decreasing trends observed for multiple parameters, including EC, nitrogen oxides and heavy metals.

For the reporting period, the majority of bores within the Waste Rock Dump area reflected trends in the CRD with groundwater levels generally decreasing until November 2019 in accordance with the below average rainfall, and then increasing for the remainder of the monitoring period in response to periods of above avergage rainall. Three bores showed increasing trends during the monitoring period despite variability in CRD, although levels did not increase beyond the historical range. Continued monitoring of these bores will confirm trends in groundwater levels.

The waste rock dump leachate contains very high concentrations of nitrogen oxides, however no elevated or increasing concentrations of nitrogen oxides were observed in the groundwater. Elevated concentrations of metals, including cadmium, cobalt, copper, manganese, molybdenum, nickel, selenium and zinc, were observed in the leachate dams. A historical increasing trend in molybdenum was observed at one bore, which may indicate that leachate from the waste rock dumps may be having a localised influence on groundwater at the site. However, major ion analysis does not indicate an increasing influence of waste rock dump leachate on local groundwater during the reporting period. There was no indication of any impact of leachate from the waste rock dumps on water quality in the receiving environment of Cadiangullong Creek.

Cadia East

Groundwater levels at a number of the monitoring bores in the Cadia East zone showed trends in groundwater level that reflected the CRD. Some bores showed an increase in groundwater levels during the reporting period, which was attributed to localised recharge resulting from non-mining land use activities.

Statistical analysis of groundwater level hydrographs indicated a number of significant temporal trends, where drawdown was likely to be influenced by non-mining activities such as the pine plantations in addition to the histoical declining CRD.

Tailings Storage Facilities (TSFs)

Eastern Zone

The analysis of the TSF eastern zone data indicated that the concentrations of nitrogen oxides in the tailings decant water have been generally decreasing across the period of monitoring. 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 or on groundwater.

For the reporting period all monitoring bores in the TSF eastern zone showed trends in groundwater levels consistent with the CRD, with groundwater levels decreasing during the monitoring period until January 2020 and groundwater levels generally increasing throughout the remainder of the monitoring period. The exception to this is MB69 and MB80 where groundwater levels were relatively steady despite the variability in CRD. No influence of TSF decant water on groundwater in this zone is evident.

Western Zone

Possible influence of TSF decant water or drainage from the TSF embankments (which were constructed with waste rock) is evident at some sediment dams and seepages along the western side of the TSFs. This was indicated by elevated molybdenum concentrations at these sites. There was no indication that seepage from the TSFs is influencing water quality in Cadiangullong Creek.

Monitoring bores MB18, MB24 and MB23 are located to the west of the NTSF. All three bores show a similar increasing trend in water levels since monitoring began, and a declining trend after February 2017. Previous assessments of these trends concluded that the most likely cause of groundwater level increase in this area was the physical changes to groundwater flow and hydrogeological properties caused by the bulk mass of the TSFs. The load of the TSFs may be compressing the aquifers beneath their footprints, resulting in increased groundwater levels to the west.

While it appears that there has been an influence of tailings decant water or drainage from waste rock at a particular seepage and two dams to the west of the TSFs, this influence appears to be limited spatially, and to surface waters only, as the trends in groundwater levels and quality are more likely attributable to the influence of the bulk mass of the TSFs on the aquifer.

Southern Zone

The influence of TSF decant water on sites south of the STSF is evidenced by elevated nitrogen oxide and molybdenum concentrations at sites directly south of the STSF. This influence is greatest in the seepage collection dam, which appears to be limiting the influence of TSF decant water at sites downstream of the dam. The influence of TSF decant water is evident in the tributary closest to Panuara Road, but less so at the other sites in the Rodds Creek tributaries south of Panuara Road and in Rodds Creek itself. This influence appears to be spatially limited as lower concentrations of these parameters decrease to background levels at sites further downstream in Rodds Creek and Cadiangullong Creek.

No influence of seepage from the STSF on water quality was evident in the receiving environment at site 412702 on Cadiangullong Creek, based on the monitoring records for key parameters associated with the TSF decant water, including nitrogen oxides, molybdenum, and the ratios of major ions.

Molybdenum concentrations are generally elevated in the TSF decant ponds, though similar concentrations have not been observed in the groundwater at any of the monitoring bores.

The assessment found that the influence of tailings dam water on surface water and groundwater in the TSF southern zone is localised in extent, and for groundwater appears to affect only shallow bores. No change in TSF decant water influence to the south of the STSF is evident during the 2019-20 reporting period.

Dewatering facilities

Blayney Dewatering Facility

The Blayney Dewatering Facility was in care and maintenance for the first half of 2019-2020. Demolition of the facility occurred between March and April 2020. Remediation works on the site are ongoing for handover to the site owner.

Variability in water quality parameters is generally observed at both sites, though some spatial trends are apparent, such as copper concentrations generally being higher at the downstream of the two monitoring sites, and manganese and iron concentrations higher at upstream site. Following the conclusion of operations at the Blayney Dewatering Facility copper concentrations have generally reduced, though historical drought conditions have resulted in elevated copper concentrations at the downstream site, which were likely associated with historical contamination at the site.

Cadia Dewatering Facility

The potential influence of the Cadia dewatering facility has been observed based on elevated concentrations of copper and molybdenum at the monitoring sites within close proximity of the facility. There has been no impact on the concentrations of copper and molybdenum observed in the downstream receiving environment of Belubula River.

Regional Bores

There are a number of bores monitored by Cadia outside the predicted impact zone of the operation. Groundwater levels at these bores generally reflect trends in the CRD. Groundwater quality at these bores has been relatively stable, with no trends observed.

Site Specific Guideline Value (SSGV) Assessment

The WMP specifies SSGVs for five surface water monitoring sites. 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.

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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 Cadia Hill pit is currently being used for tailings disposal. 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.

1.2 Purpose of this report

GHD Pty Ltd (GHD) were engaged by CHPL to undertake an assessment of surface water quality, groundwater quality and groundwater levels to meet internal and annual reporting requirements for the 2019-2020 reporting period.

This report presents that review of surface water and groundwater monitoring data from sites in the Cadia complex to assess the impacts of Cadia operations, compare the results for the 2019-2020 reporting period to those from previous years, and identify any long term trends.

For the purpose of reporting, Cadia have separated the surface water and groundwater monitoring locations into discrete zones that incorporate potential sources of pollution and receptors, being groundwater aquifers and local creeks. All surface water and groundwater monitoring sites are shown in Figure 1-1. The zones and their respective figures showing surface and groundwater monitoring sites are listed in Table 1-1.

Table 1-1 Water management zone figures

Zone	Figure
Ridgeway area	Figure 3-1
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1.3 Scope and 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 the Newcrest Mining Limited as set out in section 1.2 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.

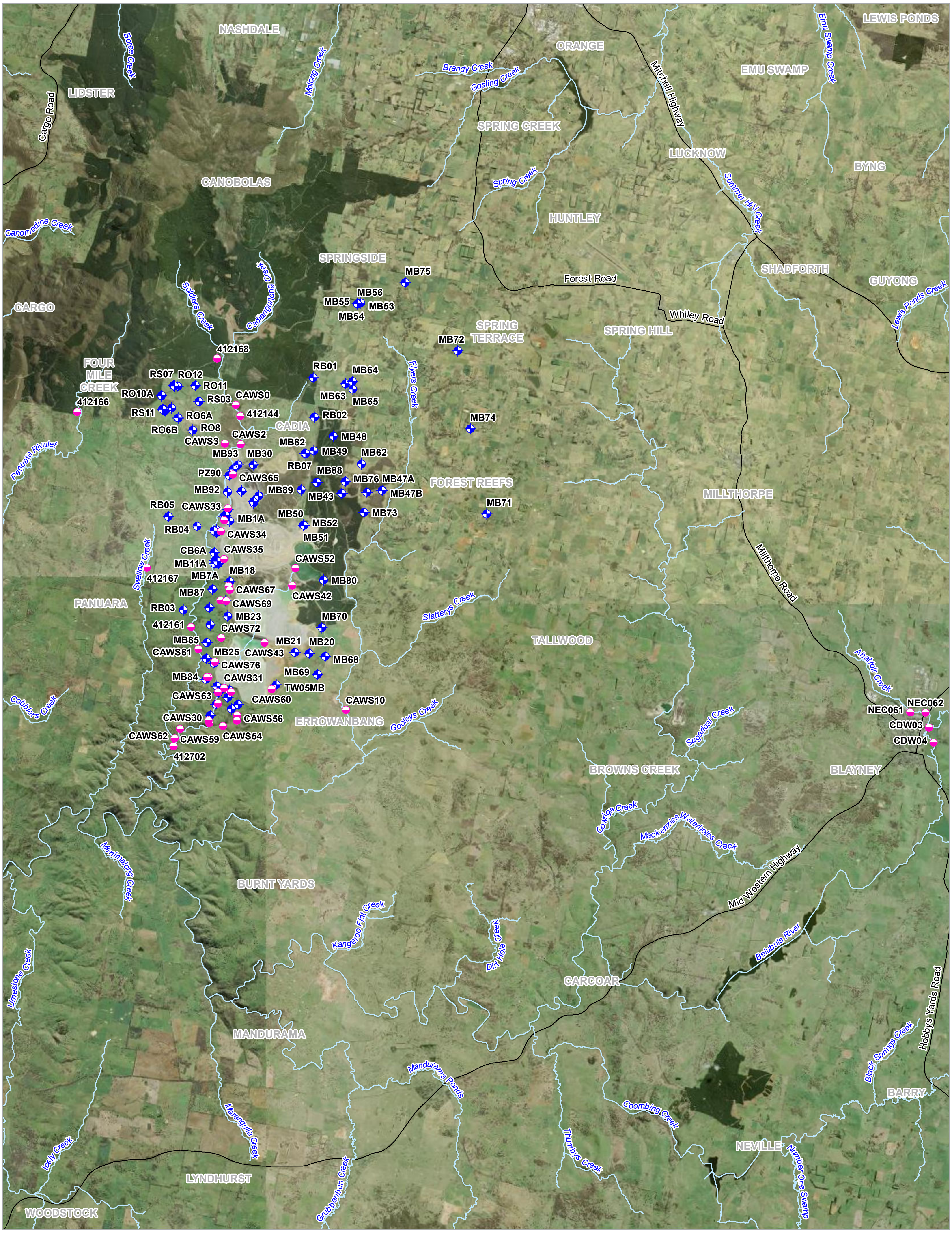
The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that 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.

GHD has prepared this report on the basis of information provided by Newcrest Mining Limited and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

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.



Legend

- Surface water monitoring location
- Groundwater monitoring location
- Watercourse
- Road

Paper Size ISO A3

0 0.8 1.6 2.4 3.2

Kilometres

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

N

Newcrest Mining Limited
CVO AEMR –
Surface and Groundwater Assessment

Project No. 12532418
Revision No. 0
Date 03 Sep 2020

Overview

FIGURE 1-1

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Print date: 03 Sep 2020 - 16:06

Data source: Newcrest: Bores, 2019. LPI:DCDB/DTDB, 2017. © Department of Finance, Services & Innovation 2017. Created by: pkiem, fmackay

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

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.

2.2.1 Rainfall

Daily rainfall data were obtained from the Bureau of Meteorology Orange Airport Station (Station Number 63303).

The rainfall dataset was used to generate a Cumulative Rainfall Departure (CRD) curve (accumulative monthly residual rainfall). CRD is the monthly accumulation of the difference between the observed monthly rainfall and the long term average monthly rainfall. Any increase in the CRD reflects above average rainfall while a decrease in CRD reflects below average rainfall. The CRD curve only deviates from zero due to atypical (above and below average) rainfall.

The prolonged drought throughout the central west NSW continued throughout the 2019-2020 reporting period until January 2020 when above average rainfall was recorded. The Bureau of Meteorology recorded 784.6 mm of rain at the Orange Airport Station during the reporting period which represents approximately 10% less rain than the long-term 24 year average of 843.8 mm. The Cadia site weather stations at the Southern Lease boundary and Ridgeway recorded a combined rainfall average of 555.3 mm during the reporting period. The CRD was negative for seven of the last twelve months. The CRD is shown on the hydrographs in Appendix C.

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.

2.5 Hydrogeology

There are three main aquifer systems within Cadia's mining leases and surrounding area. Baseline groundwater quality data indicated limited hydraulic connection between the three-aquifer systems. Aquifer details are summarised below.

2.5.1 Tertiary Basalt

Tertiary Basalt (Orange Basalt) is situated predominately throughout the northern portion of the site, with small isolated outliers to the east, west and south. The regional groundwater level within this unit is approximately 20 m below ground level (AGE 2009 as reported by Cadia 2019) and groundwater quality is typically fresh.

2.5.2 Silurian Sediments

Silurian Sediments are a fine grained low permeability unit with groundwater intercepted within the fractured sandstone/siltstone and limestone layers. Groundwater depths range from 25 m to 64 m below ground level (AGE 2009 as reported by Cadia 2019). Groundwater quality is variable from fresh to saline, and calcium-bicarbonate dominant.

2.5.3 Ordovician Volcanics

Ordovician Volcanics are a low yielding groundwater source associated with the fractured and faulted basement rocks. Groundwater is typically brackish to saline, calcium-magnesium-sulfate dominant.

Regional groundwater flow is to the south west.

3. Surface and groundwater assessment

This section presents an assessment of surface and groundwater quality and groundwater level changes across the main mine site areas (refer to Table 1-1). The purpose of this assessment is to identify any adverse trends from the monitoring results and potential impacts from mining operations within each zone.

3.1 Groundwater

Groundwater monitoring and assessment of data are undertaken in accordance with the Water Management Plan (WMP) (Cadia, 2019). The current WMP revision was approved by the NSW Department of Planning, Industry and Environment (DPIE) in November 2019.

Monitoring at Cadia commenced in 1994 and the program has been continually expanded since then. Cadia currently has 124 monitoring boreholes, seven water supply bores and drilling underway to install a further ten test and water monitoring bores. Monitoring is undertaken from standpipe monitoring bores at and around Ridgeway, Cadia Hill, Cadia East, the Southern Waste Rock Dump (SWRD) and TSFs, as well as regional bores for comparative purposes.

Monitoring bore details are summarised in Appendix E.

Groundwater quality data and groundwater level hydrographs are presented in Appendix B and Appendix C respectively.

3.1.1 Decommissioned bores

Monitoring bore MB89 was abandoned during the reporting period due to its proximity to the mine subsidence zone which prevented safe access. Monitoring bore MB95 was inundated by the Cadia Hill Pit tailings disposal in May 2020. Two replacement monitoring bores for MB95 are planned for construction in July 2020.

3.1.2 Groundwater level guidelines

Groundwater level guidelines were developed for the updated WMP (Cadia, 2019). Baseline conditions could not be established for all bores due to changes in levels following the time of installation. These bores have not been included in the groundwater level guidelines at this stage. Groundwater level guidelines are not compliance guidelines. The guidelines should be viewed as a value at which an investigation is recommended to be conducted to determine the potential source of a higher than normal result for that particular site.

Cadia East groundwater level guidelines

Groundwater level guidelines for Cadia East are summarised in Table 3-1.

Table 3-1 Cadia East groundwater level guidelines

Bore	Aquifer	Drawdown (m)[1]
RB1	Tertiary Basalt	3
MB43	Silurian Shallow	3
MB44A	Silurian Deep	3
MB44B	Shallow Basalt	3
MB47A	Silurian Limestone	3
MB48	Silurian Sandstone	3
MB55	Shallow Basalt	3
MB62	Silurian Deep	3
MB71	Deep Basalt	3
MB76	Silurian Deep	3

1 Groundwater drawdown greater than 3 m above what is considered normal climatic variation.

TSF groundwater level guidelines

Groundwater level guidelines for the bores in the vicinity of the STSF and the NTSF are summarised in Table 3-2. The guideline value is exceeded when the groundwater level in the bores in the vicinity of the STSF and STSF is greater than the guideline value.

Table 3-2 TSF groundwater level guidelines

Bore	Guideline level		
	Increase water level (m)[1]	Initial water level (mAHD)	Guideline level (m AHD)
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

1 Increase is from the initial measured water level data

Ridgeway groundwater level guidelines

Groundwater level guidelines for Ridgeway are summarised in Table 3-3.

Table 3-3 Ridgeway groundwater level guidelines

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

3.1.3 Groundwater quality triggers

Groundwater quality impact assessment triggers have been developed as part of the WMP (Cadia, 2019). Groundwater from the Orange Basalt and Silurian Sedimentary aquifer to the north and east of Cadia East (primarily on private property) is used for private drinking water and stock purposes. Therefore impact assessment criteria for these bores is adopted as the greater of the Australian Drinking Water Guidelines (NHMRC, 2011) or the 80th percentile of baseline conditions. Groundwater from the Silurian Sedimentary and Ordovician Volcanics aquifers to the south are generally poorer quality and used for limited stock water suppliers.

The impact assessment criteria for these bores adopted the ANZECC Livestock Guidelines (ANZECC, 2000).

Baseline conditions could not be established for all bores due to changes in water quality following the time of installation. These bores have not been included in the groundwater quality triggers at this stage. Groundwater quality triggers are not compliance trigger values. The trigger values should be viewed as a value at which an investigation is recommended to be conducted to determine the potential source of a higher than normal result for that particular parameter or site.

Cadia East

Groundwater quality triggers for Cadia East are shown in Table 3-4.

Cadia Hill Pit ground water quality triggers

Groundwater quality triggers for Cadia Hill Pit are shown in Table 3-5.

Table 3-4 Cadia East groundwater quality triggers

Bore	pH	TDS (mg/L)	Sulfate (mg/L)	Aluminium (mg/L)	Arsenic (mg/L)	Copper (mg/L)	Mercury (mg/L)	Lead (mg/L)	Manganese (mg/L)	Nickel (mg/L)	Zinc (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	0.001	0.01	0.5	0.02	3	3	50
MB84	6.5–8.5	600	250	0.2	0.01	1	0.001	0.01	0.5	0.02	3	3	50
MB85	6.5–8.5	600	250	0.2	0.01	1	0.001	0.01	0.5	0.02	3	3	50
MB86	6.5–8.5	600	250	0.2	0.01	1	0.001	0.01	0.5	0.02	3	3	50
MB87	6.5–8.5	600	250	0.2	0.01	1	0.001	0.01	0.5	0.02	3	3	50
MB88	6.5–8.5	600	250	0.2	0.01	1	0.001	0.01	0.1	0.02	3	3	50
MB89[1]	6.5-8.5	600	250	0.2	0.01	1	0.001	0.01	0.1	0.02	3	3	50

Note: Trigger values for metals refer to dissolved concentrations

Some of these bores are in the western TSF zone

1 MB89 was inundated during the reporting period.

Table 3-5 Cadia Hill Pit groundwater quality triggers

Bore	pH	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)
MB89 MB91 MB92 MB93 MB95	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]

Note: Trigger values for metals refer to dissolved concentrations

1 ANZECC/ARMCANZ (2000) Guidelines (Livestock)

2 Value is recommended by DPI Water letter dated 2 May 2017 (ref: OUT17/17244)

TSF groundwater quality triggers

Groundwater quality triggers for the TSF are shown in Table 3-6.

Table 3-6 TSF groundwater quality triggers

Bore	pH	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[1]	3090[1]	10[1]	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[2]	0.4	0.01[2]	0.5[2]	1	20	0.001[2]	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[2]	0.4	0.01[2]	0.5[2]	1	20	0.001[2]	33	132
MB79	6.5–8.5	2000	1000	5	0.01[2]	0.4 (sheep); 0.1 (cattle)	0.01[2]	0.5[2]	1	20	0.001[2]	9.1	90.3

Note: Trigger values for metals refer to dissolved concentrations

1 Value greater than drinking or stock water use.

2 Value is recommended by DPI Water letter dated 7 February 2017 (ref: OUT17/6198)

3.2 Surface water

Surface water quality monitoring and assessment of data is undertaken in accordance with the WMP (Cadia, 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. 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 3-7 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.

Table 3-7 Surface water monitoring sites

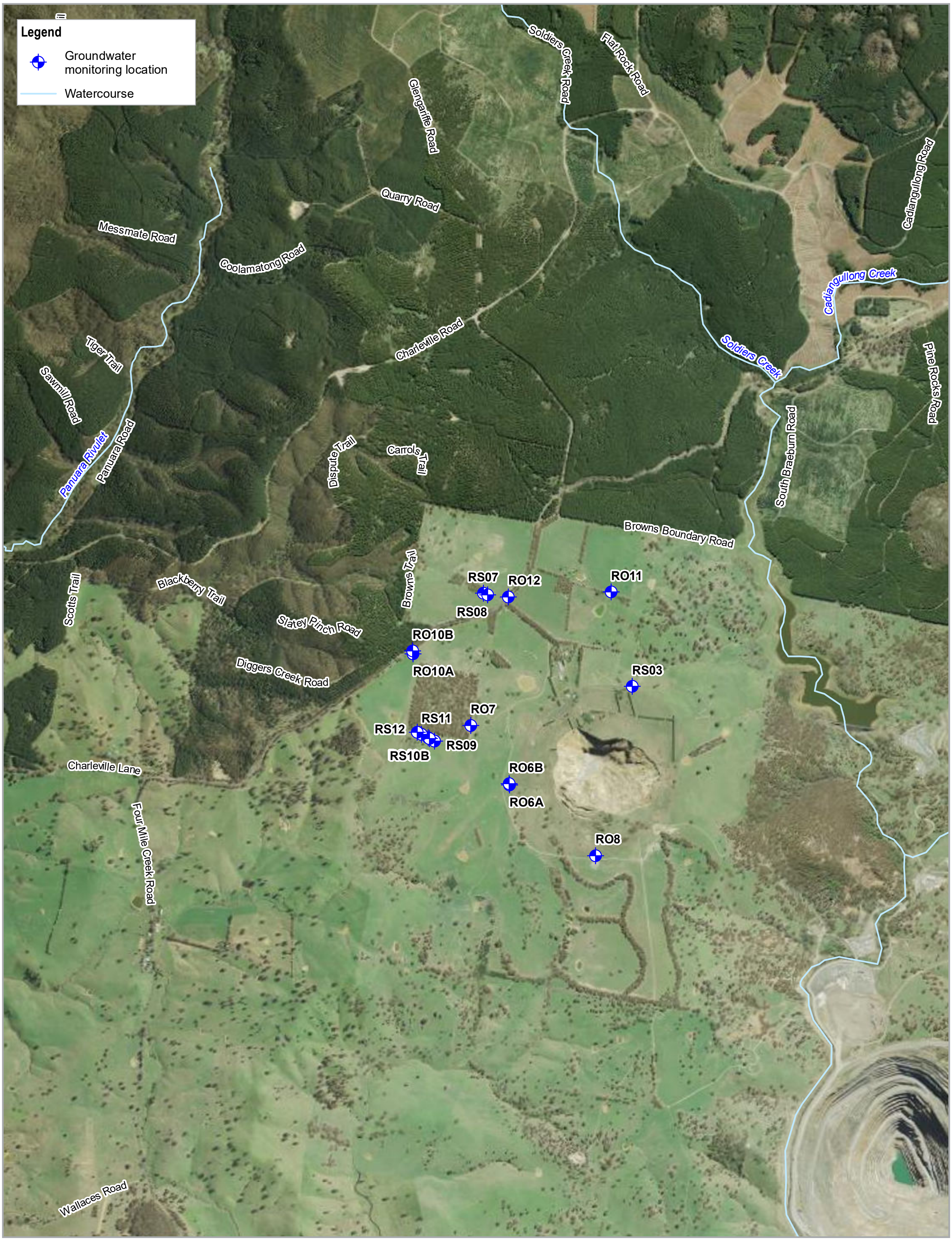
Site ID	Purpose / Description	Area
412168	Background water quality reference location located upstream from Cadiangullong Dam	Upper Cadiangullong Creek
CAWS0	Water quality for process raw water. Farthest upstream surface water monitoring location on Cadiangullong Creek	
CAWS2 CAWS3	Potential for impact from historical mining activities located along Cadiangullong Creek	
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 proceesing area	
412161	Potential for impact from mining, processing & Southern Waste Rock Dumps (SWRDs)	Waste Rock Dumps
CAWS34 CAWS35	Monitor development of leachate water quality from waste rock dumps	
CAWS37	Monitor for potential seepage impacts from SWRD and NTSF	
CAWS52	Water quality in the mixed water storage dam (Rodds Creek Dam)	
CAWS42 CAWS43	Monitor development of TSF decant water quality. Used to determine potential impacts of the TSF on surface and/or groundwater quality	TSF Eastern Zone
CAWS60	Assess potential for seepage contributions on eastern side of southern TSF	
CAWS61 CAWS62	Potential impact from mining, processing and TSF	TSF Westen Zone
CAWS64	Assess any influence of TSF on surrounding groundwater quality	
CAWS67 CAWS68 CAWS69 CAWS72 CAWS75	Monitor for potential for seepage impacts on the western side of the NTSF and STSF	

Site ID	Purpose / Description	Area
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	

3.3 Ridgeway area

Mining at Ridgeway commenced in 2002. The Ridgeway Deeps and Ridgeway underground mines were placed into care and maintenance in March 2016. Following a seismic event in April 2017, the Ridgeway mine was re-opened to provide ore for processing while ground support at Cadia East was enhanced. Mining at Ridgeway ceased in September 2017 and it was again placed into care and maintenance. The receptor in this part of the mine is groundwater. There is no surface water or groundwater quality monitoring undertaken in this area.

Groundwater levels are monitored biannually in the Ridgeway area by bores RO10A, RO10B, RO11, RO12, RO6A, RO6B, RO7, RO8, RS10A, RS10B, RS11, RS12, RS03, RS07, RS08 and RS09.



Paper Size ISO A4

0 250 500 750 1,000

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 and Groundwater Assessment

Ridgeway Area

Project No.	**12532418**
Revision No.	**0**
Date	**03 Sep 2020**

FIGURE 3-1

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Print date: 03 Sep 2020 - 16:06

Data source: Newcrest: Bores, 2019. LPI: DCDB/DTDB, 2017. © Department of Finance, Services & Innovation 2017. Created by: pkiem, fmackay

3.3.1 Groundwater

Ordovician Volcanic

The groundwater levels at RO6B and RO10B historically reflect trends in the CRD. This trend has continued during the reporting period with groundwater levels at RO6B and RO10B decreasing by 0.08 m and 0.63 m between May 2019 and November 2019 respectively in accordance with the decreasing CRD over this period. Groundwater levels at RO6B and RO10B increased by 0.21 m and 0.08 m between November 2019 and June 2020 in accordance with the increasing CRD over this period. Groundwater levels at RO6B and RO10B were above the guideline values during the reporting period. The groundwater level hydrograph for RO6B is plotted with the CRD in Figure 3-2.

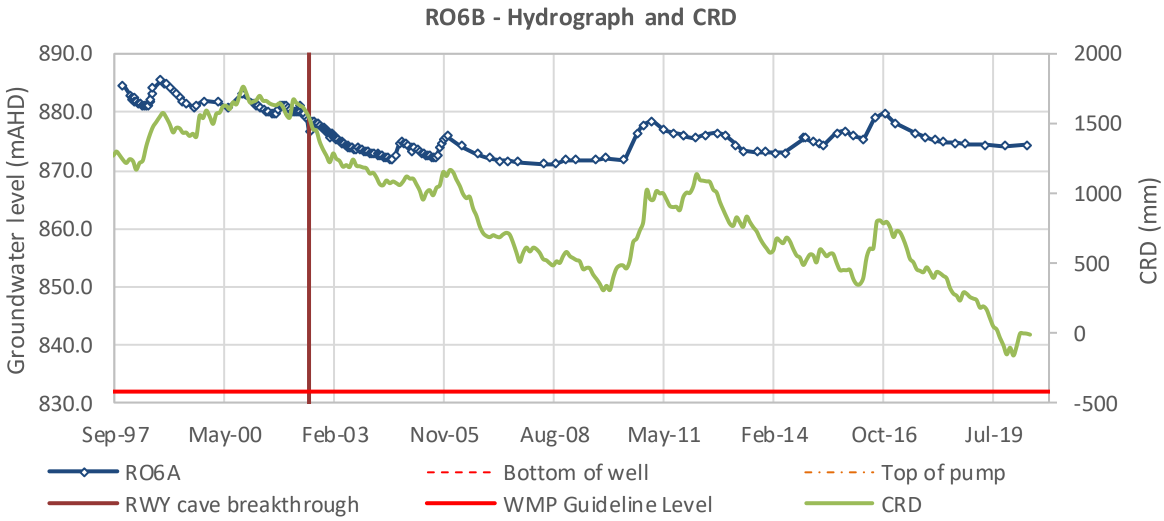


Figure 3-2 RO6B groundwater level hydrograph

Tertiary Basalt

The groundwater levels at RO6A, RO7 and RO10A historically reflect trends in the CRD. During the previous reporting period, the groundwater levels at RO6A, RO7 and RO10A showed a declining trend in accordance with the CRD. This trend continued between May 2019 and November 2019 at RO7 and RO10A with groundwater levels decreasing 0.41 m and 0.36 m respectively in accordance with the decreasing CRD over this period. However, groundwater level at RO6A increased by 0.6 m between May 2019 and November 2019. The cause of this increase in groundwater level at RO6A is unclear. Between November 2019 and June 2020 groundwater levels at RO6A, RO7 and RO10A increased by 0.11 m, 0.38 m and 0.15 m respectively. This increase in groundwater levels between November 2019 and June 2020 is consistent with the CRD.

RO8 has been dry since 2003.

The groundwater level at RO11 has remained relatively stable since September 2002. However there was a decrease in groundwater level of 1.1 m over the reporting period. Additional monitoring in August 2020 indicates that the decrease in groundwater level at RO11 was likely a temporary fluctuation, with levels returning to typical values in August 2020.

Prior to 2006 the groundwater level at RO12 strongly reflected the trends in the CRD. However since 2006 the groundwater level has remained relatively stable and only shows recovery following extended periods of above average rainfall, for example after May 2010, and after July 2016. Groundwater levels at RO12 remained relatively stable throughout the monitoring period. The groundwater level at RO12 was above the guideline value for the reporting period (refer Figure 3-3).

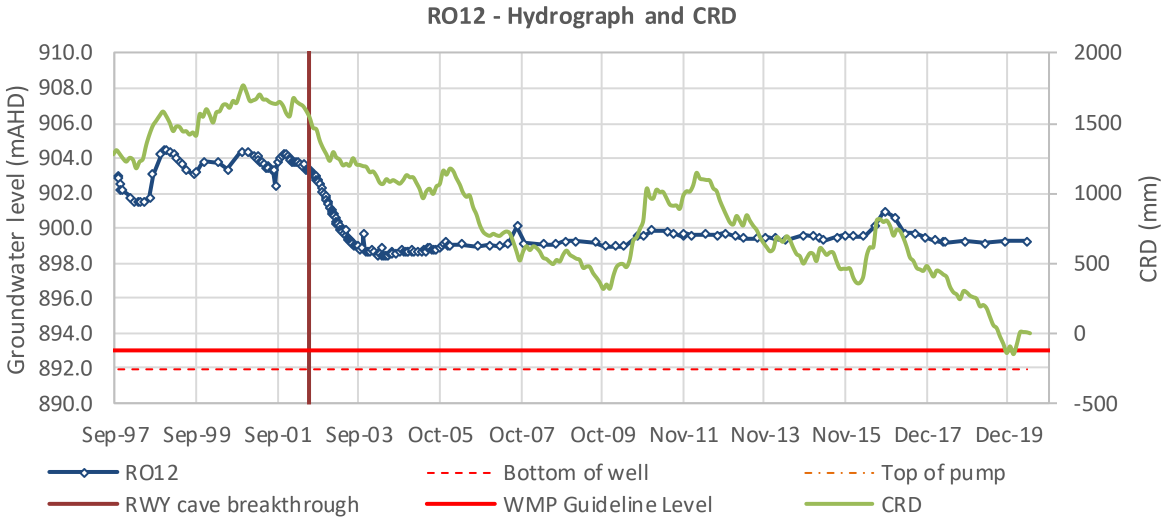


Figure 3-3 RO12 groundwater level hydrograph

Soil and clay

Historically the shallow bores generally reflect trends in the CRD. The shallow bores show a rapid response to rainfall recharge and a slower decline.

RS03, RS09, RS10A and RS10B have had periods of being dry throughout the historical record, including this reporting period.

Historically there are large variations in the groundwater levels in shallow bores RS07 and RS08. The groundwater levels at RS07 and RS08 showed declining trends during the previous reporting period which was consistent with the CRD. This decreasing trend continued for the portion of the reporting period up to November 2019 where groundwater levels at RS07 and RS08 decreased by 0.43 m and 0.33 m respectively, which is consistent with CRD. For the remainder of the reporting period groundwater levels at RS07 and RS08 increased slightly by 0.04 m and 0.12 m respectively, which is consistent with CRD. Groundwater levels at RS07 are shown in Figure 3-4.

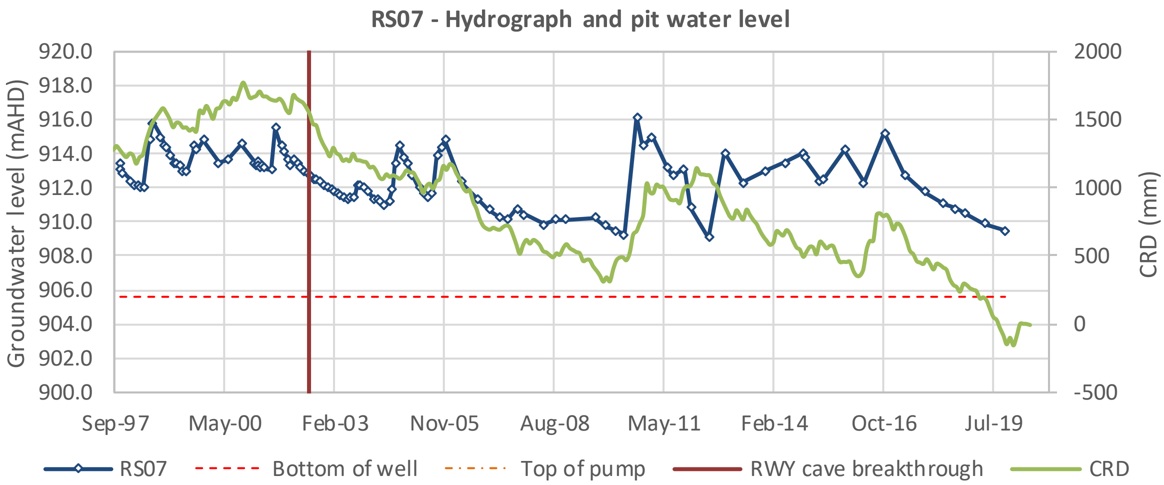


Figure 3-4 RS07 groundwater level hydrograph

The groundwater level at RS11 showed a declining trend during the previous reporting period. This decreasing trend continued during the reporting period. RS11 was observed to be dry in June 2020. This represents a drop in groundwater level of 1 m since November 2019. The groundwater level at RS12 has showed some variability in the previous reporting period. However the groundwater level showed a historical decreasing trend between late 2016 and late 2018 with groundwater levels decreasing by approximately 3 m during this period. During the monitoring period RS12 was observed to be dry. Based on the bore depth, this would represent a drop of approximately 2.4 m over the monitoring period. It is recommended that this decline be verified and investigated further, although an investigation is not required under the WMP as this site does not have a groundwater level trigger value.

3.3.2 Summary

The majority of groundwater level monitoring bores varied in accordance with CRD or showed declining trends during the reporting period as a result of severe drought conditions. Observations for the reporting period are summarised in Table 3-8. Hydrographs are plotted with the CRD in Appendix C.

A number of bores went dry during the monitoring period including RS11 and RS12.

Table 3-8 Ridgeway area observations

Aquifer					
Ordovician Volcanic		Tertiary Basalt		Soil/clay	
Bores	Observation	Bores	Observations	Bores	Observation
RO6B RO10B	RO6B showed an approximate 0.7 m increase RO10B varied in accordance with CRD	RO6A RO7 RO8 RO10A RO11 RO12	RO8 dry. RO6A increased by 0.7 m RO7 and RO10A varied in accordance with CRD. RO11 decreased by 1.1 m. RO12 stable during the reporting period.	RS03 RS07 RS08 RS09 RS10A/B RS11 RS12	RS03, RS09 and RS10A/B were dry. RS07 and RS08 varied in accordance with CRD. RS11 and RS12 declined until they went dry during the monitoring period.

3.4 Upper Cadiangullong Creek

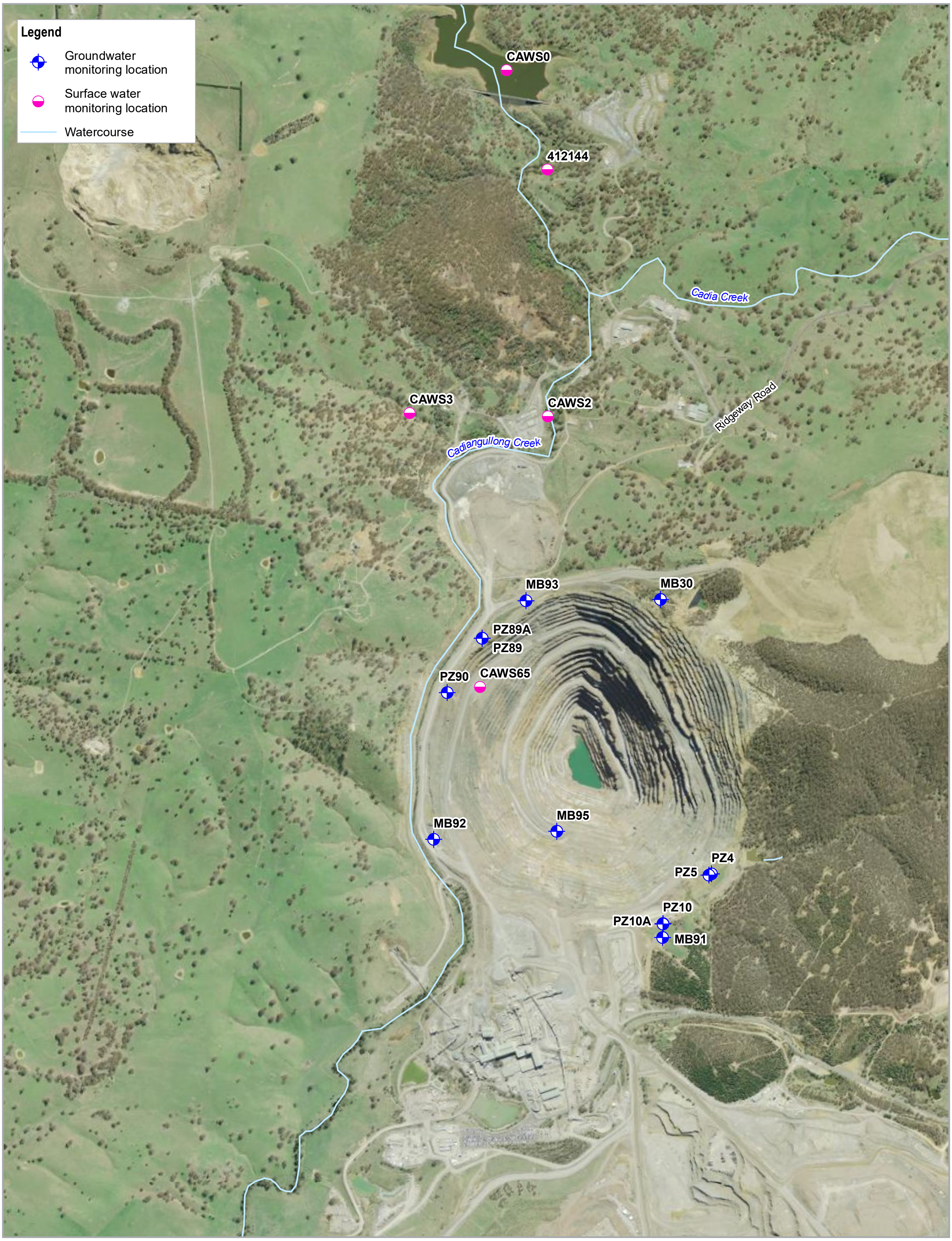
3.4.1 Surface water

Upper Cadiangullong Creek runs from the Cadiangullong Dam to the Cadia Hill Pit. This reach of the creek adjoins core 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. There are no groundwater monitoring locations within Upper Cadiangullong Creek.

The following surface water sites are within the Upper Cadiangullong Creek area:

- 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 for the 2019/2020 reporting period have not been included in this report as samples were inadvertently collected from an incorrect location. The correct CAWS3 sampling location targets an historic mine seepage pathway from the entrance of an historic mine adit. However, during the reporting period, this sample was obtained from a downstream location in a gully where external surface water mixing occurred, hence exhibiting different results than previously recorded. The correct surface water monitoring location for CAWS3 will be sampled from July 2020 with the reinstatement of results reported in the 2020/2021 AEMR.



Paper Size ISO A4

0 125 250 375 500

Metres

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

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GHD

Newcrest Mining Limited
CVO AEMR –
Surface and Groundwater Assessment

Cadia Hill Pit, Cadia Extended Pit and Upper Cadiangullong Creek

Project No. **12532418**
Revision No. **0**
Date **03 Sep 2020**

FIGURE 3-5

Data source: Newcrest: Bores, 2019. LPI: DCDB/DTDB, 2017. © Department of Finance, Services & Innovation 2017. Created by: pkiem, fmackay

Physicochemical parameters

pH in Upper Cadiangullong Creek has been relatively stable in the reporting period, ranging from 6.74 to 8.85.

EC at all of the Upper Cadiangullong Creek sites has remained below 500 µS/cm. While results were not available for CAWS3 during the reporting period, historically EC at this site has ranged between 1288 and 1764 µS/cm. The elevated EC at CAWS3 has been indicative of seepage from the historical mine adit.

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.

Nutrients

There has been no temporal trend in nutrient concentrations observed in the Upper Cadiangullong Creek area in recent years.

Dissolved metals

Elevated aluminium concentrations have been observed at all sites, though no trend has been observed in the period of monitoring. The elevated results in this reporting period are consistent with historical results.

Historically elevated cadmium, molybdenum, nickel and zinc concentrations at CAWS3 indicate influence of seepage from the historical mine adit.

Elevated copper results have been observed historically at CAWS2 and CAWS3 likely due to the influence of historic mine seepage. Available results from the reporting period show a continuation of the decreasing trend that has been observed since December 2016.

There were two instances of elevated manganese at 412144 in the dataset of 3.18 mg/L and 9.1 mg/L on 13 March 2019 and 23 March 2020 respectively. There is however no trend evident of increasing manganese concentrations at 412144.

3.4.2 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 previous reporting periods with elevated cadmium, zinc, molybdenum and nickel 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 (CAWS33).

3.5 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.

A network of 12 groundwater monitoring points were established in the vicinity of the Cadia Hill Pit to verify groundwater flow (hydraulic gradient towards historical and current mining areas) and potential impacts on groundwater quality resulting from deposition of tailings in the pit. Four bores were established during July and August 2018 (MB91, MB92, MB93 and MB95) and seven pre-existing piezometers (originally established for pit wall stability monitoring) were reinstated as groundwater monitoring points (PZ4, PZ5, PZ10, PZ10A, PZ89, PZ89A and PZ90). The pre-existing MB30, operational since March 2004, also forms part of the monitoring network. Monitoring bores MB30, MB91, MB92 and MB93 are installed to depths of 100-200 m with the screened zone well above the decant pond level. Monitoring bore MB95 was installed within a geological fault structure and the screened zone is below the decant pond level. Two additional bores in the pit (MB94 and MB96) and four additional bores between the pit and Cadiangullong Creek are planned for installation during the next reporting period.

Since the start of deposition (4 May 2018) the pit decant pond level has risen by approximately 180 m. The rate of water level rise in the pit decant pond is influenced by the rate of dewatering from the pit. However the pit water level rose at a constant rate throughout the current reporting period.

A prohibition notice was issued by the NSW Natural Resources Regulator in January 2019, which has restricted access to several monitoring bores to the south west of the pit, including PZ4, PZ5, PZ10, PZ10A and MB91. Monitoring of these bores resumed in September 2019 when the prohibition notice ceased.

Groundwater quality is monitored at MB30, MB91, MB92, MB93 and MB95 on a monthly basis. As discussed in Section 3.1.1 monitoring bore MB95 was inundated by the Cadia Hill Pit tailings disposal in May 2020. Groundwater levels are monitored monthly at all 12 monitoring points.

The only surface water site in the Cadia Hill Pit area is CAWS65, which monitors the TSF decant pond water.

Monitoring locations for the Cadia Hill Pit are shown in Figure 3-5.

3.5.1 Surface water

Physicochemical parameters

Elevated TSS concentrations have been observed in the pit at site CAWS65 following the deposition of tailings in the pit, with concentrations regularly exceeding 100,000 mg/L up until June 2019. TSS concentrations have since generally reduced to concentrations less than 600 mg/L with the exception of two results, 17,900 and 24,200 mg/L, in September 2019 and November 2019 respectively. High TSS results are to be expected given that the sample represents tailings slurry.

Nutrients

Total Kjeldahl nitrogen data for CAWS65 indicate that the majority of the nitrogen is present as organic matter or ammonia. Total phosphorous concentrations have been elevated at CAWS65 following the deposition of tailings in the pit. However, as with TSS concentrations, phosphorus results have reduced since June 2019 with results for the reporting period ranging between the LOR of 0.01 mg/L and 33.8 mg/L.

Dissolved metals

The concentrations of various metals increased in the pit following the deposition of tailings. This includes antimony, arsenic, molybdenum, nickel and the major cations. Dissolved metal concentrations showed a notable increase in the June 2020 results, potentially associated with a rainfall event two days prior to sampling. No trend in metals concentrations has been observed at CAWS65.

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 3-6. Sulfate concentrations have historically shown an increasing trend, but shows a decreasing trend in 2020 results.

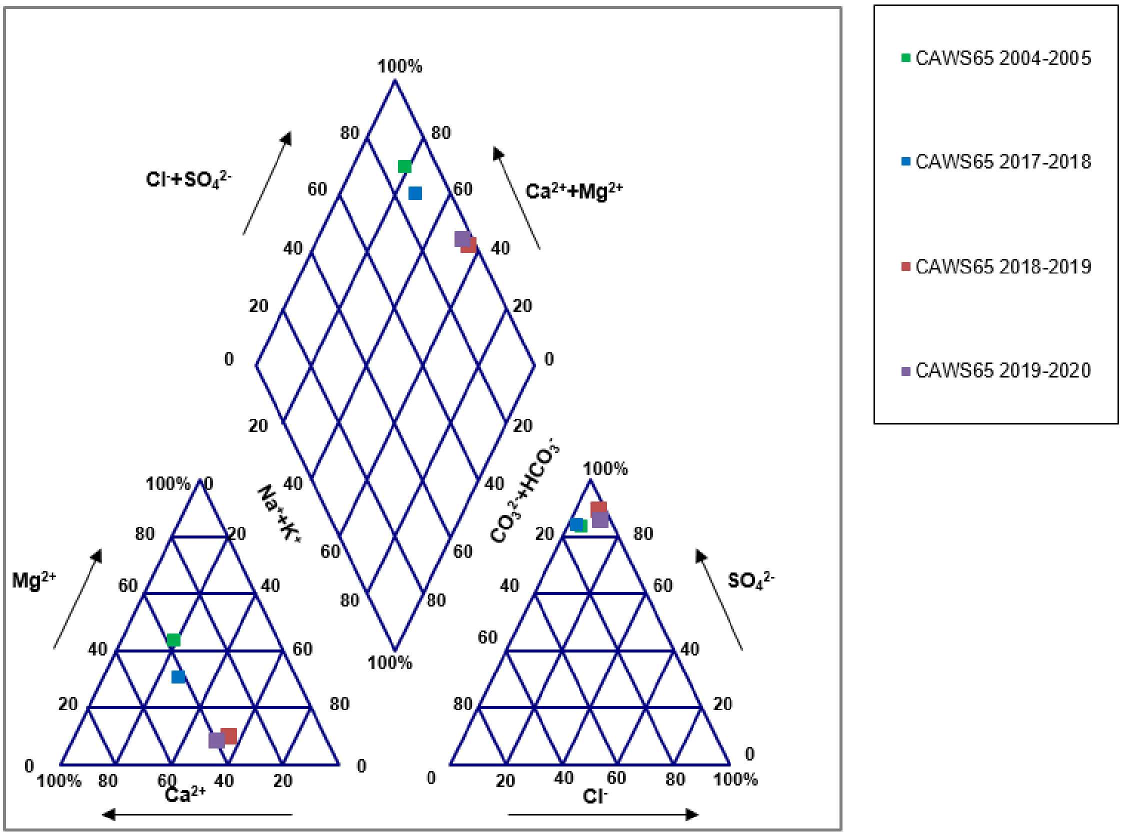

Figure 3-6 Piper chart showing differences in major ion compositions following tailings deposition

3.5.2 Groundwater

Decant water levels for the Cadia Hill Pit are plotted against groundwater levels for all monitoring bores in Figure 3-7. The figure shows that the groundwater levels in the majority of the bores are more than 100 m above the decant water level, and therefore unlikely to be affected by decant water. The groundwater level for MB95 is comparable to the decant water level, with levels at MB95 slightly above the decant level (by 3-4 m) for most of the reporting period. On occasions the decant level appears to be above the groundwater level at MB95, however this needs to be verified by more frequent monitoring at both sites. It should be noted that the screened elevation at MB95 is between 241 and 277 m AHD, which is well below the decant water level but above the base of the pit. As discussed below, there is also an increasing trend in groundwater level at MB30. Groundwater levels at MB30 are also shown in Figure 3-13. As discussed below, MB30 is screened over 200 m above the decant water level. MB30 is installed in the same fault as MB95 and there may be hydraulic connectivity between MB30 and MB95. Groundwater level trends and the likely hydraulic connection between the decant water and groundwater is discussed in the following sections.

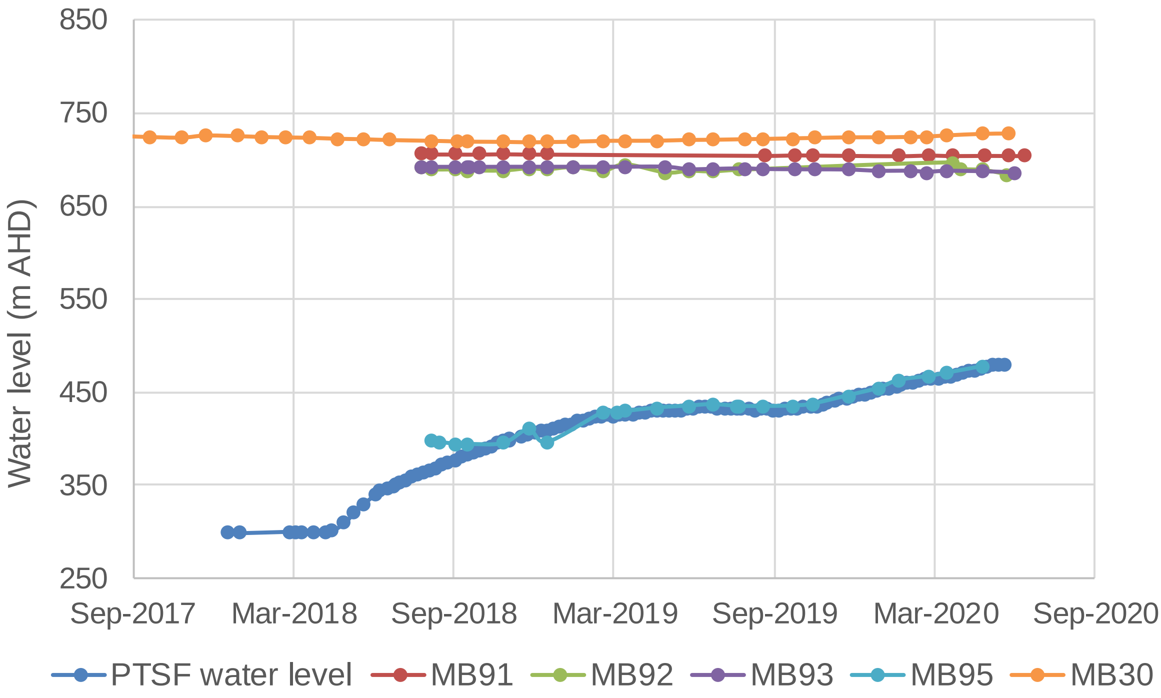

Figure 3-7 Cadia Hill Pit groundwater level hydrographs and decant water level

Ordovician Volcanic

Monitoring bores MB91, MB92, MB93 and MB95 were installed in July 2018, after tailings deposition in the pit began. Monitoring bore MB91 shows an overall decreasing trend in groundwater level since monitoring began. Monitoring of this bore was not undertaken between January 2019 and September 2019 due to the enforced prohibition zone. Following the resumption of monitoring at MB91, groundwater levels fluctuated between approximately 704.2 m AHD and 703.4 m AHD.

The groundwater level at MB92 has fluctuated by up to 7 m between successive readings. Further monitoring is required to determine a trend. Since January 2019 TDS concentrations at MB92 have reduced. Nickel concentrations at MB92 increased at the end of the previous reporting period, refer Figure 3-8. However, during the current reporting period, nickel concentrations at MB92 have generally been lower and did not exceed the guideline value of 0.02 mg/L, with the exception of some variability in April 2020. Manganese concentrations at MB92 exceeded the guideline value in April 2020. It is not possible for MB92 to be influenced by tailings decant water at this time since the screened interval of the bore is well over 100 m above the decant water level.

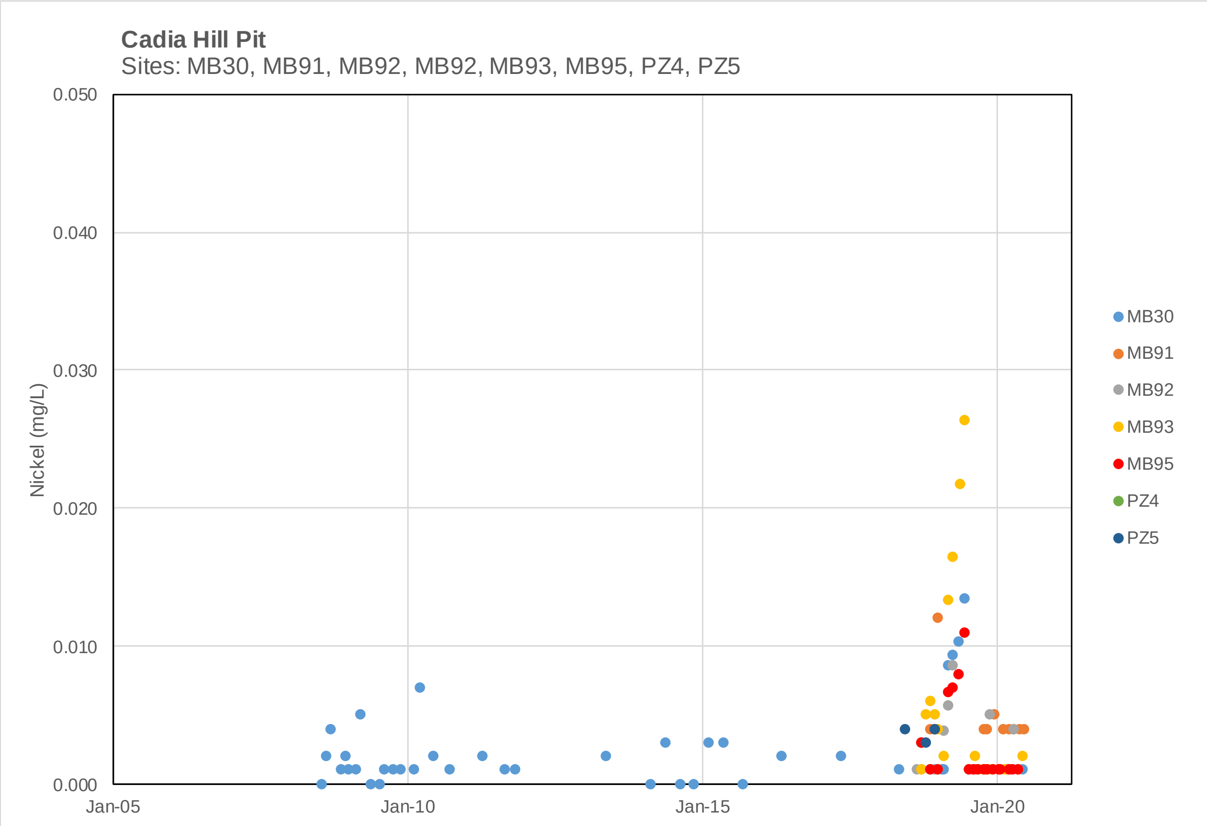

Figure 3-8 Nickel concentrations in the Cadia Hill Pit area

The groundwater level at MB93 increased by approximately 0.9 m between June and August 2019. For the remainder of the monitoring period the groundwater level at MB93 was generally decreasing with levels dropping by approximately 4.4 m between August 2019 and June 2020. This may be associated with dewatering of the Cadia Extended Pit to the north. As with MB92, nickel at MB93 was elevated at the end of the previous reporting period and have been lower during the current reporting period.

It is not possible for MB93 water chemistry to be influenced by tailings decant water at this time since the screened interval of the bore is well over 100 m above the decant water level. Groundwater levels at MB93 are shown in Figure 3-9.

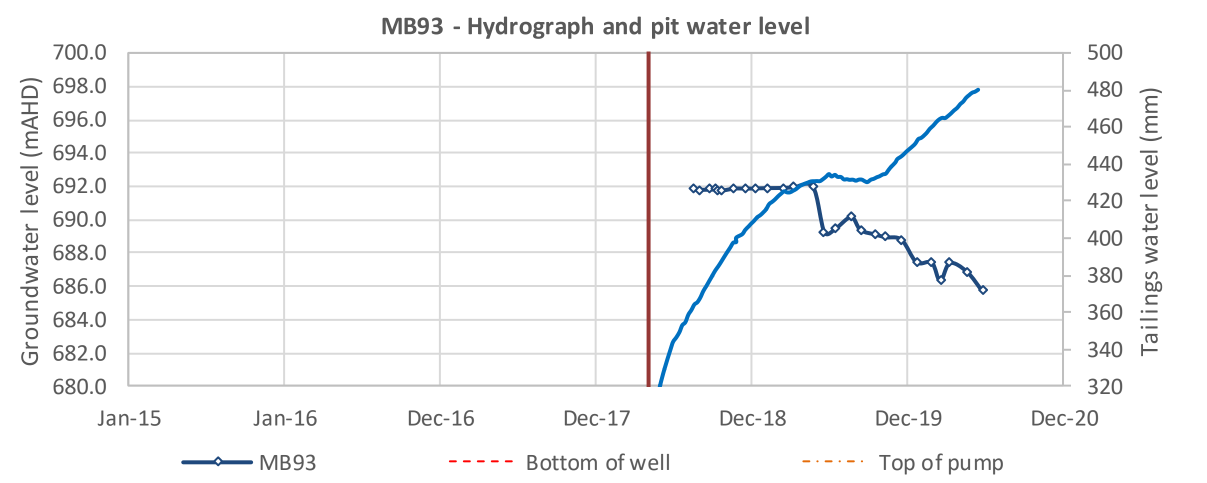

Figure 3-9 MB93 groundwater level hydrograph

The trigger value for manganese of 0.5 mg/L was exceeded at MB93 during the reporting period. CHPL's Level 1 investigations from the 2018-2019 reporting period concluded that there is no suggestion from the data that manganese represents a mine related impact. Over the previous and current monitoring periods there was an overall decreasing trend in pH at MB93, however pH increased slightly in May and June 2020. The guideline value for sulfate was exceeded at MB93 in August 2019 and February 2020. Sulfate concentrations at MB93 were generally lower than the previous reporting period. It is possible that groundwater chemistry has been influenced by the fall in groundwater levels at MB93. This will be verified as part of the next annual review as dewatering of the Cadia Extended Pit has ceased.

MB95 is the only bore with groundwater levels at a similar elevation to the decant pond level. The increasing trend observed at MB95 is similar to the increasing trend in the decant pond water level, refer Figure 3-10. MB95 and the pit decant appear to be hydraulically connected. During the monitoring period the groundwater level at MB95 has generally remained two to three metres higher than the decant pond level which suggests groundwater flow towards the pit rather than seepage from the pit. The January 2019 groundwater level measurement at MB95 was considered erroneous.

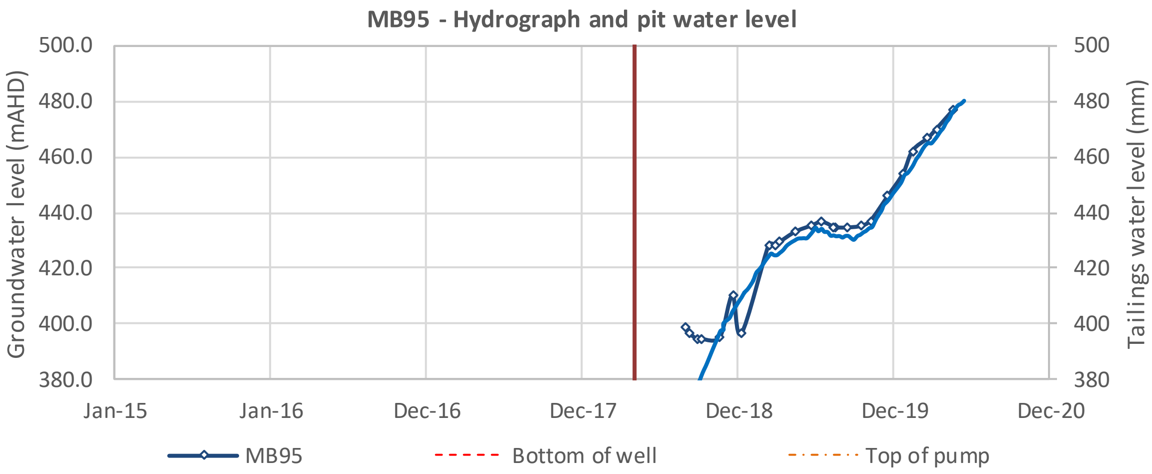

Figure 3-10 MB95 groundwater level hydrograph

The trigger value for arsenic was exceeded at MB95 during the current reporting period. An increasing trend in arsenic concentrations was observed during the previous reporting period, refer Figure 3-11. During the current reporting period, arsenic concentrations at MB95 were generally lower, varying between 0.029 mg/L and 0.007 mg/L. There was an increasing trend in manganese at MB95 during the reporting period. There were minor detections of molybdenum (>0.009 mg/L) in May and June 2020. During the previous reporting period there were increasing concentrations of chromium and nickel observed, however during the current reporting period concentrations were lower. During the current monitoring period there was a declining trend in magnesium.

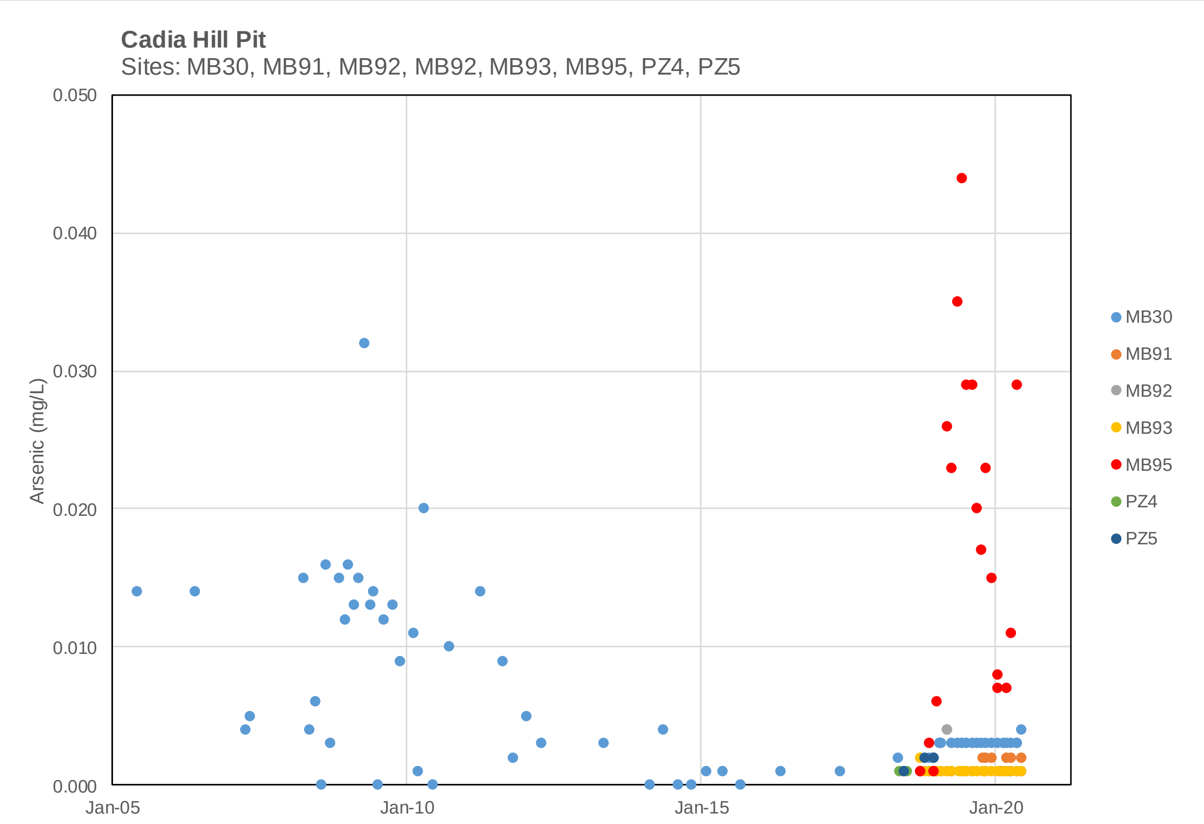

Figure 3-11 Arsenic concentrations in the Cadia Hill Pit area

Groundwater levels at PZ89 showed an overall decreasing trend for the reporting period. Between June 2019 and August 2019, groundwater levels at PZ89 increased approximately 3.2 m however, for the remainder of the reporting period groundwater levels decreased approximately 4.4 m as shown in Figure 3-12. As for MB93, groundwater at PZ89 is likely to be influenced by dewatering of the Cadia Extended Pit to the north.

Groundwater levels at PZ90 were relatively stable throughout the monitoring period, with levels varying by only about 1 m. Groundwater levels at PZ89A have been stable since monitoring commenced. A large drop in groundwater level was observed at PZ89A between October 2019 and February 2020, however subsequent monitoring indicates this was a measurement error with groundwater levels returning to historical levels.

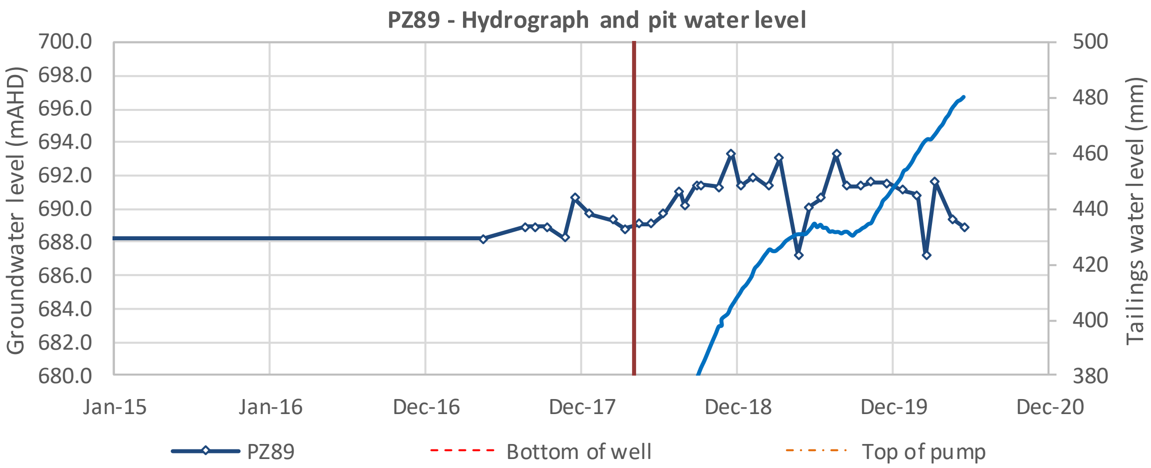

Figure 3-12 PZ89 groundwater level hydrograph

Monitoring was not undertaken at PZ4, PZ5, PZ10 and PZ10A between February 2019 and August 2019 due to the enforced prohibition zone. Since monitoring recommenced in September 2019, groundwater levels at PZ4 have decreased by approximately 4 m and groundwater levels at PZ5 decreased by 0.3 m. Groundwater levels at PZ10 and PZ10A decreased in June 2020with drops of 7.4 m and 1 m respectively. Continued monitoring of PZ10 and PZ10A is recommended to verify this decrease in groundwater level.

Tertiary Basalt

Historically there has been a declining trend in the groundwater level at MB30 since mid-2010. This trend has been attributed to mining at Cadia Hill Pit and the overall negative trend in the CRD. Since December 2018 the groundwater level at MB30 has been increasingincluding an increase in groundwater level during the reporting period of 6.7 m as shown in Figure 3-13. This increasing trend does not correspond with CRD trends over the reporting period. The screened interval of bore MB30 is over 200 m above the decant level and therefore is unlikely to be influenced by decant water. MB30 was installed into the same fault zone as MB95, and there may be hydraulic connectivity between MB30 and MB95. Due to the uncertainty regarding the connection between MB30, MB95 and the pit decant, an additional bore, MB94, is being installed between MB30 and the decant pond in July 2020.

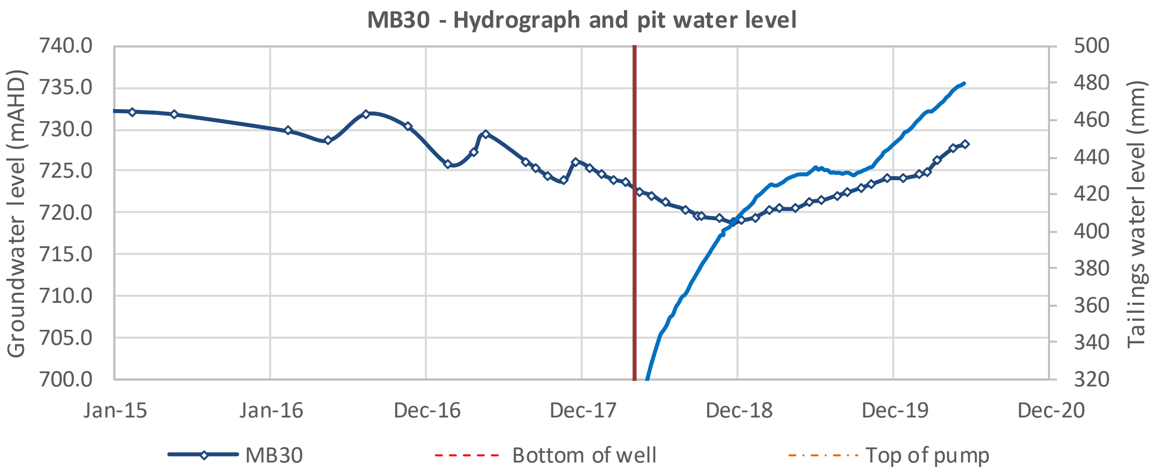

Figure 3-13 MB30 groundwater level hydrograph

Since January 2015 there has been a declining trend in calcium, chloride, EC, sodium, sulfate and magnesium concentrations at MB30. During the reporting period the concentrations of these parameters were stable and lower than during the previous reporting period.

Groundwater level observations for the reporting period are summarised in Table 3-9. The remaining hydrographs are plotted with the CRD in Appendix C.

Table 3-9 Cadia Hill Pit groundwater level observations

Ordovician Volcanic		Tertiary Basalt	
Bores	**Observation**	**Bores**	**Observations**
MB91 MB92 MB93 MB95 PZ10 PZ10A PZ4	MB91 showed an overall declining trend. Localised influence of decant water on water levels at MB95 appears possible. Levels at MB95 increasing in accordance with the pit water level.	MB30	Increased 6.7 m during reporting period.

Ordovician Volcanic		Tertiary Basalt	
PZ5 PZ89 PZ89A PZ90	MB92 showed large fluctuations, up to 7 m between successive readings. Large drop in groundwater levels in June 2020 at PZ10 and PZ10A. PZ4 and PZ5 showed decreasing trends following the resumption of monitoring. . MB93 and PZ89, showed an overall decreasing trend. PZ89A and PZ90 relatively stable.		

A piper diagram of major cation and anion concentrations for MB30, MB91, MB92, MB93, MB95 and CAWS65 is shown in Figure 3-14. The plot shows a movement in water type for CAWS65 from calcium sulfate to sodium sulfate, with the sulfate dominance increasing over time. The plot also indicates some similarity in water type between MB95 and CAWS65, however the water chemistry at MB95 does not follow the same trend in cation and anion dominance as CAWS65 with variability in sulfate and bicarbonate dominance. Overall, there appears to be some localised influence of decant water at MB95, which may be the result of seepage during times when the decant water level is above the local groundwater level at MB95. However, the piper plot suggests there is mixing between decant water and background Ordovician groundwater at MB95 as the groundwater level equilibrates to the rising decant pond level. It is considered that there would be no migration of decant water beyond the localised seepage area in the immediate vicinity of the pit due to the strong hydraulic gradient towards the pit. There is minimal change in the major ion chemistry at the other groundwater sites and no indication of decant water influence at these sites.

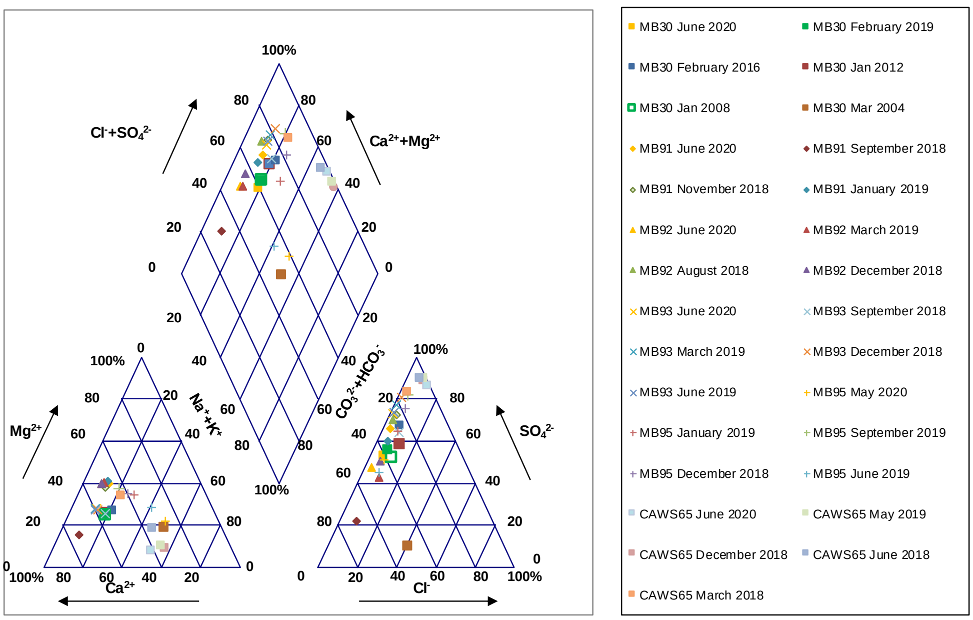

Figure 3-14 Piper diagram for MB30, MB91, MB92, MB93 and MB95 and CAWS65

3.5.3 Summary

The influence of tailings deposition in the pit is evident in the water quality results at site CAWS65, which monitors the standing water in the pit. This influence is shown by increased salinity and elevated concentrations of TSS, antimony, arsenic, molybdenum and nickel.

The groundwater level at MB95 showed an increasing trend similar to the trend observed in the pit decant water level indicating ongoing connection between pit water and groundwater in the immediate vicinity of the pit. Arsenic, molybdenum and nickel concentrations were elevated in the pit decant water. Compared to surrounding monitoring locations (MB91, MB92 and MB93) arsenic and molybdenum were elevated either during the current, or previous reporting period at MB95. The trigger value for arsenic and molybdenum was exceeded at MB95. The piper diagram indicates some similarity in water chemistry between CAWS65 and MB95 however there appears to be mixing between decant water and groundwater at MB95 and perhaps other geochemical processes. Based on these lines of evidence, 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.

Groundwater levels were increasing or stable at MB95, PZ90 and MB30. Groundwater levels were generally decreasing at MB91, MB93 and PZ89. Groundwater levels at MB92 fluctuated during the reporting period. Large drops in groundwater levels were observed in June 2020 at PZ10 and PZ10A that needs to be verified by continued monitoring.

MB93 exceeded the sulfate concentration trigger, MB95 exceeded the arsenic concentration trigger, and MB92 and MB93 exceeded the manganese concentration trigger during the reporting period. Despite exceeding the trigger value, concentrations of these parameters are generally within the typical range of values. It is possible that groundwater levels at PZ89 and MB93 have been influenced by dewatering of the Cadia Extended Pit to the north which has now ceased.

3.6 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. Though no discharges from the SROP occur and the clay lining likely prevents any significant seepage, the potential influence of the water at CAWS73 on nearby groundwater and surface water has been assessed.

The ore processing area is monitored by groundwater bores MB1A, MB1B, MB2A, MB2B, MB3A, MB3B, CB14A and CB14B, and surface water monitoring in Cadiangullong Creek at CAWS33.

Paper Size ISO A4

0 60 120 180 240

Metres

N

Horizontal Datum: GDA 1994
Grid: GCS GDA 1994

GHD

Newcrest Mining Limited
CVO AEMR –
Surface and Groundwater Assessment

Ore Processing Area

Project No. 12532418
Revision No. 0
Date 03 Sep 2020

FIGURE 3-15

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Print date: 03 Sep 2020 - 16:06

Data source: Newcrest: Bores, 2019. LPI: DCDB/DTDB, 2017. © Department of Finance, Services & Innovation 2017. Created by: pkiem, fmackay

3.6.1 Surface water

Physicochemical parameters

EC results for CAWS73 range between 1,430 and 4,140 µS/cm, and for CAWS33 range between 174 and 1,960 µS/cm during the reporting period. 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, when compared with CAWS33 being a surface water monitoring location on Cadiangullong Creek. EC levels during the reporting period remained within historical values.

TSS concentrations at CAWS33 have remained low throughout the period of monitoring, with a maximum of 28 mg/L recorded. TSS concentrations at CAWS73 have been more variable, ranging between 4 and 94 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 area is captured.

pH results for both sites remain steady with CAWS73 ranging from 8.36 to 9.28, and CAWS33 ranging from 7.1 to 8.27. pH is trending towards levels in the pH neutral range at both sites.

Nutrients

Elevated nitrogen concentrations have been regularly observed at CAWS73, as shown in Figure 3-16 and Figure 3-17 below. These figures show that the majority of the nitrogen observed at CAWS73, mostly nitrogen oxides concentrations, had been generally decreasing from 2011 to late 2018. However, since this time nitrogen oxide concentrations have shown an increasing trend at CAWS73.

No similar trend was observed in total phosphorous concentrations at CAWS73. No trend in nutrient concentrations at CAWS33 has been observed across the period of monitoring.

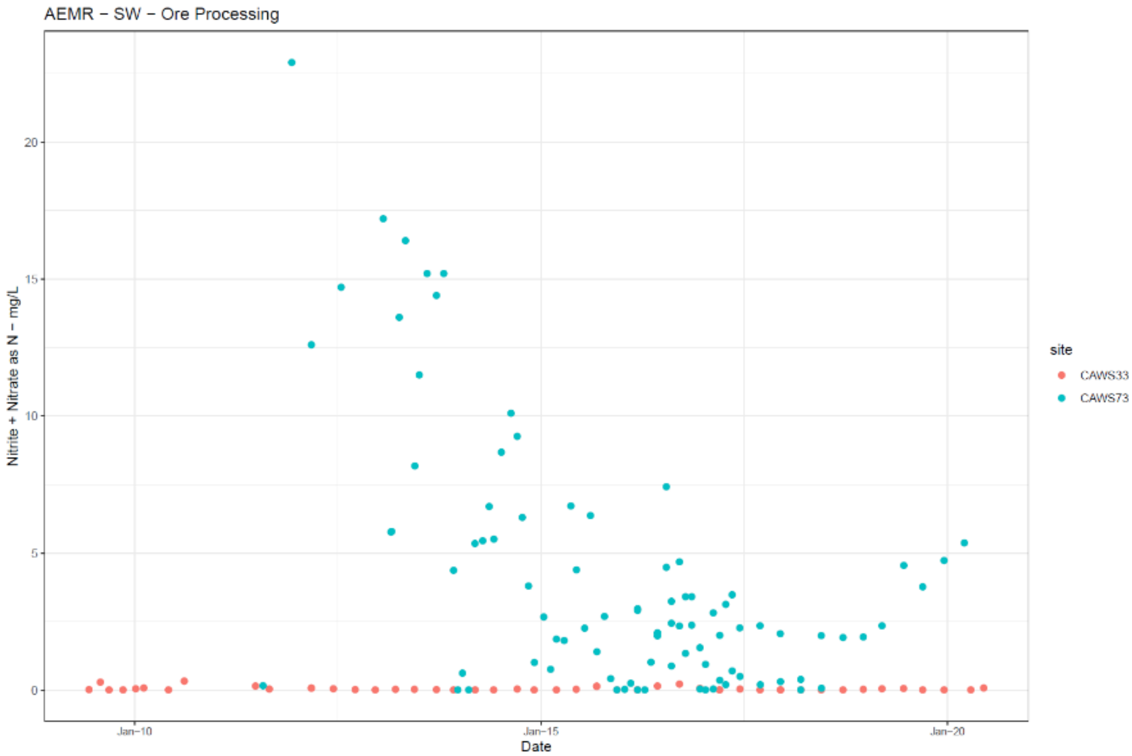

Figure 3-16 Nitrogen oxides concentrations in the Ore Processing Area

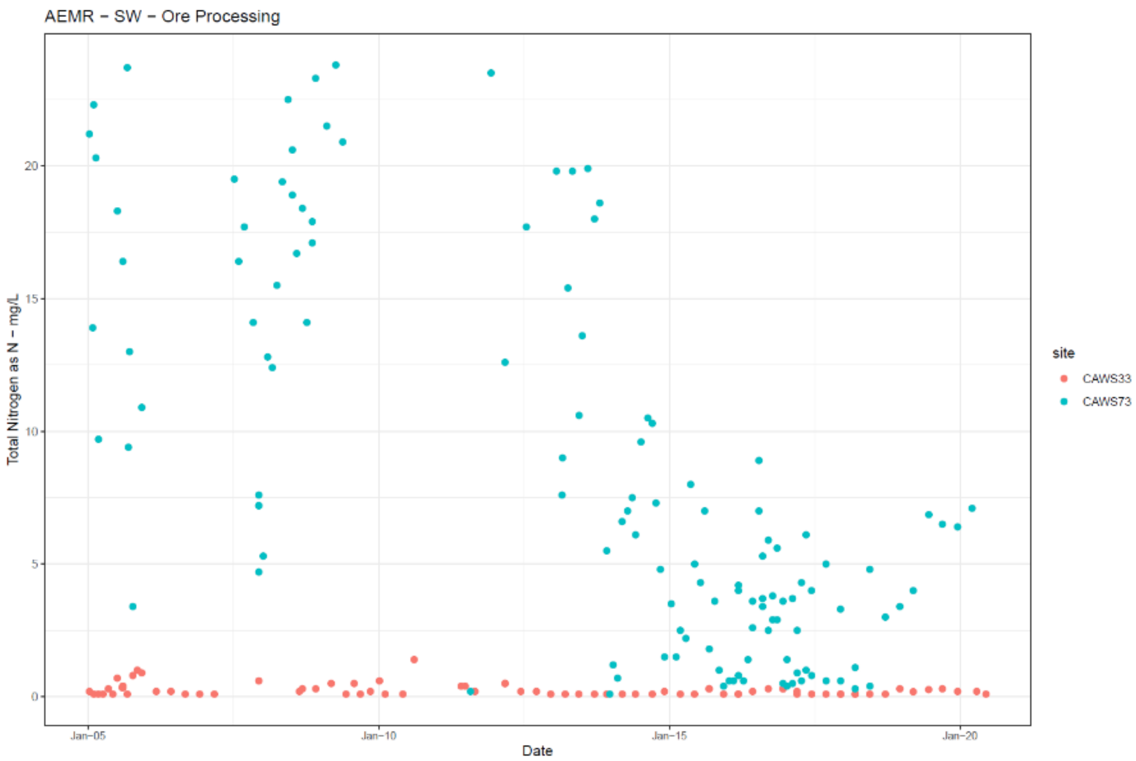

Figure 3-17 Total Nitrogen concentrations in the Ore Processing Area

Dissolved metals

No significant trends in dissolved metal concentrations were observed at CAWS33. Dissolved aluminium concentrations have been occasionally elevated at CAWS33 pre-2018, however this is most 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.

Increasing trends in the concentrations of major cations sodium, magnesium, calcium and potassium have been observed at CAWS73. CAWS73 captures runoff from around the ore treatment complex and the water captured is recycled for reuse on site. As such, increased salinity is to be expected at CAW73, especially during periods of low rainfall. Likewise, copper results have shown an increasing trend during the drought period.

3.6.2 Groundwater

The groundwater level at MB1A has historically not shown any relationship with CRD. This trend at MB1A has continued during the monitoring period, with groundwater levels at MB1A increasing over the monitoring period up to March 2020 despite generally decreasing CRD. Groundwater levels at MB1A were 3.3 m lower in June 2020. Additional monitoring conducted in August 2020 indicated this groundwater level observed at MB1A from June 2020 is an anomaly.

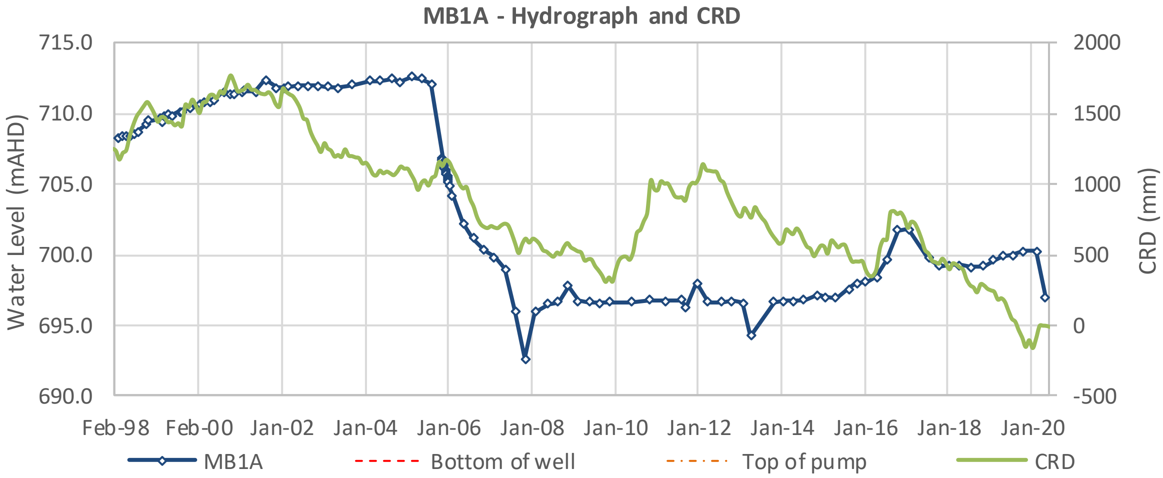

Figure 3-18 MB1A groundwater level hydrograph

MB1B has been dry for the majority of the monitoring record. MB1B was dry during the previous and current reporting periods.

The groundwater levels at MB2A and MB2B generally reflect the trends in the CRD for the majority of the monitoring period. For the previous reporting period the groundwater level increased approximately 1 m at MB2A and remained stable at MB2B despite a declining CRD trend. During the current reporting period groundwater levels at MB2A and MB2B were stable (refer Figure 3-19).

Arsenic concentrations were generally elevated at MB2A during the reporting period. Arsenic concentrations were above the historical range of results in August 2019, November 2019 and June 2020. Iron concentrations at MB2A were increasing during the monitoring period. No increasing trends in iron concentrations were observed in the SROP and therefore the increase at MB2A may be a localised influence from the soil and lithology. During the reporting period there was a generally increasing trend in manganese at MB2A, however concentrations remained within the historical range of values.

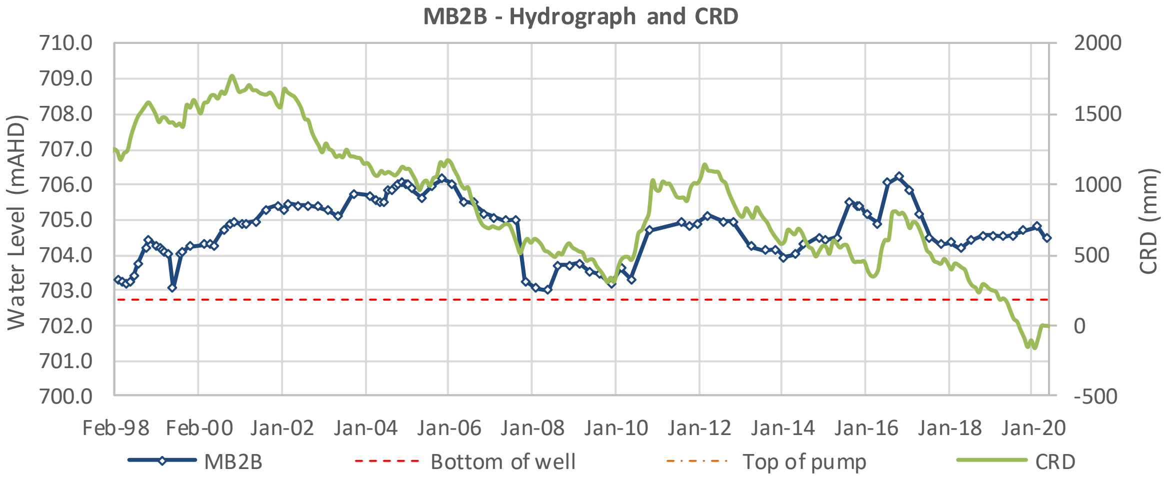

Figure 3-19 MB2B groundwater level hydrograph

The groundwater levels at MB3A and MB3B generally reflect the trends in the CRD for the majority of the monitoring period. For the previous reporting period the groundwater level increased at MB3A and remained stable at MB3B despite decreasing CRD. During the current reporting period groundwater levels at MB3A and MB3B were gradually increasing up to November 2019 despite decreasing CRD over this period. Groundwater levels at MB3A and MB3B fell slightly (by approximately 0.4 m) in March 2020 despite relatively steady CRD. Groundwater levels at MB3A are shown in Figure 3-20.

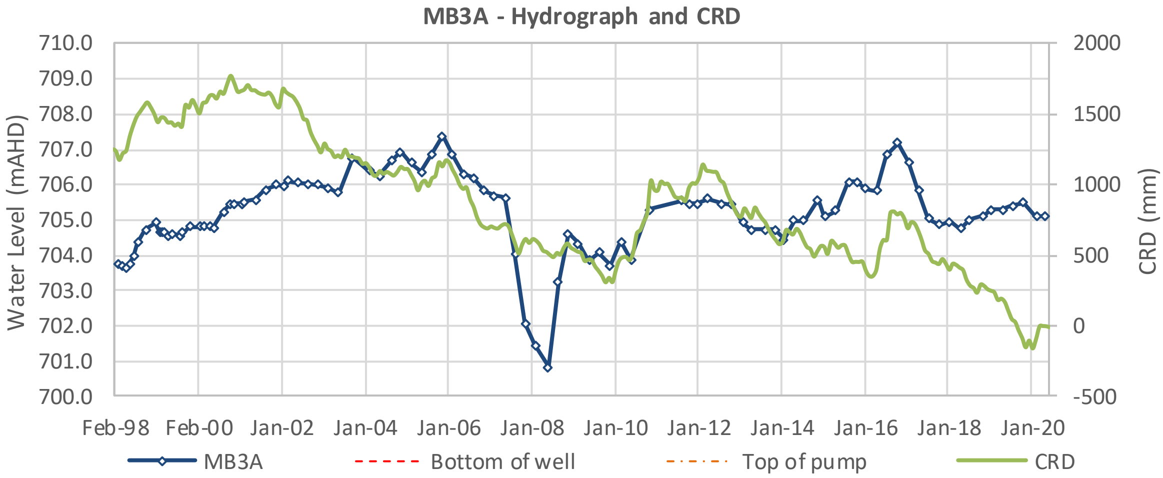

Figure 3-20 MB3A groundwater level hydrograph

During the previous reporting period, concentrations of TDS, nickel, calcium and sulfate were observed to be increasing at MB3A. During the current reporting period, concentrations of these parameters were stable or decreasing.

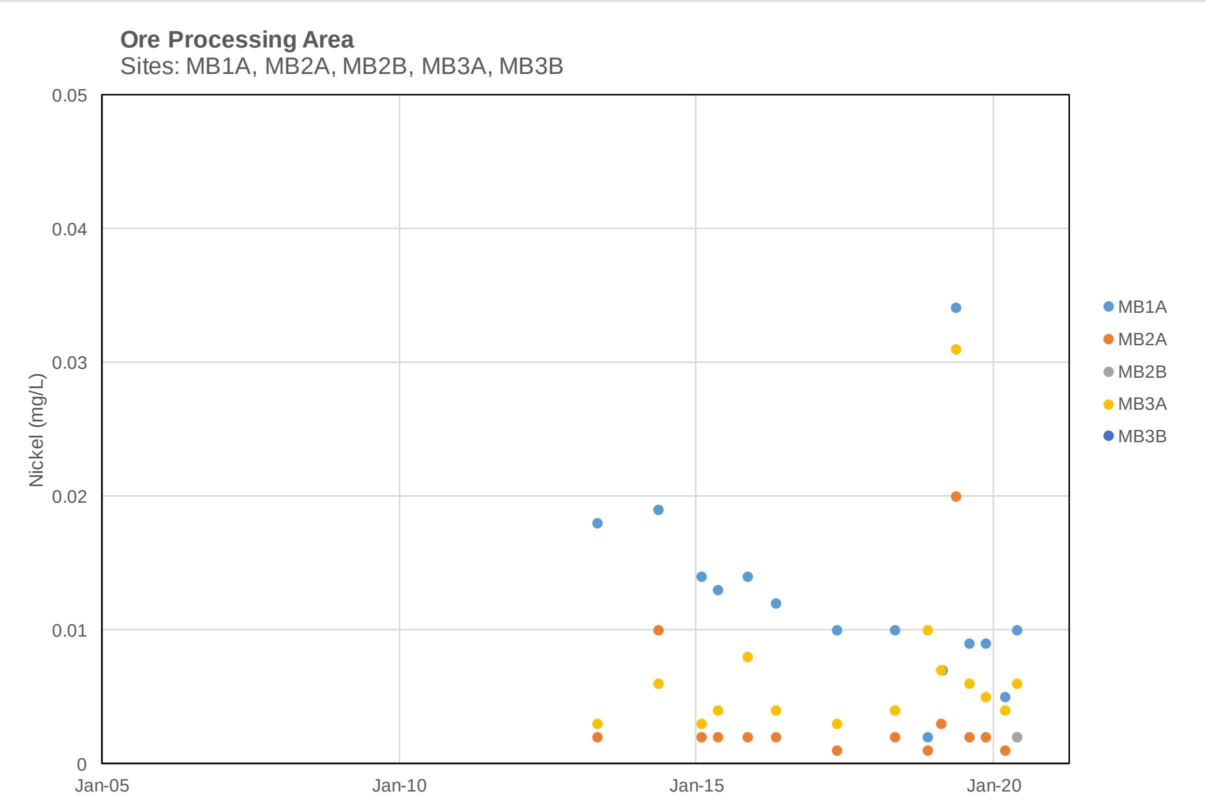

Figure 3-21 Nickel concentrations in the ore processing area

Zinc concentrations have shown historical variability at MB1A, MB2A and MB3A. This variability continued during the reporting period, with concentrations remaining within the range of historical results.

Monitoring bores CB14A and CB14B are located further to the north of the SROP, adjacent to Cadiangullong Creek. The groundwater levels at these bores generally reflect the trends in the CRD for the majority of the monitoring period.

During the previous reporting period groundwater levels increased by 0.5 m at CB14A and were steady at CB14B despite decreasing CRD. During the current monitoring period, groundwater levels at CB14A and CB14B were steady despite decreasing and increasing trends in the CRD. Groundwater levels at CB14A are shown in Figure 3-22. The observed groundwater level in July 2019 is considered to be an error.

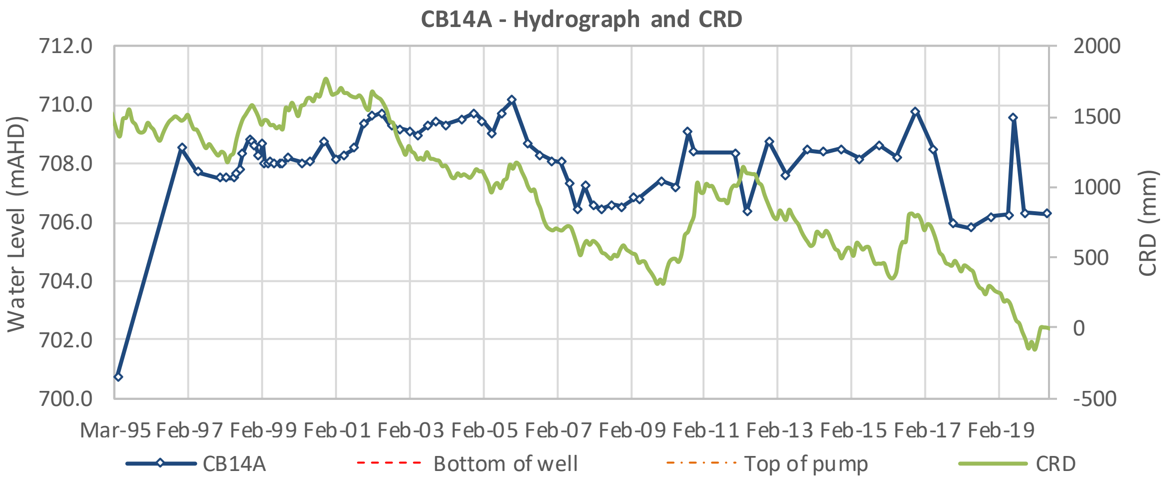

Figure 3-22 CB14A groundwater level hydrograph

Observations for the reporting period are summarised in Table 3-10. Hydrographs are plotted with the CRD in Appendix C.

Table 3-10 Ore processing area groundwater level observations

Aquifer					
Ordovician Volcanic		Silurian Sediment		Soil/clay	
Bores	Observation	Bores	Observations	Bores	Observations
MB2A	MB2A stable	MB1A MB3A CB14A CB14B	MB1A decreased by 3.3 m in June. MB3A remained relatively stable. CB14A and CB14B stable	MB1B MB2B MB3B	MB1B dry MB2B, MB3B remained stable.

The piper diagram in Figure 3-23 compares the major ion chemistry for CAWS73 and bores MB1A, MB2A and MB3A. The stormwater in the SROP and shallow groundwater are similar water types and have generally not changed over time so it is not possible to determine whether there is an increasing influence of pond water on groundwater. It is noted that the major ion concentrations are generally higher in groundwater.

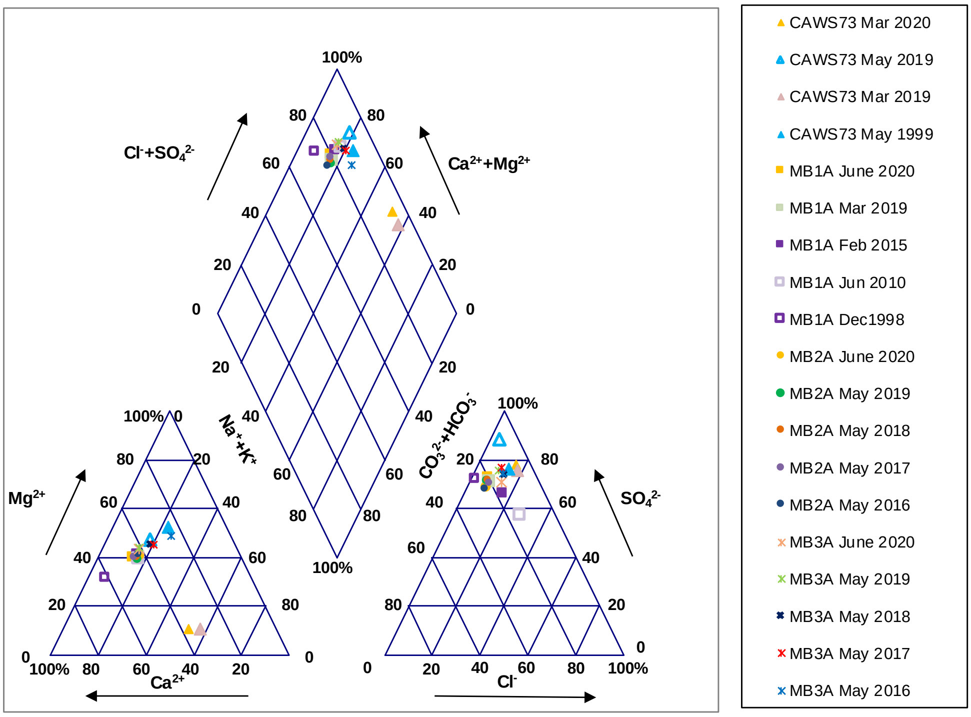

Figure 3-23 Piper diagram for MB1A, MB2A, MB3A and CAWS73

3.6.3 Summary

Water quality trends at site CAWS73 (the SROP) were observed, including an increasing trend of nitrogen oxides in the 2019/2020 reporting period. This followed a decreasing trend up to the end of 2019 which at the time was attributed to improved process efficiencies and/or water management.

Copper concentrations and major cations showed increasing trends at CAWS73 which are likely associated with low rainfall in the period.

The groundwater levels within the Ore Processing Area were generally steady during the monitoring period. Review of groundwater quality data indicates that the site runoff pond is not influencing groundwater. Major ion chemistry between SROP water and shallow groundwater is similar, although major ion concentrations are higher in groundwater so it is unlikely that the pond water is influencing the major ion chemistry of the groundwater. Elevated nitrogen and molybdenum, which characterises SROP water, is not detected in local groundwater.

No trends in the water quality at site CAWS33 were observed.

Hydrocarbon assessment

In March 2010 a monitoring program was submitted to the EPA to determine potential soil and water contamination from the diesel seep identified in December 2008. The plan was endorsed by the EPA. In accordance with this monitoring plan, sampling of three groundwater bores (MB1A, MB2A and MB3A) down gradient of the seep has been undertaken.

Groundwater sampling results available for review are shown in Table 3-11. The results show TPH concentrations above the detection limit in August 2018 at MB3A. Additional analysis undertaken by ALS Laboratory Group indicated that the chromographic profile for MB3A was not a characteristic of petroleum products.

Table 3-11 TPH groundwater sampling results

Sample date	Parameter	MB1A (µg/L)	MB2A (µg/L)	MB3A (µg/L)
August 2018	TPH C10-C14	<50	<50	<50
	TPH C15-C28	<100	<100	200
	TPH C29-C36	<50	<50	120
	TPH (sum) C10-C36	<50	<50	80
December 2018	TPH C10-C14	<50	<50	<50
	TPH C15-C28	<100	<100	<100
	TPH C29-C36	<50	<50	<50
	TPH (sum) C10-C36	<50	<50	<50
February – March 2019	TPH C10-C14	<50	<50	<50
	TPH C15-C28	<100	<100	<100
	TPH C29-C36	<50	<50	<50
	TPH (sum) C10-C36	<50	<50	<50
May 2019	TPH C10-C14	<50	<50	<50
	TPH C15-C28	<100	<100	<100
	TPH C29-C36	<50	<50	<50
	TPH (sum) C10-C36	<50	<50	<50
August 2019	TPH C10-C14	<50	<50	<50
	TPH C15-C28	<100	<100	<100
	TPH C29-C36	<50	<50	<50
	TPH (sum) C10-C36	<50	<50	<50

3.7 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.

Groundwater is monitored in the waste rock dump area by MB4A/B, MB5C, MB6A/B, MB7A/B, MB8A/B, MB9A/B, MB10A/B, MB11A/B and CB6A.

The nearest downstream Cadiangullong Creek site is 412161, which is the potential receptor for any impact of the SWRDs on surface water quality.

Paper Size ISO A4

0 125 250 375 500

Metres

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

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Surface and Groundwater Assessment

Project No. 12532418
Revision No. 0
Date 03 Sep 2020

Waste Rock Dumps

FIGURE 3-24

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Print date: 03 Sep 2020 - 16:06

Data source: Newcrest: Bores, 2019. LPI: DCDB/DTDB, 2017. © Department of Finance, Services & Innovation 2017. Created by: pkiem, fmackay

3.7.1 Surface water

Physicochemical parameters

The pH of the waste rock dump leachate at CAWS34 ranges from slightly acidic and trending towards slightly alkaline, whereas the pH at CAWS35 is slightly alkaline.

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 3000 µS/cm. EC at CAWS52 has recently showed an increasing trend likely due to drought conditions (see Figure 3-25).

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.

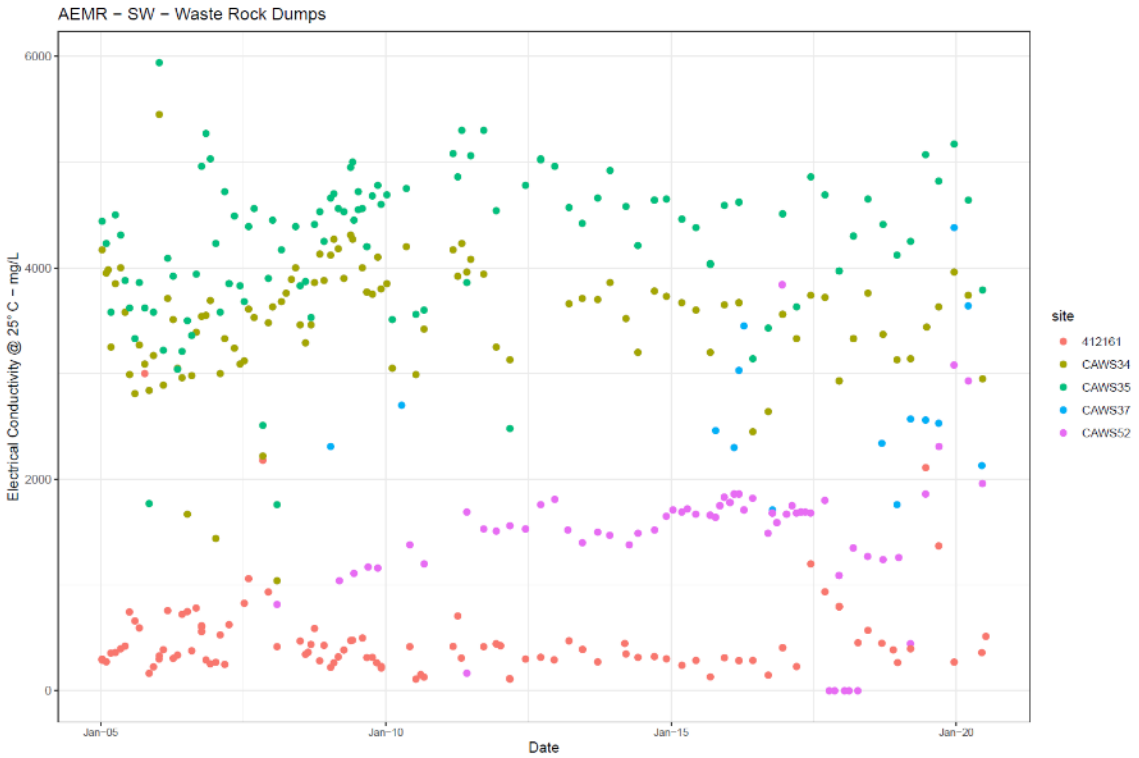


Figure 3-25 Electrical conductivity in the waste rock dumps area

Nutrients

The waste rock dump leachate contains very high concentrations of nitrogen oxides, as shown Figure 3-26. 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.

A decreasing trend in nitrogen oxide concentrations has also been observed at Rodds Creek Dam (CAWS52), which likely reflects the influence of pumped NTSF decant water to the dam.

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.

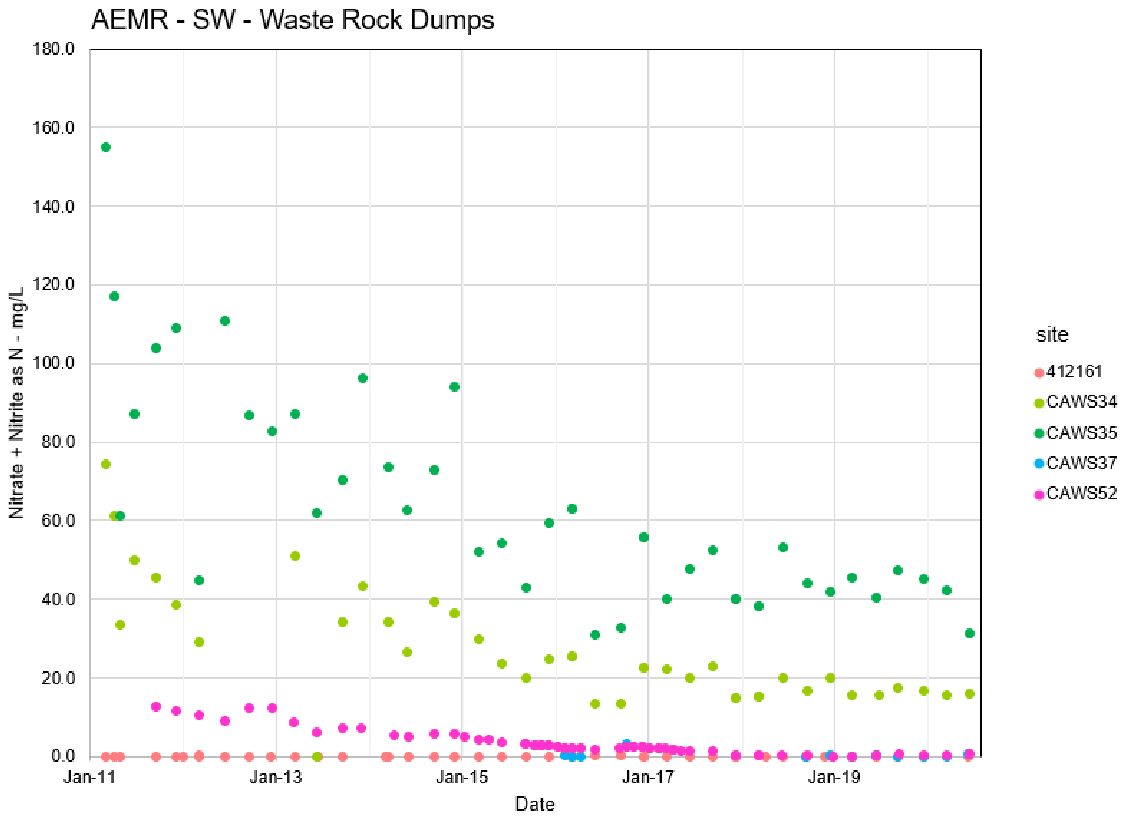


Figure 3-26 Nitrogen oxide concentrations in the waste rock dumps area

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. The exception to this trend is molybdenum (Figure 3-27), which has remained elevated at CAWS35, with no increase or decrease, however there is some sinuosity suggesting an annual cycle. 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 influences of process water as well as tailings decant water pumped to Rodds Creek Dam from the NTSF. The CAWS52 molybdenum results have shown an increasing trend since monitoring records began.

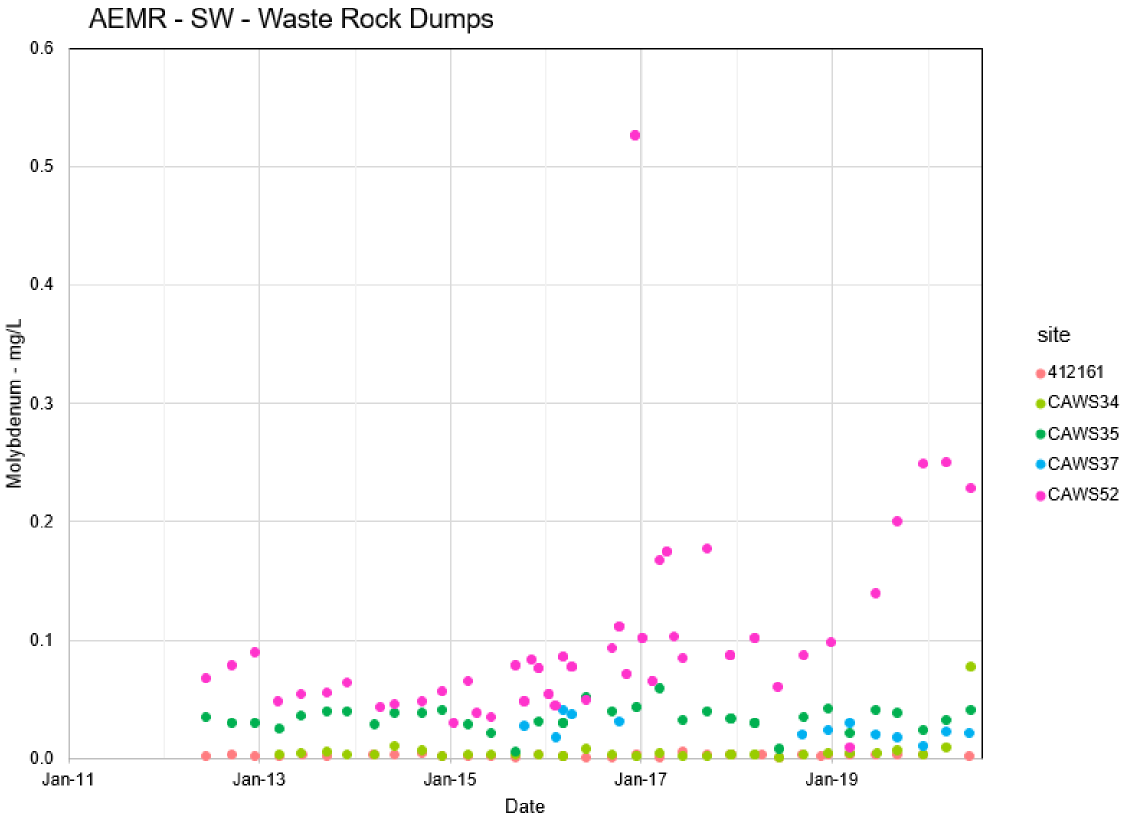


Figure 3-27 Molybdenum concentrations in the waste rock dumps area

Major ion composition

Average major ion (calcium, magnesium, sodium, potassium, chloride, bicarbonate and sulfate) concentrations at CAWS34, CAWS35, CAWS52 and 412161 for the 2017-2018, 2018-2019 and 2019-2020 reporting periods and all available previous data for each site were used to create the Piper chart presented as Figure 3-28. 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 impact of the leachate in the creek between 1994 and 2020. The water at Rodds Creek Dam is also shown to be ionically dissimilar to that of the leachate at CAWS34 and CAWS35, with less dominance of calcium, magnesium and sulfate, though greater sulfate dominance than that observed at 412161, which is indicative of water pumped to the dam from the NSTF.

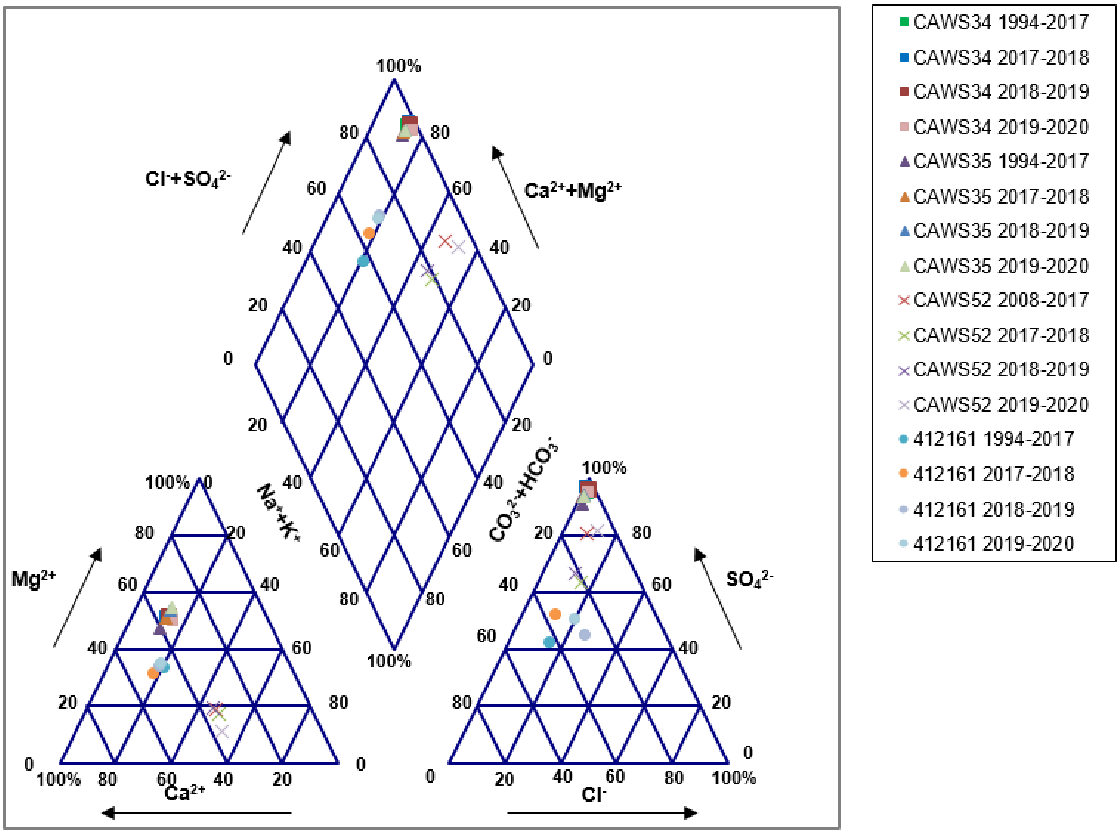


Figure 3-28 Piper chart showing differences in major ion compositions at CAWS34, CAWS35, CAWS52 and 412161

3.7.2 Groundwater

Soil and clay

The shallow monitoring bores within the soil and clay layer historically reflect trends in the CRD. Review of monitoring data at MB4B indicates that the increase in groundwater level in the previous reporting period is likely to be an error. Since early 2017 groundwater levels at MB4B were generally decreasing in accordance with decreasing CRD. Groundwater levels at MB4B increased in June 2020 by approximately 0.5 m likely due to increasing CRD.

The groundwater levels at MB6B, MB8B, MB10B and MB11B showed overall declining trends during the previous monitoring period, consistent with the CRD. The groundwater levels at these bores generally continued to vary in accordance with CRD during the current reporting period, with groundwater levels decreasing between May 2019 and November 2019, and then increasing by between 0.3 m and 1.1 m between November 2019 and June 2020. The exception to this was MB8B where groundwater levels increased by 1.2 m throughout the current monitoring period.

During the previous reporting period, groundwater levels at MB9B were relatively constant. However during this reporting period groundwater levels at MB9B varied in accordance with CRD with levels decreasing by 2.2 m between May 2019 and March 2020 and increasing by 1.3 m between March 2020 and June 2020.

During the previous monitoring period groundwater levels at MB7B responded to CRD; groundwater levels increased in response to the above average rainfall event in October/November 2018 and then continued to follow a declining trend in accordance with CRD. During the current reporting period groundwater levels at MB7B continued to decrease up to November 2019 in accordance with CRD then responded to a period of above average rainfall (refer Figure 3-29).

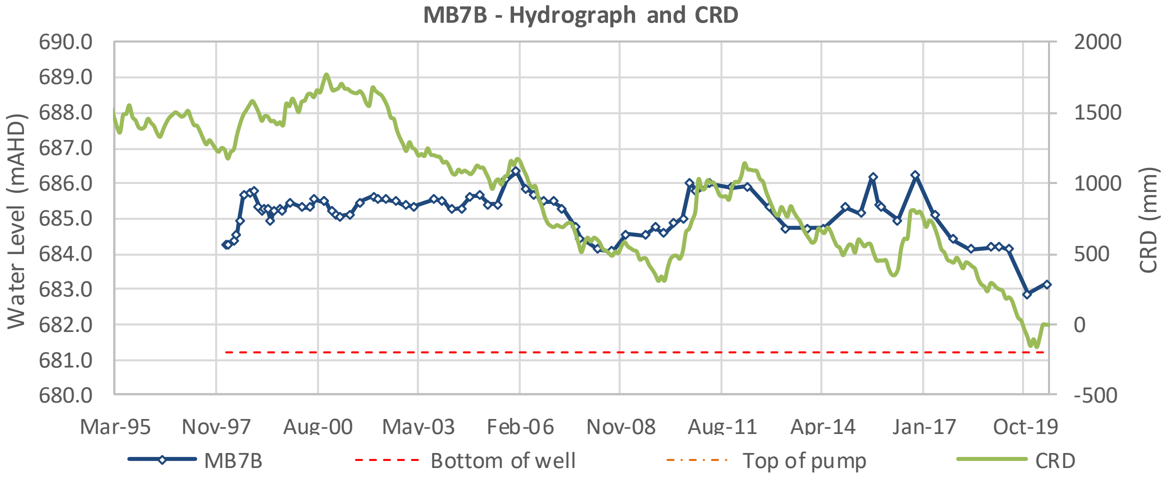


Figure 3-29 MB7B groundwater level hydrograph

Tertiary Basalt

The groundwater level at MB5C showed a rapid decline between April and July 2017. During the previous reporting period there was a delayed increase in the groundwater level following the above average rainfall event in October/November 2018. Following this the groundwater level showed a declining trend, consistent with the CRD. This decreasing trend continued throughout the current reporting period in accordance with CRD until groundwater levels increased in response to a period of above average rainfall in March and April 2020 (refer Figure 3-30).

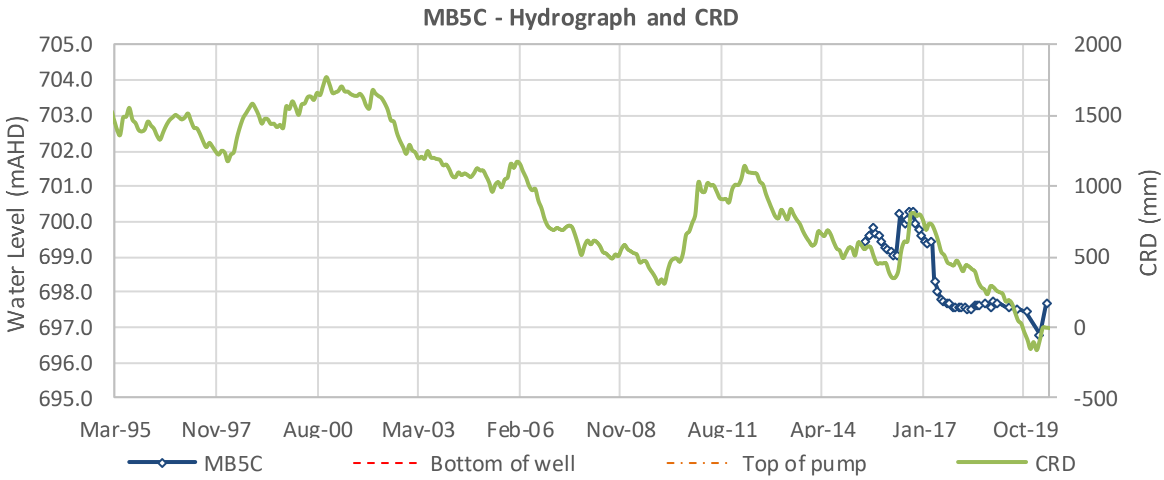


Figure 3-30 MB5C groundwater level hydrograph

Ordovician Volcanic

The groundwater levels in the Ordovician Volcanics have historically followed the trends in the CRD. For the previous reporting period the groundwater level at MB6A increased in response to the above average rainfall event in October/November 2018 and then followed a declining trend, consistent with the CRD. During the current reporting period groundwater levels continued to follow the CRD trend, with groundwater levels continuing to decrease until they displayed a response to increasing CRD in June 2020. During the previous reporting period, MB4A declined approximately 0.5 m in accordance with decreasing CRD. During the current reporting period this decreasing trend at MB4A continued until groundwater levels increased following a period of increasing CRD. Similarly, MB9A has continued to show a trend of responding to CRD with groundwater levels decreasing during the reporting period up to November 2019 in accordance with CRD. Groundwater levels at MB9A increased in 2020 following a period of increasing CRD.

Silurian sediment

The groundwater levels within the Silurian Sediment monitoring bores have historically reflected trends in the CRD.

CB6A is the monitoring bore for the CB6 production bore adjacent to the Southern Leachate Dam. Since November 2018 the groundwater levels show influence from pumping with rapid decline and recovery (refer Figure 3-31).

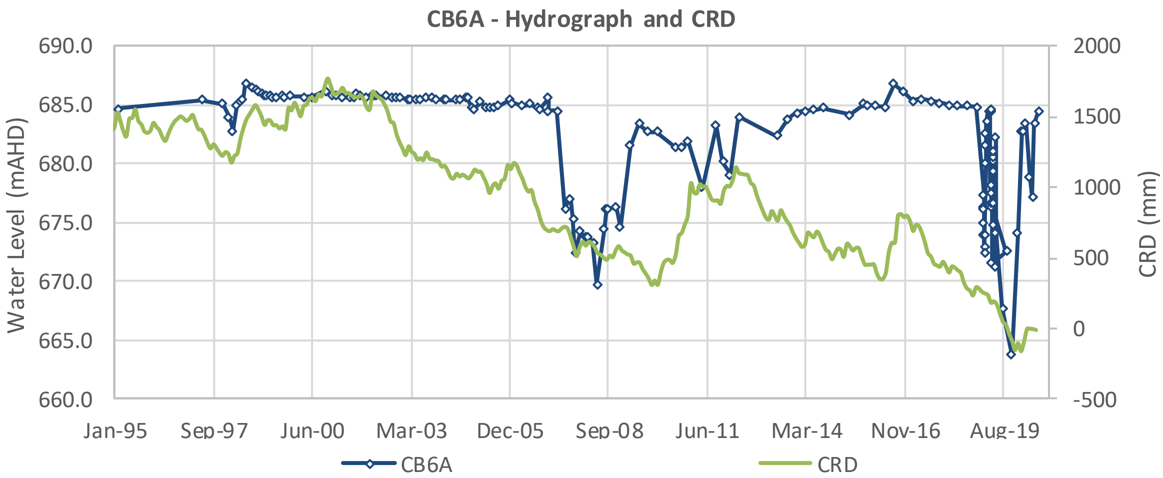


Figure 3-31 CB6A groundwater level hydrograph

MB7A, MB8A, MB10A and MB11A show similar historical trends, generally following trends in the CRD. For the previous reporting period, the groundwater levels at these bores showed an increase in response to the above average rainfall event in October/November 2018, and then followed a declining trend in accordance with CRD. During the current reporting period, groundwater levels at MB7A and MB10A continued to follow trends in CRD with groundwater levels at MB7A and MB10A decreasing in the period up to November 2019 in accordance with CRD and then increasing in accordance with increasing CRD. However groundwater levels at MB8A and MB11A consistently increased throughout the reporting period by 1.5 m and 0.8 m respectively, despite periods of decreasing and increasing CRD, although levels at these locations did not increase above the historical range.

Groundwater level observations for the reporting period are summarised in Table 3-12. Remaining hydrographs are plotted with the CRD in Appendix C.

Table 3-12 Waste rock dump groundwater level observations

Aquifer					
Ordovician Volcanic		Silurian Sediment		Soil/clay	
Bores	Observation	Bores	Observations	Bores	Observation
MB4A MB6A MB9A MB5C (Basalt)	MB4A, MB6A and MB9A varied in accordance with CRD trends MB5C varied in accordance with CRD trends	MB7A MB8A MB10A MB11A CB6A	MB7A, MB10A responded to changes in CRD. MB8A and MB11A increased approximately 1.5 m and 0.8 m respectively CB6A shows influence from pumping	MB4B MB6B MB7B MB8B MB9B MB10B MB11B	MB4B, MB6B, MB7B, MB9B, MB10B and MB11B fluctuated in accordance with CRD trends. MB8B increased by 1.2 m

Groundwater quality

Historically, EC, TDS, calcium, magnesium and sulfate measurements show an increasing trend at the majority of bores.

At the southern bores, during the current reporting period EC and TDS was slightly decreasing at CB6A, MB7A and MB11A and was constant or slightly increasing at MB8A, MB9A and MB10A. Trends in calcium, magnesium, sodium and sulfate at these bores generally reflected the trends in EC and TDS. Bores that are monitored quarterly (CB6A, MB9A and MB10A) displayed variability in EC, TDS and major cations and anions due to rainfall. Concentrations of these parameters at CB6A, MB9A and MB10A were lower in March 2020 following a period of above average rainfall. There was a peak in sulfate at MB8A and MB9A in November 2019, prior to the period of above average rainfall. Sulfate concentrations at MB8A and MB9A were lower in subsequent monitoring rounds.

At the northern bores (MB4A, MB5C and MB6A), during the reporting period TDS and EC was generally constant or slightly decreasing. TDS concentrations at northern bores are plotted in Figure 3-32. Concentrations of calcium, magnesium, sodium and sulfate at these bores were generally constant during the monitoring period. At MB5C, which is monitored quarterly, variability in EC, TDS and major cations and anions due to rainfall was evident. At MB5C, concentrations of these parameters were lower in March 2020 following a period of above average rainfall.

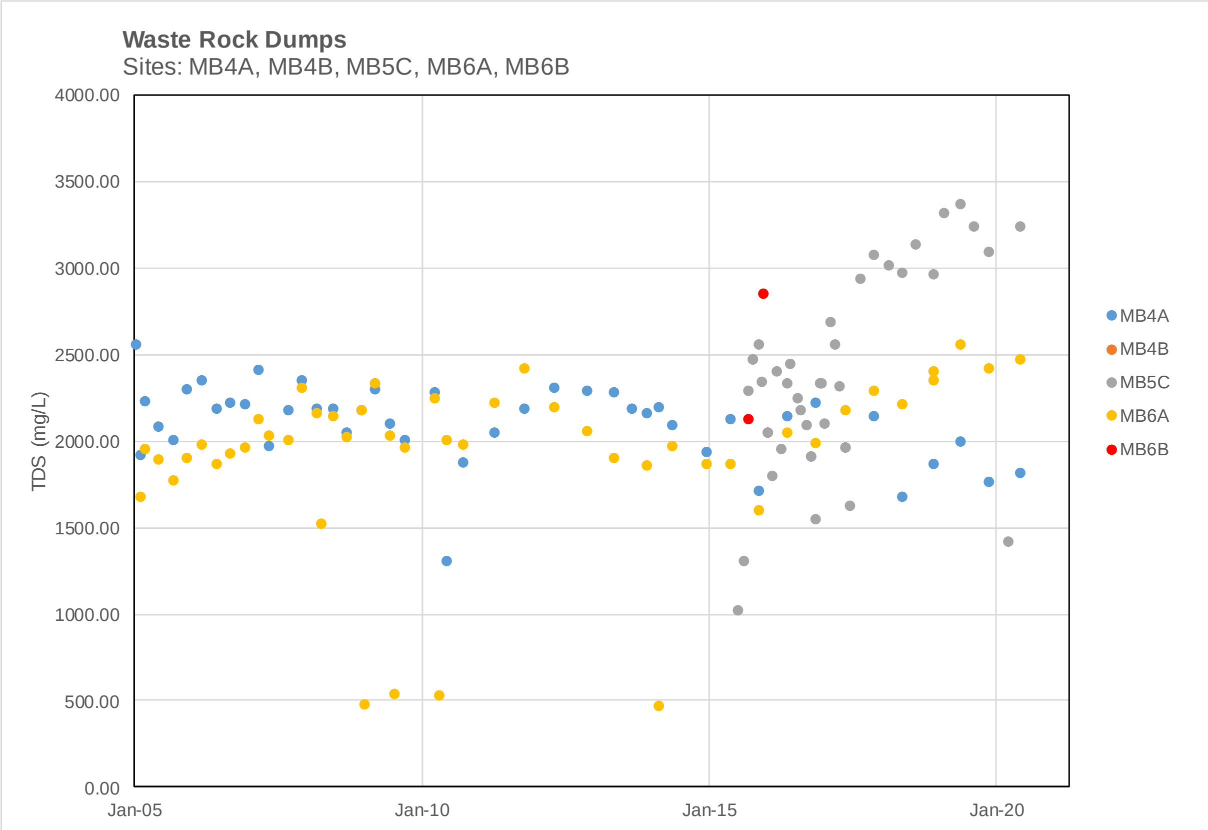


Figure 3-32 TDS concentrations for monitoring bores within the waste rock dump area (northern bores)

During the previous reporting period, an increasing trend in nickel was observed at the majority of the northern bores. CHPL's Level 1 investigations concluded that elevated nickel was due to field or laboratory contamination or interference. Nickel concentrations at the northern bores were lower in the current monitoring period.

During the previous reporting period, an increasing trend in copper was identified at MB8A, MB9A and MB11A. During the current reporting period, copper concentrations were lower, similar to long term averages, with the exception of MB11A where copper was elevated in the June 2020 monitoring round. During the previous monitoring round, molybdenum concentrations at CB6 were increasing up to 0.006 mg/L. However since May 2019 molybdenum concentrations at CB6 were constant between 0.002 mg/L and 0.003 mg/L.

There was a slight spike in nitrate at CB6A in March 2020. Nitrate concentrations decreased at CB6A in subsequent monitoring rounds. No spike in nitrate was observed at surrounding bores in the southern waste rock dump area.

The Piper diagrams in Figure 3-33 and Figure 3-34 compare major ion chemistry of local groundwater to that of the northern leachate pond and southern leachate pond respectively. Waste rock dump leachate is calcium/magnesium sulfate dominant. Groundwater is generally calcium sulfate dominant. Prior to the current monitoring period, there appears to be some increase in sulfate dominance over time at MB5C, MB6A, MB8A and MB10A which indicates there may be some localised influence of SWRD leachate on groundwater. However, with the exception of manganese at MB6A, there are no trends in metals or nitrate that indicates influence of SWRD leachate at these bores.

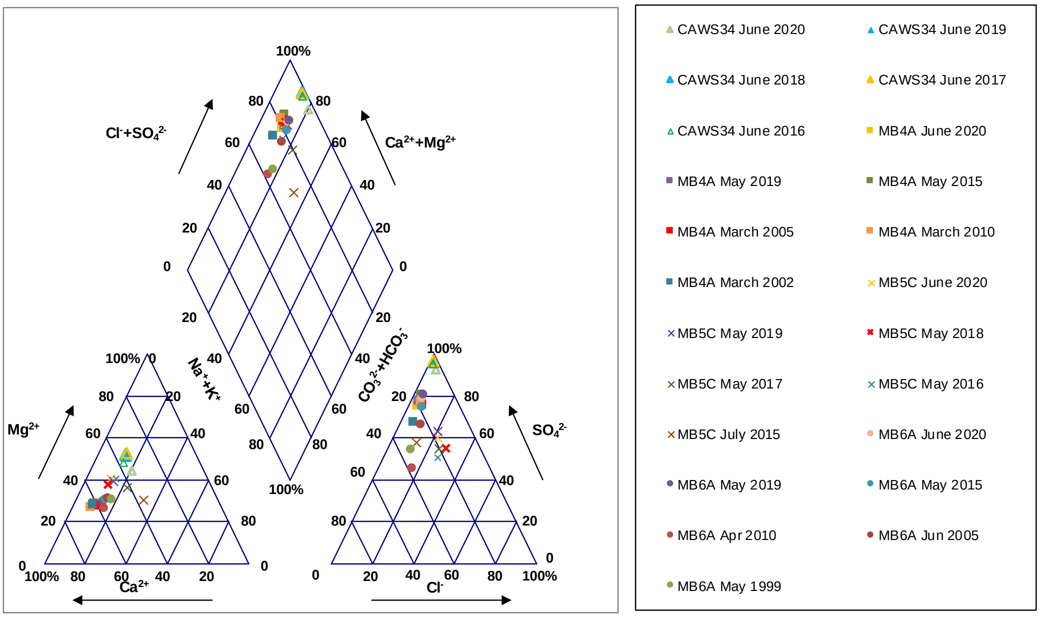


Figure 3-33 Piper diagram for MB6A, MB4A, MB5C and CAWS34

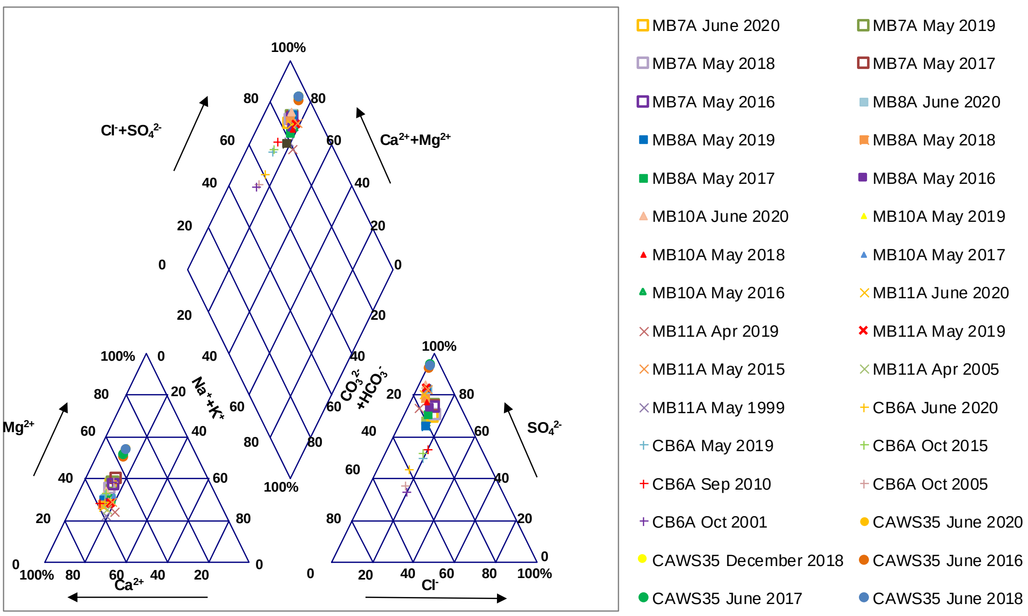


Figure 3-34 Piper diagram for MB7A, MB8A, MB10A, MB11A, CB6A and CAWS35

3.7.3 Summary

For the reporting period, the majority of bores within the Waste Rock Dump area reflected trends in the CRD. MB8A, MB8B and MB11A showed increasing trends however this needs to be confirmed with further monitoring.

The waste rock dump leachate contains very high concentrations of nitrogen oxides, however, with the exception of a short term spike in nitrate at CB6A in March 2020, no elevated or increasing concentrations of nitrogen oxides were observed in the groundwater. There appears to be some increase in sulfate dominance over time at MB5C, MB6A, MB8A and MB10A which indicates there may be some localised influence of SWRD leachate on groundwater. However, there are no changes in metals or nitrate at these bores that indicates influence of the SWRD leachate. Additionally, sulfate concentrations at these locations were relatively constant during the monitoring period and there was no change in influence of WRD leachate on local groundwater during the reporting period. The waste rock dump leachate is not ionically similar to the water in Cadiangullong Creek at 412161, which indicates that there has been no impact of the leachate in the creek.

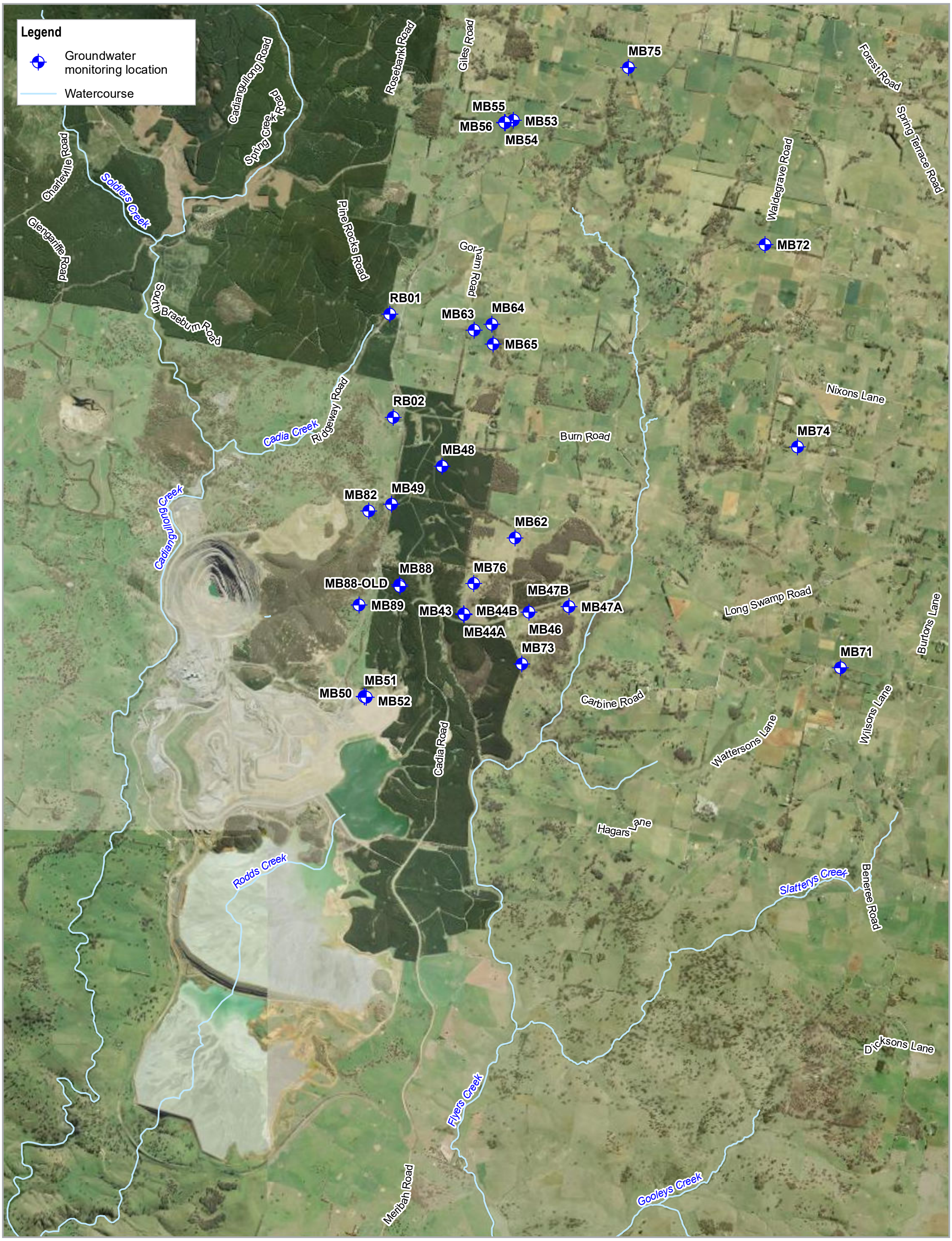
There is an increasing trend in dissolved molybdenum concentrations at Rodds Creek Dam, CAWS52, over the reporting period. This is likely due to increased reuse of mine water by pumping TSF decant water to Rodds Creek Dam. TSF decant water sites CAWS42 and CAWS43 have also shown an increasing trend in molybdenum concentrations over this period. However, there is no suggestion of migration of this increasing trend at hydrologically downgradient groundwater monitoring bores on the western side of the NTSF. Also, there were no increasing trends in molybdenum concentrations at surface water monitoring locations in the Western TSF Zone during the reporting period.

3.8 Cadia East

The focus of the assessment in the Cadia East area is on groundwater drawdown as a result of the underground mining operations and groundwater quality changes that may occur due to level changes.

Groundwater is monitored at Cadia East by MB43, MB44A, MB44B, MB46, MB47A, MB47B, MB48, MB49, MB50, MB51, MB52, MB53, MB54, MB55, MB56, MB62, MB63, MB64, MB65, MB71, MB72, MB73, MB74, MB75, MB76, MB82, MB88, MB89, RB01 and RB02.

There are no surface water monitoring sites in the Cadia East zone.



Paper Size ISO A4

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Metres

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

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Project No. 12532418
Revision No. 0
Date 03 Sep 2020

Cadia East

FIGURE 3-35

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Print date: 03 Sep 2020 - 16:07

Data source: Newcrest: Bores, 2019. LPI: DCDB/DTDB, 2017. © Department of Finance, Services & Innovation 2017. Created by: pkiem, fmackay

3.8.1 Groundwater

Tertiary Basalt

A previous AEMR report (2017-2018) discussed the groundwater level at MB45, and attributed the decline to the lowering of pressure in the underlying bedrock or bore construction methodology. The groundwater level at MB45 continued to decline, until November 2018 when the bore was decommissioned. An additional bore, MB88, was installed nearby to determine whether groundwater levels were declining in the Tertiary Basalt or underlying Silurian/Ordovician bedrock. Monitoring of MB88 began in July 2017, and the groundwater level declined approximately 5 m by September 2018. This bore was redrilled in August 2018, and the groundwater level continued to decline by approximately 2.5 m until January 2019. Since January 2019 the groundwater level at MB88 has increased by approximately 0.9 m, despite generally decreasing CRD, refer Figure 3-36.

During the previous reporting period elevated concentrations of molybdenum and sodium were observed at MB88. During the current reporting period, molybdenum was lower (0.005 mg/L) and constant at MB88; and sodium was within the range of typical values (approximately 120 mg/L).

Arsenic concentrations have been decreasing at MB88 since September 2018 and CHPL’s Level 1 investigations concluded that the elevated arsenic readings are not indicative of a broader increase in arsenic. During the reporting period, arsenic was consistently below the limit of reporting (0.001 mg/L). The manganese trigger value was exceeded at MB88 during the reporting period. During the current reporting period manganese concentrations were similar to the previous reporting period and were within the range of historical results. CHPL’s Level 1 investigations concluded that there is no suggestion from the data that manganese represents a mine related impact.

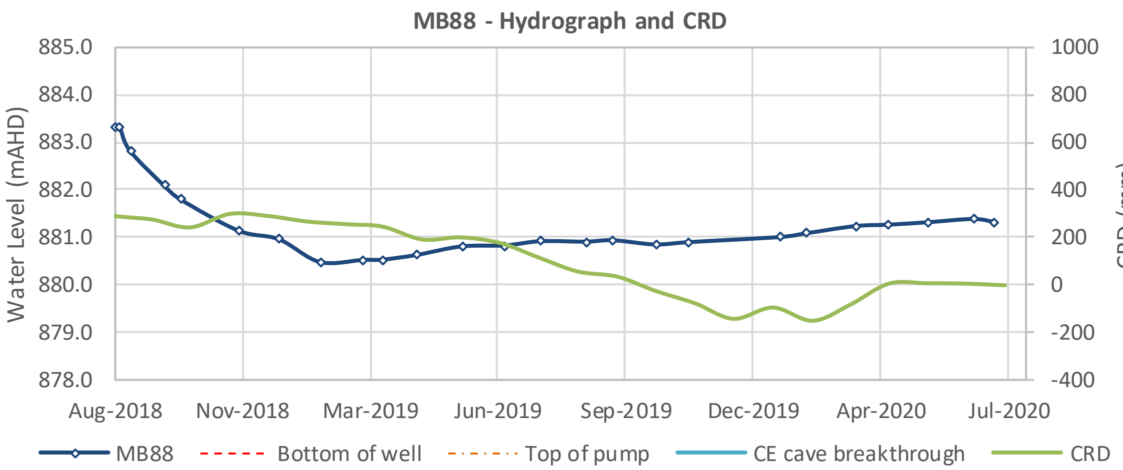


Figure 3-36 MB88 groundwater level hydrograph

The groundwater level at MB49 has displayed a historical decreasing trend, generally attributable to the overall declining CRD. During the reporting period this decreasing trend generally continued. Groundwater levels at MB49 were relatively stable between March 2020 and June 2020, likely due to a period of increasing CRD (refer Figure 3-37). pH below the guideline value was observed at MB49 which could be attributable to the ongoing drawdown in groundwater level.

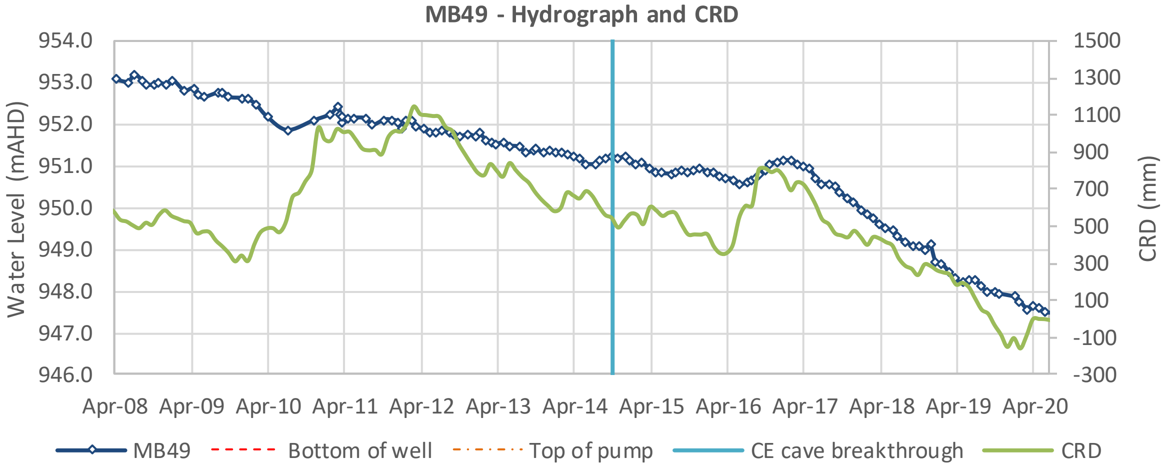


Figure 3-37 MB49 groundwater level hydrograph

Since October 2016, the groundwater levels at MB44B and MB73 (Silurian Sediments), refer Figure 3-38, have been declining. This trend continued during the previous and current reporting periods. The declining trend appears to reflect the CRD however the groundwater levels in these bores prior to October 2016 do not show significant drawdown response during periods of below average rainfall.

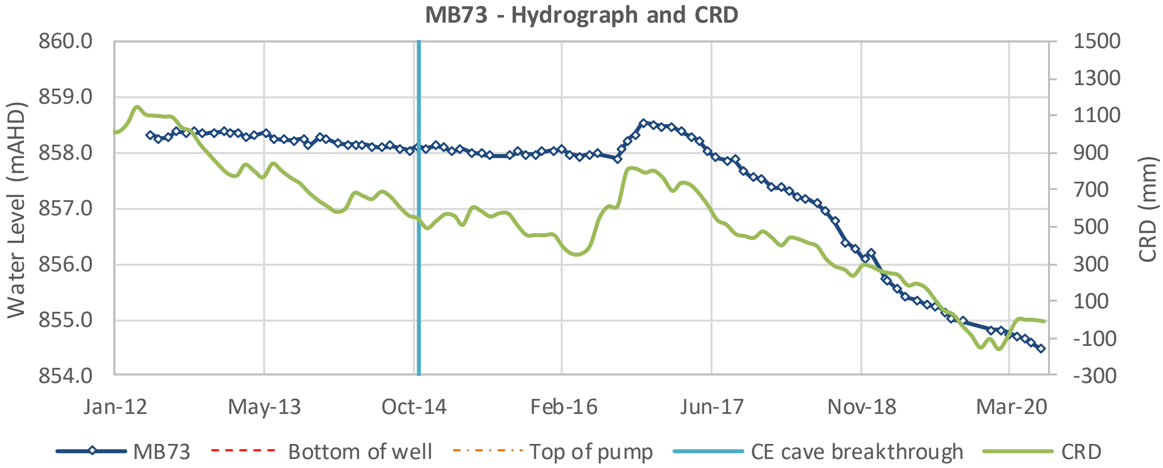


Figure 3-38 MB73 groundwater level hydrographs

The groundwater level data for MB44B and MB73 was statistically assessed using the Hydrograph Analysis Rainfall and Time Trends (HARTT) statistical method. HARTT is a Microsoft Excel based regression model developed by the Western Australian Department of Agriculture and Food (Ferdowsian et al, 2000). HARTT involves establishing an underlying temporal trend in the groundwater level by separating the effect of above and below average rainfall. As such, the relationship between groundwater change and typical rainfall is established and it is possible to identify other factors that may influence the groundwater level.

For MB73 and MB44B the HARTT analysis indicates a statistically significant decreasing time trend (independent of rainfall). The declining groundwater level trend can therefore not be entirely attributed to lack of rainfall. Both MB44B and MB73 are located within areas of pine plantations which would intercept rainfall recharge, and may be contributing to the increased rate of groundwater level decline. Both bores are located outside the predicted influence of mining based on 2016 groundwater model and therefore it is most likely that the trend is not related to mining activities. Therefore it is considered that there has not been an exceedance of guideline level at MB44B.

Monitoring bores MB53, MB54, MB55 and MB56 are located towards the far north of the site. These bores historically reflect trends in the CRD. During the previous reporting period groundwater levels at MB53 and MB56 continued to respond to CRD trends; however MB54 and MB55 showed an increasing trend between November 2018 and May 2019 despite a period of decreasing CRD. During the current reporting period groundwater levels at MB53, MB54, MB55 (refer Figure 3-39), and MB56 were steady or were gradually increasing despite decreasing CRD for most of the reporting period. The increasing trends despite decreasing CRD may be due to bores recharging as a localised change in land use. The increase in groundwater levels between March 2020 and June 2020 at these bores is potentially due to increasing CRD over this period. The groundwater level guideline at MB55 was not exceeded during the reporting period.

Historically there have been increasing nitrate and total nitrogen concentrations at MB54 and MB56, likely attributable to farming activities in the area surrounding these bores. During the reporting period, nitrate and total nitrogen were slightly elevated in September 2019 but decreased throughout the remainder of the reporting period. Nitrate remained below the guideline value at MB54 and MB56. pH below the guideline was observed at MB54 and MB56 during the reporting period. Continued monitoring of pH is recommended to confirm trends at MB54 and MB56.

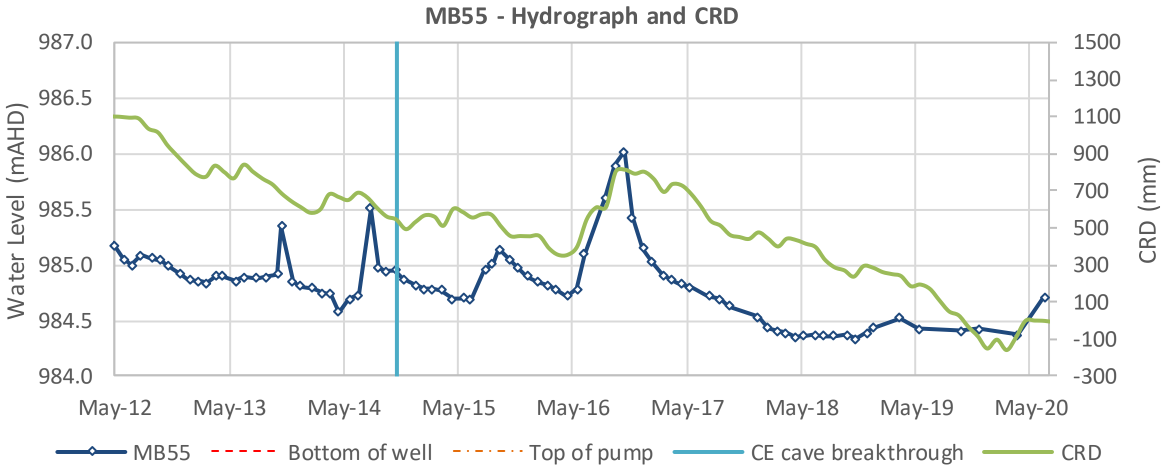


Figure 3-39 MB55 groundwater level hydrograph

MB72 and MB74 are located to the far east of the site. MB72 and MB74 historically reflect trends in the CRD. During the previous reporting period groundwater levels at MB74 showed a decreasing trend which continued through the majority of the reporting period. Groundwater levels at MB74 increased between March 2020 and June 2020 in response to a period of increasing CRD. The groundwater level at MB72 has experienced periods of increasing groundwater level despite decreasing CRD, including between May 2018 and October 2018, and between May 2019 and October 2019. Increasing groundwater level during periods of decreasing CRD was previously attributed to changing land use (GHD, 2019). Groundwater levels at MB72 were decreasing between August 2019 and March 2020 during a period of decreasing CRD. Groundwater levels at MB72 increased between March 2020 and June 2020, likely in response to increasing CRD over this period.

MB63, MB64 and MB65 (Silurian Sediments) are located to the north of the site and outside the influence of mining based on the 2016 groundwater model. Previous review of groundwater levels indicated seasonal variation at MB63. For the four years prior to September 2017, groundwater levels peaked between September and November and reached a minimum between May and July. The seasonal variation was considered to be non-mining related due to the distance of the bores from mining activities. However during the reporting period groundwater levels at MB63 were generally in decline. However groundwater levels at MB63 did respond to a period of generally increasing CRD between March 2020 and June 2020 (refer Figure 3-40).

The groundwater level hydrograph for MB63 was assessed using the HARTT method. The HARTT analysis indicated a statistically insignificant time trend. The historical declining groundwater level trend between 2017 and 2019 is therefore consistent with the CRD, and the lack of any significant rainfall recharge events over this period. Regression statistics are shown in Appendix D.

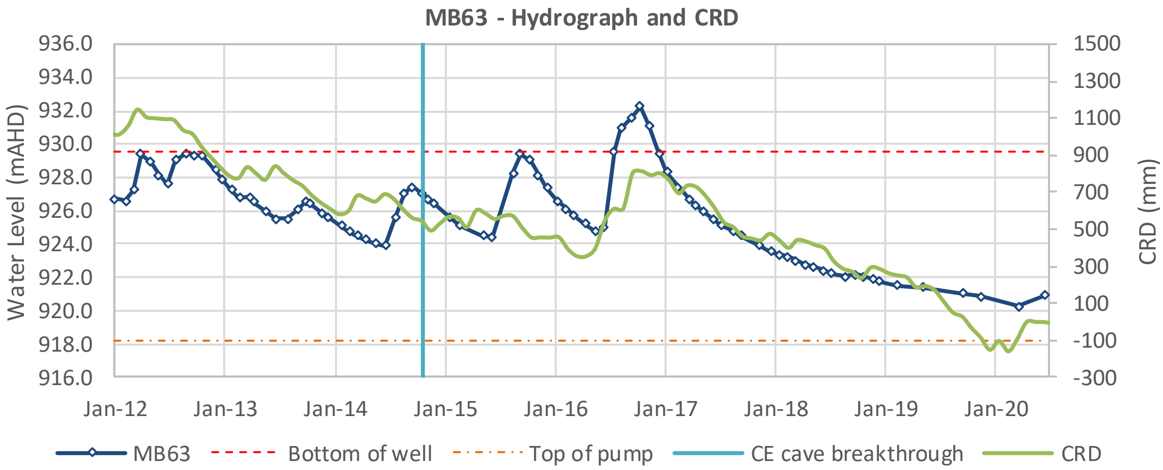


Figure 3-40 MB63 groundwater level hydrograph

MB64 shows a similar season trend to MB63 prior to September 2017. The bore showed a declining trend between September 2017 and June 2018. However between June and November 2018 the groundwater level at MB64 increased by approximately 1 m. Since November 2018 groundwater levels at MB64 have been declining, reflecting CRD, until between March and June 2020 where groundwater levels increased in response to increasing CRD. MB65 within the Silurian Sediments showed a similar trend to MB64, and is screened at a similar depth. pH below the guideline value was observed at MB63, MB64 and MB65 during the reporting period. The low pH value may be due to historically low groundwater levels at these bores due to a long period of below average rainfall between 2017 and December 2019.

RB01 and RB02 are located to the north of the site, and are outside the influence of mining, based on the 2016 groundwater modelling. These bores historically reflect trends in the CRD. During the reporting period groundwater levels at RB01 and RB02 generally continued to decline by 0.35 m and 0.44 m respectively. Groundwater levels at RB01 and RB02 did not respond to the period of above average rainfall between March and April 2020. Continued monitoring at RB01 and RB02 is recommended. Since January 1999 groundwater levels at RB01 have declined by 2.6 m, which is less than the drawdown guideline.

Silurian Sediments

Monitoring bores MB50, MB51 and MB52 are located to the south of Cadia East and potentially within the influence of mining, based on 2016 groundwater modelling. The monitoring bores are also located near the SWRD. MB50 has generally shown an increasing trend since monitoring commenced (refer Figure 3-41). The 2017-2018 AEMR attributed increasing groundwater levels to the SWRD. Since December 2018 groundwater levels at MB50 have been generally decreasing in accordance with decreasing CRD. However groundwater levels at MB50 did respond between April and June 2020 following a period of increasing CRD.

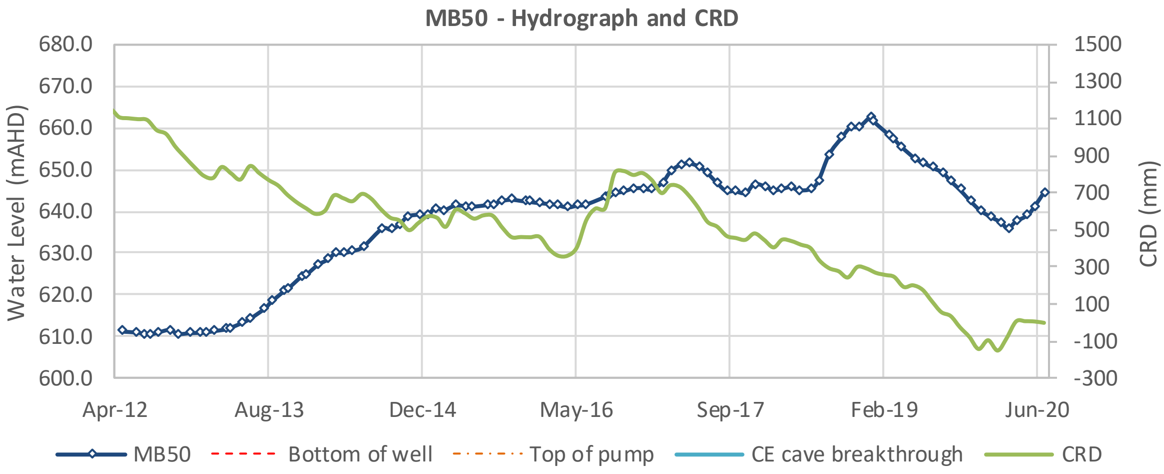


Figure 3-41 MB50 groundwater level hydrograph

At shallower monitoring bores MB51 and MB52, for the previous and current reporting period groundwater levels reflected the trends in CRD. During the current reporting period, the magnitude of increasing and decreasing trends at these bores have been considerably larger. At MB51 and MB52 groundwater levels decreased by over 10 m between August 2019 and February 2020 and increased by 5 m to 10 m between March 2020 and May 2020. Elevated sulfate concentrations have historically been observed at MB51 (refer Figure 3-42). During the current reporting period, sulfate concentrations at MB51 were very variable, potentially due to changes in groundwater levels over the monitoring period.

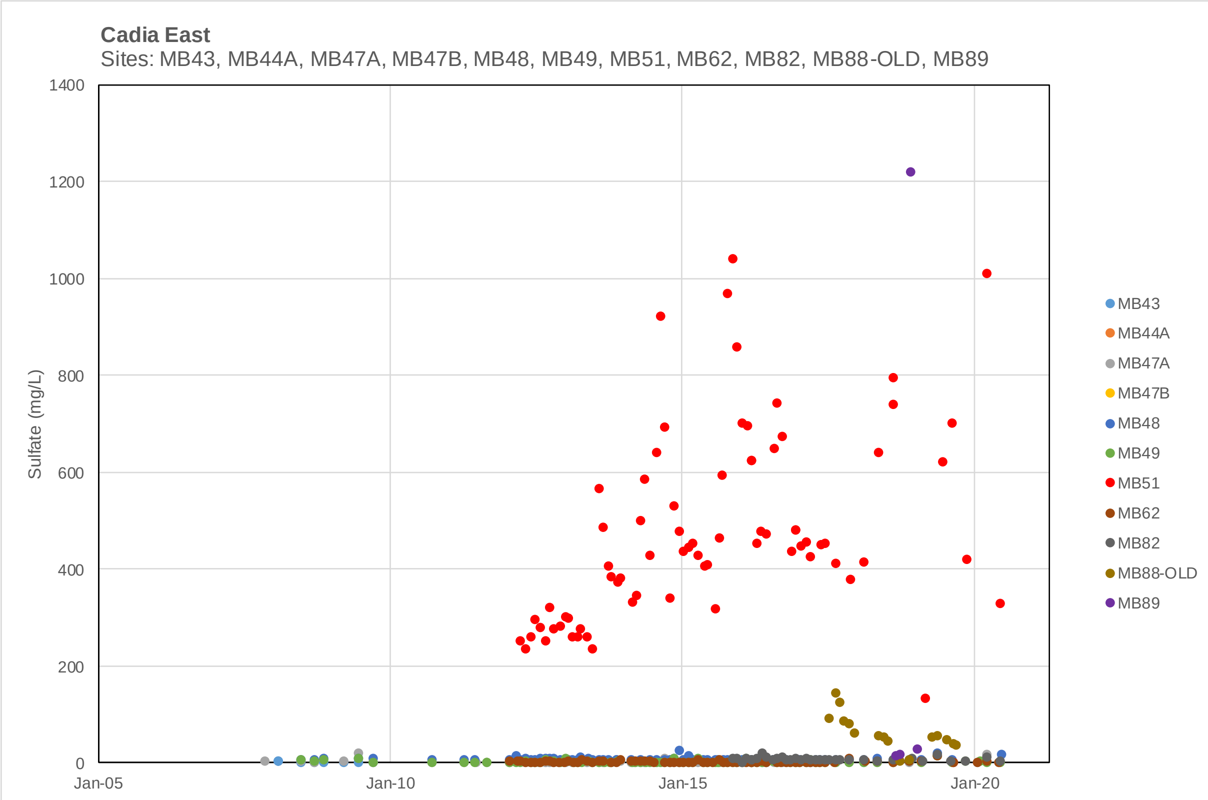


Figure 3-42 Cadia East sulfate concentrations

The 2017-2018 AEMR reported seasonal variation at MB62. For the four years prior to September 2017, groundwater levels peaked between September and November and reached a minimum between May and July. During the reporting period however the seasonal variation was not evident and groundwater levels have continued to decline until between April 2020 and June 2020 where groundwater levels increased in response to a period of increasing CRD (refer Figure 3-43).

The groundwater level hydrograph for MB62 was assessed using the HARTT method. The HARTT analysis indicated a statistically significant decreasing time trend, independent of rainfall. The analysis also indicated statistical significance of the rainfall variable, and therefore the historical declining groundwater level trend between 2017 and 2019 can be attributed to both the declining CRD over this period and other time dependent influence/s. The bore is located outside the predicted influence of mining based on 2016 groundwater model and in the vicinity of the pine plantation and therefore the declining groundwater level is most likely attributable to a non-mining land use activity. Therefore the declining groundwater level at MB62 is not considered an exceedance of the guideline level. Regression statistics are shown in Appendix D.

pH below the guideline value was observed at MB62 during the reporting period. The low pH value may be due to historically low groundwater levels at MB62 due to a long period of below average rainfall between 2017 and December 2019.

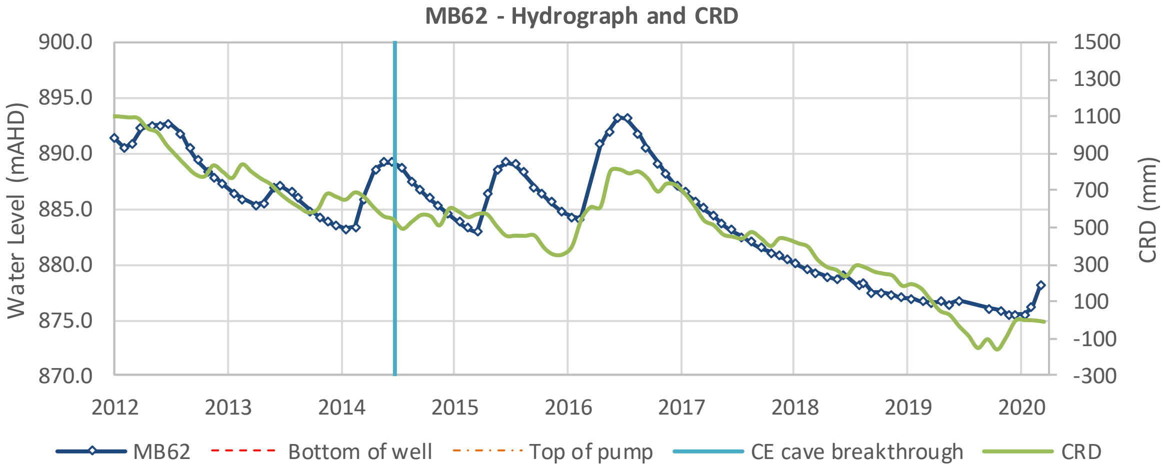


Figure 3-43 MB62 groundwater level hydrograph

MB48 is located to the north of the mining activities and outside the influence of mining based on the 2016 groundwater model. The bore is located within an area of pine plantations. The groundwater level at MB48 has displayed a historical decreasing trend since 2011 that continued during the reporting period until April to June 2020 when groundwater levels at MB48 increased. This increase in groundwater level is likely due to a period of increasing CRD.

The groundwater level hydrograph for MB48 was assessed using the HARTT method. The HARTT analysis indicated a statistically significant decreasing time trend, independent of rainfall. The analysis also indicated statistical significance of the rainfall variable, and therefore the historical declining groundwater level trend between 2017 and 2019 can be attributed to both the declining CRD over this period and other time dependent influence/s. As previously stated, the bore is located outside the predicted influence of mining and within the area of pine plantations and therefore the declining trend is most likely attributable to non-mining influences. Therefore the groundwater level is not considered to exceed the guideline value. Regression statistics are shown in Appendix D. The manganese trigger value was exceeded at MB48 during the reporting period and pH measurements below the guideline value were observed. Manganese concentrations have been between 1 mg/L and 1.5 mg/L throughout the period of monitoring at MB48 including throughout the current reporting period. Therefore managanese concentrations at MB48 and therefore the exceedance of the trigger value in this monitoring period is unlikely to be due to mining activities. The low pH value may be due to historically low groundwater levels at MB48 due to a long period of below average rainfall between 2017 and December 2019.

MB82 is located to the north of Cadia East, adjacent to the northern waste rock dump. The groundwater level has historically followed trends in the CRD. During the previous reporting period the groundwater level showed a declining trend which continued into the current reporting period. The declining groundwater level trend is generally consistent with the CRD, however groundwater levels did not respond to the period of above average rainfall in March and April 2020.

MB47A and MB47B are located to the east of the mine and historically reflect trends in the CRD. During the previous reporting period groundwater levels showed a declining trend and this has continued into the current reporting period, until February 2020 where groundwater levels very slightly increased in response to a period of increasing CRD. These trends in groundwater level are consistent with CRD over this period. The groundwater level guideline for MB47A was not exceeded during the reporting period (refer Figure 3-44).

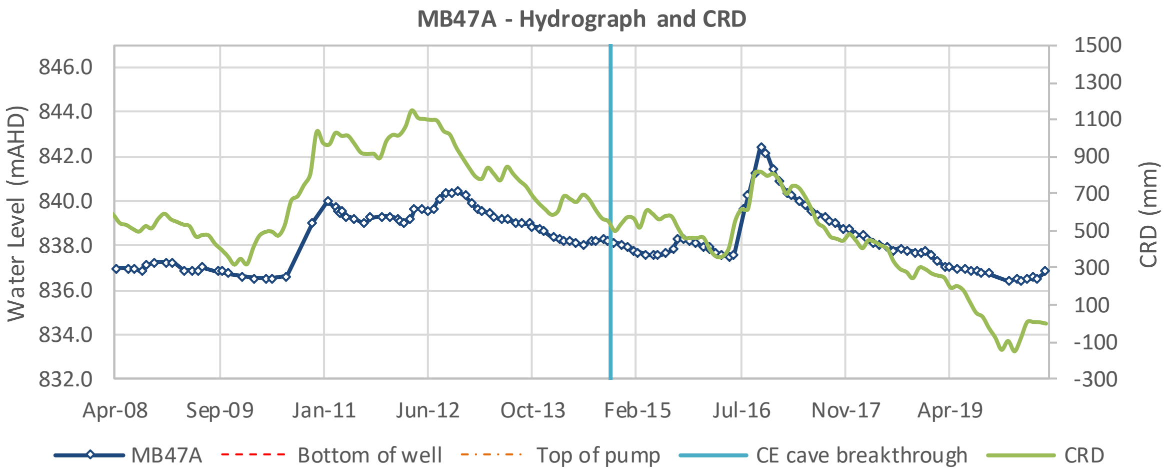


Figure 3-44 MB47A groundwater level hydrograph

MB46 is located to the east of the mine. During the previous reporting period groundwater levels showed a declining trend and this has continued for the monitoring period. Groundwater levels at MB46 did increase slightly between January 2020 and February 2020 likely due to a period of above average rainfall in January. However groundwater level did not respond to the period of above average rainfall in March and April 2020, with groundwater levels decreasing over this period.

MB76 is also located to the east of the mine. During the previous reporting period groundwater levels showed a declining trend until September 2018, which is consistent with the declining CRD. Groundwater levels were relatively stable until April 2019 which may have been a delayed response to the above average rainfall observed in October/November 2018. Between April 2019 and September 2019, groundwater levels at MB76 were relatively variable with a gradual increasing trend. This is despite decreasing CRD between April 2019 and September 2019. Monitoring bore MB76 was not able to be accessed between September 2019 and February 2020 due to Forestry NSW restrictions during high bushfire risk periods. When monitoring recommenced in February 2020 groundwater levels at MB76 were over 2 m lower. This is likely due to declining CRD over this period. Groundwater levels continued to gradually decline over the remainder of the monitoring period, despite generally increasing CRD over this period. As the drawdown in groundwater level at MB76 is less than 3 m above what is considered normal climatic variation, this is not considered to be an exceedance of the groundwater level guideline. Continued monitoring of groundwater levels at MB76 is recommended to confirm the trends in groundwater level at this location.

Historically groundwater levels at MB43 and MB44A reflect trends in the CRD. MB43 has been dry since January 2019 and has remained dry throughout the reporting period. Groundwater levels at MB44A continued to decline throughout the monitoring period. This decline in groundwater levels reflects the declining CRD, however the groundwater levels had not yet responded to the above average rainfall by the end of the reporting period. As the decline in groundwater level is in accordance with CRD, it is not considered to be an exceedance of the groundwater level guideline value (which is based on a 3 m drawdown due to mining).

Ordovician Volcanics

MB71 and MB75 are located to the east and far north-east of the site respectively. The bores historically reflect trends in the CRD. During the previous reporting period groundwater levels were generally decreasing with the exception of between May 2018 and November 2018 when groundwater levels stabilised, which may be the result of localised recharge. During the current reporting period groundwater levels at MB71 continued to gradually decrease, with groundwater levels decreasing 0.9 m over the reporting period, while groundwater levels were steady at MB75. As the changes in groundwater level at MB71 are generally in accordance with CRD, the decreasing trend at MB71 during the monitoring period is not considered to be an exceedance of the groundwater level guideline value (which is based on a 3 m drawdown due to mining). The reading at MB75 in March 2020 is not consistent with prior or subsequent readings and is therefore likely to be an error. Increasing molybdenum was observed at MB75 during the previous reporting period. Molybdenum concentrations were relatively constant during the reporting period with values within the historical range. There was a spike in zinc concentration at MB75 in March 2020. Zinc concentration returned to within the range of previous values in the following monitoring round.

Groundwater level observations for the reporting period are summarised in Table 3-13. Remaining hydrographs are plotted with the CRD in Appendix C.

Table 3-13 Cadia East groundwater level observations

Aquifer					
Ordovician Volcanic		**Tertiary Basalt**		**Silurian Sediments**	
Bores	**Observation**	**Bores**	**Observations**	**Bores**	**Observation**
MB71 MB75	MB71, overall declining trend MB75 steady	RB01 RB02 MB49 MB44B MB53 MB55 MB55 MB63 MB64 MB72 MB74 MB88	MB53, MB54, MB55, MB56 and MB88 overall increasing trend MB63, MB64, MB72 and MB74 generally gradually decreasing, with response to rainfall in 2020. MB49, RB01, RB02, and overall declining trend. MB44B declining (significant decreasing time trend)	MB43 MB44A MB46 MB47A MB47B MB48 MB50 MB51 MB52 MB62 MB65 MB73 MB76 MB82	MB47A, MB47B MB48, MB50, MB62, MB65 generally decreasing, responded to rainfall in 2020. MB73 declining (significant decreasing time trend). MB43 dry MB44A, MB46, MB82 overall declining trend MB51 & MB52 responded to CRD MB76 displayed variability, overall declining trend.

3.8.2 Summary

For the reporting period, the majority of groundwater levels show an overall declining trend, generally reflecting the CRD. A number of bores did show a response to a period of above average rainfall in March and April 2020.

The HARTT method was used to assess the influence of time dependent trends on the groundwater level hydrographs for MB44B, MB48, MB62, MB63 and MB73. Time dependent trends were statistically significant at MB44B, MB48, MB62 and MB73. Due to the proximity of these sites to the pine plantations it is considered most likely that these decreasing trends are not mining related and associated with other land uses. As these decreasing trends are not mining related they are not considered exceedances of the groundwater level guideline values.

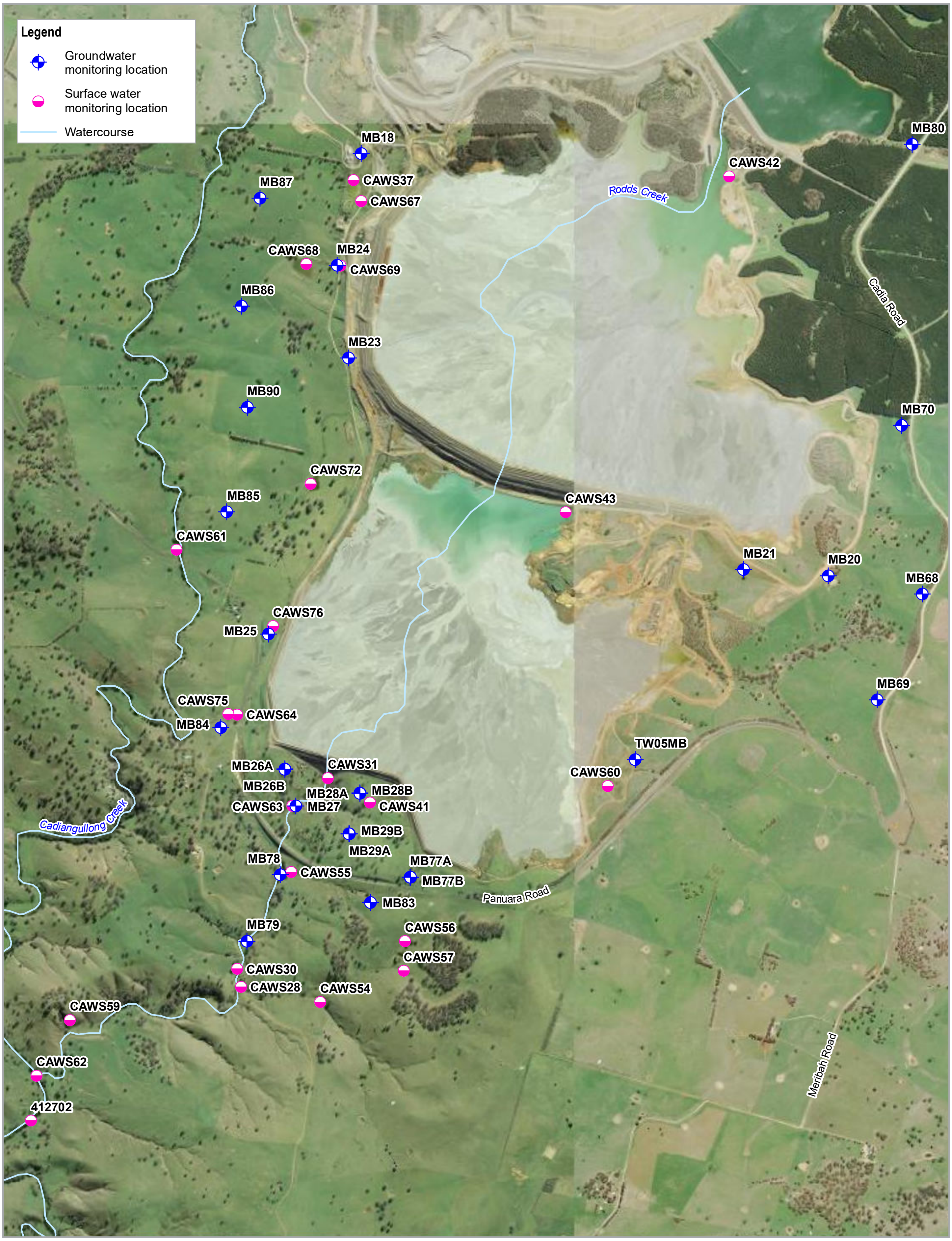
The manganese trigger was exceeded at MB48 and MB88 during the reporting period. pH below the guideline value was observed at MB48, MB49, MB54, MB56, MB62, MB63, MB64 and MB65. CHPL's previous Level 1 investigations concluded that additional data are required to confirm whether the low pH readings represent a change in the pH or are due to change from laboratory to field measured pH. These bores are all located upgradient of Cadia East and any potential mine related influence. At the majority of these locations the low pH may be attributable to historically low groundwater levels due to a long period of below average rainfall.

3.9 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. Particular focus has been given to groundwater changes to the south of the STSF.

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.

The historical groundwater monitoring data for bores around the NTSF and STSF have been previously reviewed and analysed by GHD (2016) and GHD (2018). The findings from these studies are discussed in the following sections.



Paper Size ISO A4

0 250 500 750 1,000

Metres

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

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GHD

Newcrest Mining Limited
CVO AEMR –
Surface and Groundwater Assessment

Tailings Storage Facilities

Project No. 12532418
Revision No. 0
Date 03 Sep 2020

FIGURE 3-45

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Print date: 03 Sep 2020 - 16:07

Data source: Newcrest: Bores, 2019. LPI: DCDB/DTDB, 2017. © Department of Finance, Services & Innovation 2017. Created by: pkiem, fmackay

3.9.1 TSF Eastern Zone

Surface water is monitored at the following sites within the TSF eastern zone: CAWS60, CAWS42, and CAWS43.

Groundwater is monitored in the zone to the east of the STSF and NTSF at MB20, MB21, MB68, MB69 and MB70 and MB80. Since groundwater flows through the site from the north-east to south-west, it is considered that groundwater within the TSF Eastern Zone is generally up gradient of the TSFs and unlikely to be influenced by seepage.

Surface water

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 2000 µS/cm, with CAWS60 having the lowest EC, and 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 3-46). CAWS60 has been monitored since November 2015 and has generally had low nitrogen oxide concentrations which do not indicate the influence of tailings decant pond water.

Total nitrogen concentrations have followed a similar trend to that of nitrogen oxides, decreasing across the monitoring period at sites CAWS42, CAWS43 and CAWS60.

Total phosphorous concentrations have been more variable, and CAWS60 has had higher concentrations than CAWS42 and CAWS43 during the period of monitoring for the dyke pond (refer Figure 3-47). This likely reflects the influence of surrounding land use, such as agriculture runoff to the dyke pond.

A spike in total phosphorus and total nitrogen was observed at CAWS43 on 12 September 2019 with respective concentrations of 7.51 mg/L and 8 mg/L. There was no source indicator upstream at CAWS42 for this spike in nutrient and there was no impact downstream observed at CAWS31.

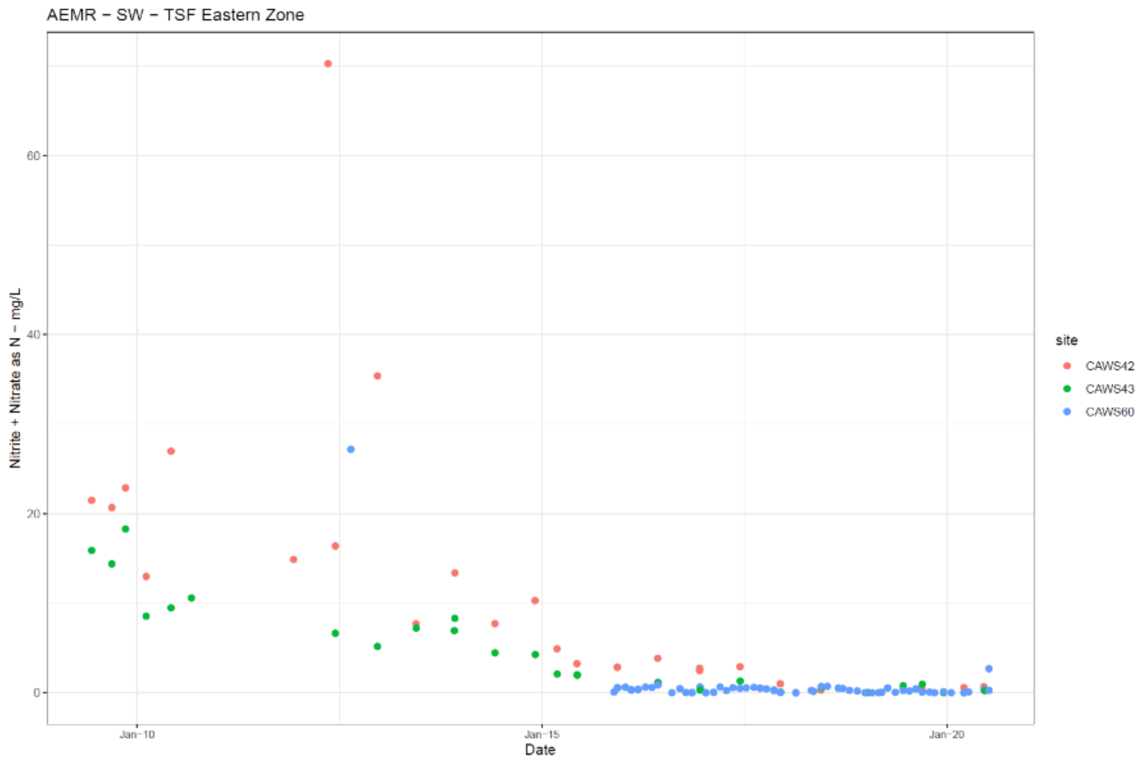


Figure 3-46 Nitrogen oxides concentrations in the TSF eastern zone

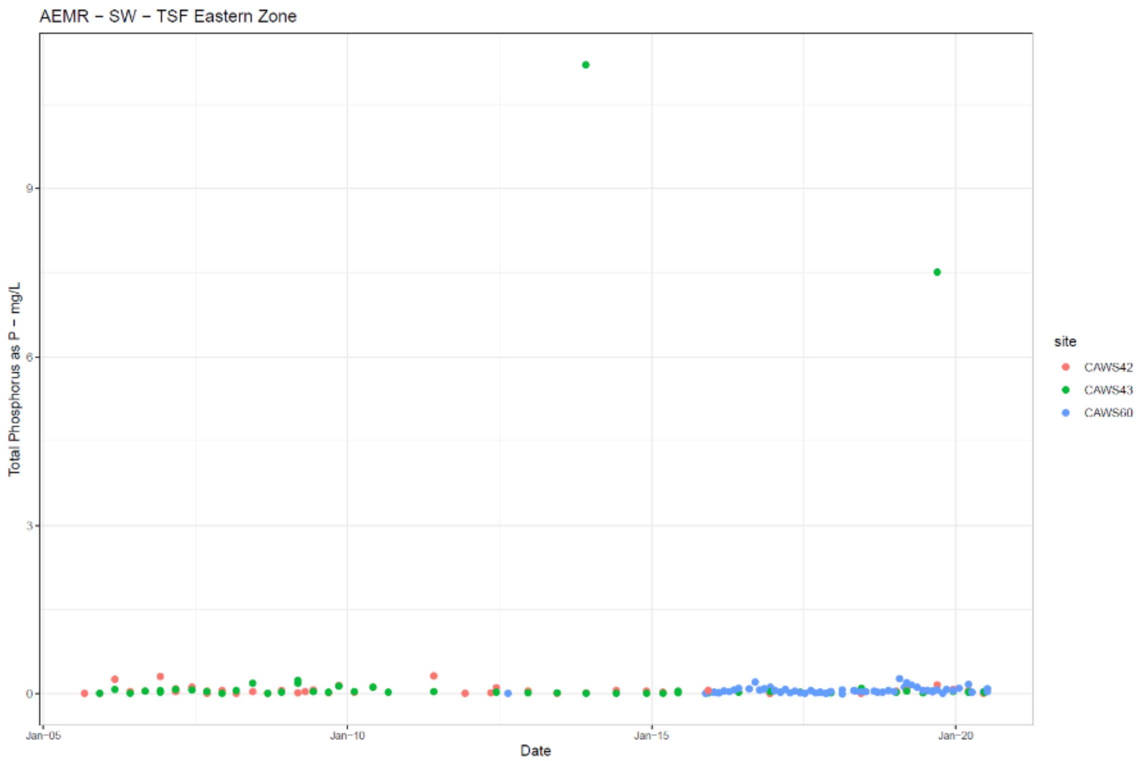


Figure 3-47 Total phosphorous concentrations in the TSF eastern zone

Dissolved metals

There were no trends evident in dissolved metal concentrations in the TSF eastern zone with the exception of the 2018/2019 reported elevated nickel concentrations at CAWS42, CAWS43 and CAWS60 during the first half of 2019. The source of these elevated nickel concentrations was unclear at the time, as there was no other concurrent increase in parameter concentrations and was potentially due to field or laboratory contamination or interference. Nickel concentrations have returned to historically low levels (<0.003 mg/L) in this reporting period.

Elevated molybdenum concentrations have been recorded at CAWS42 which is typical of tailings associated with the ore mined at Cadia (refer to Figure 3-48). Downstream at CAWS31, molybdenum concentrations are slightly higher than surrounding surface water monitoring points, but at concentrations of <0.034 mg/L, being the ANZG 2018 default toxicant guideline for freshwaters, these are not of concern. A decreasing trend has been seen at CAWS31 in recent times.

Iron concentrations have been occasionally elevated at CAWS60 though no trend was evident in the data. It is likely that the elevated iron concentrations reflect the influence of runoff from the pastures surrounding the site.

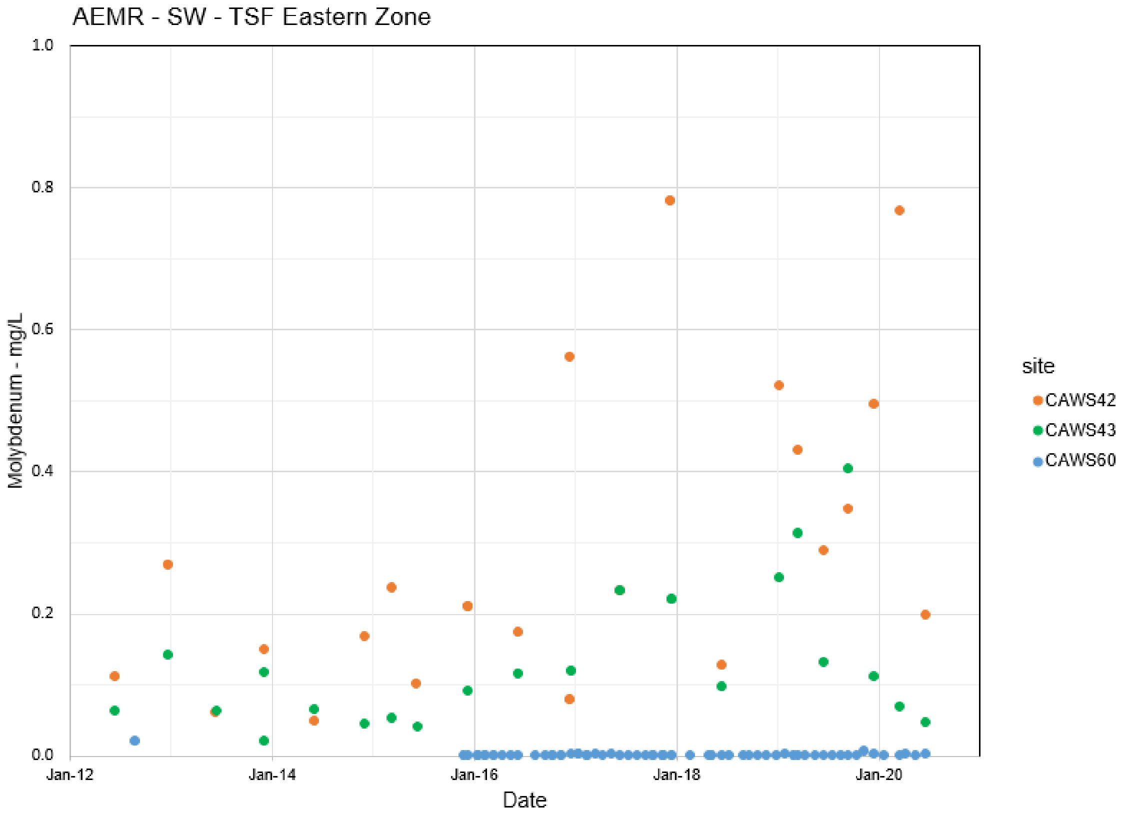


Figure 3-48 Molybdenum concentrations in the TSF eastern zone

Major ion composition

Average major ion (calcium, magnesium, sodium, potassium, chloride, bicarbonate and sulfate) concentrations at CAWS42, CAWS43 and CAWS60 for the 2017-2018, 2018-2019 and 2019-2020 reporting periods and the previous history of monitoring were used to create the Piper chart presented as Figure 3-49. 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.

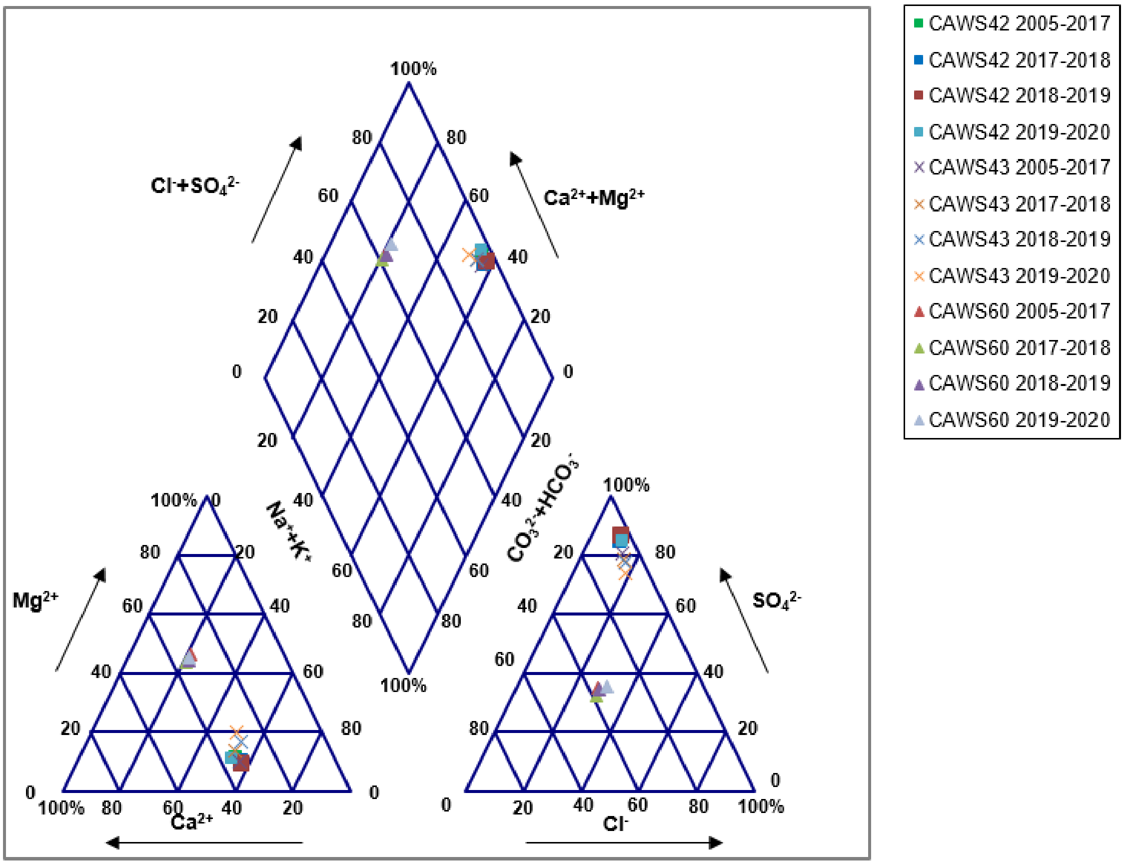


Figure 3-49 Piper chart showing differences in major ion composition in the TSF eastern zone in the reporting period

Groundwater

Silurian Sediments

Historically the groundwater levels at MB20 generally reflect trends in the CRD. During the previous reporting period the groundwater level at MB20 showed an overall declining trend. During the current reporting period groundwater levels at MB20 were overall relatively steady, with groundwater levels decreasing between August and November 2019 in response to decreasing CRD and increasing between November 2019 and June 2020 in response to increasing CRD.

The historical groundwater quality data shows elevated concentrations of aluminium, cadmium, cobalt, copper, zinc, mercury, chloride, magnesium, manganese, sulfate, potassium, sodium, calcium and TDS at MB20 compared to the other monitoring bores in the area. Many of these parameters have been elevated prior to the construction of the TSFs and therefore represent background groundwater quality. During the reporting period the trigger value for sulfate was exceeded at MB20 in November 2019 (3390 mg/L), March 2020 (3120 mg/L) and June 2020 (3100 mg/L). Aluminium and pH triggers were also exceeded at MB20 during the monitoring period. Sulfate and aluminium concentrations and pH values likely reflect natural variation in background groundwater quality and reported concentrations in the current period are within the range of historical values. Aluminium and sulfate concentrations for bores east of the TSF are shown in Figure 3-50 and Figure 3-51 respectively.

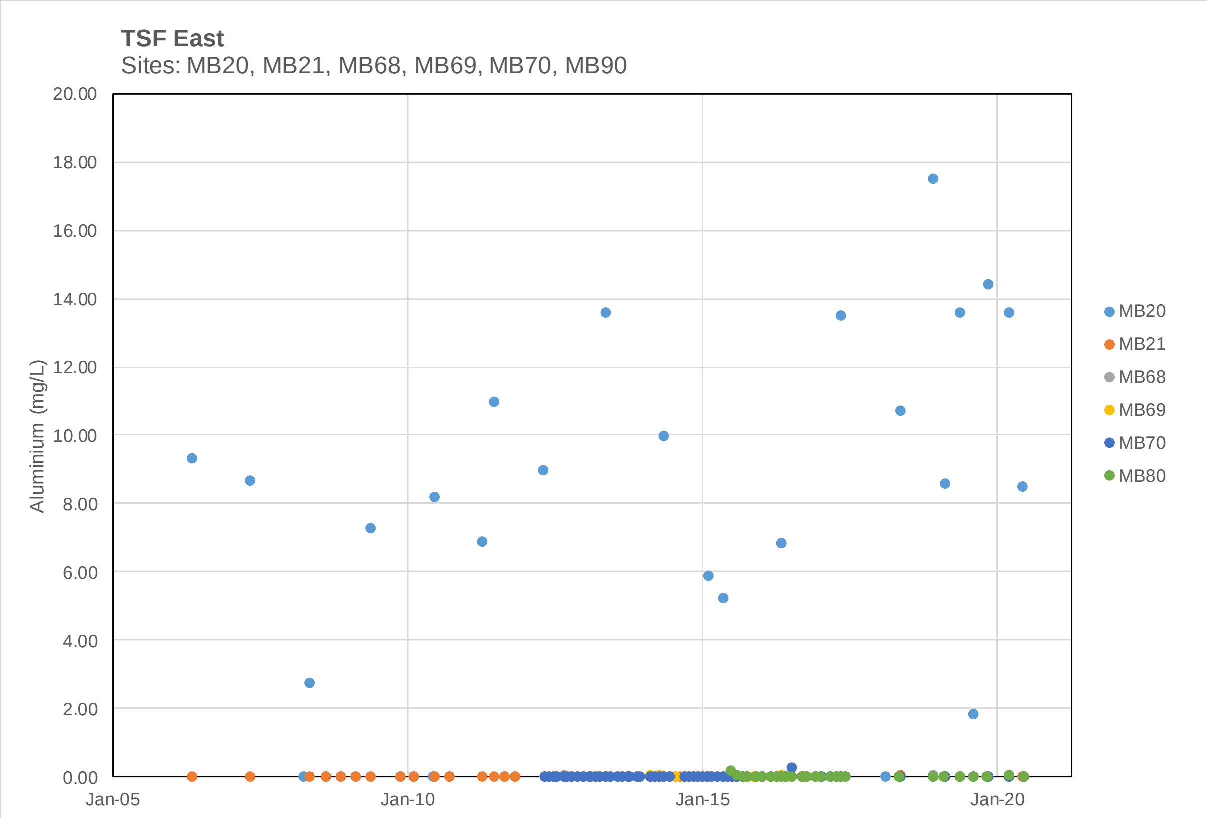


Figure 3-50 Aluminium concentrations for bores to the east of the TSF

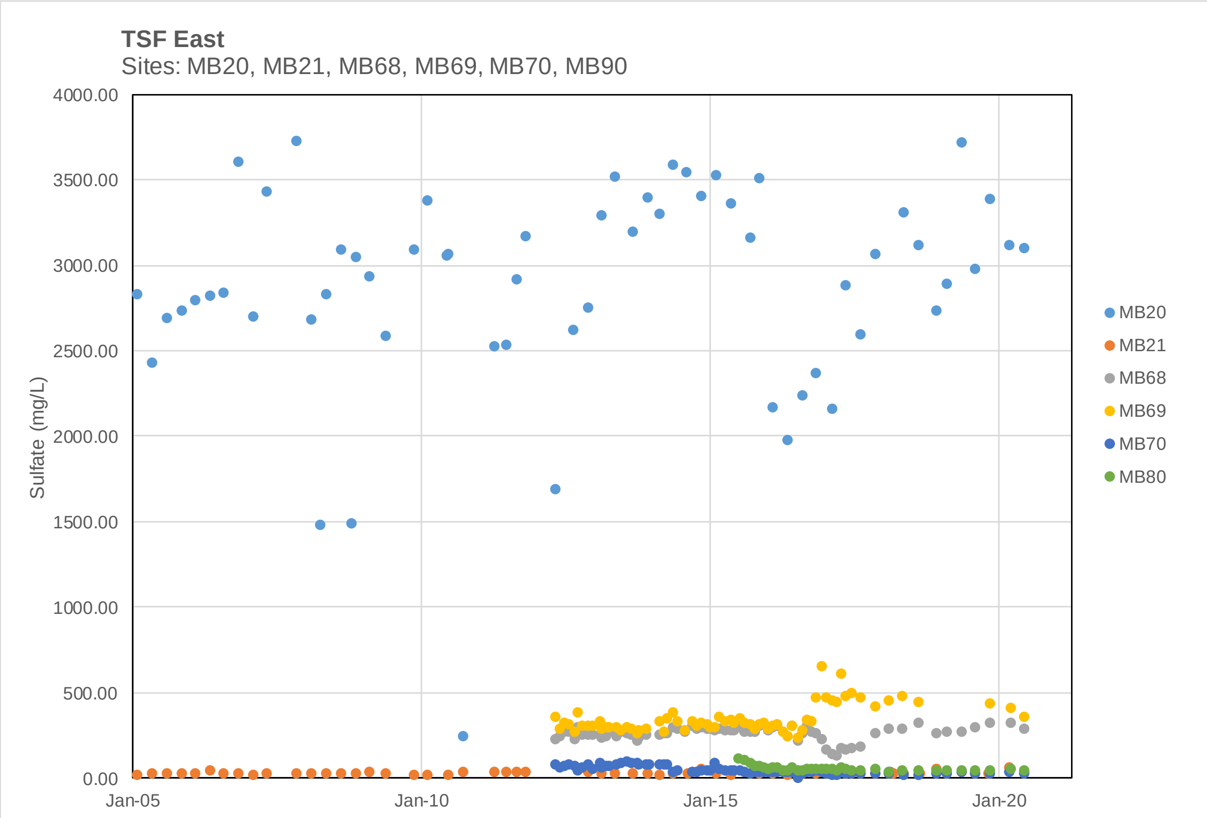


Figure 3-51 Sulfate concentrations for bores to the east of the TSF

Historically, groundwater levels at MB80 (Silurian Sediments) have responded to CRD. During the previous monitoring period, groundwater levels at MB80 showed significant variability. It is likely that the groundwater levels recorded in May and August 2019 are errors as they are not consistent with preceding or following measurements. For the remainder of the current monitoring period groundwater levels at MB80 were relatively stable. Continued monitoring at MB80 is recommended to confirm trends in groundwater levels.

Ordovician Volcanics

Historically the groundwater levels at MB68 and MB70 reflected trends in the CRD. The groundwater levels increased rapidly between May 2016 and November 2016 following a period of above average rainfall. Since January 2017 the groundwater levels have shown a declining trend consistent with CRD until June 2020 when groundwater levels increased slightly following a period of increasing CRD.

pH below the guideline value was observed at MB70 during the current monitoring period which may be attributable to the historically low groundwater levels due to the extended period of below average rainfall from 2017 to December 2019.

Historically groundwater levels at MB69 show a declining trend. The groundwater levels increased rapidly between May 2016 and November 2016 following a period of above average rainfall during the same period (refer Figure 3-52). Since October 2016 the groundwater level has declined which is generally consistent with CRD. During the reporting period, groundwater levels at MB69 were steady.

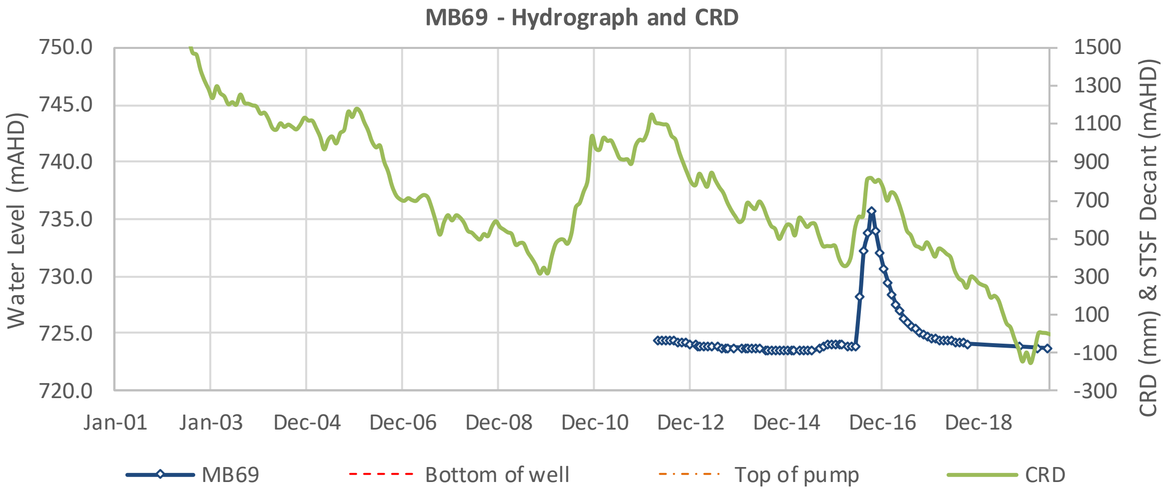


Figure 3-52 MB69 groundwater level hydrograph

The groundwater level at MB21 has historically reflected the trends in the CRD. The groundwater level increased rapidly between May 2016 and November 2016 following a period of above average rainfall during a similar period. Since November 2016 the groundwater level has shown an overall declining trend, consistent with CRD. Groundwater levels at MB21 increased by 1.2 m between March and June 2020 in response to a period of increasing CRD (refer Figure 3-53).

There was a very slight spike in sulfate at MB21 in March 2020 (64 mg/L). While this concentration was above the historical range of results, it was significantly lower than surrounding monitoring locations (refer Figure 3-51) and below the trigger of 1000 mg/L. Sulfate concentration at MB21 returned to within the typical range of values in June 2020.

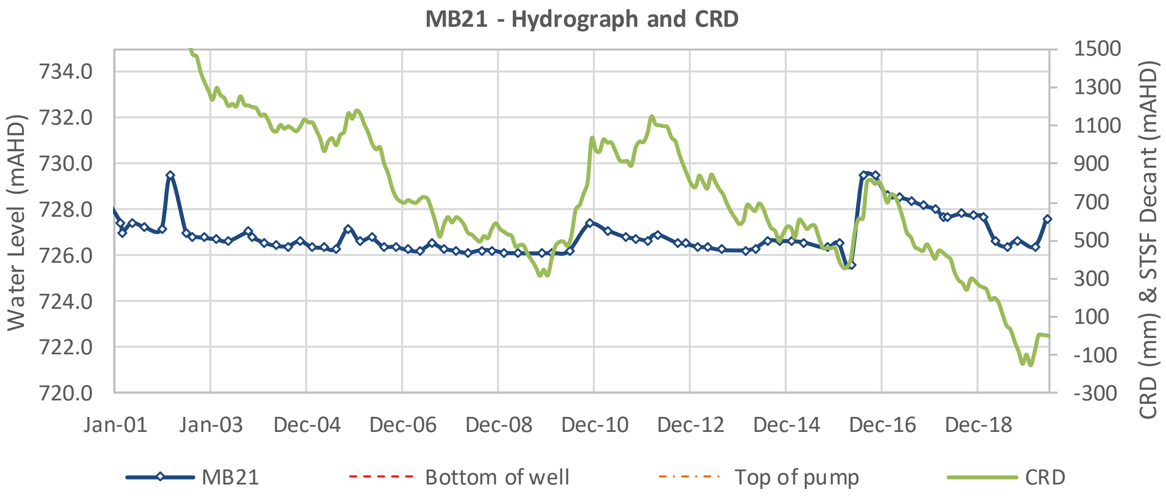


Figure 3-53 MB21 groundwater level hydrograph

Groundwater level observations are summarised in Table 3-14. Groundwater level hydrographs are plotted with the CRD in Appendix C.

Table 3-14 Groundwater level observations for bores to the east of the TSFs

Aquifer			
Ordovician Volcanic		Silurian Sediments	
Bores	Observation	Bores	Observation
MB21 MB68 MB69 MB70	MB21, MB68, MB70 fluctuated in accordance with CRD MB69 steady	MB20 MB80	MB20 varied in response to CRD. MB80 fluctuated. Additional monitoring required to confirm trends.

Based on the Piper diagram in Figure 3-54, groundwater in this zone is generally calcium/magnesium bicarbonate dominant, although MB20 is a more sulfate dominant groundwater. Most groundwater sites are dissimilar to decant water in terms of major ion composition with the exception of MB20, although it is noted that the elevated sulfate at MB20 has been observed prior to the operation of TSFs and is therefore likely to be representative of background groundwater.

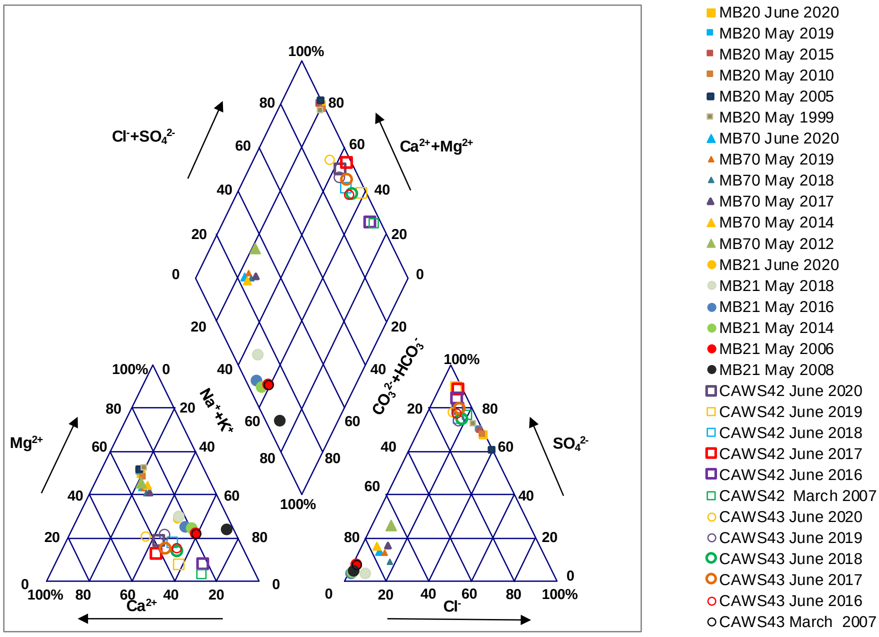


Figure 3-54 Piper diagram for MB20, MB21, MB70, CAWS42 and CAWS43

Summary

For the reporting period the groundwater levels at all monitoring bores varied in accordance with CRD, with the exception of MB69 where groundwater levels were steady and MB80 where groundwater levels were overall steady.

pH below the guideline value was observed at MB20 and MB70 which may be attributable to the low groundwater levels at these locations following the extended period of below average rainfall between 2017 and December 2019.

The historical groundwater quality data shows elevated concentrations of aluminium, cadmium, cobalt, copper, zinc, mercury, chloride, magnesium, manganese, sulfate, potassium, sodium, calcium and TDS at MB20 compared to the other monitoring bores in the area, however this is likely to be representative of background groundwater. During the reporting period the trigger value for sulfate was exceeded at MB20 in November 2019 (3390 mg/L), March 2020 (3120 mg/L) and June 2020 (3100 mg/L). Aluminium concentration triggers were also exceeded at MB20 during the monitoring period. Sulfate and aluminium likely reflect natural variation in background groundwater quality and reported concentrations in the current period are within the range of historical values.

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 or on groundwater.

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.

3.9.2 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.

Groundwater is monitored to the west of the TSFs by MB18, MB23, MB24, MB25, MB84, MB85, MB86, MB87 and MB90 (MB19A/B was destroyed in 2018 and has been replaced by MB90). There is evidence for a groundwater divide between the TSFs and Cadiangullong Creek to the west, associated with the catchment divide that runs north-south and separates the Rodds Creek and Cadiangullong Creek catchments. Due to the nature of the topography to the west of the TSFs, groundwater to the immediate west of the TSFs flows to the south towards Rodds Creek rather than to the west towards Cadiangullong Creek.

Surface water

Physicochemical parameters

pH at the TSF western zone sites has been stable in the reporting period and has generally been slightly alkaline with the exception of CAWS61 which sits in the pH neutral range.

EC at sediment dam site CAWS72 has shown an increasing trend since June 2016, as shown in Figure 3-55. This likely reflects the prevailing dry conditions during this period, causing higher salinity levels from lack of flow into the sediment dam and increased evaporation.

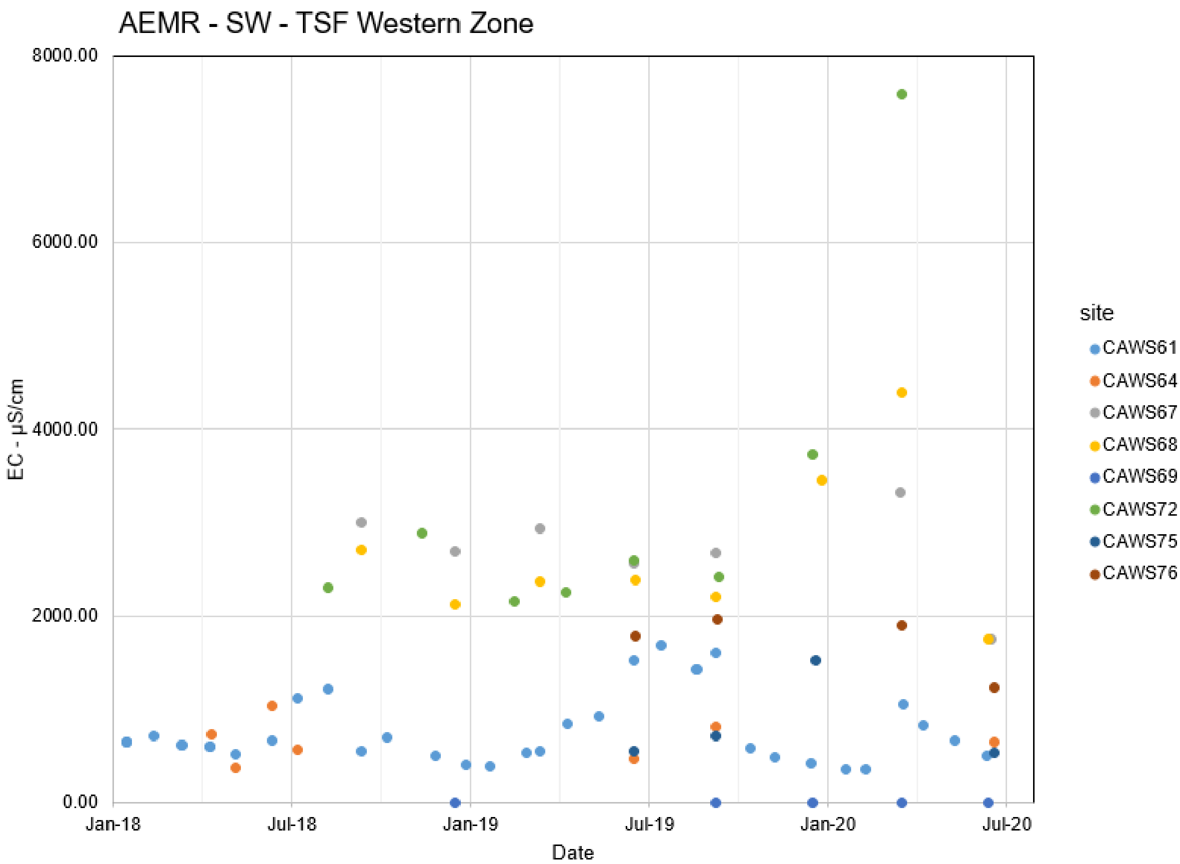


Figure 3-55 EC at TSF western zone sites

TSS concentrations in the TSF western zone have been variable, with the only trend evident at CAWS67. Here TSS concentrations have been gradually increasing, likely due to drought conditions forcing livestock to frequent the sediment dam more often in the period and hence stir up sediment.

Nutrients

Elevated nitrogen oxide concentrations were observed at CAWS69 in September and December 2018, though no similar observations were made at nearby site CAWS68.

Recent elevated total nitrogen and total phosphorous in the TSF western zone likely indicate the influence of surrounding land use rather than an impact from tailings decant water, considering the low total phosphorous concentrations observed in the tailings decant ponds.

Dissolved metals

Scattered elevated copper results have been observed at CAWS72, CAWS61 and CAWS64, however these are isolated and infrequent with no apparent trends evident.

There was an instance of an elevated iron result (5.27 mg/L) at Cadiangullong Creek site, CAWS61 on 20 March 2020. This result cannot be explained as results for monitoring events either side of this elevated result are low at concentrations < 0.2 mg/L.

Similar to copper, scattered elevated manganese concentrations have been observed at CAWS64, CAWS72, CAWS67 and CAWS61. Likewise these elevated manganese results are isolated and infrequent with no apparent data trends.

Molybdenum concentrations at sites CAWS67, CAWS68, CAWS69 and CAWS76 have been elevated compared to other sites within the TSF western zone (Figure 3-56), which, considering the consistently elevated molybdenum concentrations in TSF decant water and WRD leachate, indicates possible seepage from the TSFs and/or drainage/runoff from the TSF embankments, which are made from waste rock. No trend in these concentrations during the reporting period was evident however, indicating that the degree of the TSF influence has not increased during the reporting period. Furthermore, molybdenum concentrations remain low at CAWS61 with results < 0.005 mg/L, below the ANZG 2018 default toxicant guideline for freshwaters of 0.034 mg/L. CAWS61 being the downstream indicator for any seepages from CAWS67, CAWS68, CAWS69 and CAWS76 impacting on Cadiangullong Creek. Therefore there is no inferred surface water contmaination impact from the TSF western zone on the receiving watercourse.

Dissolved nickel concentrations at sites in the TSF western zone were elevated in the first half of 2019 as reported in the 2018/2019 AEMR, as observed for the TSF eastern zone sites. The source of these elevated nickel concentrations is unclear, as there was no other concurrent increase in parameter concentrations and may have been attributable to field or laboratory contamination or interference. Nickel concentrations following this have returned to results less than the laboratory detection limit at all locations.

Elevated zinc concentrations have been observed at CAWS68, CAWS61 and CAWS64, however no trend in these concentrations was evident with results.

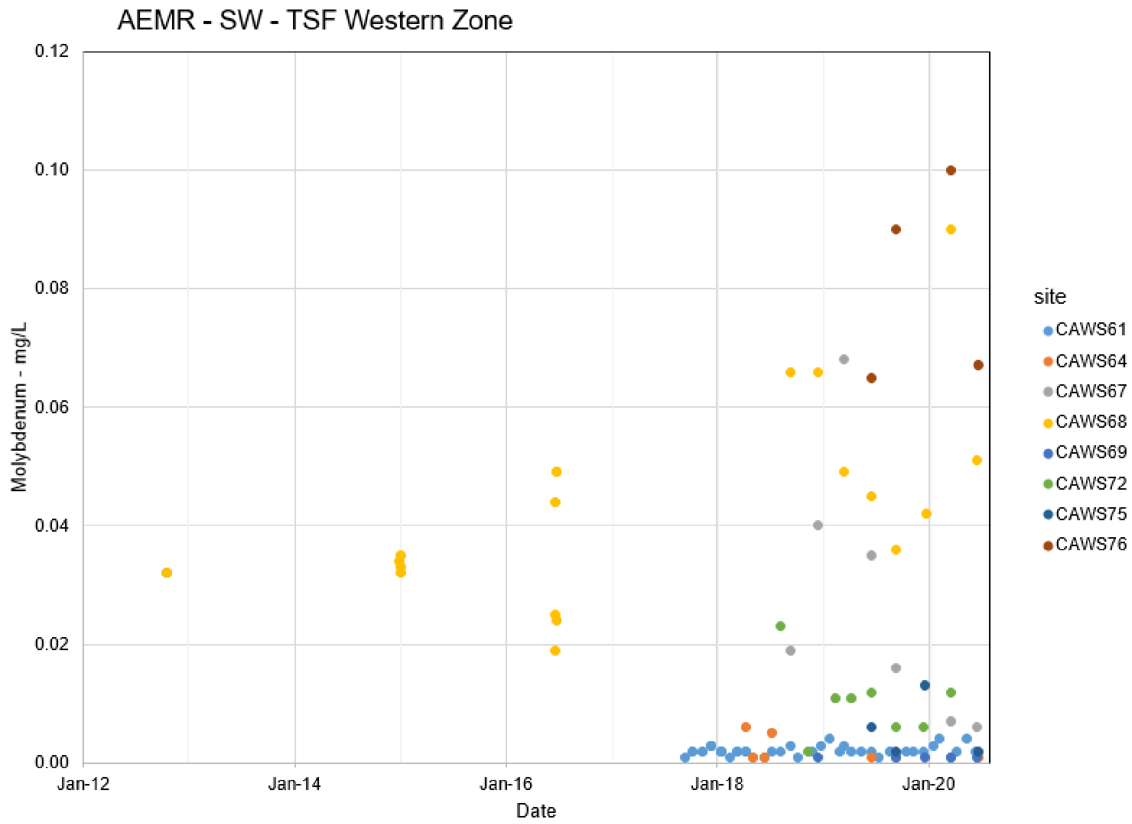


Figure 3-56 Dissolved molybdenum concentrations at TSF western zone sites

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 3-57. The Piper chart indicates some possible influence from the TSF decant water or drainage from the waste rock embankments on the sediment dams and seepages at CAWS68, CAWS69 and CAWS72 due to elevated sulfate concentrations. However it is noted 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 decant.

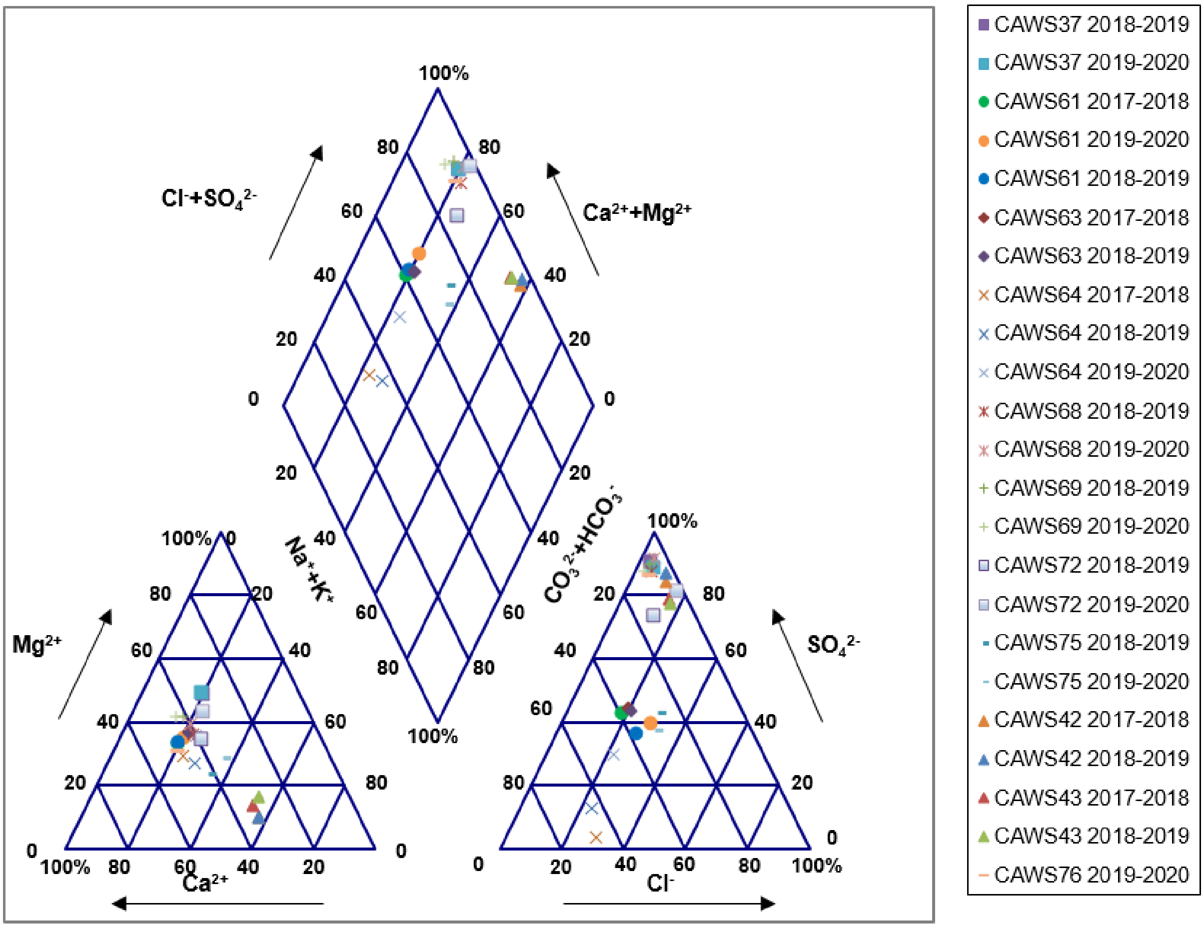


Figure 3-57 Piper chart showing differences in major ion composition in the TSF western zone in the reporting period

Groundwater

Silurian Sediments

The groundwater levels at MB18, located to the north-west of the NTSF, have shown an increasing trend for the majority of the monitoring period. However, since February 2017 the groundwater level has shown an overall declining trend (refer Figure 3-58). The groundwater level is still below the guideline level.

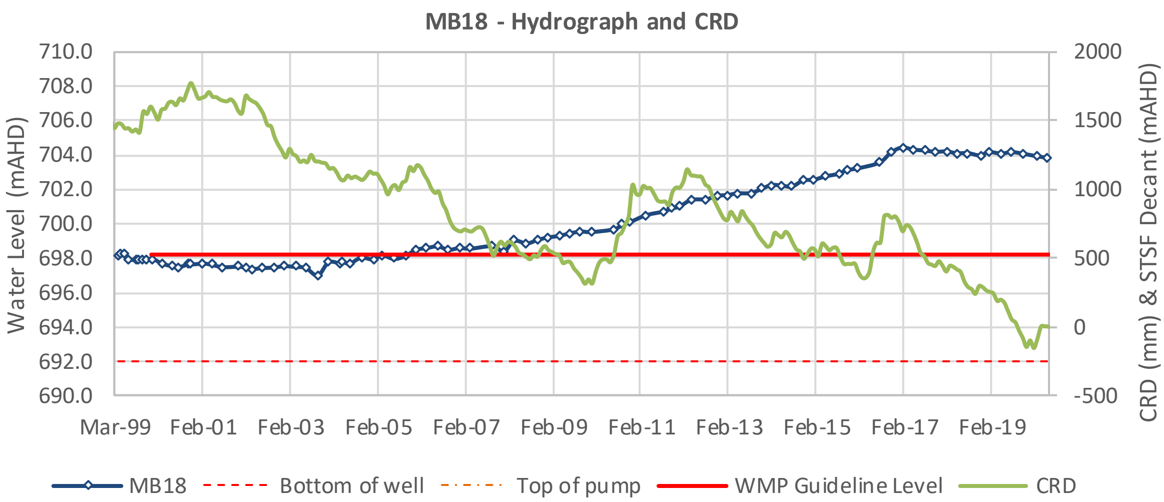


Figure 3-58 MB18 groundwater level hydrograph

The groundwater level at MB85 showed an overall declining trend since monitoring began. The observed groundwater level in March 2020 is likely an error as it is not consistent with previous or following measurements. Groundwater levels at MB85 increased in May and June 2020 in response to above average rainfall in March and April 2020.

The groundwater level at MB84 shows an overall declining trend until October 2018. Groundwater levels at MB84 were showing a generally increasing trend between October 2018 and April 2019, potentially in response to a period of above average rainfall in October/November 2018. The observed groundwater level in May 2019 is potentially an error as it is not consistent with prior or following groundwater level measurements. Between May 2019 and March 2020 groundwater levels at MB84 were generally decreasing. There is some variability in groundwater levels between January and June 2020 which is potentially short term responses to rainfall events. Continued monitoring at MB84 is required to confirm this.

Ordovician Volcanics

The groundwater levels at MB23 and MB24, located to the west of the NTSF, have shown an increasing trend for the majority of the monitoring record. Since February 2017 the groundwater level has declined. Both bores showed a response to above average rainfall in April and May 2020. The influence of rainfall recharge is more evident in MB24 compared to MB23, even though both bores are screened at similar depths. The groundwater levels at both MB23 and MB24 are still below the guideline levels.

The groundwater level at MB25 shows an overall increasing trend until January 2010. After January 2010 the groundwater level generally reflects the trends in the CRD. Groundwater levels at MB25 were generally increasing during the reporting period. Groundwater levels increased in June 2020 following a period of increasing CRD. The groundwater level for MB25 remains below the guideline value.

The groundwater levels at MB86 and MB87 show declining trends since monitoring began. Groundwater levels at MB87 responded to the period of above average rainfall in April and May 2020. Groundwater levels at MB86 decreased throughout the reporting period.

Tertiary Basalt

The groundwater level at MB90 within the Tertiary Baslt (replacement for MB19A) previously increased between August 2018 and December 2018 potentially in response to a period of above average rainfall in October/November 2018. Since December 2018 groundwater levels at MB90 have generally been declining, potentially due to generally declining CRD over this period. Groundwater levels at MB90 increased in May and June 2020 following a period of above average rainfall in April and May 2020, refer Figure 3-59.

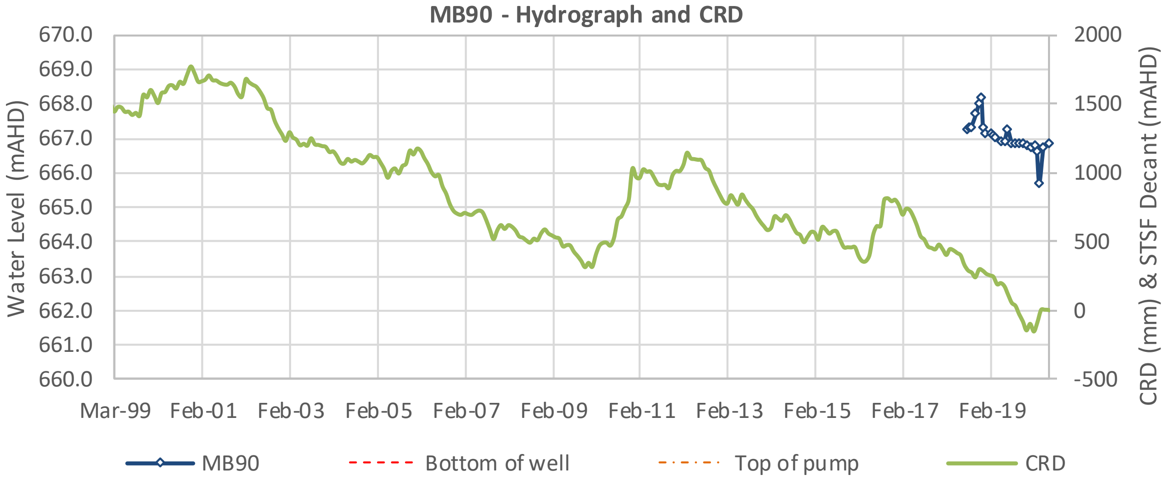


Figure 3-59 MB90 groundwater level hydrograph

Groundwater level observations are summarised in Table 3-15. Hydrographs are plotted with the CRD in Appendix C.

Table 3-15 Groundwater level observations for bores to the west of the TSFs

Aquifer					
Ordovician Volcanic		Tertiary Basalt		Silurian Sediments	
Bores	Observation	Bores	Observations	Bores	Observation
MB23 MB24 MB25 MB86 MB87	MB23, MB86, MB87 overall declining trend. MB24 steady MB25 increasing trend	MB90	Overall declining trend.	MB18 MB84 MB85	MB18 overall declining trend. MB84 and MB85 variability due to rainfall.

Quality

During the previous reporting period there was an increasing trend in nickel concentrations at all bores, although no exceedances of the trigger value evident. This increasing trend in nickel was likely attributable to field or laboratory contamination or interference. However during the current reporting period nickel concentrations were lower at all bores (refer Figure 3-60). There was still some variability in nickel at MB24, MB85, MB86 and MB87 during the current reporting period.

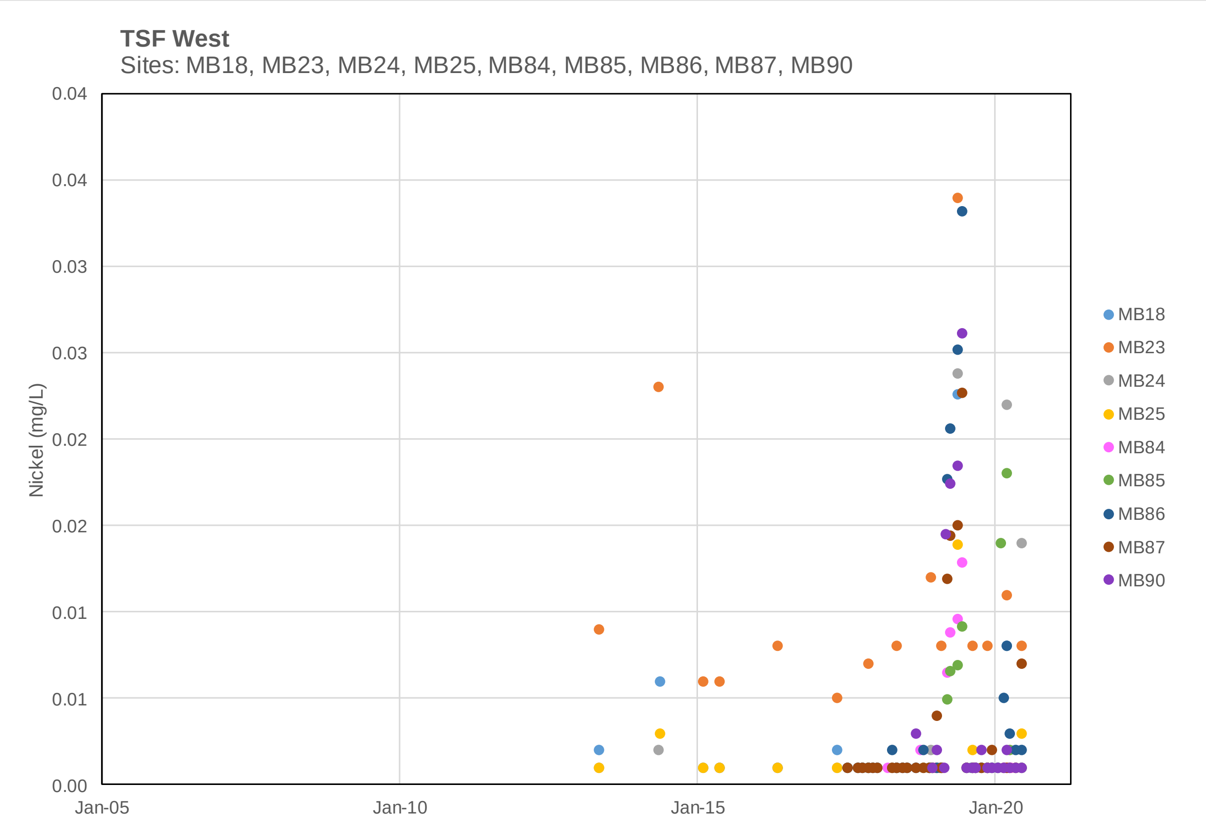


Figure 3-60 Nickel concentrations in bores to the west of the TSFs

The lower trigger value was exceeded for pH at MB84 and MB86 during the current reporting period. pH has been relatively constant at MB84 and MB86 since monitoring at these sites commenced in 2018. Review of pH trigger values at these sites is recommended.

Nitrogen concentrations displayed a decreasing trend in the previous reporting period at MB84 and MB87. During the current reporting period, nitrogen concentrations were relatively constant at MB87 but were gradually increasing at MB84. Nitrogen concentrations at MB84 remained within the range of historical results.

During the previous reporting period aluminium concentrations increased at MB90. However during the current reporting period aluminium concentrations returned to typical values at MB90, with the exception of April and May 2020 where aluminium concentrations increased to 0.02 mg/L. Aluminium concentration at MB90 returned to typical values in June 2020. Aluminium concentrations are plotted in Figure 3-61.

During the previous reporting period an increasing trend in arsenic concentration was observed at MB18, MB86 and MB90. During the current reporting period, arsenic concentrations were lower.

There was a slight spike in aluminium at MB84 (0.43 mg/L) and MB85 (0.03 mg/L) in February 2020 (refer Figure 3-61). The aluminium concentration at MB84 in February 2020 was above the trigger value of 0.2 mg/L. CHPL’s Level 1 investigations indicates the result was an outlier due to return to normal conditions. The aluminium concentration was not considered a persistent mine related water quality issue.

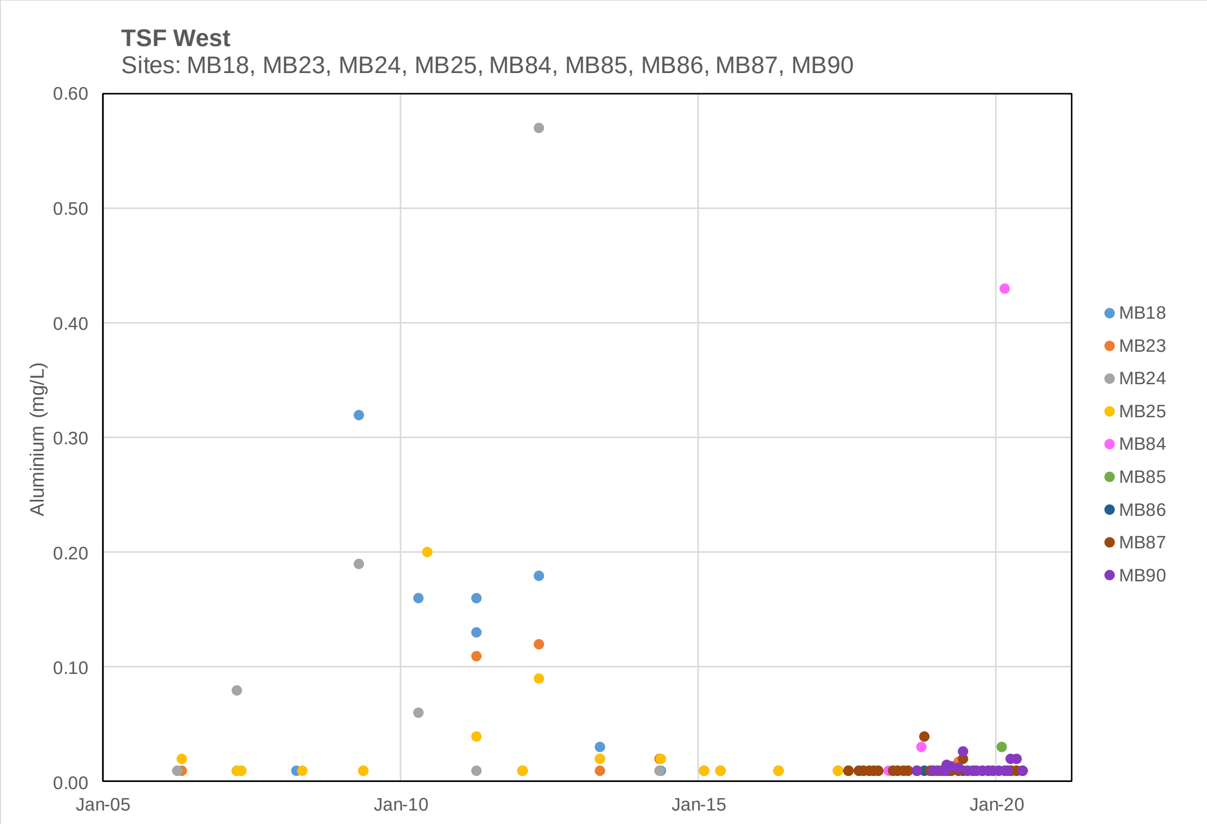


Figure 3-61 Aluminium concentrations in bores to the west of the TSF

Cadmium concentrations showed an increasing trend at MB23 between 2016 and late 2018. Since this time cadmium concentrations at MB23 have been relatively constant. Chromium concentrations were elevated (up to 0.03 mg/L) at MB90 during the previous reporting period. During the current reporting period, chromium concentrations returned to within the historical range of concentrations for bores to the west of the TSF (refer Figure 3-62).

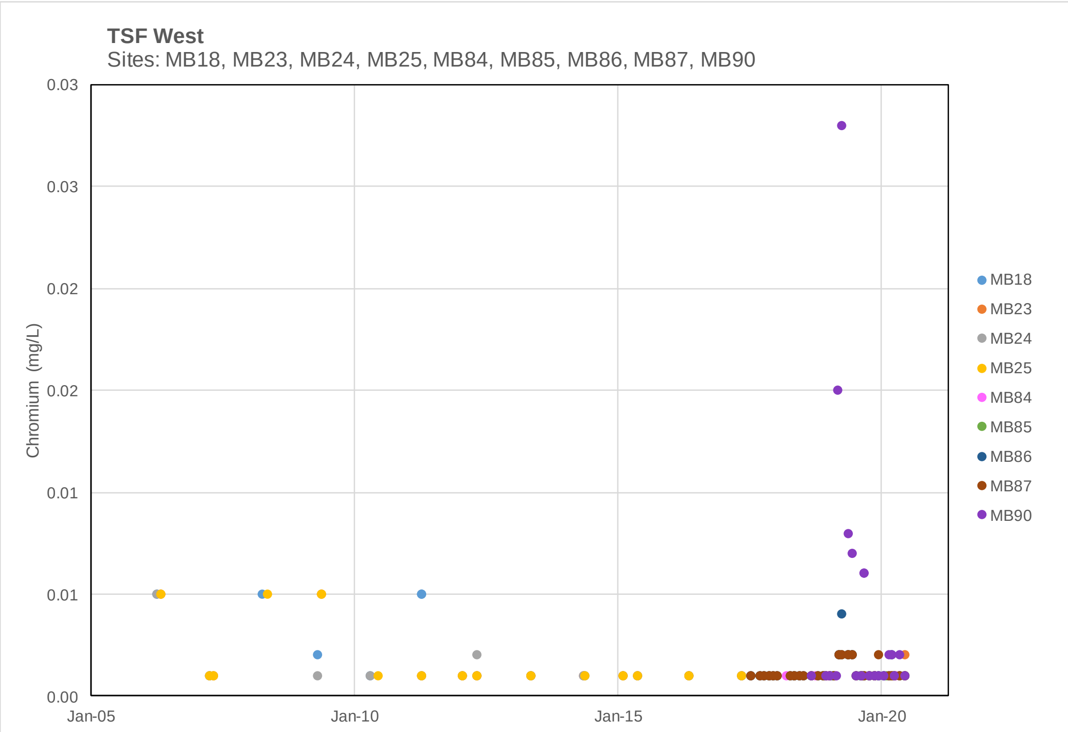


Figure 3-62 Chromium concentrations in bores to the west of the TSFs

Chloride concentrations showed an increasing historical trend at MB86. During the current reporting period, chloride concentrations at MB86 were very slightly decreasing. Chloride concentrations remain relatively stable at the remaining bores. Selenium concentrations increased at MB23 during the previous reporting period. Selenium concentrations were relatively constant at MB23 during the current reporting period.

During the current reporting period manganese concentrations were generally increasing at MB18, MB85, MB87 and MB90. Manganese concentrations at MB25 increased in June 2020 to 1.48 mg/L. Continued monitoring of manganese concentrations is recommended to confirm the trend at MB25. Manganese concentrations showed an increasing trend at MB24 during the previous reporting period, however were decreasing during the current reporting period. A historical decreasing trend in manganese has been observed at MB86, with manganese concentrations relatively constant during the current reporting period. Manganese concentrations are plotted in Figure 3-63.

During the reporting period sulfate concentrations exceeded the trigger value at MB84, MB86 and MB87 (refer Figure 3-64). Review of groundwater quality by CHPL indicated that sulfate is naturally elevated at these locations. Exceedances of the trigger values are due to sulfate being naturally elevated at these locations. The exceedances of these trigger values are not attributable to impacts of mining. Review of these trigger values is recommended as part of the next review of the WMP.

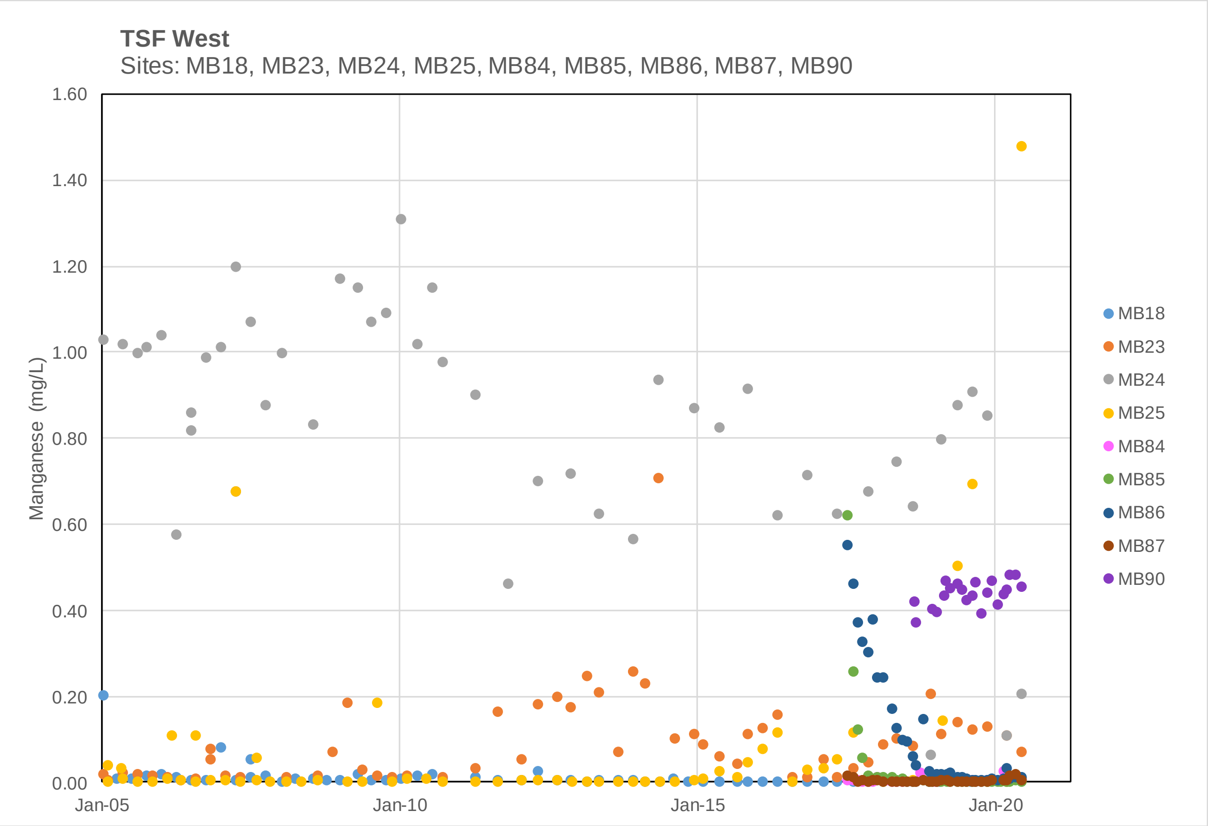


Figure 3-63 Manganese concentrations at bores to the west of the TSFs

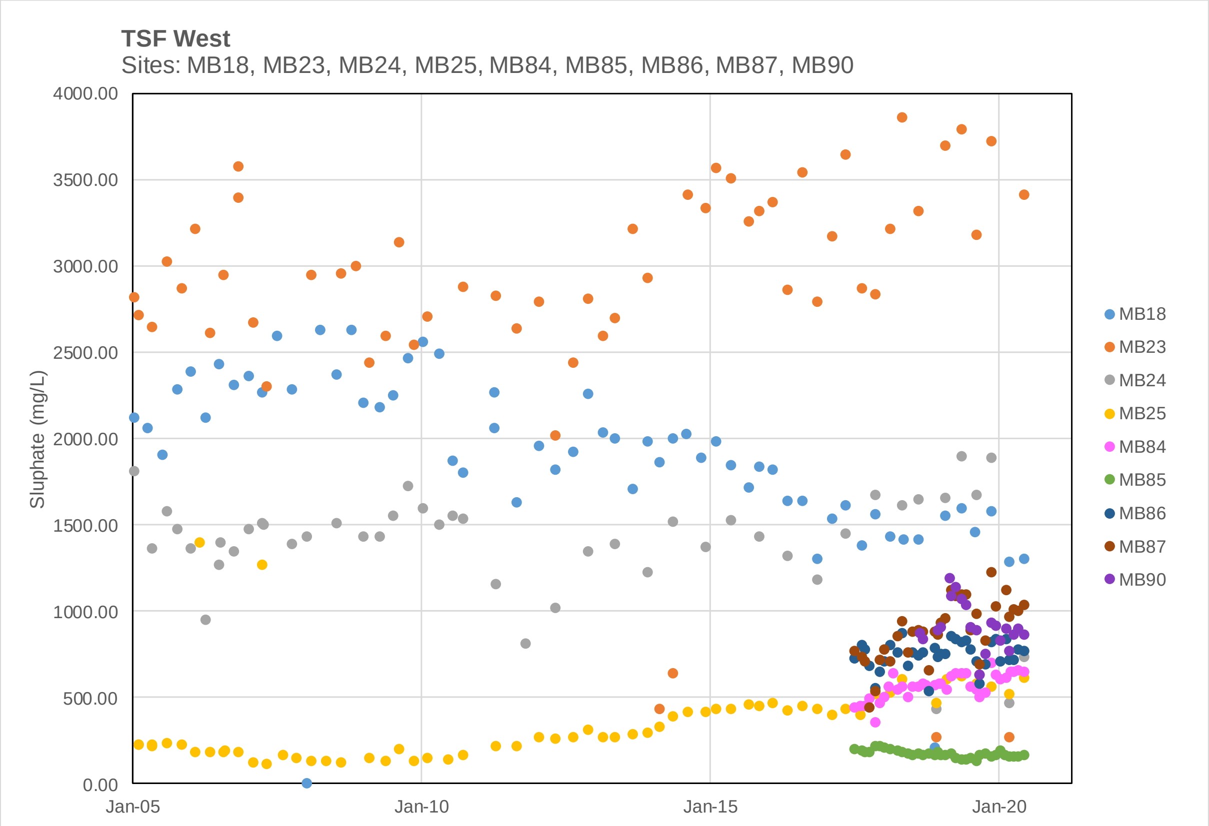


Figure 3-64 Sulfate concentrations at bores to the west of the TSFs

The Piper diagram in Figure 3-65 indicates minimal influence of decant water on local groundwater. Although the local groundwater has naturally elevated sulfate concentrations, the major cation chemistry is dissimilar to the decant water.

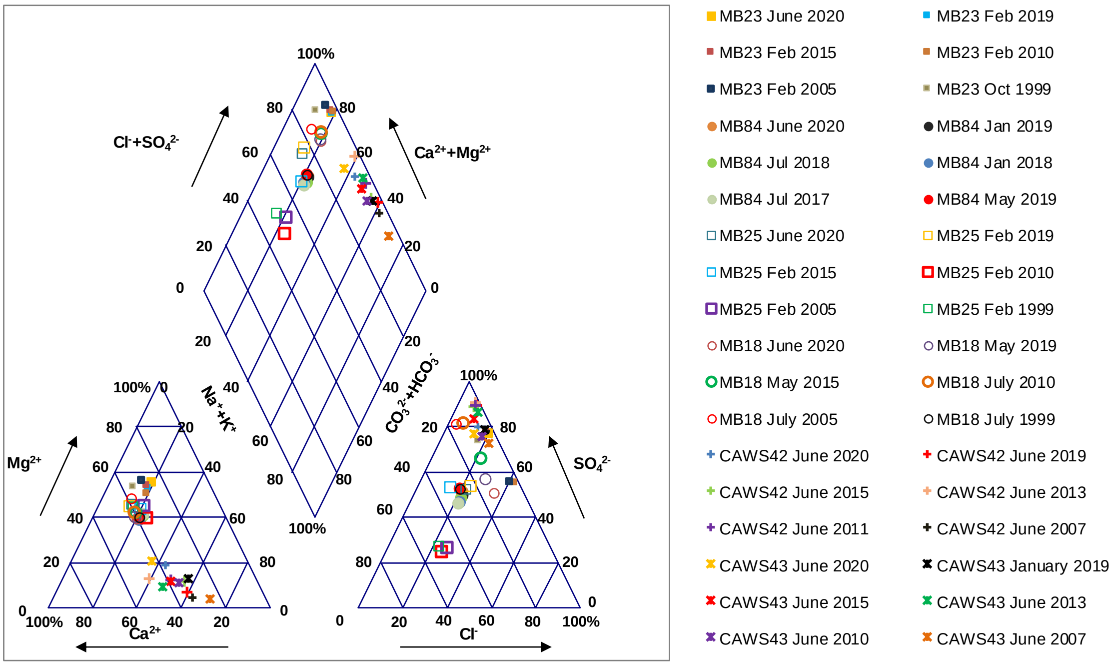


Figure 3-65 Piper diagram for MB18, MB23, MB25, MB84, CAWS42 and CAWS43

Summary

Monitoring bores MB18, MB23 and MB24 are located to the west of the NTSF. All three bores show a similar increasing trend in water levels since monitoring began, and a generally declining trend after February 2017. The potential causes were discussed in the 2017-2018 AEMR, and have been included here for completeness. Review of data collected in the 2019-2020 monitoring period is generally consistent with the outcomes of the investigation discussed in the 2017-2018 AEMR.

A review of groundwater monitoring data was undertaken by GHD in 2016 to investigate the TSF influence on groundwater. Further review was undertaken as part of the preparation of the TSF Seepage Management Options Study (GHD 2018). Statistical analyses of groundwater hydrographs for bores to the west of the NTSF were conducted as part of this review. The analyses indicated that the groundwater hydrographs for MB18, MB23 and MB24 showed significant increasing temporal trends (independent of rainfall) of greater than 0.01 m/month. The review concluded that the trends were most evident between 2001 and 2012, and were less evident over the past few years (including the 2017-2018 reporting period).

Geochemical analysis undertaken as part of the review indicated that the groundwater was not comparable with the tailings decant water, and therefore it was concluded that the observed groundwater increase could not be attributed to seepage from the TSF. The Seepage Management Options Study (GHD 2018) provided further evidence that TSF seepage to groundwater in the west is unlikely based on the groundwater flow direction. GHD (2018) concluded that the most likely primary cause of groundwater level increase was the physical changes to groundwater flow and hydrogeological properties caused by the bulk mass of the TSFs. The load of the TSFs would be compressing the aquifers beneath the footprint, resulting in increased groundwater levels to the west where the groundwater can expand.

During the reporting period groundwater levels were generally decreasing in MB18, MB23, MB86 and MB87. During the reporting period groundwater levels at MB25 were generally increasing and were steady at MB24. Groundwater levels at these bores were with groundwater level guidelines. Groundwater levels at MB84 and MB85 showed variability in response to periods of above average rainfall.

During the previous reporting period there was an increasing trend in nickel concentrations at all bores. However during the current reporting period nickel concentrations were lower at all bores. There was still some variability in nickel at MB24, MB85, MB86 and MB87 during the current reporting period. CHPL's Level 1 investigations concluded that elevated nickel was due to field or laboratory contamination or interference.

During the reporting period sulfate concentrations exceeded the trigger value at MB84, MB86 and MB87; and pH was below the lower trigger value at MB84 and MB86. There is a slight spike in aluminium at MB84 (0.43 mg/L) and MB85 (0.03 mg/L) in February 2020. The aluminium concentration was above the trigger value at MB84 in February 2020.

During the current reporting period manganese concentrations were generally increasing at MB18, MB85, MB87 and MB90.

Surface water monitoring sites showed many instances of elevated dissolved metals during the reporting period with sporadic elevated concentrations of copper, manganese, iron, molybdenum, nickel and zinc. Molybdenum concentrations at sites CAWS67, CAWS68, CAWS69 and CAWS76 have been elevated compared to other sites within the TSF western zone, which, considering the consistently elevated molybdenum concentrations in TSF decant water and WRD leachate, indicates possible seepage from the TSFs. However, there is no indication of elevated molybdenum concentrations at CAWS61 on Cadiangullong Creek which would be the downstream receptor for any seepages from CAWS67, CAWS68, CAWS69 and CAWS76. Therefore there is no inferred surface water contmaination impact from the TSF western zone on the receiving watercourse.

Overall, while it appears that there is an influence of tailings decant water or drainage from TSF embankments (which were constructed with waste rock) at a particular seepage and two dams to the west of the TSFs, this influence appears to be limited spatially, and to fully contained surface waters only, as the trends in groundwater levels and quality are more likely attributable to the influence of the bulk mass of the TSFs on the aquifer. It is also noted that the two dams and the seepage are contained surface water bodies from which water is recovered for re-use.

3.9.3 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.

Groundwater is monitored to the south of the TSFs by MB26A/B, MB27, MB28A/B, MB29A/B, MB77A/B, MB78, MB79 and MB83.

Surface water

Physicochemical parameters

pH has been stable in the TSF southern zone, with all observations for the reporting period indicating neutral 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 increasing trend in recent years due to drought effects discussed earlier in the report.

There were no temporal trends in TSS concentrations observed for the TSF southern zone. The highest TSS concentrations were observed in a tributary of Rodds Creek at CAWS57, which is unlikely to be influenced by seepage from the STSF due to being located to the south of another tributary closer to the STSF. Elevated TSS at CAWS57 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. Elevated 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. However nitrogen oxide concentrations have been gradually reducing in the TSF southern zone (Figure 3-66). 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 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.

No trends in total phosphorous concentrations were observed, though elevated concentrations were recorded, most recently in the easternmost tributary of Rodds Creek 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.

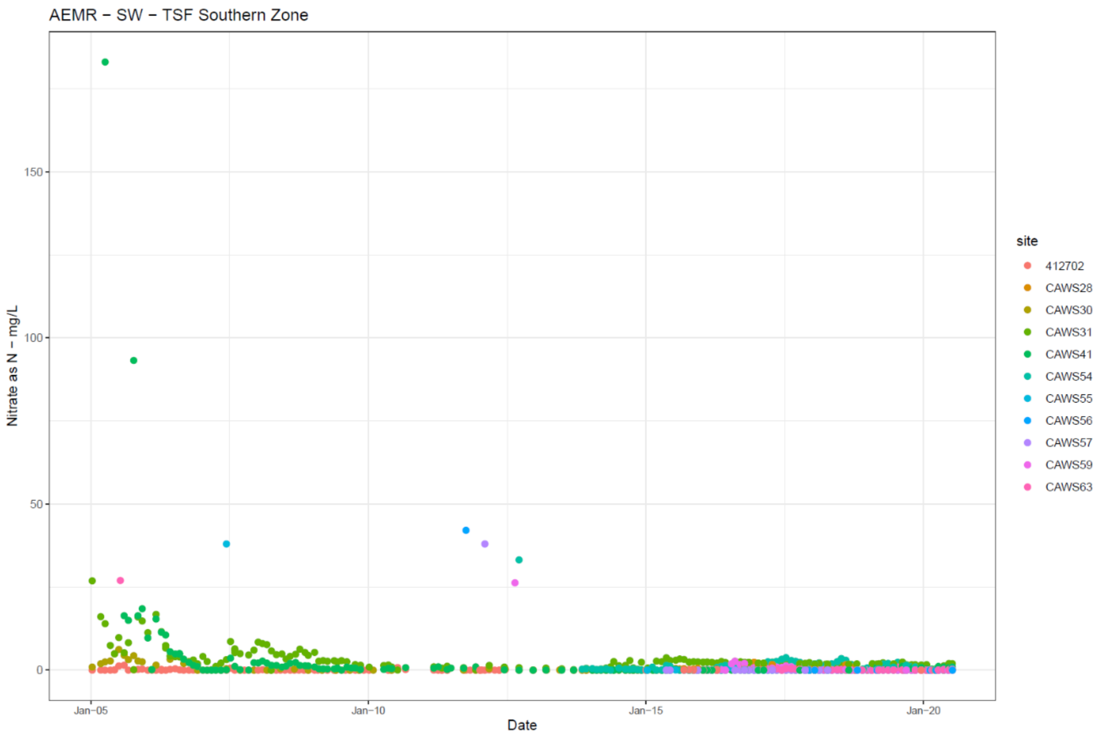


Figure 3-66 Nitrate concentrations in the TSF southern zone

Dissolved metals

Aluminium and iron concentrations have generally been highest pre-2017 at downstream Cadiangullong Creek site 412702. Since then, aluminium and iron concentrations have returned to low levels similar to other TSF southern sites. This reduction in aluminium and iron concentrations is attributable to changes in sampling practices in regards to filtration of samples. The exception is one instance of elevated iron at CAWS56 (2.9 mg/L) on 24 March 2020 where the cause is unclear as no surrounding monitoring point, including those upstream and downstream on the tributary, showed any elevated iron results. An elevated manganese result of 4.3 mg/L was also observed on this day.

Molybdenum concentrations are highest in the tailings decant water at CAWS42 and CAWS43 (refer to section 3.9.1, Figure 3-48). As has been observed in previous reporting periods, influence of seepage from the tailings is evident based on the molybdenum concentrations observed at contained systems CAWS31 and CAWS41, though no influence on sites farther downstream is evident (Figure 3-67).

Nickel concentrations were reported to be elevated at all sites in the TSF southern zone as observed for the TSF eastern and western zone sites in the 2018/2019 AEMR.Elevated nickel concentrations were likely attributable to field or laboratory contamination or interference. . Nickel concentrations dropped to the laboratory detection limit (< 0.001 mg/L) in this reporting period with the exception of a CAWS56 result (0.007 mg/L) in March 2020 and a 412702 result (0.002 mg/L) in April 2020.

Elevated zinc concentrations have been observed at all sites in the southern zone mostly pre-2019, though no spatial or temporal trends are apparent. Results in the reporting period are generally < 0.005 mg/L.

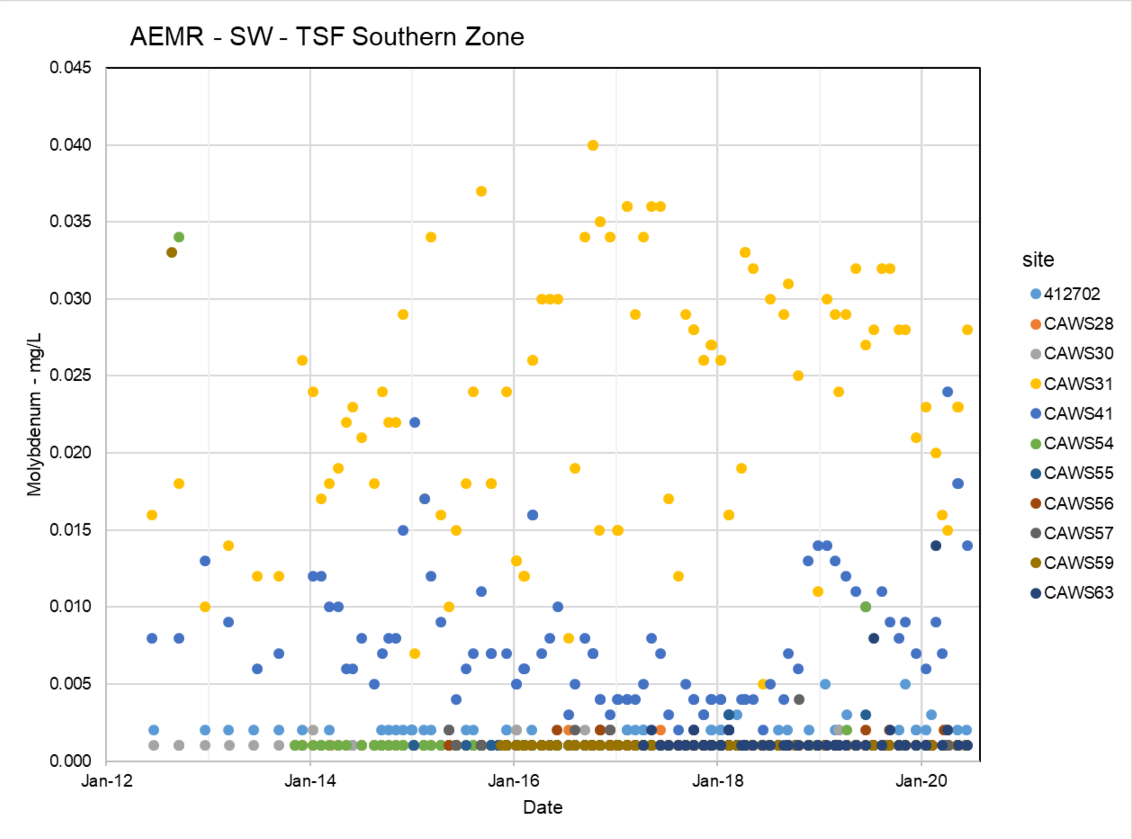


Figure 3-67 Molybdenum concentrations in the TSF southern zone.

Groundwater

Ordovician Volcanics

Previous assessments concluded that groundwater at MB27 and several surface water monitoring sites were likely to be influenced by tailings seepage. The extent of the influence was difficult to determine due to variable background groundwater quality data. Assessment conducted by GHD (2018) concluded that TSF influenced seepage has been observed at surface water and groundwater monitoring locations within an area extending 100-200 m to the south of the STSF embankment. Review of 2019-2020 data indicates that TSF influenced seepage has not extended further south of the STSF embankment during the current reporting period.

The groundwater level at MB27 remained relatively stable between May 2019 and March 2020 despite generally decreasing CRD over this period, refer Figure 3-68. This indicates ongoing influence from TSF seepage at MB27. Groundwater levels at MB27 increased in June 2020 in response to above average rainfall in March and April 2020. The groundwater level at MB27 is below the guideline value.

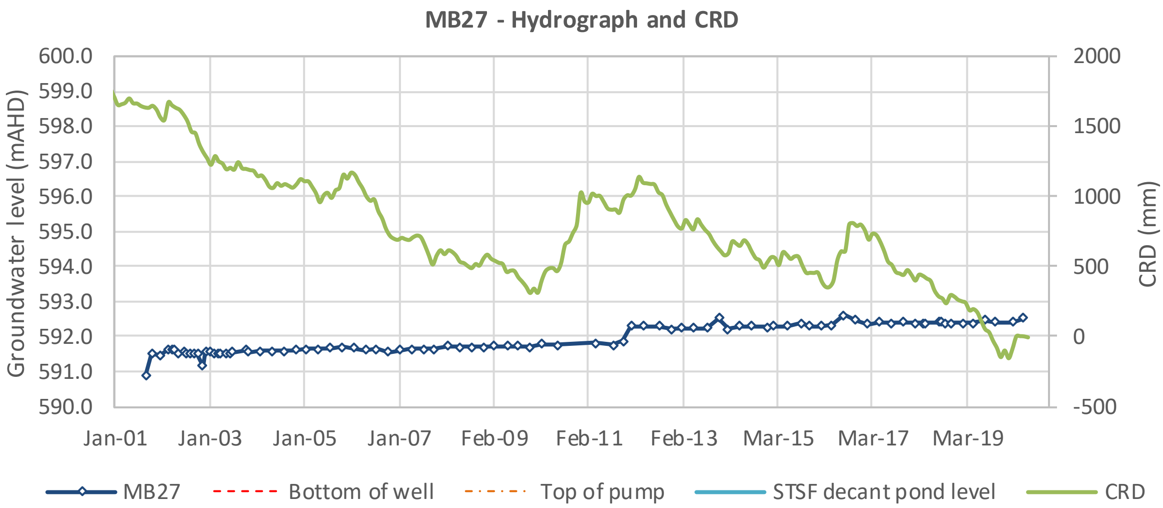


Figure 3-68 MB27 groundwater level hydrograph

The groundwater levels at MB26A and MB26B have shown an increasing trend for the majority of the monitoring record. Since December 2016, groundwater levels have showed an overall declining trend, generally consistent with the CRD.. The groundwater level for MB26B is still below the guideline value.

MB28A has been dry for the majority of the monitoring record. The groundwater levels at MB28B has shown an increasing trend for the majority of the monitoring record. Since May 2017 the groundwater level have shown an overall declining trend, generally consistent with the CRD. The rate of groundwater level decline at MB28B increased during the monitoring period. The groundwater level for MB28B is still below the guideline values.

The groundwater level at MB29A has remained relatively stable since November 2003. During the reporting period the groundwater level increased 0.1 m.

MB29B has generally reflected trends in the CRD since 2008, and has showed an overall declining trend between December 2016 and April 2018. However groundwater levels at MB29B have displayed an overall increasing trend since April 2018 (refer Figure 3-69). This increasing trend occurred despite generally decreasing CRD over this period. The groundwater level for MB29B has remained below the guideline value.

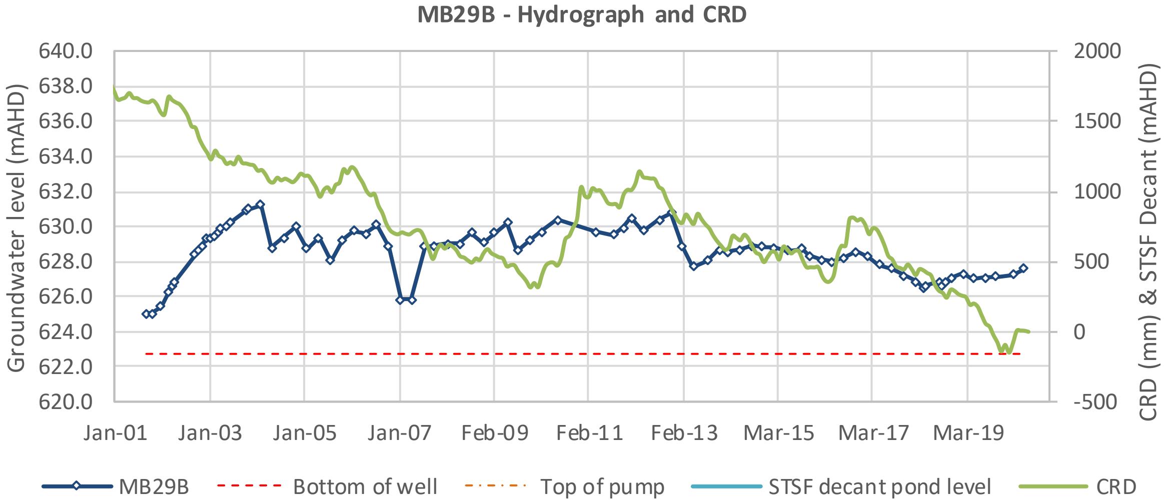


Figure 3-69 MB29B groundwater level hydrographs

Groundwater levels at MB83 have been very stable since monitoring commenced. This included throughout the monitoring period as groundwater levels varied by less than 0.1 m. The groundwater level in March 2020 is considered to be a measurement error as it is not consistent with preceding or subsequent measurements.

Silurian Sediments

The groundwater levels at MB77A and MB77B show similar trends and levels remain below the guideline value. The groundwater level decreased between July 2015 and July 2016 and then rapidly increased between July and October 2016 in response to above average rainfall. Since October 2016 the groundwater levels show fluctuations up to one metre between successive measurements and an overall declining trend. Groundwater levels did respond to the period of above average rainfall in March and April 2020.

The groundwater level at MB79 showed a historically increasing trend until June 2016. Between June 2016 and May 2018 the groundwater level showed a declining trend and an increasing trend since May 2018 (refer Figure 3-70).

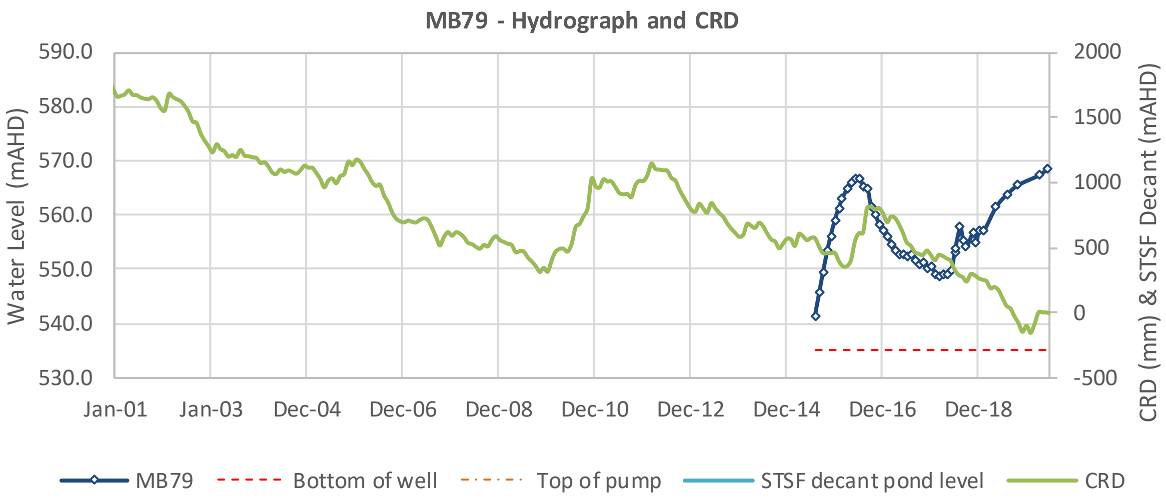


Figure 3-70 MB79 groundwater level hydrograph

Tertiary Basalt

The groundwater level at MB78 has historically reflected trends in the CRD. Since October 2017, groundwater levels at MB78 have been relatively stable. Groundwater levels decreased slightly (by approximately 0.2 m) in November 2019 and increased by a similar amount in June 2020, likely due to periods of below average and above average rainfall (refer Figure 3-71). The groundwater level at MB78 has remained below the guideline value.

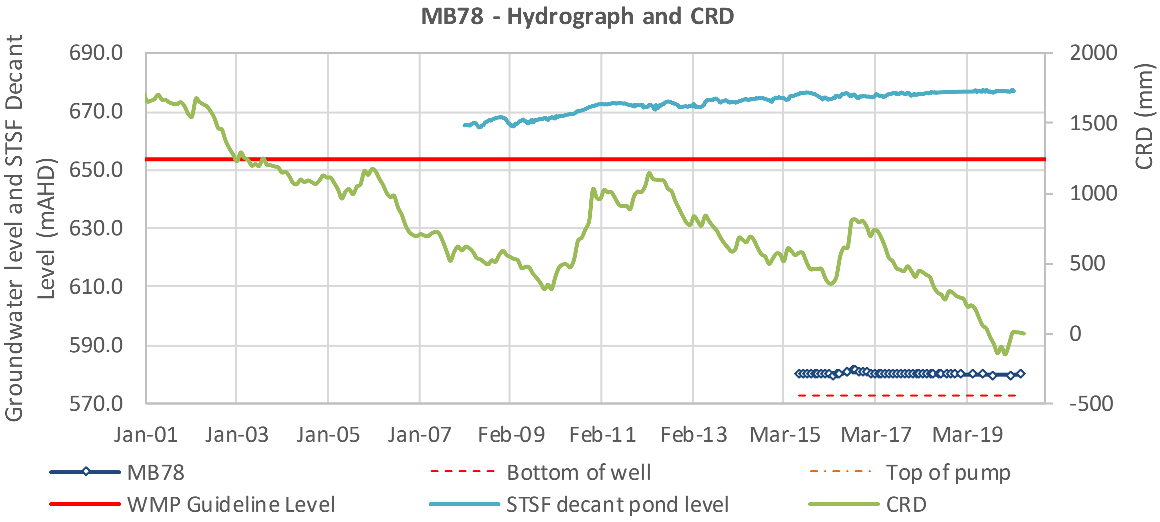


Figure 3-71 MB78 groundwater level hydrograph

Groundwater level observations for the reporting period are summarised in Table 3-16. Hydrographs are plotted with the CRD in Appendix C.

Table 3-16 Groundwater level observations in bores to the south of the STSF

Aquifer					
Ordovician Volcanic		Tertiary Basalt		Silurian Sediments	
Bores	Observation	Bores	Observations	Bores	Observation
MB26A MB26B MB27 MB28A MB28B MB29A MB29B MB83	MB27, MB29A, MB83 stable MB26A and MB26B, MB28B, overall declining trend. MB29B increasing trend MB28A dry	MB78	Stable.	MB77A MB77B MB79	MB77A and MB77B overall declining trend, fluctuating with rainfall. MB79 declining and then increasing trend.

Quality

Sulfate concentrations exceeded the guideline value at MB77A, MB77B and MB83 during the reporting period. Visual review of sulfate concentrations indicate that there does not appear to be a trend in sulfate concentrations and concentrations reported during the current period are within the historical range. Review of sulfate triggers at these monitoring locations is recommended in the next revision of the WMP.

Generally increasing trends have been observed in sulfate concentrations at MB27, MB78 and MB83, however sulfate concentrations at these locations were relatively constant during the monitoring period (refer Figure 3-72). Overall elevated sulfate concentrations are representative of background groundwater, although an increasing trend in sulfate over time may indicate decant influence. Sulfate concentrations were constant during the reporting period at MB79, the most down gradient site.

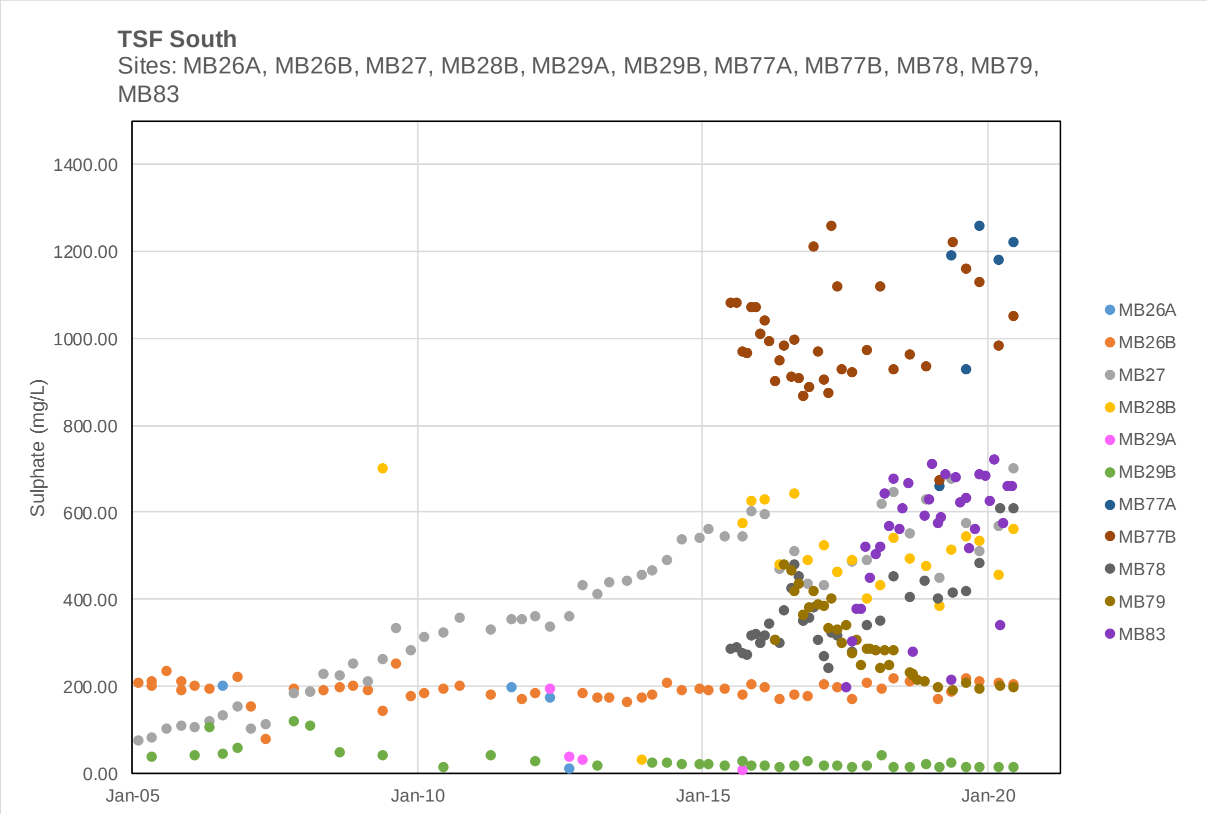


Figure 3-72 Sulfate concentrations at bores to the south of the STSF

Mercury concentrations have historically been increasing at MB26B however during the reporting period they remained stable. The manganese and nickel guidelines were exceeded at MB83 and the pH was below the guideline value. Review of trigger values at MB83 is recommended. The review should set trigger values that are indicators of potential migration of TSF influenced seepage.

During the previous monitoring period there were increasing nickel concentrations at a number of bores. Elevated nickel concentrations were likely attributable to field or laboratory contamination or interference. During the current monitoring period, nickel concentrations were lower. The exception to this was at MB28B where nickel concentrations were lower than the previous monitoring period, but did show an overall increasing trend over the current reporting period. There was a spike in nickel at MB83 in March 2020 (0.18 mg/L). Nickel concentrations were lower at MB83 in subsequent monitoring rounds.

Chromium concentrations at MB78 were elevated in August 2019 and March 2020 (0.138 mg/L and 0.036 mg/L). Chromium concentrations at MB78 were lower and within the typical range of values in the remaining monitoring rounds in the reporting period. Chromium concentrations are plotted in Figure 3-73.

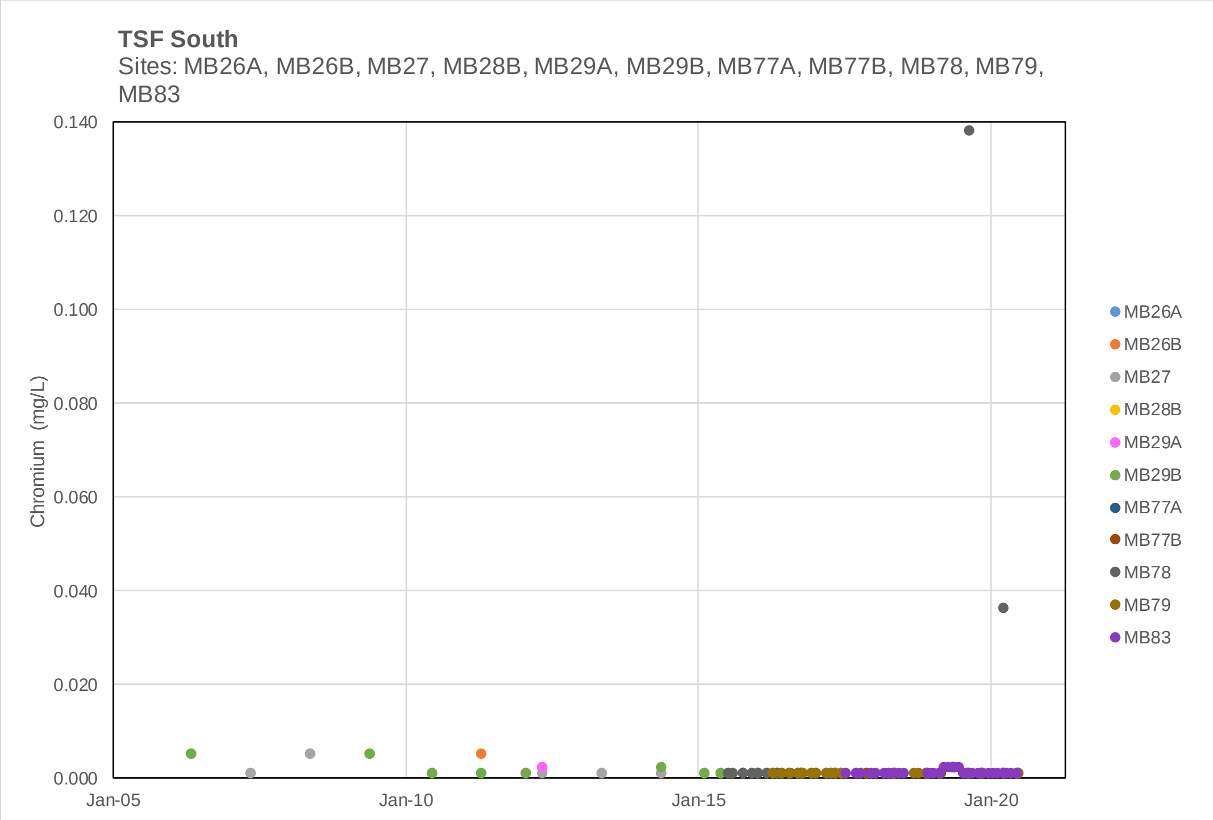


Figure 3-73 Chromium concentrations at bores to the south of the STSF

Arsenic concentrations increased at MB29B and MB83 during the last two reporting periods. Arsenic concentrations were generally constant at MB29B and MB83 during the reporting period. Arsenic concentrations are plotted in Figure 3-74.

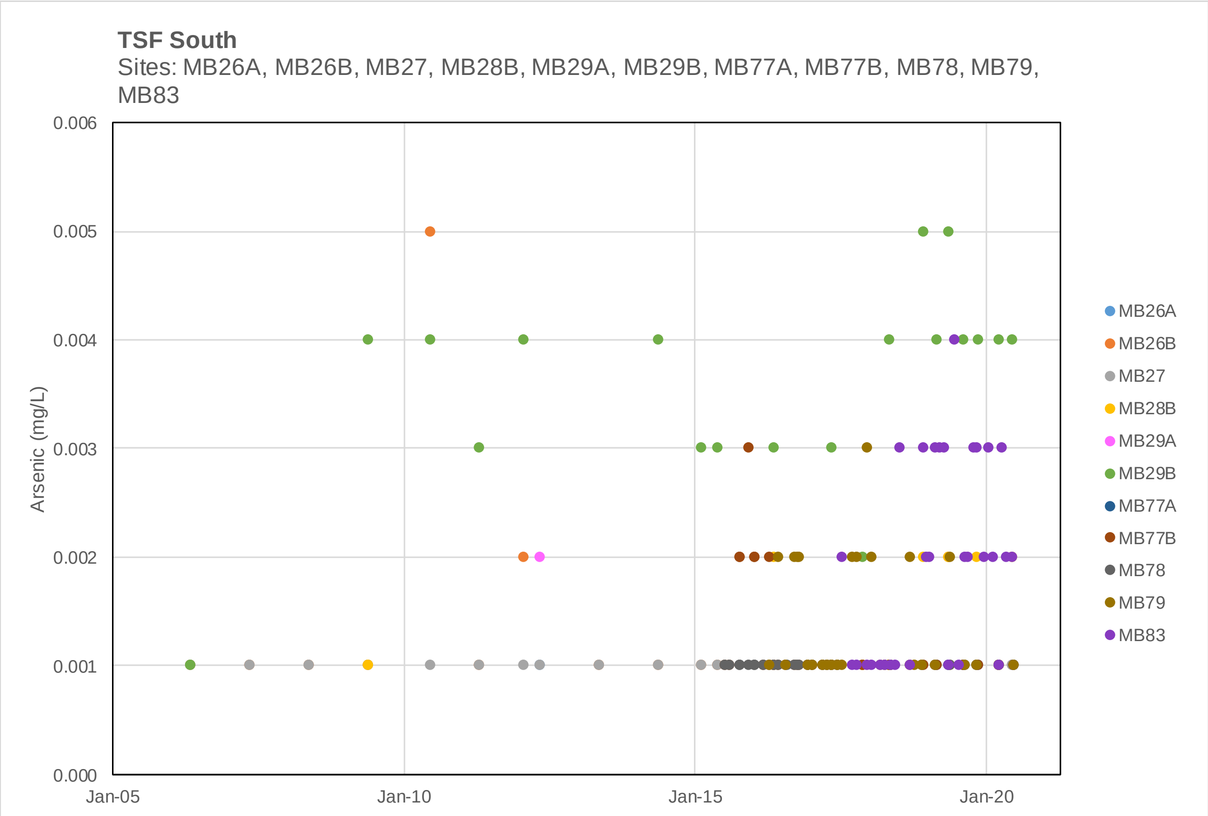


Figure 3-74 Arsenic concentrations at bores to the south of the STSF

Manganese concentrations were variable, but generally increasing at MB83 during the monitoring period. There was a spike in manganese concentrations at MB78 in June 2020 (0.166 mg/L). Continued monitoring of manganese at this location is required to determine if this is the start of an increasing trend in manganese at this location.

Nitrate and nitrogen concentrations have shown a historical decreasing trend at MB27 and MB28B. Nitrate and nitrogen concentrations at MB27 and MB28B continued to decrease during the monitoring period. Nitrate and total nitrogen concentrations were decreasing at MB78 during the previous reporting period and continued to decrease during the current reporting period. Nitrate concentrations increased at MB83 in March 2020 (0.39 mg/L) but were lower and constant for the remainder of the monitoring period.

MB27 and MB78 have generally shown similar trends in EC, TDS and major ion chemistry. Prior to the current monitoring period, EC, TDS, calcium, sodium and magnesium have shown overall increasing trends at these bores during the last two reporting periods. However, during the current reporting period, there were differences in trends in these parameters at MB27 and MB78. During the current reporting period, these parameters continued to increase at MB78 while these parameters were constant at MB27 during the reporting period.

The piper diagram in Figure 3-75 shows the most change in major ion chemistry over time at MB27 as previously reported. This change is attributable to an increase in sulfate concentration. There has been minimal change in major ion chemistry at other sites, particularly during the current reporting period. Down gradient site MB79 remains dissimilar to TSF decant in terms of major ion chemistry. TSF decant water influence on groundwater to the south of the STSF has been assessed in detail over several years and a seepage management options study was prepared in 2018. Based on groundwater quality data for the 2019-2020 reporting period there does not appear to be any change in TSF decant water influence on groundwater to the south of the STSF.

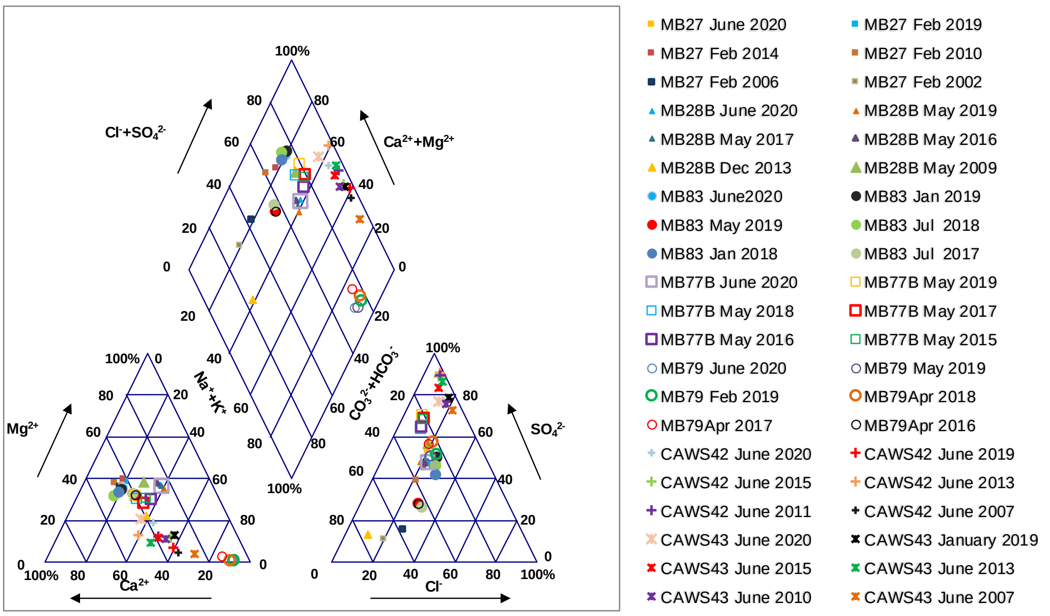


Figure 3-75 Piper diagram for MB27, MB28B, MB77B, MB79, MB83, CAWS42 and CAWS43

Summary

The groundwater levels in Ordovician Volcanic were stable at MB27, MB29A and MB83, generally decreasing at MB26A, MB26B and MB28B and stable at MB29B. The groundwater levels in Silurian monitoring bores MB77A and MB77B showed overall declining trends during the reporting period while groundwater levels at MB79 were generally increasing during the reporting period. The groundwater level at MB78 within the Tertiary Basalt has remained relatively stable during the reporting period.

Historically MB27 and MB78 show similar trends in EC, TDS and major ion chemistry, which suggests these bores are within the same aquifer. However there were some differences in EC, TDS and major ion chemistry in these bores in the reporting period.

Sulfate concentrations exceeded the guideline value at MB77A, MB77B and MB83 during the reporting period. Manganese and nickel concentrations exceeded the guideline value at MB83 during the reporting period.

Previous AEMRs have concluded that there is evidence of tailings dam water interaction with groundwater at MB27, and possible influence at MB77A, MB77B, MB78 and MB83. Previous geochemical assessments (reported in GHD, 2018) concluded that the ratio of tailings dam water to background groundwater at MB27 is approximately 20:80. Based on the major ion chemistry for MB27 during the reporting period it is considered that this ratio has not changed. The influence of tailings dam water on surface water and groundwater in the TSF southern zone is localised in extent, and for groundwater appears to affect only shallow bores. There does not appear to be any increased influence throughout the 2019-2020 reporting period at any groundwater or surface water site.

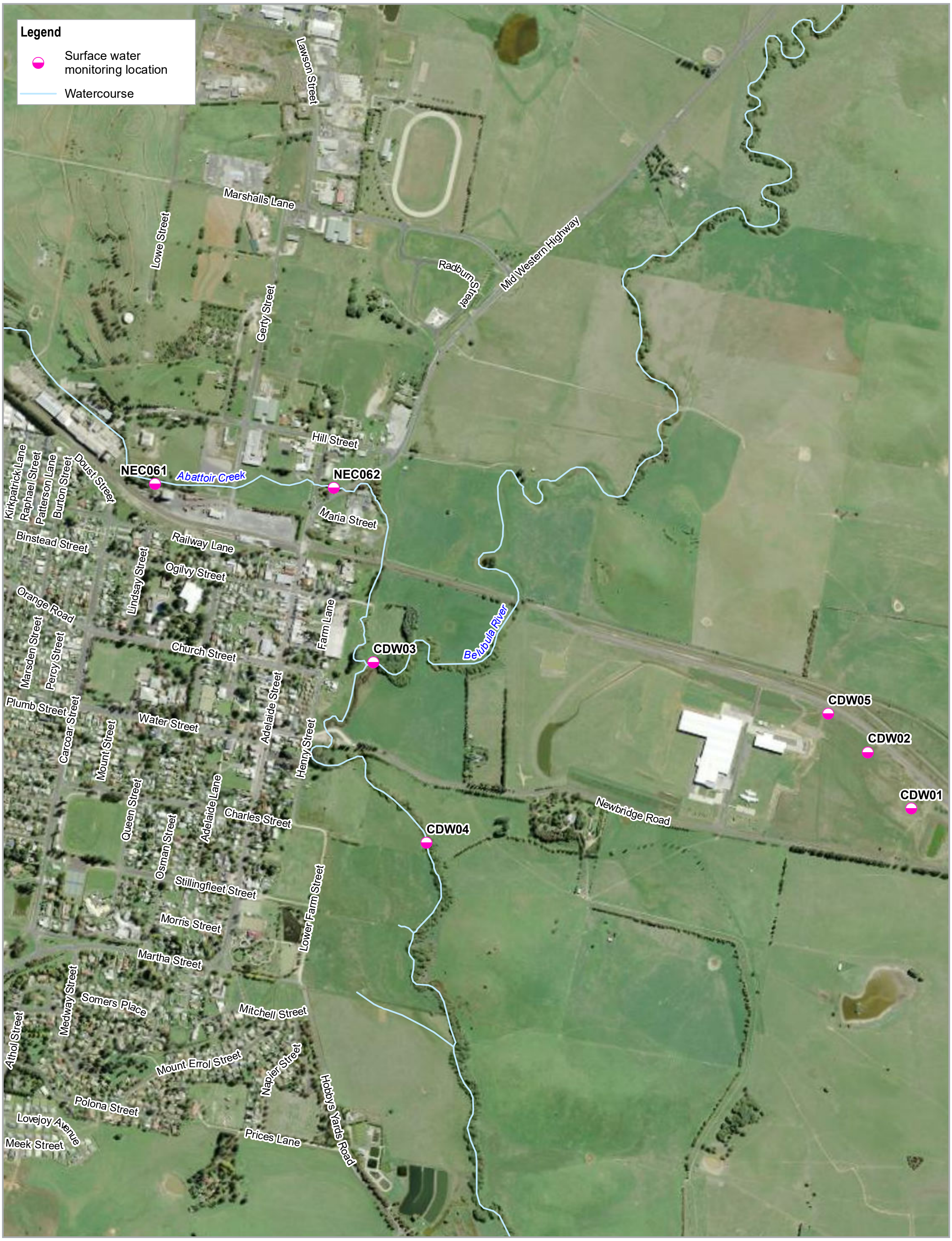
The surface water monitoring site CAWS31, which attempts to capture potential seepage from the STSF showed increased molybdenum concentrations over the reporting period. However, as mentioned in section 3.9.2, molybdenum concentrations at CAWS31 are less than the ANZG 2018 default toxicant guideline for freshwaters of 0.034 mg/L and currently does not pose a further risk to downstream receiving waters. There are no other concerning results at other surface water monitoring locations within the TSF Southen Zone.

No impact of seepage from the STSF on water quality was evident at down gradient bore MB79 or 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.

3.10 Dewatering facilities

The Blayney and Cadia Dewatering Facilities are located approximately 21 km and 23.5 km respectively to the east of the Cadia 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 in care and maintenance, acting only to pump return water to Cadia for reuse, for the first half of 2019/2020. Demolition of the facility occurred between March and April 2020. Remediation works on the site are ongoing for handover to the site owner.

Monitoring at the Blayney and Cadia dewatering facilities is limited to surface water monitoring.



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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Newcrest Mining Limited
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Surface and Groundwater Assessment

Blayney Dewatering Facility and Cadia Dewatering Facility

Project No.	**12532418**
Revision No.	**0**
Date	**03 Sep 2020**

FIGURE 3-76

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Data source: Newcrest: Bores, 2019. LPI: DCDB/DTDB, 2017. © Department of Finance, Services & Innovation 2017. Created by: pkiem, fmackay

3.10.1 Blayney Dewatering Facility

Surface water is monitored at NEC061 and NEC062 in the Blayney Dewatering Facility (BDF) area. Monitoring at NEC061 was limited during the reporting period whilst demolition works were undertaken.

Physicochemical parameters

pH at the Blayney dewatering facility sites has ranged between 6.1 and 7.8 in the reporting period, with no temporal trends evident.

EC at these sites has ranged between 120 and 769 µS/cm and shows a general decreasing trend since the start of 2017.

No temporal trends in TSS concentrations were observed, though concentrations have generally been highest at NEC061, with the highest result occurring in December 2018 (87 mg/L).

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 sites which suggests influence from upstream sources, such as industrial and agricultural runoff, is causing some sporadic elevated nutrient concentrations.

Dissolved metals

The upstream site (NEC061) has historically shown elevated arsenic concentrations which suggests there is an arsenic source impacting Abattoir Creek upstream of the Blayney Dewatering Facility. Arsenic concentrations remain low at the downstream monitoring site (NEC062).

Copper concentrations have been occasionally elevated at NEC061 and NEC062, with higher concentrations observed at the latter (downstream) site (Figure 3-77). Copper concentrations at NEC62 reduced in 2017 and 2018, though have since risen again, likely as a result of the ongoing drought conditions and the historical contamination of creek sediments from the operation of the facility. Recent copper concentrations at NEC062 remain generally below 0.01 mg/L with the exception of three results in 2018 and 2019 of 0.014 mg/L, 0.022 mg/L and 0.011 mg/L. 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 Blayney Dewatering Facility have, on average, been more elevated that those measured upstream, with the facility likely contributing to elevated copper concentrations in the creek. Following demolition of the facility, Cadia will undertake the removal of copper contaminated onsite soils. It is anticipated that copper discharges from the site and the water quality downstream of the site will improve subsequent to the completion of the onsite remediation works.

Manganese and iron concentrations have been occasionally elevated at NEC061 and generally higher than those observed at NEC062.

Elevated zinc concentrations have been observed at both sites prior to the 2017/2018 reporting period. In the last two reporting periods, zinc concentrations have lowered significantly and remained < 0.03 mg/L.

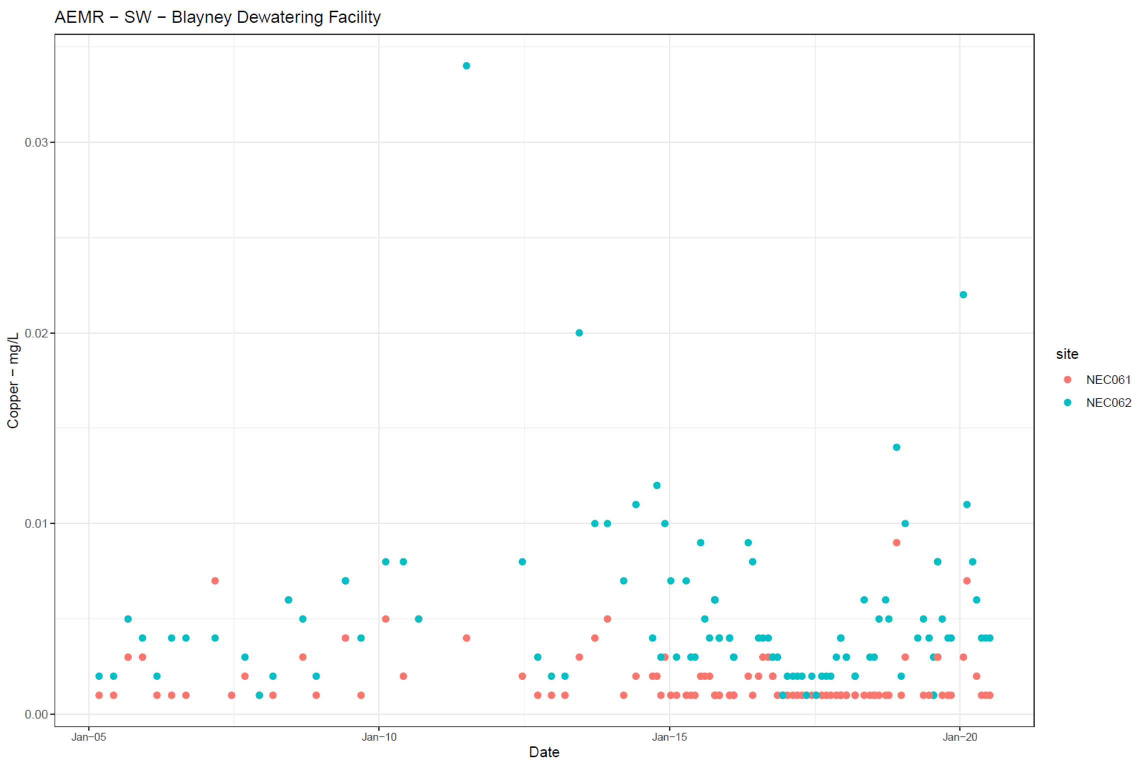


Figure 3-77 Dissolved copper concentrations in the Blayney Dewatering Facility Area

Summary

Water quality at the Blayney dewatering facility sites has been generally stable, with few temporal trends observed. Variability in water quality parameters is generally observed at both sites, though some spatial trends are apparent, such as copper concentrations generally being higher at downstream site NEC062 with arsenic, iron and manganese concentrations higher at NEC061. The higher copper concentrations at the downstream site likely reflect the influence of the facility due to contamination as identified and assessed in the Ecological Risk Assessment for Abattoir Creek (GHD, 2020b).

3.10.2 Cadia Dewatering Facility

Surface water is monitored at CDW01, CDW02, CDW03, CDW04 and CDW05 in the Cadia Dewatering Facility area. Monitoring at CDW01 was discontinued in March 2020 due a new drainage configuration being constructed which negated the need for this monitoring point. Some samples at CDW04 were missed during the reporting period due to newly installed fencing, limiting access to the Belubula River. A gate will be installed for access to this location.

Physicochemical parameters

pH in the Cadia Dewatering Facility area ranges from slightly acidic at CDW03 to slightly alkaline at CDW01. A spatial trend has been observed adjacent to the facility, with pH generally ranging from highest at the furthest upstream site (CDW01) to lowest at downstream sites CDW03 and CDW04.

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 Cadia Dewatering Facility (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.

Nutrients

The concentrations of nitrogen oxides have been consistently highest at CDW05 (Figure 3-78), and a temporal trend has been observed at the site, with the lowest concentrations observed during summer months. 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.

No trends in the concentrations of total phosphorous were observed however, elevated concentrations exist at all monitoring points including the upstream monitoring point on the Belubula River. This suggests that background levels of phosphorus in watercourses is naturally elevated in the catchment.

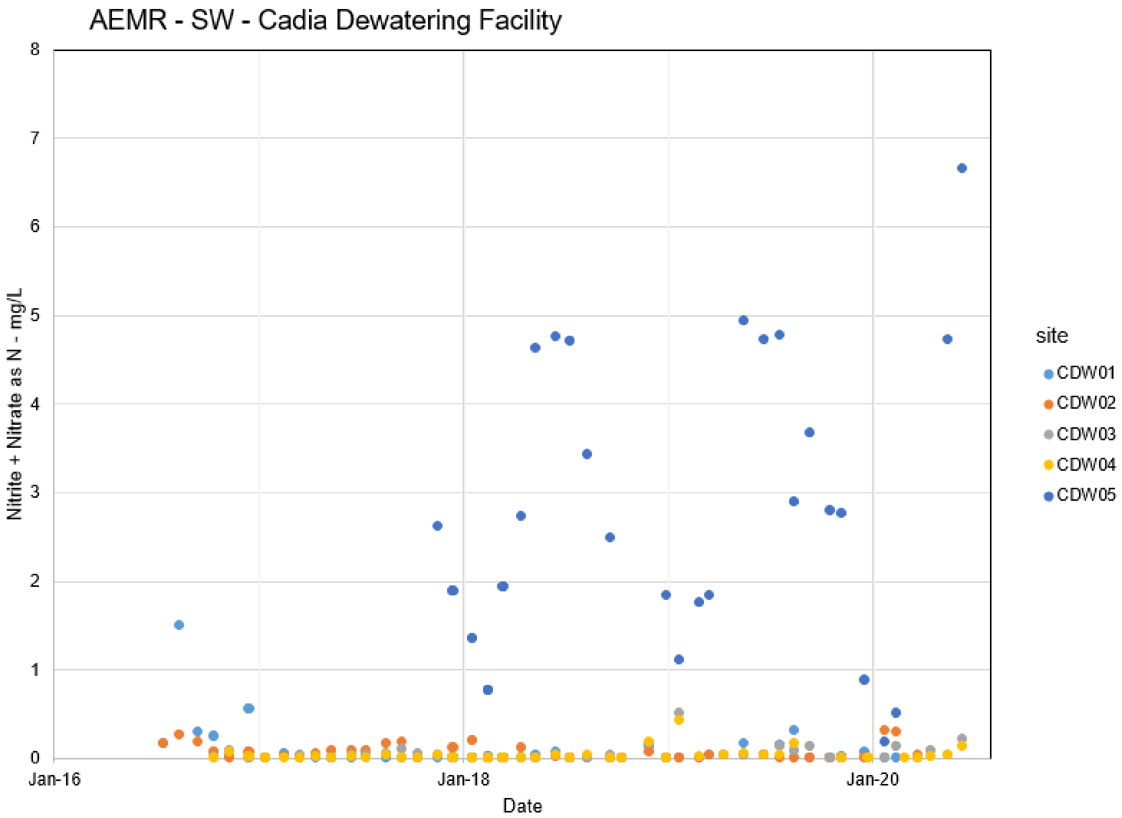


Figure 3-78 Nitrogen oxide concentrations in the Cadia Dewatering Facility Area

Dissolved metals

An elevated result of arsenic was recorded in the reporting period at the upstream Belubula River site CDW03. All other results were < 0.007 mg/L.

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.

Copper concentrations have generally been highest at CDW01 and CDW02, though a general decreasing trend is indicated by the data. Concentrations are low at CDW05 (downstream of CDW01 and CDW02) which suggest that the elevated copper concentrations are localised in the proximity of the Cadia Dewatering Facility and do not migrate downstream to sensitive watercourses. Elevated copper concentrations have been observed at the Belubula River site upstream of the facility (CDW03) compared with the downstream site (CDW04), which indicates that the exceedances of the ANZG (2018) default guideline value observed in the river were unlikely to be associated with the facility. There does not appear to be any relationship between the trends in dissolved copper concentrations observed at NEC062 and those observed at CDW03, which indicates that there is minimal influence of either dewatering facility on copper concentrations in Belubula River.

Molybdenum concentrations have historically been highest at CDW02, though were higher at CDW01 during the first half of 2019, refer to Figure 3-80. Considering the presence of molybdenum in the ore at Cadia these observations may reflect the influence of the dewatering facility's operation at CDW02 and CDW01, though no such influence has been observed at CDW05 or in the receiving environment of Belubula River at sites CDW03 and CDW04.

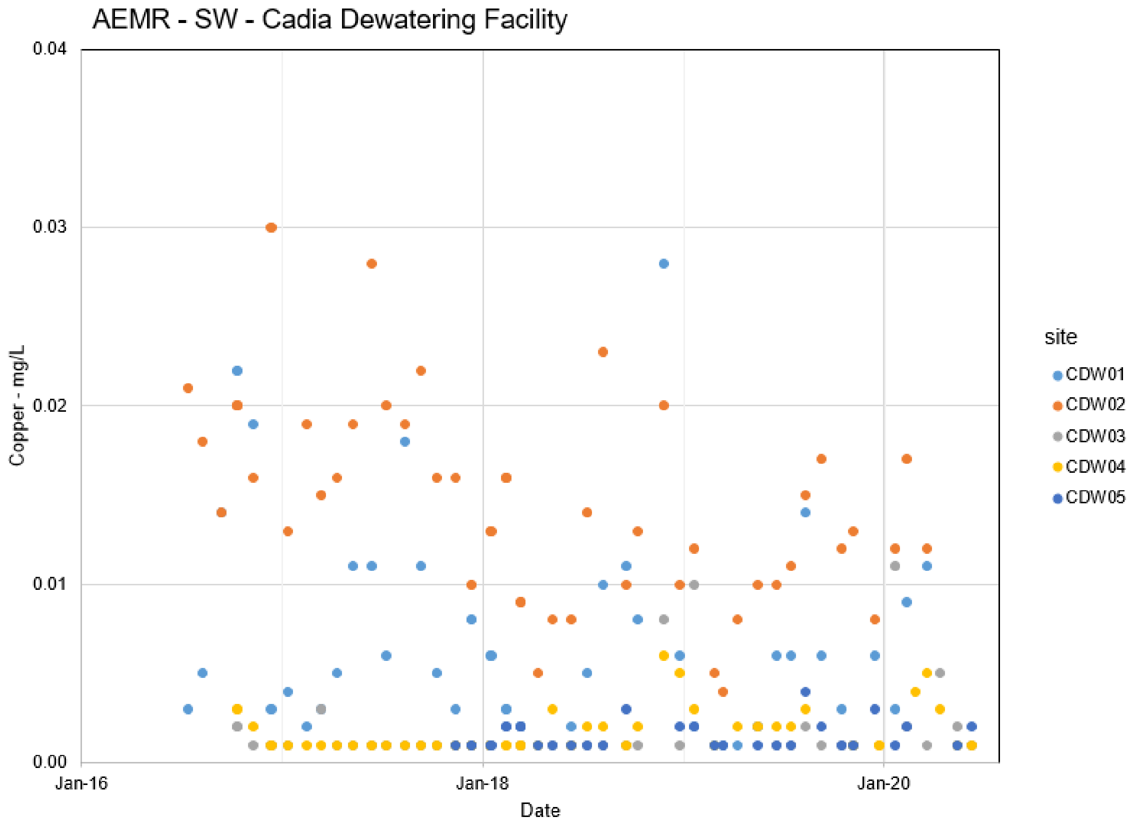


Figure 3-79 Dissolved copper concentrations in the Cadia Dewatering Facility Area

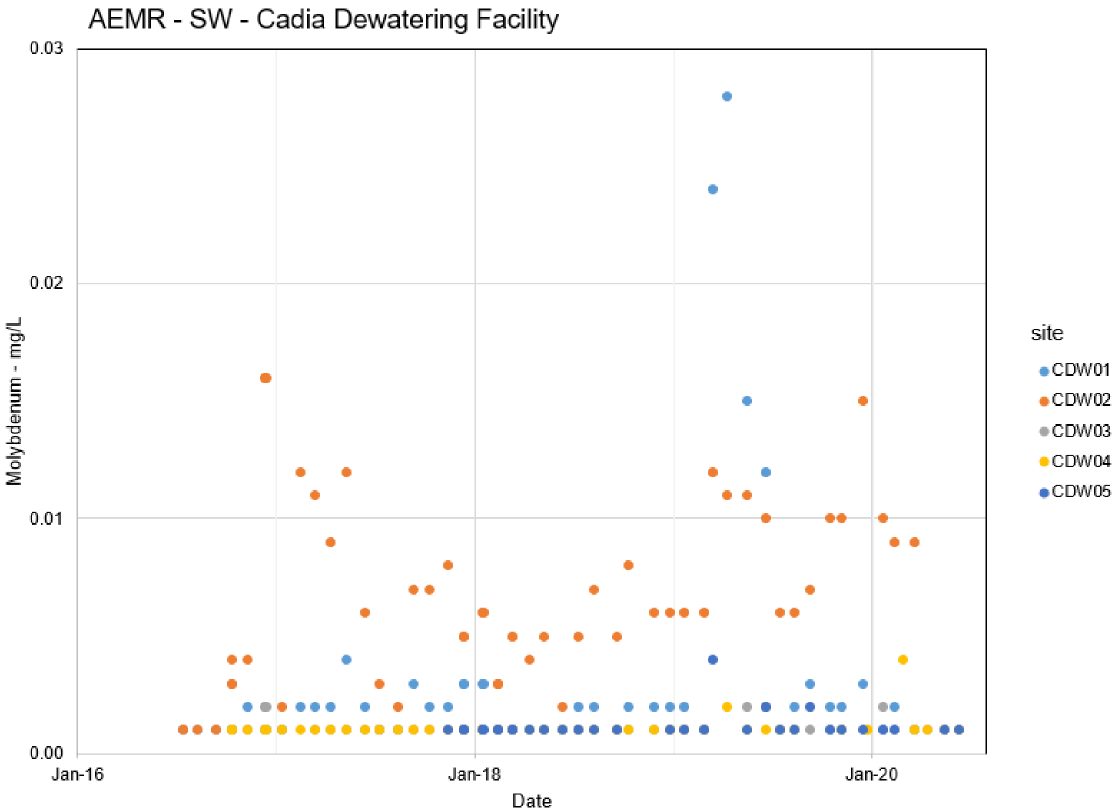


Figure 3-80 Dissolved molybdenum concentrations in the Cadia Dewatering Facility Area

Summary

The potential influence of the Cadia dewatering facility on water quality has been observed at CDW01 and CDW02, based on elevated concentrations of copper and molybdenum. There has been minimal impact on the concentrations of these parameters observed in the downstream receiving environment of Belubula River. Drainage improvement works at the Cadia Dewatering Facility area have further reduced the risk of impacts on the downstream receiving environment.

3.11 Regional bores

There are a number of bores monitored by Cadia outside the predicted impact zone of the operation. These bores include RB03, RB04, RB05, RB07 and MB81. RB03 is screened within the Tertiary Basalt, and the remaining bores are screened in Silurian Sediment. The bores MB71, MB72 and MB75, located to the far north-east of the site, are included within the Cadia East zone but could also be considered to be regional bores.

The groundwater levels at RB03, RB04 and RB05 historically reflect trends in the CRD. For the previous reporting period groundwater levels at these bores declined and this continued into this reporting period reflecting declining CRD over this period. Groundwater levels at RB05 increased in June 2020 following a period of above average rainfall. Since November 2016 the groundwater level has declined approximately 4.6 m, 4.2 m and 0.9 m respectively in bores RB03, RB04 and RB05. The groundwater level for RB05 is plotted with CRD in Figure 3-81.

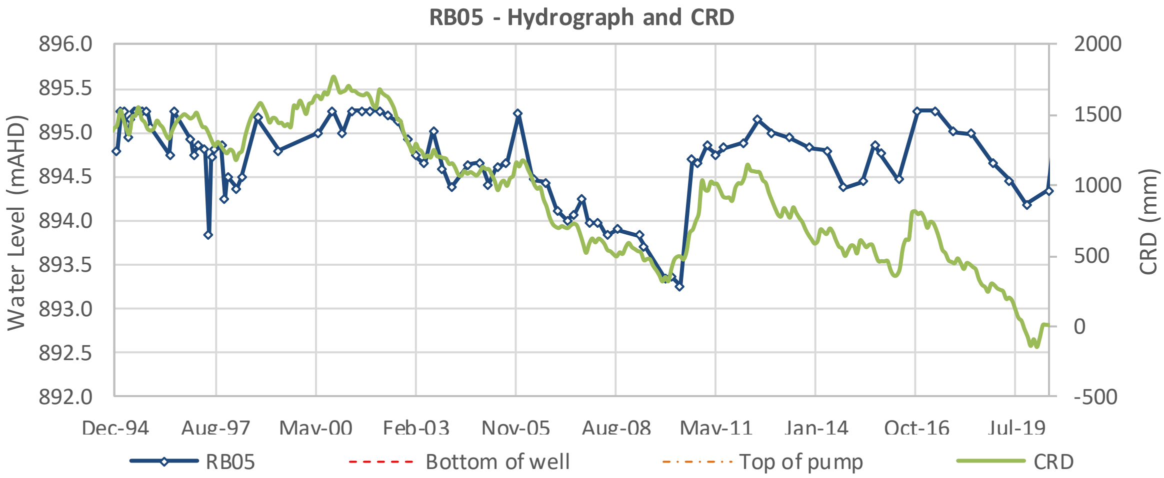


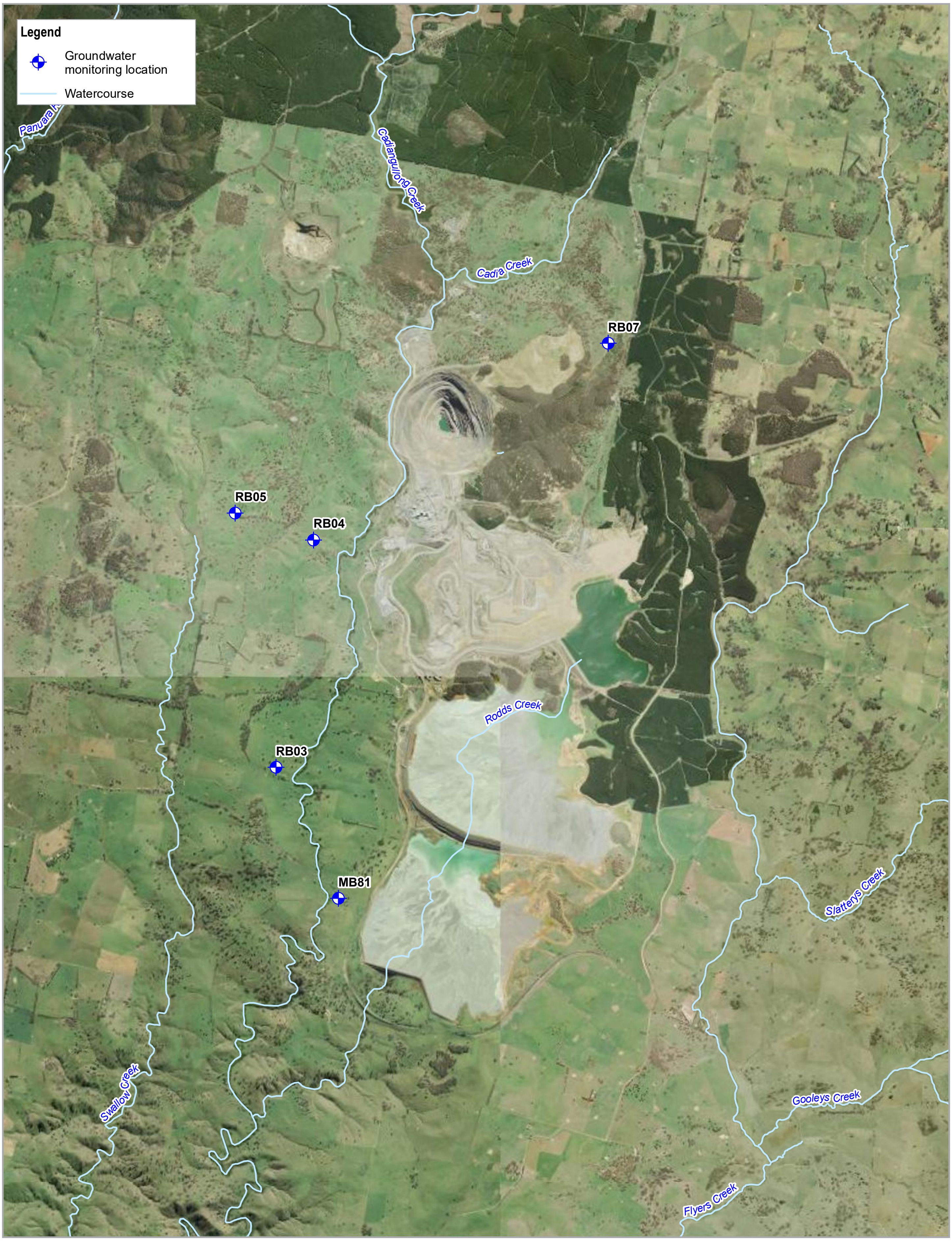
Figure 3-81 RB05 groundwater level hydrograph

The groundwater level at RB07 has historically reflected trends in the CRD. Since January 2013 the groundwater level at RB07 has continued to decline, and does not show a response to rainfall recharge. Since November 2016 the groundwater level has declined by approximately 3.6 m.

The groundwater level at MB81 has historically reflected trends in the CRD. During the previous reporting period groundwater levels were generally decreasing in accordance with decreasing CRD. During the current reporting period groundwater levels were generally very gradually decreasing in accordance with CRD until April and May 2020 when groundwater levels responded to a period of above average rainfall.

Remaining hydrographs are plotted with the CRD in Appendix C.

Groundwater quality is monitored at MB81. The EC at MB81 has been relatively stable at around 2,000 µs/cm throughout the monitoring record. Manganese concentrations have shown an overall declining trend since monitoring began. No other increasing or decreasing trends were evident in the data series.



Paper Size ISO A4

0 500 1,000 1,500 2,000

Metres

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

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Revision No. **0**
Date **03 Sep 2020**

Regional Bores

FIGURE 3-82

N:\AU\Orange\Projects\22\20341\GIS\Maps\Deliverables\12532418\GSWA\12532418_GSW007_Regional_0.mxd
Print date: 03 Sep 2020 - 16:07

Data source: Newcrest: Bores, 2019. LPI: DCDB/DTDB, 2017. © Department of Finance, Services & Innovation 2017. Created by: pkiem, fmackay

4. SSGV assessment

4.1 Site specific guideline values

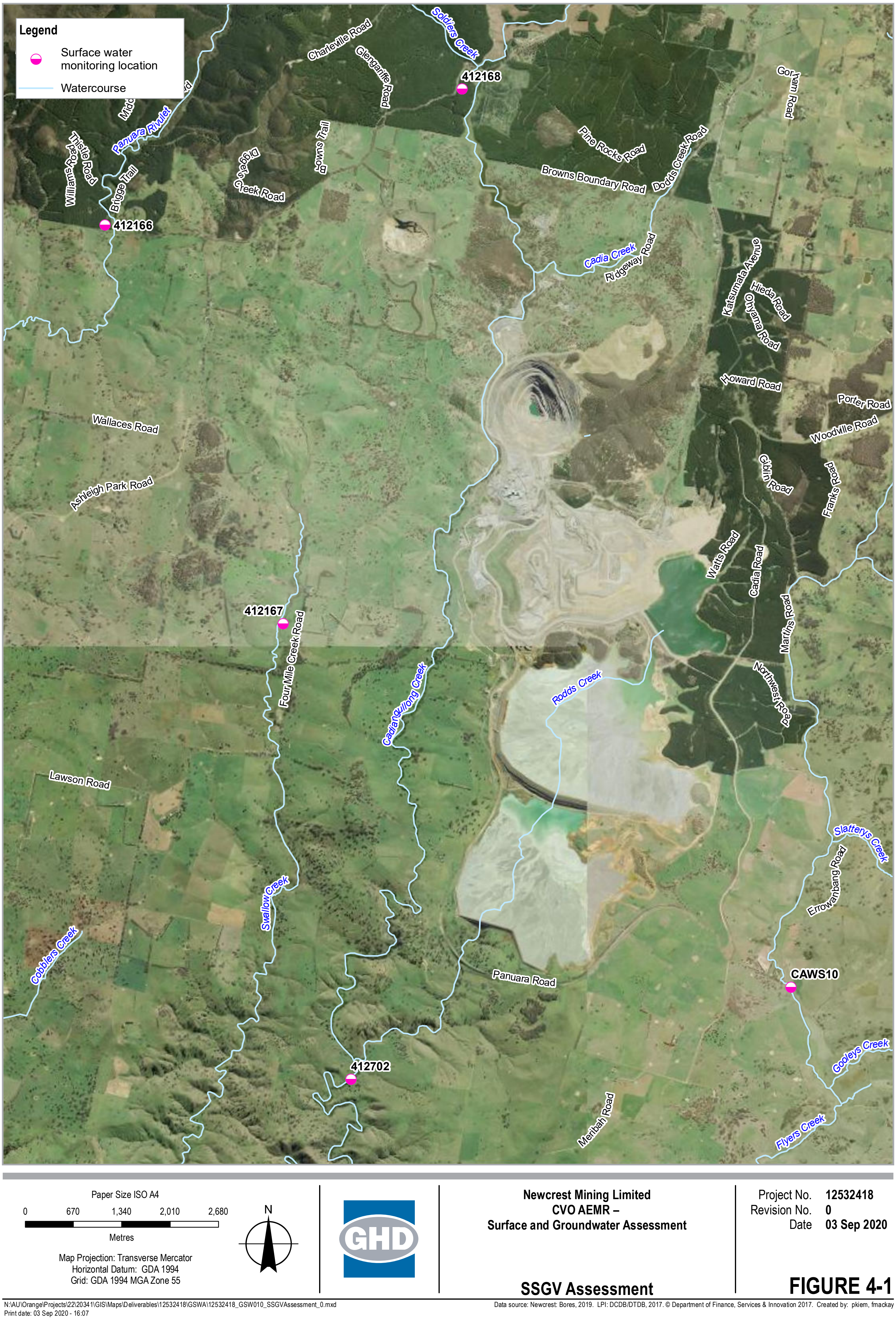
Site specific guideline values (SSGVs) have been determined from the baseline data in accordance with ANZG 2018. A review of SSGVs for the downstream Oaky Creek site was conducted in 2018 (GHD, 2018a). This review was as part of a 10-year review of the aquatic ecosystem monitoring program and the findings 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 determined site. The location of the SSGV sites are shown in Figure 4-1. These SSGVs provide a risk-based indicator of changes in downstream water quality and a robust basis for investigation where exceedances are identified.

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 Cadia. 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	1960	2,950	965	1960
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



Newcrest Mining Limited
CVO AEMR –
Surface and Groundwater Assessment

SSGV Assessment

Project No. 12532418
Revision No. 0
Date 03 Sep 2020

FIGURE 4-1

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Print date: 03 Sep 2020 - 16:07

Data source: Newcrest: Bores, 2019. LPI: DCDB/DTDB, 2017. © Department of Finance, Services & Innovation 2017. Created by: pkiem, fmackay

4.2 Cadiangullong Creek

Cadiangullong Creek flows north to south through Cadia mine. Potential mine derived sources of pollution are discussed throughout Section 3.4 to 3.9.

At Oaky Creek Gauging Station (412702), the following exceedances of the SSGVs were observed during the reporting period:

- The EC SSGV, 875 µS/cm, was exceeded in July, August and September of 2019 and April and May of 2020, with values ranging from 1089 to 1847 µS/cm. Flow at 412702 was low on one of the two days of the 2020 exceedances, being 8 April 2020 (1.0 ML/day). On the date of the second 2020 exceedance, 12 May 2020, flow was 6.7 ML/day. The level one investigation for the exceedances found that a number of these exceedances were attributed to the cessation of riparian releases, occuring between 8 April 2019 and 27 September 2019 (GHD, 2020a) following approval from the DPIE Water Division. Very low or no flow can cause increases in salinity due to evaporative concentration and a higher proportion of saline groundwater in the creek.
- The dissolved iron concentration in April and June 2020 was 0.16 mg/L and 0.13 mg/L respectively compared with a SSGV of 0.12 mg/L. The level one investigation found that these exceedances occurred during times when elevated dissolved iron concentrations were recorded upstream on Cadiangullong Creek. This includes the upstream background locations of CAWS0 and 412144 which measured dissolved iron concentrations of 0.38 mg/L and 0.5 mg/L respectively in June 2020. This suggests possible sample contamination or laboratory error. Iron values returned to normal levels in the subsequent monitoring round.
- The total nitrogen concentration on 20 January 2020 was 0.7 mg/L compared with a SSGV of 0.6 mg/L. The findings of the level one investigations indicated that these exceedances were likely related to a flushing event caused by rainfall (18.2 mm recorded on 20/01/2020) with increased agricultural nutrient inputs, and were not indicative of an increasing trend in nitrogen concentrations.
- Total phosphorous concentrations 20 January and 10 February 2020 of 0.07 mg/L exceeded the SSGV of 0.06 mg/L. Level one investigations indicated that the 20 January 2020 concentration was directly related to the rainfall event mentioned in the total nitrogen discussion (above). Similarly, the rainfall on 9 and 10 February 2020 totalled 14.2 mm, therefore this exceedance was also attributed to a rainfall event flushing agricultural nutrients into the creek system.

4.3 Rodds Creek

At Rodds Creek site CAWS63, SSGVs are based on EPL 5590 water quality concentration limits at EPA 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. There is however potential for the mining operations to impact on flow in Flyers Creek with a high volume of groundwater baseflow making up total annual flows and, Cadia hold a water extraction licence on Flyers Creek between the upstream and downstream monitoring locations (CAWS44 and CAWS10).

The only exceedances of the SSGVs for Flyers Creek site CAWS10 during the reporting period were on 24 March 2020 with a total nitrogen concentration of 1 mg/L, and a total phosphorous concentration of 0.26 mg/L observed compared with the SSGVs of 0.6 mg/L and 0.09 mg/L respectively. The level one investigations for these exceedances found no trends in total nitrogen or total phosphorus concentrations. No extraction of water from Flyers Creek was undertaken in the six months prior to monitoring in March 2020. The exceedances were attributed to agricultural inputs from above average rainfall causing elevated nutrient concentrations in surface water runoff following the drought period experienced prior to quarter 1, 2020.

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.

At Diggers Creek site 412166, exceedances of the SSGVs during the reporting period all occurred on 20 January 2020, with the following results:

- A pH value of 6.46 below the lower limit SSGV of 6.5
- An EC value of 3443 µS/cm exceeded the SSGV of 1960 µS/cm
- A total phosphorus concentration was 1.14 mg/L exceeding the SSGV of 0.09 mg/L
- A total nitrogen concentration was 2.6 mg/L exceededing the SSGV of 0.6 mg/L
- A dissolved iron concentration of 6.5 mg/L exceeding the SSGV of 1.65 mg/L
- A dissolved zinc concentration of 0.117 mg/L exceeding the SSGV of 0.077 mg/L, and
- A dissolved manganese concentration of 9.19 mg/L exceeding the SSGV of 1.9 mg/L.

The findings of the level one investigations indicated that these exceedances were likely related to a flushing event caused by rainfall (18.2 mm recorded on 20/01/2020) following a long period of drought which increased agricultural nutrient inputs and stirred up dissolved metals in creek sediments.

At Swallow Creek site 412167, the following exceedances of the SSGVs were observed during the reporting period:

- An EC value of 2,878 µS/cm on 16 December 2019 compared with an SSGV of 1,960 µS/cm. The level one investigations found that these EC values were attributable to the ongoing drought conditions and the subsequent low flows in the creek observed throughout 2019.
- Total phosphorus concentration was 0.14 mg/L on 20 January 2020 exceeding the SSGV of 0.09 mg/L. As with the Diggers Creek exceedances on this day, this exceedance was attributed to a flushing event caused by rainfall which increased agricultural nutrient inputs into the creek system.

5. Recommendations and conclusions

5.1 Key performance and/or management issues

The review of surface water and groundwater monitoring results for the 2019-2020 reporting period 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 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.

5.2 Proposed improvements

The following changes to the existing monitoring program are recommended to inform the issues discussed above:

- The installation of additional monitoring bores within the Cadia Hill Pit area is recommended. Two additional bores in the Cadia Hill Pit and four additional bores in between the pit and Cadiangullong Creek are planned for installation during the next reporting period.
- Groundwater quality triggers are reviewed as part of the next revision of the WMP.

6. References

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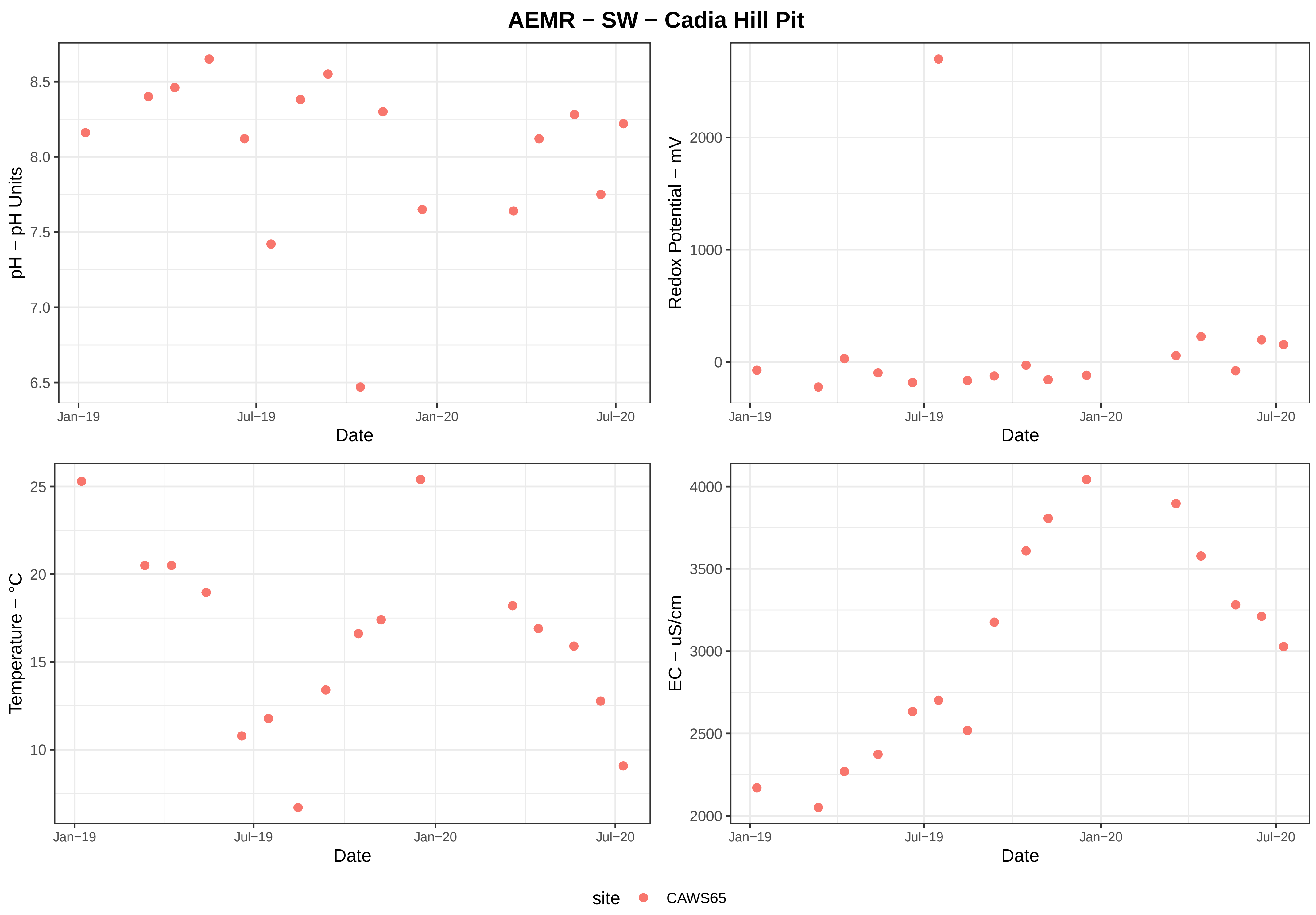
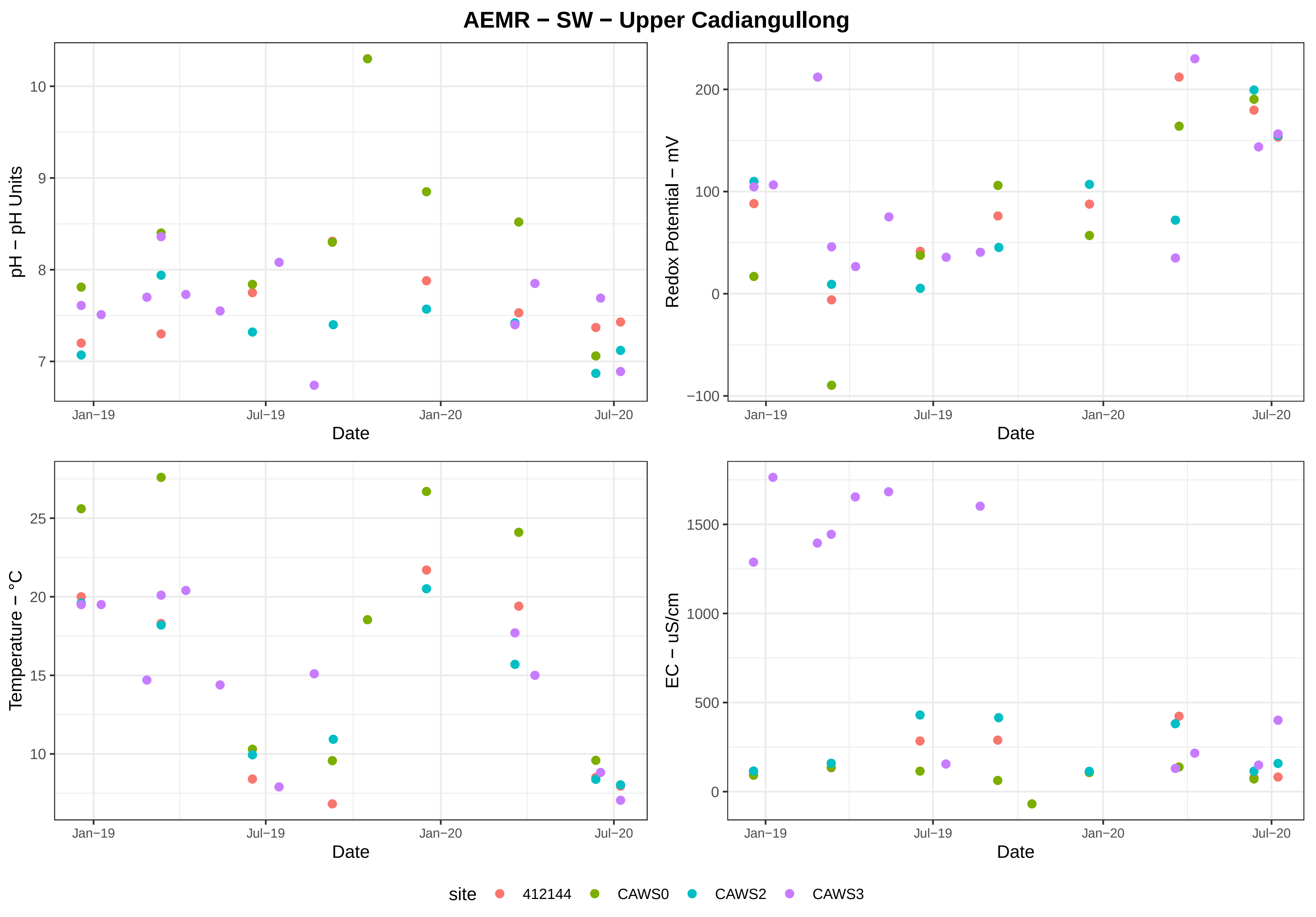
Appendices

Appendix A – Surface water quality graphs



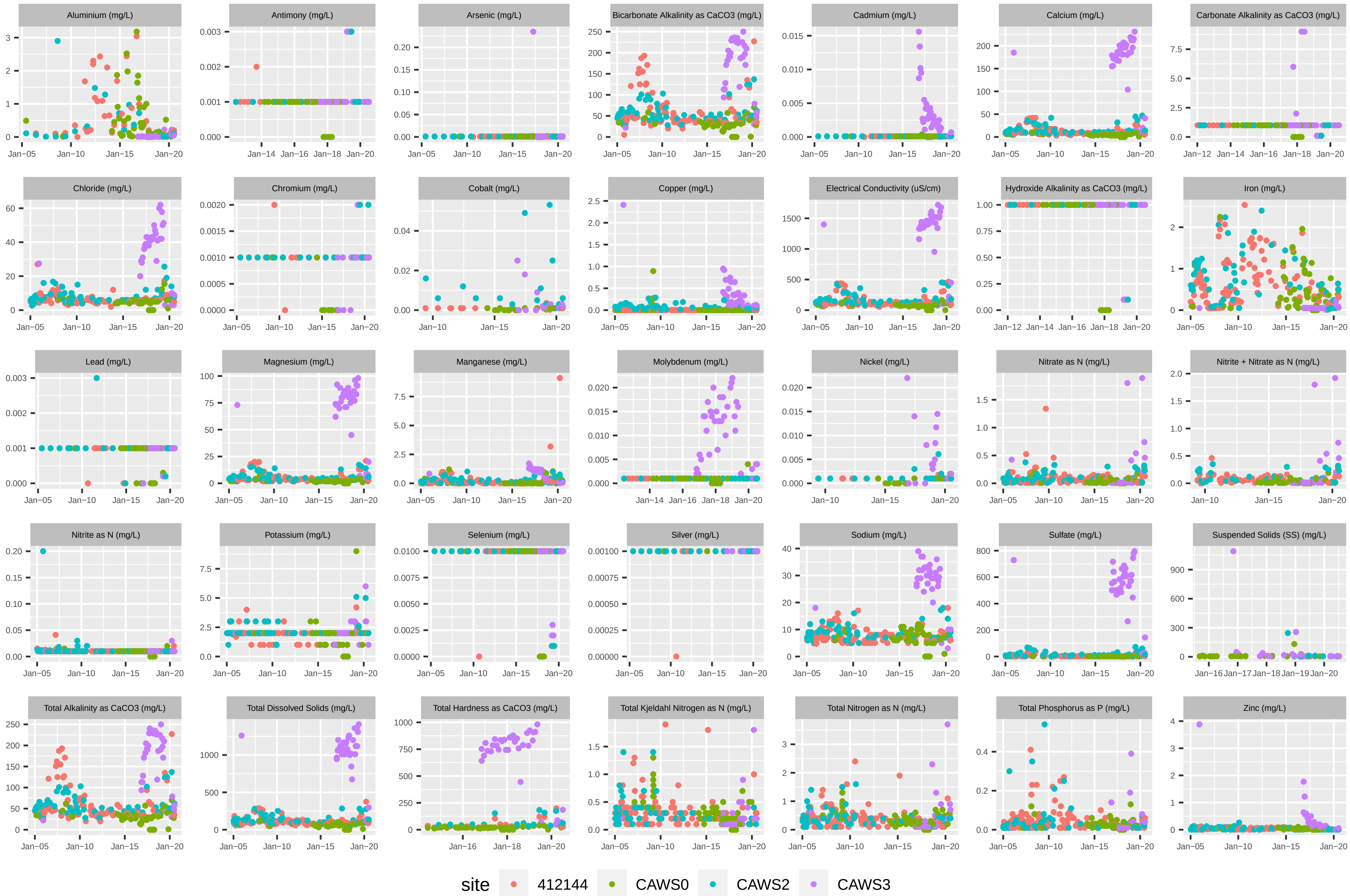
AEMR – SW – Cadia Hill Pit
pH – pH Units
8.5
8.0
7.5
7.0
6.5
Redox Potential – mV
2000
1000
0
Temperature – °C
25
20
15
10
EC – uS/cm
4000
3500
3000
2500
2000
Jan–19
Jul–19
Jan–20
Jul–20
Date
site
CAWS65

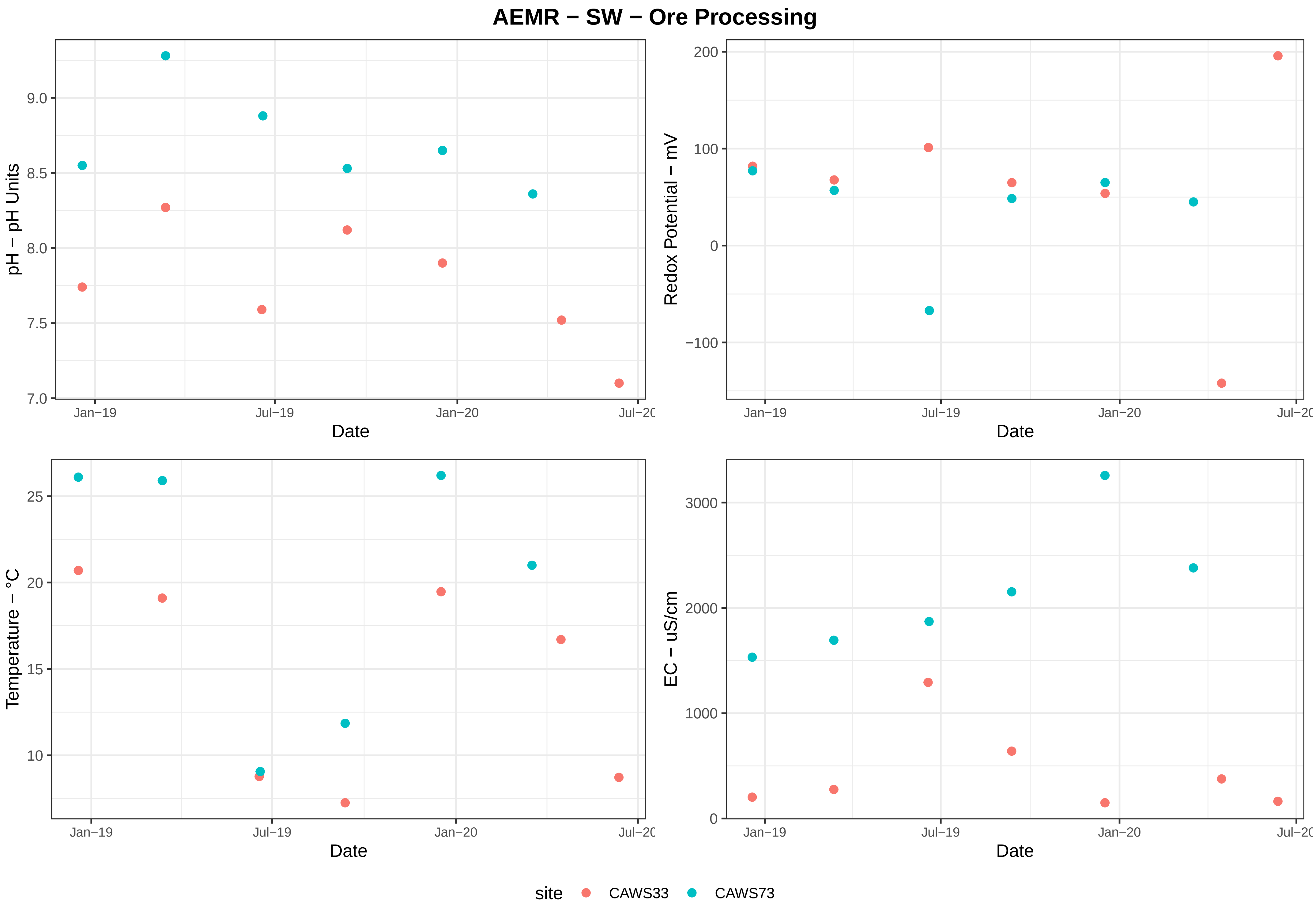
AEMR − SW − Cadia Hill Pit

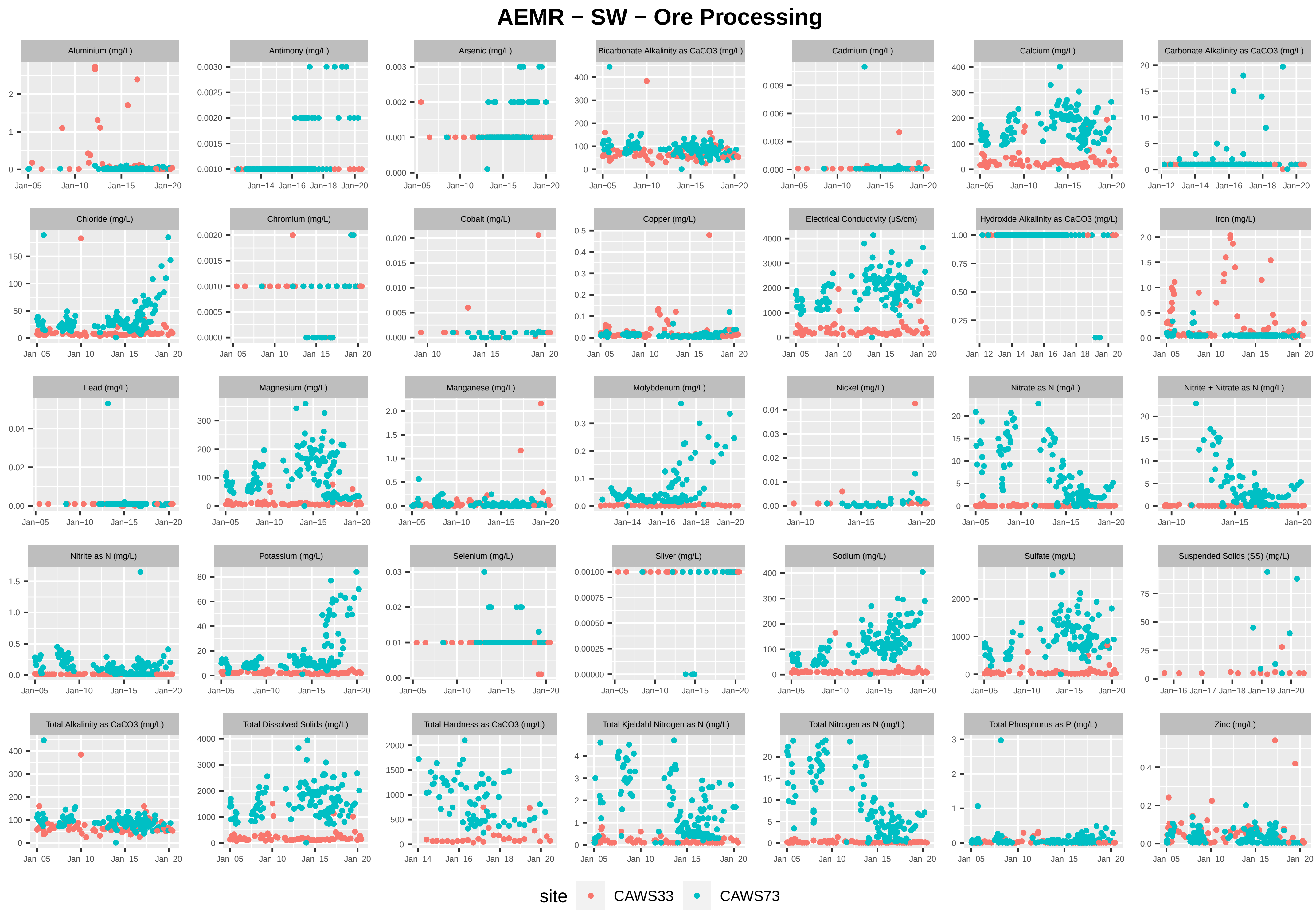


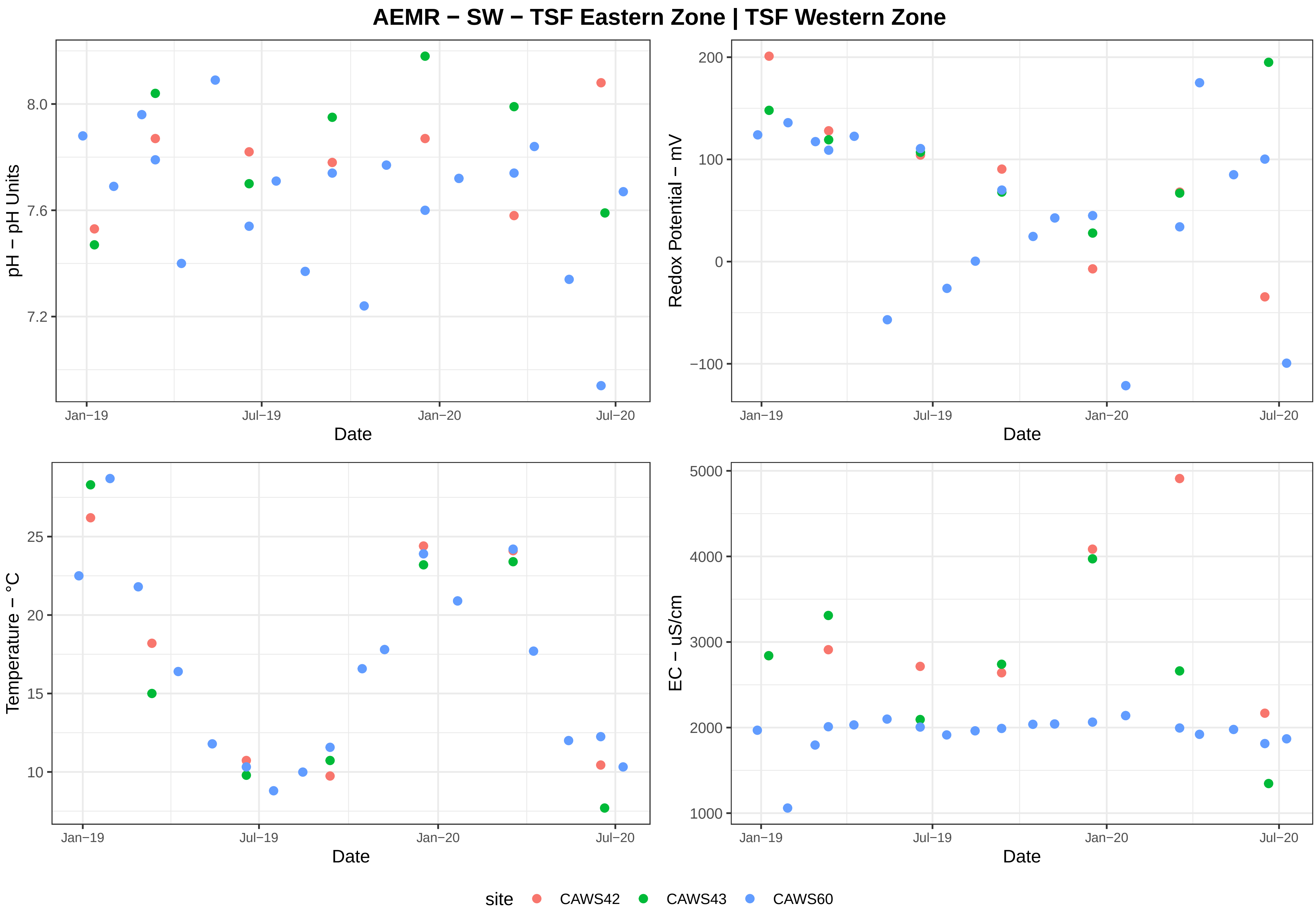
AEMR − SW − Upper Cadiangullong
pH − pH Units
Redox Potential − mV
Temperature − °C
EC − uS/cm
Date
Jan−19
Jul−19
Jan−20
Jul−20
site
412144
CAWS0
CAWS2
CAWS3

AEMR – SW – Upper Cadiangullong

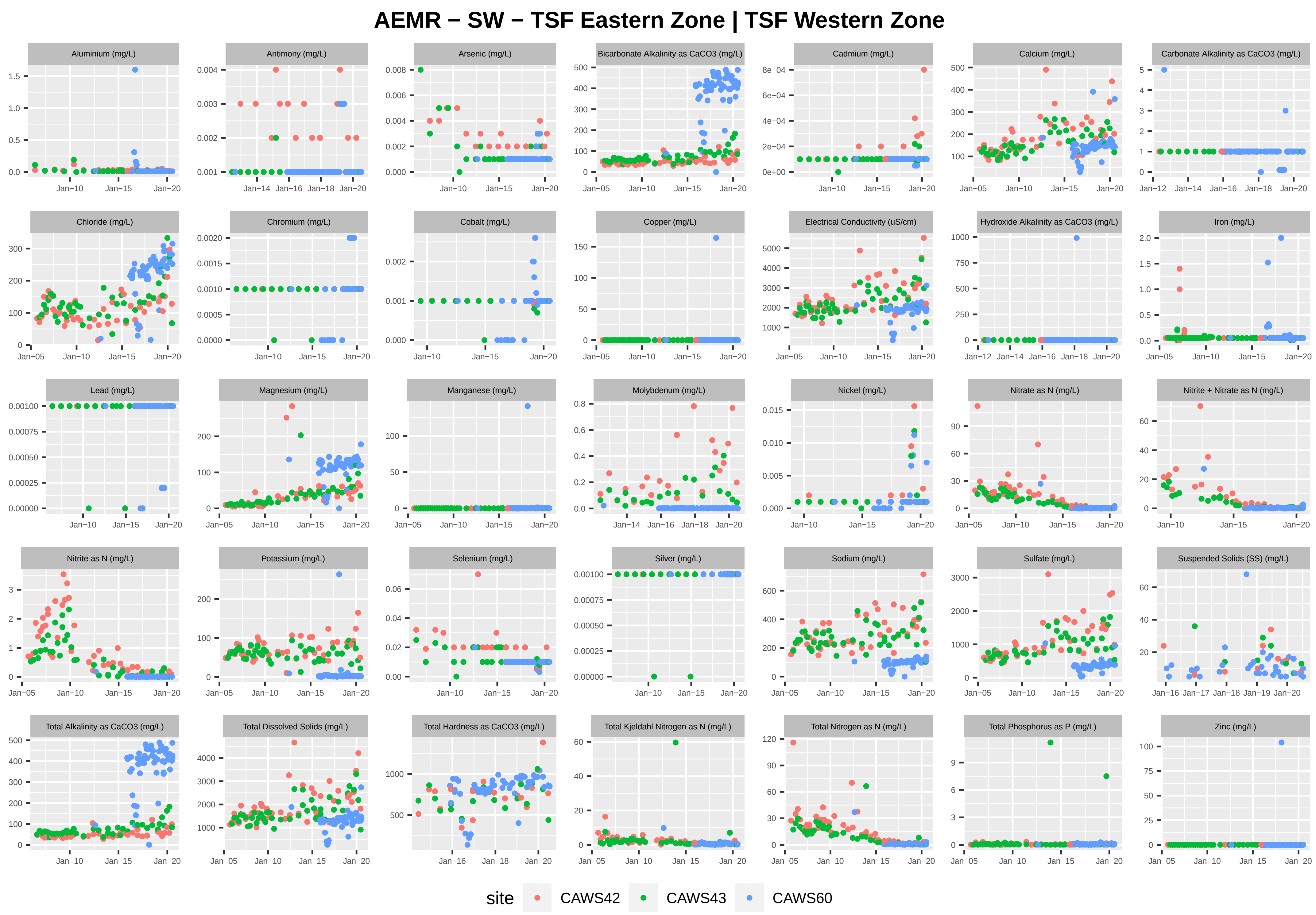


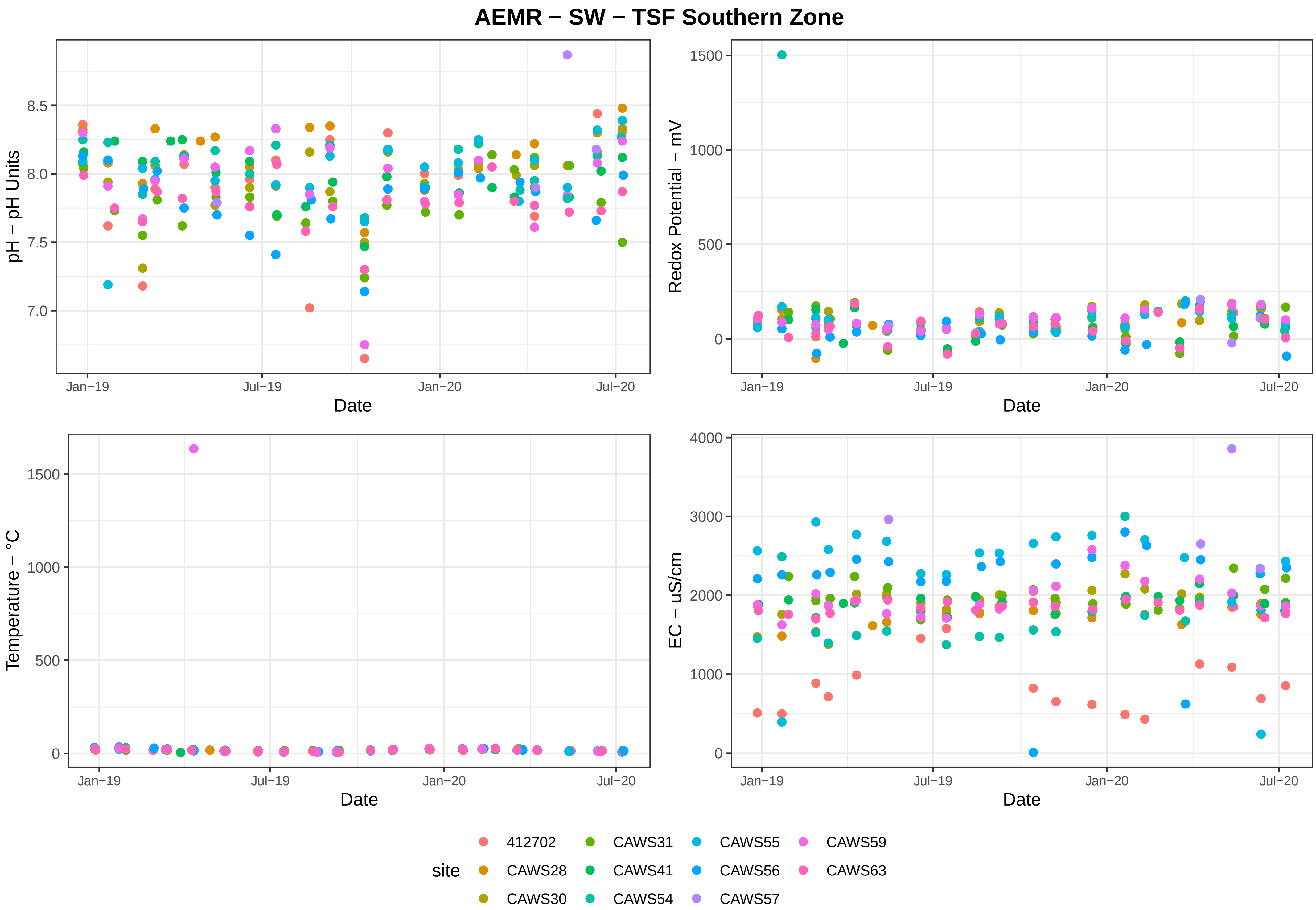

AEMR – SW – Ore Processing
pH – pH Units
9.0
8.5
8.0
7.5
7.0
Redox Potential – mV
200
100
0
−100
Temperature – °C
25
20
15
10
EC – uS/cm
3000
2000
1000
0
Jan−19
Jul−19
Jan−20
Jul−20
Date
site
CAWS33
CAWS73

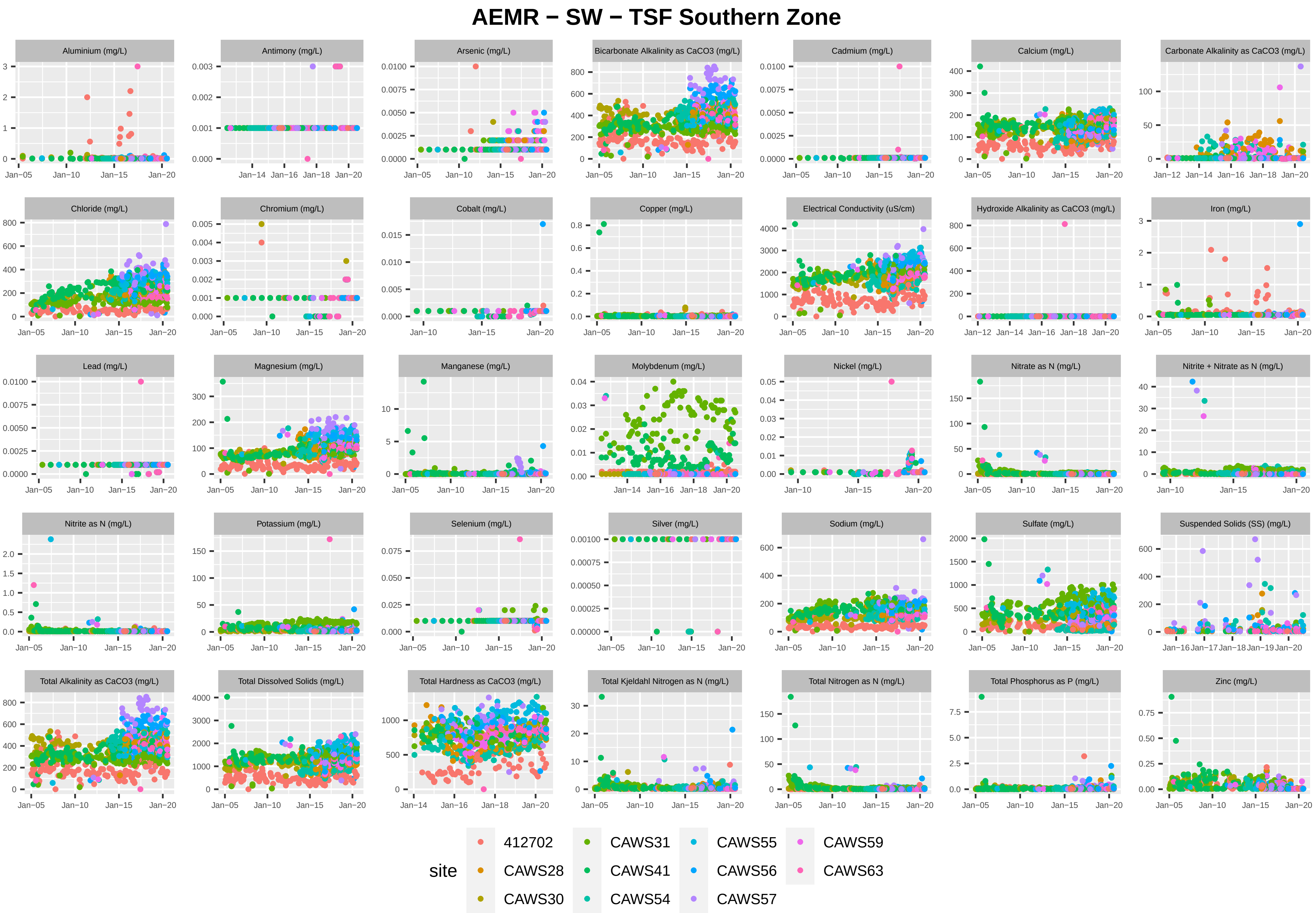

AEMR – SW – Ore Processing
Aluminium (mg/L)
Antimony (mg/L)
Arsenic (mg/L)
Bicarbonate Alkalinity as CaCO3 (mg/L)
Cadmium (mg/L)
Calcium (mg/L)
Carbonate Alkalinity as CaCO3 (mg/L)
Chloride (mg/L)
Chromium (mg/L)
Cobalt (mg/L)
Copper (mg/L)
Electrical Conductivity (uS/cm)
Hydroxide Alkalinity as CaCO3 (mg/L)
Iron (mg/L)
Lead (mg/L)
Magnesium (mg/L)
Manganese (mg/L)
Molybdenum (mg/L)
Nickel (mg/L)
Nitrate as N (mg/L)
Nitrite + Nitrate as N (mg/L)
Nitrite as N (mg/L)
Potassium (mg/L)
Selenium (mg/L)
Silver (mg/L)
Sodium (mg/L)
Sulfate (mg/L)
Suspended Solids (SS) (mg/L)
Total Alkalinity as CaCO3 (mg/L)
Total Dissolved Solids (mg/L)
Total Hardness as CaCO3 (mg/L)
Total Kjeldahl Nitrogen as N (mg/L)
Total Nitrogen as N (mg/L)
Total Phosphorus as P (mg/L)
Zinc (mg/L)
site
CAWS33
CAWS73



AEMR − SW − TSF Eastern Zone | TSF Western Zone
pH − pH Units
8.0
7.6
7.2
Redox Potential − mV
200
100
0
−100
Temperature − °C
25
20
15
10
EC − uS/cm
5000
4000
3000
2000
1000
Jan−19
Jul−19
Jan−20
Jul−20
Date
site
CAWS42
CAWS43
CAWS60


AEMR – SW – TSF Eastern Zone | TSF Western Zone
Aluminium (mg/L)
Antimony (mg/L)
Arsenic (mg/L)
Bicarbonate Alkalinity as CaCO3 (mg/L)
Cadmium (mg/L)
Calcium (mg/L)
Carbonate Alkalinity as CaCO3 (mg/L)
Chloride (mg/L)
Chromium (mg/L)
Cobalt (mg/L)
Copper (mg/L)
Electrical Conductivity (uS/cm)
Hydroxide Alkalinity as CaCO3 (mg/L)
Iron (mg/L)
Lead (mg/L)
Magnesium (mg/L)
Manganese (mg/L)
Molybdenum (mg/L)
Nickel (mg/L)
Nitrate as N (mg/L)
Nitrite + Nitrate as N (mg/L)
Nitrite as N (mg/L)
Potassium (mg/L)
Selenium (mg/L)
Silver (mg/L)
Sodium (mg/L)
Sulfate (mg/L)
Suspended Solids (SS) (mg/L)
Total Alkalinity as CaCO3 (mg/L)
Total Dissolved Solids (mg/L)
Total Hardness as CaCO3 (mg/L)
Total Kjeldahl Nitrogen as N (mg/L)
Total Nitrogen as N (mg/L)
Total Phosphorus as P (mg/L)
Zinc (mg/L)
site
CAWS42
CAWS43
CAWS60


AEMR – SW – TSF Southern Zone
pH – pH Units
8.5
8.0
7.5
7.0
Jan–19
Jul–19
Jan–20
Jul–20
Date
Redox Potential – mV
1500
1000
500
0
Temperature – °C
1500
1000
500
0
EC – uS/cm
4000
3000
2000
1000
0
site
412702
CAWS28
CAWS30
CAWS31
CAWS41
CAWS54
CAWS55
CAWS56
CAWS57
CAWS59
CAWS63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Antimony (mg/L)
Arsenic (mg/L)
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Cadmium (mg/L)
Calcium (mg/L)
Carbonate Alkalinity as CaCO3 (mg/L)
Chloride (mg/L)
Chromium (mg/L)
Cobalt (mg/L)
Copper (mg/L)
Electrical Conductivity (uS/cm)
Hydroxide Alkalinity as CaCO3 (mg/L)
Iron (mg/L)
Lead (mg/L)
Magnesium (mg/L)
Manganese (mg/L)
Molybdenum (mg/L)
Nickel (mg/L)
Nitrate as N (mg/L)
Nitrite + Nitrate as N (mg/L)
Nitrite as N (mg/L)
Potassium (mg/L)
Selenium (mg/L)
Silver (mg/L)
Sodium (mg/L)
Sulfate (mg/L)
Suspended Solids (SS) (mg/L)
Total Alkalinity as CaCO3 (mg/L)
Total Dissolved Solids (mg/L)
Total Hardness as CaCO3 (mg/L)
Total Kjeldahl Nitrogen as N (mg/L)
Total Nitrogen as N (mg/L)
Total Phosphorus as P (mg/L)
Zinc (mg/L)
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412702
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CAWS30
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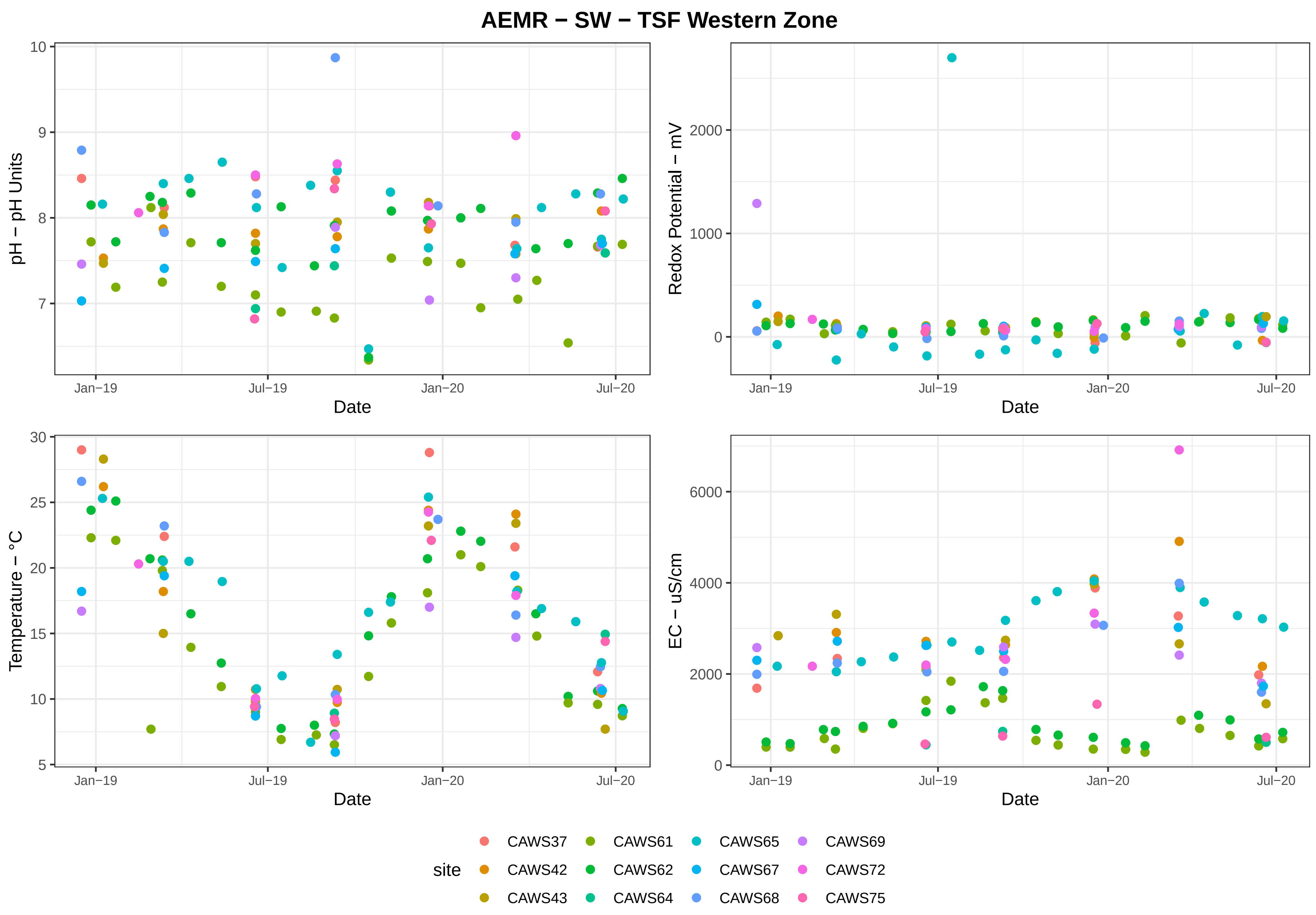
AEMR – SW – TSF Western Zone
pH – pH Units
Redox Potential – mV
Temperature – °C
EC – uS/cm
Date
Jan–19
Jul–19
Jan–20
Jul–20
site
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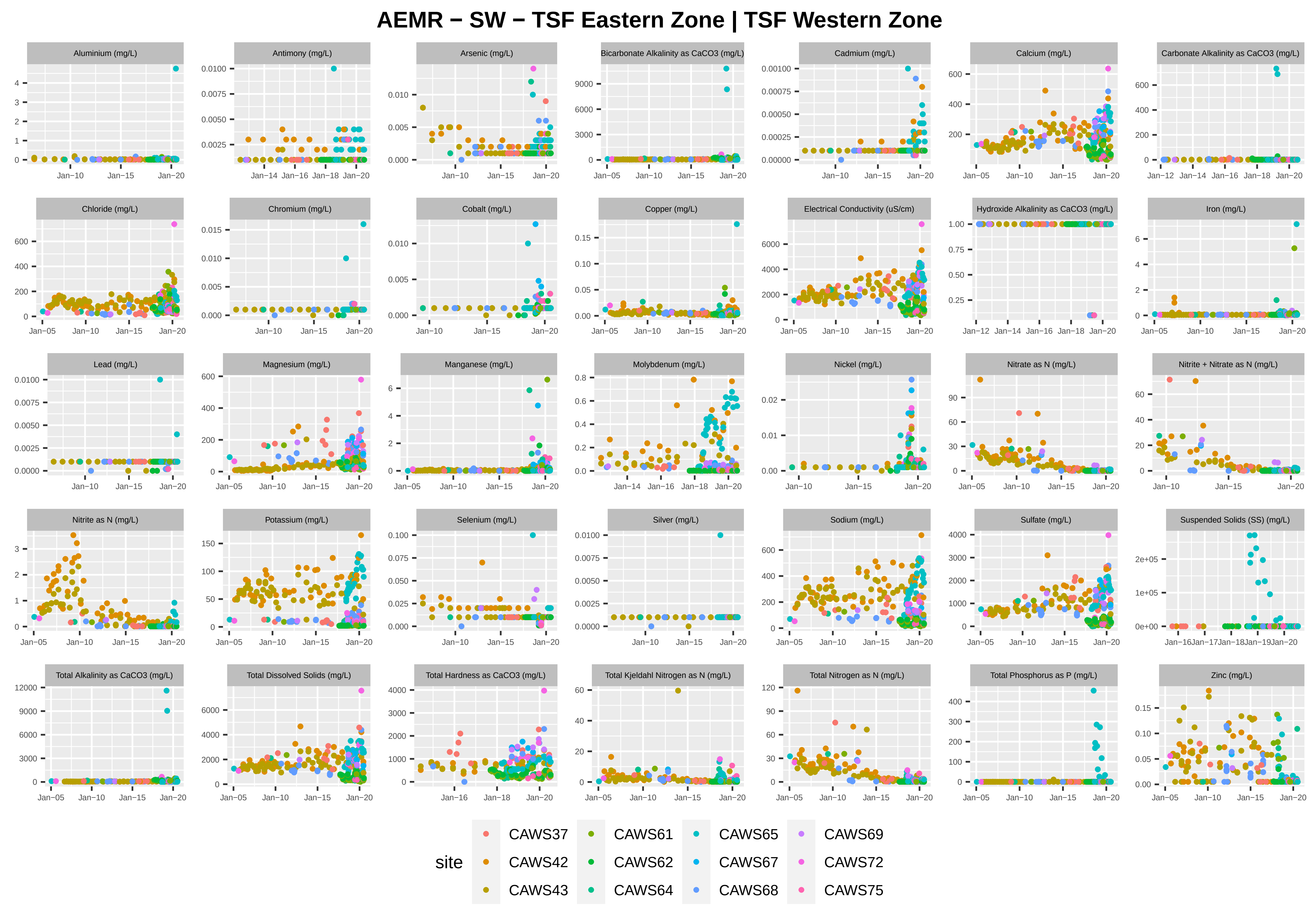
CAWS67
CAWS68
CAWS69
CAWS72
CAWS75


AEMR − SW − TSF Eastern Zone | TSF Western Zone
Aluminium (mg/L)
Antimony (mg/L)
Arsenic (mg/L)
Bicarbonate Alkalinity as CaCO3 (mg/L)
Cadmium (mg/L)
Calcium (mg/L)
Carbonate Alkalinity as CaCO3 (mg/L)
Chloride (mg/L)
Chromium (mg/L)
Cobalt (mg/L)
Copper (mg/L)
Electrical Conductivity (uS/cm)
Hydroxide Alkalinity as CaCO3 (mg/L)
Iron (mg/L)
Lead (mg/L)
Magnesium (mg/L)
Manganese (mg/L)
Molybdenum (mg/L)
Nickel (mg/L)
Nitrate as N (mg/L)
Nitrite + Nitrate as N (mg/L)
Nitrite as N (mg/L)
Potassium (mg/L)
Selenium (mg/L)
Silver (mg/L)
Sodium (mg/L)
Sulfate (mg/L)
Suspended Solids (SS) (mg/L)
Total Alkalinity as CaCO3 (mg/L)
Total Dissolved Solids (mg/L)
Total Hardness as CaCO3 (mg/L)
Total Kjeldahl Nitrogen as N (mg/L)
Total Nitrogen as N (mg/L)
Total Phosphorus as P (mg/L)
Zinc (mg/L)
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CAWS37
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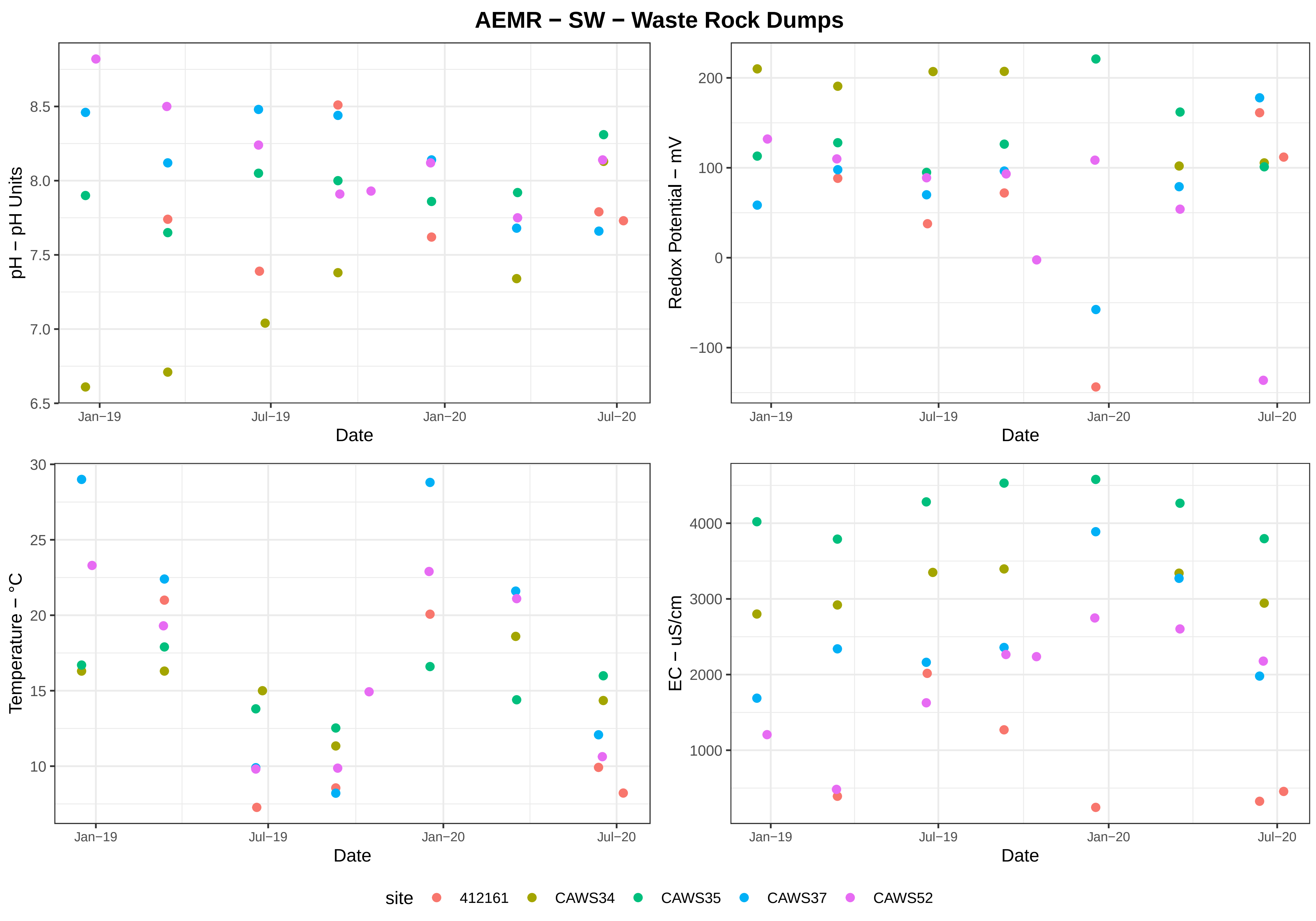
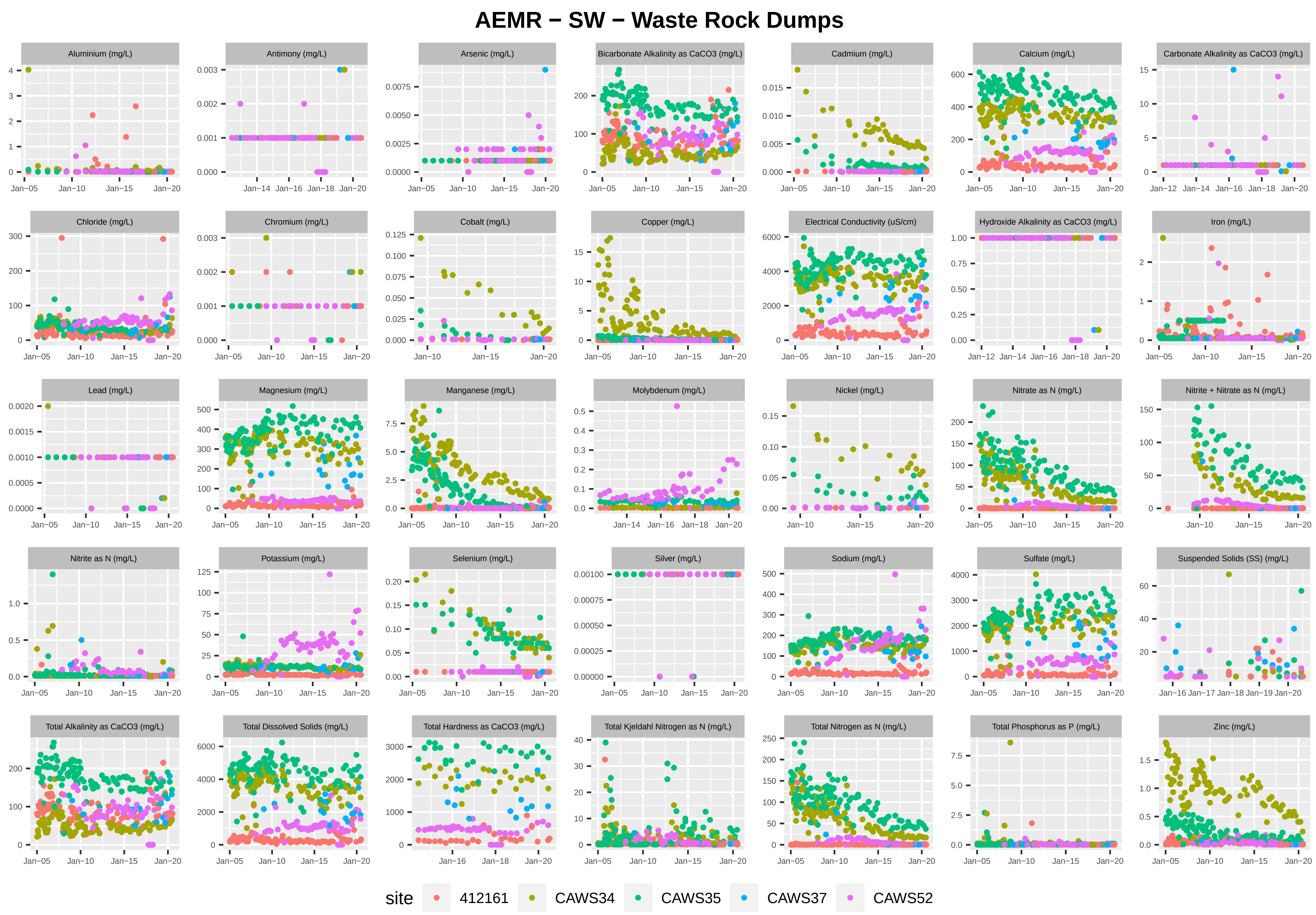

AEMR − SW − Waste Rock Dumps
pH − pH Units
Date
Redox Potential − mV
Temperature − °C
EC − uS/cm
Jan−19
Jul−19
Jan−20
Jul−20
site
412161
CAWS34
CAWS35
CAWS37
CAWS52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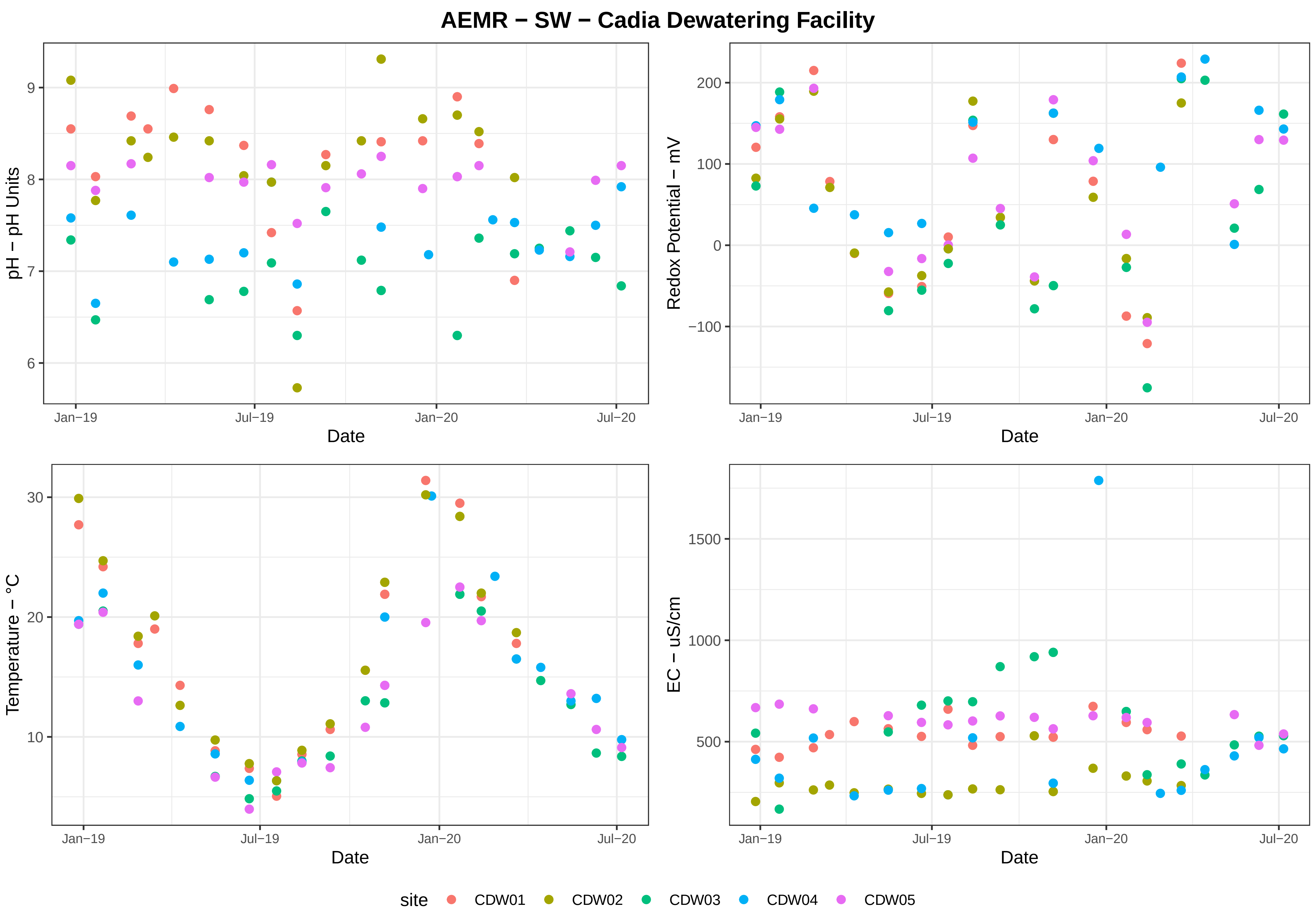
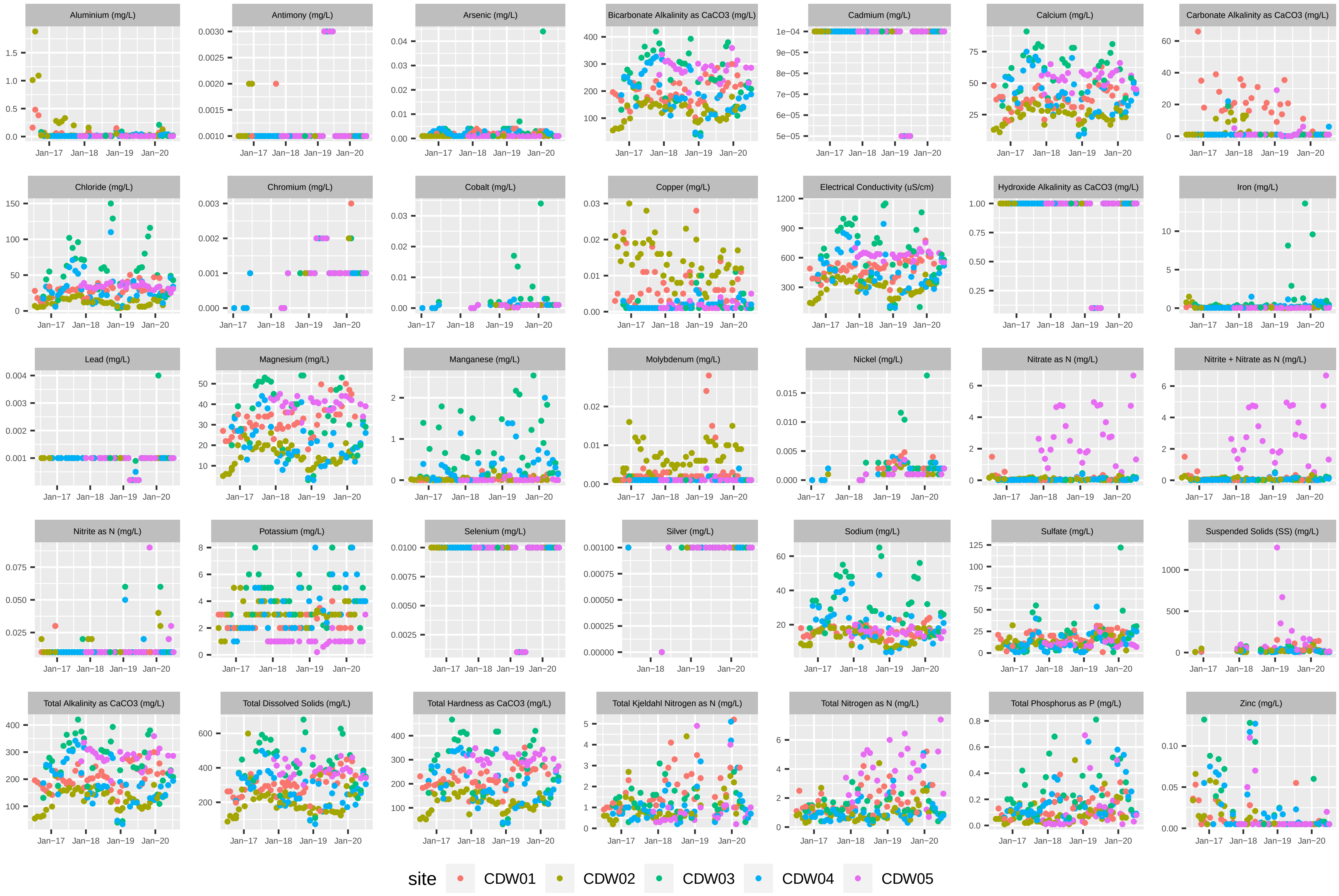
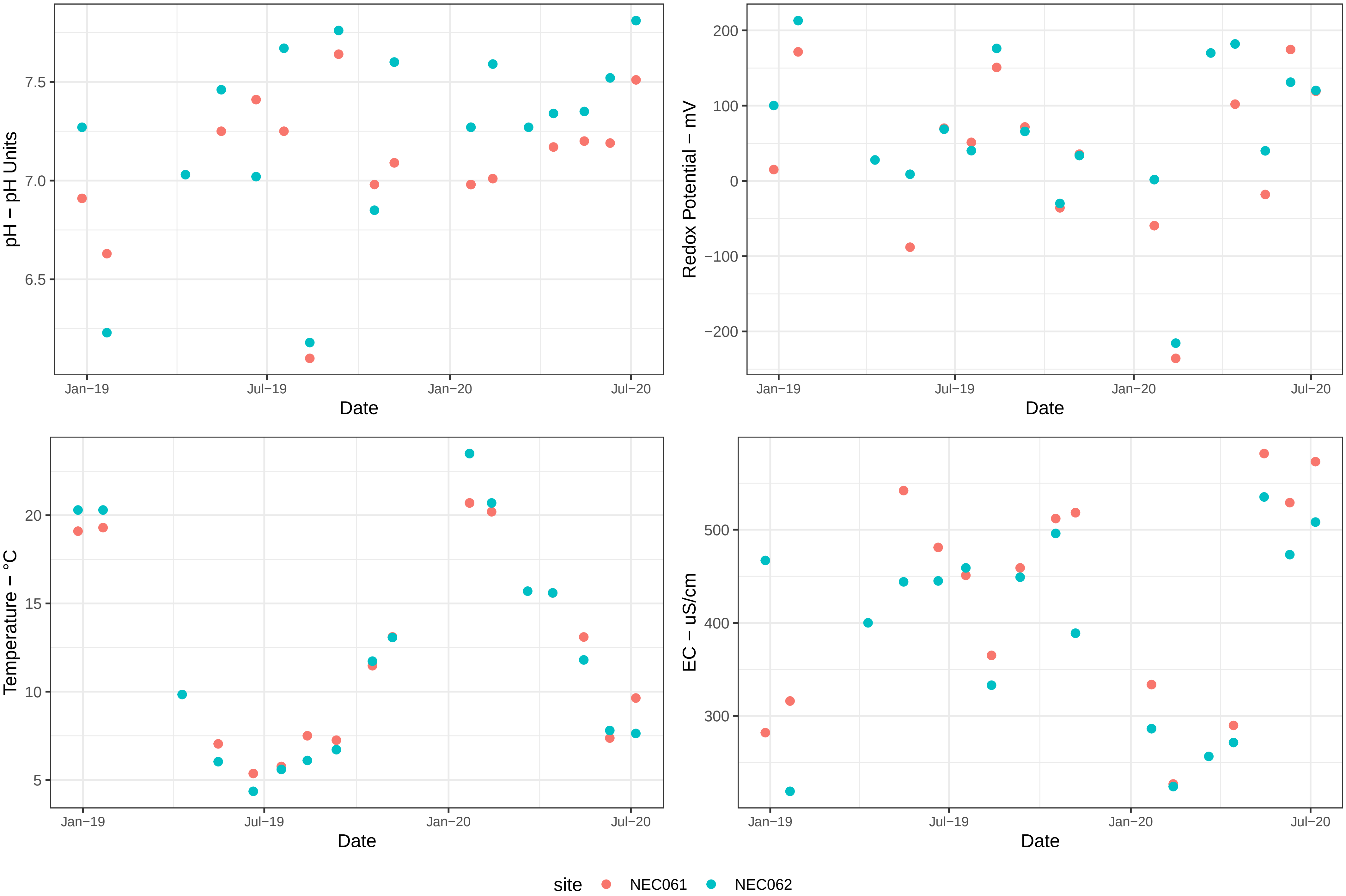
Calcium (mg/L)
Carbonate Alkalinity as CaCO3 (mg/L)
Chloride (mg/L)
Chromium (mg/L)
Cobalt (mg/L)
Copper (mg/L)
Electrical Conductivity (uS/cm)
Hydroxide Alkalinity as CaCO3 (mg/L)
Iron (mg/L)
Lead (mg/L)
Magnesium (mg/L)
Manganese (mg/L)
Molybdenum (mg/L)
Nickel (mg/L)
Nitrate as N (mg/L)
Nitrite + Nitrate as N (mg/L)
Nitrite as N (mg/L)
Potassium (mg/L)
Selenium (mg/L)
Silver (mg/L)
Sodium (mg/L)
Sulfate (mg/L)
Suspended Solids (SS) (mg/L)
Total Alkalinity as CaCO3 (mg/L)
Total Dissolved Solids (mg/L)
Total Hardness as CaCO3 (mg/L)
Total Kjeldahl Nitrogen as N (mg/L)
Total Nitrogen as N (mg/L)
Total Phosphorus as P (mg/L)
Zinc (mg/L)
site
412161
CAWS34
CAWS35
CAWS37
CAWS52


AEMR – SW – Cadia Dewatering Facility
pH – pH Units
Redox Potential – mV
Temperature – °C
EC – uS/cm
Date
Jan–19
Jul–19
Jan–20
Jul–20
9
8
7
6
200
100
0
–100
30
20
10
1500
1000
500
site
CDW01
CDW02
CDW03
CDW04
CDW05

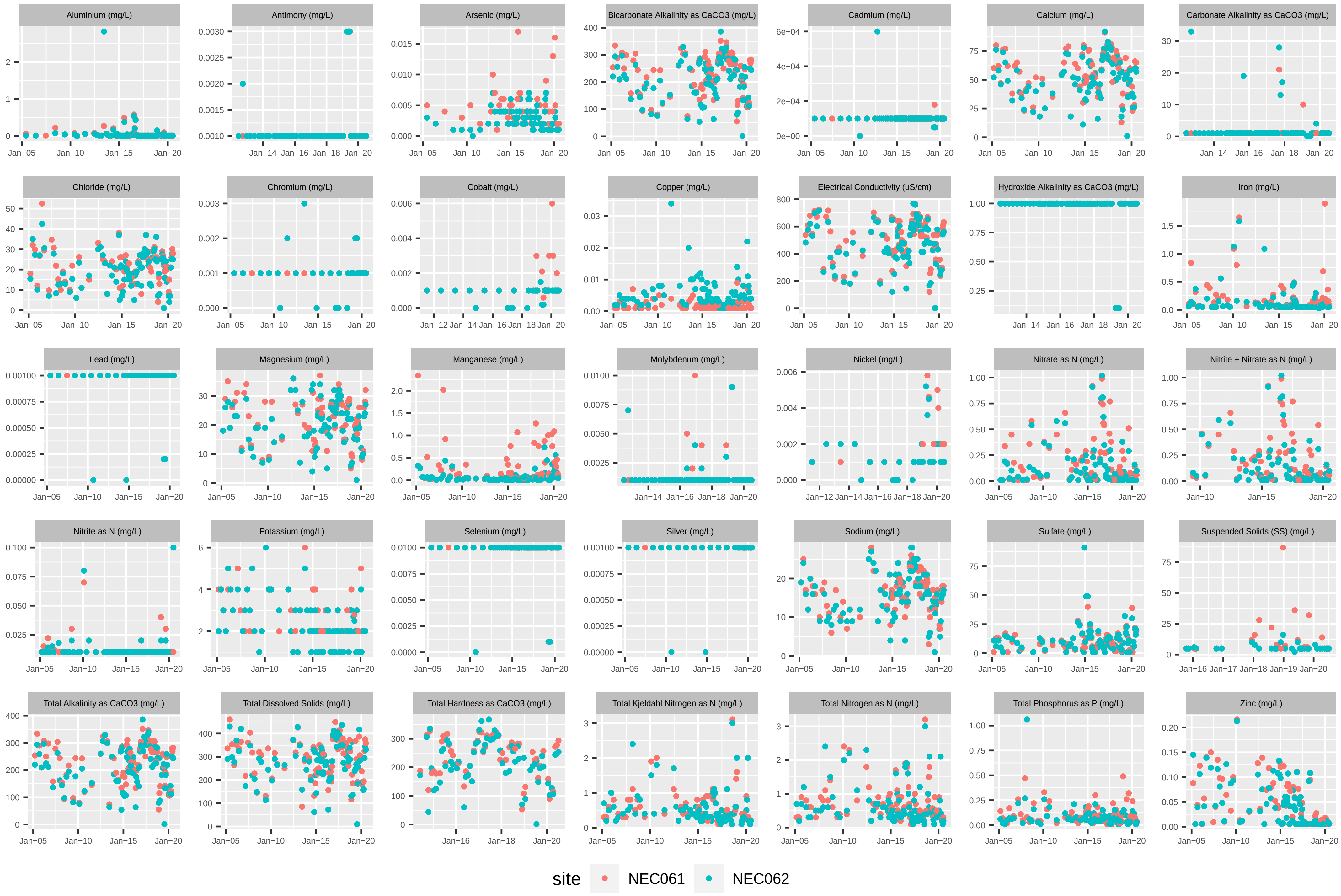
AEMR − SW − Cadia Dewatering Facility



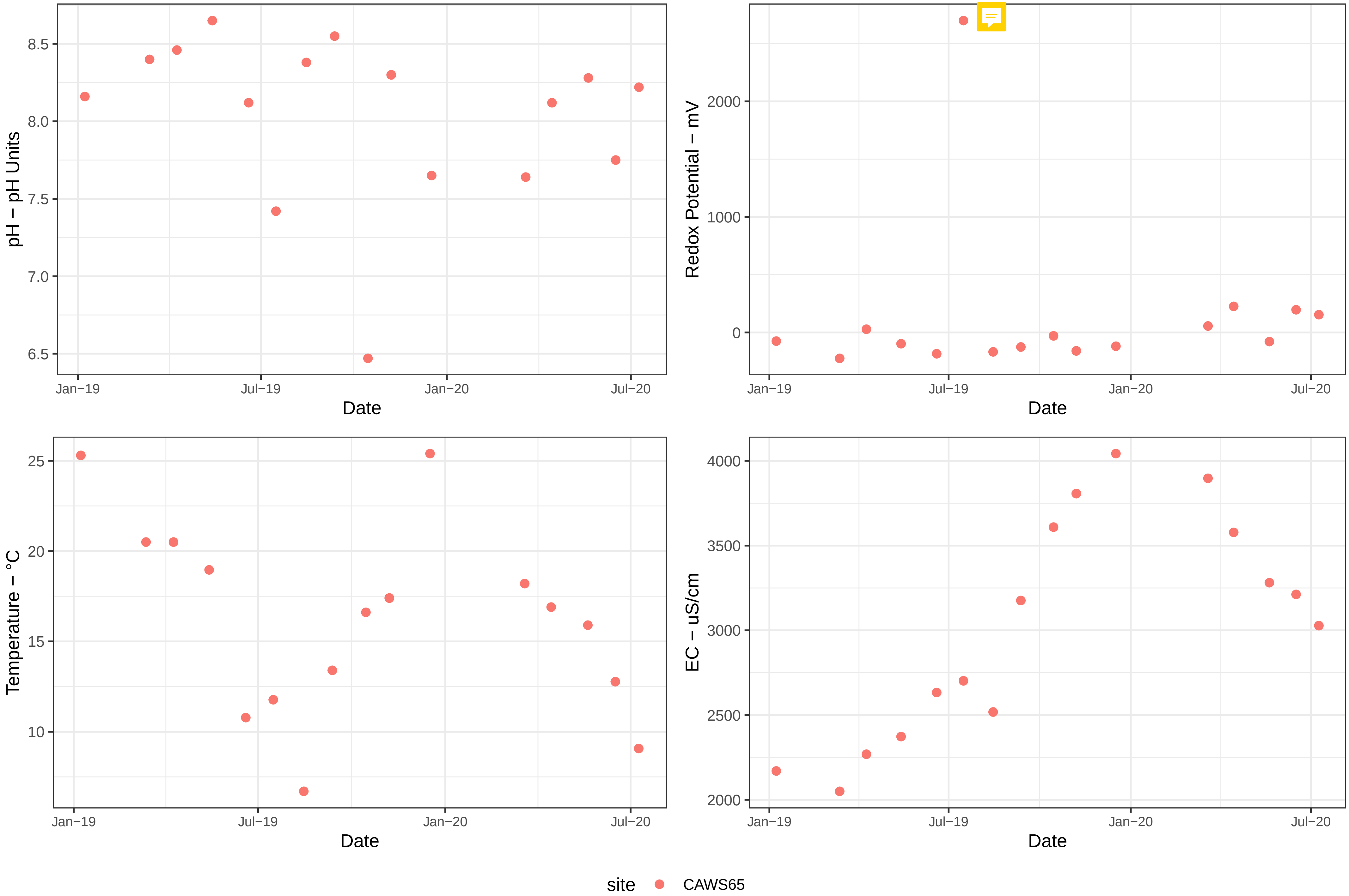
AEMR – SW – Blayney Dewatering Facility



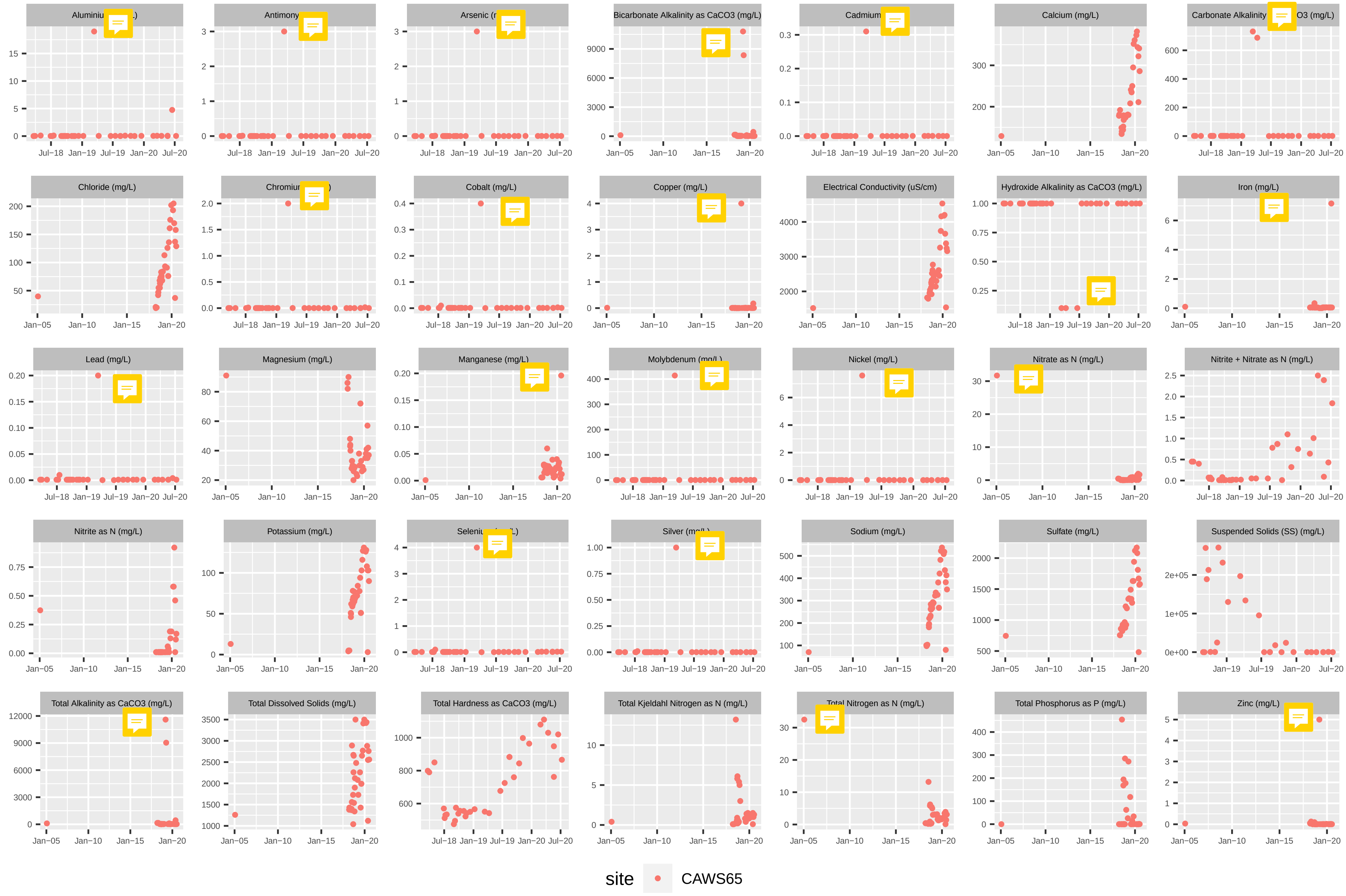
AEMR − SW − Blayney Dewatering Facility

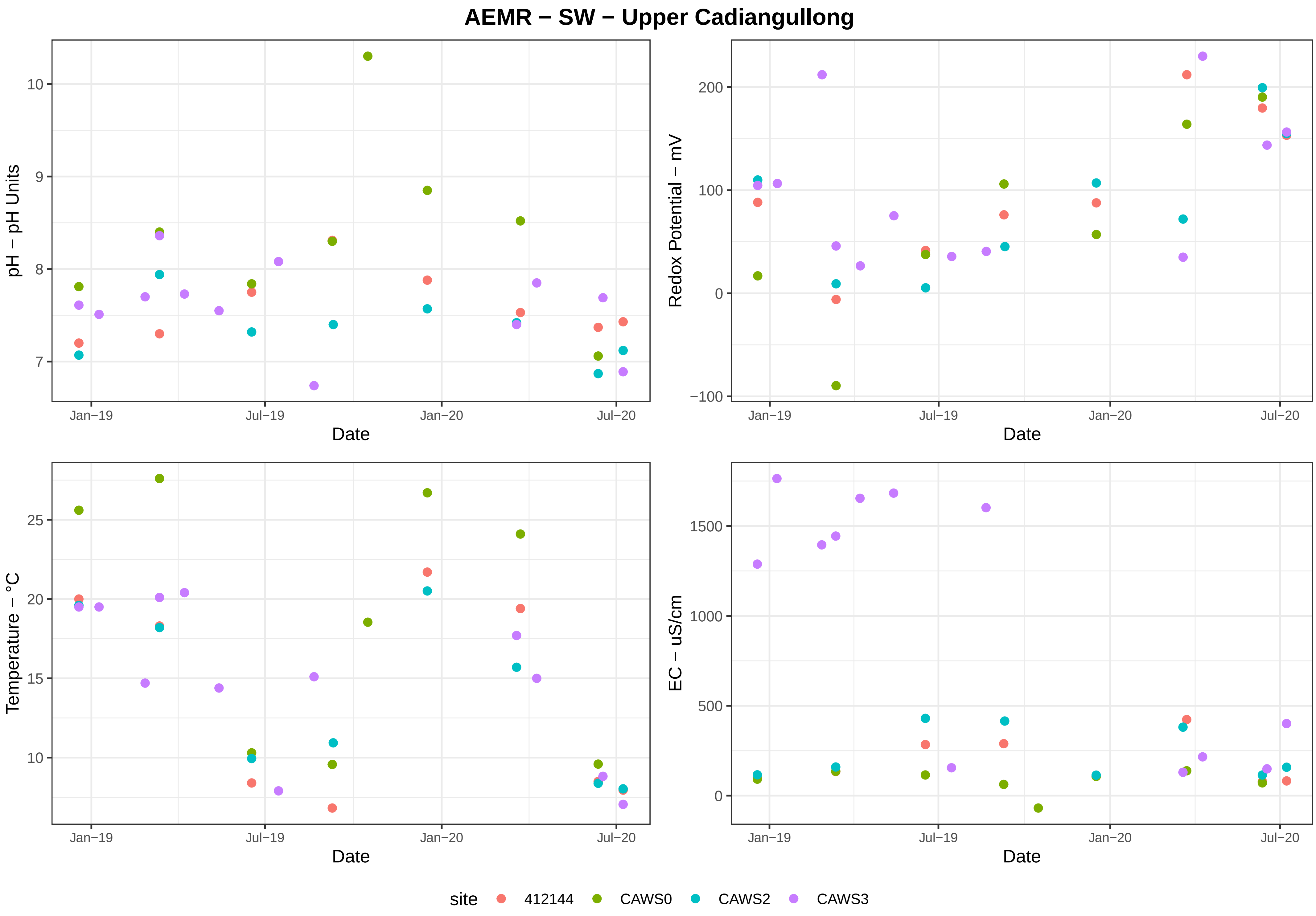


AEMR – SW – Cadia Hill Pit

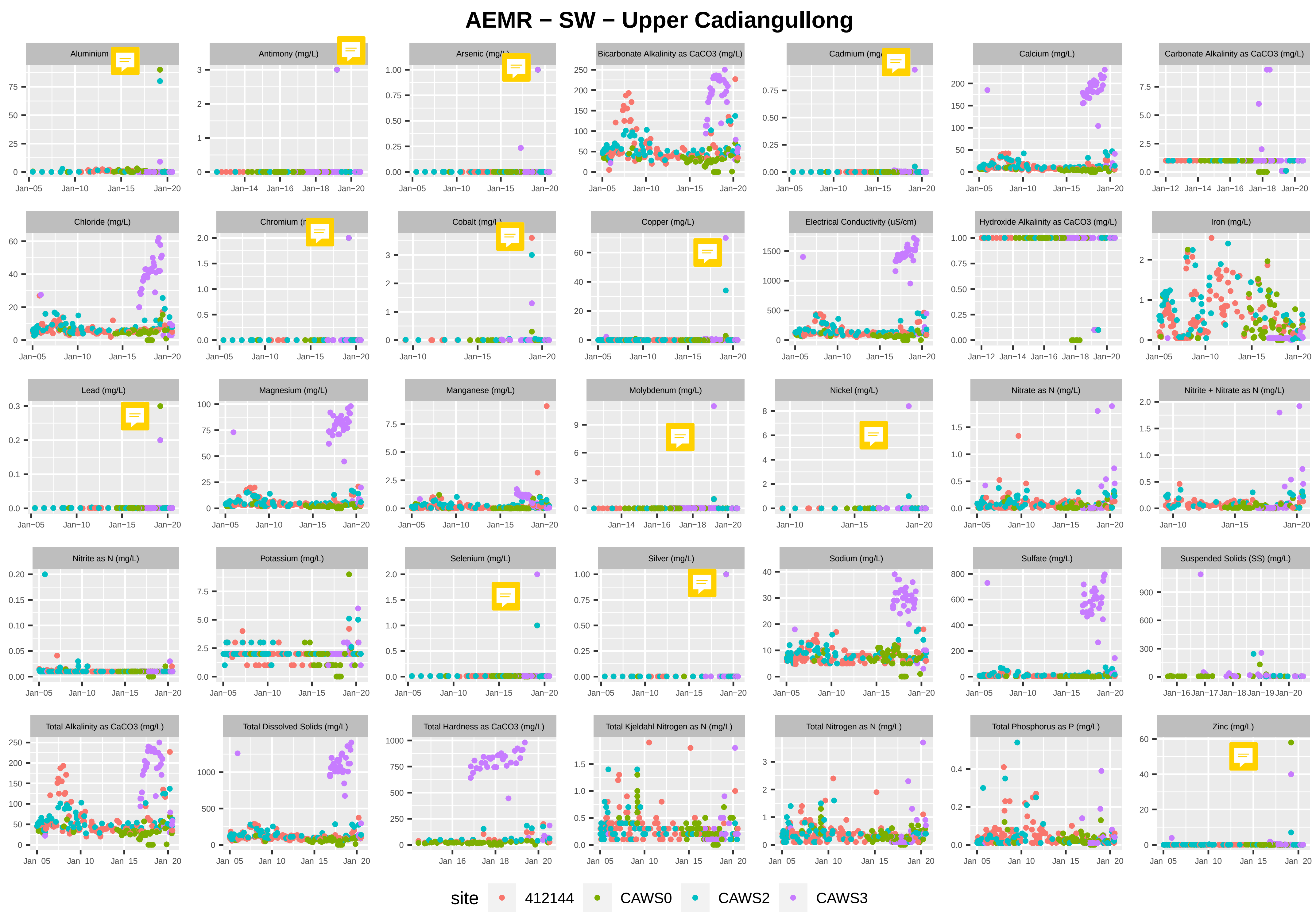


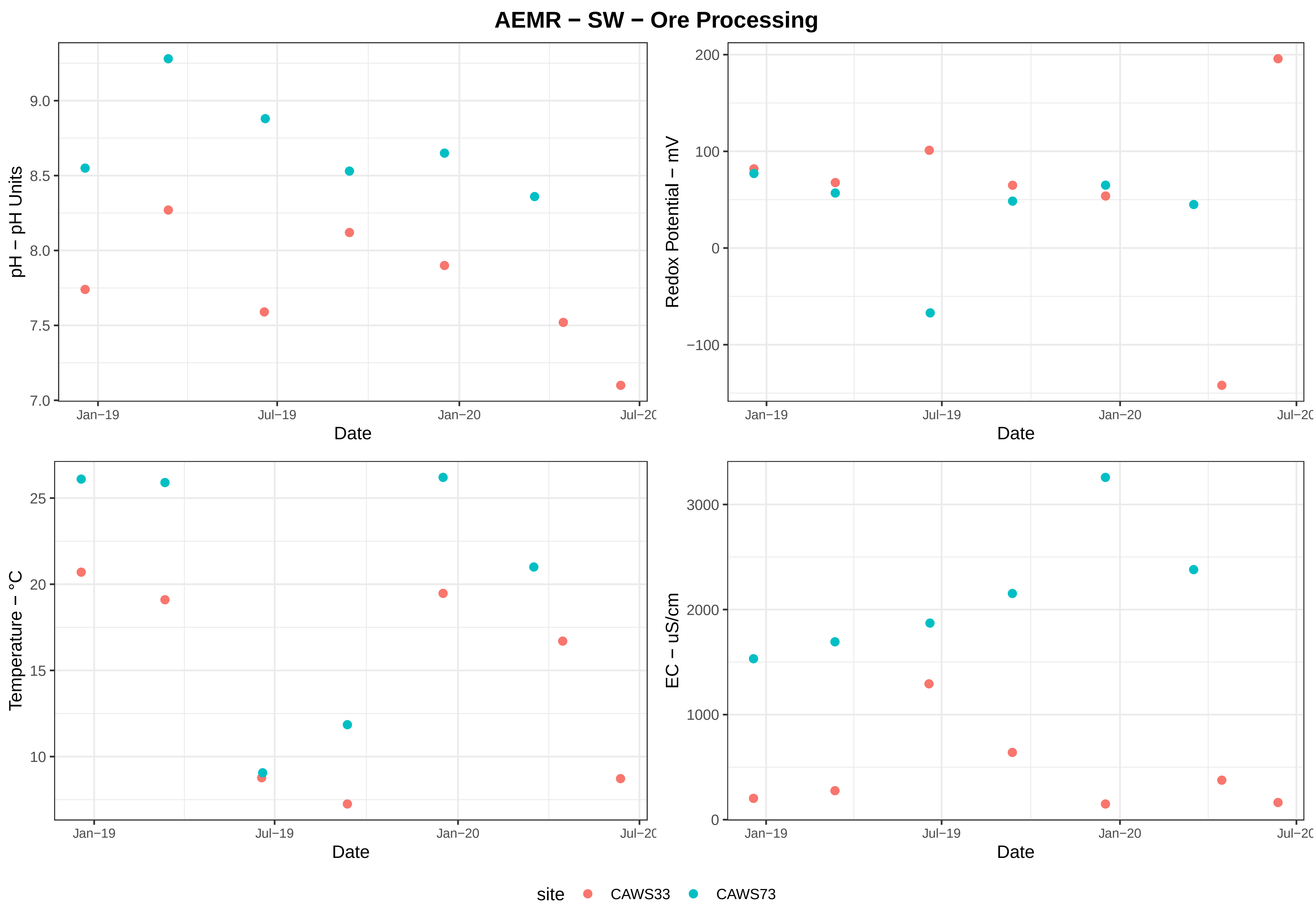
AEMR − SW − Cadia Hill Pit





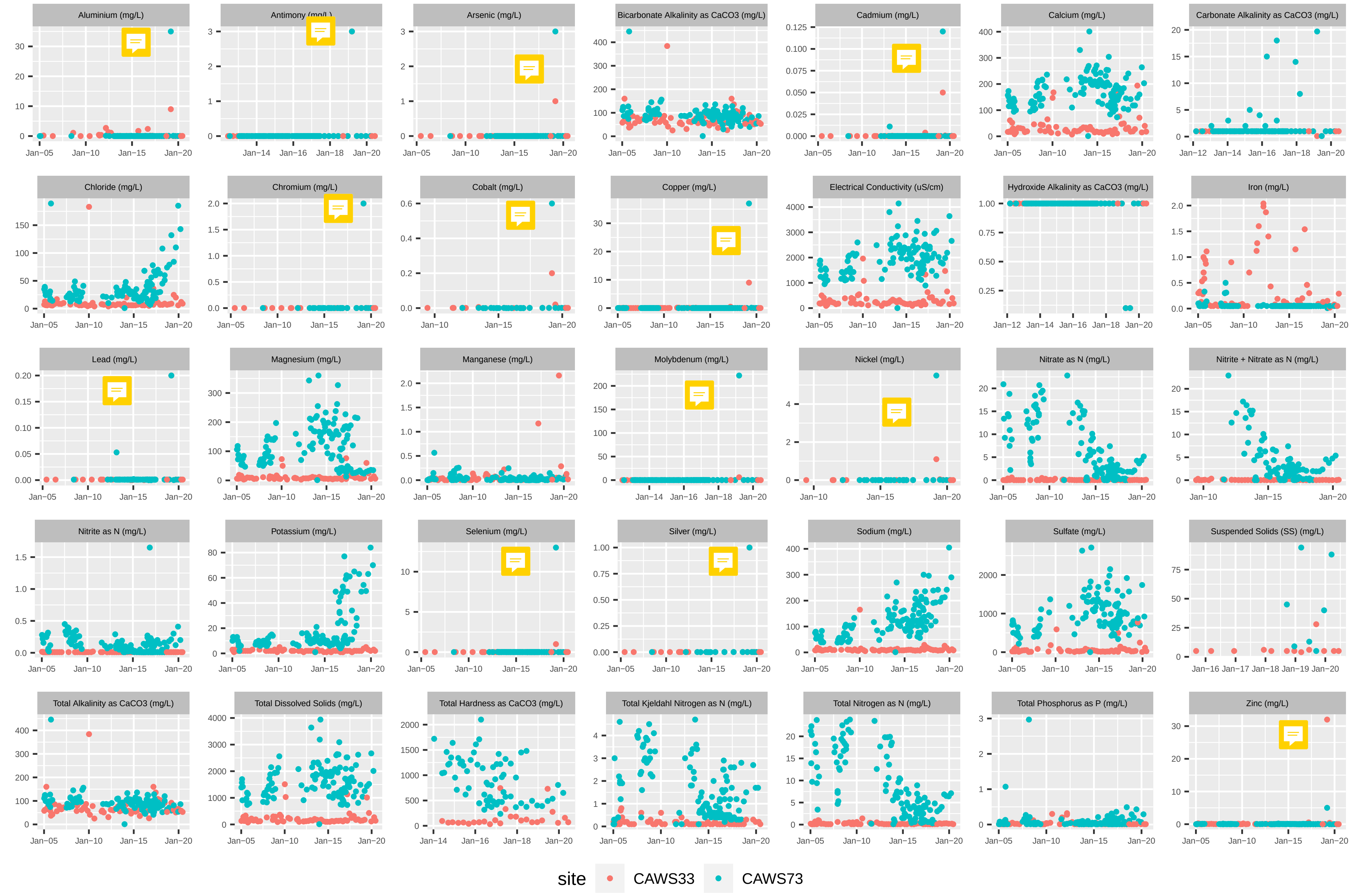
AEMR − SW − Upper Cadiangullong
pH − pH Units
Redox Potential − mV
Temperature − °C
EC − uS/cm
Date
Jan−19
Jul−19
Jan−20
Jul−20
site
412144
CAWS0
CAWS2
CAWS3


AEMR – SW – Upper Cadiangullong
Aluminium
Antimony (mg/L)
Arsenic (mg/L)
Bicarbonate Alkalinity as CaCO3 (mg/L)
Cadmium (mg/L)
Calcium (mg/L)
Carbonate Alkalinity as CaCO3 (mg/L)
Chloride (mg/L)
Chromium
Cobalt (mg/L)
Copper (mg/L)
Electrical Conductivity (uS/cm)
Hydroxide Alkalinity as CaCO3 (mg/L)
Iron (mg/L)
Lead (mg/L)
Magnesium (mg/L)
Manganese (mg/L)
Molybdenum (mg/L)
Nickel (mg/L)
Nitrate as N (mg/L)
Nitrite + Nitrate as N (mg/L)
Nitrite as N (mg/L)
Potassium (mg/L)
Selenium (mg/L)
Silver (mg/L)
Sodium (mg/L)
Sulfate (mg/L)
Suspended Solids (SS) (mg/L)
Total Alkalinity as CaCO3 (mg/L)
Total Dissolved Solids (mg/L)
Total Hardness as CaCO3 (mg/L)
Total Kjeldahl Nitrogen as N (mg/L)
Total Nitrogen as N (mg/L)
Total Phosphorus as P (mg/L)
Zinc (mg/L)
site 412144 CAWS0 CAWS2 CAWS3

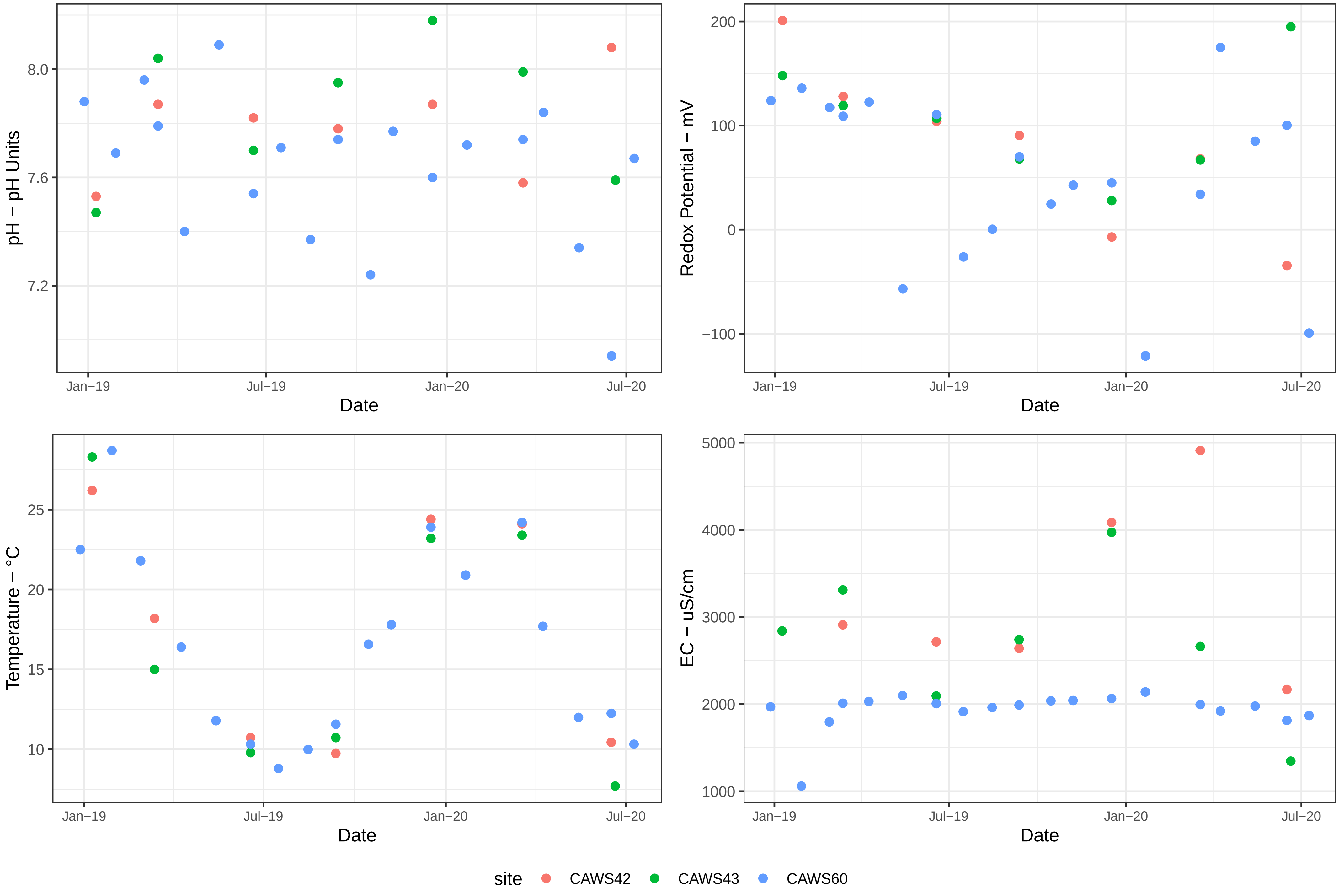


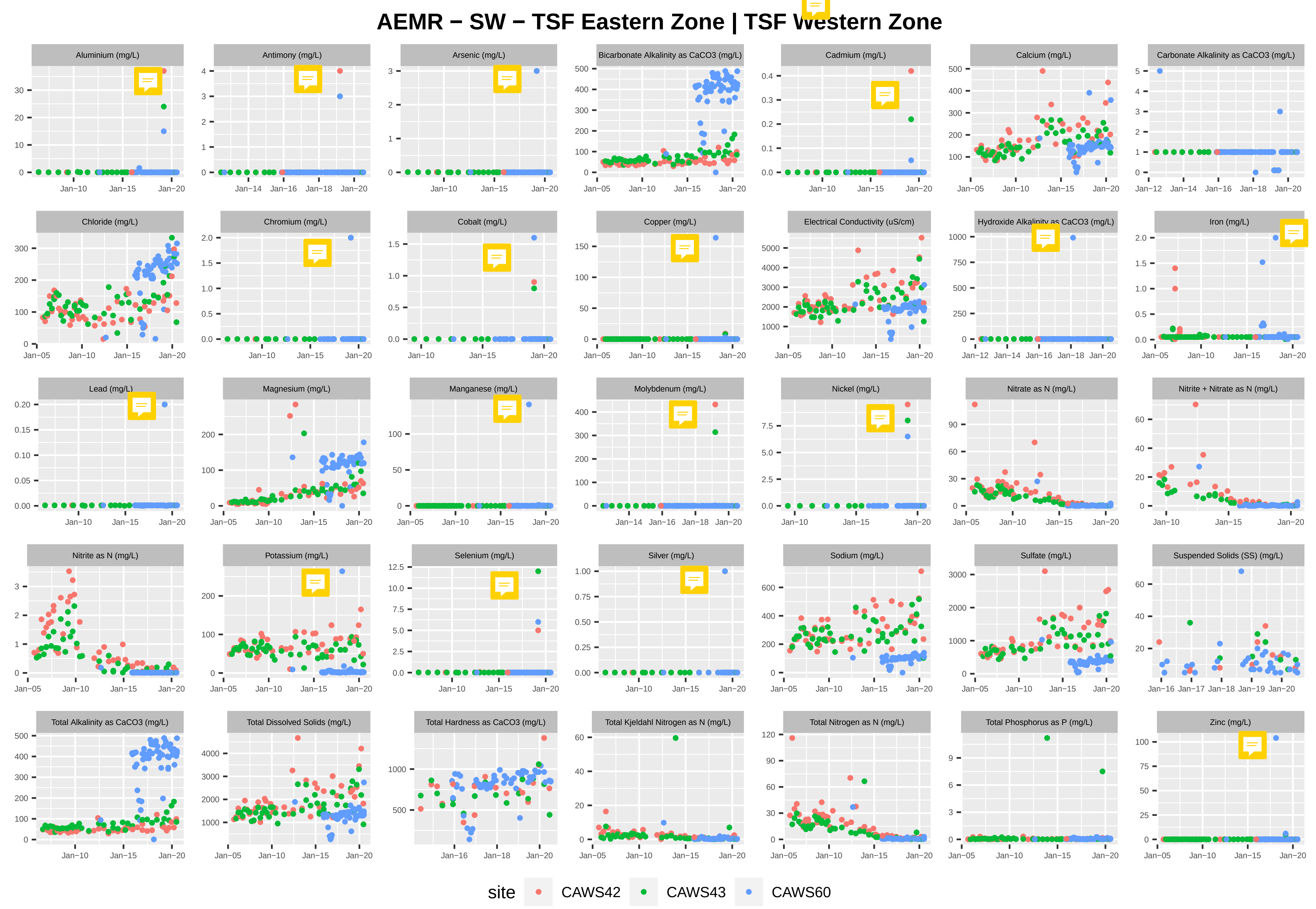
AEMR – SW – Ore Processing
pH – pH Units
9.0
8.5
8.0
7.5
7.0
Redox Potential – mV
200
100
0
−100
Temperature – °C
25
20
15
10
EC – uS/cm
3000
2000
1000
0
Jan−19
Jul−19
Jan−20
Jul−20
Date
site
CAWS33
CAWS73

AEMR – SW – Ore Processing

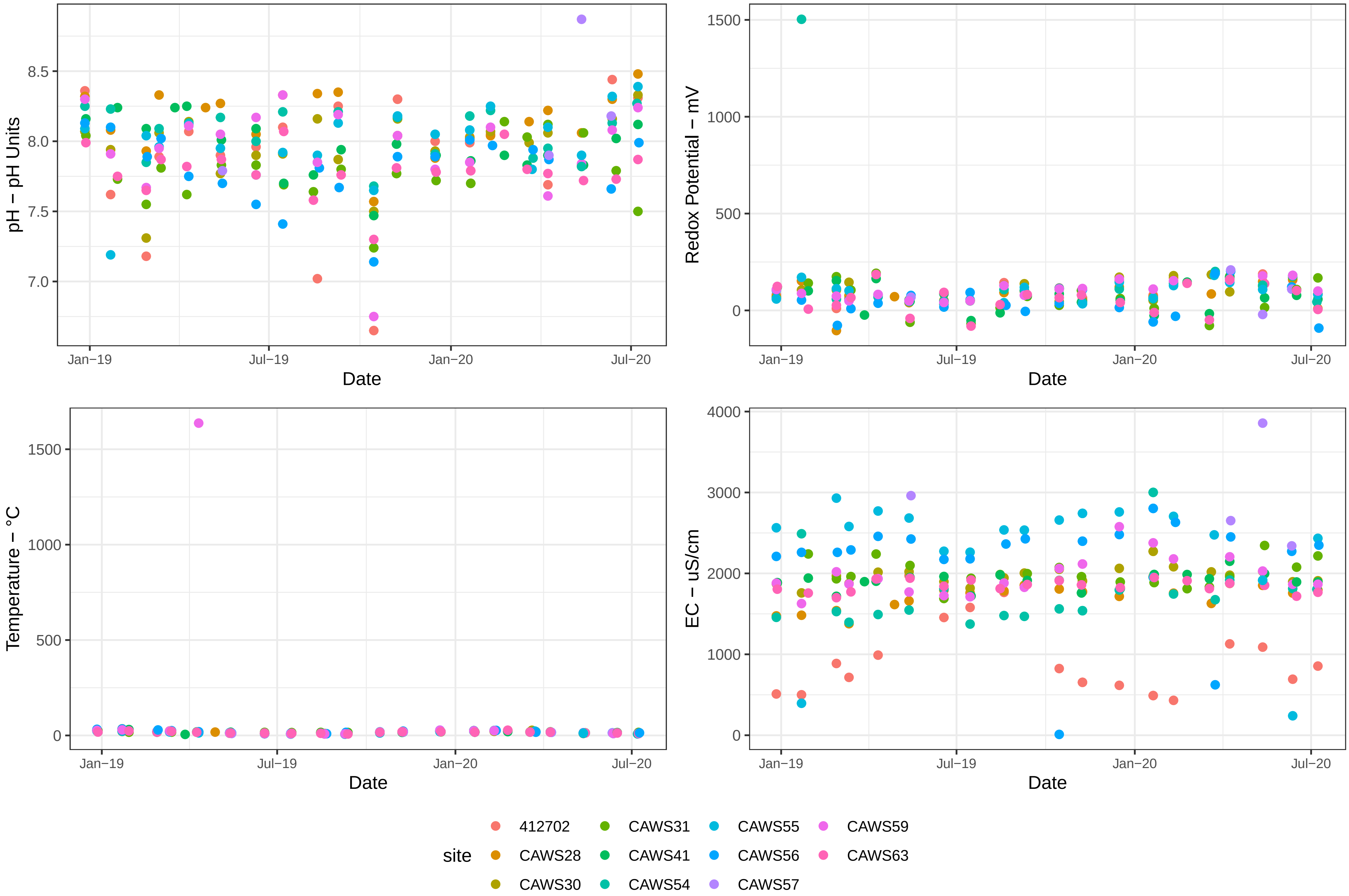


AEMR − SW − TSF Eastern Zone | TSF Western Zone

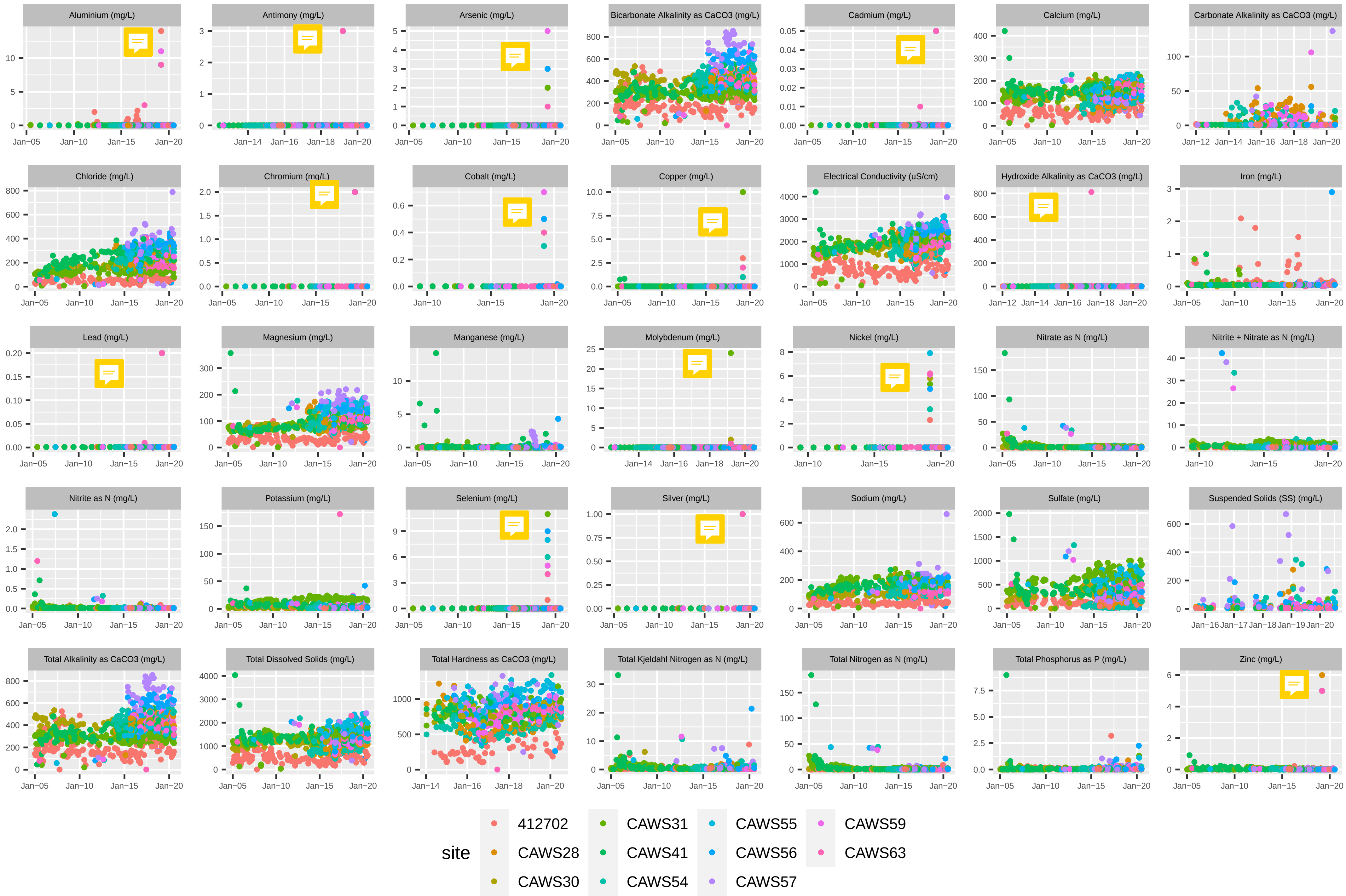


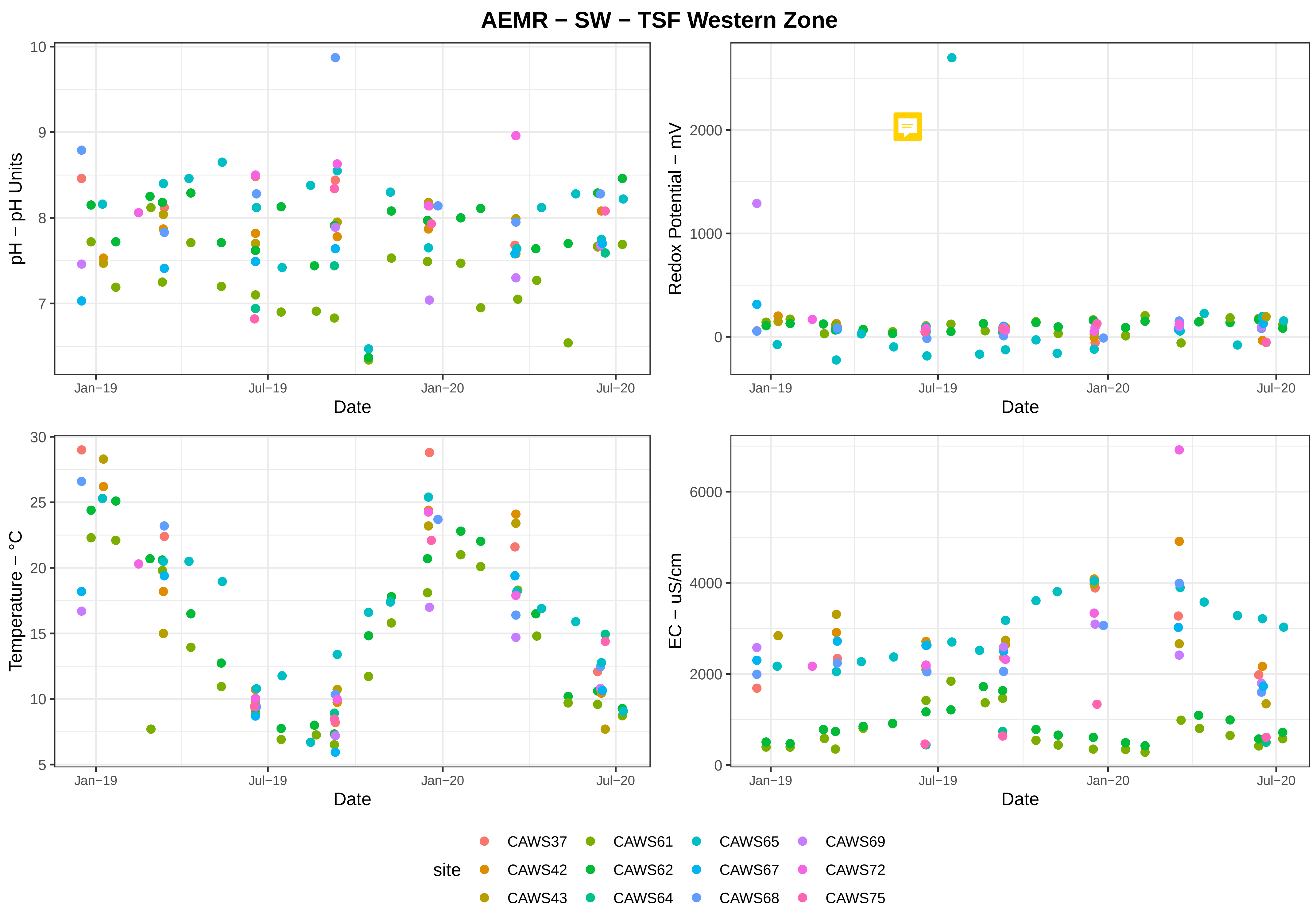

AEMR – SW – TSF Eastern Zone | TSF Western Zone
Aluminium (mg/L)
Antimony (mg/L)
Arsenic (mg/L)
Bicarbonate Alkalinity as CaCO3 (mg/L)
Cadmium (mg/L)
Calcium (mg/L)
Carbonate Alkalinity as CaCO3 (mg/L)
Chloride (mg/L)
Chromium (mg/L)
Cobalt (mg/L)
Copper (mg/L)
Electrical Conductivity (uS/cm)
Hydroxide Alkalinity as CaCO3 (mg/L)
Iron (mg/L)
Lead (mg/L)
Magnesium (mg/L)
Manganese (mg/L)
Molybdenum (mg/L)
Nickel (mg/L)
Nitrate as N (mg/L)
Nitrite + Nitrate as N (mg/L)
Nitrite as N (mg/L)
Potassium (mg/L)
Selenium (mg/L)
Silver (mg/L)
Sodium (mg/L)
Sulfate (mg/L)
Suspended Solids (SS) (mg/L)
Total Alkalinity as CaCO3 (mg/L)
Total Dissolved Solids (mg/L)
Total Hardness as CaCO3 (mg/L)
Total Kjeldahl Nitrogen as N (mg/L)
Total Nitrogen as N (mg/L)
Total Phosphorus as P (mg/L)
Zinc (mg/L)
site
CAWS42
CAWS43
CAWS60

AEMR – SW – TSF Southern Zone

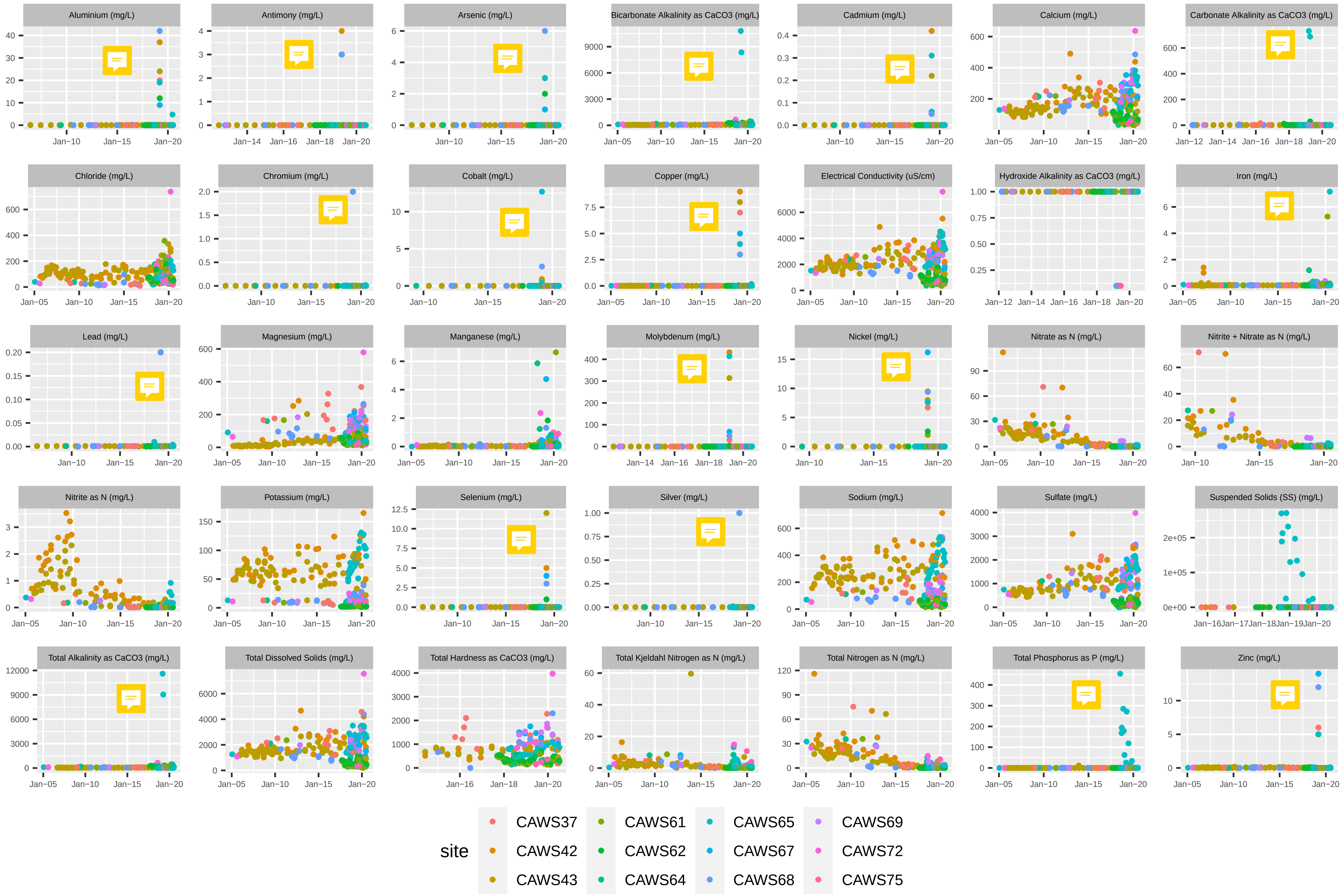


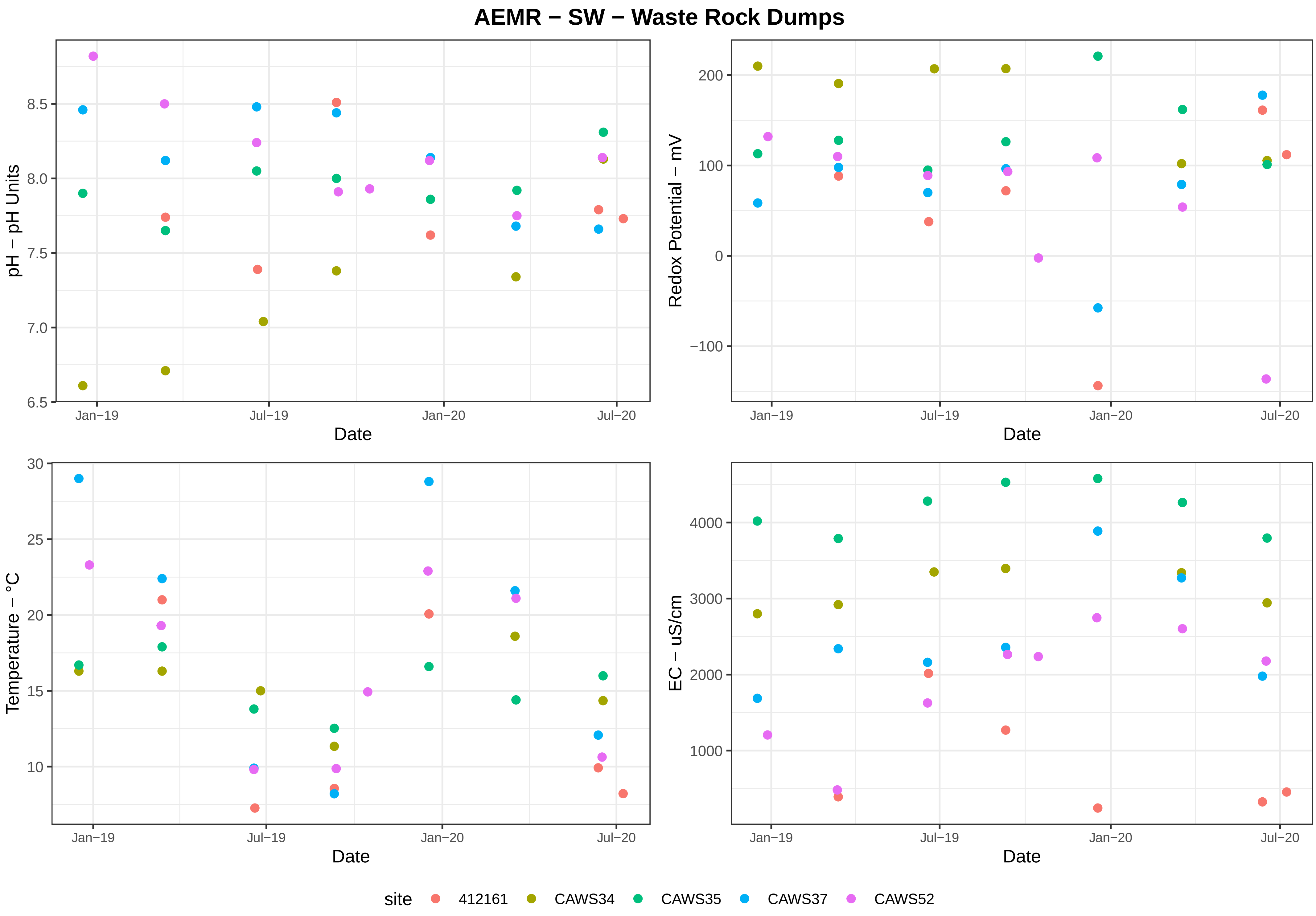
AEMR – SW – TSF Southern Zone




AEMR – SW – TSF Western Zone
pH – pH Units
Redox Potential – mV
Temperature – °C
EC – uS/cm
Date
Jan–19
Jul–19
Jan–20
Jul–20
site
CAWS37
CAWS42
CAWS43
CAWS61
CAWS62
CAWS64
CAWS65
CAWS67
CAWS68
CAWS69
CAWS72
CAWS75

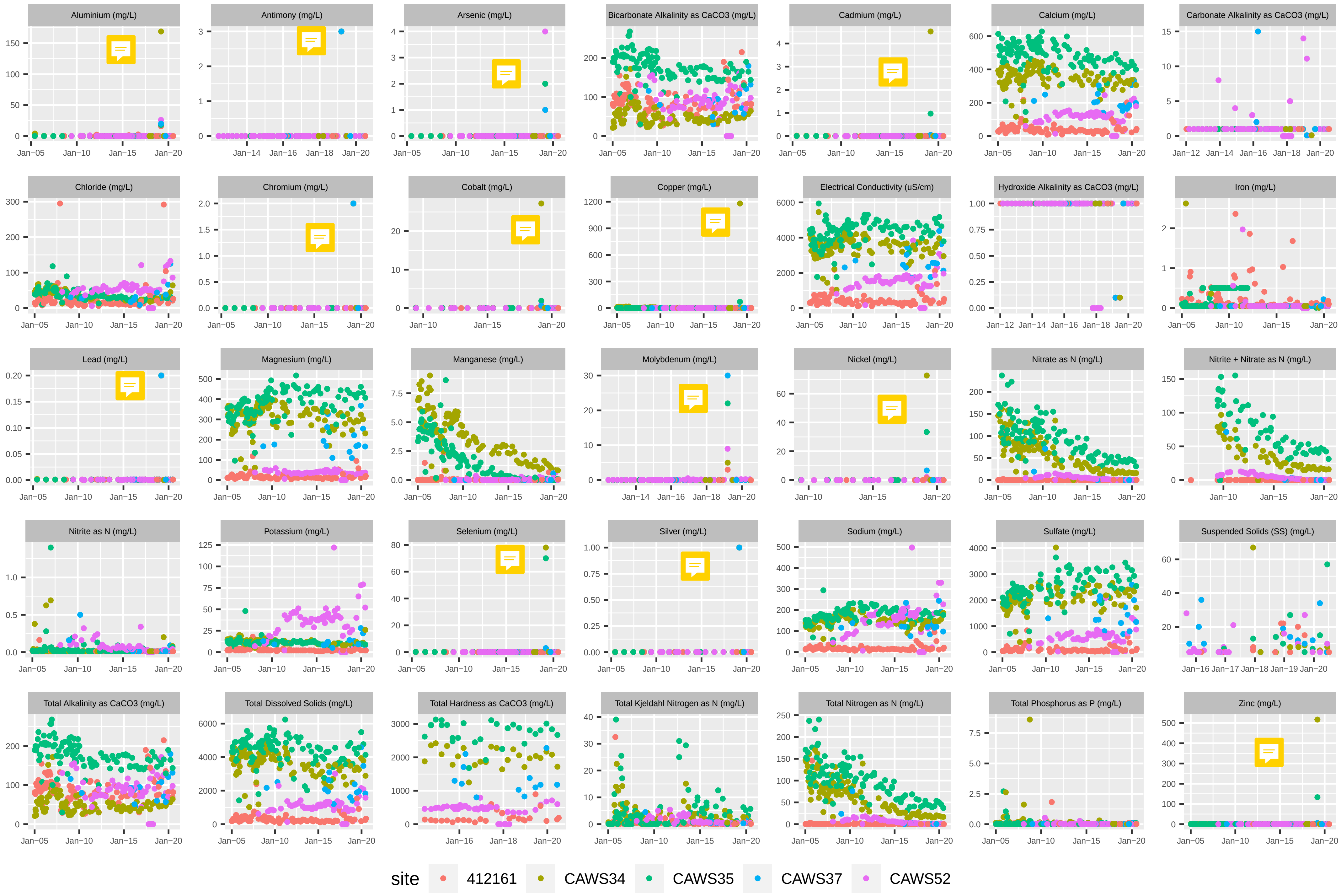
AEMR − SW − TSF Eastern Zone | TSF Western Zone



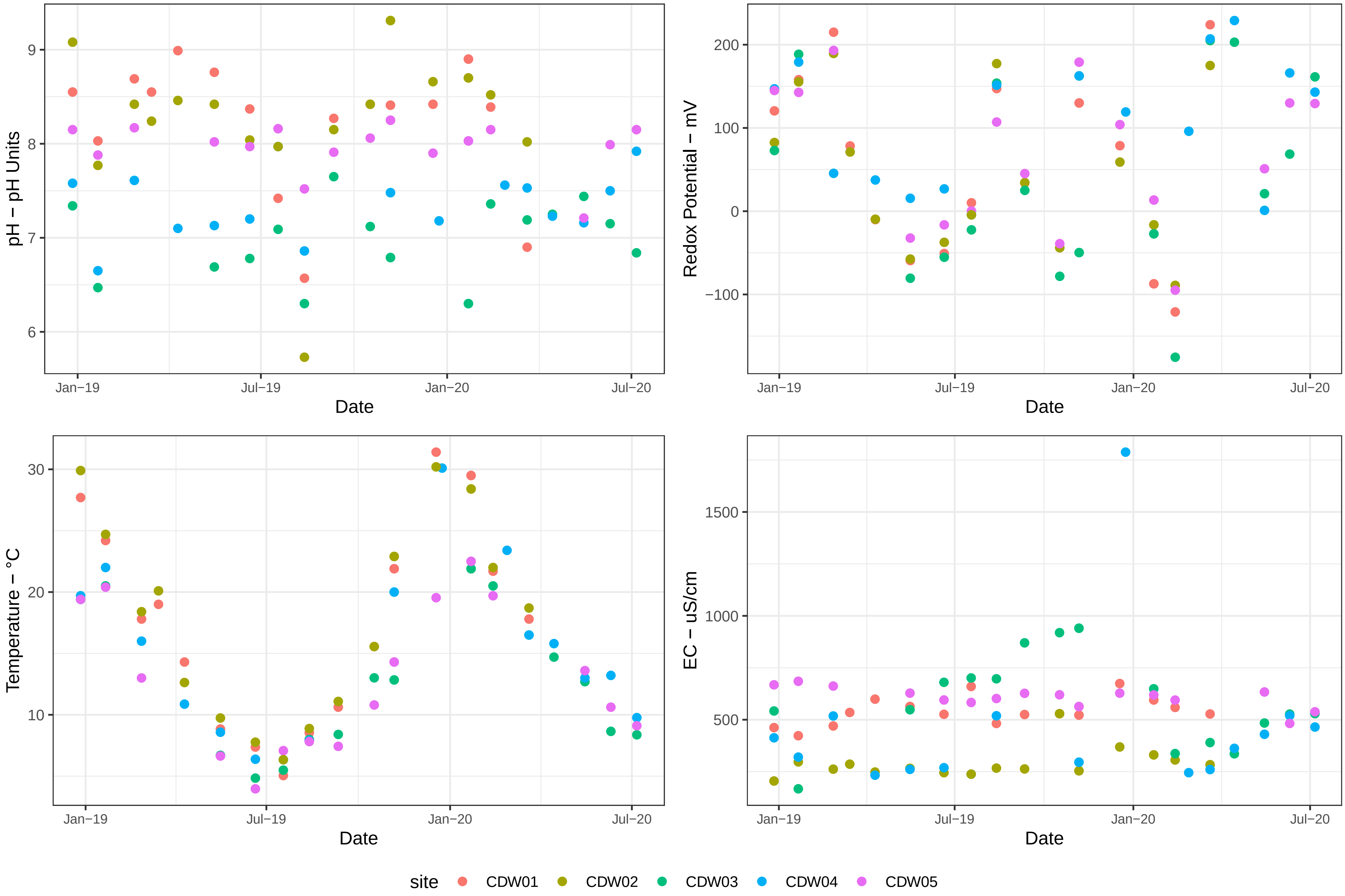


AEMR – SW – Waste Rock Dumps
pH – pH Units
Redox Potential – mV
Temperature – °C
EC – uS/cm
Date
Jan–19
Jul–19
Jan–20
Jul–20
site
412161
CAWS34
CAWS35
CAWS37
CAWS52

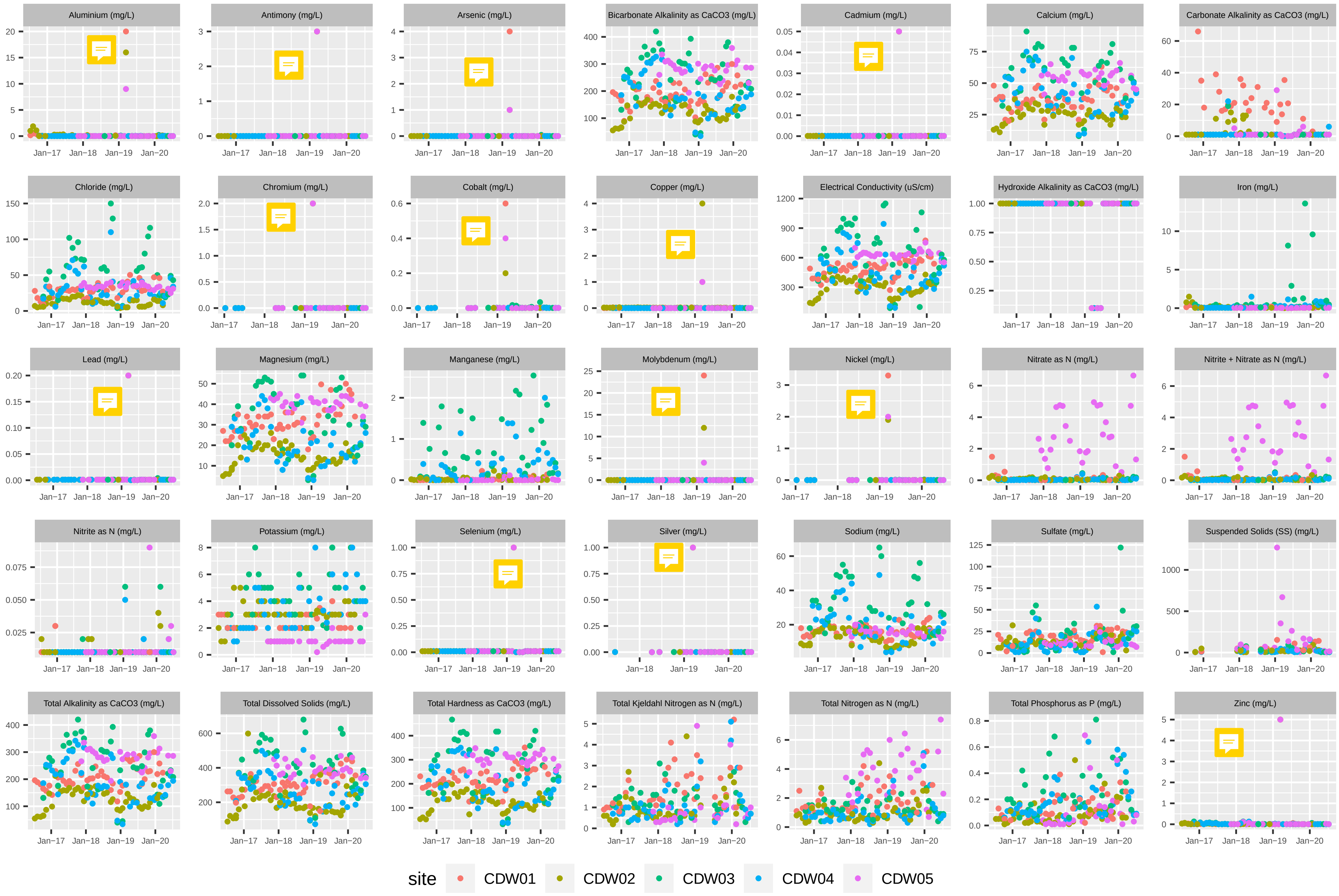
AEMR – SW – Waste Rock Dumps

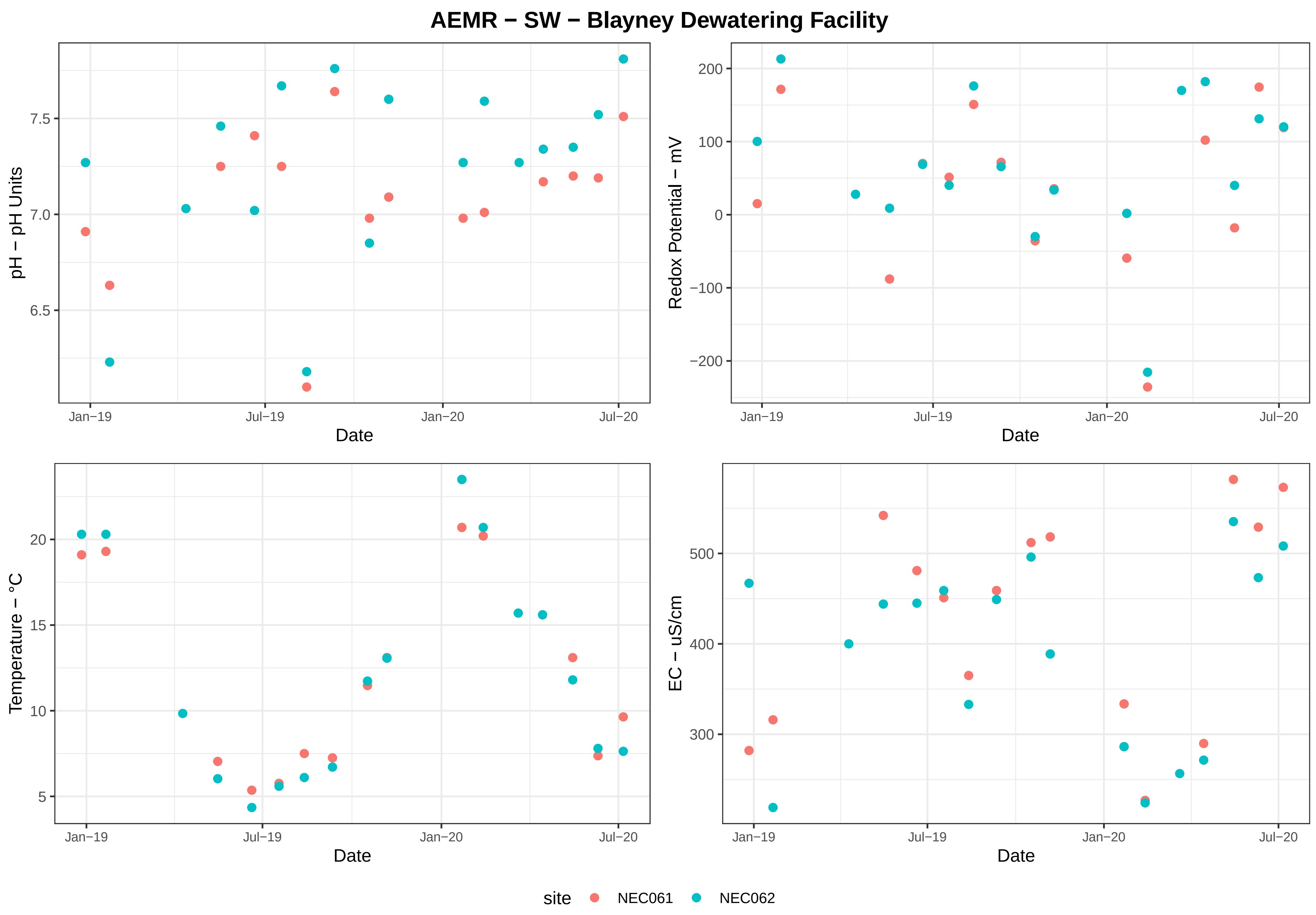


AEMR – SW – Cadia Dewatering Facility

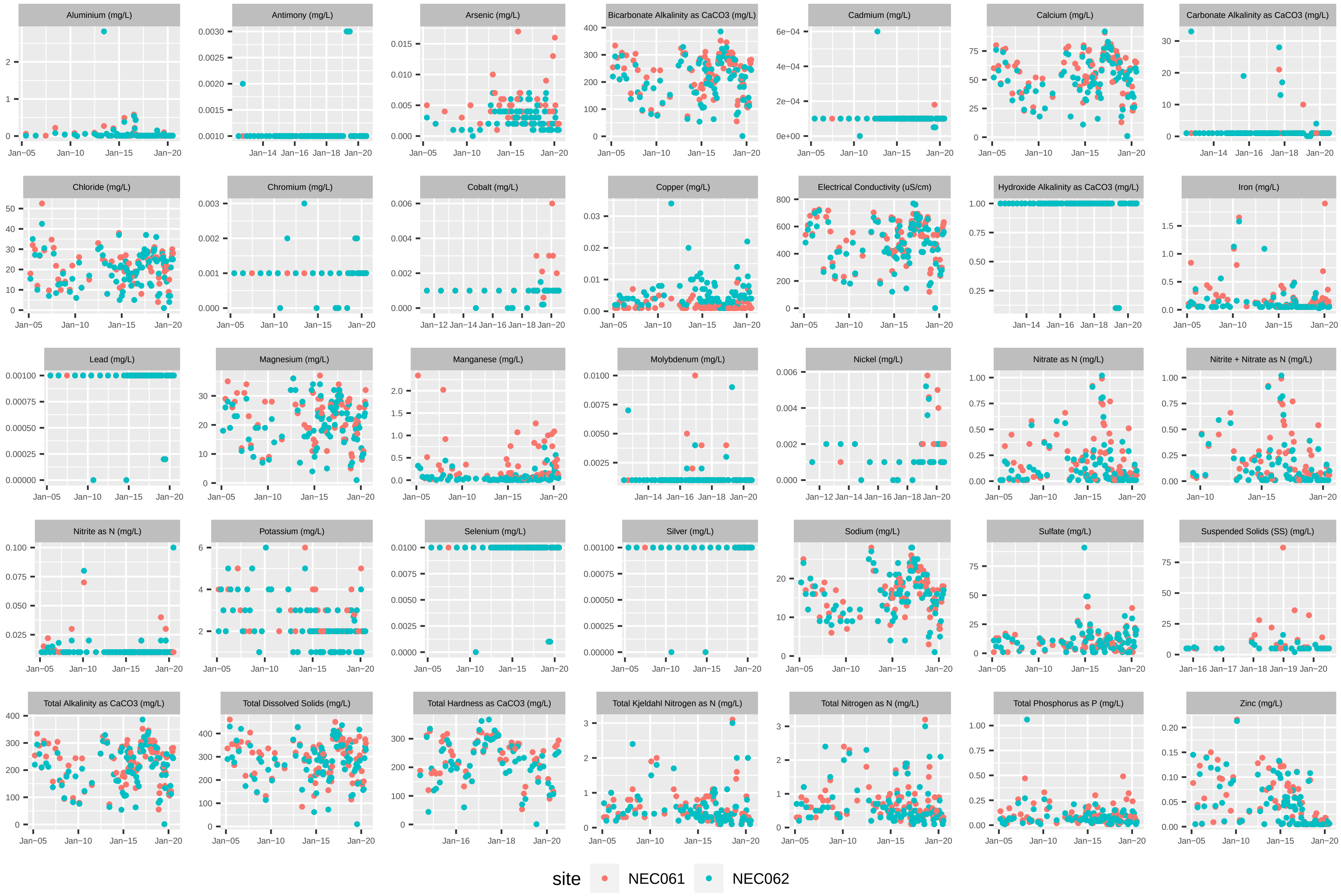


AEMR – SW – Cadia Dewatering Facility

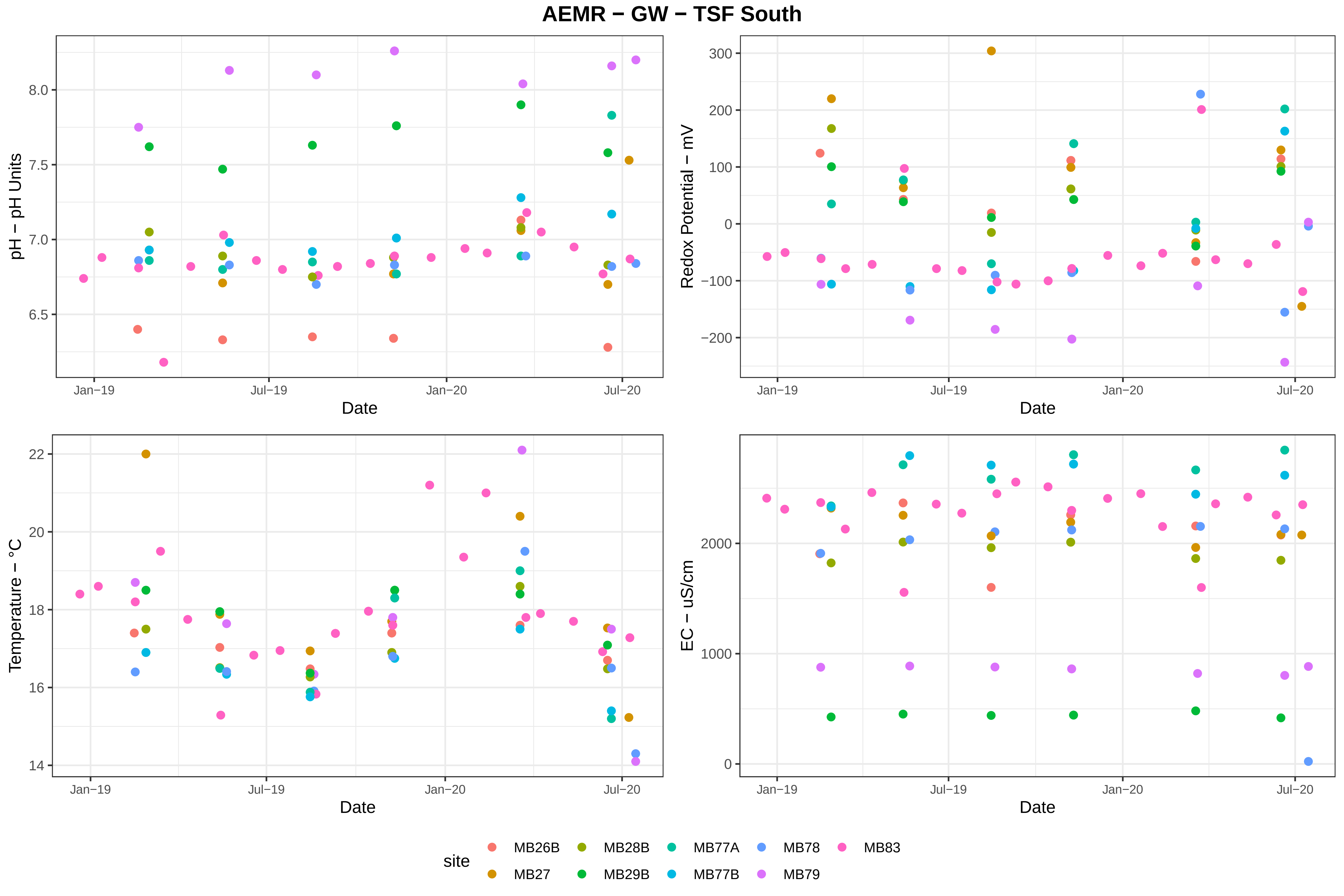



AEMR − SW − Blayney Dewatering Facility
pH − pH Units
7.5
7.0
6.5
Redox Potential − mV
200
100
0
−100
−200
Temperature − °C
20
15
10
5
EC − uS/cm
500
400
300
Jan−19
Jul−19
Jan−20
Jul−20
Date
site
NEC061
NEC062

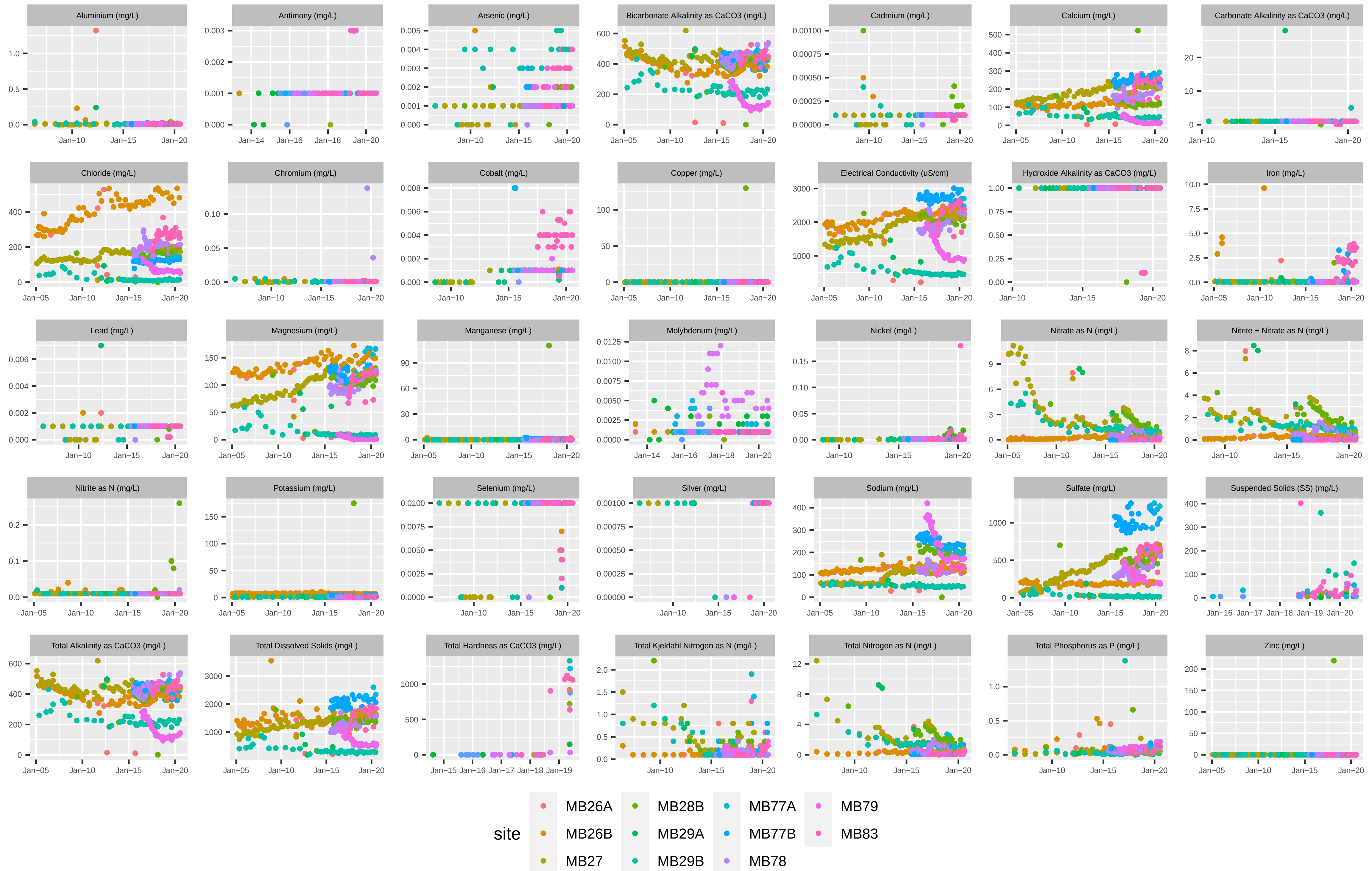
AEMR − SW − Blayney Dewatering Facility

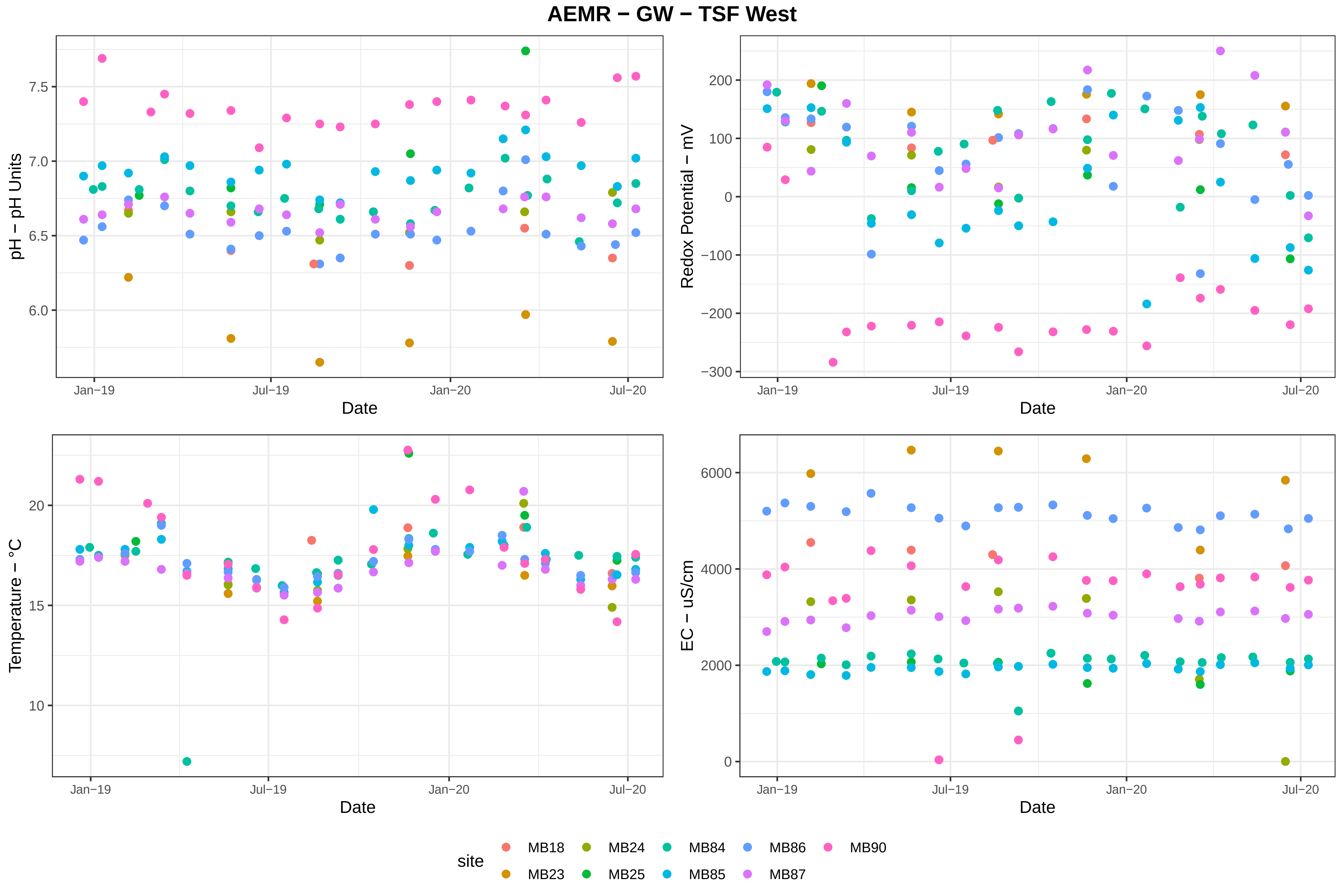


Appendix B – Groundwater quality graphs


AEMR − GW − TSF South
pH − pH Units
8.0
7.5
7.0
6.5
Redox Potential − mV
300
200
100
0
−100
−200
Temperature − °C
22
20
18
16
14
EC − uS/cm
2000
1000
0
Jan−19
Jul−19
Jan−20
Jul−20
Date
site
MB26B
MB27
MB28B
MB29B
MB77A
MB77B
MB78
MB79
MB83

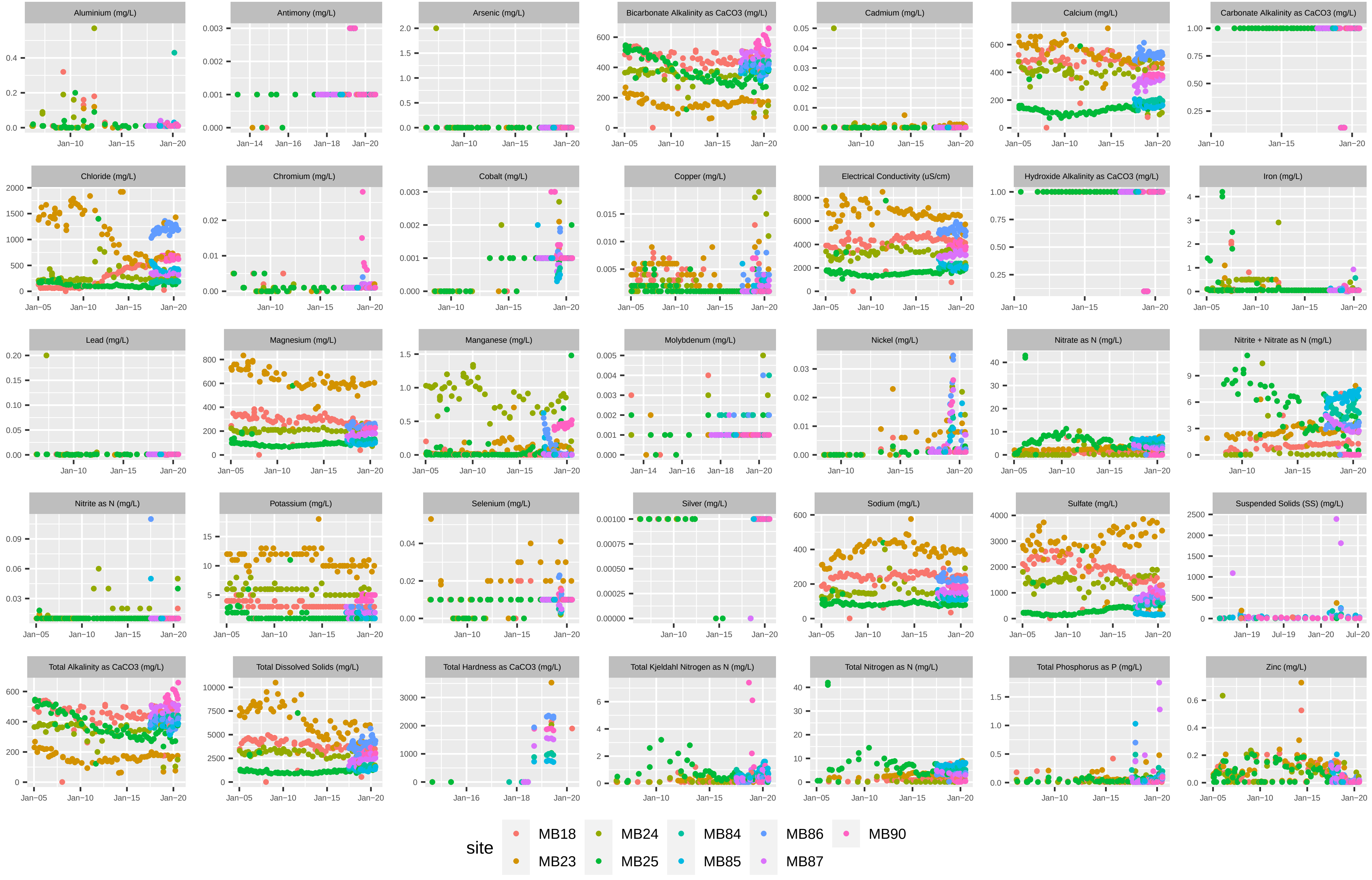
AEMR – GW – TSF South

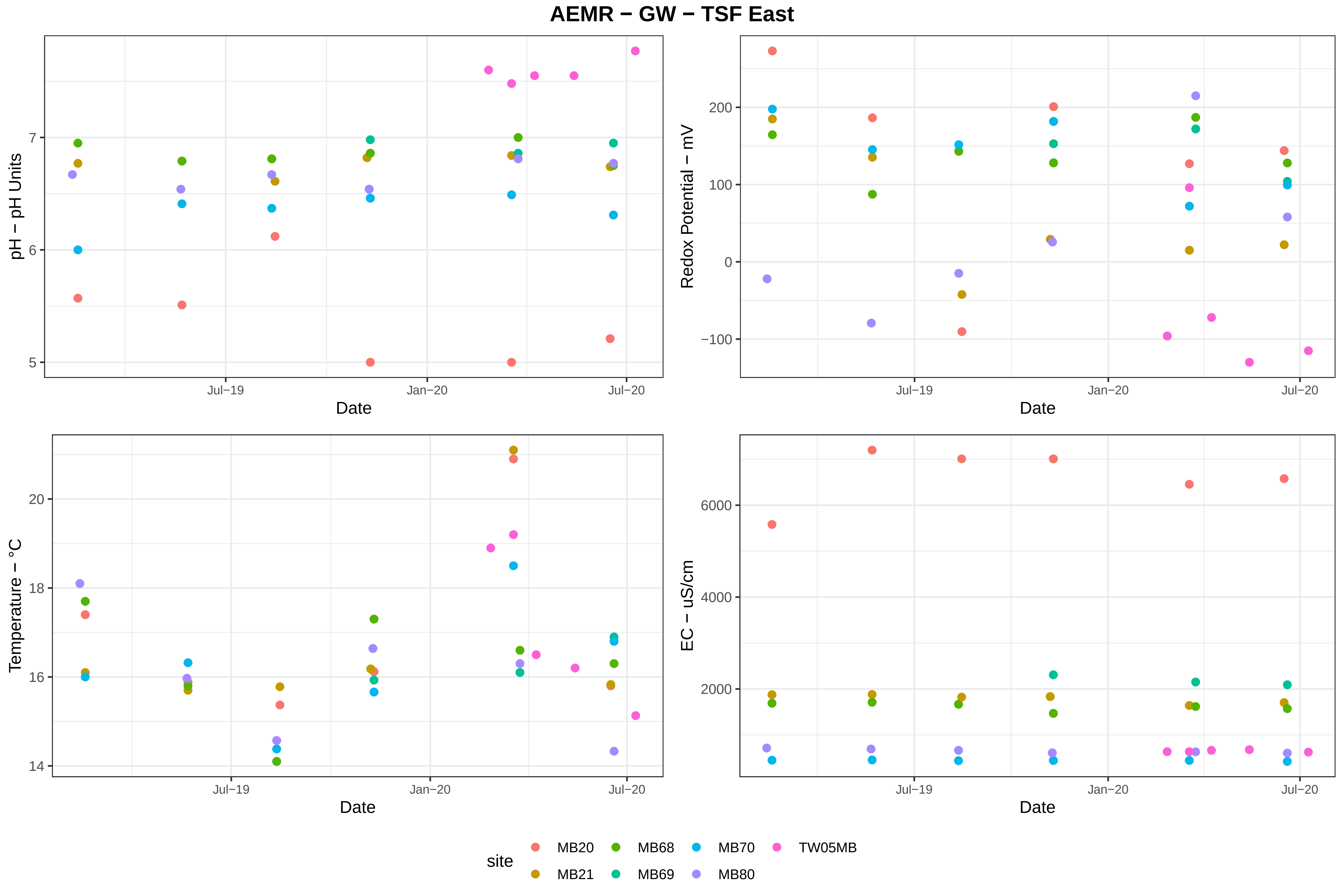


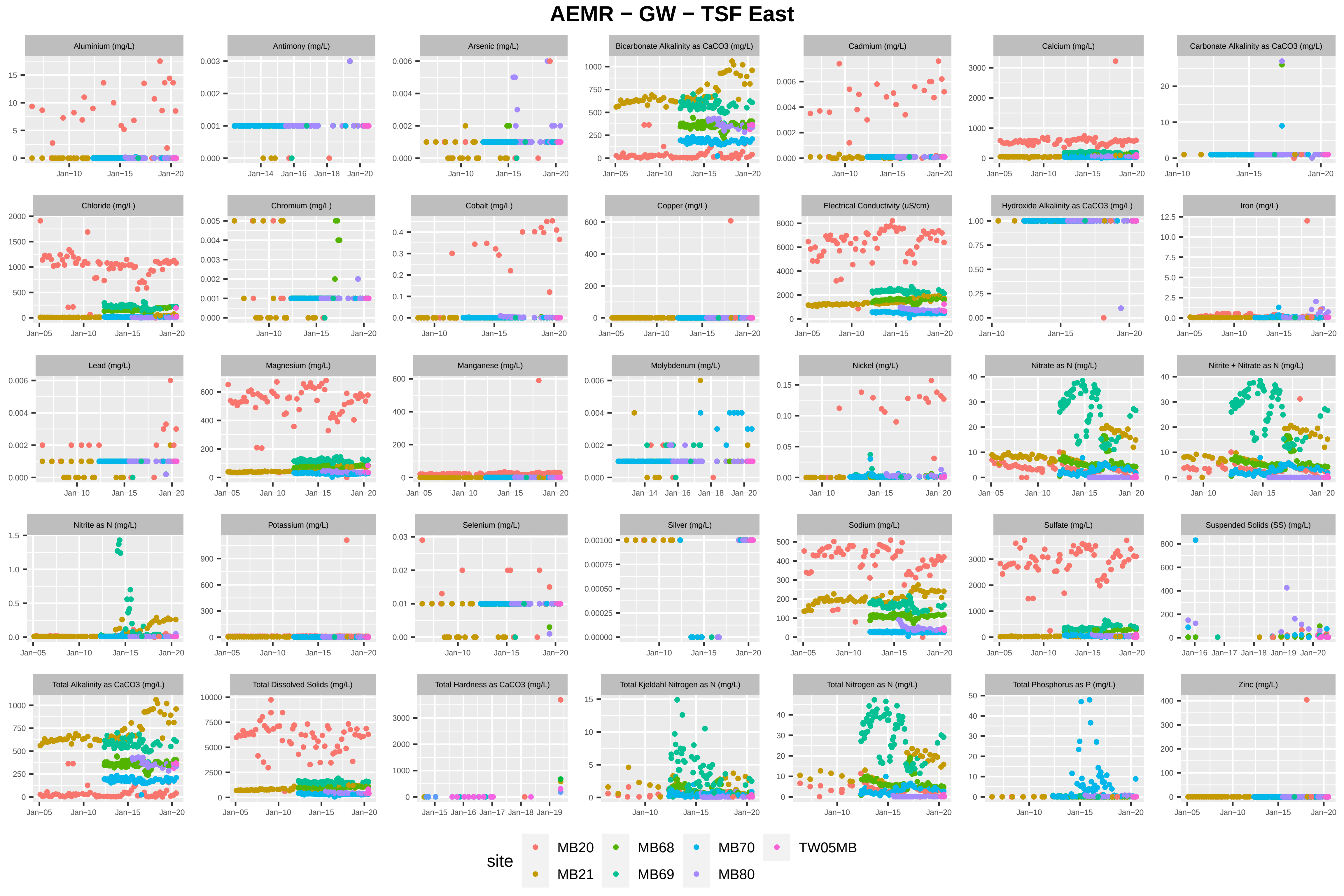


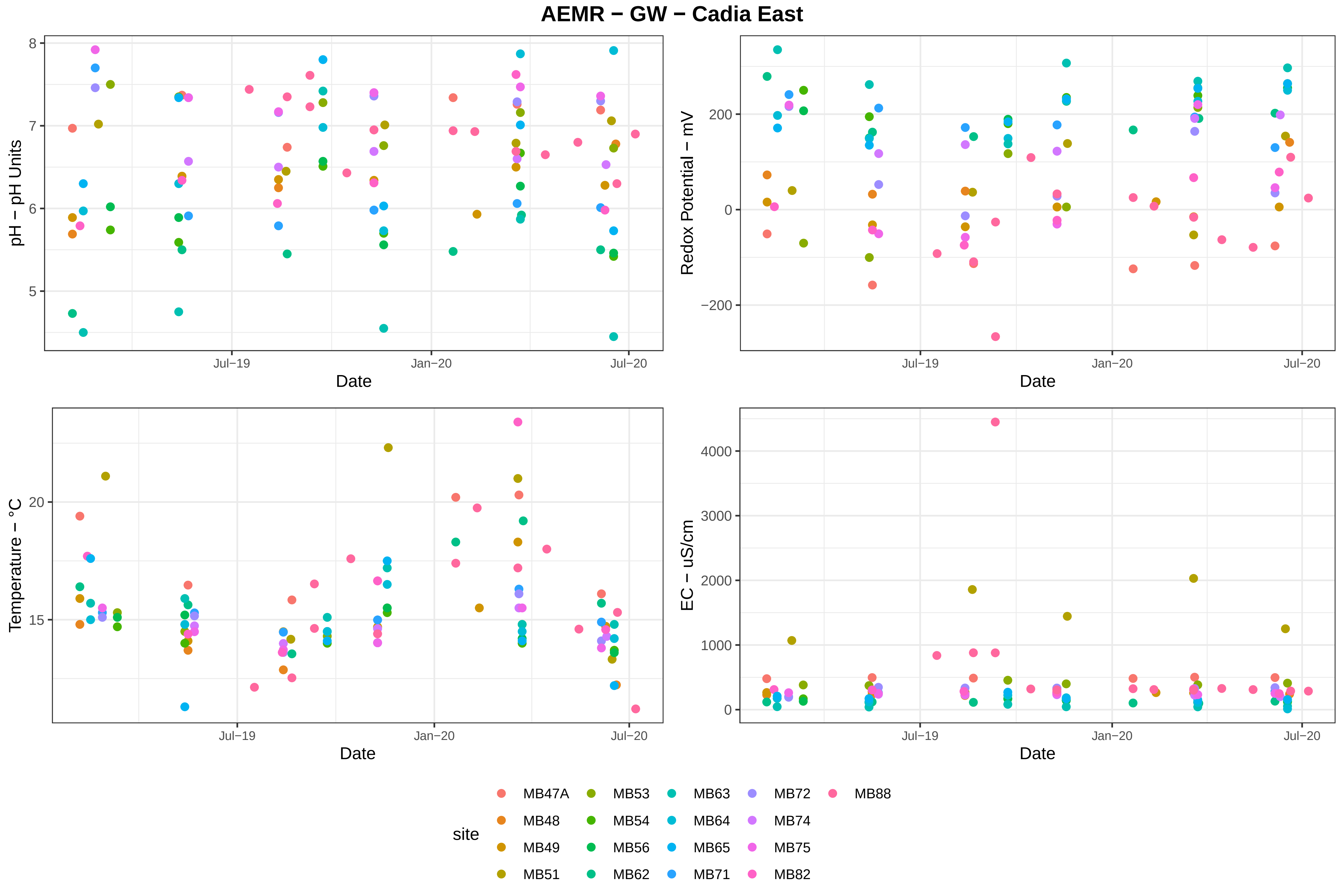
AEMR − GW − TSF West
pH − pH Units
Redox Potential − mV
Temperature − °C
EC − uS/cm
Date
Jan−19
Jul−19
Jan−20
Jul−20
site
MB18
MB23
MB24
MB25
MB84
MB85
MB86
MB87
MB90

AEMR − GW − TSF West

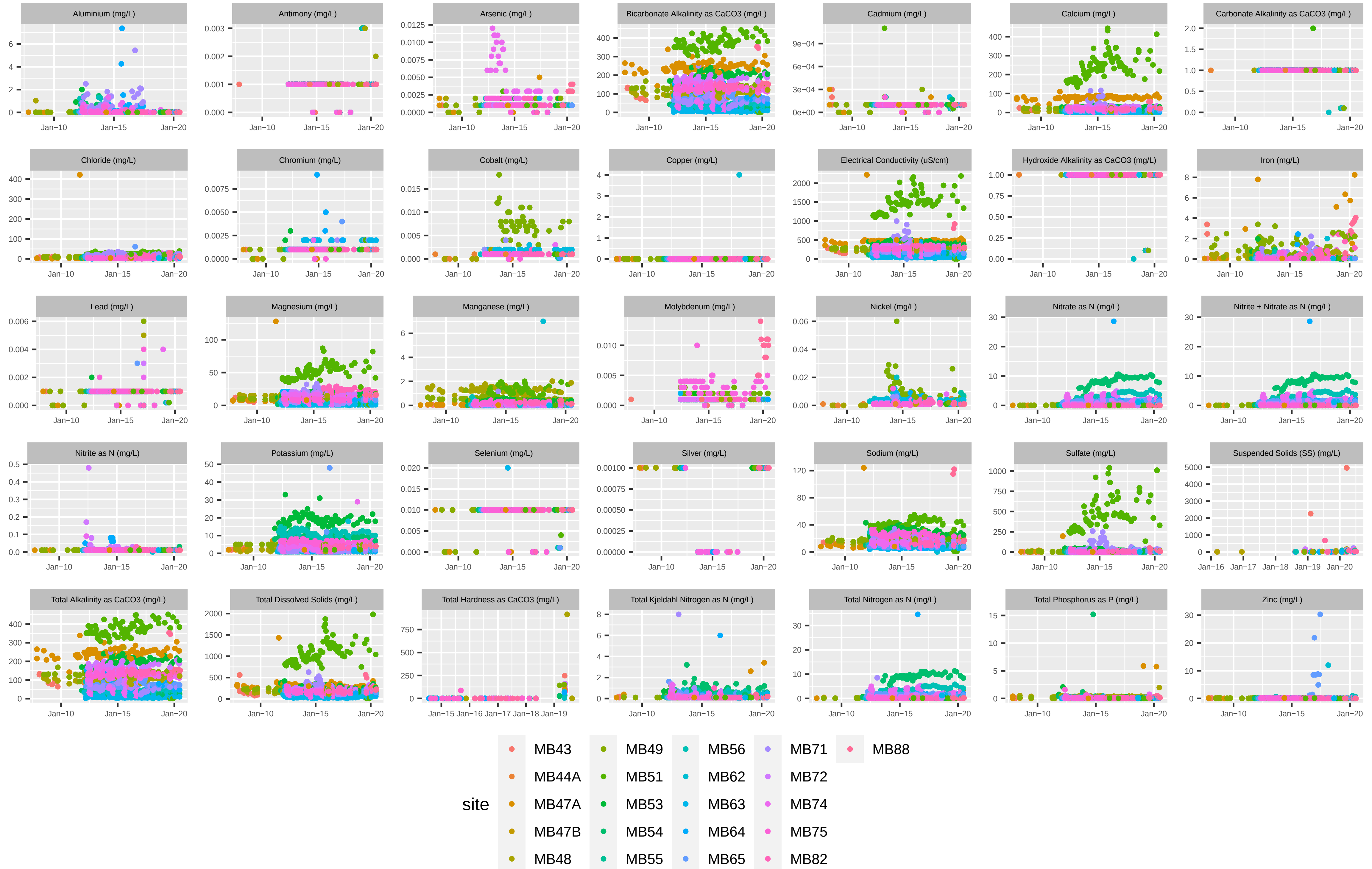


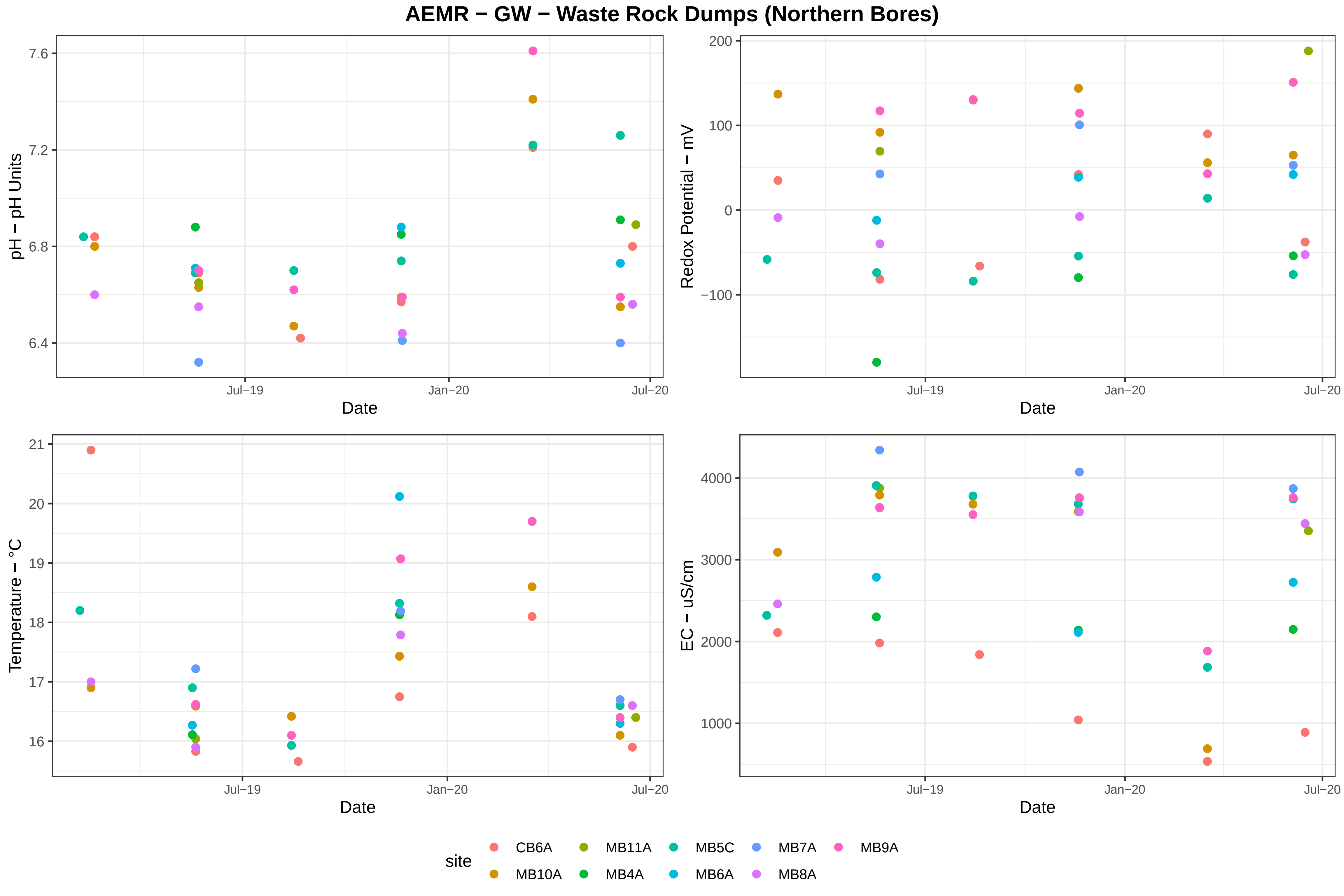

AEMR − GW − TSF East
pH − pH Units
Redox Potential − mV
Temperature − °C
EC − uS/cm
Date
Jul−19
Jan−20
Jul−20
site
MB20
MB21
MB68
MB69
MB70
MB80
TW05MB

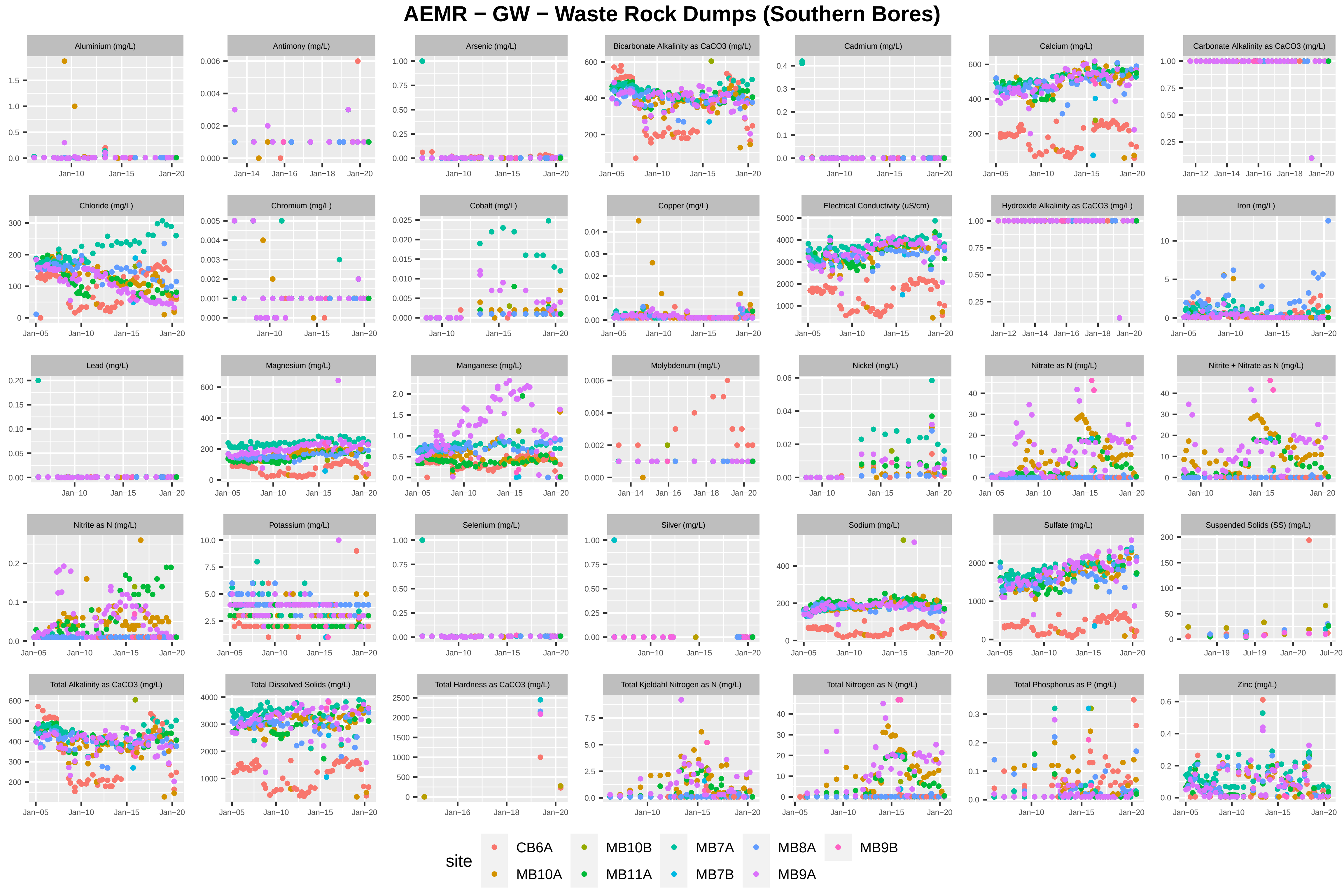

AEMR − GW − TSF East
Aluminium (mg/L)
Antimony (mg/L)
Arsenic (mg/L)
Bicarbonate Alkalinity as CaCO3 (mg/L)
Cadmium (mg/L)
Calcium (mg/L)
Carbonate Alkalinity as CaCO3 (mg/L)
Chloride (mg/L)
Chromium (mg/L)
Cobalt (mg/L)
Copper (mg/L)
Electrical Conductivity (uS/cm)
Hydroxide Alkalinity as CaCO3 (mg/L)
Iron (mg/L)
Lead (mg/L)
Magnesium (mg/L)
Manganese (mg/L)
Molybdenum (mg/L)
Nickel (mg/L)
Nitrate as N (mg/L)
Nitrite + Nitrate as N (mg/L)
Nitrite as N (mg/L)
Potassium (mg/L)
Selenium (mg/L)
Silver (mg/L)
Sodium (mg/L)
Sulfate (mg/L)
Suspended Solids (SS) (mg/L)
Total Alkalinity as CaCO3 (mg/L)
Total Dissolved Solids (mg/L)
Total Hardness as CaCO3 (mg/L)
Total Kjeldahl Nitrogen as N (mg/L)
Total Nitrogen as N (mg/L)
Total Phosphorus as P (mg/L)
Zinc (mg/L)
site
MB20
MB21
MB68
MB69
MB70
MB80
TW05MB

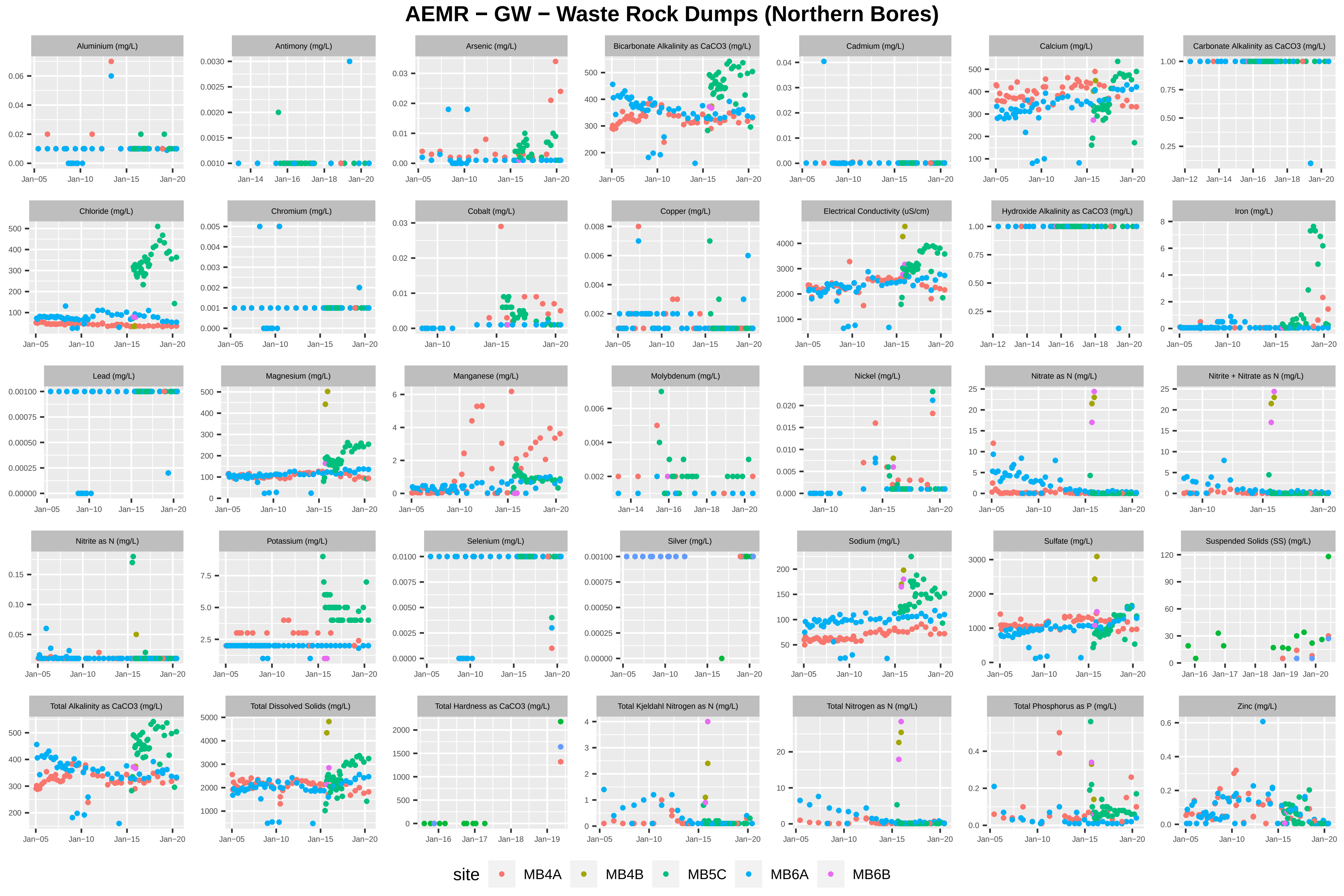

AEMR − GW − Cadia East
pH − pH Units
Redox Potential − mV
Temperature − °C
EC − uS/cm
Date
Jul−19
Jan−20
Jul−20
site
MB47A
MB48
MB49
MB51
MB53
MB54
MB56
MB62
MB63
MB64
MB65
MB71
MB72
MB74
MB75
MB82
MB88

AEMR − GW − Cadia East

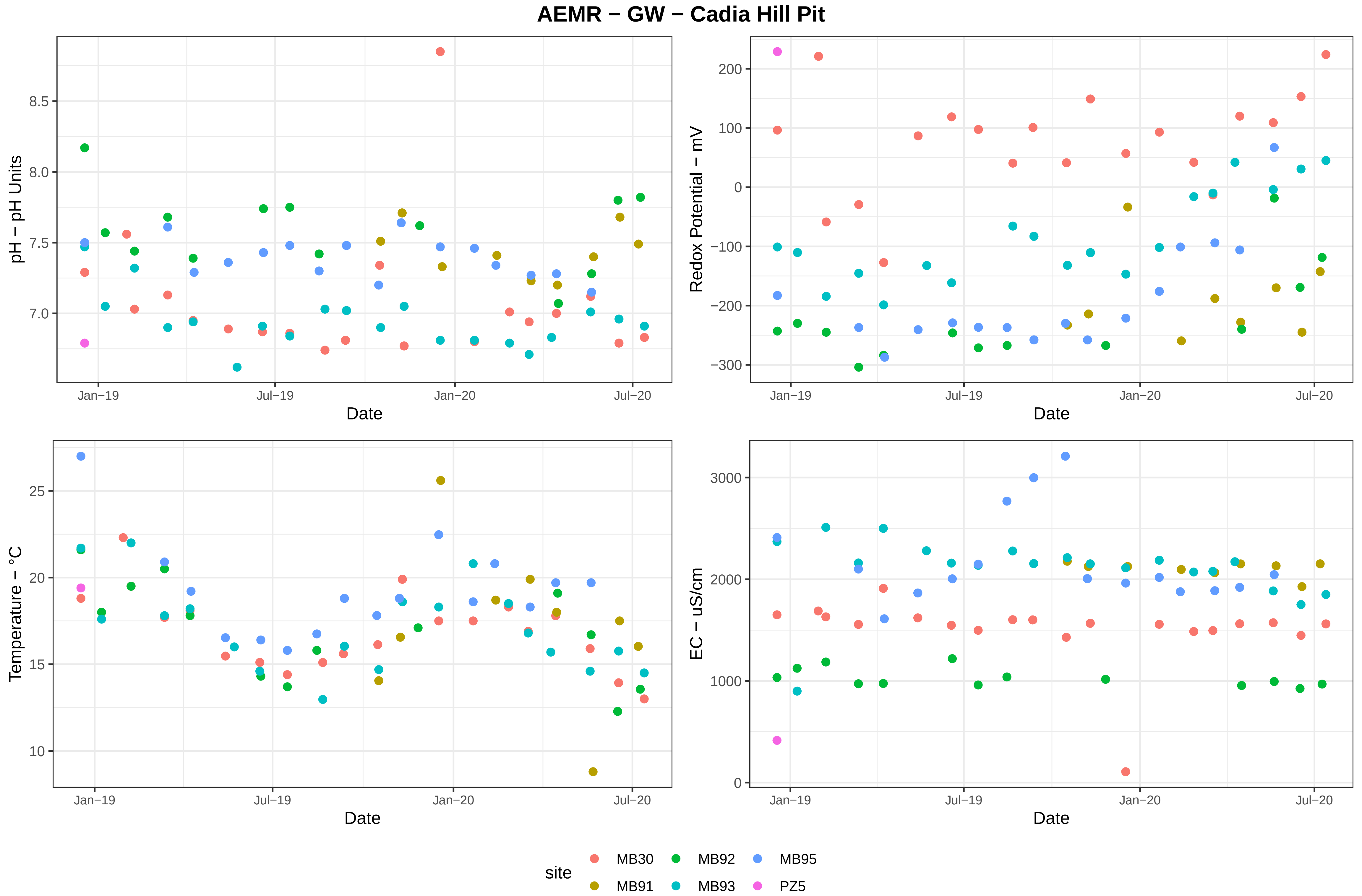



AEMR − GW − Waste Rock Dumps (Northern Bores)
pH − pH Units
Redox Potential − mV
Temperature − °C
EC − uS/cm
Date
Jul−19
Jan−20
Jul−20
site
CB6A
MB10A
MB11A
MB4A
MB5C
MB6A
MB7A
MB8A
MB9A

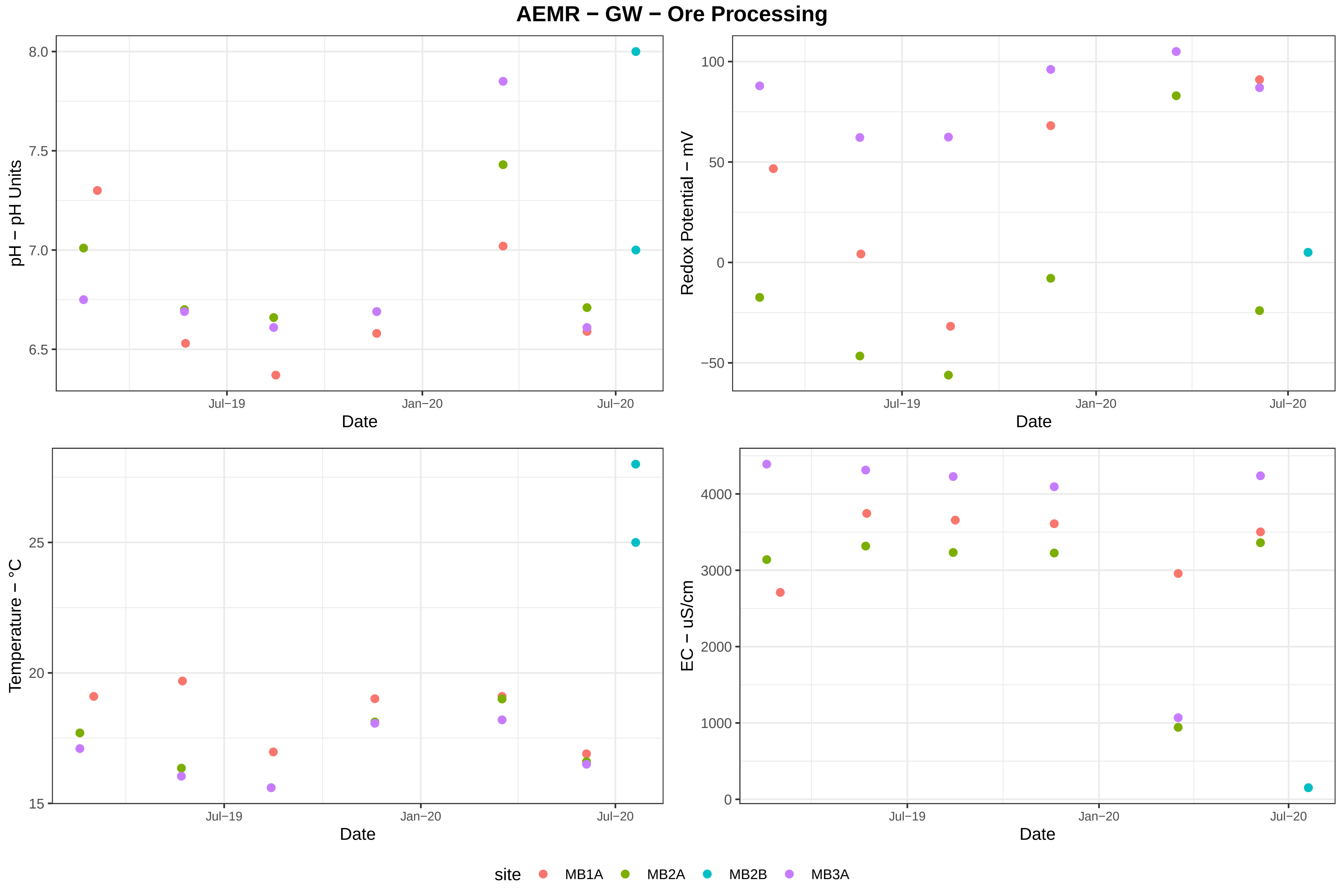

AEMR − GW − Waste Rock Dumps (Southern Bores)
Aluminium (mg/L)
Antimony (mg/L)
Arsenic (mg/L)
Bicarbonate Alkalinity as CaCO3 (mg/L)
Cadmium (mg/L)
Calcium (mg/L)
Carbonate Alkalinity as CaCO3 (mg/L)
Chloride (mg/L)
Chromium (mg/L)
Cobalt (mg/L)
Copper (mg/L)
Electrical Conductivity (uS/cm)
Hydroxide Alkalinity as CaCO3 (mg/L)
Iron (mg/L)
Lead (mg/L)
Magnesium (mg/L)
Manganese (mg/L)
Molybdenum (mg/L)
Nickel (mg/L)
Nitrate as N (mg/L)
Nitrite + Nitrate as N (mg/L)
Nitrite as N (mg/L)
Potassium (mg/L)
Selenium (mg/L)
Silver (mg/L)
Sodium (mg/L)
Sulfate (mg/L)
Suspended Solids (SS) (mg/L)
Total Alkalinity as CaCO3 (mg/L)
Total Dissolved Solids (mg/L)
Total Hardness as CaCO3 (mg/L)
Total Kjeldahl Nitrogen as N (mg/L)
Total Nitrogen as N (mg/L)
Total Phosphorus as P (mg/L)
Zinc (mg/L)
site
CB6A
MB10A
MB10B
MB11A
MB7A
MB7B
MB8A
MB9A
MB9B

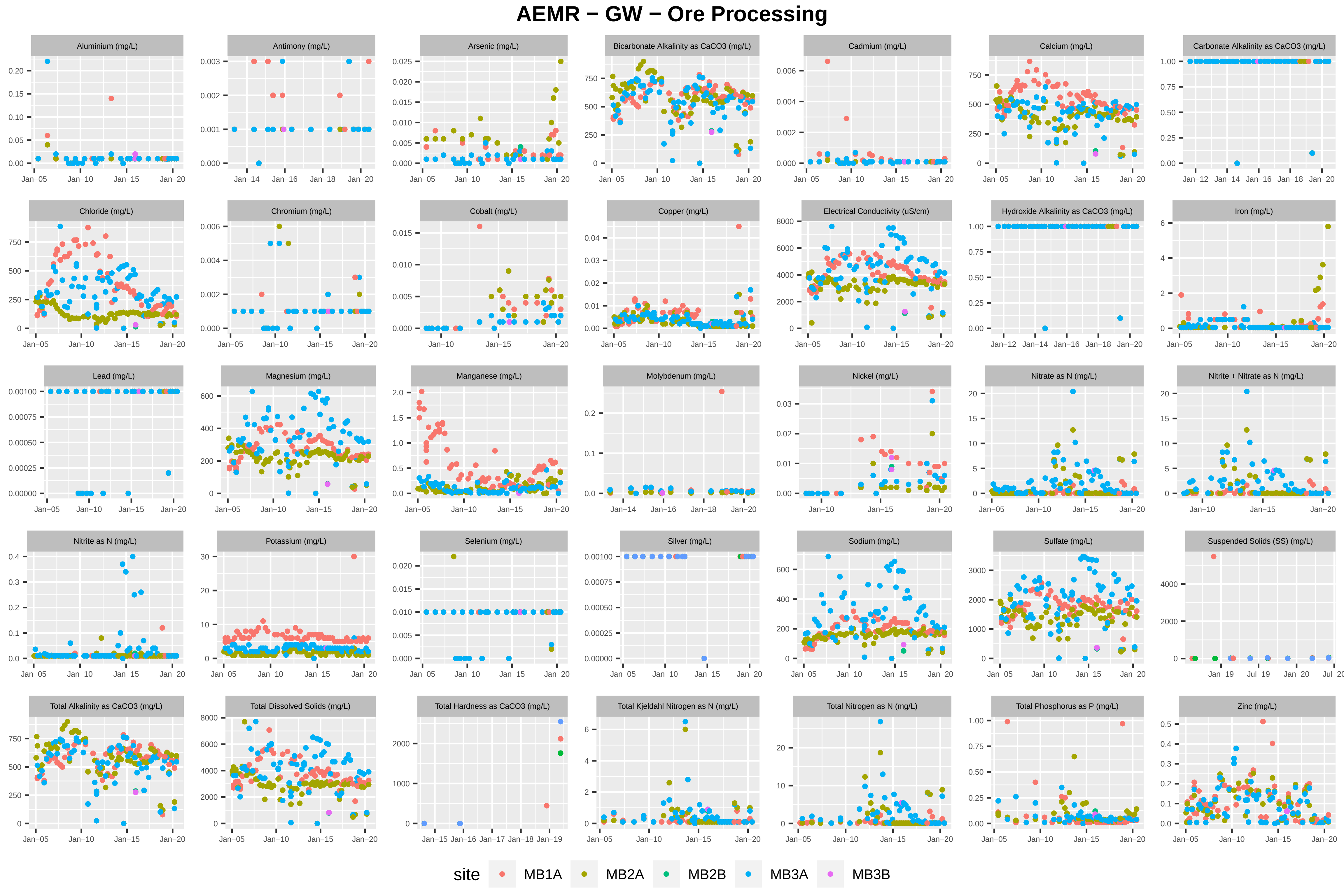


AEMR − GW − Waste Rock Dumps (Northern Bores)
Aluminium (mg/L)
Antimony (mg/L)
Arsenic (mg/L)
Bicarbonate Alkalinity as CaCO3 (mg/L)
Cadmium (mg/L)
Calcium (mg/L)
Carbonate Alkalinity as CaCO3 (mg/L)
Chloride (mg/L)
Chromium (mg/L)
Cobalt (mg/L)
Copper (mg/L)
Electrical Conductivity (uS/cm)
Hydroxide Alkalinity as CaCO3 (mg/L)
Iron (mg/L)
Lead (mg/L)
Magnesium (mg/L)
Manganese (mg/L)
Molybdenum (mg/L)
Nickel (mg/L)
Nitrate as N (mg/L)
Nitrite + Nitrate as N (mg/L)
Nitrite as N (mg/L)
Potassium (mg/L)
Selenium (mg/L)
Silver (mg/L)
Sodium (mg/L)
Sulfate (mg/L)
Suspended Solids (SS) (mg/L)
Total Alkalinity as CaCO3 (mg/L)
Total Dissolved Solids (mg/L)
Total Hardness as CaCO3 (mg/L)
Total Kjeldahl Nitrogen as N (mg/L)
Total Nitrogen as N (mg/L)
Total Phosphorus as P (mg/L)
Zinc (mg/L)
site
MB4A
MB4B
MB5C
MB6A
MB6B

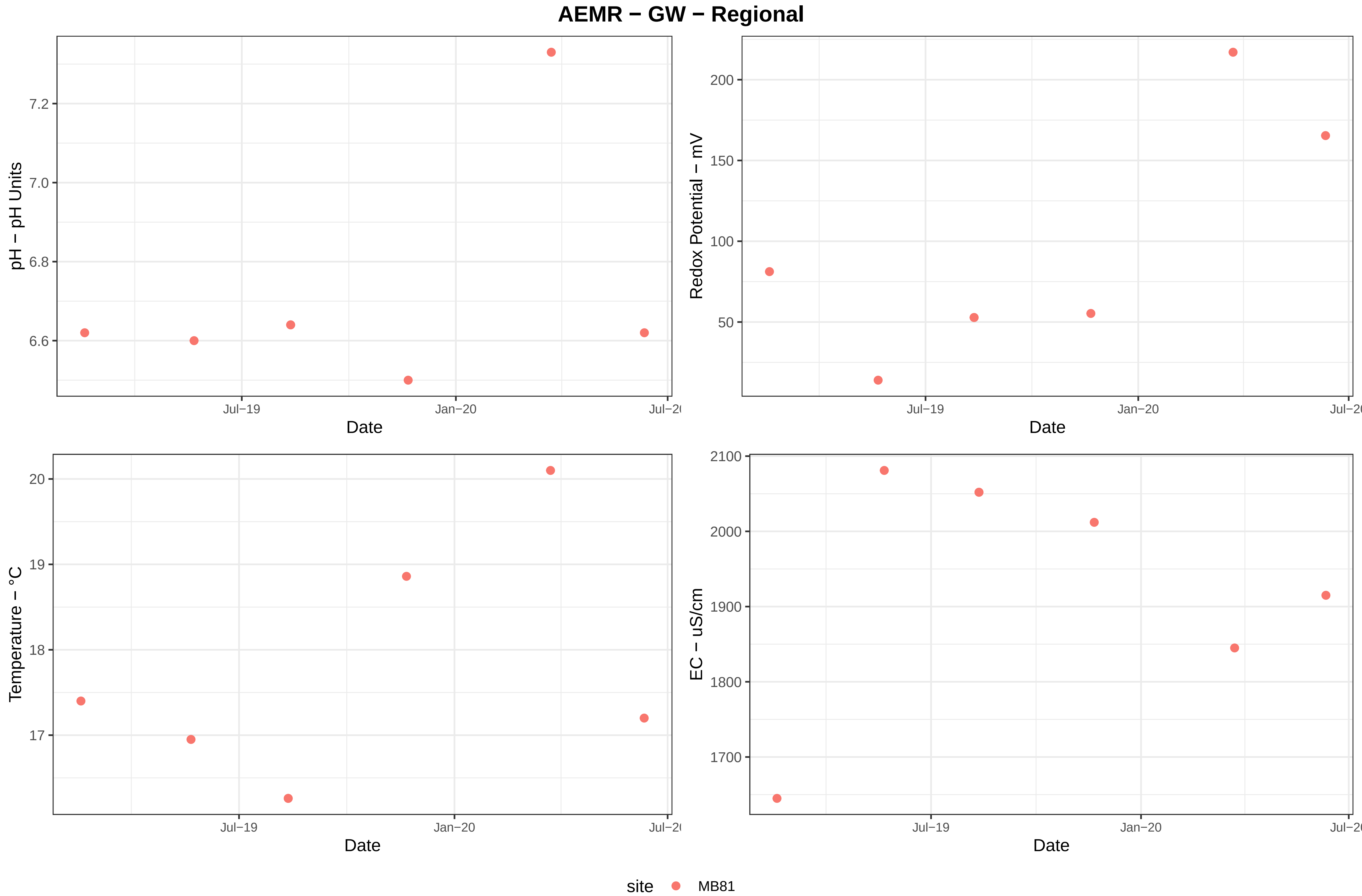

AEMR − GW − Cadia Hill Pit
pH − pH Units
Redox Potential − mV
Temperature − °C
EC − uS/cm
Date
Jan−19
Jul−19
Jan−20
Jul−20
8.5
8.0
7.5
7.0
200
100
0
−100
−200
−300
25
20
15
10
3000
2000
1000
0
site
MB30
MB91
MB92
MB93
MB95
PZ5

AEMR − GW − Cadia Hill Pit


AEMR − GW − Ore Processing
pH − pH Units
8.0
7.5
7.0
6.5
Jul−19
Jan−20
Jul−20
Date
Redox Potential − mV
100
50
0
−50
Jul−19
Jan−20
Jul−20
Date
Temperature − °C
25
20
15
Jul−19
Jan−20
Jul−20
Date
EC − uS/cm
4000
3000
2000
1000
0
Jul−19
Jan−20
Jul−20
Date
site
MB1A
MB2A
MB2B
MB3A



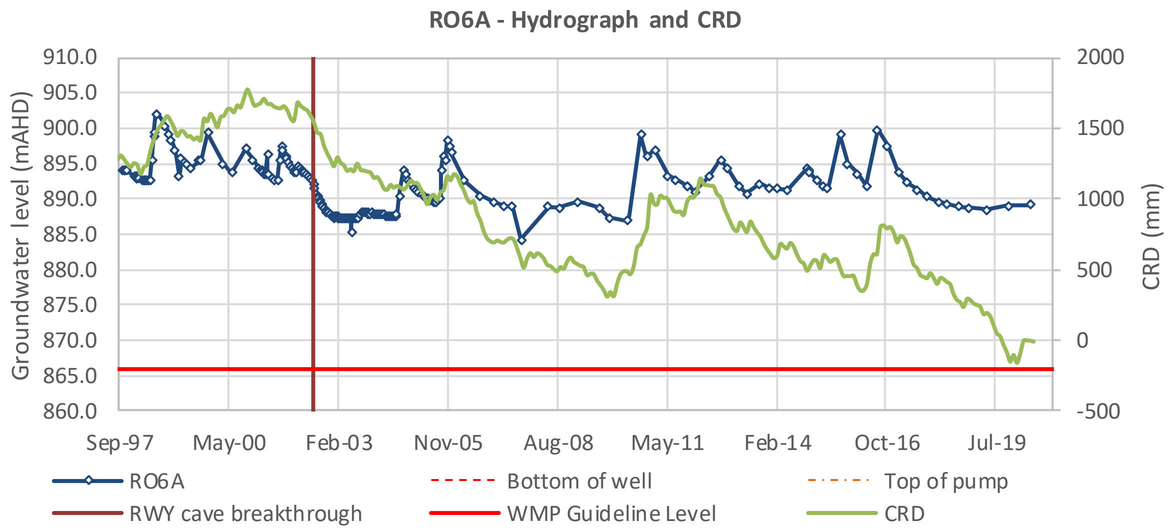
AEMR – GW – Ore Processing
Aluminium (mg/L)
Antimony (mg/L)
Arsenic (mg/L)
Bicarbonate Alkalinity as CaCO3 (mg/L)
Cadmium (mg/L)
Calcium (mg/L)
Carbonate Alkalinity as CaCO3 (mg/L)
Chloride (mg/L)
Chromium (mg/L)
Cobalt (mg/L)
Copper (mg/L)
Electrical Conductivity (uS/cm)
Hydroxide Alkalinity as CaCO3 (mg/L)
Iron (mg/L)
Lead (mg/L)
Magnesium (mg/L)
Manganese (mg/L)
Molybdenum (mg/L)
Nickel (mg/L)
Nitrate as N (mg/L)
Nitrite + Nitrate as N (mg/L)
Nitrite as N (mg/L)
Potassium (mg/L)
Selenium (mg/L)
Silver (mg/L)
Sodium (mg/L)
Sulfate (mg/L)
Suspended Solids (SS) (mg/L)
Total Alkalinity as CaCO3 (mg/L)
Total Dissolved Solids (mg/L)
Total Hardness as CaCO3 (mg/L)
Total Kjeldahl Nitrogen as N (mg/L)
Total Nitrogen as N (mg/L)
Total Phosphorus as P (mg/L)
Zinc (mg/L)
site
MB1A
MB2A
MB2B
MB3A
MB3B

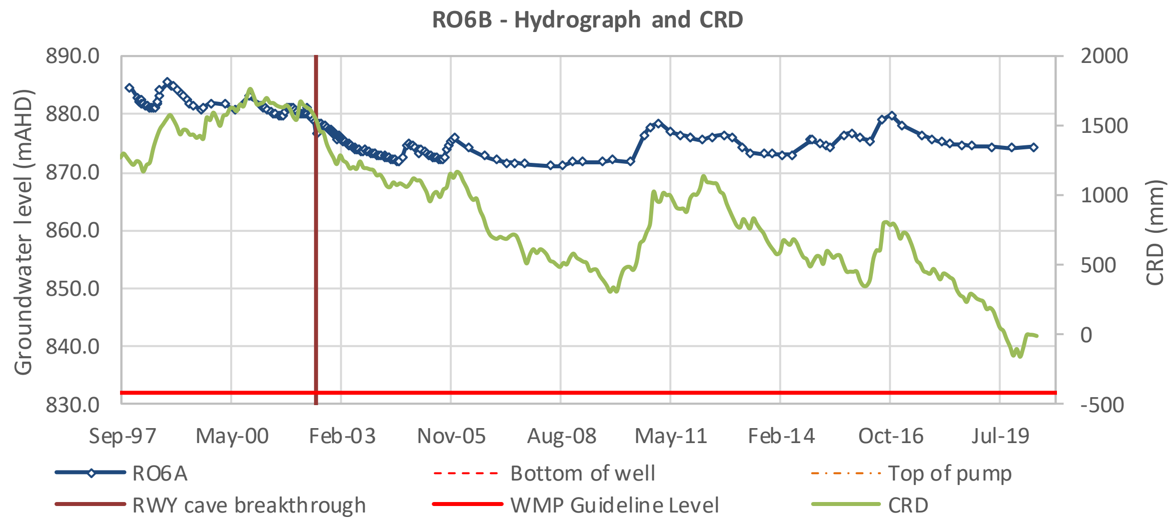

AEMR − GW − Regional
pH − pH Units
7.2
7.0
6.8
6.6
Redox Potential − mV
200
150
100
50
Temperature − °C
20
19
18
17
EC − uS/cm
2100
2000
1900
1800
1700
Jul−19
Jan−20
Date
site
MB81

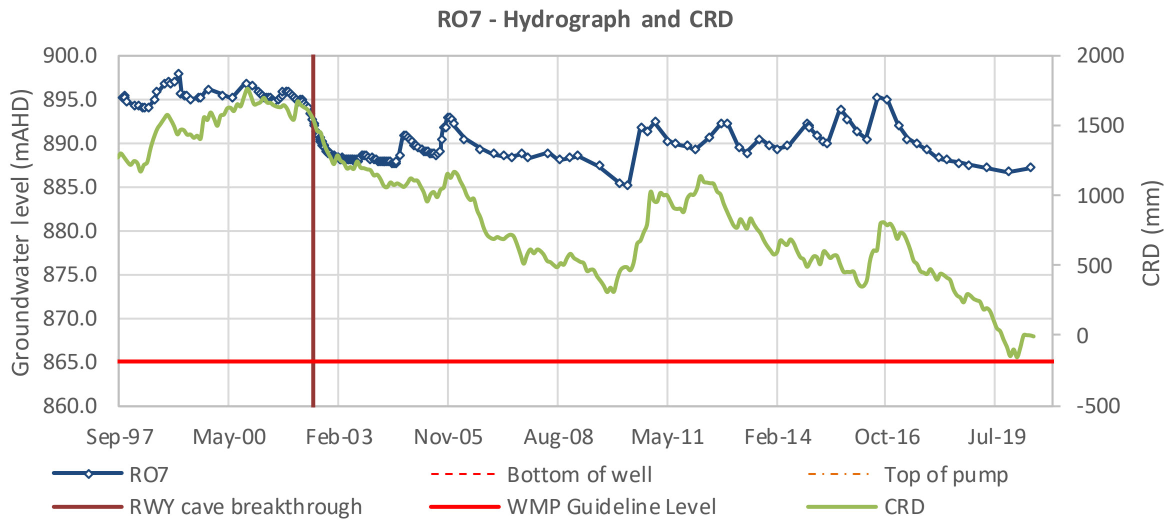

AEMR − GW − Regional
Aluminium (mg/L)
Antimony (mg/L)
Arsenic (mg/L)
Bicarbonate Alkalinity as CaCO3 (mg/L)
Cadmium (mg/L)
Calcium (mg/L)
Carbonate Alkalinity as CaCO3 (mg/L)
Chloride (mg/L)
Chromium (mg/L)
Cobalt (mg/L)
Copper (mg/L)
Electrical Conductivity (uS/cm)
Hydroxide Alkalinity as CaCO3 (mg/L)
Iron (mg/L)
Lead (mg/L)
Magnesium (mg/L)
Manganese (mg/L)
Molybdenum (mg/L)
Nickel (mg/L)
Nitrate as N (mg/L)
Nitrite + Nitrate as N (mg/L)
Nitrite as N (mg/L)
Potassium (mg/L)
Selenium (mg/L)
Silver (mg/L)
Sodium (mg/L)
Sulfate (mg/L)
Suspended Solids (SS) (mg/L)
Total Alkalinity as CaCO3 (mg/L)
Total Dissolved Solids (mg/L)
Total Hardness as CaCO3 (mg/L)
Total Kjeldahl Nitrogen as N (mg/L)
Total Nitrogen as N (mg/L)
Total Phosphorus as P (mg/L)
Zinc (mg/L)
Jan−16 Jan−17 Jan−18 Jan−19 Jan−20
site
MB81
RB03
RB04
RB05

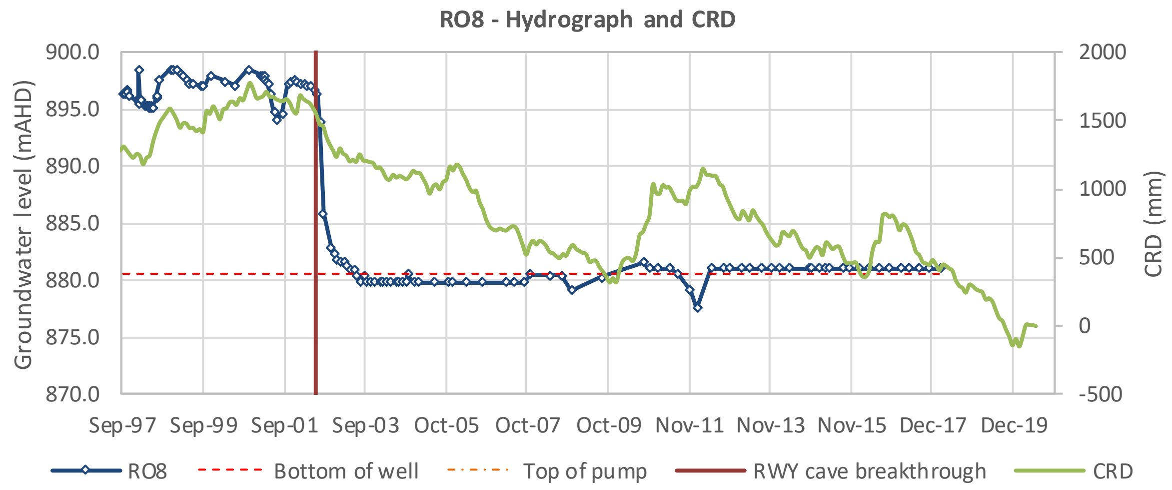
Appendix C – Groundwater level graphs

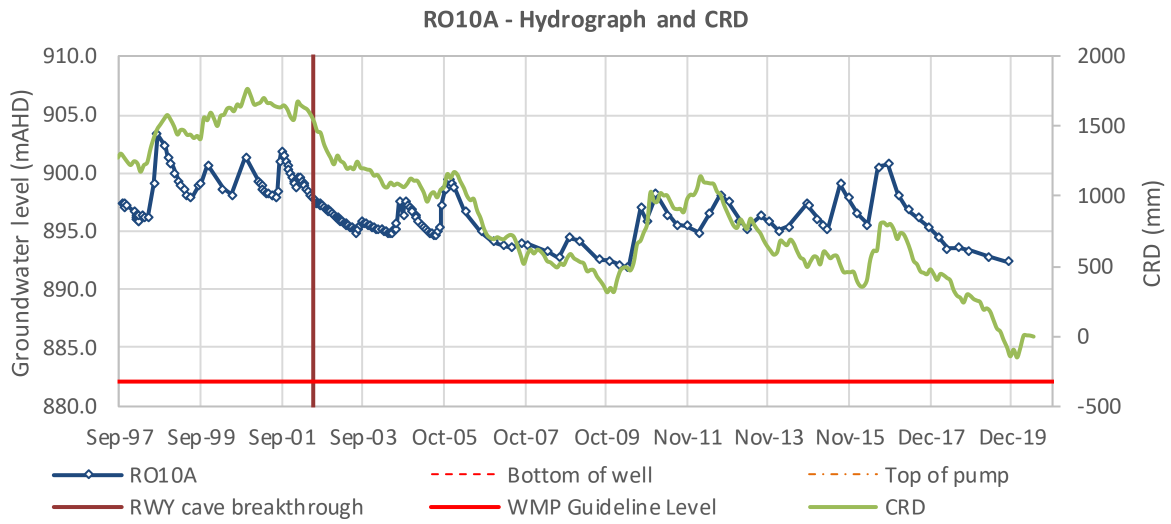
Ridgeway area

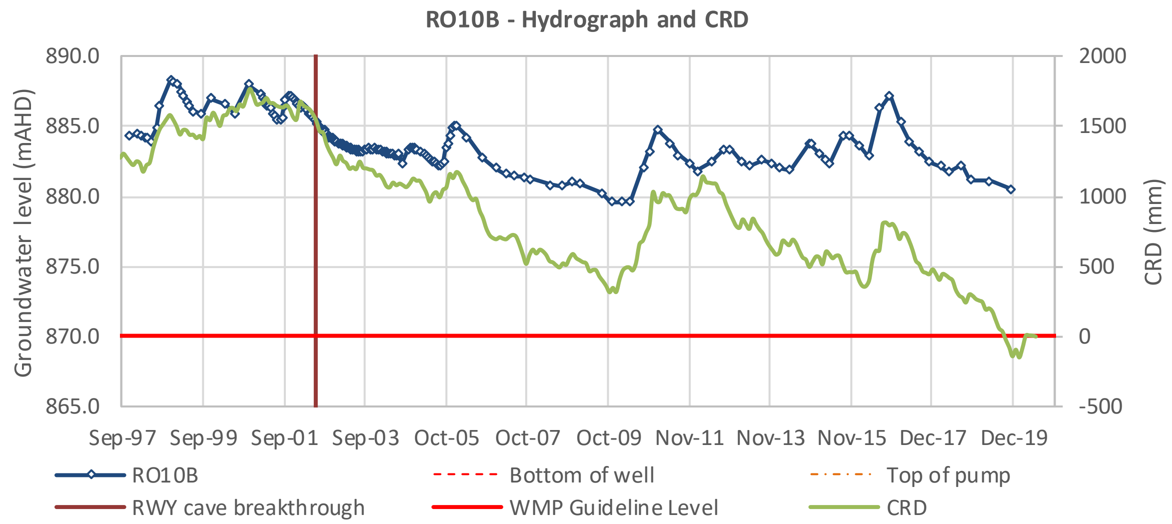


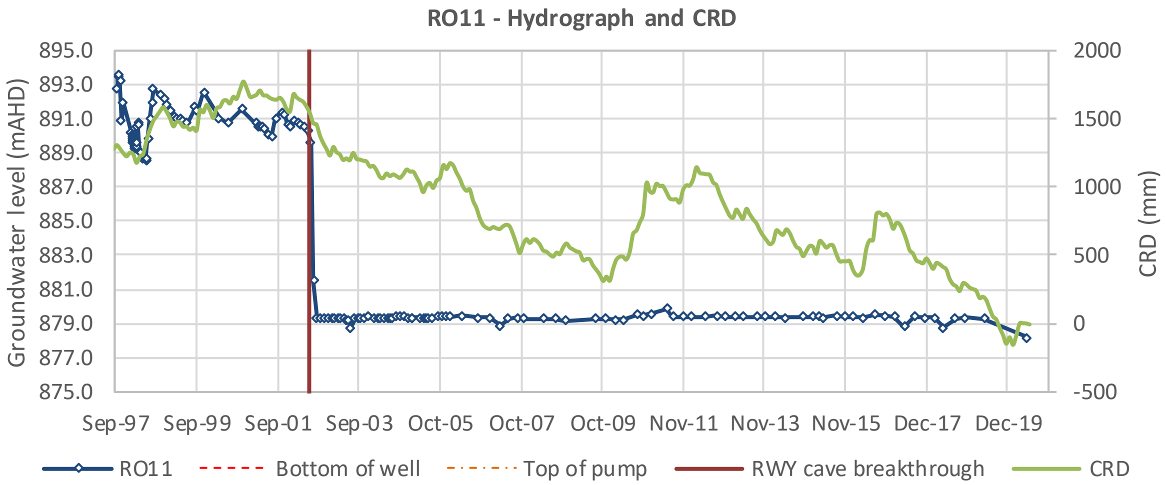


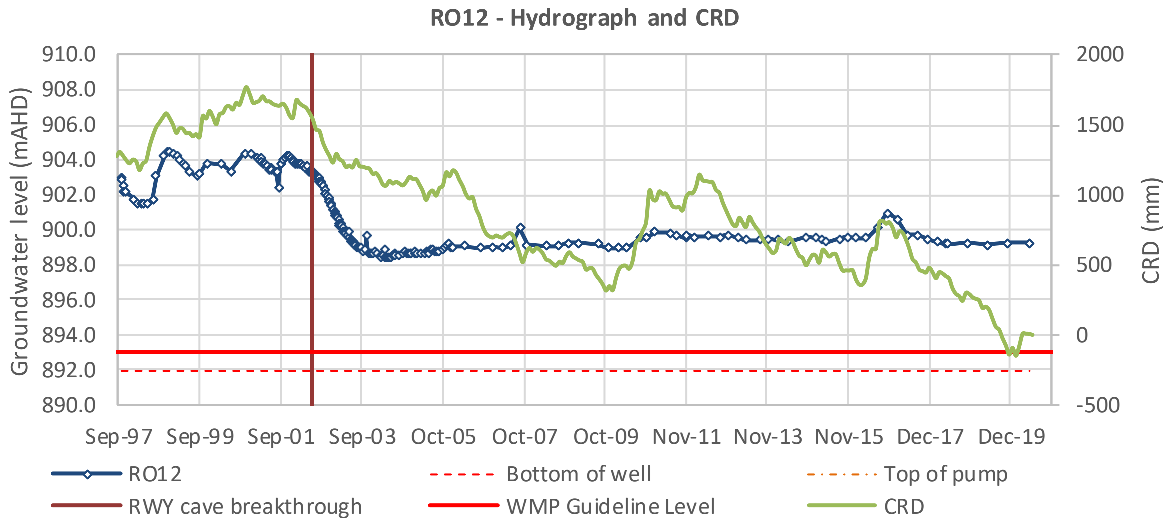


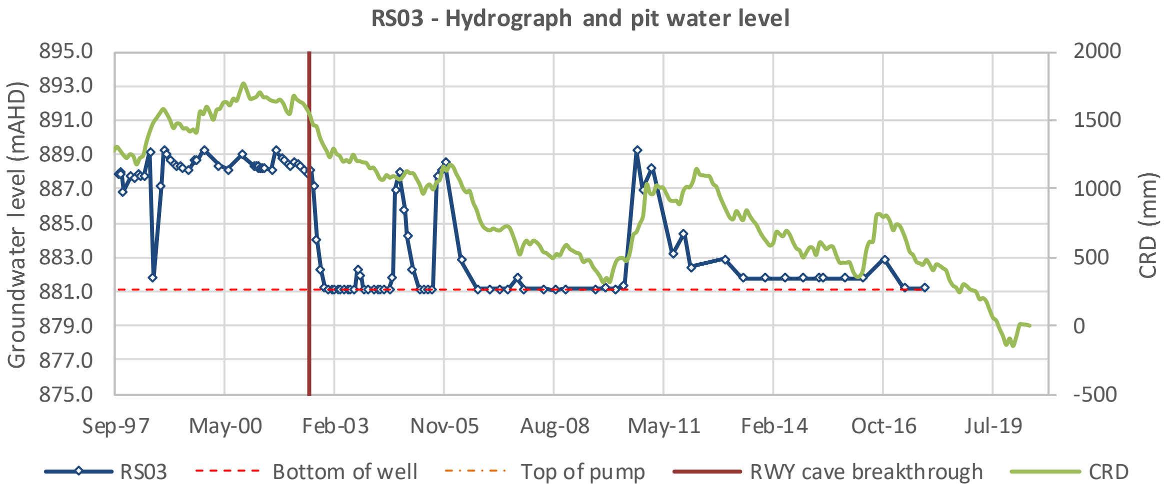


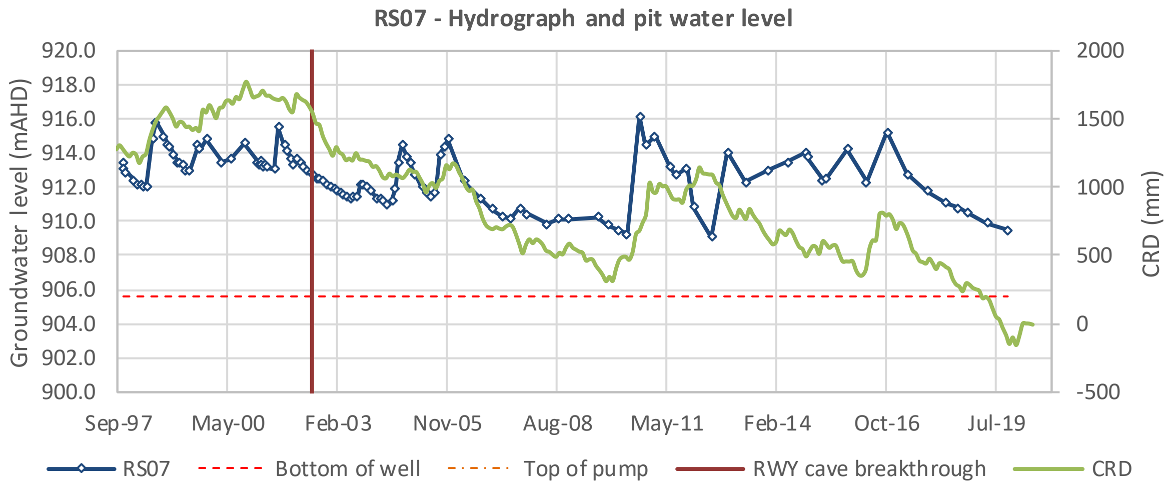


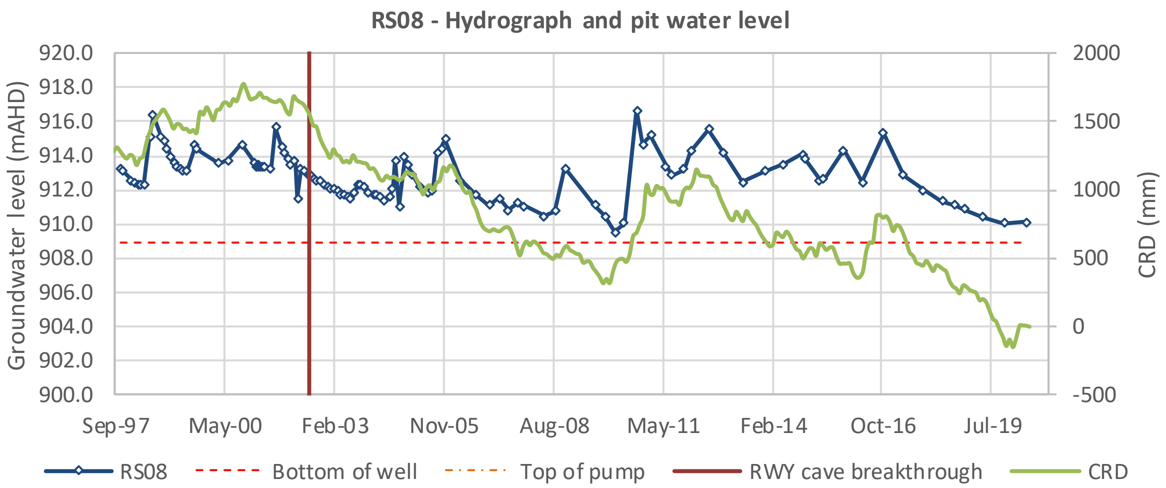


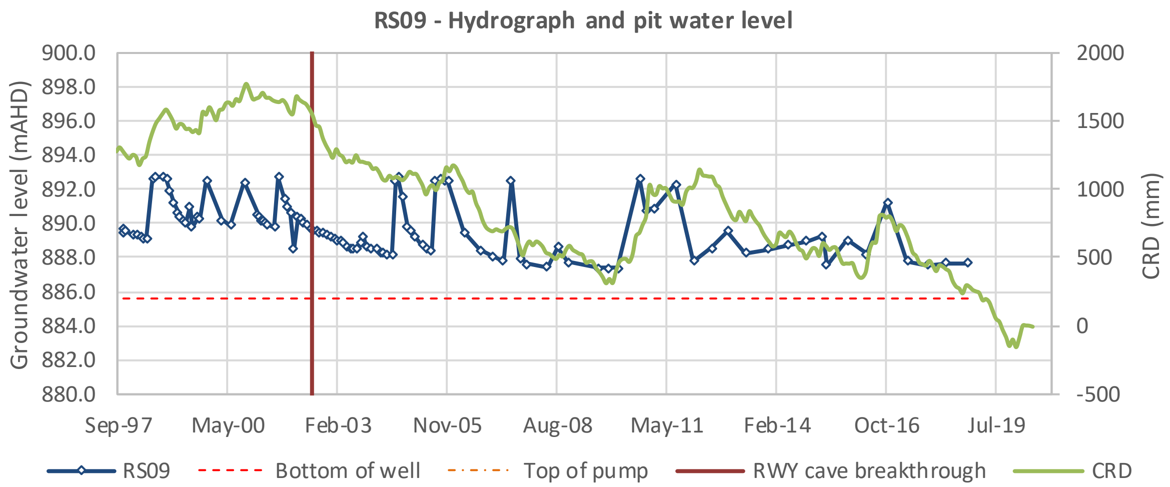

RO11 - Hydrograph and CRD
Groundwater level (mAHD)
895.0
893.0
891.0
889.0
887.0
885.0
883.0
881.0
879.0
877.0
875.0
CRD (mm)
2000
1500
1000
500
0
-500
Sep-97 Sep-99 Sep-01 Sep-03 Oct-05 Oct-07 Oct-09 Nov-11 Nov-13 Nov-15 Dec-17 Dec-19
RO11
Bottom of well
Top of pump
RWY cave breakthrough
CRD

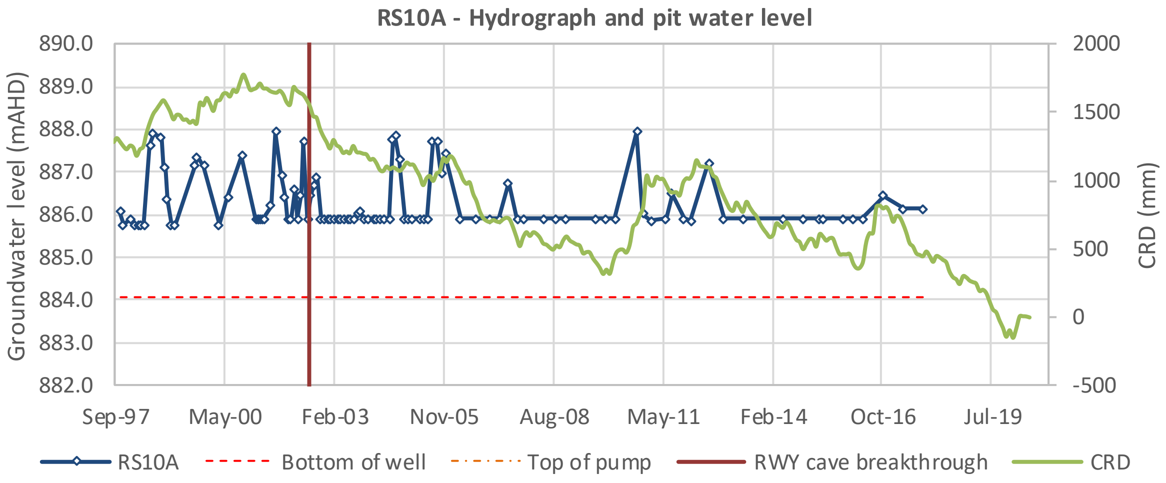

RO12 - Hydrograph and CRD
Groundwater level (mAHD)
910.0
908.0
906.0
904.0
902.0
900.0
898.0
896.0
894.0
892.0
890.0
CRD (mm)
2000
1500
1000
500
0
-500
Sep-97 Sep-99 Sep-01 Sep-03 Oct-05 Oct-07 Oct-09 Nov-11 Nov-13 Nov-15 Dec-17 Dec-19
RO12
Bottom of well
Top of pump
RWY cave breakthrough
WMP Guideline Level
CRD

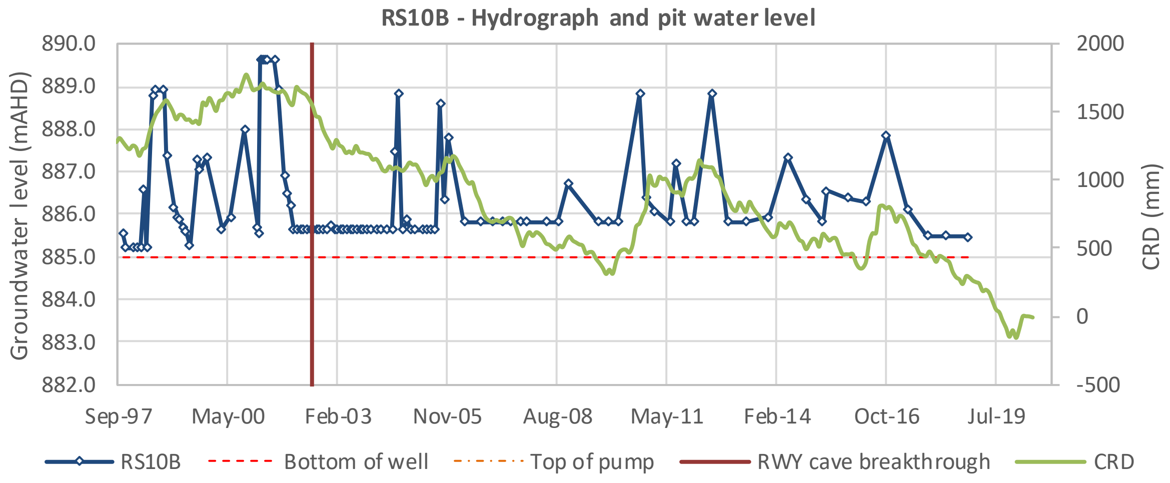

RS03 - Hydrograph and pit water level
Groundwater level (mAHD)
895.0
893.0
891.0
889.0
887.0
885.0
883.0
881.0
879.0
877.0
875.0
CRD (mm)
2000
1500
1000
500
0
-500
Sep-97 May-00 Feb-03 Nov-05 Aug-08 May-11 Feb-14 Oct-16 Jul-19
RS03
Bottom of well
Top of pump
RWY cave breakthrough
CRD


RS07 - Hydrograph and pit water level
Groundwater level (mAHD)
920.0
918.0
916.0
914.0
912.0
910.0
908.0
906.0
904.0
902.0
900.0
CRD (mm)
2000
1500
1000
500
0
-500
Sep-97 May-00 Feb-03 Nov-05 Aug-08 May-11 Feb-14 Oct-16 Jul-19
RS07
Bottom of well
Top of pump
RWY cave breakthrough
CRD

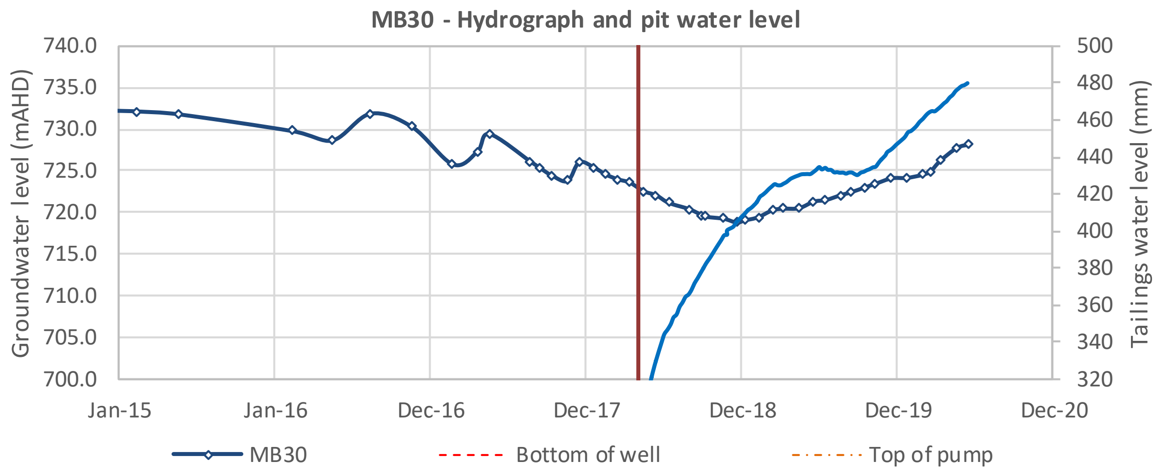

RS08 - Hydrograph and pit water level
Groundwater level (mAHD)
920.0
918.0
916.0
914.0
912.0
910.0
908.0
906.0
904.0
902.0
900.0
CRD (mm)
2000
1500
1000
500
0
-500
Sep-97 May-00 Feb-03 Nov-05 Aug-08 May-11 Feb-14 Oct-16 Jul-19
RS08
Bottom of well
Top of pump
RWY cave breakthrough
CRD

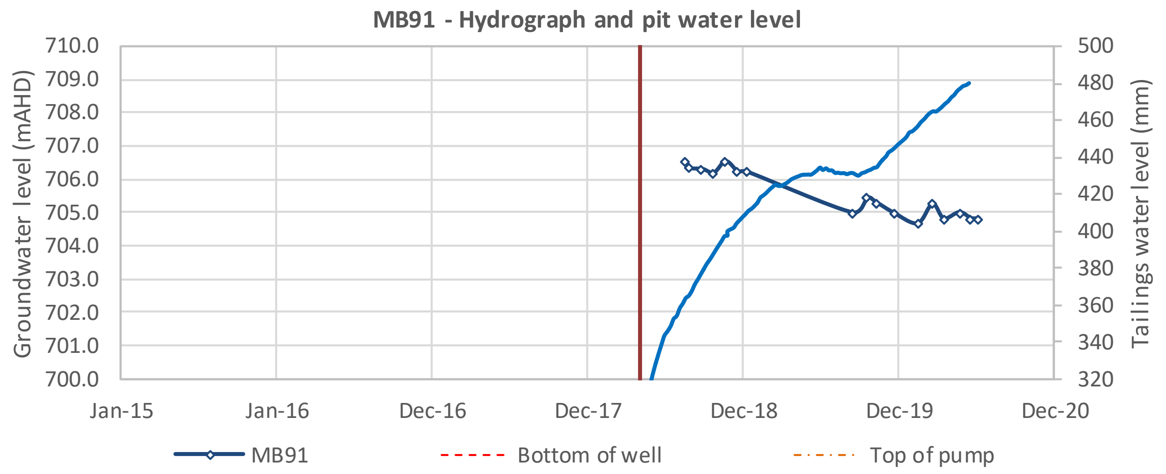

RS09 - Hydrograph and pit water level
Groundwater level (mAHD)
900.0
898.0
896.0
894.0
892.0
890.0
888.0
886.0
884.0
882.0
880.0
CRD (mm)
2000
1500
1000
500
0
-500
Sep-97 May-00 Feb-03 Nov-05 Aug-08 May-11 Feb-14 Oct-16 Jul-19
RS09
Bottom of well
Top of pump
RWY cave breakthrough
CRD

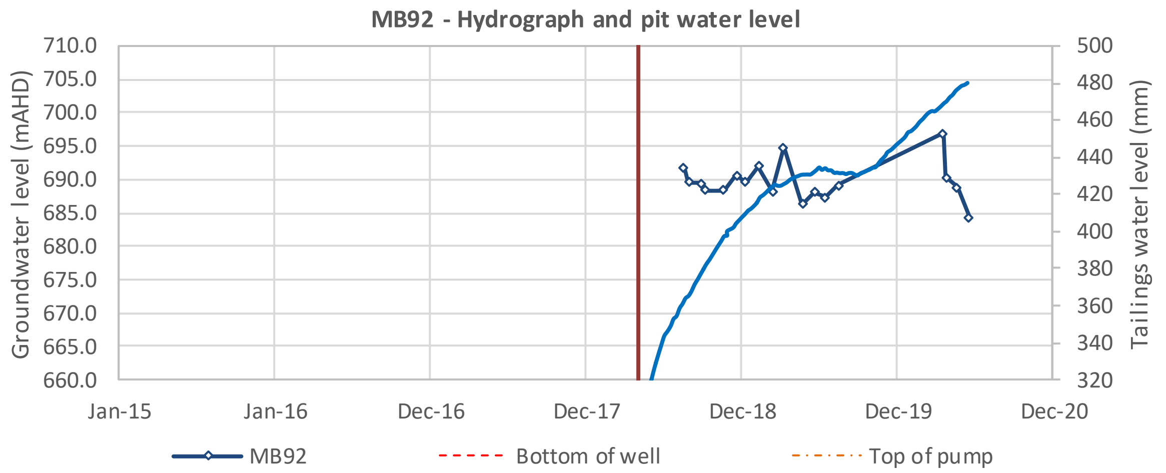

RS10A - Hydrograph and pit water level
Groundwater level (mAHD)
CRD (mm)
890.0
889.0
888.0
887.0
886.0
885.0
884.0
883.0
882.0
2000
1500
1000
500
0
-500
Sep-97
May-00
Feb-03
Nov-05
Aug-08
May-11
Feb-14
Oct-16
Jul-19
RS10A
Bottom of well
Top of pump
RWY cave breakthrough
CRD

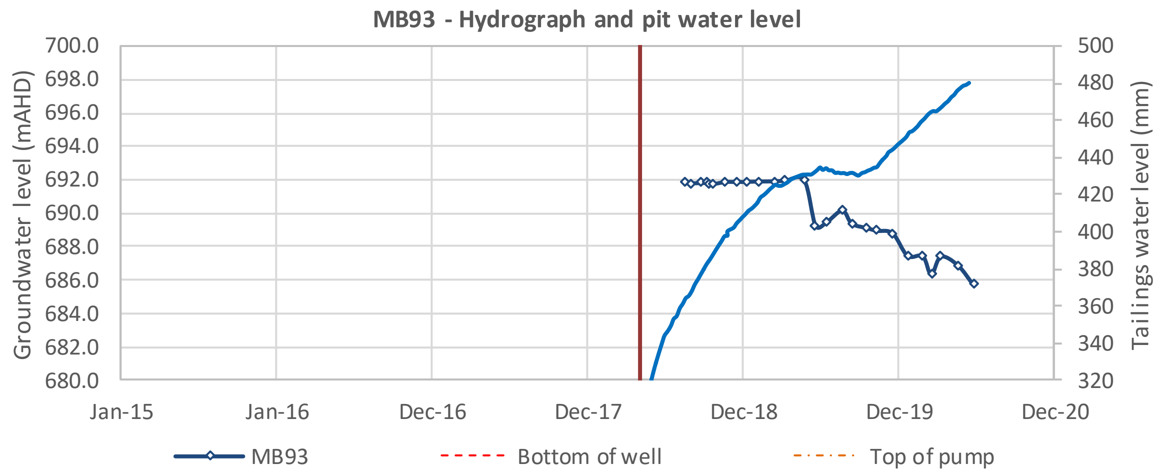

RS10B - Hydrograph and pit water level
Groundwater level (mAHD)
CRD (mm)
890.0
889.0
888.0
887.0
886.0
885.0
884.0
883.0
882.0
2000
1500
1000
500
0
-500
Sep-97
May-00
Feb-03
Nov-05
Aug-08
May-11
Feb-14
Oct-16
Jul-19
RS10B
Bottom of well
Top of pump
RWY cave breakthrough
CRD

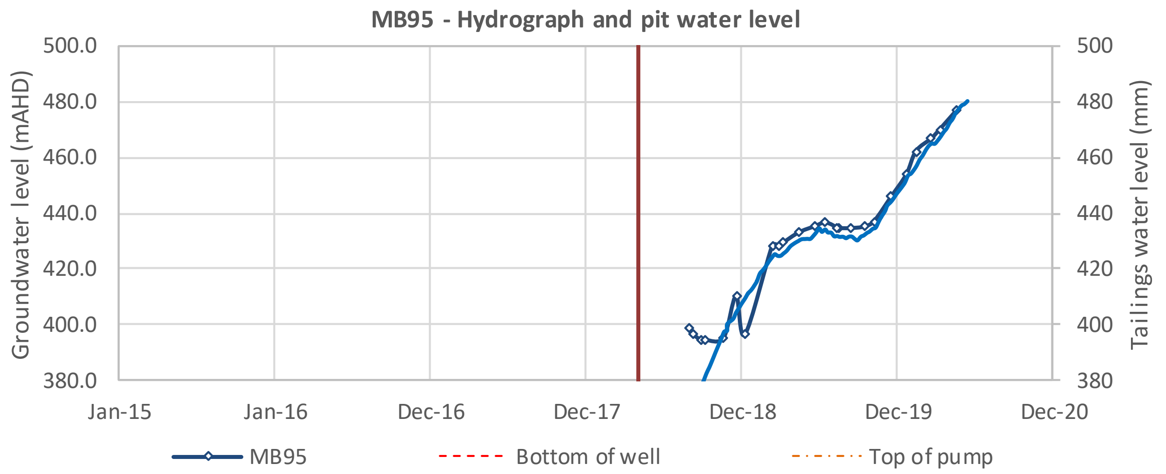
Cadia Hill Pit

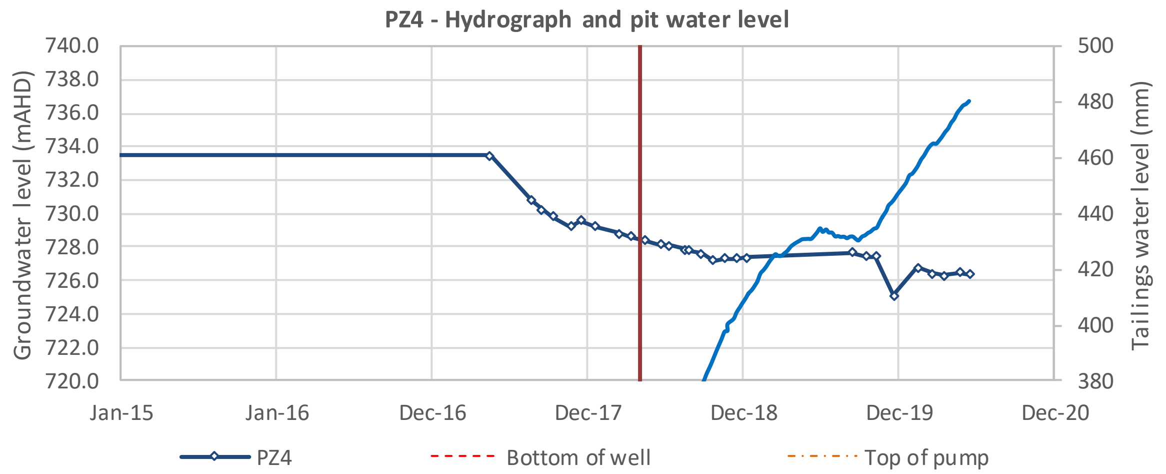


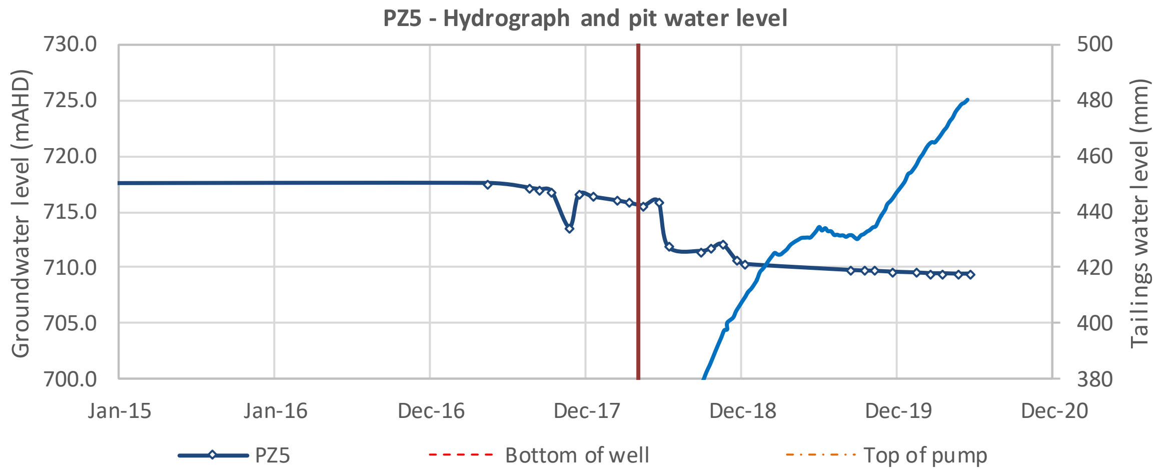


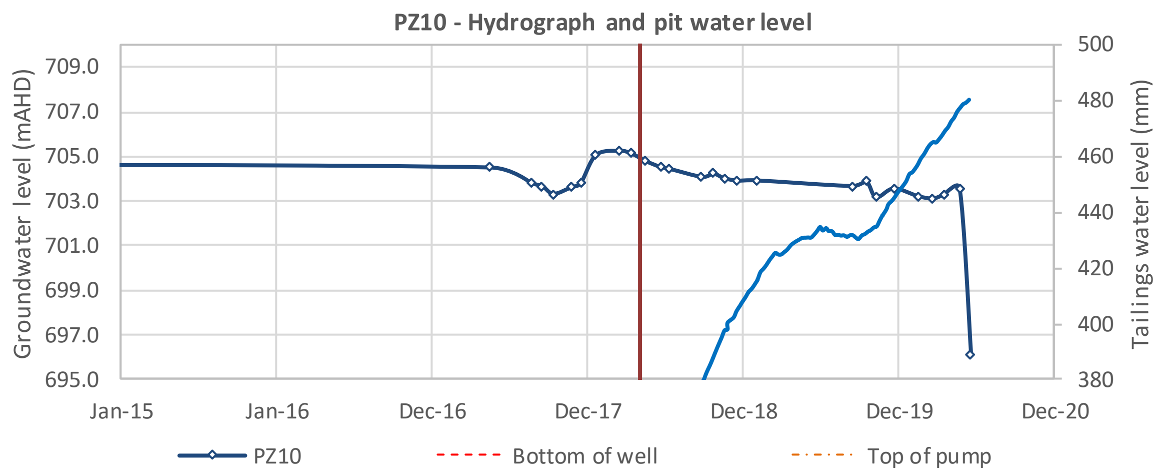


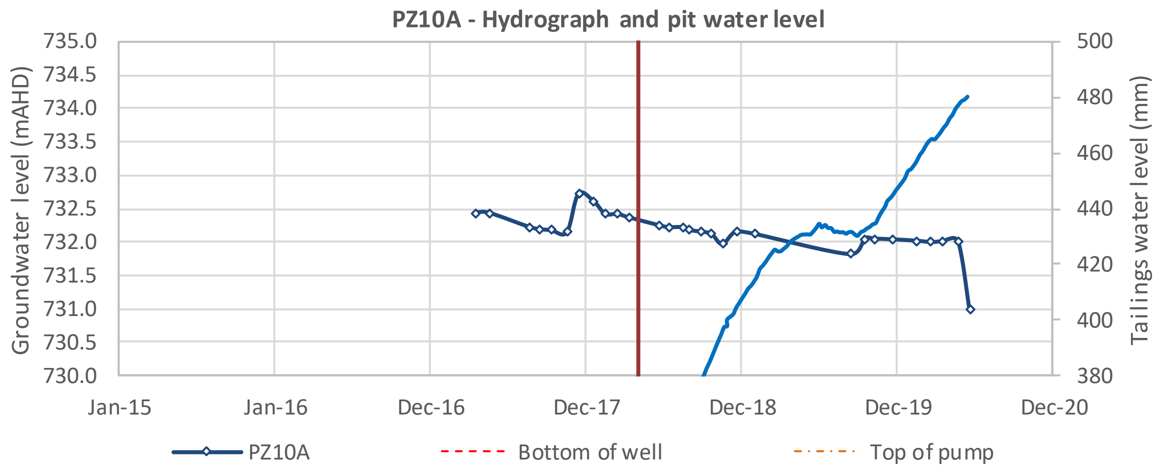


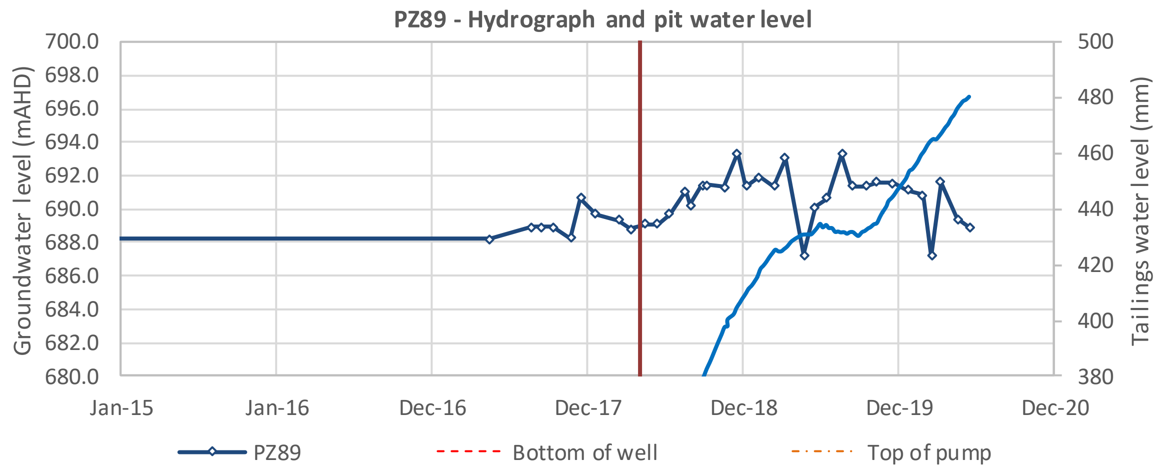


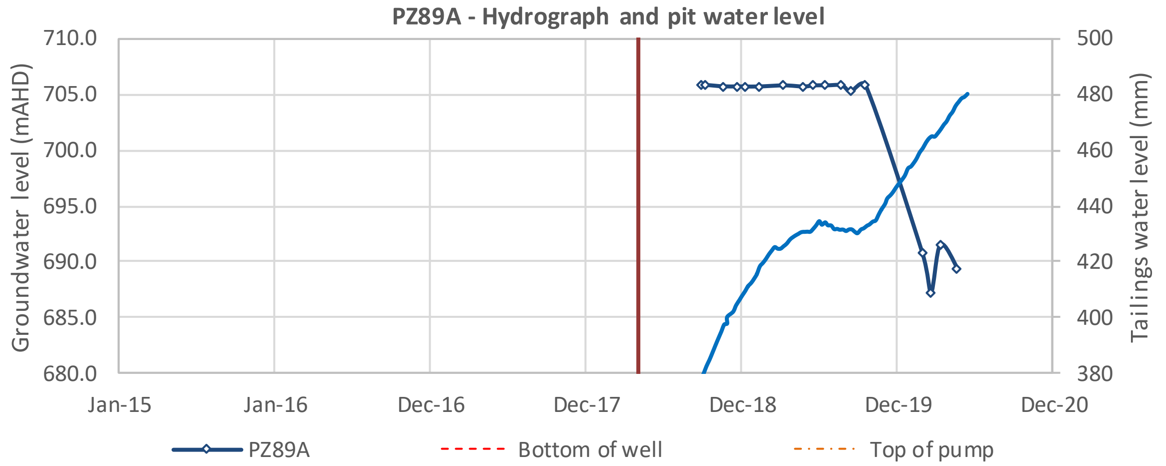


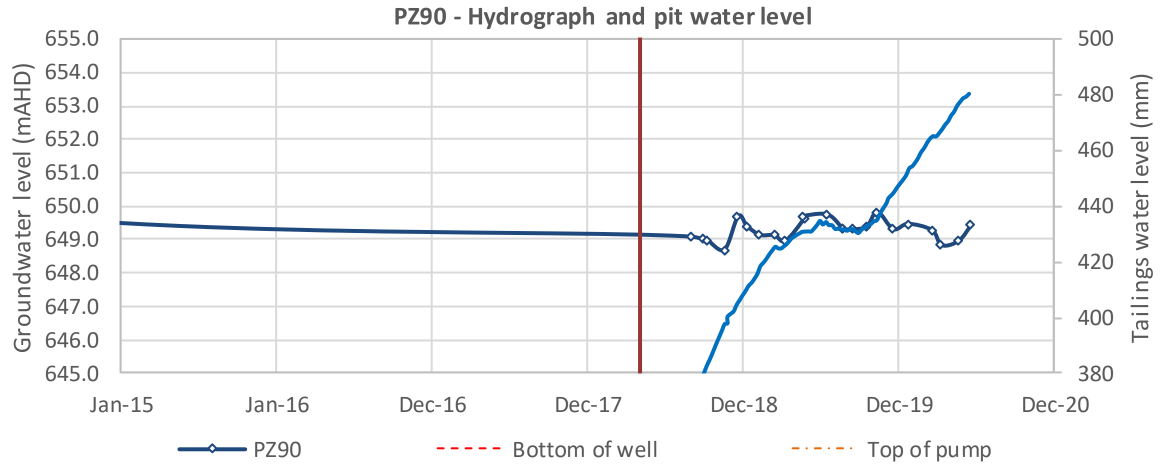

PZ5 - Hydrograph and pit water level
Groundwater level (mAHD)
730.0
725.0
720.0
715.0
710.0
705.0
700.0
Tailings water level (mm)
500
480
460
440
420
400
380
Jan-15
Jan-16
Dec-16
Dec-17
Dec-18
Dec-19
Dec-20
PZ5
Bottom of well
Top of pump

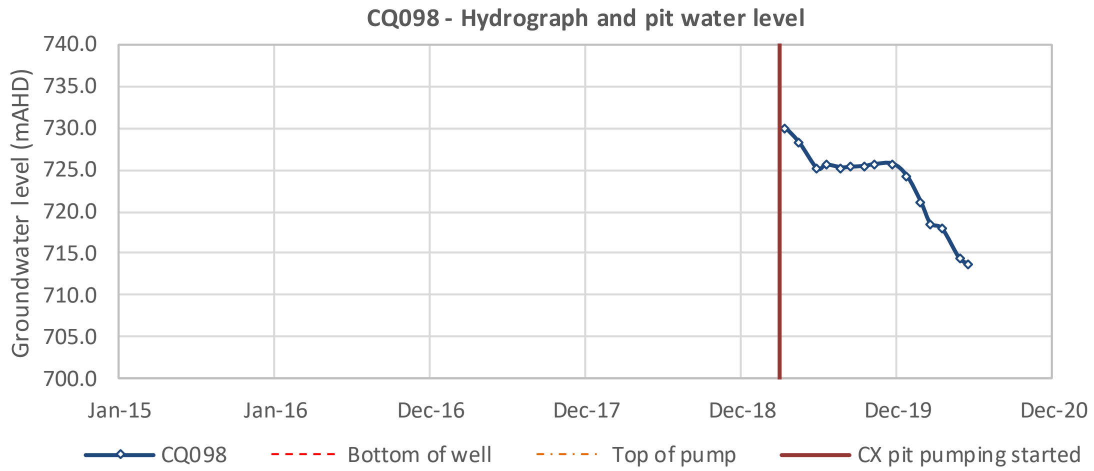

PZ10 - Hydrograph and pit water level
Groundwater level (mAHD)
709.0
707.0
705.0
703.0
701.0
699.0
697.0
695.0
Tailings water level (mm)
500
480
460
440
420
400
380
Jan-15
Jan-16
Dec-16
Dec-17
Dec-18
Dec-19
Dec-20
PZ10
Bottom of well
Top of pump


PZ10A - Hydrograph and pit water level
Groundwater level (mAHD)
735.0
734.5
734.0
733.5
733.0
732.5
732.0
731.5
731.0
730.5
730.0
Tailings water level (mm)
500
480
460
440
420
400
380
Jan-15
Jan-16
Dec-16
Dec-17
Dec-18
Dec-19
Dec-20
PZ10A
Bottom of well
Top of pump

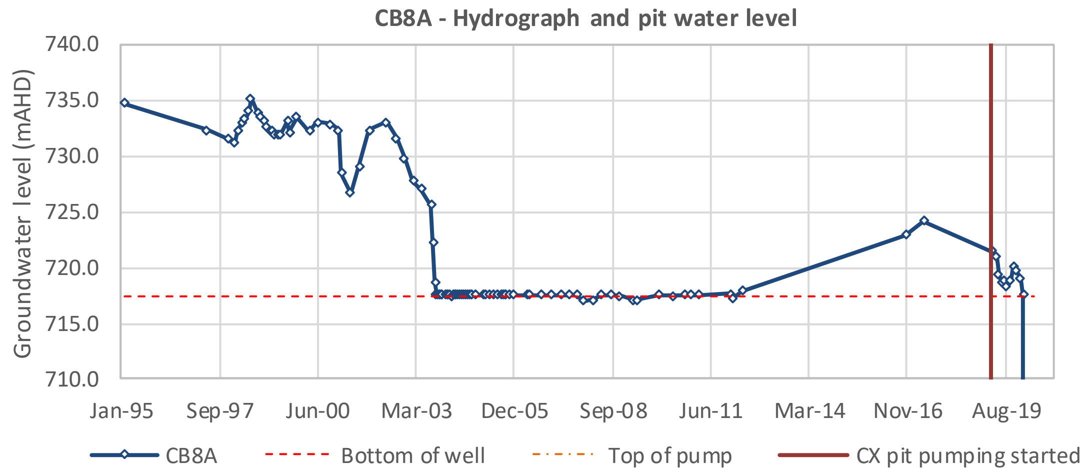

PZ89 - Hydrograph and pit water level
Groundwater level (mAHD)
700.0
698.0
696.0
694.0
692.0
690.0
688.0
686.0
684.0
682.0
680.0
Tailings water level (mm)
500
480
460
440
420
400
380
Jan-15
Jan-16
Dec-16
Dec-17
Dec-18
Dec-19
Dec-20
PZ89
Bottom of well
Top of pump


PZ89A - Hydrograph and pit water level
Groundwater level (mAHD)
710.0
705.0
700.0
695.0
690.0
685.0
680.0
Tailings water level (mm)
500
480
460
440
420
400
380
Jan-15
Jan-16
Dec-16
Dec-17
Dec-18
Dec-19
Dec-20
PZ89A
Bottom of well
Top of pump

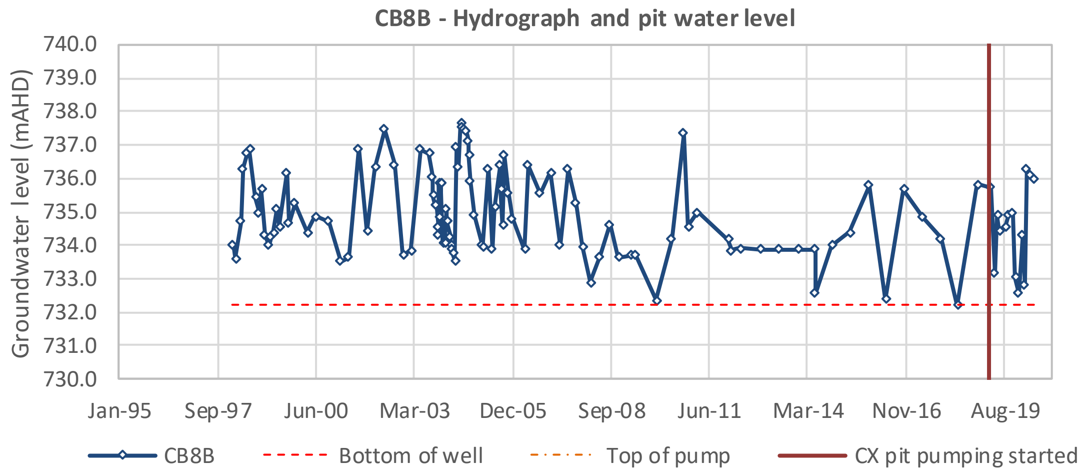

PZ90 - Hydrograph and pit water level
Groundwater level (mAHD)
655.0
654.0
653.0
652.0
651.0
650.0
649.0
648.0
647.0
646.0
645.0
Tailings water level (mm)
500
480
460
440
420
400
380
Jan-15
Jan-16
Dec-16
Dec-17
Dec-18
Dec-19
Dec-20
PZ90
Bottom of well
Top of pump



CQ098 - Hydrograph and pit water level
Groundwater level (mAHD)
740.0
735.0
730.0
725.0
720.0
715.0
710.0
705.0
700.0
Jan-15
Jan-16
Dec-16
Dec-17
Dec-18
Dec-19
Dec-20
CQ098
Bottom of well
Top of pump
CX pit pumping started

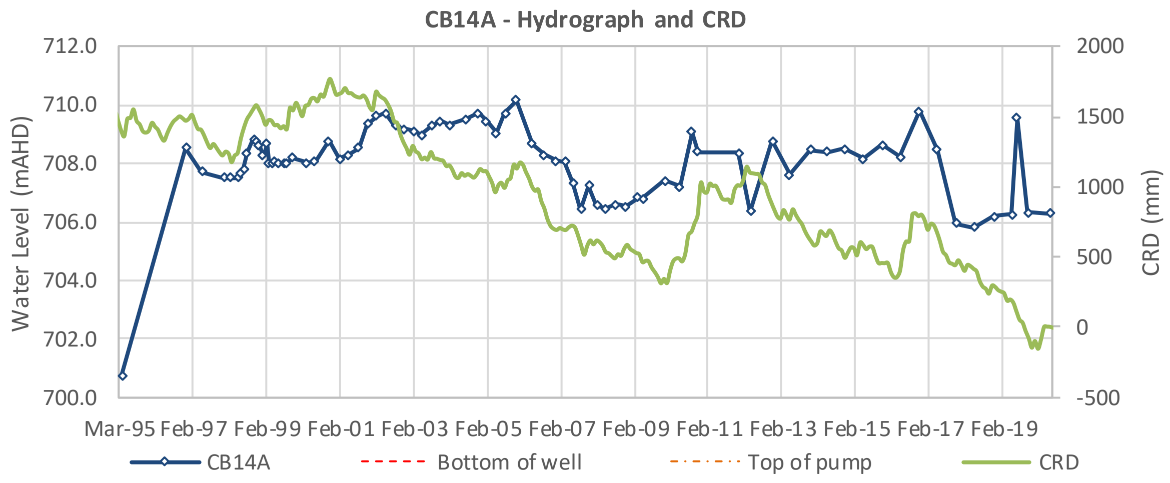


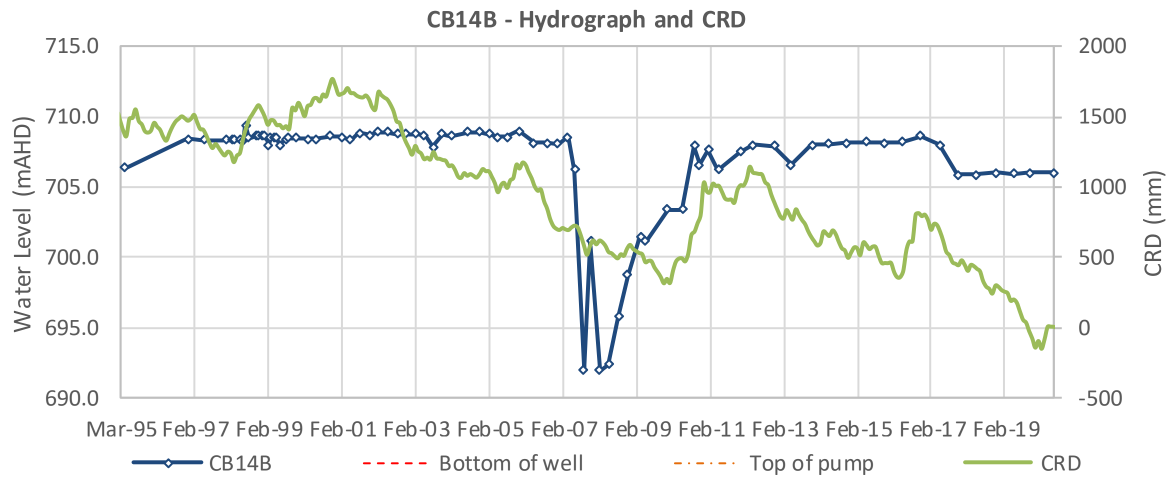
CB8A - Hydrograph and pit water level
Groundwater level (mAHD)
740.0
735.0
730.0
725.0
720.0
715.0
710.0
Jan-95
Sep-97
Jun-00
Mar-03
Dec-05
Sep-08
Jun-11
Mar-14
Nov-16
Aug-19
CB8A
Bottom of well
Top of pump
CX pit pumping started

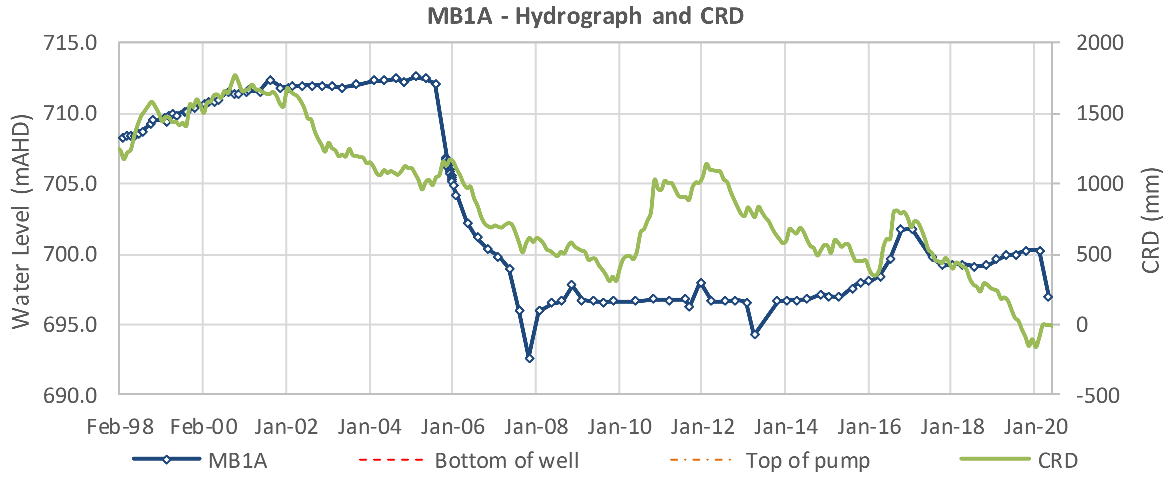


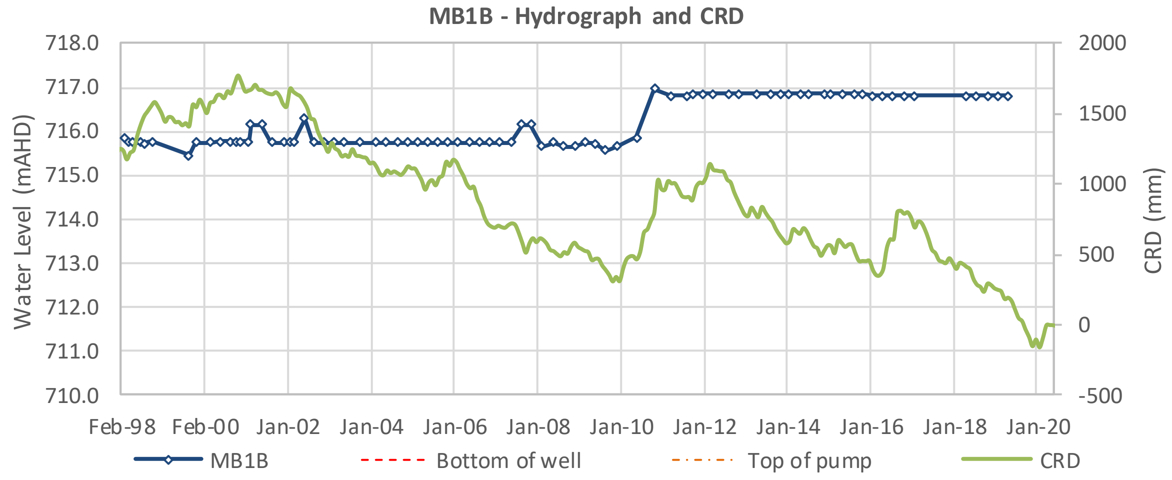
CB8B - Hydrograph and pit water level
Groundwater level (mAHD)
740.0
739.0
738.0
737.0
736.0
735.0
734.0
733.0
732.0
731.0
730.0
Jan-95
Sep-97
Jun-00
Mar-03
Dec-05
Sep-08
Jun-11
Mar-14
Nov-16
Aug-19
CB8B
Bottom of well
Top of pump
CX pit pumping started

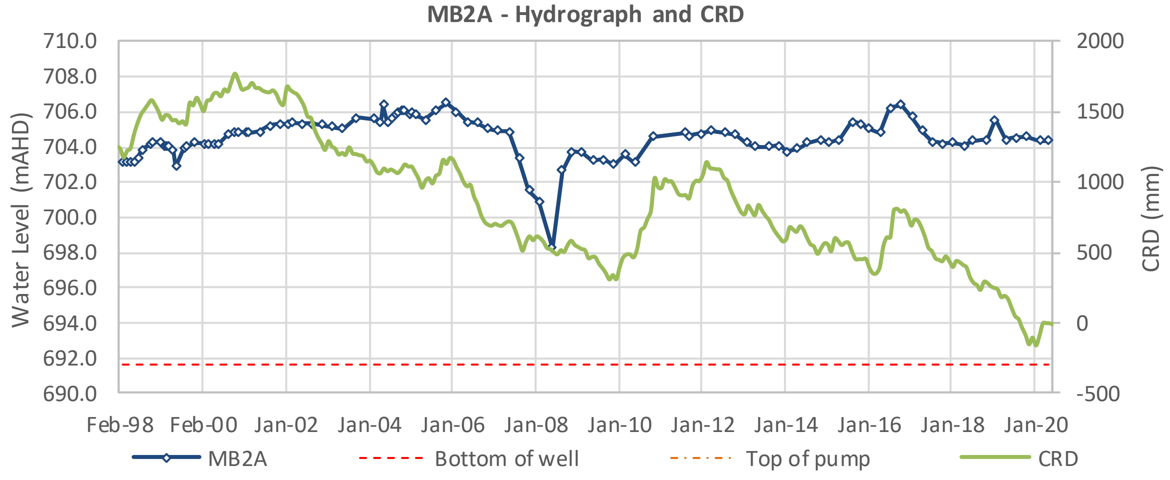
Ore processing area

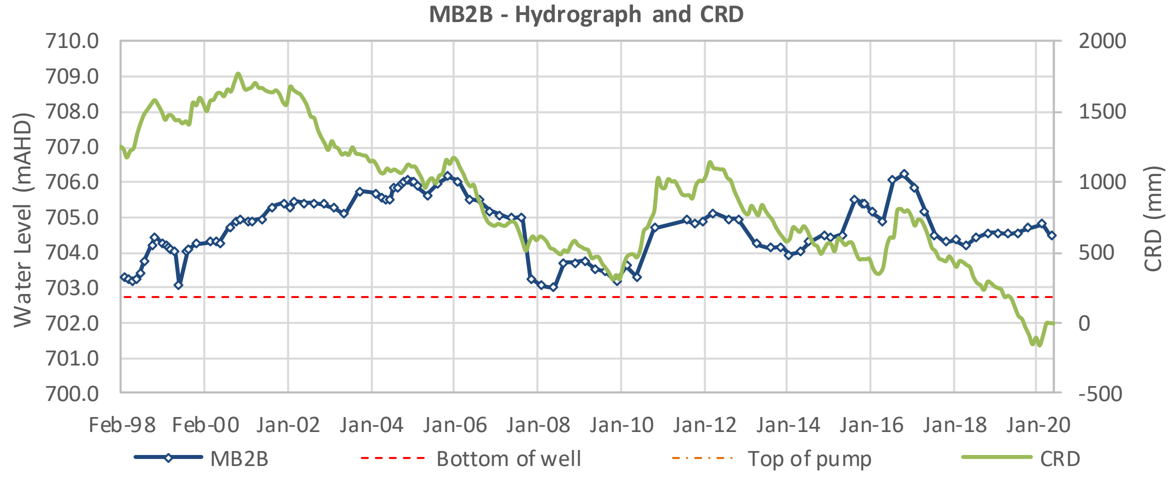


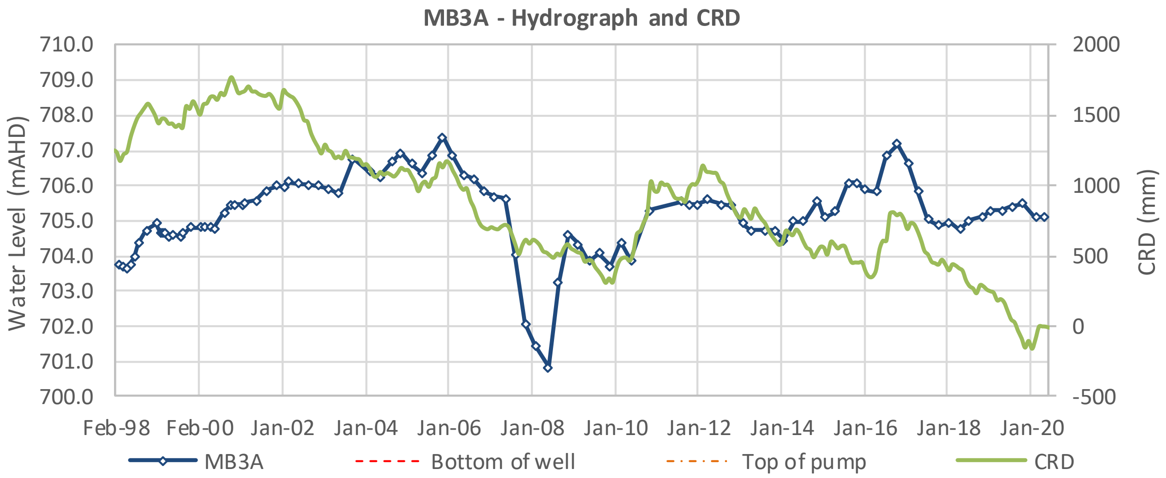


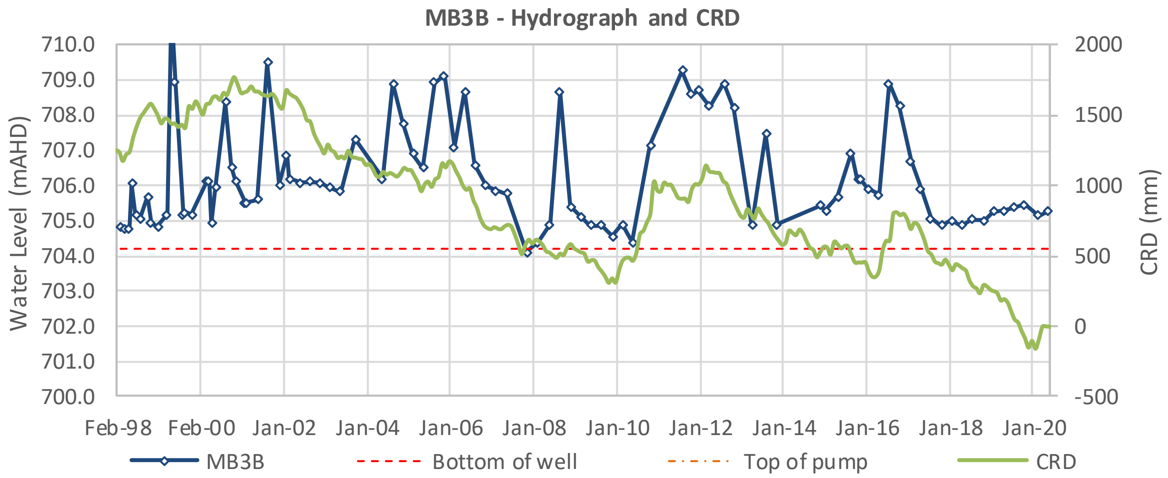




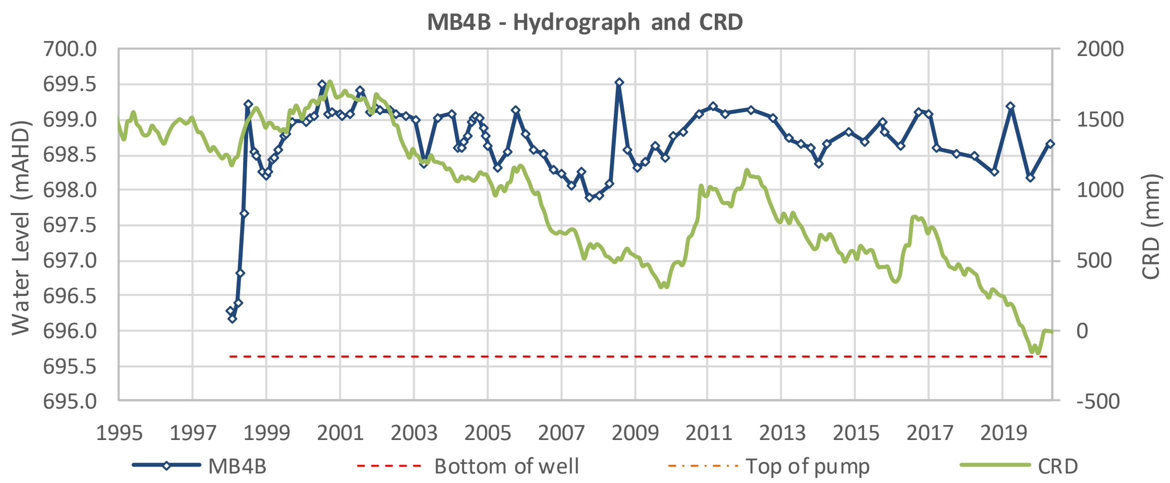


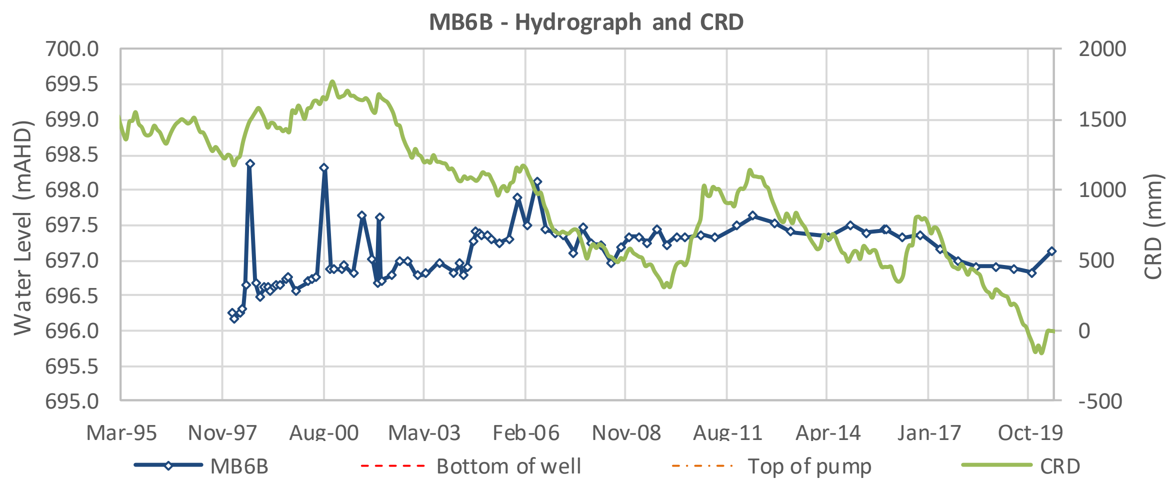


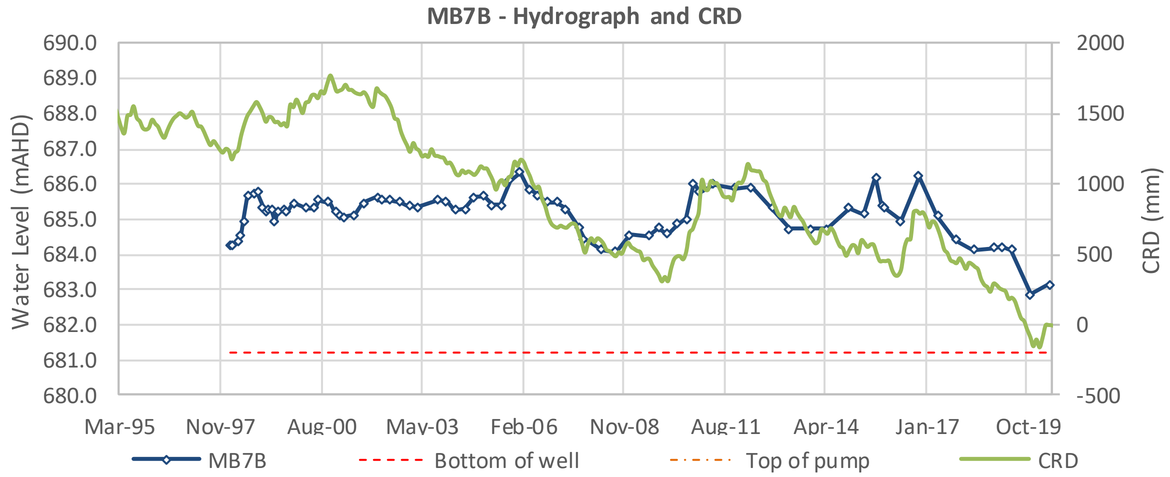

MB3A - Hydrograph and CRD
Water Level (mAHD)
CRD (mm)
710.0
709.0
708.0
707.0
706.0
705.0
704.0
703.0
702.0
701.0
700.0
2000
1500
1000
500
0
-500
Feb-98
Feb-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Jan-16
Jan-18
Jan-20
MB3A
Bottom of well
Top of pump
CRD

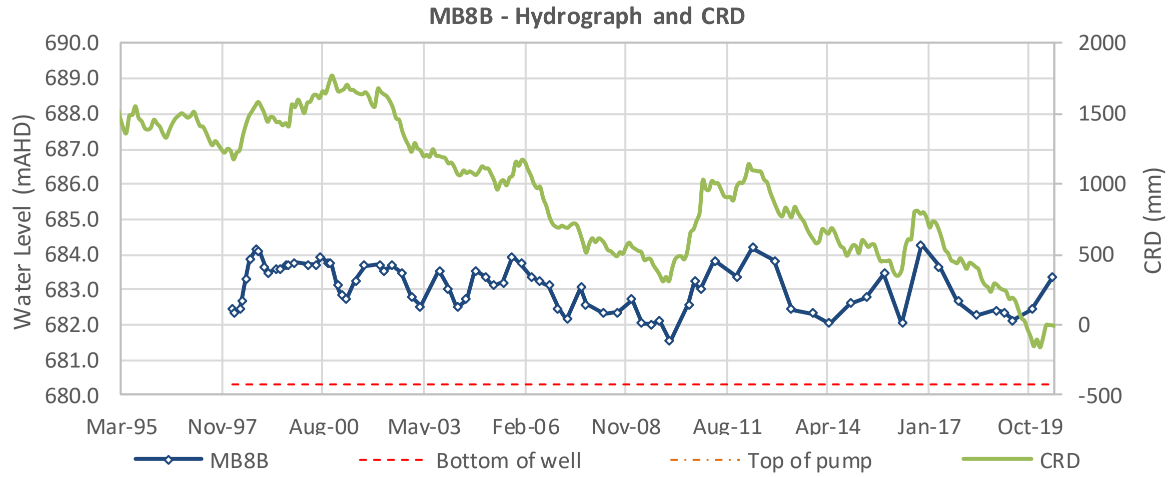

MB3B - Hydrograph and CRD
Water Level (mAHD)
CRD (mm)
710.0
709.0
708.0
707.0
706.0
705.0
704.0
703.0
702.0
701.0
700.0
2000
1500
1000
500
0
-500
Feb-98
Feb-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Jan-16
Jan-18
Jan-20
MB3B
Bottom of well
Top of pump
CRD

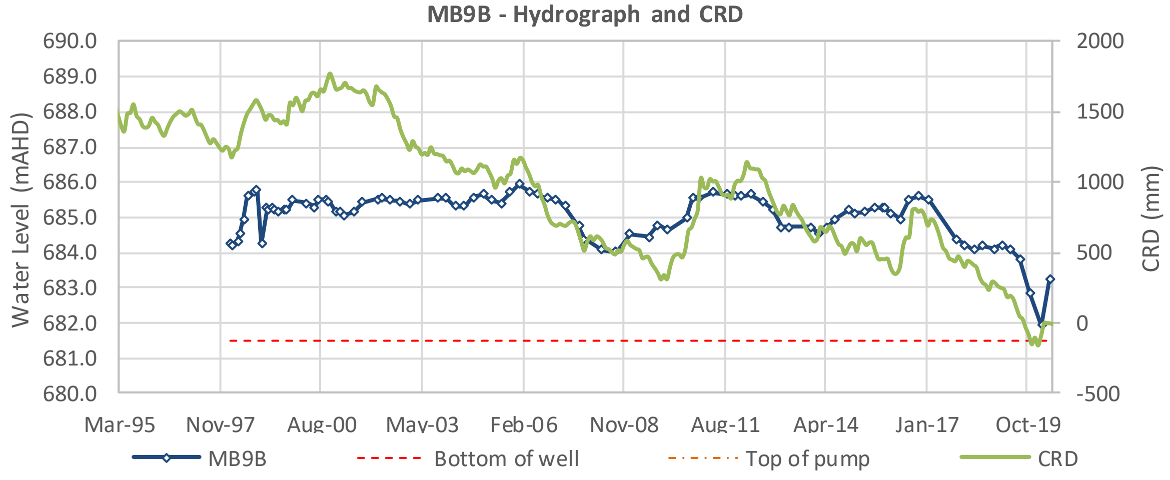
Waste rock dumps

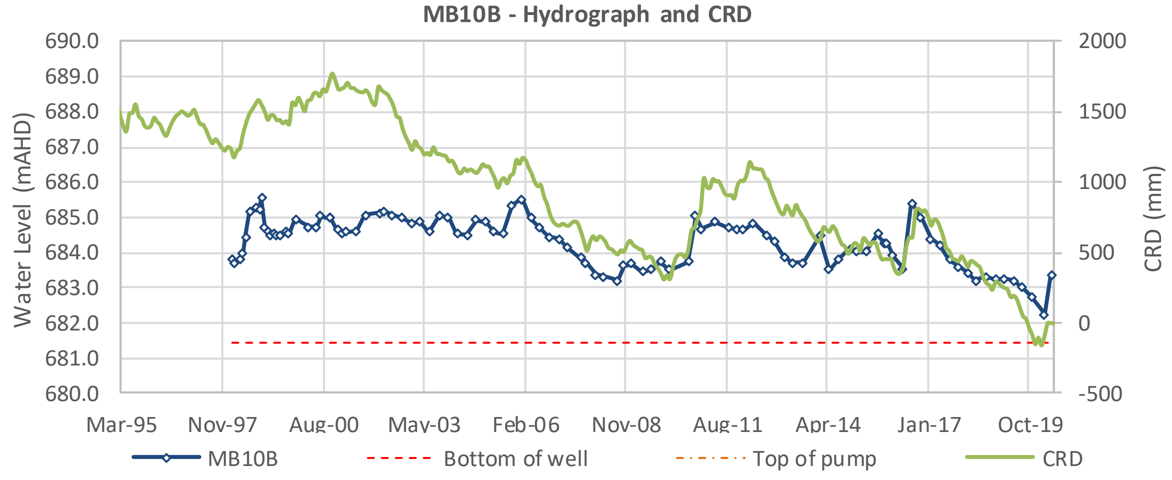


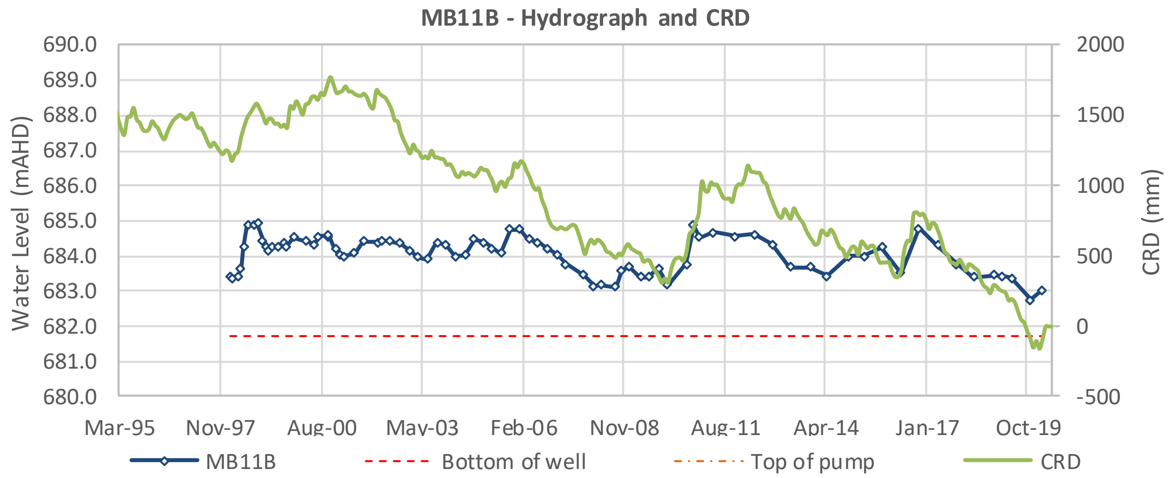


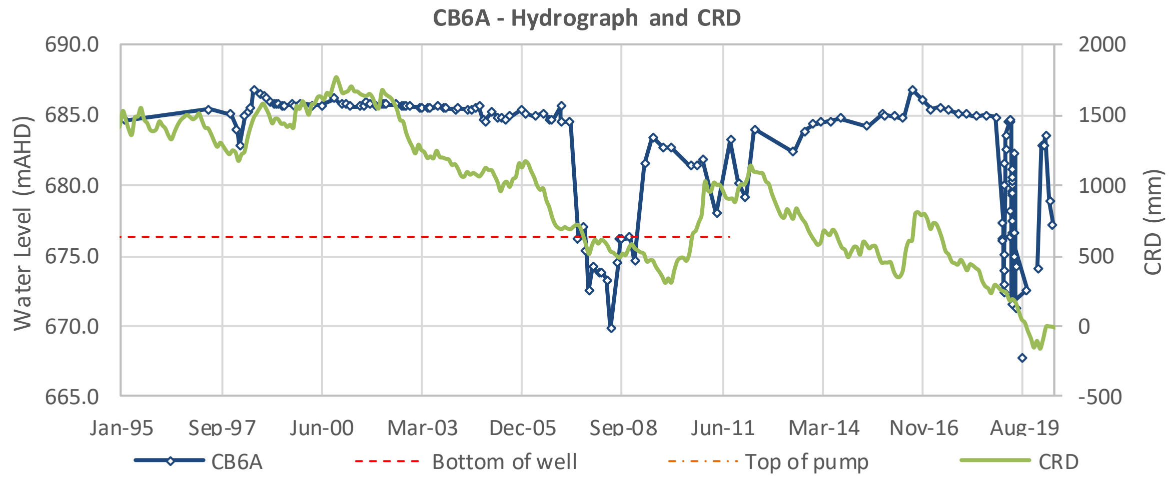


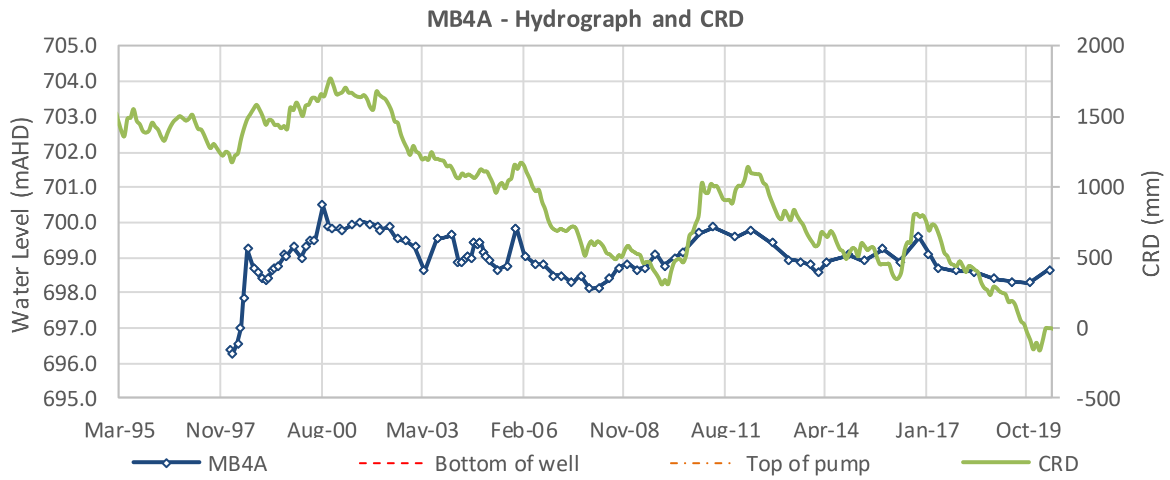


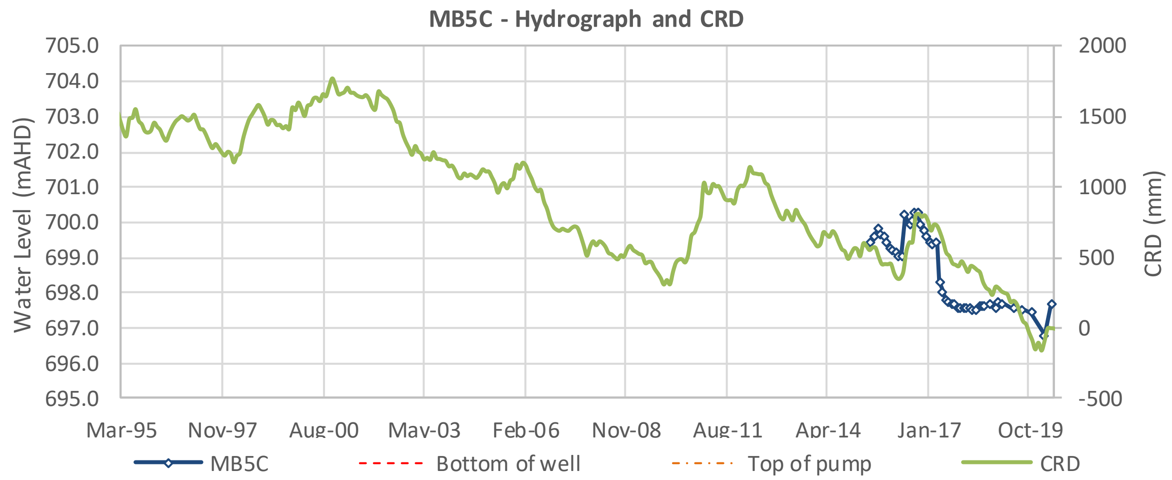


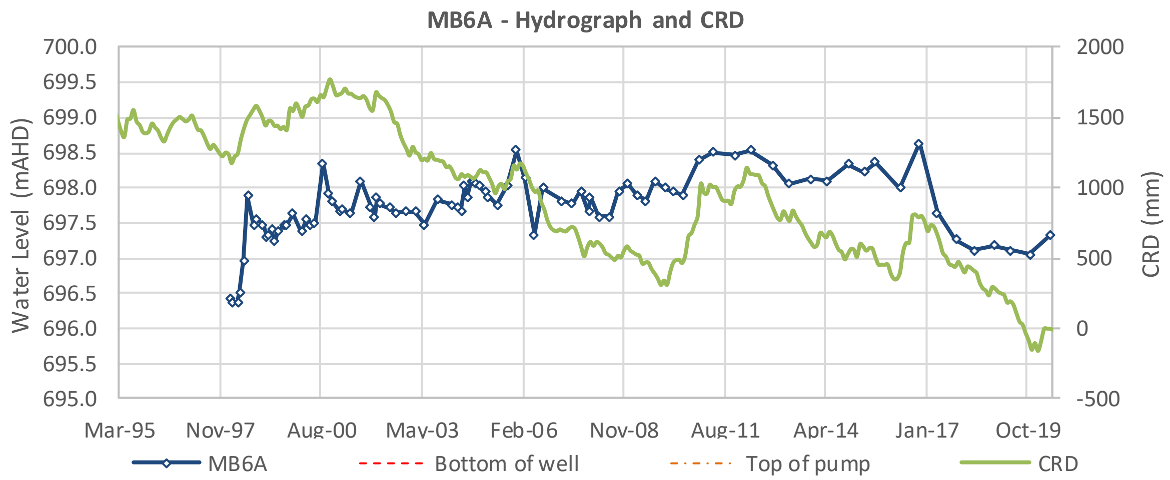


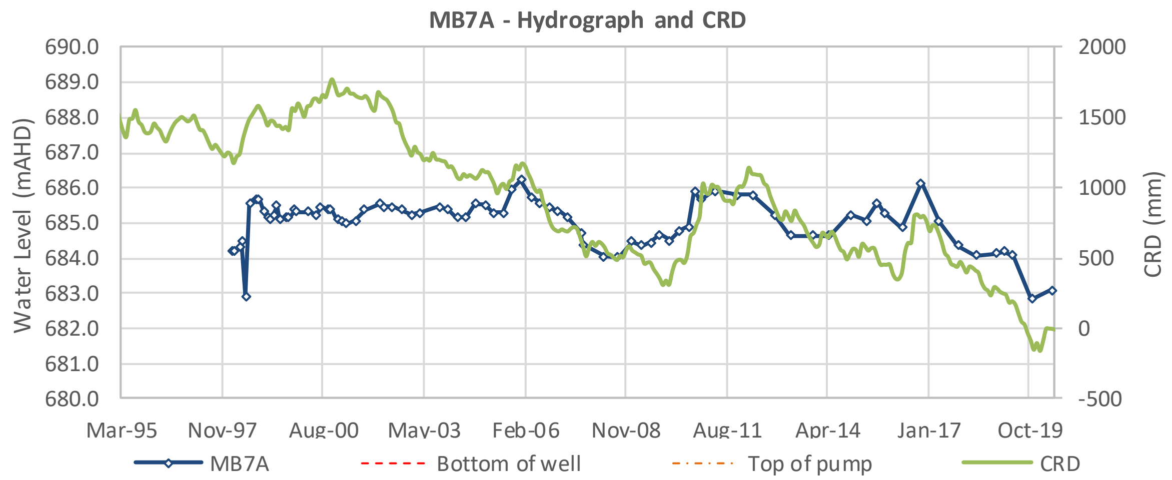

MB11B - Hydrograph and CRD
Water Level (mAHD)
CRD (mm)
MB11B
Bottom of well
Top of pump
CRD

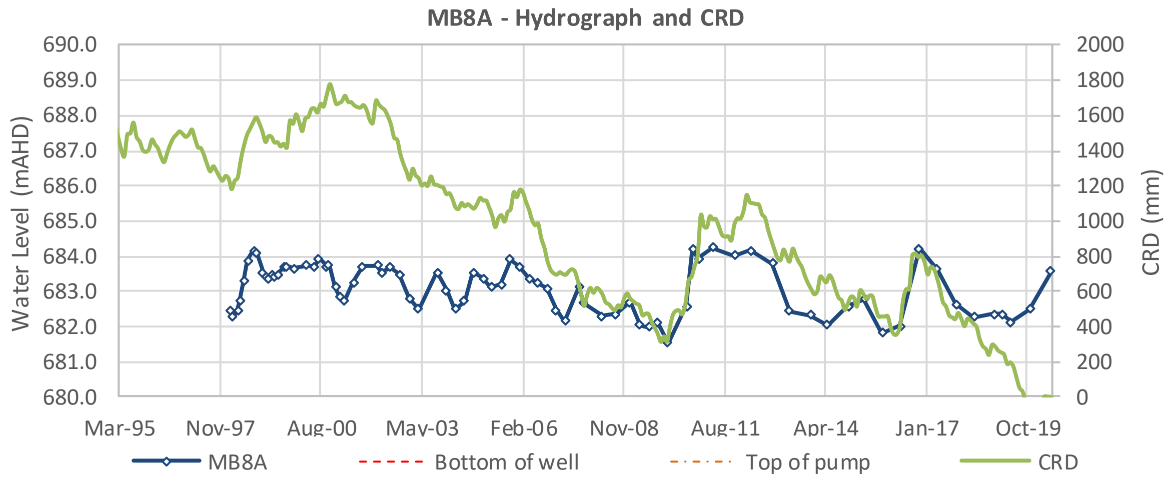

CB6A - Hydrograph and CRD
Water Level (mAHD)
CRD (mm)
CB6A
Bottom of well
Top of pump
CRD

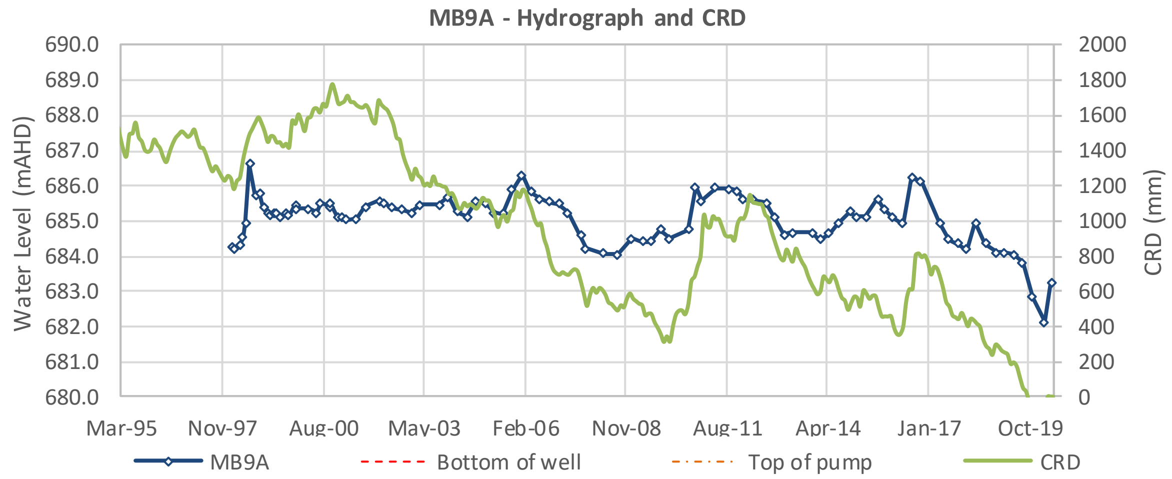

MB4A - Hydrograph and CRD
Water Level (mAHD)
CRD (mm)
MB4A
Bottom of well
Top of pump
CRD

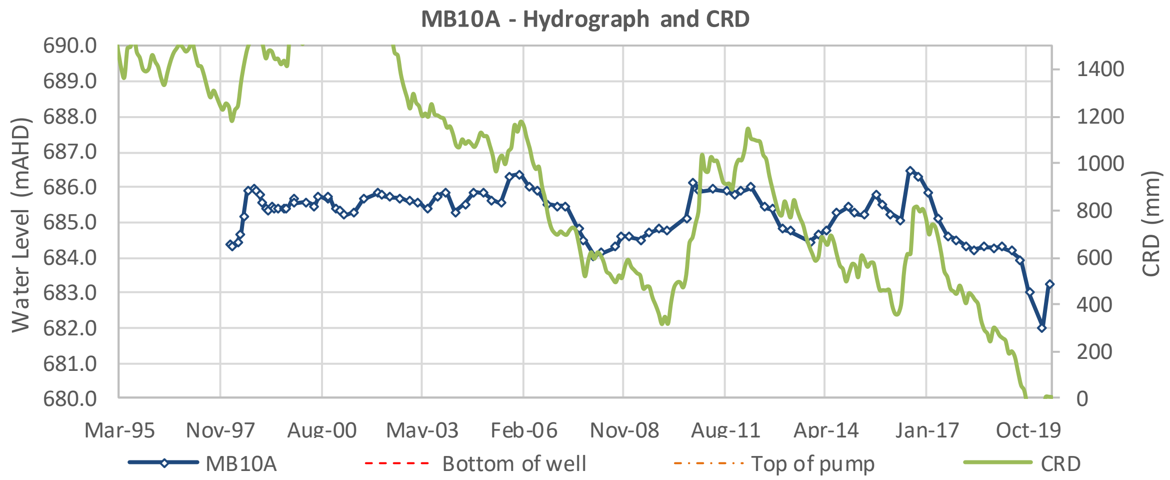

MB5C - Hydrograph and CRD
Water Level (mAHD)
CRD (mm)
MB5C
Bottom of well
Top of pump
CRD

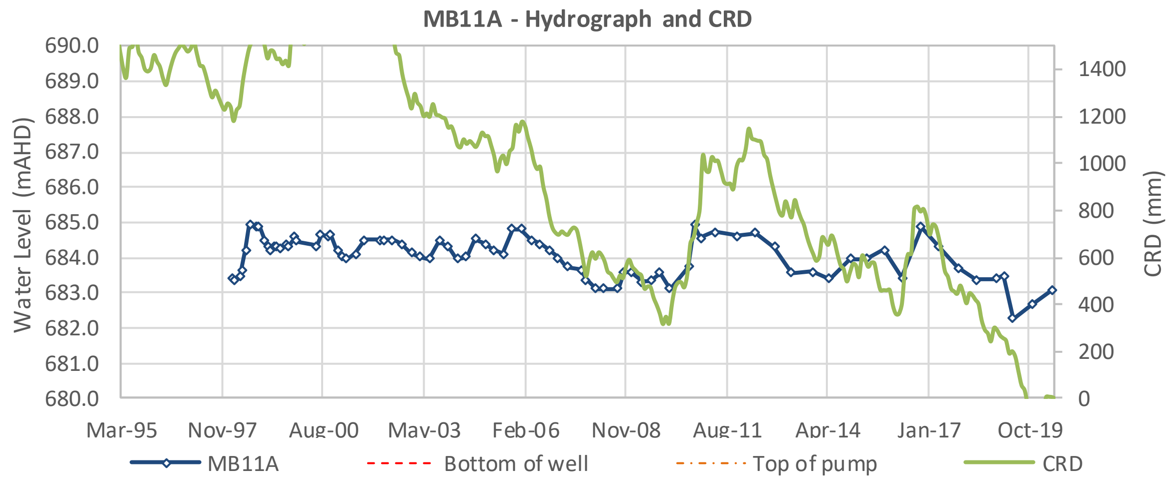

MB6A - Hydrograph and CRD
Water Level (mAHD)
CRD (mm)
MB6A
Bottom of well
Top of pump
CRD


MB7A - Hydrograph and CRD
Water Level (mAHD)
CRD (mm)
MB7A
Bottom of well
Top of pump
CRD

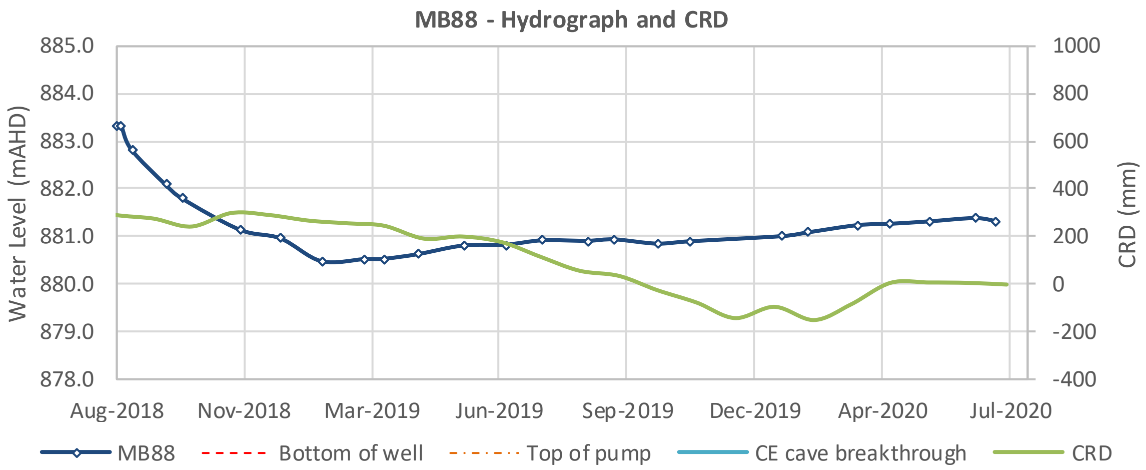

MB8A - Hydrograph and CRD
Water Level (mAHD)
CRD (mm)
690.0
689.0
688.0
687.0
686.0
685.0
684.0
683.0
682.0
681.0
680.0
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Mar-95
Nov-97
Aug-00
May-03
Feb-06
Nov-08
Aug-11
Apr-14
Jan-17
Oct-19
MB8A
Bottom of well
Top of pump
CRD

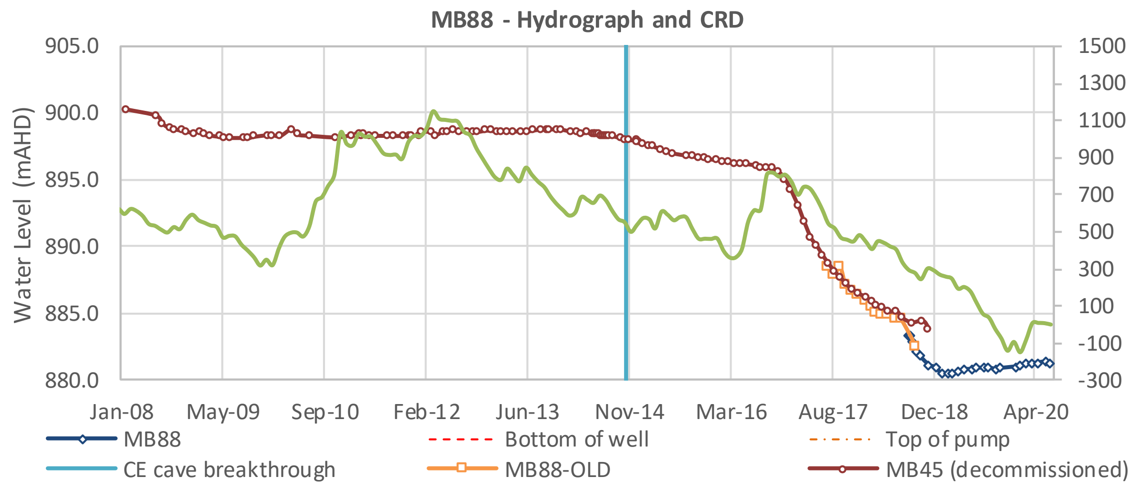

MB9A - Hydrograph and CRD
Water Level (mAHD)
CRD (mm)
690.0
689.0
688.0
687.0
686.0
685.0
684.0
683.0
682.0
681.0
680.0
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Mar-95
Nov-97
Aug-00
May-03
Feb-06
Nov-08
Aug-11
Apr-14
Jan-17
Oct-19
MB9A
Bottom of well
Top of pump
CRD

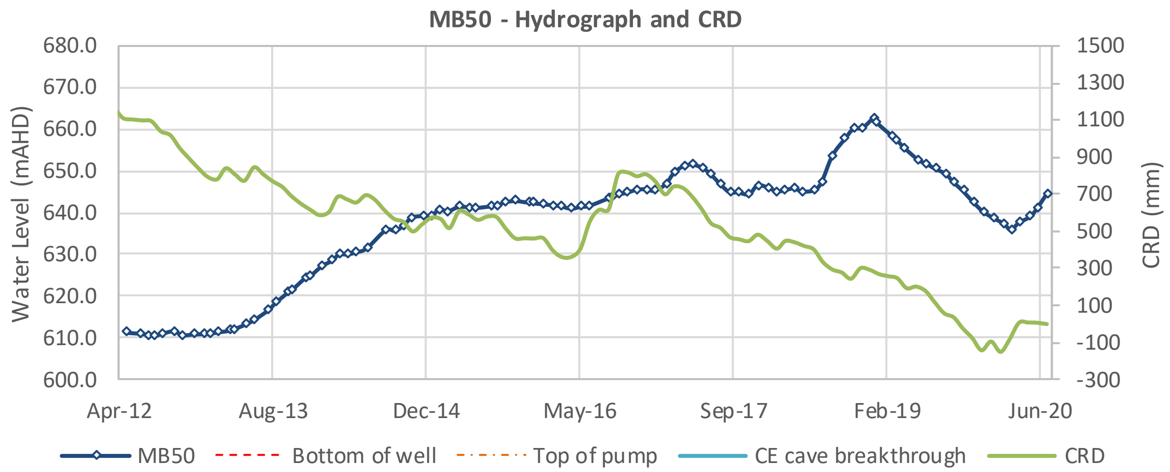

MB10A - Hydrograph and CRD
Water Level (mAHD)
CRD (mm)
690.0
689.0
688.0
687.0
686.0
685.0
684.0
683.0
682.0
681.0
680.0
1400
1200
1000
800
600
400
200
0
Mar-95
Nov-97
Aug-00
May-03
Feb-06
Nov-08
Aug-11
Apr-14
Jan-17
Oct-19
MB10A
Bottom of well
Top of pump
CRD

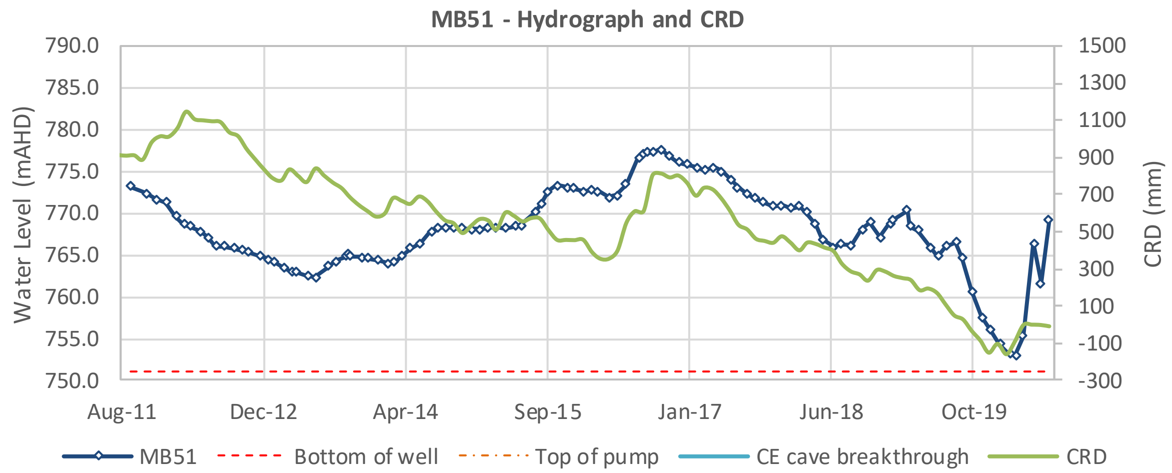

MB11A - Hydrograph and CRD
Water Level (mAHD)
CRD (mm)
690.0
689.0
688.0
687.0
686.0
685.0
684.0
683.0
682.0
681.0
680.0
1400
1200
1000
800
600
400
200
0
Mar-95
Nov-97
Aug-00
May-03
Feb-06
Nov-08
Aug-11
Apr-14
Jan-17
Oct-19
MB11A
Bottom of well
Top of pump
CRD

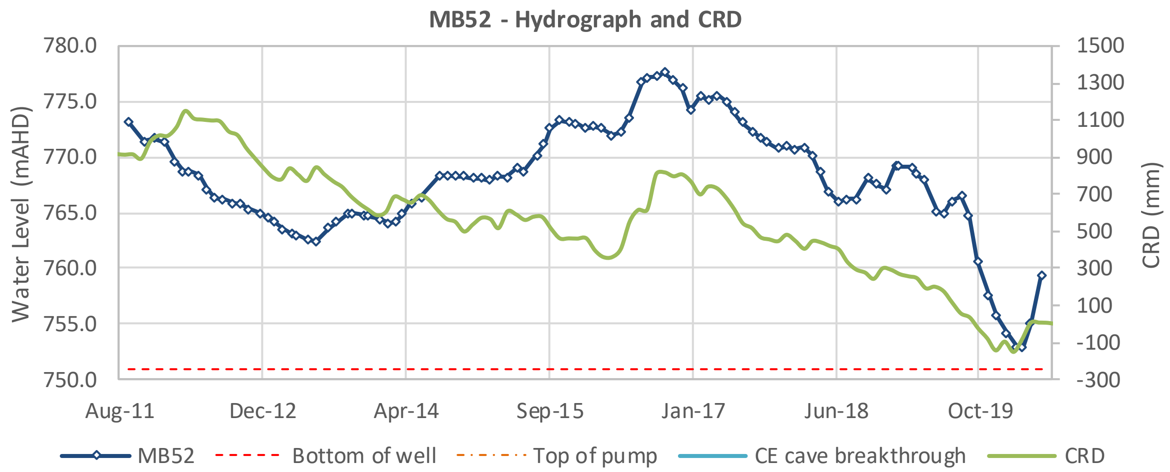
Cadia East

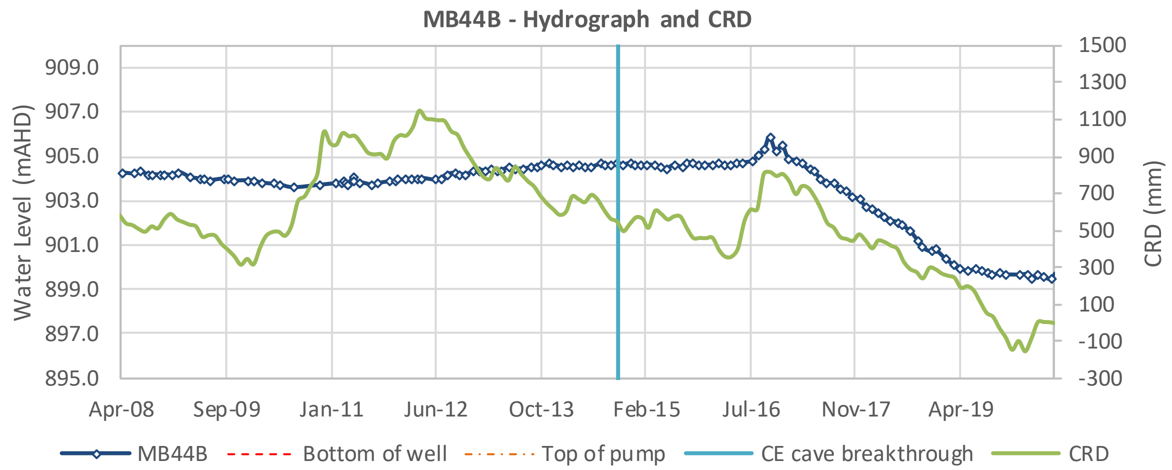

MB88 - Hydrograph and CRD
Water Level (mAHD)
885.0
884.0
883.0
882.0
881.0
880.0
879.0
878.0
CRD (mm)
1000
800
600
400
200
0
-200
-400
Aug-2018
Nov-2018
Mar-2019
Jun-2019
Sep-2019
Dec-2019
Apr-2020
Jul-2020
MB88
Bottom of well
Top of pump
CE cave breakthrough
CRD

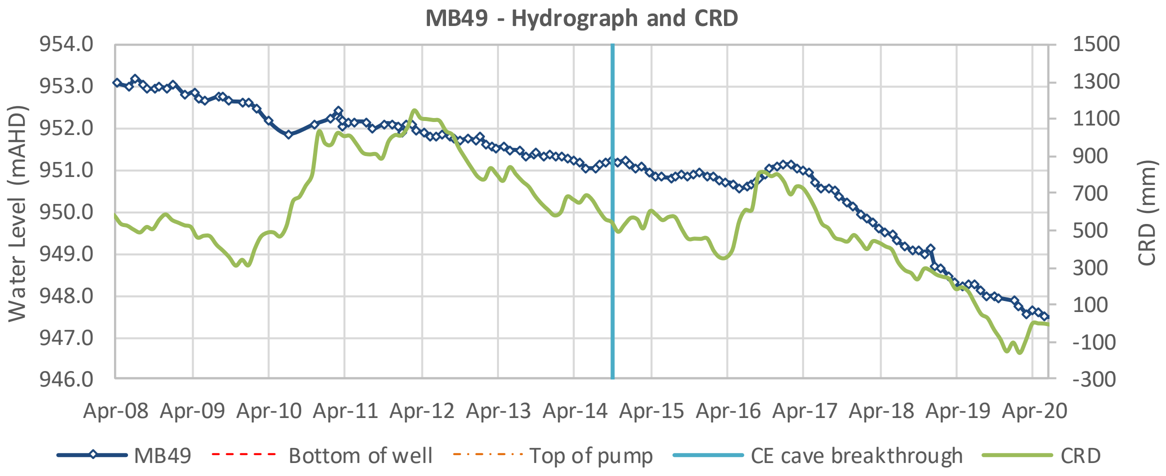

MB88 - Hydrograph and CRD
Water Level (mAHD)
905.0
900.0
895.0
890.0
885.0
880.0
CRD (mm)
1500
1300
1100
900
700
500
300
100
-100
-300
Jan-08
May-09
Sep-10
Feb-12
Jun-13
Nov-14
Mar-16
Aug-17
Dec-18
Apr-20
MB88
Bottom of well
Top of pump
CE cave breakthrough
MB88-OLD
MB45 (decommissioned)

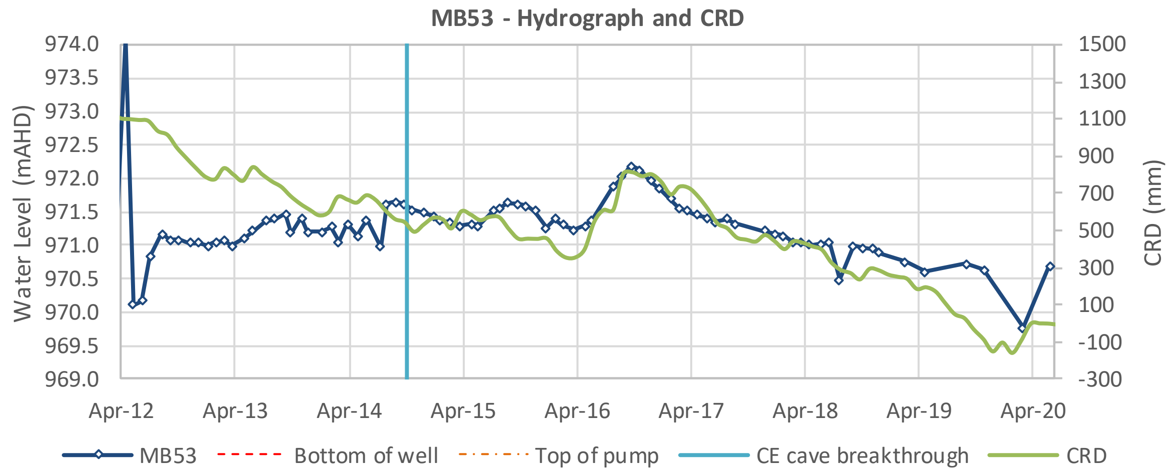

MB50 - Hydrograph and CRD
Water Level (mAHD)
680.0
670.0
660.0
650.0
640.0
630.0
620.0
610.0
600.0
CRD (mm)
1500
1300
1100
900
700
500
300
100
-100
-300
Apr-12
Aug-13
Dec-14
May-16
Sep-17
Feb-19
Jun-20
MB50
Bottom of well
Top of pump
CE cave breakthrough
CRD

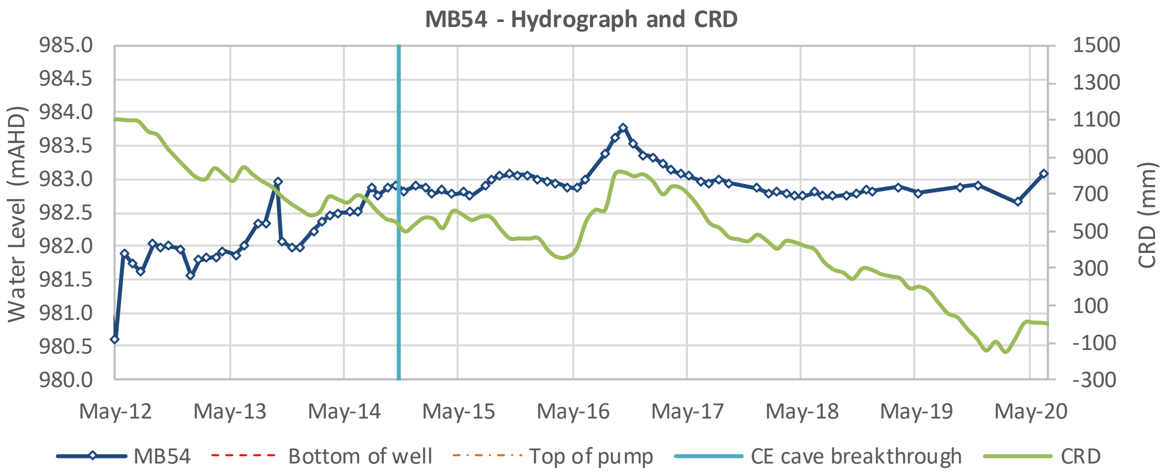

MB51 - Hydrograph and CRD
Water Level (mAHD)
790.0
785.0
780.0
775.0
770.0
765.0
760.0
755.0
750.0
CRD (mm)
1500
1300
1100
900
700
500
300
100
-100
-300
Aug-11
Dec-12
Apr-14
Sep-15
Jan-17
Jun-18
Oct-19
MB51
Bottom of well
Top of pump
CE cave breakthrough
CRD

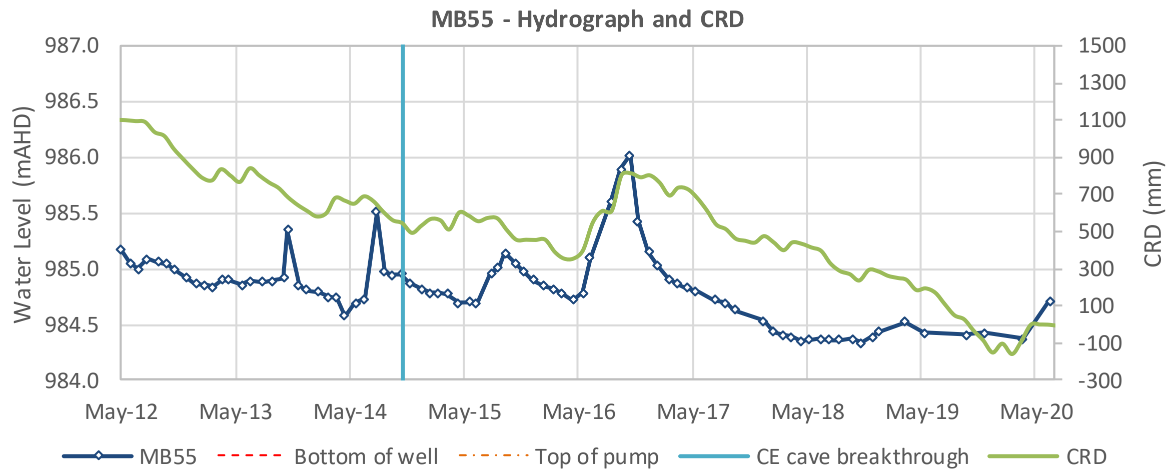

MB52 - Hydrograph and CRD
Water Level (mAHD)
780.0
775.0
770.0
765.0
760.0
755.0
750.0
CRD (mm)
1500
1300
1100
900
700
500
300
100
-100
-300
Aug-11
Dec-12
Apr-14
Sep-15
Jan-17
Jun-18
Oct-19
MB52
Bottom of well
Top of pump
CE cave breakthrough
CRD

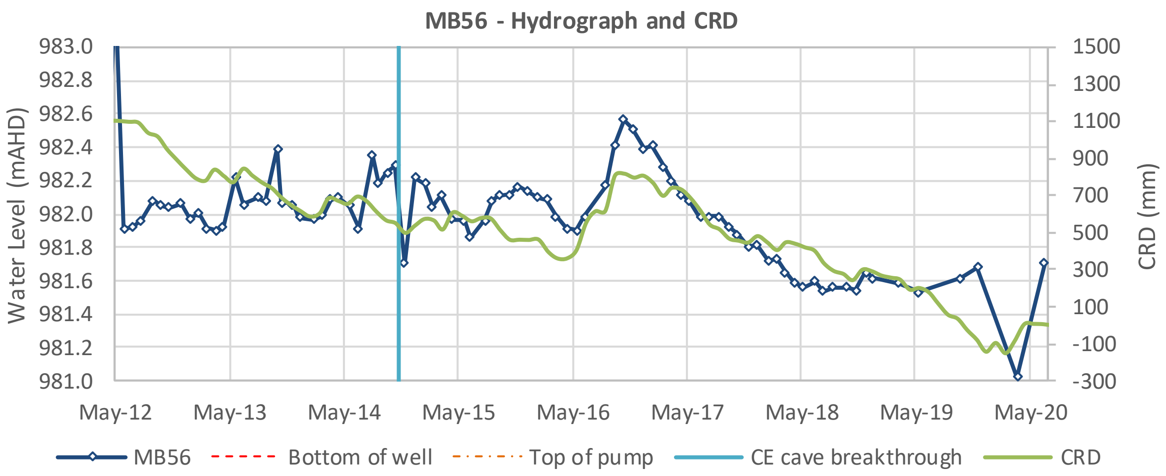

MB44B - Hydrograph and CRD
Water Level (mAHD)
909.0
907.0
905.0
903.0
901.0
899.0
897.0
895.0
CRD (mm)
1500
1300
1100
900
700
500
300
100
-100
-300
Apr-08
Sep-09
Jan-11
Jun-12
Oct-13
Feb-15
Jul-16
Nov-17
Apr-19
MB44B
Bottom of well
Top of pump
CE cave breakthrough
CRD

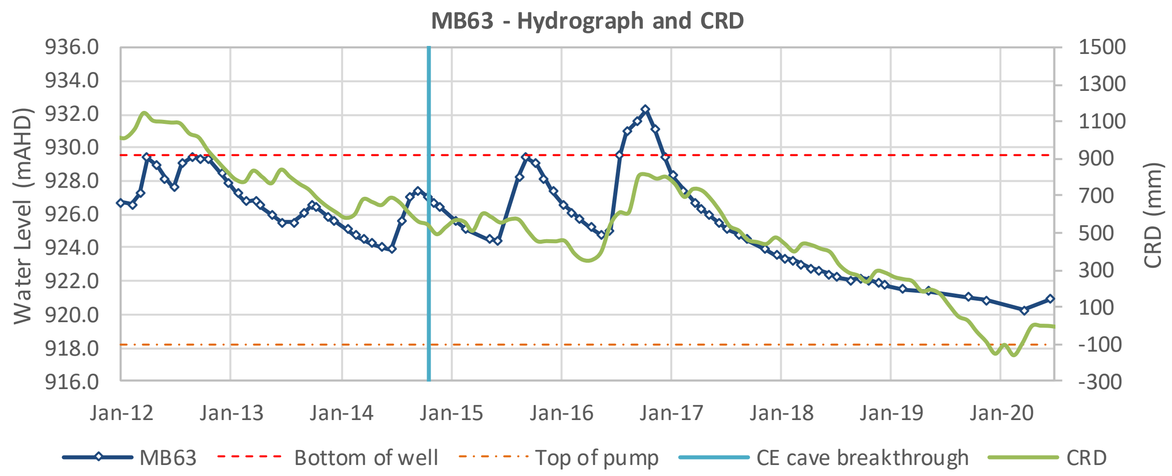

MB49 - Hydrograph and CRD
Water Level (mAHD)
954.0 953.0 952.0 951.0 950.0 949.0 948.0 947.0 946.0
CRD (mm)
1500 1300 1100 900 700 500 300 100 -100 -300
Apr-08 Apr-09 Apr-10 Apr-11 Apr-12 Apr-13 Apr-14 Apr-15 Apr-16 Apr-17 Apr-18 Apr-19 Apr-20
MB49
Bottom of well
Top of pump
CE cave breakthrough
CRD

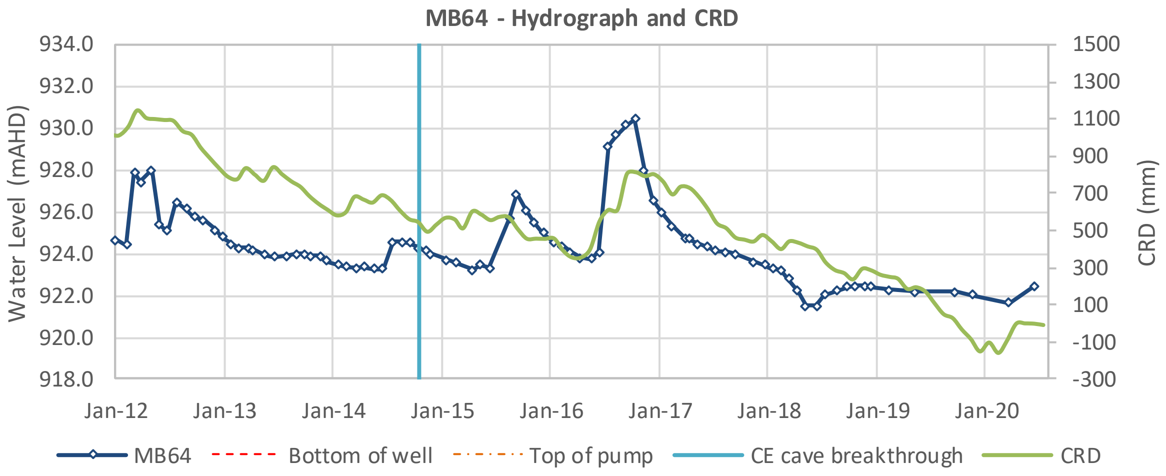

MB53 - Hydrograph and CRD
Water Level (mAHD)
974.0 973.5 973.0 972.5 972.0 971.5 971.0 970.5 970.0 969.5 969.0
CRD (mm)
1500 1300 1100 900 700 500 300 100 -100 -300
Apr-12 Apr-13 Apr-14 Apr-15 Apr-16 Apr-17 Apr-18 Apr-19 Apr-20
MB53
Bottom of well
Top of pump
CE cave breakthrough
CRD

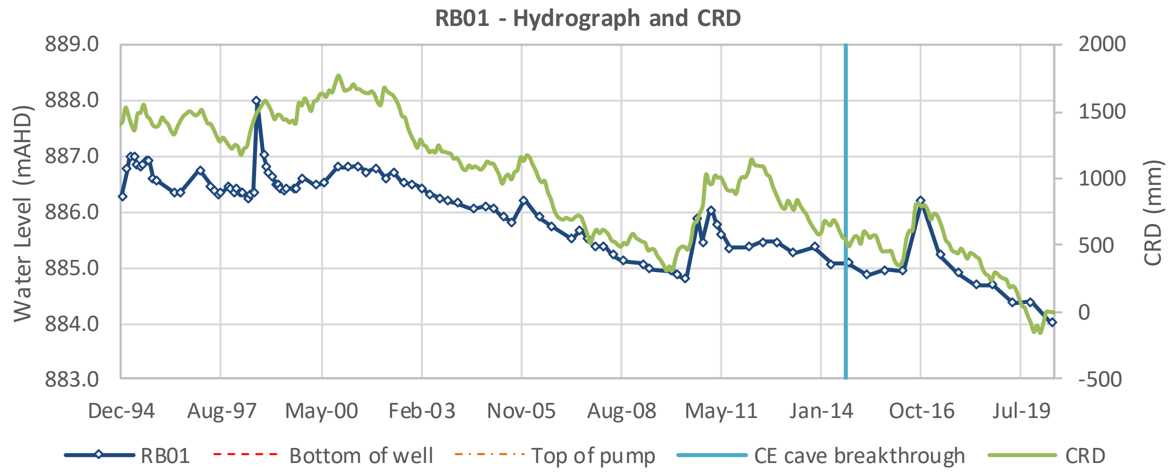

MB54 - Hydrograph and CRD
Water Level (mAHD)
985.0 984.5 984.0 983.5 983.0 982.5 982.0 981.5 981.0 980.5 980.0
CRD (mm)
1500 1300 1100 900 700 500 300 100 -100 -300
May-12 May-13 May-14 May-15 May-16 May-17 May-18 May-19 May-20
MB54
Bottom of well
Top of pump
CE cave breakthrough
CRD

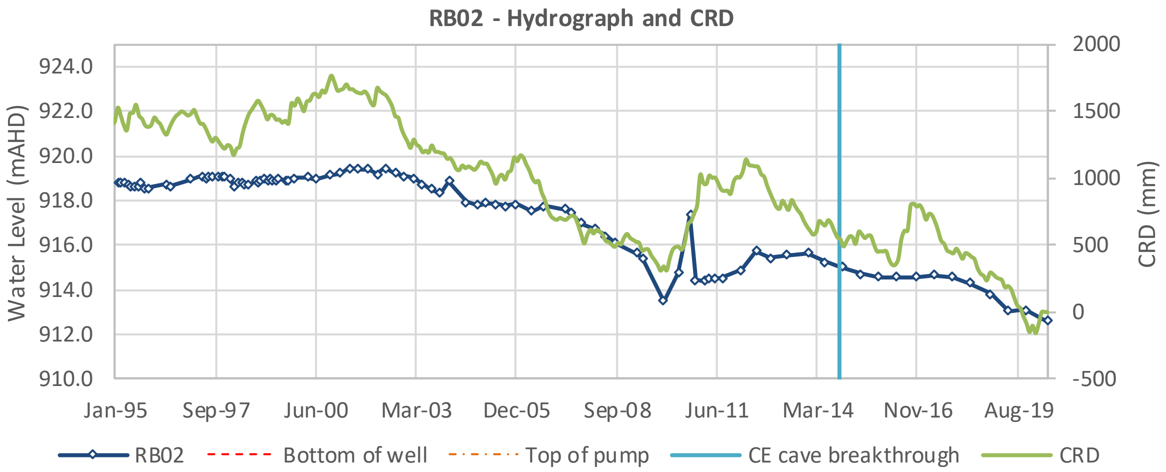

MB55 - Hydrograph and CRD
Water Level (mAHD)
987.0 986.5 986.0 985.5 985.0 984.5 984.0
CRD (mm)
1500 1300 1100 900 700 500 300 100 -100 -300
May-12 May-13 May-14 May-15 May-16 May-17 May-18 May-19 May-20
MB55
Bottom of well
Top of pump
CE cave breakthrough
CRD

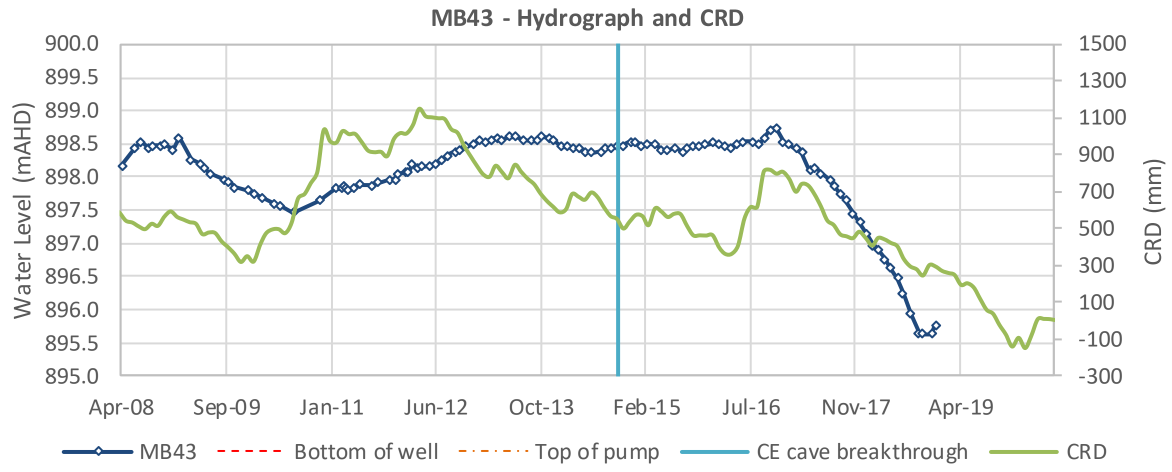

MB56 - Hydrograph and CRD
Water Level (mAHD)
983.0 982.8 982.6 982.4 982.2 982.0 981.8 981.6 981.4 981.2 981.0
CRD (mm)
1500 1300 1100 900 700 500 300 100 -100 -300
May-12 May-13 May-14 May-15 May-16 May-17 May-18 May-19 May-20
MB56
Bottom of well
Top of pump
CE cave breakthrough
CRD

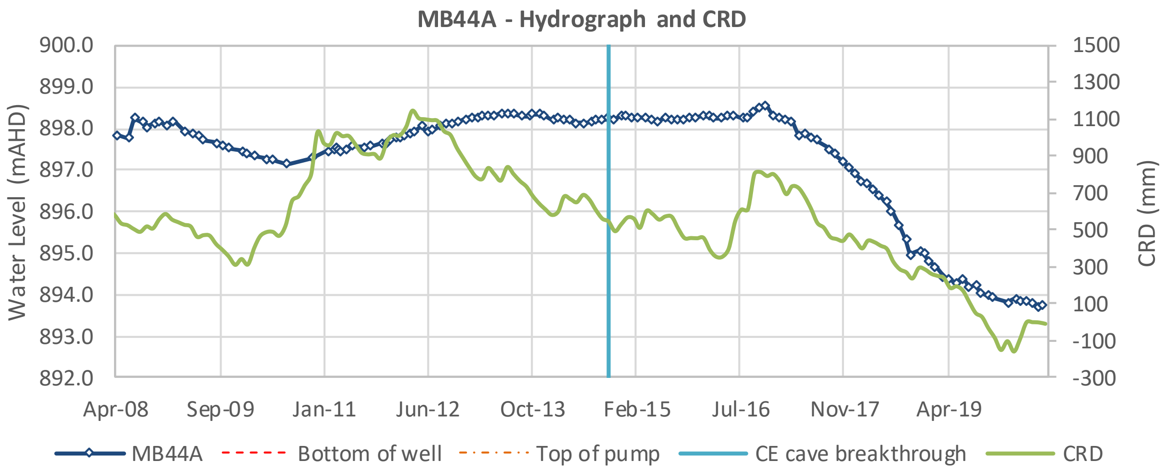

MB63 - Hydrograph and CRD
Water Level (mAHD)
936.0 934.0 932.0 930.0 928.0 926.0 924.0 922.0 920.0 918.0 916.0
CRD (mm)
1500 1300 1100 900 700 500 300 100 -100 -300
Jan-12 Jan-13 Jan-14 Jan-15 Jan-16 Jan-17 Jan-18 Jan-19 Jan-20
MB63
Bottom of well
Top of pump
CE cave breakthrough
CRD

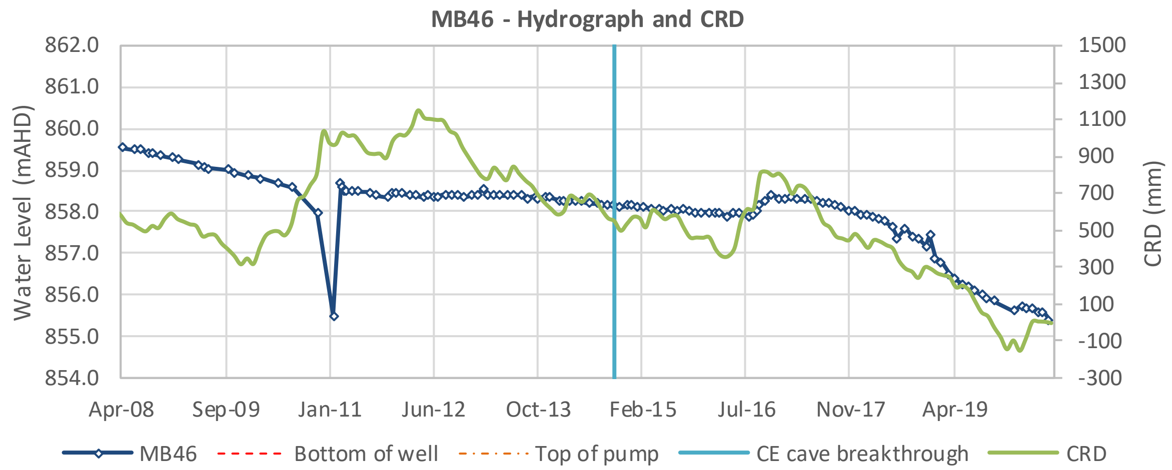

MB64 - Hydrograph and CRD
Water Level (mAHD)
CRD (mm)
934.0
932.0
930.0
928.0
926.0
924.0
922.0
920.0
918.0
1500
1300
1100
900
700
500
300
100
-100
-300
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
MB64
Bottom of well
Top of pump
CE cave breakthrough
CRD

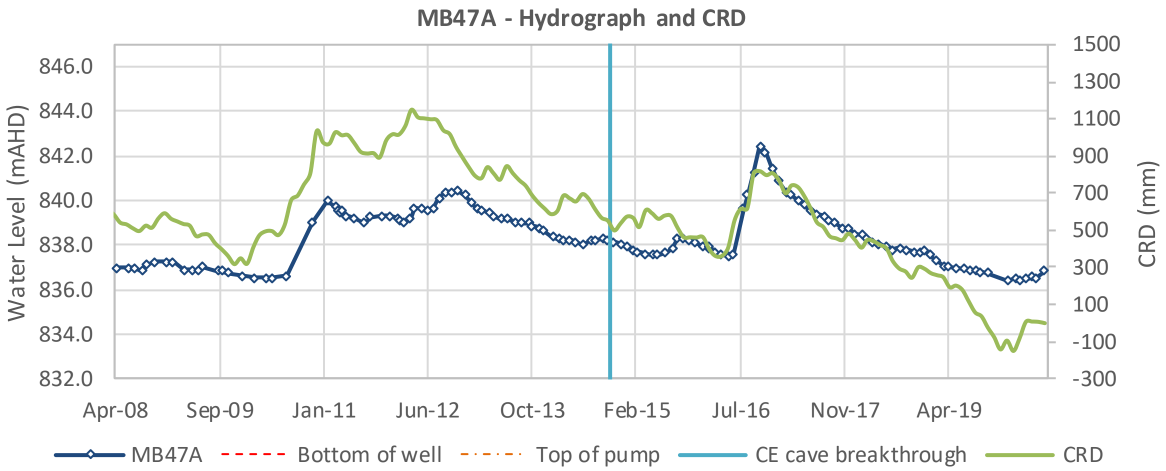

RB01 - Hydrograph and CRD
Water Level (mAHD)
CRD (mm)
889.0
888.0
887.0
886.0
885.0
884.0
883.0
2000
1500
1000
500
0
-500
Dec-94
Aug-97
May-00
Feb-03
Nov-05
Aug-08
May-11
Jan-14
Oct-16
Jul-19
RB01
Bottom of well
Top of pump
CE cave breakthrough
CRD

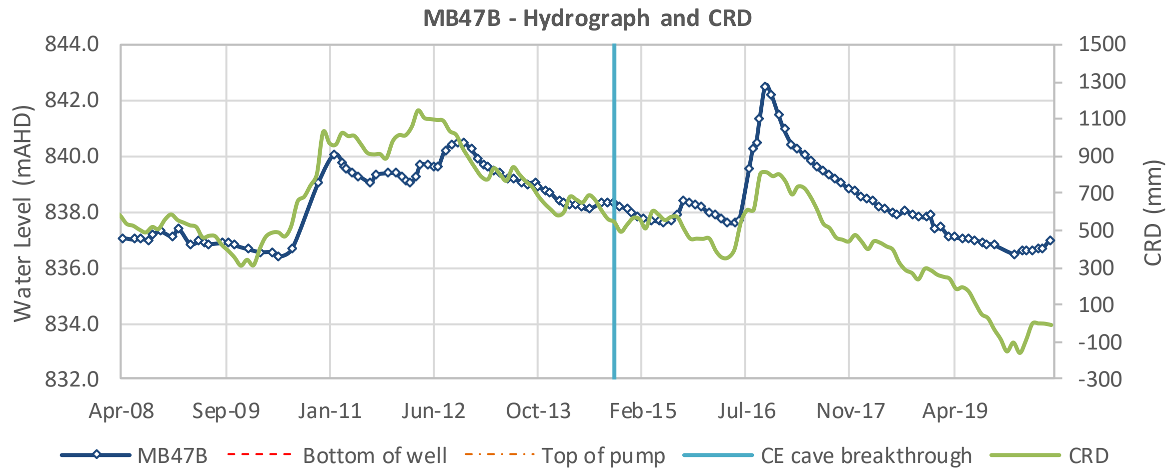

RB02 - Hydrograph and CRD
Water Level (mAHD)
CRD (mm)
924.0
922.0
920.0
918.0
916.0
914.0
912.0
910.0
2000
1500
1000
500
0
-500
Jan-95
Sep-97
Jun-00
Mar-03
Dec-05
Sep-08
Jun-11
Mar-14
Nov-16
Aug-19
RB02
Bottom of well
Top of pump
CE cave breakthrough
CRD

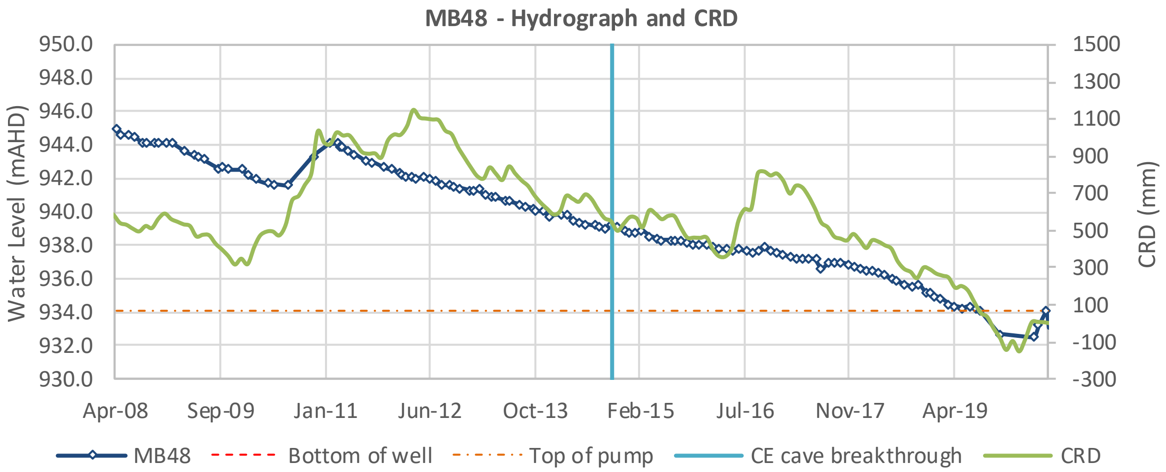

MB43 - Hydrograph and CRD
Water Level (mAHD)
CRD (mm)
900.0
899.5
899.0
898.5
898.0
897.5
897.0
896.5
896.0
895.5
895.0
1500
1300
1100
900
700
500
300
100
-100
-300
Apr-08
Sep-09
Jan-11
Jun-12
Oct-13
Feb-15
Jul-16
Nov-17
Apr-19
MB43
Bottom of well
Top of pump
CE cave breakthrough
CRD

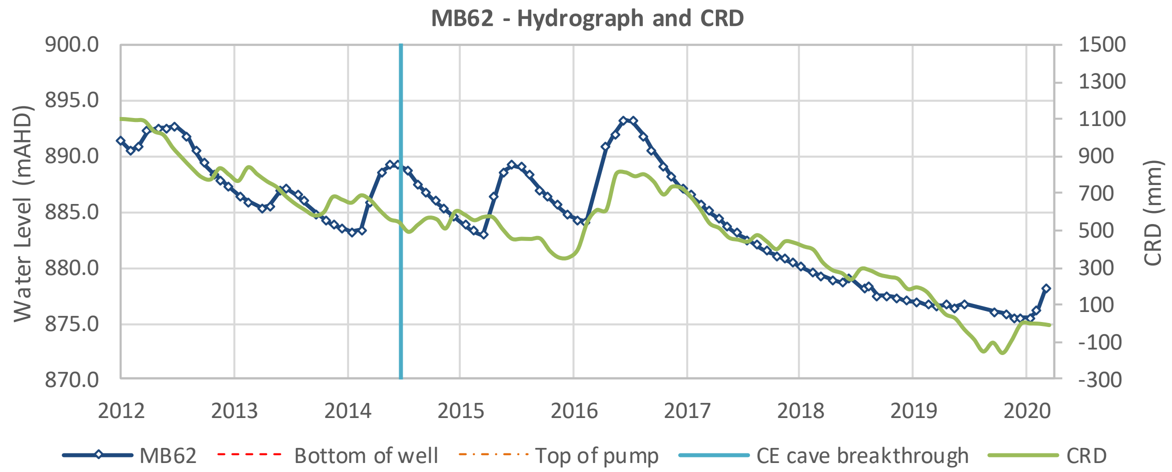

MB44A - Hydrograph and CRD
Water Level (mAHD)
CRD (mm)
900.0
899.0
898.0
897.0
896.0
895.0
894.0
893.0
892.0
1500
1300
1100
900
700
500
300
100
-100
-300
Apr-08
Sep-09
Jan-11
Jun-12
Oct-13
Feb-15
Jul-16
Nov-17
Apr-19
MB44A
Bottom of well
Top of pump
CE cave breakthrough
CRD

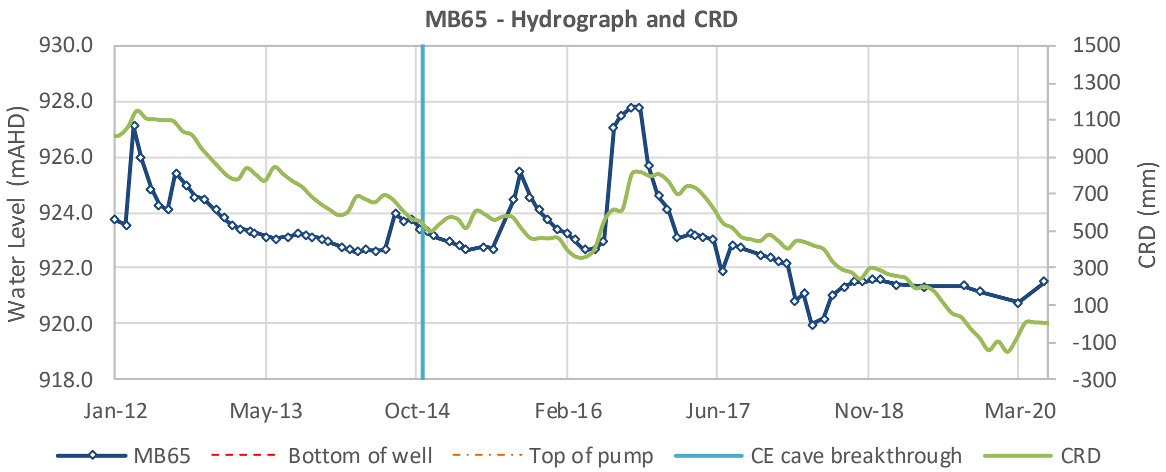

MB46 - Hydrograph and CRD
Water Level (mAHD)
CRD (mm)
862.0
861.0
860.0
859.0
858.0
857.0
856.0
855.0
854.0
1500
1300
1100
900
700
500
300
100
-100
-300
Apr-08
Sep-09
Jan-11
Jun-12
Oct-13
Feb-15
Jul-16
Nov-17
Apr-19
MB46
Bottom of well
Top of pump
CE cave breakthrough
CRD

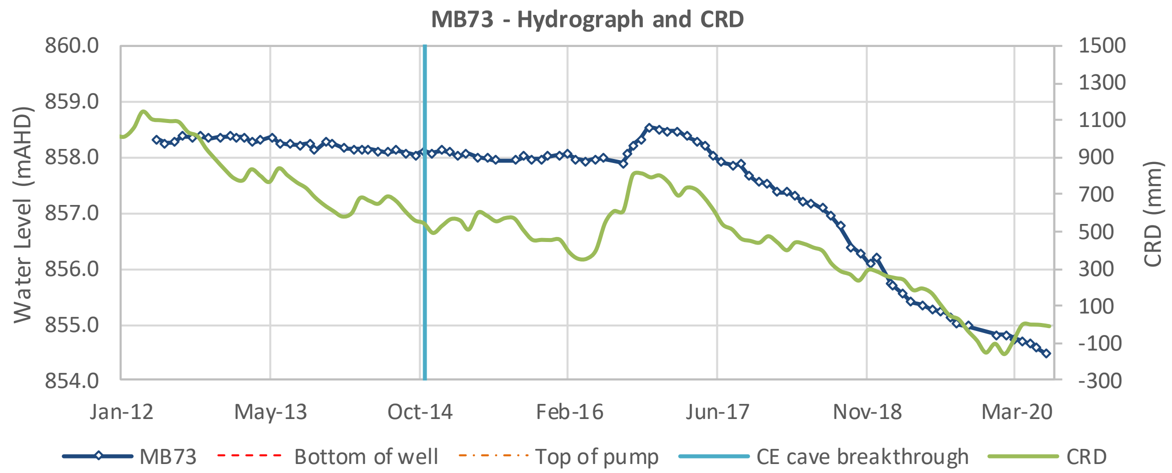

MB47A - Hydrograph and CRD
Water Level (mAHD)
CRD (mm)
MB47A
Bottom of well
Top of pump
CE cave breakthrough
CRD

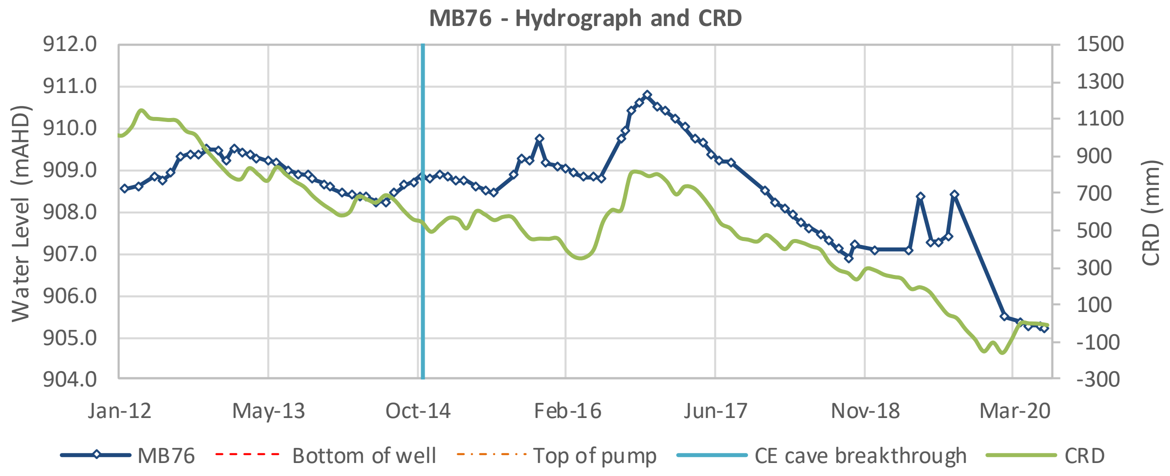

MB47B - Hydrograph and CRD
Water Level (mAHD)
CRD (mm)
MB47B
Bottom of well
Top of pump
CE cave breakthrough
CRD


MB48 - Hydrograph and CRD
Water Level (mAHD)
CRD (mm)
MB48
Bottom of well
Top of pump
CE cave breakthrough
CRD

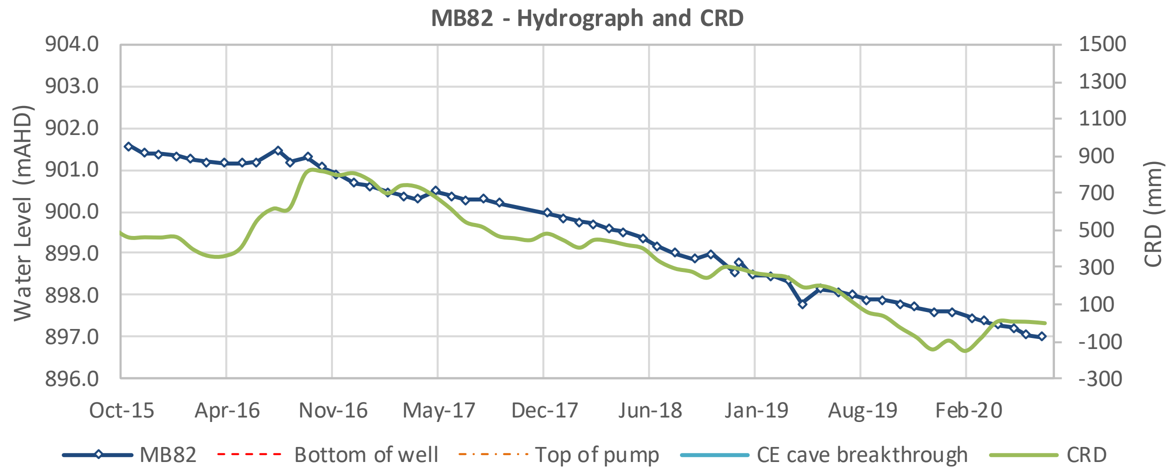

MB62 - Hydrograph and CRD
Water Level (mAHD)
CRD (mm)
MB62
Bottom of well
Top of pump
CE cave breakthrough
CRD


MB65 - Hydrograph and CRD
Water Level (mAHD)
CRD (mm)
MB65
Bottom of well
Top of pump
CE cave breakthrough
CRD

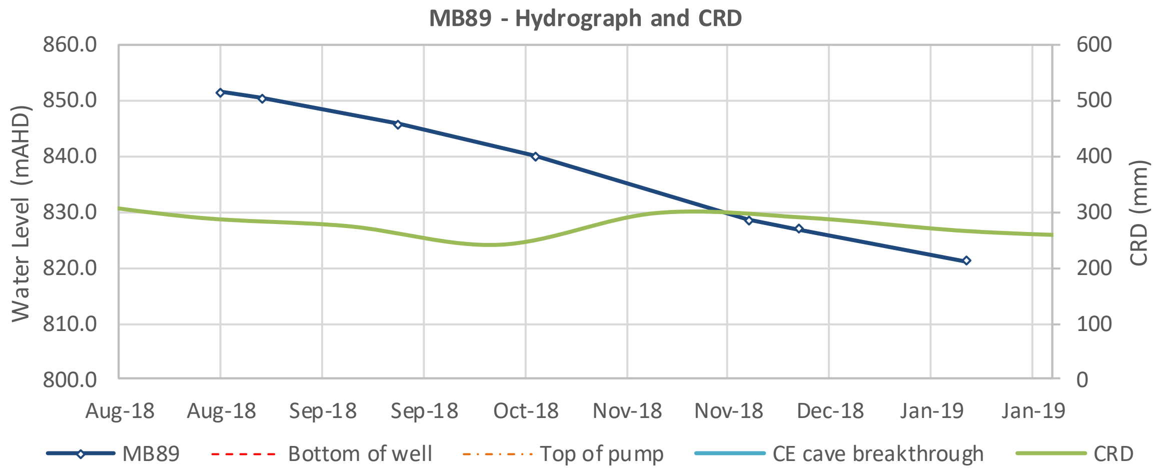

MB73 - Hydrograph and CRD
Water Level (mAHD)
CRD (mm)
MB73
Bottom of well
Top of pump
CE cave breakthrough
CRD



MB76 - Hydrograph and CRD
Water Level (mAHD)
CRD (mm)
912.0
911.0
910.0
909.0
908.0
907.0
906.0
905.0
904.0
1500
1300
1100
900
700
500
300
100
-100
-300
Jan-12
May-13
Oct-14
Feb-16
Jun-17
Nov-18
Mar-20
MB76
Bottom of well
Top of pump
CE cave breakthrough
CRD



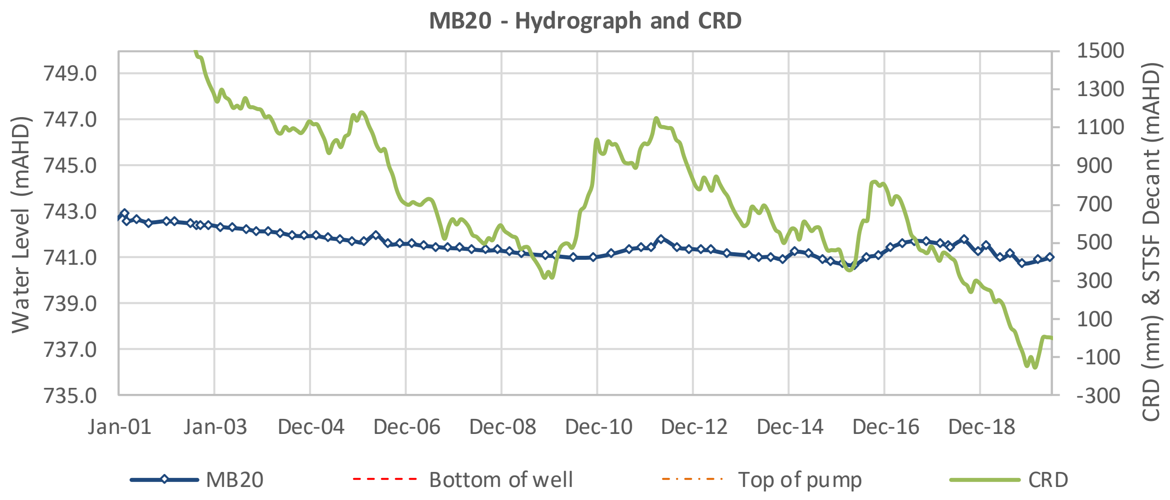
MB82 - Hydrograph and CRD
Water Level (mAHD)
CRD (mm)
904.0
903.0
902.0
901.0
900.0
899.0
898.0
897.0
896.0
1500
1300
1100
900
700
500
300
100
-100
-300
Oct-15
Apr-16
Nov-16
May-17
Dec-17
Jun-18
Jan-19
Aug-19
Feb-20
MB82
Bottom of well
Top of pump
CE cave breakthrough
CRD

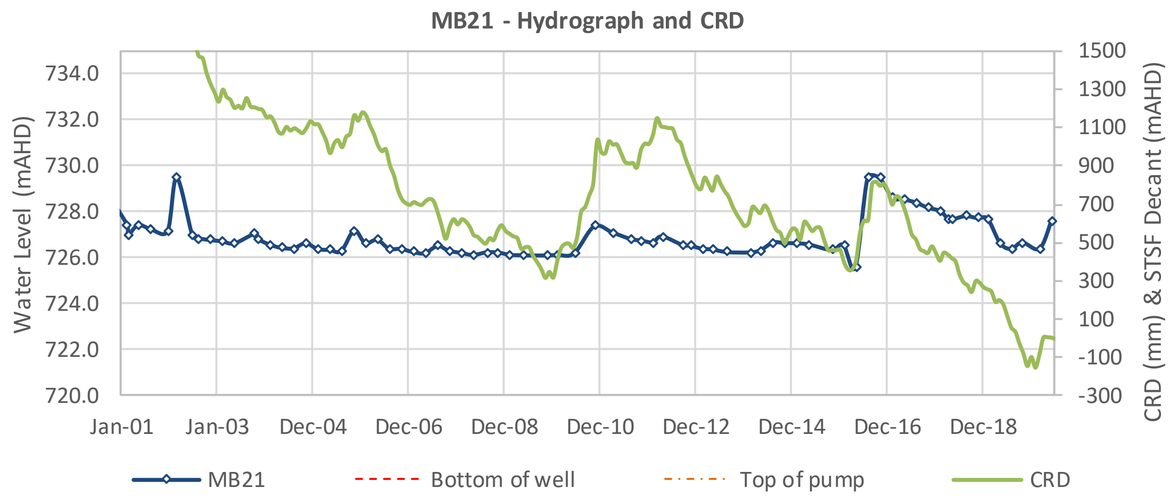


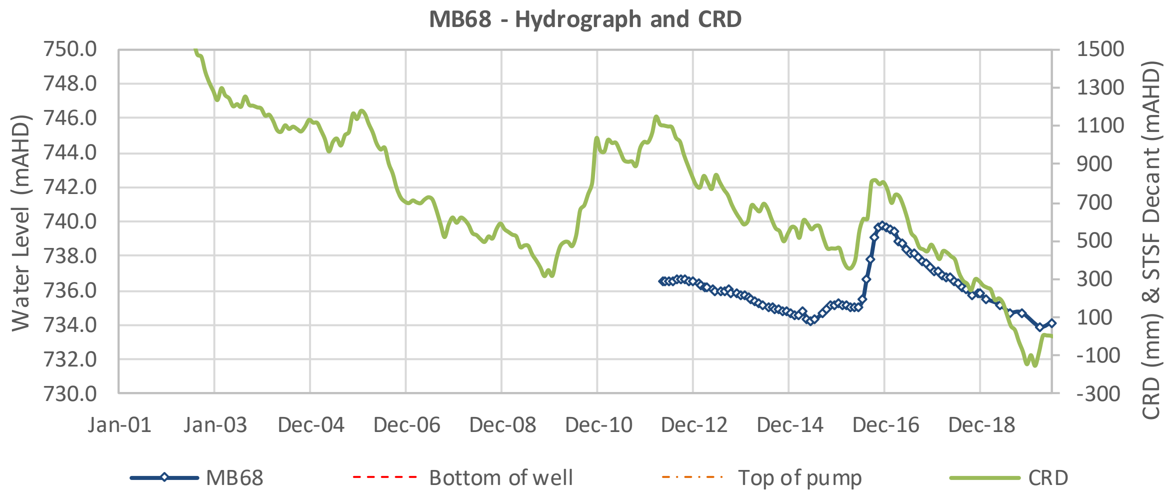
MB89 - Hydrograph and CRD
Water Level (mAHD)
CRD (mm)
860.0
850.0
840.0
830.0
820.0
810.0
800.0
600
500
400
300
200
100
0
Aug-18
Aug-18
Sep-18
Sep-18
Oct-18
Nov-18
Nov-18
Dec-18
Jan-19
Jan-19
MB89
Bottom of well
Top of pump
CE cave breakthrough
CRD

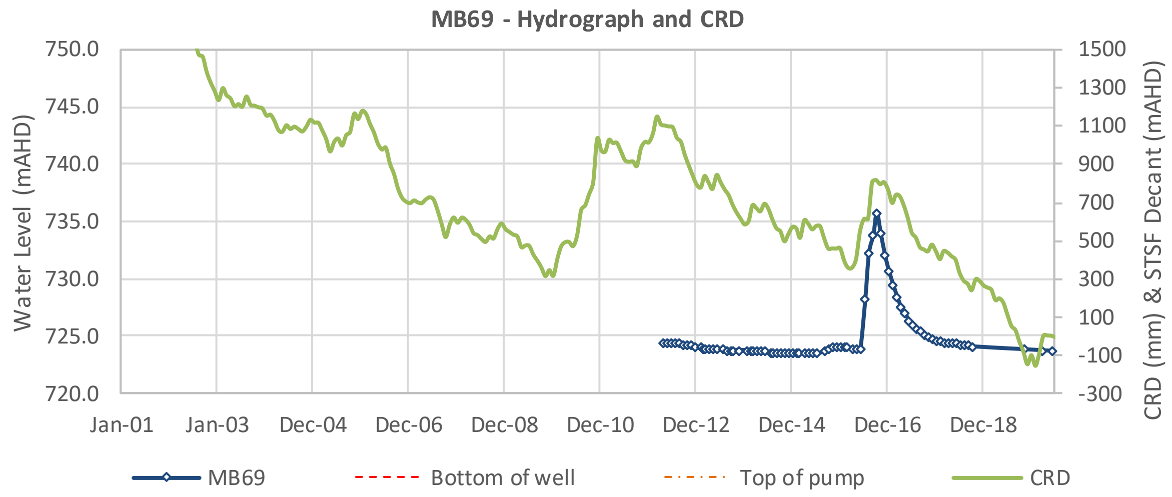
Tailings storage facilites

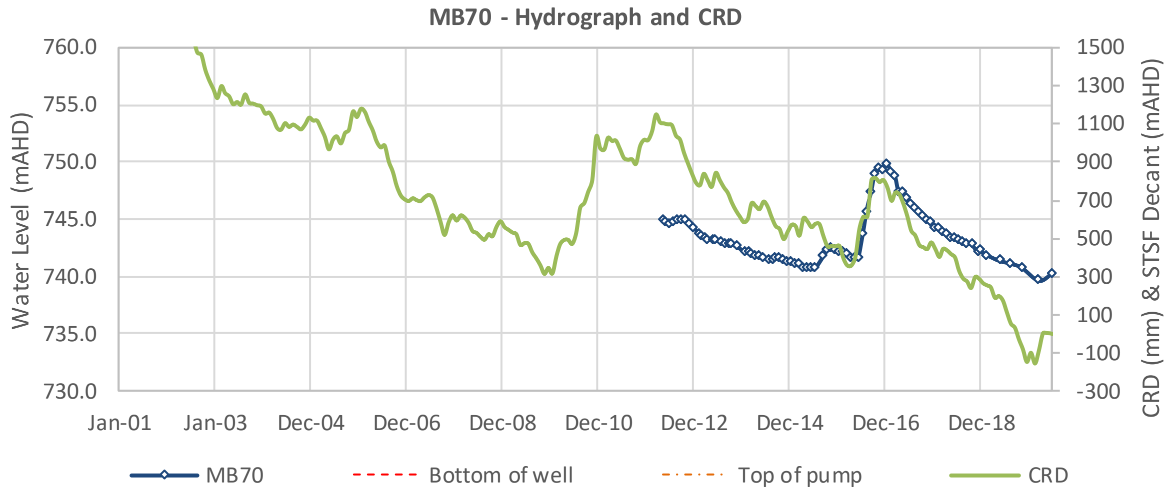
TSF Eastern Zone

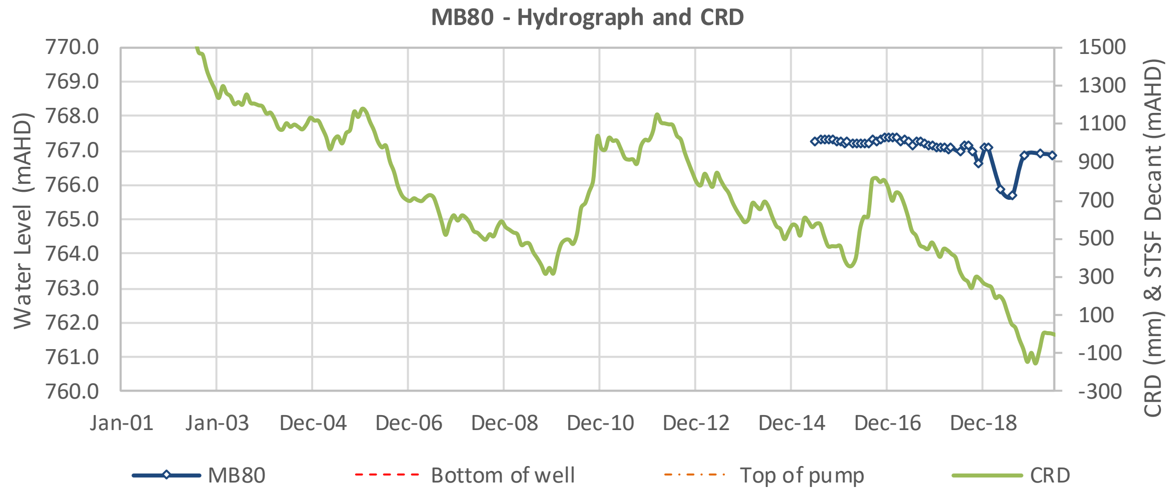


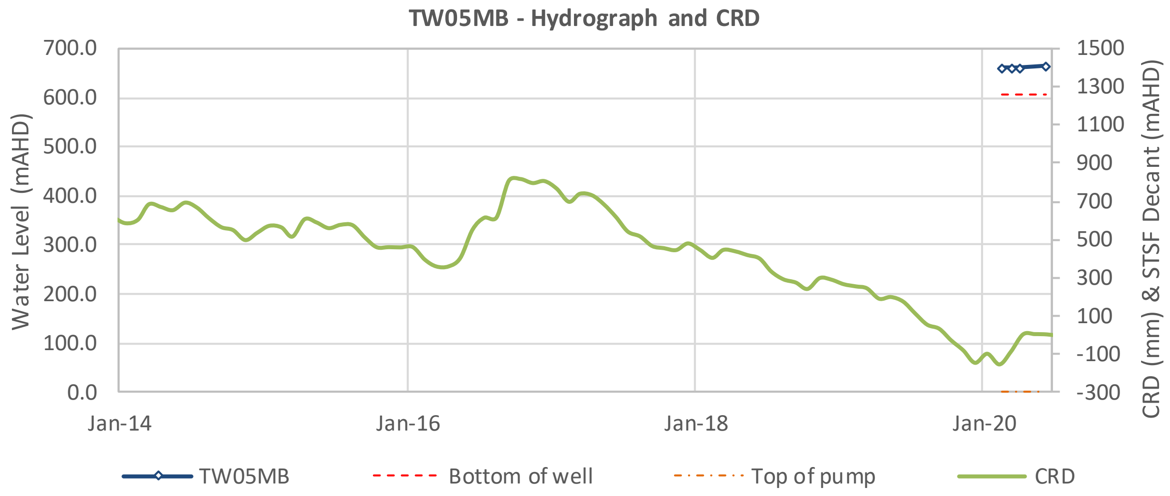






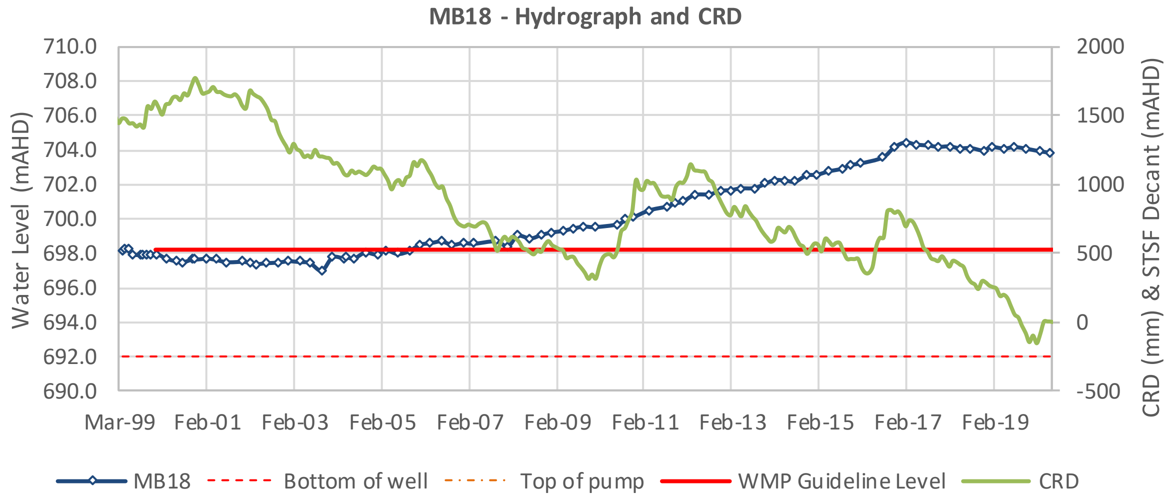


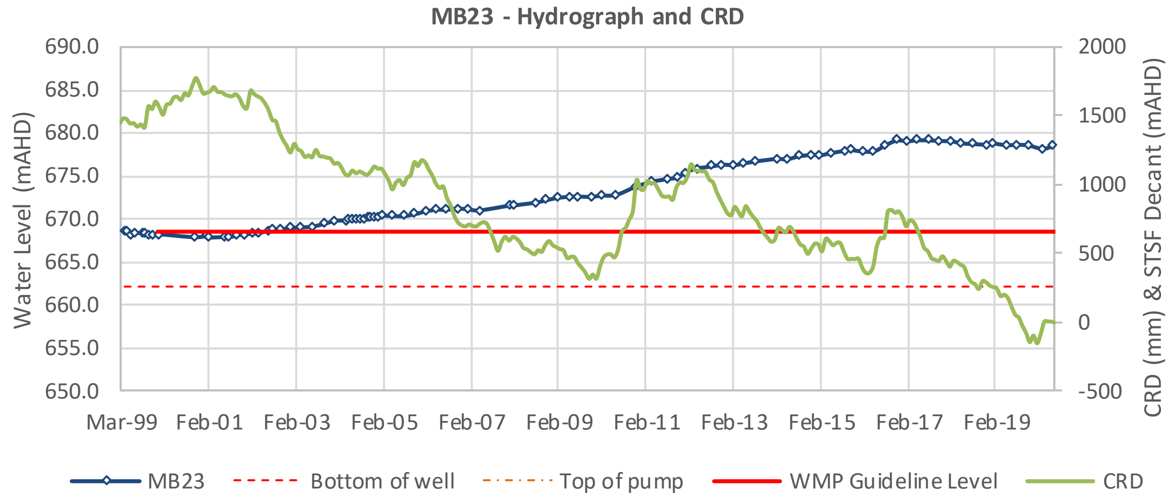


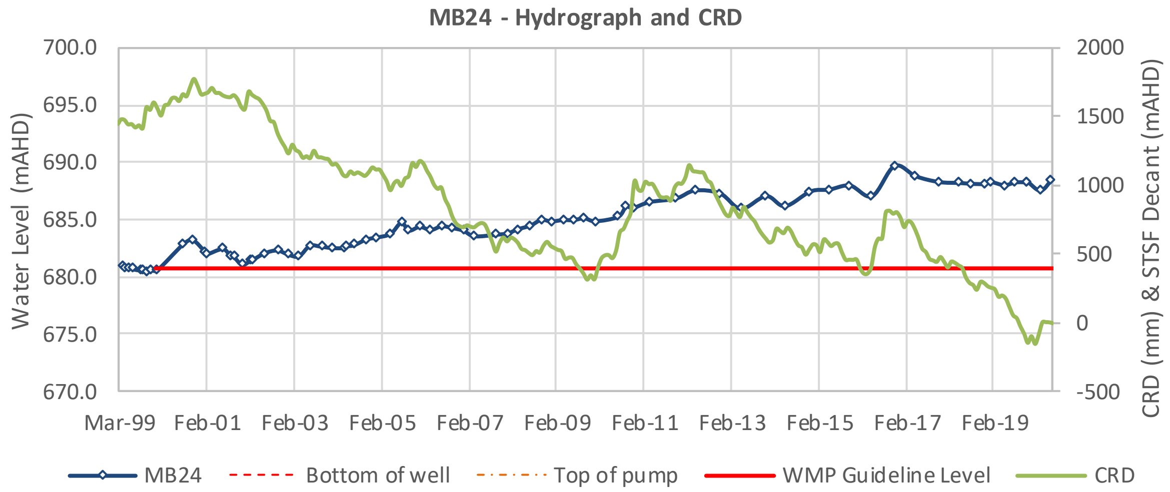


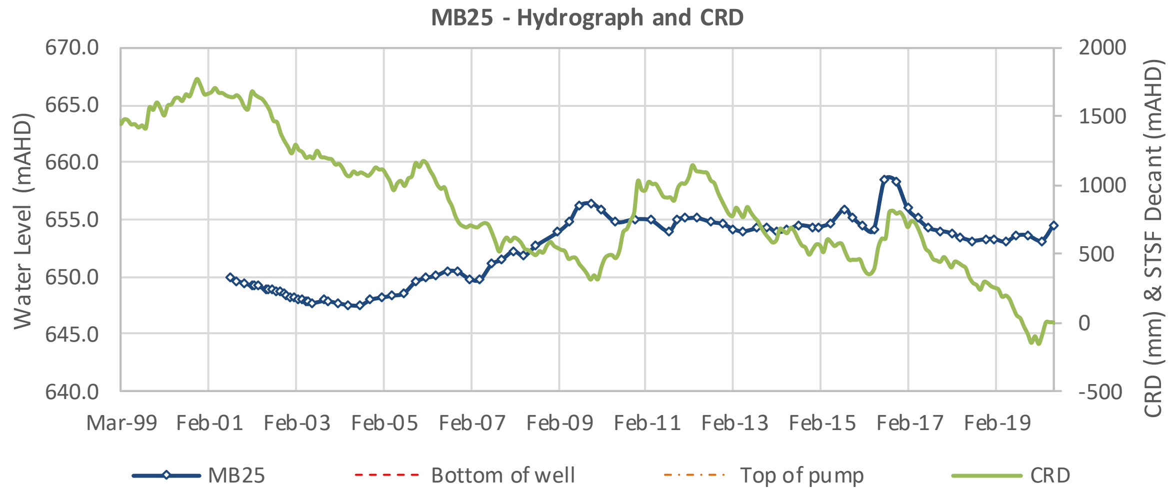
TW05MB - Hydrograph and CRD
Water Level (mAHD)
CRD (mm) & STSF Decant (mAHD)
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
1500
1300
1100
900
700
500
300
100
-100
-300
Jan-14
Jan-16
Jan-18
Jan-20
TW05MB
Bottom of well
Top of pump
CRD

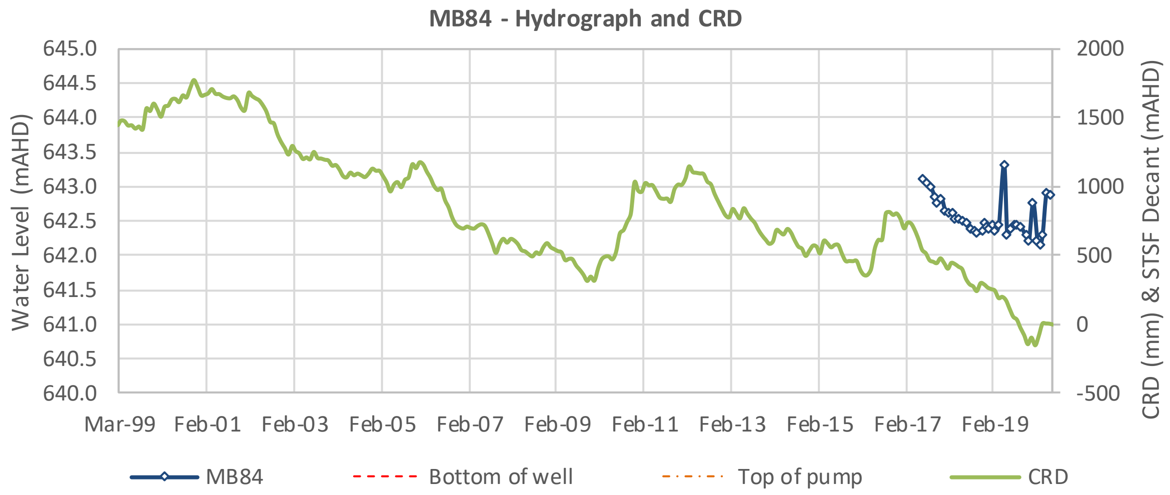
TSF Western Zone

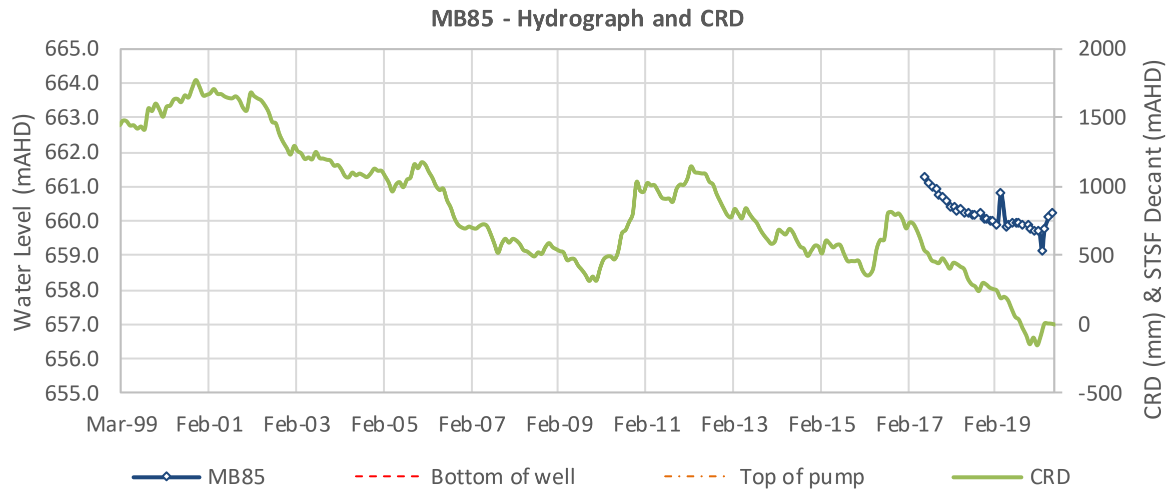


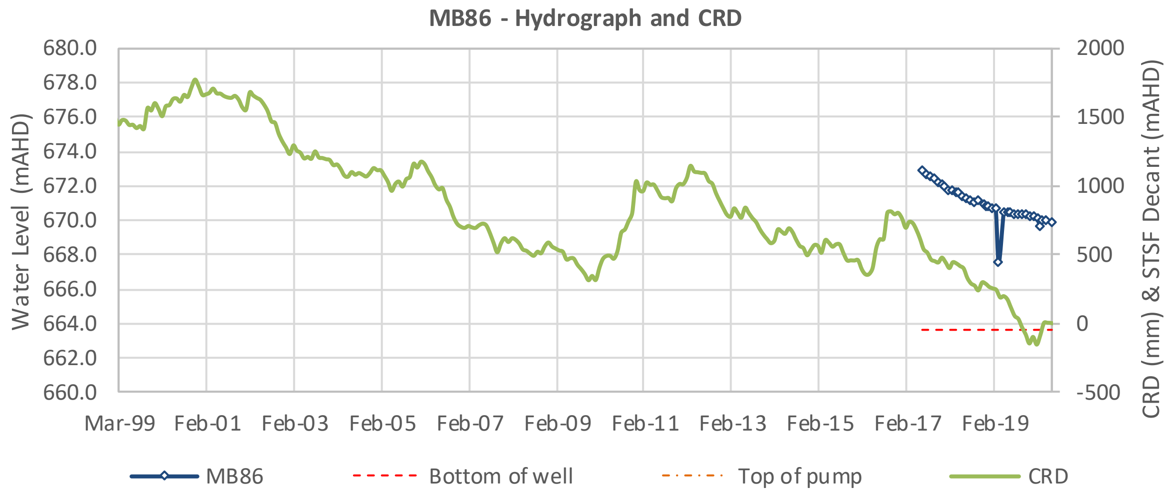




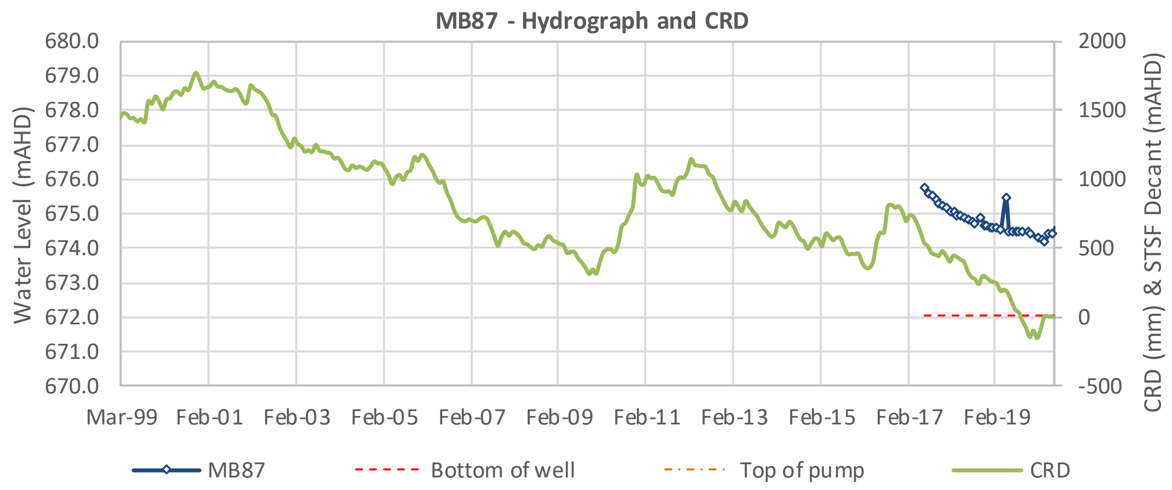




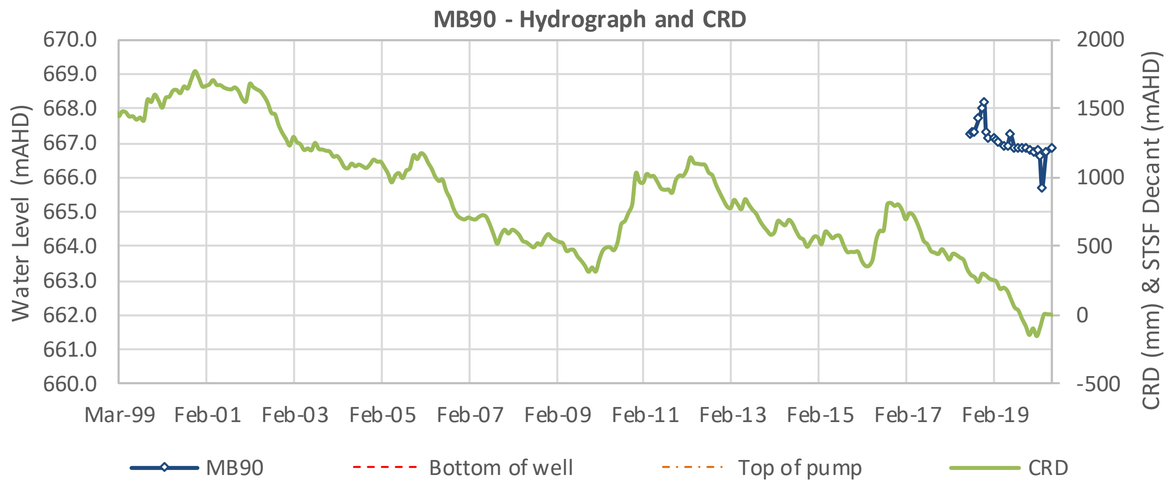




MB86 - Hydrograph and CRD
Water Level (mAHD)
CRD (mm) & STSF Decant (mAHD)
680.0
678.0
676.0
674.0
672.0
670.0
668.0
666.0
664.0
662.0
660.0
2000
1500
1000
500
0
-500
Mar-99
Feb-01
Feb-03
Feb-05
Feb-07
Feb-09
Feb-11
Feb-13
Feb-15
Feb-17
Feb-19
MB86
Bottom of well
Top of pump
CRD

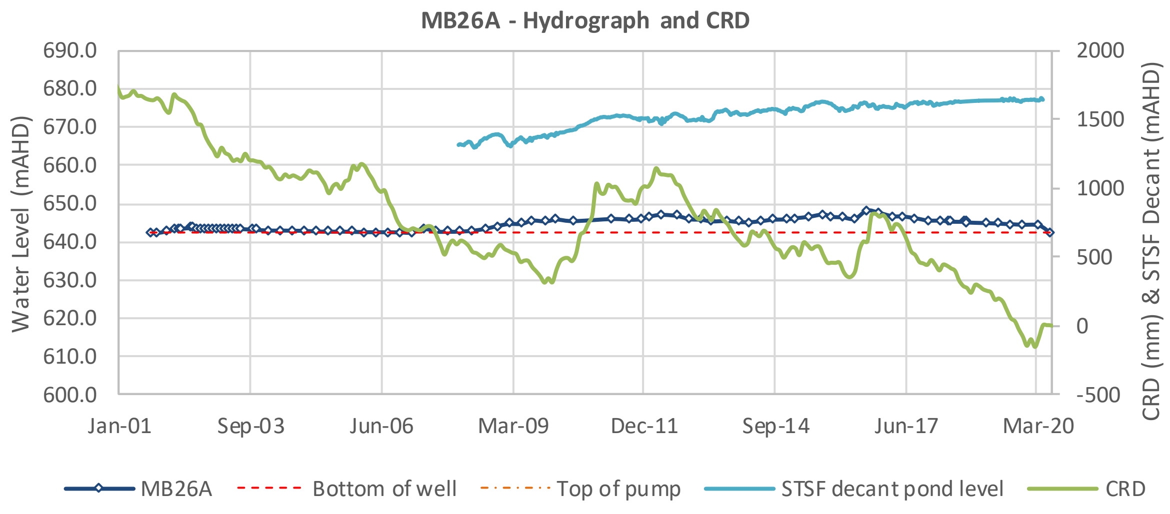


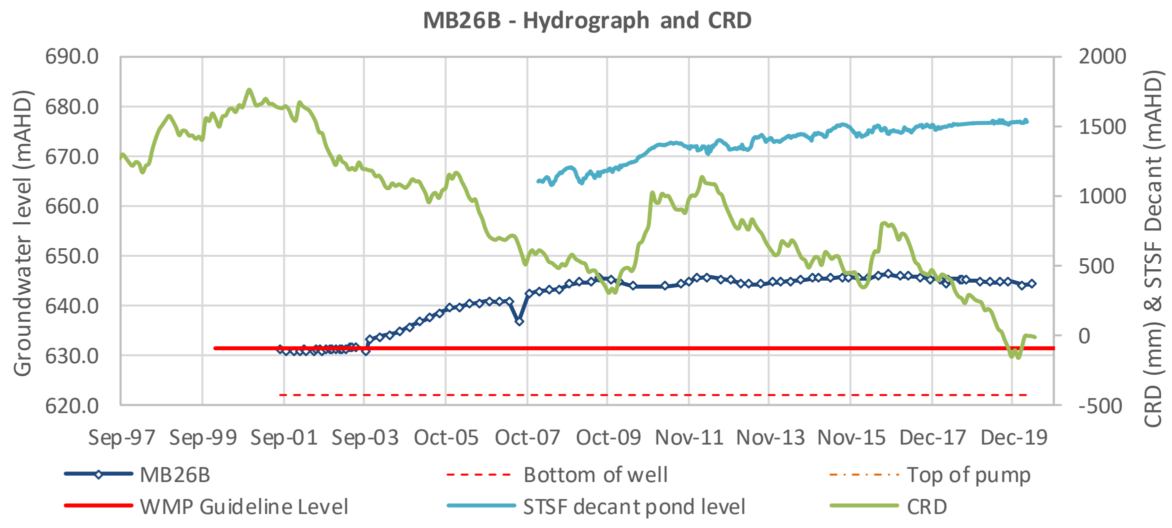
MB87 - Hydrograph and CRD
Water Level (mAHD)
CRD (mm) & STSF Decant (mAHD)
680.0
679.0
678.0
677.0
676.0
675.0
674.0
673.0
672.0
671.0
670.0
2000
1500
1000
500
0
-500
Mar-99
Feb-01
Feb-03
Feb-05
Feb-07
Feb-09
Feb-11
Feb-13
Feb-15
Feb-17
Feb-19
MB87
Bottom of well
Top of pump
CRD

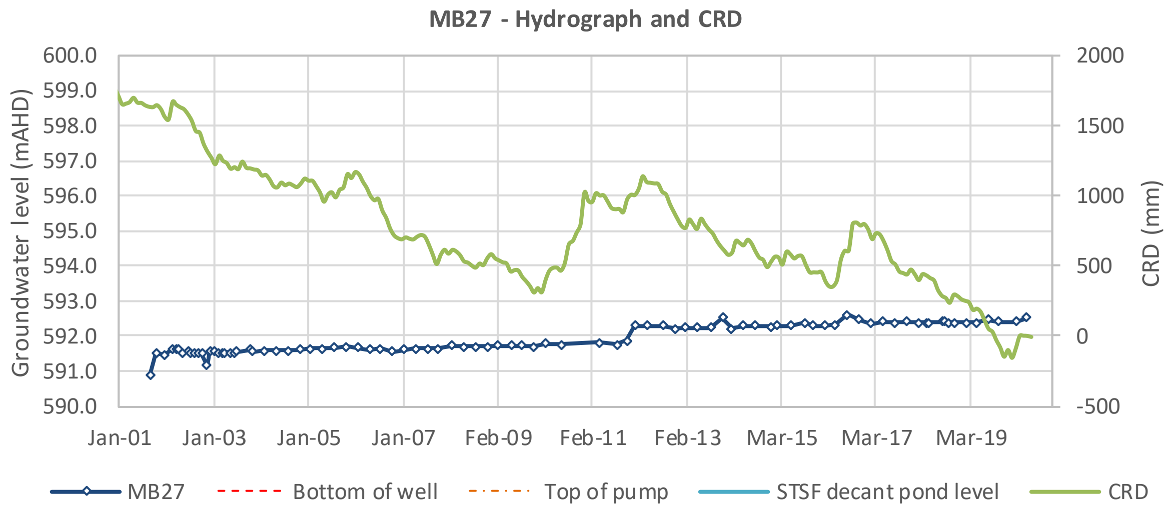


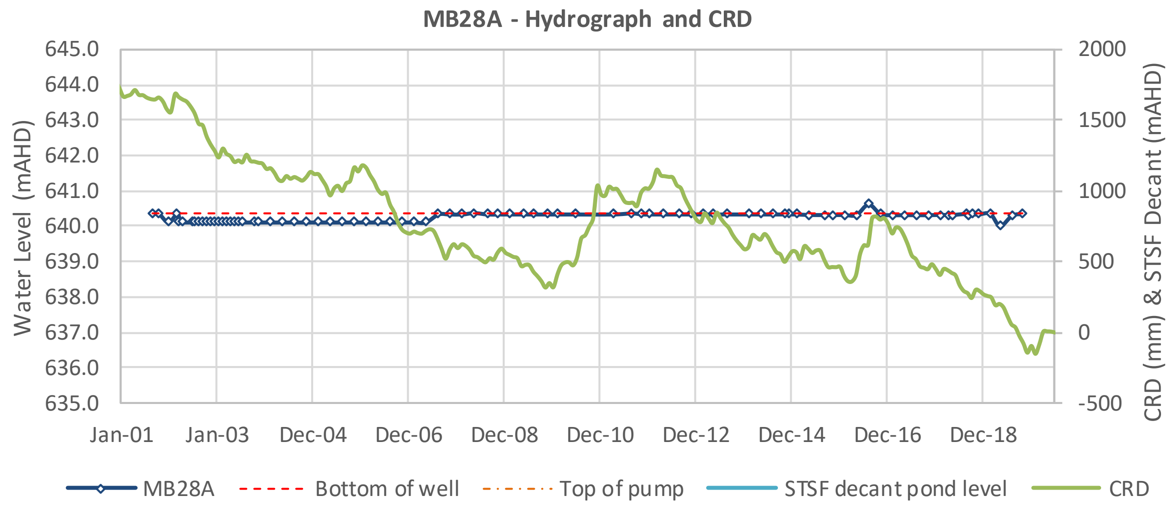
MB90 - Hydrograph and CRD
Water Level (mAHD)
CRD (mm) & STSF Decant (mAHD)
670.0
669.0
668.0
667.0
666.0
665.0
664.0
663.0
662.0
661.0
660.0
2000
1500
1000
500
0
-500
Mar-99
Feb-01
Feb-03
Feb-05
Feb-07
Feb-09
Feb-11
Feb-13
Feb-15
Feb-17
Feb-19
MB90
Bottom of well
Top of pump
CRD

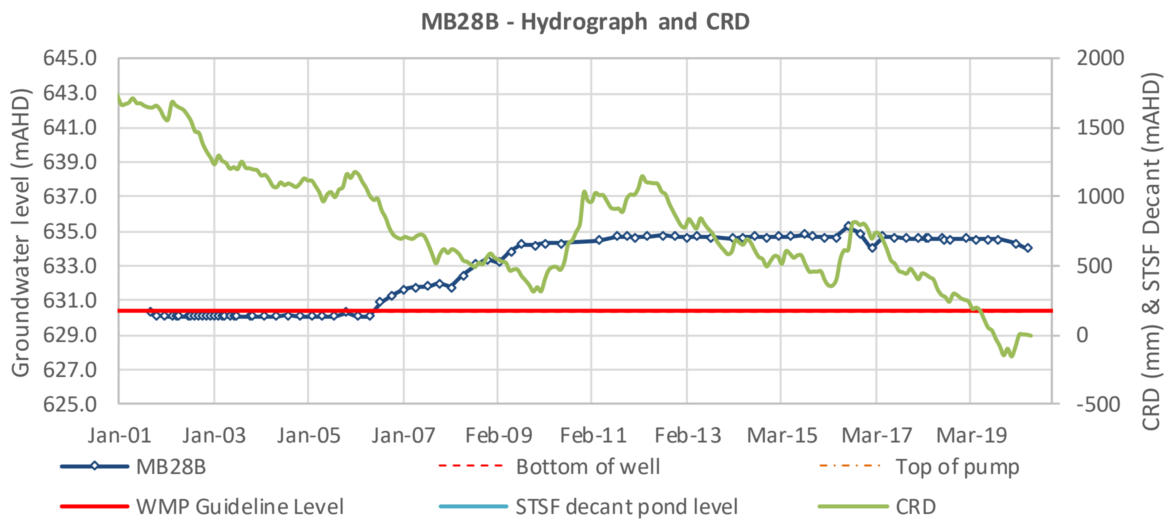
TSF Southern Zone

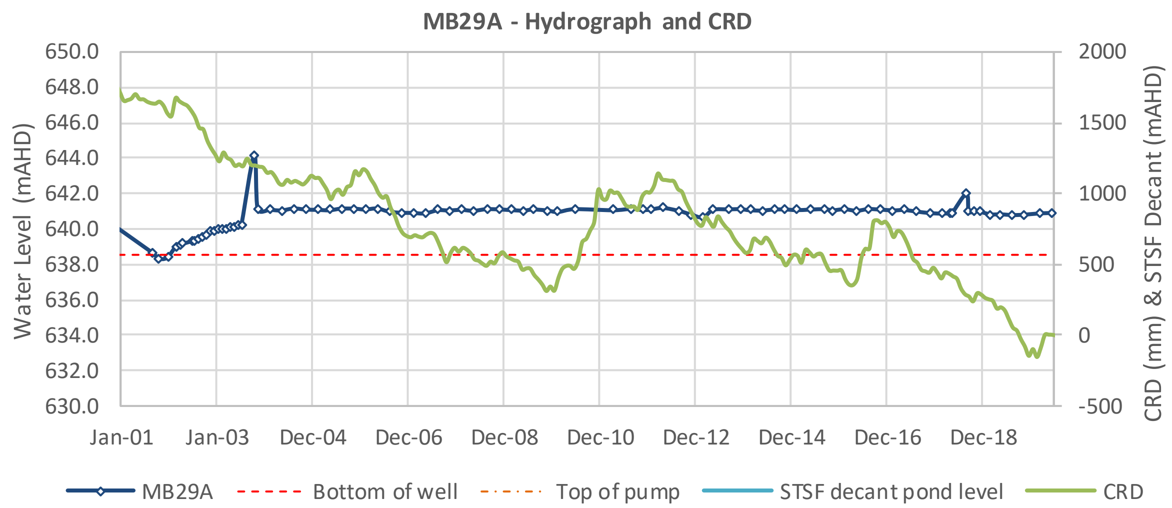


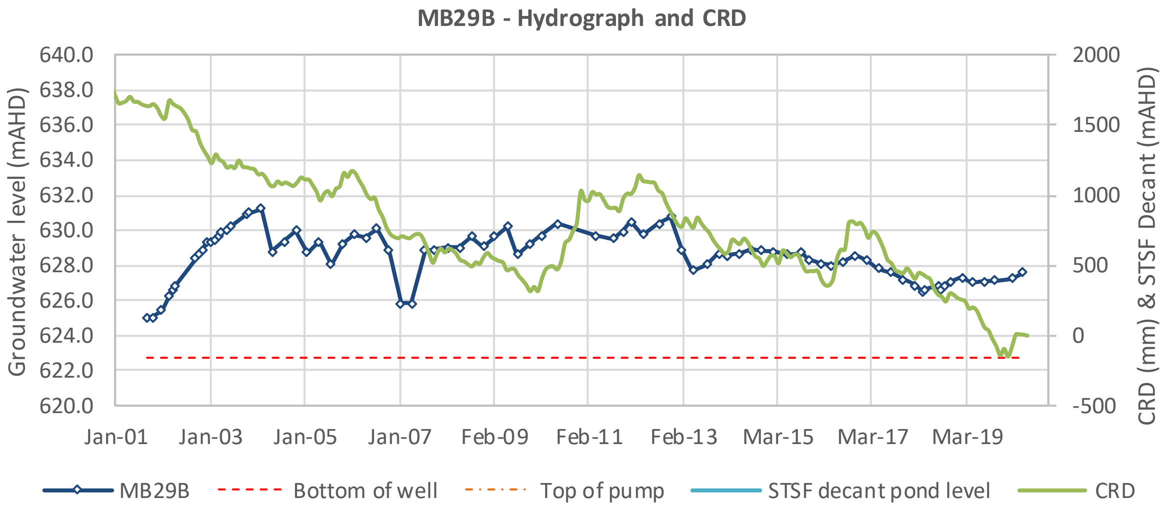


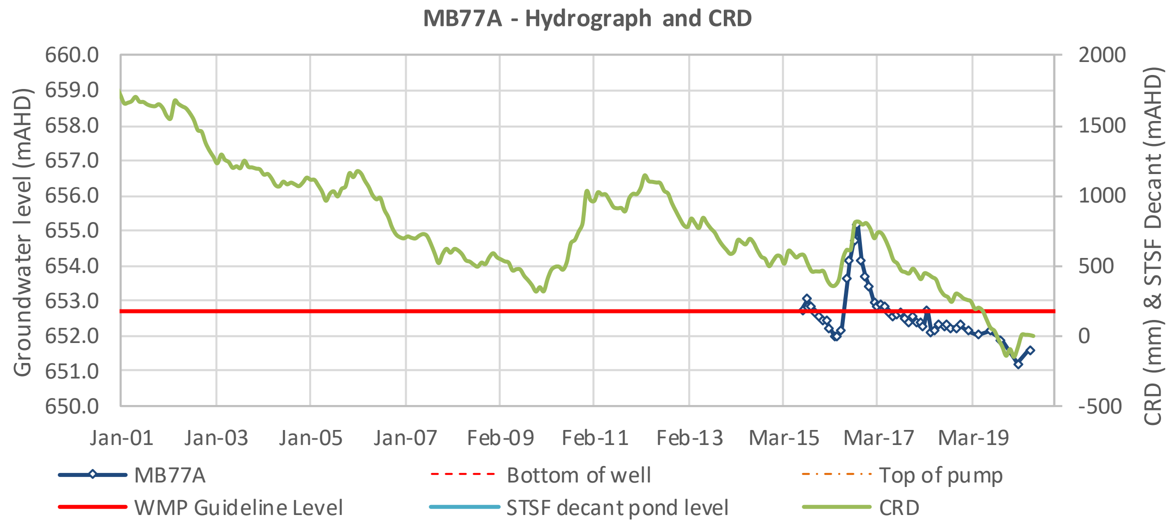


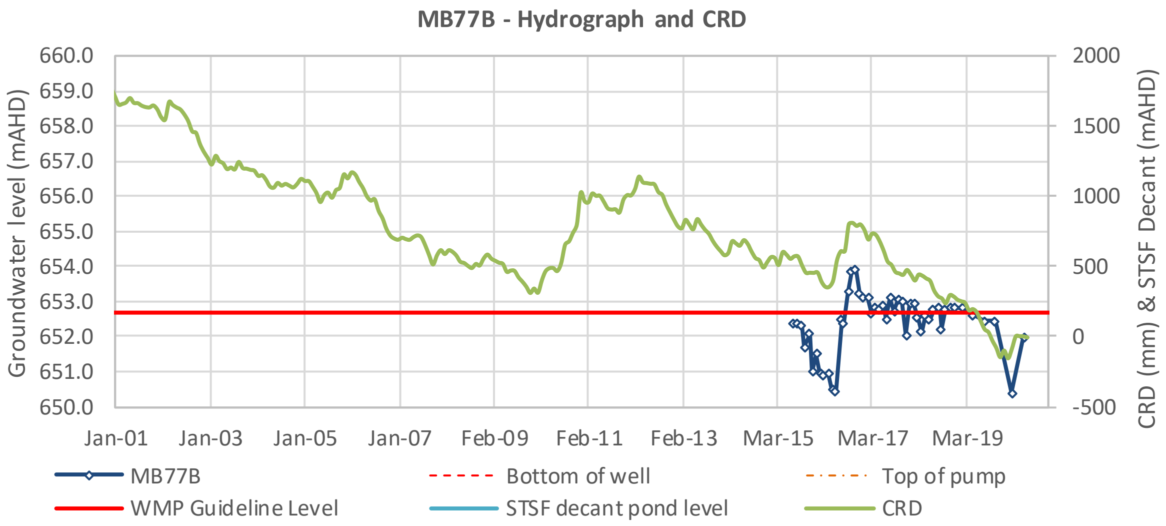


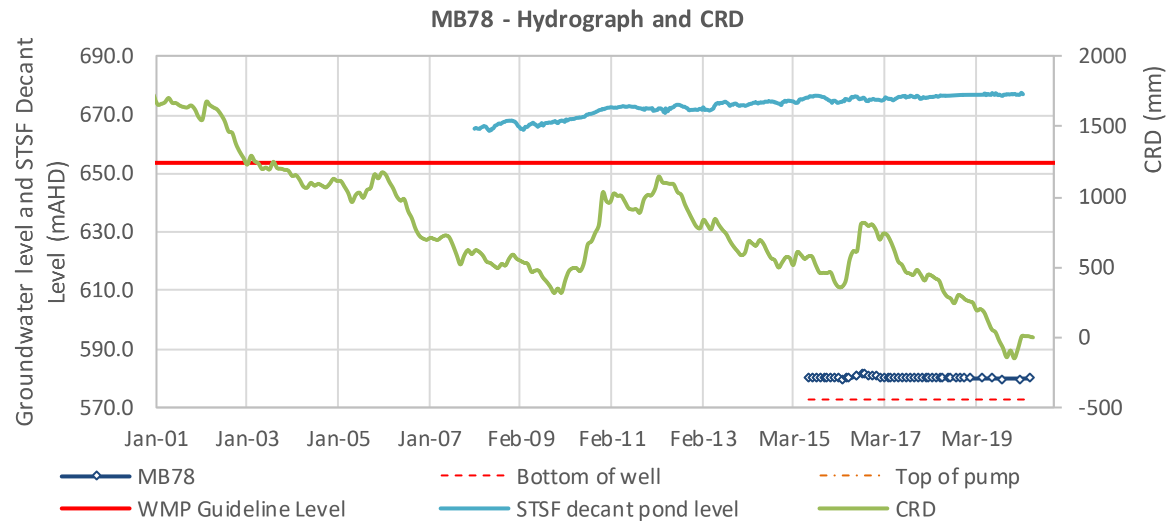


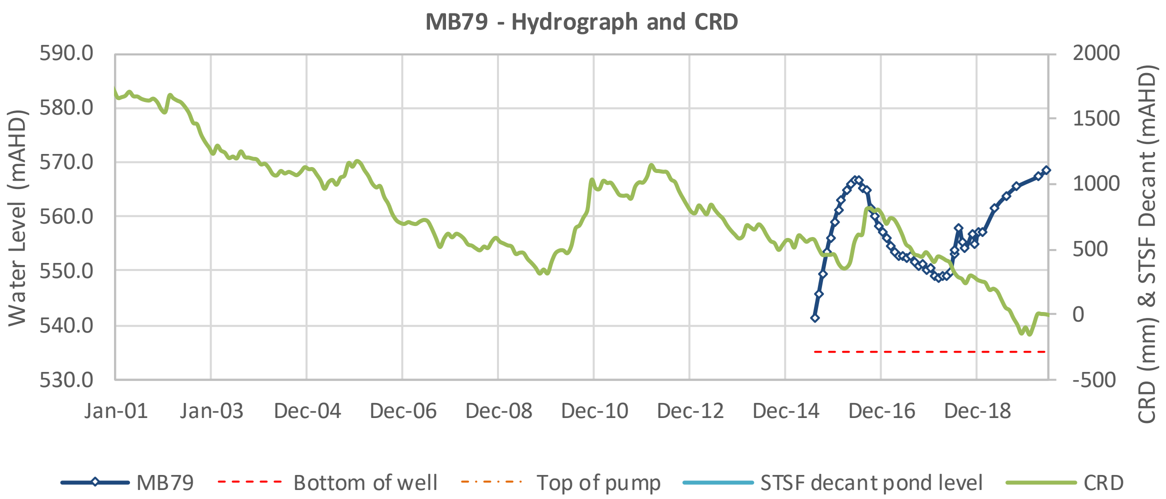



MB29B - Hydrograph and CRD
Groundwater level (mAHD)
640.0
638.0
636.0
634.0
632.0
630.0
628.0
626.0
624.0
622.0
620.0
2000
1500
1000
500
0
-500
CRD (mm) & STSF Decant (mAHD)
Jan-01
Jan-03
Jan-05
Jan-07
Feb-09
Feb-11
Feb-13
Mar-15
Mar-17
Mar-19
MB29B
Bottom of well
Top of pump
STSF decant pond level
CRD

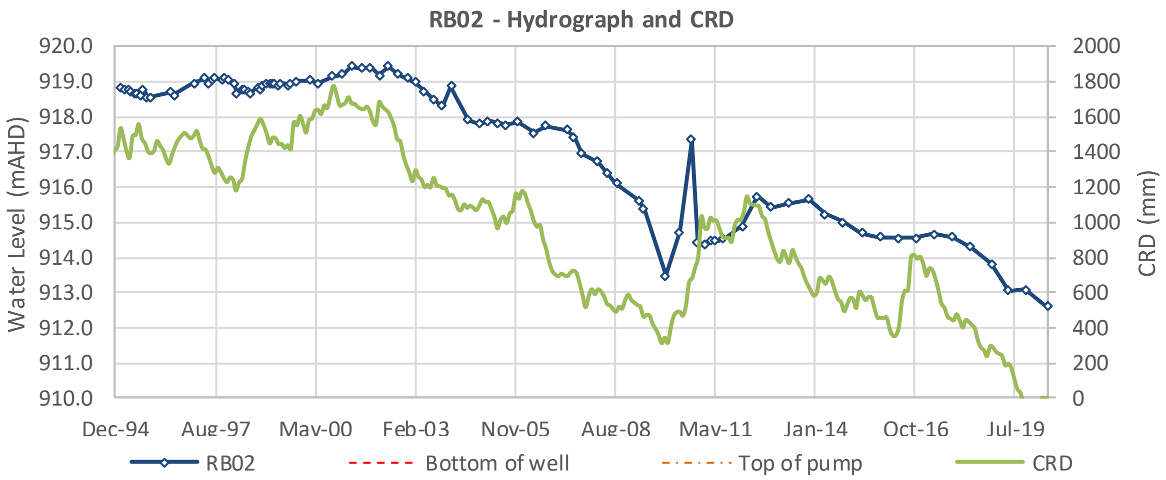

MB77A - Hydrograph and CRD
Groundwater level (mAHD)
660.0
659.0
658.0
657.0
656.0
655.0
654.0
653.0
652.0
651.0
650.0
2000
1500
1000
500
0
-500
CRD (mm) & STSF Decant (mAHD)
Jan-01
Jan-03
Jan-05
Jan-07
Feb-09
Feb-11
Feb-13
Mar-15
Mar-17
Mar-19
MB77A
Bottom of well
Top of pump
WMP Guideline Level
STSF decant pond level
CRD

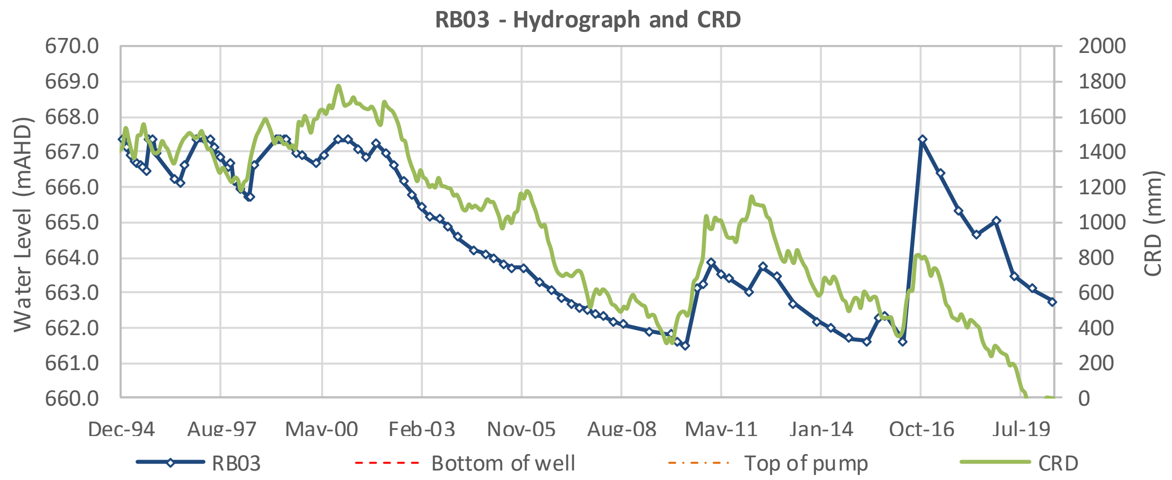

MB77B - Hydrograph and CRD
Groundwater level (mAHD)
660.0
659.0
658.0
657.0
656.0
655.0
654.0
653.0
652.0
651.0
650.0
2000
1500
1000
500
0
-500
CRD (mm) & STSF Decant (mAHD)
Jan-01
Jan-03
Jan-05
Jan-07
Feb-09
Feb-11
Feb-13
Mar-15
Mar-17
Mar-19
MB77B
Bottom of well
Top of pump
WMP Guideline Level
STSF decant pond level
CRD

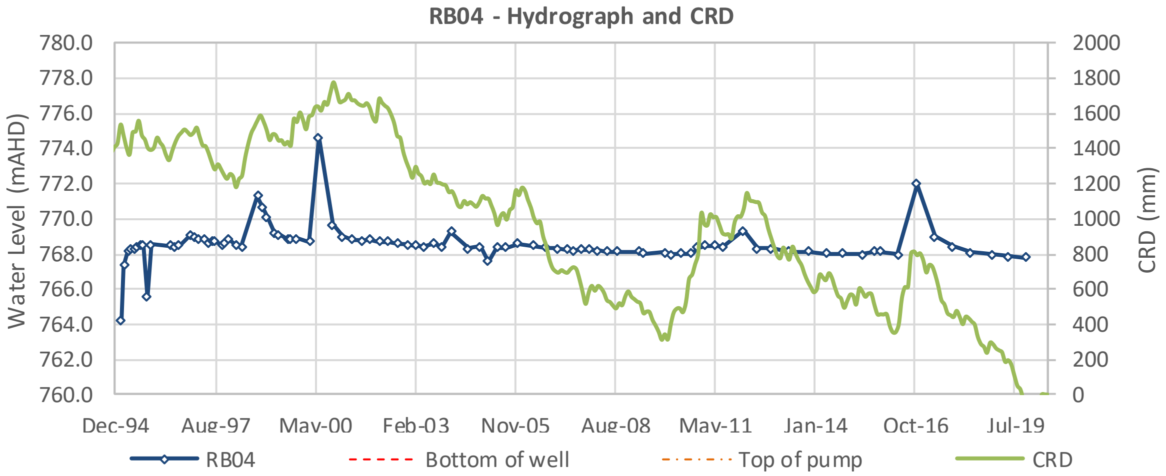

MB78 - Hydrograph and CRD
Groundwater level and STSF Decant Level (mAHD)
690.0
670.0
650.0
630.0
610.0
590.0
570.0
2000
1500
1000
500
0
-500
CRD (mm)
Jan-01
Jan-03
Jan-05
Jan-07
Feb-09
Feb-11
Feb-13
Mar-15
Mar-17
Mar-19
MB78
Bottom of well
Top of pump
WMP Guideline Level
STSF decant pond level
CRD

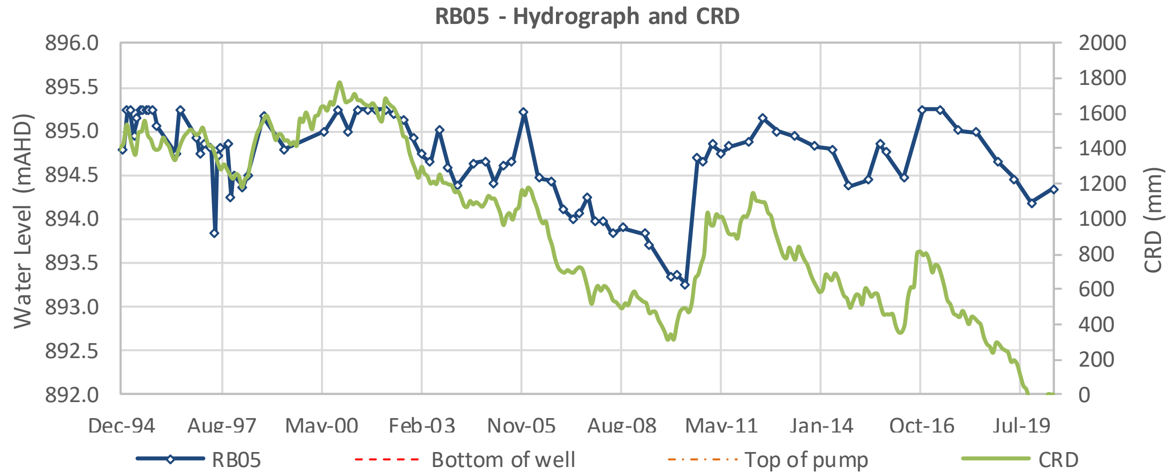

MB79 - Hydrograph and CRD
Water Level (mAHD)
590.0
580.0
570.0
560.0
550.0
540.0
530.0
2000
1500
1000
500
0
-500
CRD (mm) & STSF Decant (mAHD)
Jan-01
Jan-03
Dec-04
Dec-06
Dec-08
Dec-10
Dec-12
Dec-14
Dec-16
Dec-18
MB79
Bottom of well
Top of pump
STSF decant pond level
CRD

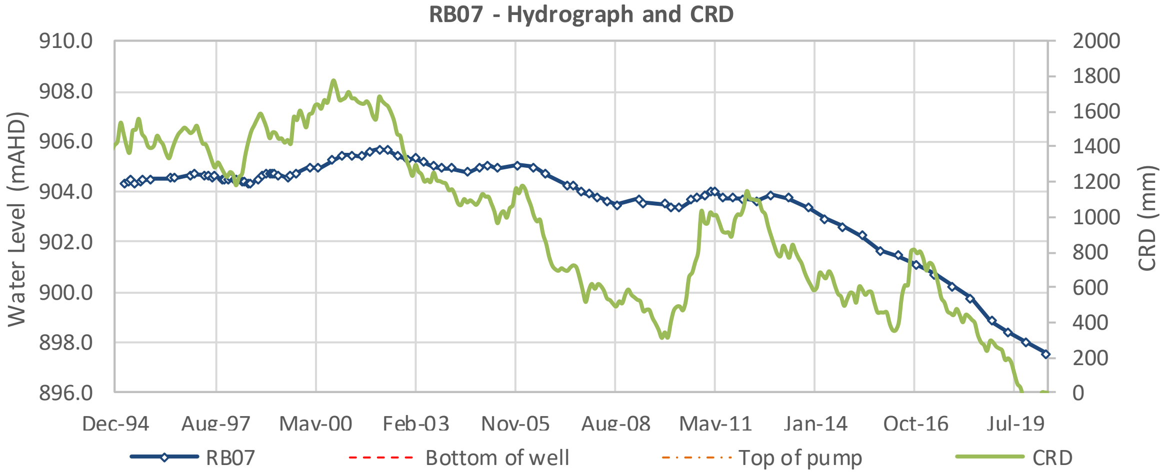
Regional bores

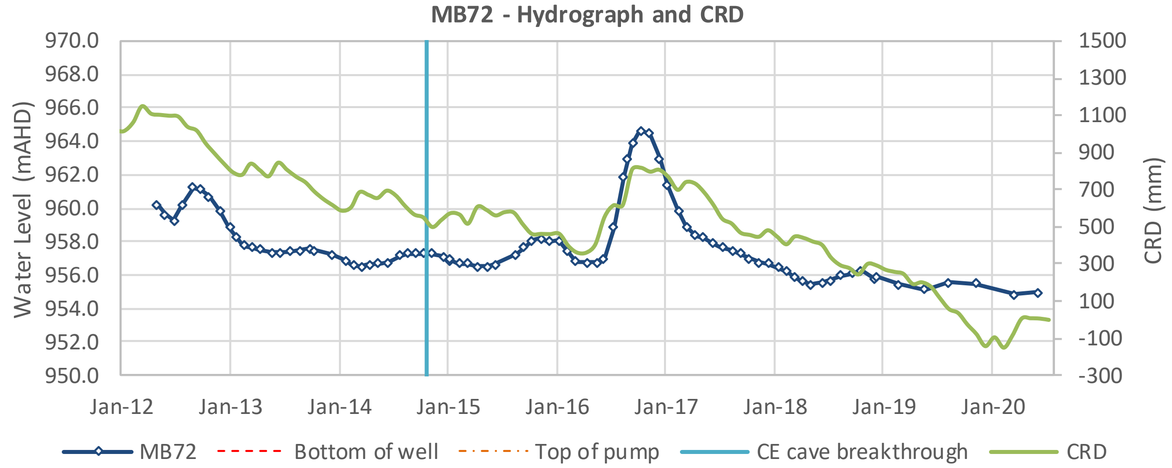


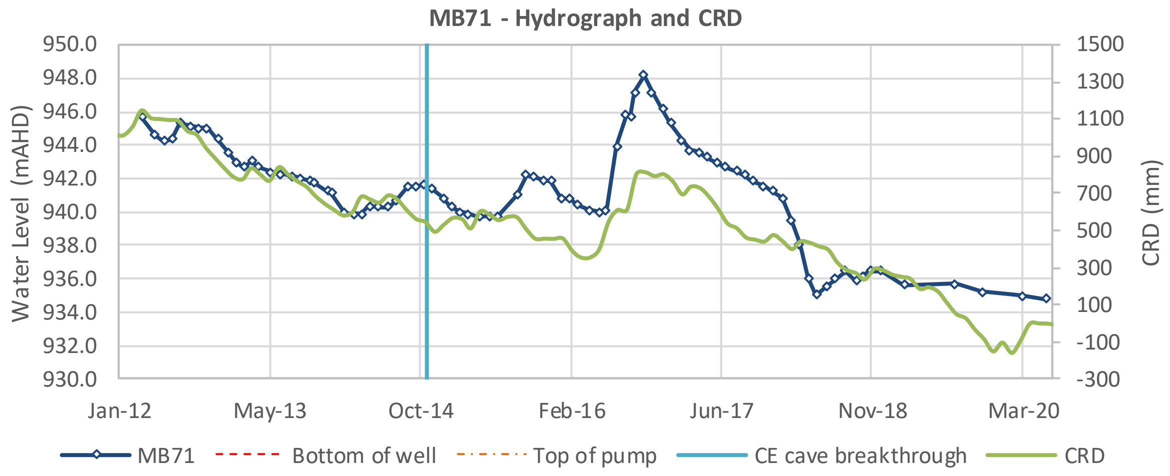


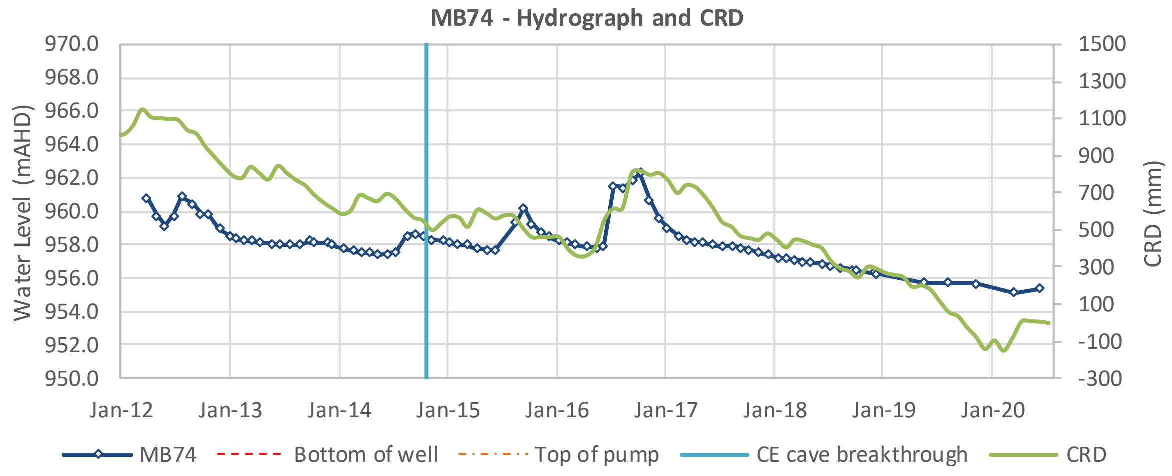


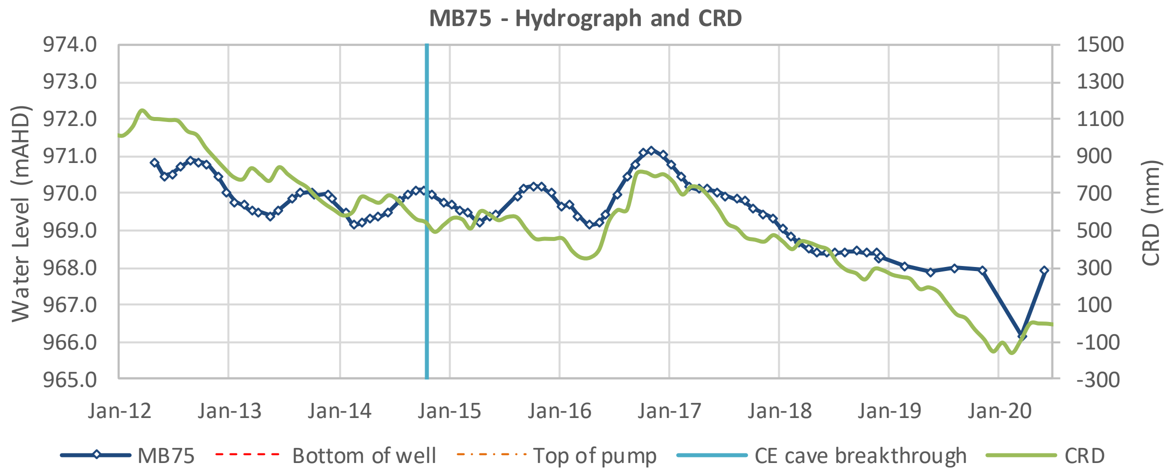







MB71 - Hydrograph and CRD
Water Level (mAHD)
CRD (mm)
950.0
948.0
946.0
944.0
942.0
940.0
938.0
936.0
934.0
932.0
930.0
1500
1300
1100
900
700
500
300
100
-100
-300
Jan-12
May-13
Oct-14
Feb-16
Jun-17
Nov-18
Mar-20
MB71
Bottom of well
Top of pump
CE cave breakthrough
CRD


MB74 - Hydrograph and CRD
Water Level (mAHD)
CRD (mm)
970.0
968.0
966.0
964.0
962.0
960.0
958.0
956.0
954.0
952.0
950.0
1500
1300
1100
900
700
500
300
100
-100
-300
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
MB74
Bottom of well
Top of pump
CE cave breakthrough
CRD


MB75 - Hydrograph and CRD
Water Level (mAHD)
CRD (mm)
974.0
973.0
972.0
971.0
970.0
969.0
968.0
967.0
966.0
965.0
1500
1300
1100
900
700
500
300
100
-100
-300
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
MB75
Bottom of well
Top of pump
CE cave breakthrough
CRD

Appendix D – Regression statistics

Table D-1 HARTT analysis results

Bore	R^2	Rainfall coefficient *a* (m/mm)	p-value (rain)	Time coefficient *b* (m/month)	p-value (time)	c (m)
MB44B	0.655	0.004	0.000	-0.018	0.000	903.360
MB48	0.985	0.002	0.000	-0.073	0.000	943.926
MB62	0.822	0.014	0.000	-0.036	0.005	897.906
MB63	0.611	0.009	0.000	-0.002	0.884	921.283
MB73	0.836	0.003	0.000	-0.013	0.000	856.693

Appendix E – Monitoring bores

Table E-1 Monitoring bores

Bore	Coordinates (MGA Zone 55)		Ground elevation (m AHD)	Top of casing (m agl)	Top of casing (m AHD)	Base of well (m AHD)	Aquifer	Screen zone (m bgl)
	Easting	Northing						
CB14A	684,907.2	6,295,330.8	711.78	1.04	712.82	699.48	Silurian Sediments	No Data
CB14B	684,908.9	6,295,332.6	711.76	1.01	712.77	674.26	Silurian Sediments	No Data
CB6A	684,406.8	6,293,812.7	688.46	0.38	688.84	648.46	Silurian Sediments	0.5-38
CB8A	685,417.7	6,297,580.3	738.47	0.46	738.93	717.47	Silurian Sediments	No Data
CB8B	685,456.3	6,297,539.4	738.40	0.57	738.96	732.20	Soil/Clay	0.3-6
CQ098	685,084.9	6,297,128.5	735.00	0.10	735.10	434.40	Backfilled pit	open hole
MB10A	684,515.9	6,293,538.5	688.04	0.58	688.62	670.04	Silurian Sediments	12-18
MB10B	684,516.5	6,293,539.5	688.11	0.40	688.51	681.41	Soil/Clay	0.7-6.7
MB11A	684,450.5	6,293,528.6	686.71	0.52	687.23	668.41	Silurian Sediments	12-18
MB11B	684,451.9	6,293,529.1	686.74	0.62	687.36	681.74	Soil/Clay	3.2-5.0
MB18	684,985.0	6,292,785.0	722.00	0.42	722.42	692.00	Silurian Sediments	17.6-29.6
MB1A	684,979.7	6,294,930.1	722.25	0.49	722.74	686.25	Silurian Sediments	28.5 - 34.5
MB1B	684,978.4	6,294,930.2	722.28	0.38	722.66	715.78	Soil/Clay	0.3 - 6.3
MB20	687,797.7	6,290,242.0	769.81	0.68	770.49	729.91	Silurian Sediments	9.9-39.9
MB21	687,285.6	6,290,278.2	738.67	0.39	739.06	708.77	Ordovician Volcanics	11.9-29.9
MB23	684,907.8	6,291,553.8	703.49	0.33	703.82	662.19	Ordovician Volcanics	11.37-41.37
MB24	684,839.4	6,292,111.9	696.44	1.10	697.54	665.54	Ordovician Volcanics	12.98-30.98
MB25	684,425.0	6,289,890.0	668.90	0.39	669.29	638.40	Ordovician Volcanics	18.5-30.5
MB26A	684,523.9	6,289,077.2	653.17	0.78	653.94	642.42	Ordovician Volcanics	4.5-10.5
MB26B	684,525.3	6,289,076.6	653.12	0.74	653.86	622.22	Ordovician Volcanics	19.0-30.0
MB27	684,590.1	6,288,854.6	593.94	0.83	594.77	582.44	Ordovician Volcanics	4.0-11.5
MB28A	684,976.4	6,288,932.8	650.95	0.80	651.75	640.35	Ordovician Volcanics	4.5-10.6
MB28B	684,975.6	6,288,931.8	650.96	0.77	651.73	630.36	Ordovician Volcanics	14.0-20.5
MB29A	684,911.6	6,288,686.1	649.06	0.80	649.86	638.56	Ordovician Volcanics	3.5-10.5
MB29B	684,911.1	6,288,687.8	649.05	0.77	649.82	622.75	Ordovician Volcanics	11.2-24.0
MB2A	684,779.8	6,295,098.5	709.23	0.40	709.63	691.63	Ordovician Volcanics	11.65 - 17.65

Bore	Coordinates (MGA Zone 55)		Ground elevation (m AHD)	Top of casing (m agl)	Top of casing (m AHD)	Base of well (m AHD)	Aquifer	Screen zone (m bgl)
	Easting	Northing						
MB2B	684,780.9	6,295,099.4	709.26	0.50	709.76	702.76	Soil/Clay	0.5 - 6.5
MB30	685,816.7	6,296,922.9	758.43	0.46	758.89	658.43	Tertiary Basalt	4-76
MB3A	684,827.4	6,295,130.2	710.55	0.61	711.16	694.55	Silurian Sediments	10 - 16
MB3B	684,828.6	6,295,130.8	710.60	0.50	711.10	704.20	Soil/Clay	0.45 - 6.45
MB43	688,945.4	6,295,921.0	932.97	0.48	933.45	757.97	Silurian Sediments	75-175
MB44A	688,950.9	6,295,906.8	932.62	0.33	932.94	790.62	Silurian Sediments	82-142
MB44B	688,950.7	6,295,916.4	932.88	0.29	933.16	885.88	Tertiary Basalt	26-47
MB46	689,833.8	6,295,943.8	923.61	0.35	923.96	835.61	Silurian Sediments	55-88
MB47A	690,383.8	6,296,020.2	871.63	0.59	872.22	689.63	Silurian Sediments	152-182
MB47B	690,380.3	6,296,020.0	871.76	0.45	872.21	799.76	Silurian Sediments	40-72
MB48	688,651.4	6,297,936.4	973.66	0.43	974.09	904.66	Silurian Sediments	26-69
MB49	687,958.9	6,297,415.0	961.11	0.56	961.67	922.11	Tertiary Basalt	20-39
MB4A	684,510.3	6,294,619.2	702.08	0.46	702.54	678.98	Ordovician Volcanics	17.1-23.1
MB4B	684,510.2	6,294,617.8	701.93	0.60	702.53	695.63	Soil/Clay	0.3-6.3
MB50	687,583.8	6,294,789.7	807.28	0.52	807.80	590.28	Silurian Sediments	197-217
MB51	687,590.6	6,294,787.2	807.17	0.45	807.62	751.17	Silurian Sediments	42-54
MB52	687,612.8	6,294,782.5	806.97	0.39	807.36	750.97	Silurian Sediments	35-55
MB53	689,622.1	6,302,656.8	985.15	0.54	985.69	937.15	Tertiary Basalt	27-45
MB54	689,514.7	6,302,625.0	991.49	0.52	992.01	968.99	Tertiary Basalt	15-21
MB55	689,507.5	6,302,626.4	992.13	0.60	992.73	983.13	Tertiary Basalt	6-9
MB56	689,499.6	6,302,627.7	992.86	0.49	993.35	960.86	Tertiary Basalt	23-30
MB5C	684,520.6	6,294,547.7	703.05	0.51	703.56	647.05	Tertiary Basalt	43-55
MB62	689,647.8	6,296,954.9	902.88	0.46	903.34	837.88	Silurian Sediments	39-63
MB63	689,086.8	6,299,792.7	947.75	0.48	948.23	929.55	Tertiary Basalt	10-16
MB64	689,326.7	6,299,876.2	932.47	0.15	932.62	866.47	Tertiary Basalt	25-62
MB65	689,344.3	6,299,605.6	927.59	0.20	927.79	862.59	Silurian Sediments	26-62
MB68	688,363.0	6,290,131.7	767.62	0.49	768.10	686.62	Ordovician Volcanics	64-78
MB69	688,092.5	6,289,493.8	754.16	0.42	754.58	685.81	Ordovician Volcanics	26.4-62.4

Bore	Coordinates (MGA Zone 55)		Ground elevation (m AHD)	Top of casing (m agl)	Top of casing (m AHD)	Base of well (m AHD)	Aquifer	Screen zone (m bgl)
	Easting	Northing						
MB6A	684,421.6	6,294,589.7	699.89	0.37	700.26	682.39	Ordovician Volcanics	11.59-17.59
MB6B	684,423.6	6,294,589.4	699.93	0.50	700.43	693.43	Soil/Clay	0.5-6.5
MB70	688,240.2	6,291,147.3	766.22	0.39	766.61	688.82	Ordovician Volcanics	47.4-71.4
MB71	694,087.3	6,295,181.8	951.76	0.38	952.15	914.96	Ordovician Volcanics	21.8-33.8
MB72	693,060.6	6,300,962.7	974.92	0.41	975.33	930.92	Tertiary Basalt	29.2-41.2
MB73	689,735.5	6,295,235.2	915.29	0.44	915.73	818.29	Silurian Sediments	75.35-94.35
MB74	693,501.0	6,298,198.3	962.90	0.47	963.37	936.30	Tertiary Basalt	6.6-24.6
MB75	691,195.1	6,303,380.4	976.11	0.43	976.54	914.21	Ordovician Volcanics	43.9-58.9
MB76	689,080.2	6,296,331.6	926.34	0.60	926.93	885.34	Silurian Sediments	25-26
MB77A	685,277.8	6,288,426.7	659.54	0.51	660.05	646.54	Silurian Sediments	6-12
MB77B	685,279.8	6,288,426.3	659.55	0.48	660.03	630.35	Silurian Sediments	23-29
MB78	684,496.0	6,288,441.0	586.00	0.52	586.52	572.50	Tertiary Basalt	6-12.5
MB79	684,296.0	6,288,041.0	575.00	0.58	575.58	535.00	Silurian Sediments	34-40
MB7A	684,588.1	6,293,429.5	687.33	1.15	688.48	669.33	Silurian Sediments	12-18
MB7B	684,589.7	6,293,430.2	687.62	0.62	688.24	681.22	Soil/Clay	0.45-6.45
MB80	688,301.4	6,292,840.5	804.10	0.73	804.83	740.10	Silurian Sediments	54-64
MB81	684,152.7	6,290,068.7	657.48	0.56	658.04	638.48	Silurian Sediments	14-19
MB82	687,647.8	6,297,323.7	962.54	0.75	963.29	858.54	Silurian Sediments	91-103
MB83	685,040.4	6,288,274.5	648.21	0.45	648.66	607.71	Ordovician Volcanics	37.2-40.2
MB84	684,138.6	6,289,326.3	649.98	0.63	650.61	635.98	Silurian Sediments	10.97-13.97
MB85	684,175.0	6,290,626.0	676.50	0.58	677.08	650.50	Silurian Sediments	25.84-22.84
MB86	684,261.4	6,291,865.4	685.65	0.66	686.30	663.65	Ordovician Volcanics	18.45-21.45
MB87	684,374.9	6,292,515.7	693.56	0.63	694.19	672.06	Ordovician Volcanics	18.4-21.4
MB88	688,067.3	6,296,312.6	948.91	0.60	949.51	858.91	Tertiary Basalt	78-90
MB8A	684,451.8	6,293,416.2	684.65	0.70	685.35	667.15	Silurian Sediments	11.5-17.5
MB8B	684,452.5	6,293,415.0	684.70	0.73	685.43	680.30	Soil/Clay	0.4-4.4
MB90	684,296.8	6,291,255.5	697.10	0.60	697.70	637.10	Tertiary Basalt	48-60
MB91	685,820.4	6,295,564.1	786.88	0.60	787.48	636.88	Ordovician Volcanics	138-150

Bore	Coordinates (MGA Zone 55)		Ground elevation (m AHD)	Top of casing (m agl)	Top of casing (m AHD)	Base of well (m AHD)	Aquifer	Screen zone (m bgl)
	Easting	Northing						
MB92	684,934.2	6,295,940.9	721.74	0.60	722.34	601.74	Ordovician Volcanics	102-120
MB93	685,276.0	6,296,919.0	732.74	0.60	733.34	612.74	Ordovician Volcanics	72-120
MB94	685706.12	6296693.39	591.04	0.60	591.64	No Data		114-140
MB96	685018.47	6296390.74	669.70	0.60	670.3	No Data		80-110
MB98	688,073.0	6,287,151.0	703.35	0.40	703.75	No Data		No Data
MB9A	684,537.8	6,293,505.8	687.65	0.78	688.43	671.15	Ordovician Volcanics	10.5-16.5
MB9B	684,538.1	6,293,507.4	687.70	0.68	688.38	681.50	Soil/Clay	0.2-6.2
MW1	709,011.3	6,288,165.1	650.00	0.40	650.40	642.50	Soil/Clay	2.5-7.5
MW2	709,114.1	6,288,145.1	650.00	0.40	650.40	641.00	Soil/Clay	3-9
MW3	709,286.3	6,288,118.4	650.00	0.40	650.40	644.00	Soil/Clay	2.5-6
MW4	709,138.5	6,288,097.8	650.00	0.40	650.40	641.00	Soil/Clay	3-9
PZ10	685,826.4	6,295,621.8	772.56	0.42	772.98	678.56	Ordovician Volcanics	75-85
PZ10A	685,826.0	6,295,619.0	772.56	0.36	772.92	712.56	Ordovician Volcanics	30-54
PZ4	686,020.7	6,295,821.4	748.97	0.30	749.27	699.12	Ordovician Volcanics	36-45
PZ5	686,010.7	6,295,815.8	747.65	0.35	748.00	647.65	Ordovician Volcanics	83-95
PZ89	685,100.0	6,296,767.4	732.66	0.30	732.96	582.66	Ordovician Volcanics	138-150
PZ89A	685,100.0	6,296,767.4	732.66	0.30	732.96	652.66	Ordovician Volcanics	52-60
PZ90	684,959.0	6,296,549.0	731.95	0.25	732.20	531.95	Ordovician Volcanics	155-170
RB01	687,934.6	6,300,011.6	902.06	0.52	902.58	852.06	Tertiary Basalt	14-50
RB02	687,982.2	6,298,603.4	951.66	0.31	951.97	891.66	Tertiary Basalt	24-60
RB03	683,340.0	6,291,777.0	667.00	0.35	667.35	645.00	Tertiary Basalt	8-22
RB04	683,830.0	6,294,745.0	795.00	0.50	795.50	735.00	Silurian Sediments	No Data
RB05	682,805.0	6,295,098.0	895.00	0.25	895.25	874.00	Silurian Sediments	6-21
RB07	687,672.8	6,297,314.0	962.58	0.88	963.46	No Data	Silurian Sediments	No Data
RO10A	682,569.1	6,299,365.9	903.63	0.52	904.15	849.63	Tertiary Basalt	39-44
RO10B	682,567.1	6,299,382.8	904.03	0.42	904.45	755.53	Ordovician Volcanics	89-136
RO11	683,764.3	6,299,739.1	908.98	0.53	909.51	872.98	Tertiary Basalt	24-36
RO12	683,143.9	6,299,709.2	923.40	0.80	924.20	891.90	Tertiary Basalt	25.4-31.4

Bore	Coordinates (MGA Zone 55)		Ground elevation (m AHD)	Top of casing (m agl)	Top of casing (m AHD)	Base of well (m AHD)	Aquifer	Screen zone (m bgl)
	Easting	Northing						
RO6A	683,151.4	6,298,576.2	901.58	0.43	902.01	859.58	Tertiary Basalt	31-37
RO6B	683,149.8	6,298,582.9	901.71	0.46	902.17	753.71	Ordovician Volcanics	52-136
RO7	682,917.5	6,298,935.0	900.71	0.63	901.34	832.71	Tertiary Basalt	50-62
RO8	683,669.6	6,298,150.5	897.97	0.56	898.53	880.47	Tertiary Basalt	11.5-17.5
RS03	683,891.5	6,299,169.7	889.13	0.68	889.81	881.13	Soil/Clay	6.5-8.0
RS07	682,993.3	6,299,730.6	917.10	0.65	917.75	905.60	Soil/Clay	10.0-11.5
RS08	683,018.5	6,299,720.1	918.87	0.64	919.51	908.87	Soil/Clay	8.5-10.0
RS09	682,699.8	6,298,840.1	891.45	2.04	893.48	885.65	Soil/Clay	4.3-5.8
RS10A	682,662.0	6,298,859.7	888.08	0.73	888.81	884.08	Soil/Clay	2.4-2.9
RS10B	682,670.2	6,298,855.3	888.97	0.66	889.63	884.97	Soil/Clay	2.5-4.0
RS11	682,621.7	6,298,880.6	883.76	0.68	884.44	873.26	Soil/Clay	9.0-10.5
RS12	682,596.0	6,298,893.9	879.82	0.80	880.62	871.82	Soil/Clay	5.0-8.0
TW05MB	686,633.0	6,289,135.0	664.68	0.60	665.28	604.68	Tertiary Basalt	30-60

Appendix F – WAL bore allocation and use

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