EC Trigger Investigation of GWc1, GWc3, GWc4 and GWc5

Wilpinjong Coal Mine

Wilpinjong

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Revision Record

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1	12 October 2023	Thea McIntyre	David Western	David Western
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Basis of Report

This report has been prepared by SLR Consulting Australia (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Wilpinjong (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

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SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

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1.0 Introduction

SLR Consulting Australia Pty Ltd (SLR) has been commissioned by Wilpinjong Coal Pty Ltd (WCPL) to investigate groundwater recharge mechanisms and drivers for changing water quality and Electrical Conductivity (EC) trigger exceedances at four coal measures monitoring bores.

This report presents a review of relevant existing information and findings on possible drivers for the observed EC trigger exceedances. Recommendations on further work to improve the confidence of these findings, as well as updates to the EC trigger levels are provided.

1.1 Project background

Wilpinjong Coal Mine (WCM) is owned and operated by Wilpinjong Coal Pty Limited (WCPL), a wholly owned subsidiary of Peabody Energy Australia Pty Ltd (Peabody). WCM is an existing open cut coal mining operation situated approximately 40 kilometres (km) north-east of Mudgee, near the Village of Wollar, in central New South Wales (NSW). WCM produces thermal coal products which are transported by rail to domestic customers for use in electricity generation and to port for export.

Coal measures monitoring bores GWc1, GWc3, GWc4 and GWc5 are monitored on a monthly basis as part of the Groundwater Management Plan (GWMP) (Peabody 2017). In line with the groundwater response plan for trigger exceedances outlined in the GWMP, further investigation is required at these bores, as recommended in the 2021 and 2022 Annual Review reports, due to ongoing or historical exceedances of EC trigger values.

1.2 Groundwater Management Plan EC compliance

Water quality triggers were established in the GWMP for EC, amongst other parameters, based on the water quality records for the baseline period between 2004 and 2009. As defined in the ANZECC and ARMCANZ (2000) guidelines, the trigger levels for EC were defined based on the 80th percentile of available baseline data for each bore.

The EC trigger values established in the 2017 GWMP are:

- GWc1 = 2,844 µS/cm
- GWc3 = 3,304 µS/cm
- GWc4 = 2,412 µS/cm
- GWc5 = 4,798 µS/cm

The GWMP also establishes a Trigger Action Response Plan (TARP) that should be followed if a trigger value is exceeded on three consecutive monthly monitoring events.

The GWMP stipulates that Peabody should “conduct a preliminary investigation with a review of the monitoring results in conjunction with site activities being undertaken at the time, baseline groundwater monitoring results, groundwater results at nearby locations, the prevailing and preceding meteorological and streamflow conditions and changes to the land-use/activities being undertaken in the contributing hydrogeological regime, including mining activities”.

The investigation undertaken to complete this report is considered the required 'preliminary investigation'.

The EC observations exceeding the trigger values at each bore are:

- GWc1 – periodic exceedances of the EC trigger since observations commenced in 2006 (2008/9, 2013, 2015/16, 2017-19, 2021/22).
- GWc3 – EC observations above the trigger level from 2013-22. Current observations near the trigger level.
- GWc4 – Stable EC observations near and above the trigger level since monitoring commenced in 2006.
- GWc5 – EC observations above the trigger level since 2010 have been relatively stable since 2013.

1.3 Scope of this report

The objective of this report is to investigate groundwater recharge mechanisms and drivers for changing water quality at GWc1, GWc3, GWc4 and GWc5 and EC trigger exceedances.

To achieve this objective, the following scope of work is presented in this report:

- Review and analysis of available information (**Section 2.0**) including:
  - Bore construction details.
  - Available groundwater quality data and preparation of graphs including:
    - graphs and maps to display up-to-date water level and quality trends;
    - water-type analysis using Piper diagrams; and
    - review of water quality and hydraulic gradients from potential water sources that may be driving observed changes in water quality.
- Summary and recommendations (included in **Section 3.0**)
  - Commentary on the potential mechanisms that could be causing the high EC and change in groundwater quality.
  - Identification of any information gaps or uncertainties and recommendations to address them.
  - Recommendations on the update of trigger levels where no effect attributable to Wilpinjong operations can be identified.

2.0 Review of existing information

This section includes a review of the available information. This assessment is limited to GWc1, GWc3, GWc4 and GWc5. However, to understand the relationship between the coal measures and the alluvium at each location, information from the nearest alluvium bore (GWa2, GWa6, GWa7, and GWa8) is also assessed. In addition, where relevant, information from other surrounding coal measures bores and mining operation features has been included.

A summary of climate conditions and mining operations is also included.

2.1 Information available

The following data was reviewed in preparation of this report:

- Annual Review 2022, Groundwater Compliance Report (SLR 2023)
- Annual Review 2021, Groundwater Compliance Report (SLR 2022)
- Wilpinjong Coal Groundwater Management Plan, August 2017, WI-ENV-MNP-0041
- Updated water quality database sent by WCPL, updated to May 2023
- Pit dam water elevation monitoring data sent by WCPL up to July 2023

2.2 Climate

Monthly rainfall at WCM is presented on **Figure 1** along with the cumulative rainfall departure (CRD). The monthly rainfall series is coloured based on whether a month is above (blue) or below (brown) the long-term average for that month.

The CRD shows trends in actual rainfall over time relative to the long-term average and provides a historical record of relatively wet and dry periods. A positive slope in the CRD indicates periods of above average rainfall, while a negative slope indicates periods of below average rainfall. A neutral slope indicates rainfall conditions are equal to average rainfall conditions.

Since commencement of mining, WCM has experienced extended periods of above average rainfall conditions between 2007 and 2012 as well as between 2020 and 2022 as indicated by a sharp upward trend in the CRD. This contrasts with the declining CRD trend preceding these periods (**Figure 1**).

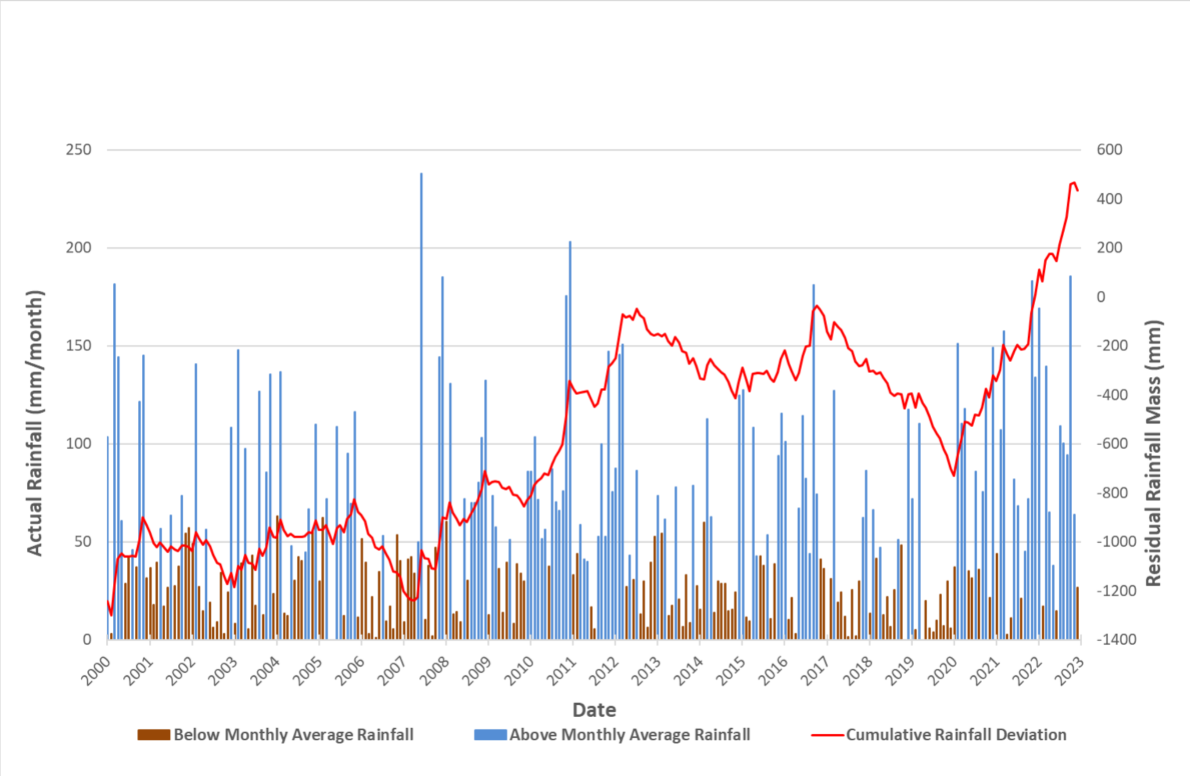


Figure 1 Monthly rainfall and CRD

Table 1 highlights the ongoing wet conditions experienced from 2020 to 2022, which was preceded by drought conditions from 2017 to the end of 2019. The annual total rainfall recorded in 2022 was 989 mm, 65% higher than the long-term average of 593.8 mm.

Variation in rainfall (at both annual and monthly time-scales) can be a key influence on surface water and shallow groundwater conditions, and deeper groundwater conditions where there is connectivity, and can influence water chemistry. Values below 20% of the average and more than 80% of the long-term average have been highlighted in **Table 1**.

Table 1 Long Term Average Rainfall and Recent Rainfall (Monthly and Annual)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Ave	***67***	***63***	***55***	***39***	***37***	***44***	***43***	***41***	***42***	***52***	***57***	***61***	***594***
2016	101	10	21	3	67	114	82	44	181	74	41	36	776
2017	13*	31	127	19	24	12	1	26	2	30	63	86	421
2018	13	66	41	47	13	22	7	26	51	49	44	118	496
2019	72	5	111	0	20	6	4	10	23	7	30	6	294
2020	37	151	110	118	35	31	86	36	76	128	22	149	979
2021	44	107	158	3	11	82	68	21	45	72	183	134	927
2022	169	17	140	65	38	15	109	101	95	126	85	31	989
2023	49	28.5	55	43.5	4	30.5	-	-	-	-	-	-	-

* No rainfall recorded at Wollar (Barrigan St). Rainfall from Bylong (Glenview) – 062107 used.

2.3 WCM Operation

WCM has been in operation since 2006 and includes 8 open pits. Open cut mining targets the Ulan Coal Seam and the underlying Moolarben Coal Member (Peabody 2022).

WCM operates a number of surface water storages (pit dams) and tailings dams around the site including Pit Dam 2, located 900 m east (downstream on Wilpinjong Creek) from GWc1. Water has also accumulated in partially backfilled open cuts around the site (Pit 3&4) following the period of above average rainfall from 2020 to 2022. Pit 3&4 voids are located within 300 m of GWc3.

WCM has been monitoring water elevations in the pit dams since 2016. The elevation of the pit dams has been plotted on the hydrographs of the nearest coal bore in **Appendix A.**

A reverse osmosis (RO) plant has been installed to allow on-site treatment of mine water and subsequent discharge to Wilpinjong Creek in accordance with an Environment Protection Licence (EPL).

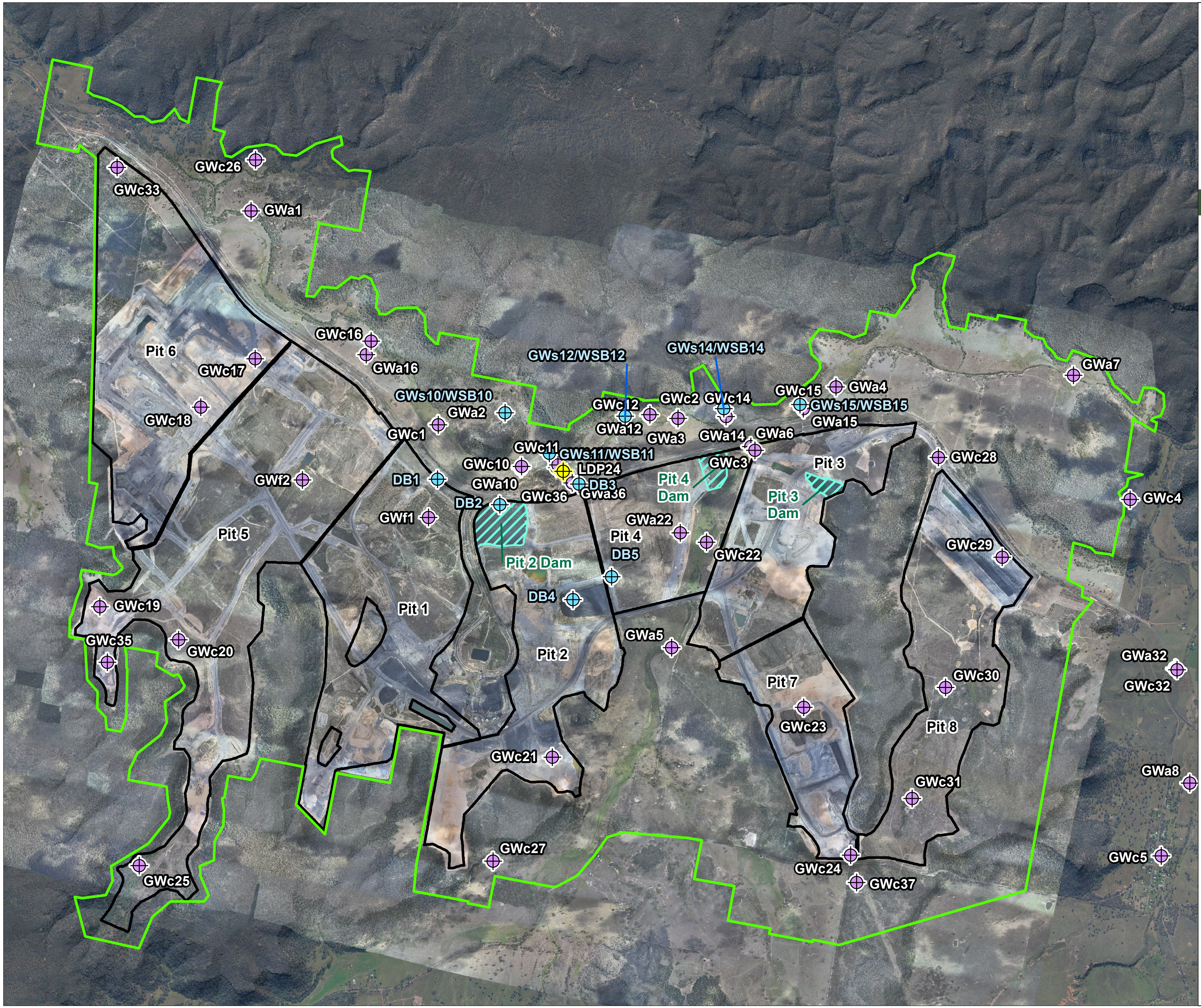
Groundwater has been extracted from dewatering bores (‘DB’ series bores) and water supply bores (‘GWS’ series bores) at WCM. Approximately 15 ML of groundwater was extracted from the ‘DB’ series bores over two months in 2006 which were then discontinued as extraction bores. Groundwater was extracted from the ‘GWS’ series bores in 2007 (approximately 98 ML over 3 months) and then again in 2019 (approximately 114 ML over 12 months). Compared to the predicted pit water inflows estimated from the groundwater model (1,300 ML/year in 2013-14 reducing to a minimum of 500 ML/year in 2024-25), the volumes pumped from the ‘DB’ and ‘GWS’ series bores are small (SLR 2020) and hence, not considered further in this assessment.

The location of the open pits, pit dams, dewatering and water supply bores and the discharge point of the RO plant (EPL 12425) is shown in **Figure 2**.

WILPINJONG COAL

Bore Locations

FIGURE 2



- Monitoring Bore
- Licensed Discharge Point
- Dewatering and Water Supply Bore
- Water Pit Dam
- WEP DA Boundary
- Approved Pit Extent

0 0.5 1 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:52,000 at A4
Project Number:	665.10014
Date:	10-Oct-2023
Drawn by:	JH

\\au.slr.local\Corporate\Projects-SLR\660-SrvWOL\660-WOL\665.10014 Wilpinjong GW\06 SLR Data\01 CADGIS\ArcGIS\GIS\66510014 F01 BoreLocations_003.mxd

2.4 Geological Setting

The local surface and structural geology at WCM has been summarised from the HydroSimulations (2015) Environmental Impact Statement (EIS) for the Wilpinjong Extension Project (WEP) and is presented on **Figure 3** (HydroSimulations, 2015).

The key geological features of the WCM area are:

- Elevated sandstone plateaus of the Narrabeen Group.
- Permian Illawarra Coal Measures (ICM), the dominant outcropping lithology over the mining lease, which includes:
  - the Moolarben Coal Member, which is a secondary economic coal resource;
  - Ulan Coal Seam (the primary economic coal resource);
  - Marrangaroo Sandstone and underlying Nile Sub-Group; and
  - Shoalhaven Group and older units acting as the ‘basement’.
- Recent, Quaternary-aged alluvium/colluvium along Wilpinjong Creek and alluvium along Cumbo Creek and Wollar Creek. Alluvial bodies are quite narrow (laterally) near to WCM.
- Unconsolidated deposits in the western portions of the WCM. Near to and within the Moolarben Coal Complex this represents a coarse-grained lithology almost 60 m deep.

Major structural features associated with a number of hingelines and faults, as shown on the Western Coalfield Map (Yoo, 1998). Faults have been observed and mapped by WCPL, such as that in Pit 3. The potential influence of these structures on groundwater conditions is currently unknown.

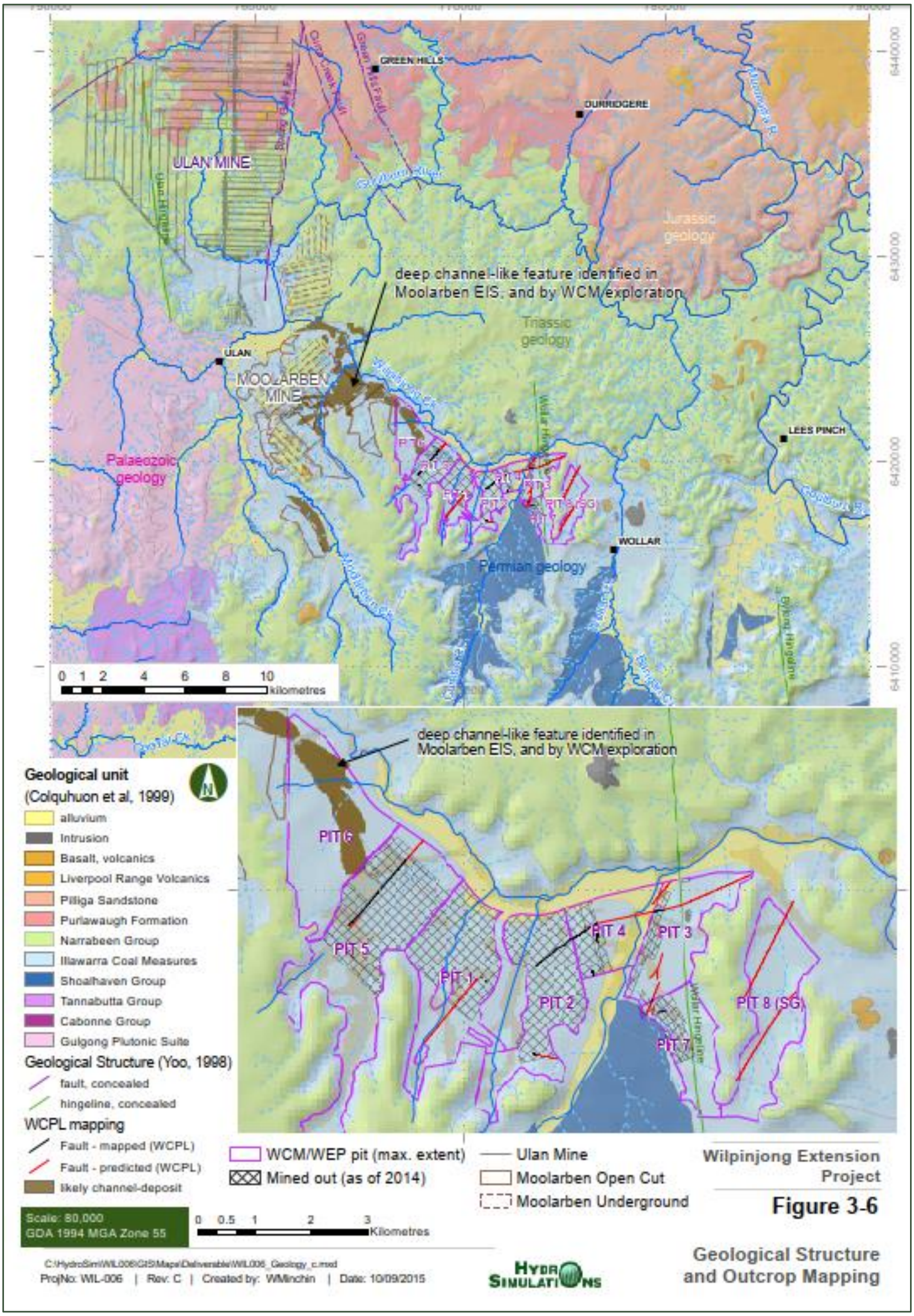


Figure 3 Wilpinjong Surface Geology and Structural setting (HydroSimulations, 2015)

2.5 Hydrogeological Setting

The hydrogeological conceptualisation developed for the Wilpinjong Extension Project (WEP) by Hydrosimulation (Hydrosimulation 2015) is summarised below.

Two groundwater systems are identified:

- A porous rock groundwater system: primarily the Illawarra Coal Measures.
- An alluvial groundwater system: associated primarily with Wilpinjong, Wollar and Cumbo Creeks.

Recharge to the groundwater systems would occur primarily from rainfall and runoff infiltration, and lateral groundwater flow. Perched water tables might be sustained at high elevations due to the presence of occasional mudstone and/or siltstone beds between the sandstone layers.

Alluvium associated with Wilpinjong Creek, Wollar Creek and Cumbo Creek are conceptualised as gaining systems under natural conditions with groundwater discharging upwards from the Permian rocks to the alluvium. This likely results in mixing between rainfall/runoff derived water and the Permian sourced groundwater.

Groundwater quality within and surrounding WCM is highly variable but generally poor. In some areas such as lower Cumbo Creek, the highest groundwater salinity is found in the alluvium and may indicate discharge of Permian water to the alluvium that subsequently undergoes evapo-concentration, further increasing the salinity. In other areas such as watercourses associated with Wilpinjong and Wollar Creeks, higher salinity is found in the coal measures compared to the alluvium, which may be related to dilution in the overlying alluvium by fresher rainfall/ runoff.

2.6 Bore construction detail

Bore construction details (e.g. gravel pack interval, hydraulic seal (bentonite/ grout), presence of well end-cap, etc) or site-specific lithology information is not available for the bores included in this study. Downhole camera surveys (DHC) were carried out in 2021 and 2022 where the depth of the bore and the screened interval was inferred based on camera outputs. Based on the depth of the screened interval, and the geological model of the site, the unit targeted by each bore was also inferred (see **Table 2**). Based on the results of the DHC, it is also noted that there is a 15 m sump at GWc1 and a 5 m sump at GWc3.

Table 2 Construction and geological summary of coal measures bores

Bore ID	Easting[1]	Northing[1]	Ground Elevation (m AHD)	Casing Stickup (m)	Downhole Camera Survey		Inferred Intersected Strata
					Screened interval m + (m AHD)	Total depth (m)	
GWc1	770339	6420335	376.3	0.29	22 – 28 (354.3 - 348.3 –)	43.4	Ulan Seam (D-G Plies)
GWc3	773517	6420073	362.5	0.42	4.8 – 11.1 (357.7 - 351.4)	16.3	Turill Seam/ Moolarben Seam of
GWc4	212468	6419295	362.6	0.37	66 - 72 (296.9 - 290.6)	77.5	[2]Ulan Seam basal plies (D-G Plies)
GWc5	777608	6415996	362.2	0.56	32 – 53 (330.2 - 309.2)	54.4	[2]Marrangaroo Formation/ Shoalhaven Group[2]

+GWc1 and GWc5 carried out by DHC in 2020, GWc3 carried out in 2021.

[1] GDA1994 MGA Zone 55

[2] GWc4 and GWc5 are located outside of the extent of the geology model reviewed for this investigation. Geology inferred based on near-point from model to both GWc4 and GWc5.

An updated site geological model could be reviewed, or additional drilling could be undertaken to confirm the most likely target formations of GWc4 and GWc5. This is recommended to be considered as part the broader GWMP and monitoring network review (see **Section 3.2**).

2.7 Groundwater levels

Hydrographs showing the groundwater level of each coal measures monitoring bore and nearest alluvium bore are presented in **Appendix A**. The hydrographs also show the date of operation of each pit, the water elevation in the closest pit dam (for GWc1 and GWc3) and the CRD (described in **Section 2.2**). The location of the pits is shown in **Figure 2**.

This section provides a discussion on observed water level trends at each of the bores considered in this investigation only. Further analysis and evaluation of the drivers of observed water level change are further discussed in **Section 3.1.**

2.7.1 GWc1

Figure A - 1 shows that at GWc1 groundwater levels in the coal seam are below groundwater levels in the overlying alluvium indicating that a downward vertical gradient exists between the alluvium and the Ulan Seam at this location. In mid-2006, there was a 13 m decrease in groundwater elevation at GWc1 which coincided with mining at Pit 1 and the 2007 drought, suggesting that this decrease was likely influenced by mining and climate at that time. Groundwater levels later recovered and have followed a similar trend to the CRD.

Where data is available, (from 2016 onwards) groundwater elevations at GWc1 also display a similar trend (although generally at a lower elevation) to water elevations in Pit Dam 2. Pit 2 Dam is located 950 m southeast of GWc1 and is separated from the backfilled Pit 1 void (directly adjacent to GWc1) by a section of unmined rock. Considering the hydraulic gradient only, stored water in Pit 2 Dam could potentially flow from the Pit 2 Dam to GWc1by a hydraulic connection via the Ulan Seam. It is noted however, that backfilled Pits 1 & 5 are closer to GWc1, and water levels within these pits could also theoretically be influencing observed groundwater levels at GWc1. As further explained in **Section 2.8**, the water type from Pit 2 Dam is distinct from the GWc1 water type and additional data is needed to demonstrate any hydraulic connection between the backfilled Pits 1 and 5 and GWc1.

2.7.2 GWc3

Figure A - 2 shows that GWc3 used to have levels above that of the nearby alluvial bore, GWa6, indicating a historical upward hydraulic gradient from the coal measures to the alluvium at this location. This upward gradient is observed to continue during the millennium drought which ended in 2007. Depressurisation in the coal measures, likely due to mining at Pit 3, Pit 4, and Pit 7, is observed in GWc3 from 2014 onwards, resulting inGWc3 groundwater levels dropping below those in the overlying alluvium (downward hydraulic gradient). GWc3 and GWa6 were recorded as dry from early 2014 to early 2016, and again from 2018 to 2020 (during dry climatic periods when mining related drawdown is also observed)**.** It is noted that observations which are considered 'dry' at GWc3 are those which have returned a depth to water greater than the depth of the screened interval (see **Table 2**). As bore construction at this location is not well understood (sealed or slotted end-cap), it is difficult to verify whether water collected from a bore sump would be representative of surrounding aquifer conditions.

From 2020 onwards, groundwater elevations at GWc3 were similar to the water level in the adjacent Pit 4 void and Pit 3 void. Pit 4 and Pit 3 voids are located 300 m west and 250 m southeast respectively. Based on water elevations, there is potential for hydraulic connection between Pit 4 and/or Pit 3 and GWc3 via the Turill/ Moolarben Seams. The potential for connection is not completely understood and requires further investigation.

2.7.3 GWc4 and GWc5

The evaluation of vertical hydraulic gradients from/ to the coal measures near GWc4 and GWc5 is difficult to directly evaluate due to the distance between each coal measures bore and the selected accompanying alluvial/ shallow bore. GWa7 is 1.3 km from GWa4 and may be more influenced by Wilpinjong Creek conditions (GWc4 is closer to Wollar Creek), while GWa8 is 0.8 km downstream of GWc5 (**Figure 2**).

Figure A - 3 shows consistent groundwater elevations (minimal fluctuations) at GWc4 through the millennium drought (to 2007), before decreasing ~3 m between 2013 and 2020. This coincides with mining at Pit 3 and 7 as well as a period of below average rainfall from 2017 to 2020. It is noted that a minimal response to above average rainfall in 2016 was observed. From 2020 to 2022, GWc4 groundwater levels return to near-baseline levels, which coincides with a period of above average rainfall (see **Section 2.2**). These trends suggest some depressurisation at GWc4 due to mining in-addition to dry climatic conditions.

Figure A - 4 shows groundwater levels at GWc5 follow the CRD trend, with no evident depressurisation due to Wilpinjong mining observable at this location. It is noted that groundwater elevations during the millennium drought (up to 2007) are the lowest observed at GWc5, suggesting that a combined mining-climate influence, as is inferred at GWc4, is not occurring at this location.

2.8 Water Quality

2.8.1 Field EC

Time series graphs showing the variation of EC have been prepared and are presented in **Appendix A**. For each coal measures monitoring bore the EC of the closest alluvium bore is also shown on the same graph as well as the CRD.

The EC of Water Treatment Plant (WTP) Feedwater (sourced from Pit 2 Dam), and other potential pit/mine water sources (Other_P2Dam_RawWD) are also considered within this EC review. While Pit 2 Dam is not directly adjacent to any of the monitoring locations considered in this assessment, it stores water pumped from other pits within WCM prior to treatment and discharge from the RO Plant. EC observations for these sources are available from 2012 to 2021 (Other_P2Dam_RawWD), and mid-2021 to 2023 (WTP_Feedwater) and are considered a useful proxy for ‘mine affected water’ at WCM.

The following sections provide a discussion on observed trends in the EC data only. Analysis of the trends, and evaluation of potential drivers of water quality change are discussed in **Section 3.1**.

2.8.1.1 GWc1

Figure A - 1 shows the variation of EC at GWc1 and nearby alluvium bore GWa2 along with WTP_Feedwater, Other_PitDam_RawWD, spoil bore GWf3 the CRD and the current EC trigger level of 2,844 µS/cm.

The EC at GWc1 is characterised by low ECs ranging between 1,500 to 2,500 µS/cm, with rapid increases to stable peaks ranging between 3,000 and 3,500 µs/cm. These peaks exceed the EC trigger value for this bore. EC at GWc1 exceeded the trigger level throughout 2021 and 2022 and has periodically exceeded the trigger value in since 2008.

The following observations in EC at GWc1 are made:

- There is no direct correlation between the peaks and troughs in EC and rainfall, with the peaks occurring during both low rainfall times (2019 to 2020) as well as high rainfall times (2021). No seasonal trend is observed.
- The changes in EC do not correlate with changing groundwater levels at GWc1.
- The EC pattern is not observed in the overlying alluvium at GWa2, or at the nearby coal bores - GWc16 (EC around 2,000 – 2,500 µs/cm) and GWc10 (EC around 2,800 to 4,000 µs/cm) (SLR, 2023). The EC trends appear unique to GWc1.
- GWc1 is located 1.3 km upgradient of the discharge point from the RO plant to Wilpinjong Creek and would not likely be influenced by it.
- There is no water quality monitoring of spoil or mine voids directly adjacent to GWc1, however there is water quality monitoring of stored water within Pit 2 Dam (WTP Feedwater) and three (3) spoil bores (GWf1, GWf2, and GWf3) that are in the vicinity of GWc1.
- Water quality monitoring of Pit 2 Dam (WTP Feedwater) shows EC levels that are similar to, but slightly higher than (3,500 – 4,000 µs/cm) GWc1 EC observations during trigger exceedance periods.
- Water quality monitoring of spoil bore GWf3 (located ~2 km south-west of GWc1) shows EC trends are similar to those observed in WTP_Feedwater but are generally higher than GWc1. It is noted that neither GWf3 or WTP_Feedwater show the same sharp decline in EC that is observed at GWc1 in 2023. Spoil bores GWf1 and 2 have historically remained dry.
- As mentioned in **Section 2.7.1**, hydraulic gradients indicate there is a potential flow path between stored water (Pit 2 Dam), groundwater within the spoil (GWf3), and groundwater at GWc1. However, the absolute EC and variation in EC at GWc1 is not matched by Pit 2 Dam stored water (WTP_Feedwater) and GWf3 and there is no clear evidence of direct influence or mixing.

2.8.1.2 GWc3

Figure A - 2 shows the variation of EC at GWc3 and GWa6 along with the CRD and the current EC trigger value of 3,304 µS/cm. As mentioned in **Section 2.7.2**, groundwater levels in GWc3 dropped below the screen level between 2019 and 2021 and those data points are not shown on **Figure A - 2.**

The following is observed:

- Baseline EC at GWc3 (2006-2009) varies between 2,000 µS/cm and 3,800 µS/cm.
- EC at GWc3 has varied from approximately 3000 µS/cm to 6,500 µS/cm between 2009 and 2021 during which time the trigger level was exceeded. It is noted that periods where observed depths to water were below the base of the screen have been discounted. (early 2014 to early 2016, and again from 2018 to 2020) as it cannot be established whether this water is representative of surrounding aquifer conditions.
- Baseline EC at GWa6 (2006 - 2009) varied between 2,000 µS/cm and 10,000 µS/cm and was generally between 2,000 to 7,000 µS/cm, higher than the EC at GWc3 (except for some periods in 2011, 2012 and 2013). Since 2021, EC at GWa6 has decreased to between 2,000 and 6,000 µS/cm, similar to GWc3.

- There is a steady increase in EC between 2007 and the commencement of mining at Pit 3 and Pit 7 (2013) and then a relatively greater increase coinciding with the decline in groundwater levels associated with the mining of Pit 3 and Pit 4. This is followed by a period of overall stabilisation until 2021. Between 2021 and 2022 EC at GWc3 declined but still exceeded the EC trigger level until September 2022 when it fell below the trigger level for the first time since 2011.
- Based on elevation, there is potential for hydraulic connection between the Pit 4 and/or Pit 3 void and GWc3 via the Turill/ Moolarben Seams. While the EC of the WTP Feedwater (used as proxy for EC of Pit 4 and 3 voids) has been similar to the EC observed at GWc3, at other times it has not. As mentioned in **Section 2.7.2** the potential hydraulic connection is not completely understood and will require further investigation that also consider the influence from Cumbo Creek surface water and alluvial groundwater.
- The RO Plant discharge to Wilpinjong Creek is unlikely to influence water quality at this location.

2.8.1.3 GWc4

Figure A - 3 shows the variation of EC at GWc4 and GWa7 along with the CRD and the current EC trigger value at GWc4 of 2,412 µS/cm.

Baseline EC (2006 – 2009) at GWc4 varies between approximately 1,900 µS/cm and 2,800 µS/cm and EC has remained within that range for the entire period of observation (up to 2023). Minor and temporary exceedances of the EC trigger level occurred in 2006, 2007, 2017, 2021 and 2022. EC at the nearest alluvium bore (GWa7) has varied between 1,000 µS/cm and 14,000 µS/cm between 2007 and 2023 but has typically averaged around 10,000 µS/cm.

No change in EC trends is observed during the decline in groundwater level at GWc4 from 2013 – 2020 attributed to a mining and climate effect. Similarly, no change in EC trends is observed at GWc4 during the observed groundwater level recovery associated with above average rainfall from 2020 – 2022.

2.8.1.4 GWc5

Figure A - 4 shows the variation of EC at GWc5 and GWa8 along with the CRD and current EC trigger level at 4,798 µS/cm.

EC gradually increased from early 2010 to 2015 from ~4,800 µS/cm to 5,800 µS/cm, and then stabilised around 5,500 µS/cm at the end of 2017 through to 2022. GWc5 is continuing to show EC levels consistently above the trigger level but below the maximum values observed before and during Pit 1 extraction at 6,030 µS/cm.

Groundwater EC at GWa5 appears to be fluctuating independently of rainfall or groundwater level trends. Similarly stable EC trends are observed at nearby alluvial bore GWa8.

2.8.2 Field pH

The variation of pH at GWc1, GWc3, GWc4 and GWc5 is shown on **Figure A - 1**, **Figure A - 2**, **Figure A - 3** and **Figure A - 4** respectively. pH at the coal measures bores reviewed in this investigation has never exceeded the 6.5 – 8.0 range defined as minimum and maximum trigger levels in the GWMP. Generally, the pH in the coal measures bores is lower than the pH in the nearest alluvial bores.

It is noted that mine water proxy data from Pit 2 (WTP_Feedwater) consistently has a higher pH than both GWc1 and GWc3 observations both during and outside of periods where EC is exceeding trigger levels.

2.8.3 Water Type

Piper diagrams allow a graphical representation of major ion (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Cl^{-}, HCO_3^{-} and SO_4^{2-}) composition of a water sample. Results that group in a cluster represent a similar water type, with water types defined according to the area in which they plot on the piper diagram.

Major ion information necessary to create the Piper plots was only available from 2012 onwards for Wilpinjong groundwater monitoring sites. Major ion information for the WTP_Feedwater which is used as a mine water proxy has data available from 2021.

The figures in **Appendix B** show Piper Plots for the coal measures bores, and corresponding alluvial bores, for all years with available water quality data (i.e. 2012 onwards). With GWc1 and GWc3 plots, which are closest to backfilled WCM pits, also including WTP_Feedwater data the following is observed:

- All four of the “GWc” bores are dominated by sodium and potassium cations.
- GWc1 and GWc3 are weakly dominated by chloride, GWc4 does not have a dominant anion and GWc5 is strongly dominated by the bicarbonate and carbonate anions.
- GWc1 and GWc3 show similar water signatures to their corresponding alluvial bores suggesting some mixing between the alluvial and underlying coal measures groundwater at these locations.
- GWc4 and GWc5 show distinct water type signature from their nearest alluvial/ shallow bore. This may be explained by the following:
    - GWc4 is 1.3 km from GWa7, with GWa7 located north of Wilpinjong Creek, while GWa4 is closer to Wollar Creek. The distance between the sites and their location in separate catchments may explain the distinct water types.
    - GWc5 is 0.8 km from GWa8 and is likely screened (see **Section 2.6**) below the Ulan Seam. The connection between the geology below the Ulan Seam and the Wollar Creek alluvium may be limited, not allowing for mixing.
- It is noted that there is no notable change in water type in any of the bores over the history of monitoring (from 2012 onwards).
- WTP_Feedwater results plot in a consistent location on the piper diagram and show an overall mixed water type, with sulfate the dominant anion and no dominant cation. There is no clear overlap of water type between WTP_Feedwater and water types at either GWc1 or GWc3.

2.8.4 Dissolved Metals

Time series of dissolved metals (aluminium, arsenic, barium, copper, iron, lead, manganese, nickel, selenium, and molybdenum) extracted from the 2022 Groundwater Annual Report (SLR 2023) are included in **Appendix D.** Concentrations in dissolved metals are only available from 2015 onwards.

No specific trends were identified based on this data.

3.0 Summary and Recommendations

This section presents the summary of the information reviewed in **Section 2.0** and recommendations for updating EC trigger levels and/or investigations improve the understanding of EC trigger exceedances.

3.1 Summary

The following presents a summary on the possible mechanisms responsible for the EC trends and trigger exceedances at each of the four bores.

3.1.1 GWc1

The following findings are drawn from information reviewed in **Section 2.0** relevant to GWc1:

- The effect of mining at Pit 1 is observed in groundwater levels at GWc1, with drawdown observed in 2006 - 2007, and some ongoing effect observable with groundwater level recovery to below that of pre-mining in response to above average rainfall from 2020 - 2022. Groundwater elevation trends at GWc1 also follow the CRD, suggesting some climatic influence.

- Since 2016, when water level monitoring of Pit Dam 2 began, groundwater elevations at GWc1 display a similar trend to the water level elevations at Pit Dam 2 (which also generally follow CRD trends). Due to the gradient from stored water in Pit 2 to GWc1, and the potential flow pathway from the Pit 2 dam to GWc1 via the Ulan Seam, there may be a potential hydraulic influence. It is noted however, that backfilled Pits 1 & 5 are closer to GWc1, and water levels and quality within these pits could also be a potential influence on observed groundwater quality conditions at GWc1. Although a gradient has been identified, there is no conclusive evidence of a groundwater quality connection as indicated by the points below.

- EC in GWc1 was similar to WTP Feedwater EC in late 2021 and early 2022, before GWc1 EC declines to below the trigger level in 2023. There is no clear correlation between earlier mine water proxy data (Other_P2Dam_RawWD) and GWc1 EC. It is noted that proxy mine water quality data does show some peaks and troughs, acknowledging these are more subtle than the peaks and troughs at GWc1 and occur at different times.

- The water type from the mine water proxy site (WTP_Feedwater) is distinct from the GWc1 water type and shows no clear evidence of direct influence or mixing. It is noted that WTP_Feedwater is not stored directly adjacent to GWc1.

- Relationships between the EC variation unique to GWc1 and timing of mining operations and climate variation have been investigated as part of this review and no direct relationship could be established for either mining or climate.

- Bore construction details are not available for GWc1, and it is difficult to evaluate whether the screened interval targeting the Ulan Seam is the only pathway for groundwater inflow into the bore. In the absence of other evidence, the step-change variation in EC observed in EC may be related to bore construction.

3.1.2 GWc3

The following findings are drawn from the information reviewed in **Section 2.0** relevant to GWc3:

- Groundwater levels at GWc3 are observed to be influenced (depressurisation) by Pit3, Pit4 and Pit 7 mining, resulting in a reversal of the pre-mining upward hydraulic gradient to the overlying Cumbo Creek alluvium. Groundwater level recovery at GWc3 in response to the above average rainfall from 2020-2022 shows a close relationship with the observed water level increase in the adjacent Pit 4 void, and similar trends to the Pit 3 void.
- Between 2006 and 2013 (before any influence of mining was observed in groundwater levels) EC at GWc3 was slightly fresher than the overlying alluvium. The cause of the observed increase in EC from 2007 to 2013 is not known. A similar increasing trend in EC is observed at GWc5 which is further from mining than GWc3 at that time.
- During the mining of Pits 3, 4 and 7 (mainly 2014-2016), when depressurisation is observed in GWc3, coal measures groundwater quality may have been influenced by recharge from more saline groundwater in the overlying alluvium, due to the observed downward hydraulic gradient.
- EC observations at GWc3 are at their maximum for the monitoring record during 2021, above both alluvial (GWa6) and mine water proxy (WTP_Feedwater) EC. This may be related to the re-mobilisation of salts from strata that was desaturated during the 2017-2020 drought. EC declines from mid 2021 to late 2022 before increasing again in 2023, with current EC observations at GWc3, GWa6 and the mine water proxy all around 4,000 µS/cm. The declining EC (mid 2021 to late 2022) is likely related to the increase in low EC water in the system associated with above average rainfall conditions during this time, while recent observations show potential for some interaction between the groundwater system near GWc3 and adjacent stored water.
- The water type from the mine water proxy site (WTP_Feedwater) is distinct from the GWc3 water type. It is noted that a similar comparison against water stored in Pit 3 and Pit 4, directly adjacent would be of use.

Based on the above findings, the observed EC trends at GWc3 may have been influenced by a combination of mining and climatic influences.

SLR recommends further investigation/ consideration of:

- GWc3 bore construction, which may necessitate replacement or reconstruction of this bore.
- any connection between the stored water in Pit 3 and/or Pit 4 and the adjacent Permian and alluvial aquifers at this location.

Once there is improved confidence in bore construction and any relationship between the water storages and the Permian groundwater system at GWc3 is better understood, an appropriate update to the EC trigger level can be considered.

3.1.3 GWc4

The following conclusions are drawn from the information reviewed in **Section 2.0** relevant to GWc4:

- Relationships have been investigated between EC trends at GWc4, the timing of mining operations and climatic variation for the period of monitoring. While some drawdown due to Pit 3 and Pit 7 mining is likely to have occurred, there was no meaningful change to EC observations.

Based on the above conclusions, there is no meaningful change in EC observed at GWc4 caused by WCM mining.

A revised EC trigger level at this bore is recommended based on the 80th %ile EC observation from the entire GWc4 monitoring record (to 2023). This value would be 2,440 µS/cm which is 28 µS/cm higher than the current trigger level (2,412 µS/cm). Ongoing review of water quality against compliance trigger levels from the GWMP (Peabody, 2017) is recommended for GWc4, with trigger exceedances evaluated against the established TARP process.

3.1.4 GWc5

The following conclusions are drawn from the information reviewed in **Section 2.0** relevant to GW5:

- Relationships have been investigated between EC variation at GWc5, the timing of mining operations and climatic variations. No direct relationship could be established, and there is no evidence of WCM mining influencing groundwater level or quality at GWc5.

The observed EC is likely to be representative of normal conditions at this site. SLR recommends that the trigger level could be revised to include all data until 2023 as no influence of mining has been observed. This value is 5,560 µS/cm which is 762 µS/cm higher than the current trigger level (4,798 µS/cm). Ongoing review of water quality against compliance trigger levels from the GWMP (Peabody, 2017) is recommended for GWc4, with trigger exceedances evaluated against the established TARP process.

3.2 Recommendations

As a result of this preliminary investigation into observed EC trigger exceedances at WCM coal measures monitoring bores, SLR recommends the following:

- Redrill/ replacement of GWc1 and GWc3 so that bore construction can be ruled out as influencing EC observations. Alternatively, decommissioning GWc1 and use of GWc16 as its replacement could be considered.

- Undertaking further investigation of the potential connection between the alluvial and Permian aquifers in lower Cumbo Creek (monitored by GWa6 and GWc3), and the adjacent Pit 3 and Pit 4 water storages.

- Update the GWc4 EC trigger level to 2,440 µS/cm based on the 80th percentile EC value from the entire monitoring record.

- Update the GWc5 EC trigger level to 5,560 µS/cm based on the 80th percentile EC value from the entire monitoring record.

- While updates to specific trigger levels at GWc4 and GWc5 have been provided as part of this report, it is understood that a broader review of the GWMP, groundwater monitoring network, and groundwater trigger levels will be undertaken by WCPL as part of the next GWMP update. This review should:
    - capture the recommendation to re-drill and/or decommission and replace GWc1 and GWc3;
    - consider the location of currently active and future mine areas;
    - focus on the use of monitoring wells where construction and intercepted geology is well understood; and
    - consider updating water quality trigger levels using a risk-based approach to reflect environmental, human, and industry use values at a broader ‘aquifer’ scale.

4.0 References

AS/NZS 5667.11:1998 *Water quality - Sampling Guidance on sampling of groundwaters*

Freeze and Cherry 1979, *Groundwater,* Prentice Hall, Inc.

HydroSimulations 2015. Wilpinjong Extension Project: Groundwater Assessment. Report HC2015/042 for Wilpinjong Coal Pty Ltd. November 2015

Peabody 2017, Wilpinjong Coal Groundwater Management Plan, WI-ENV-MNP-0041, August 2017

SLR 2020, Wilpinjong Coal Mine Groundwater Model Update Report, SLR Ref: 665.10014.0000-R01, Version 1.0, Juen 2020

SLR 2022, Wilpinjong Annual Review 2022, Groundwater Compliance, SLR Ref: 665.10014.01305-R01, Version No: -v2.0, March 2022

SLR 2023a, Wilpinjong Annual Review 2022, Groundwater Compliance, SLR Ref: 665.10014.02205-R01, Version No: -v1.0, March 2023

SLR 2023b, Groundwater Sampling Study, Wilpinjong Coal Mine, SLR ref: 665.10014.01905, 29 August 2023

Appendix A Time series of groundwater levels, ph and Electrical conductivity

EC Trigger Investigation of GWc1, GWc3, GWc4 and GWc5

Wilpinjong Coal Mine

Wilpinjong

SLR Project No.: 665.10014.01515

15 December 2023

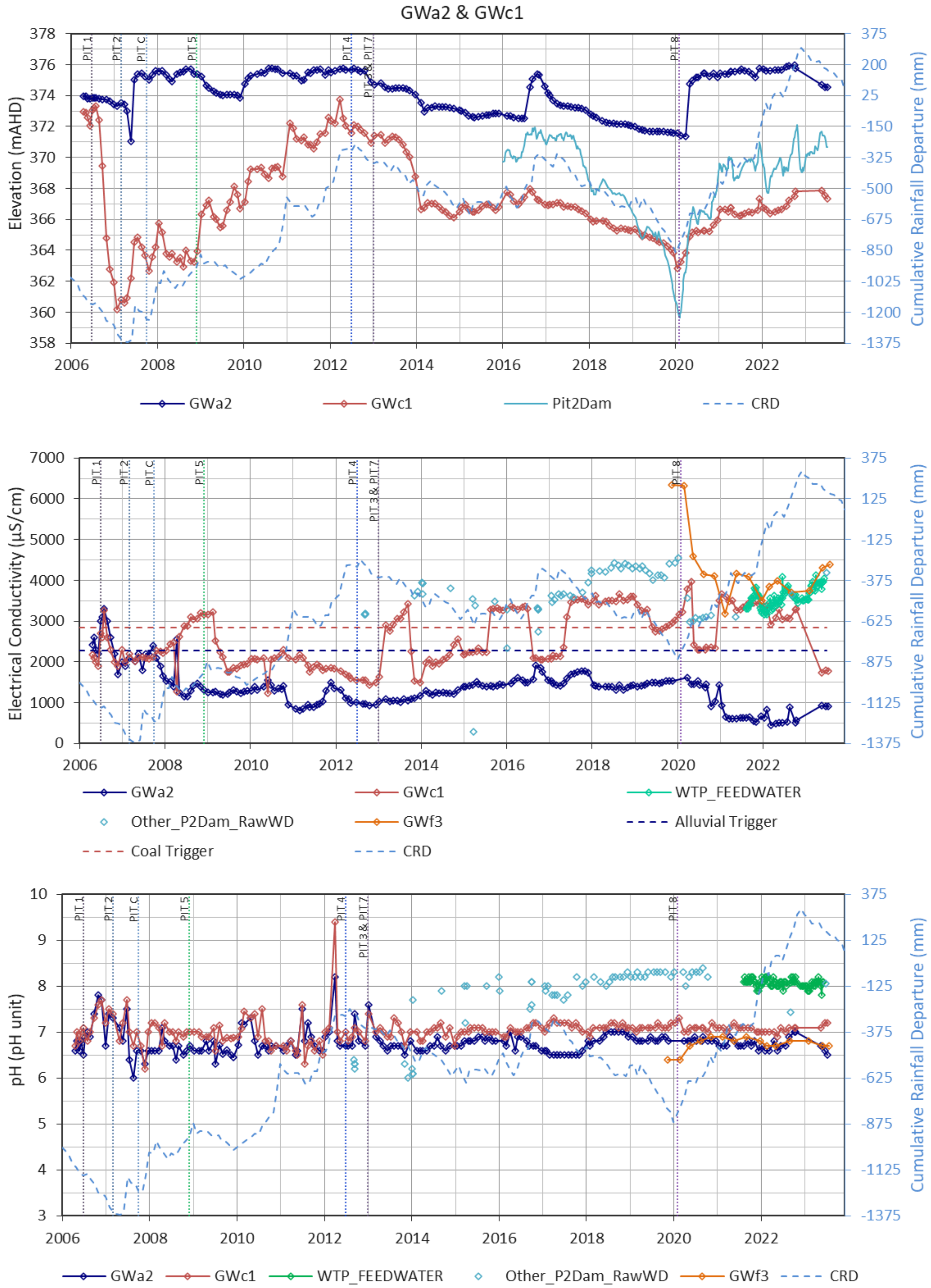


Figure A - 1 Time series GWc1 and GWa2

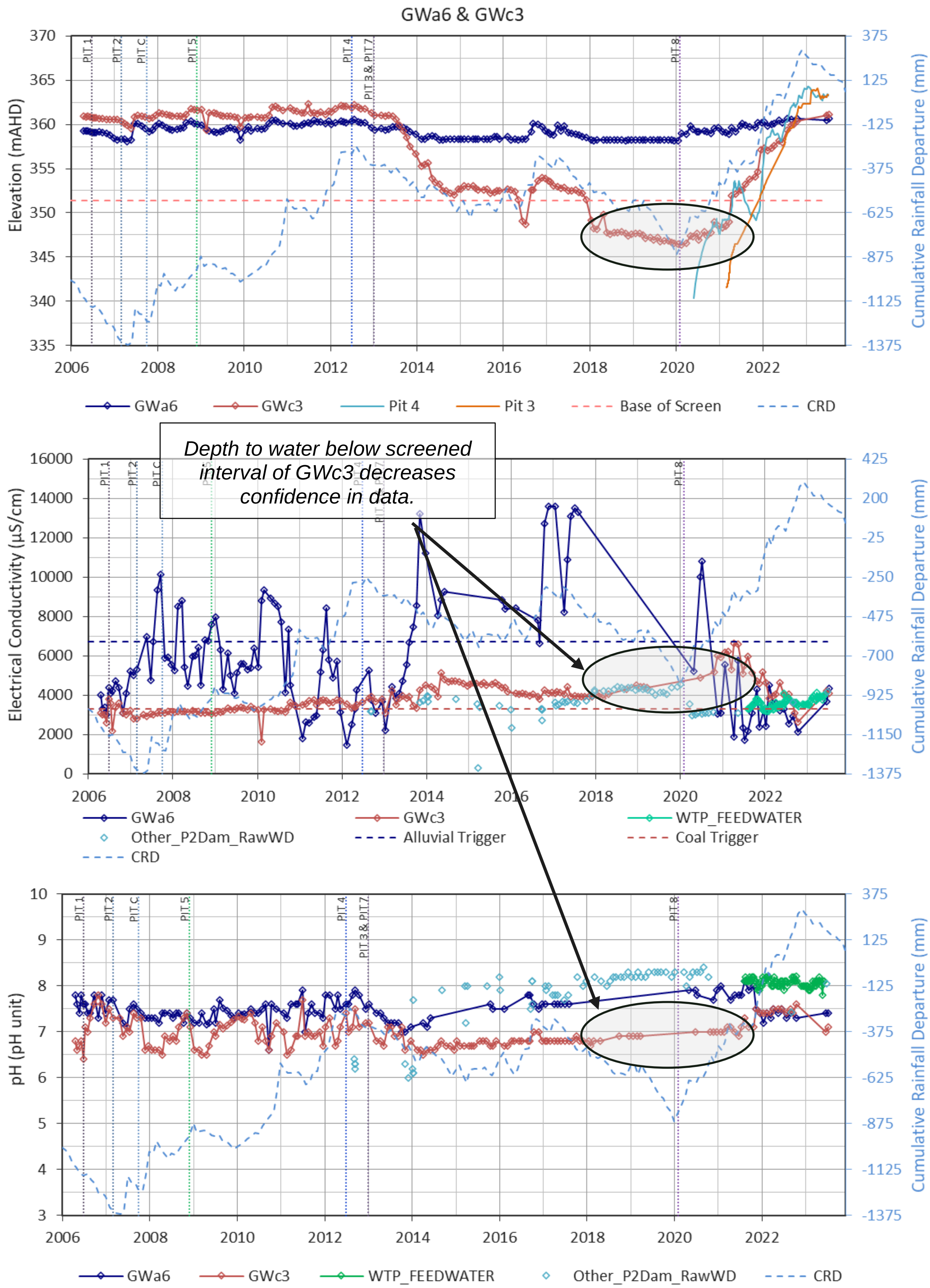


Figure A - 2 Time series GWc3 and GWa6

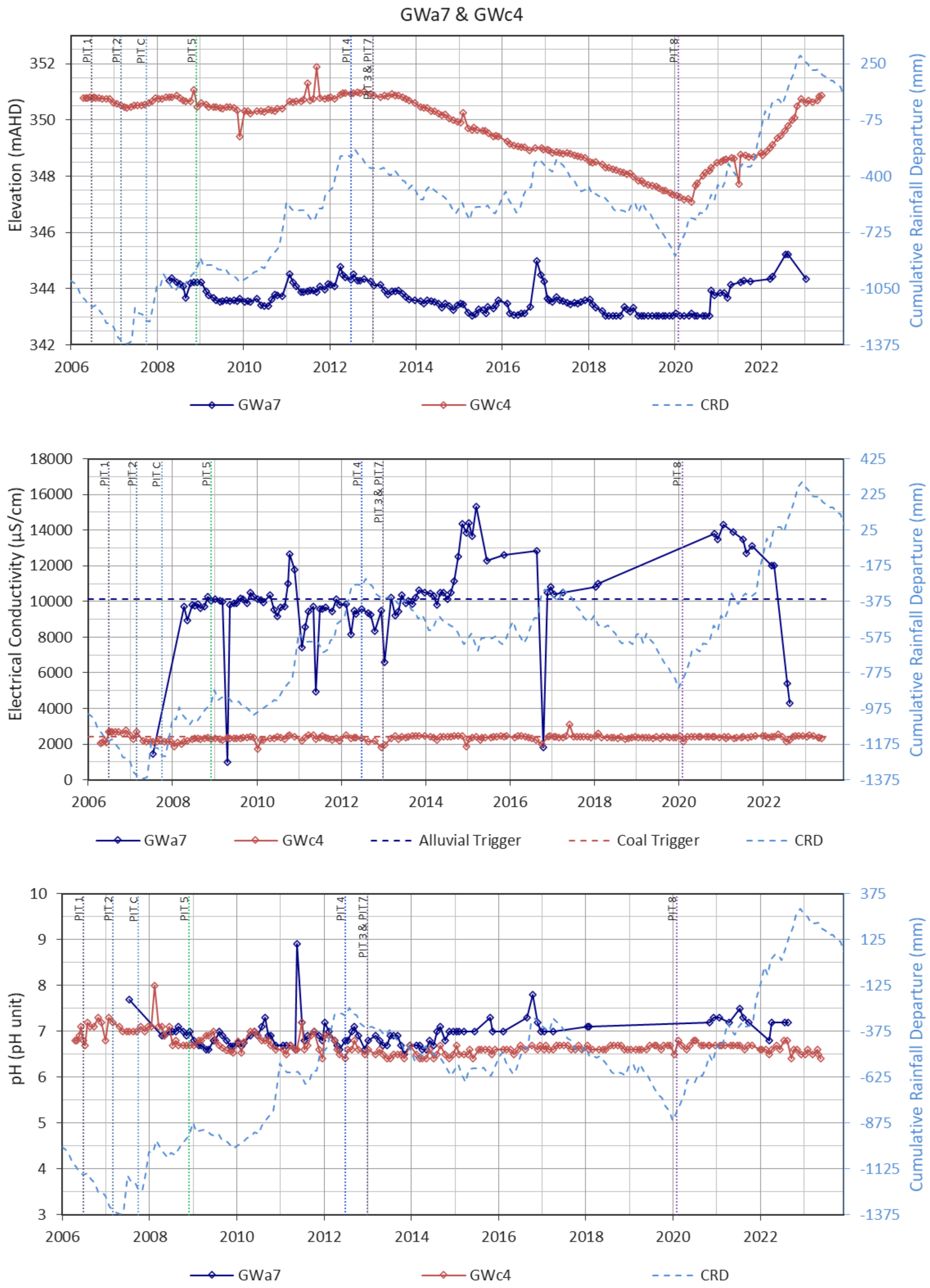


Figure A - 3 Time series GWc4 and GWa7

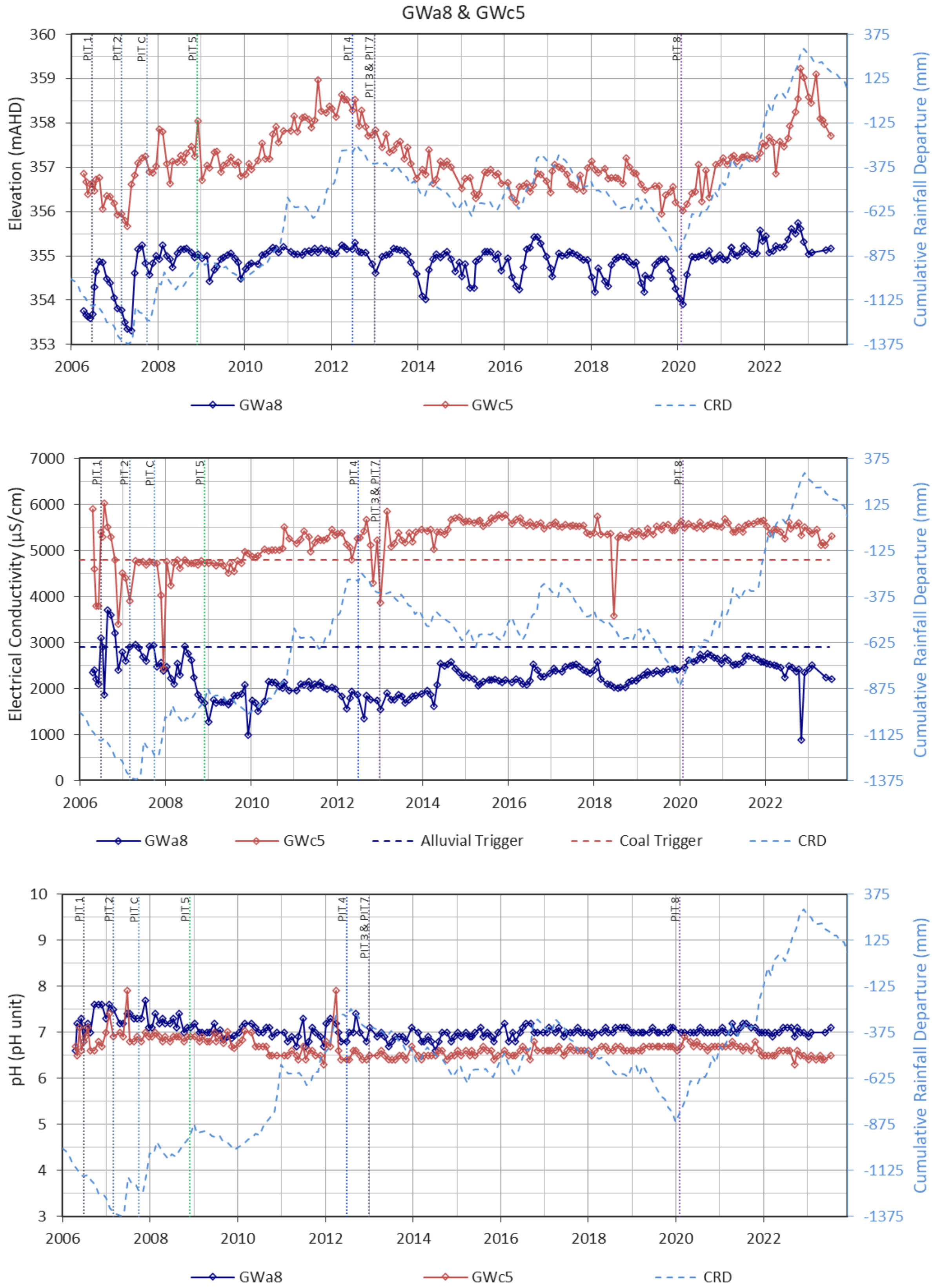


Figure A - 4 Time series GWC5 and GWa8

Appendix B Piper plots

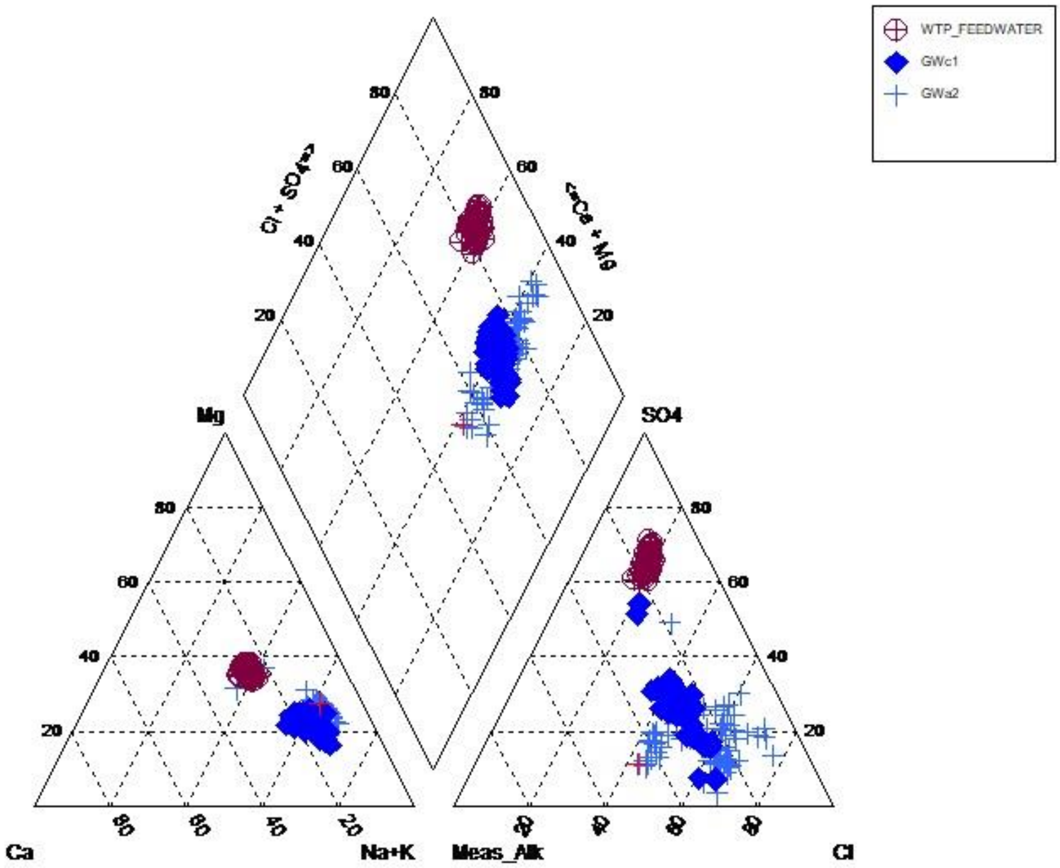
EC Trigger Investigation of GWc1, GWc3, GWc4 and GWc5

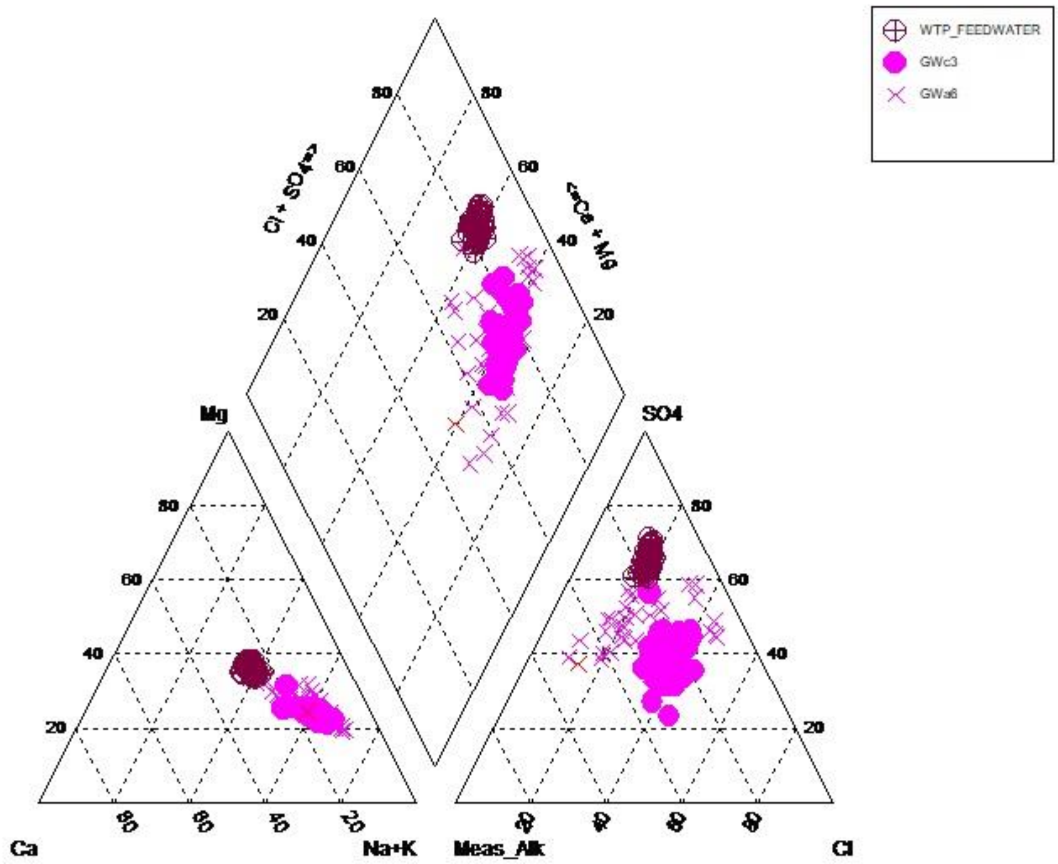
Wilpinjong Coal Mine

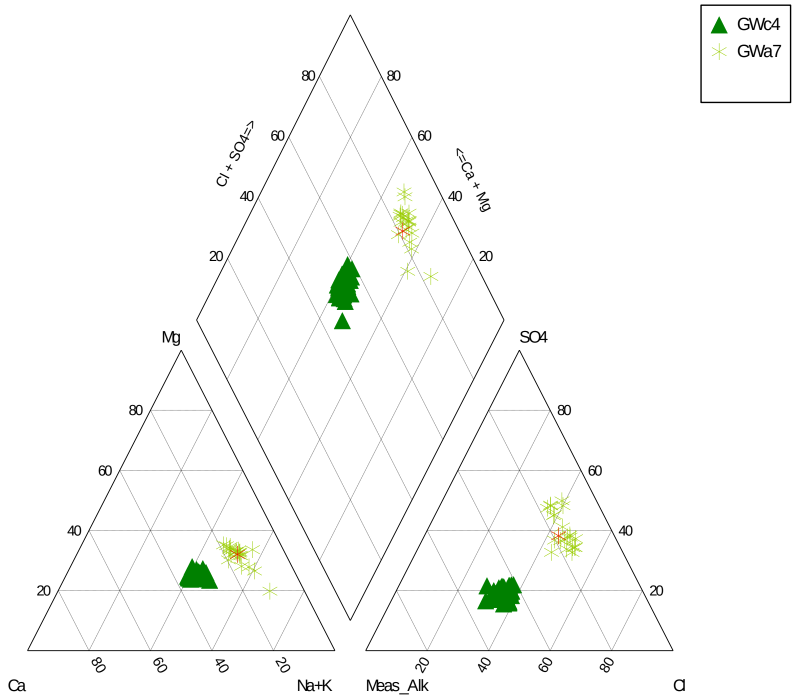
Wilpinjong

SLR Project No.: 665.10014.01515

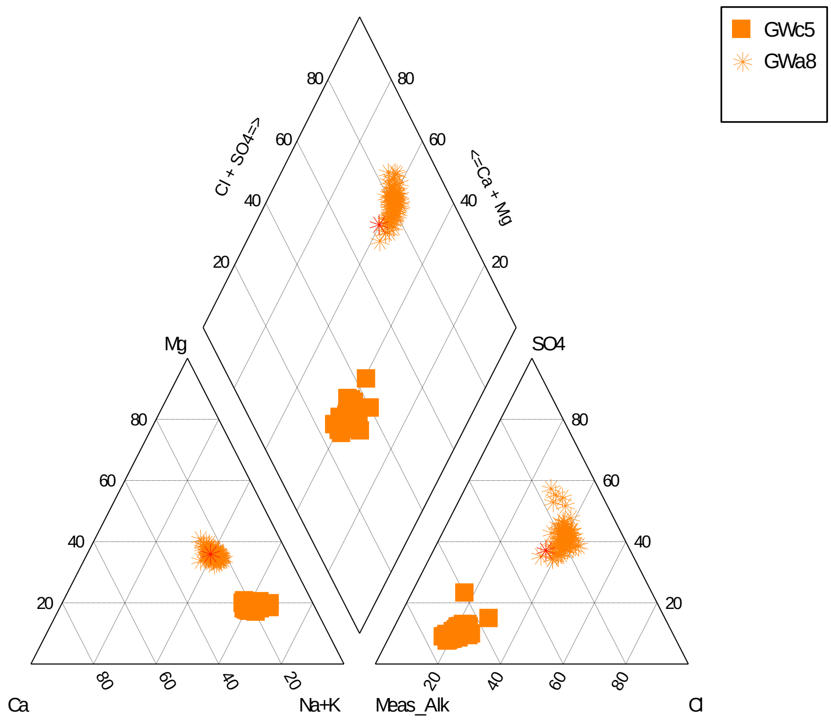
15 December 2023


WTP_FEEDWATER
GWc1
GWa2
Cl + SO4=>
<=Ca + Mg
Mg
SO4
Ca
Na+K
Meas_Alk
Cl
80
60
40
20


WTP_FEEDWATER
GWc3
GWa6
Cl + SO4=>
<=Ca + Mg
Mg
SO4
Ca
Na+K
Meas_Alk
Cl
80
60
40
20



GWc4
GWa7
Cl + SO4=>
<=Ca + Mg
Mg
SO4
Ca
Na+K
Meas_Alk
Cl



GWc5
GWa8
Cl + SO4=>
<=Ca + Mg
Mg
SO4
Ca
Na+K
Meas_Alk
Cl

Appendix C Dissolved Metals Information

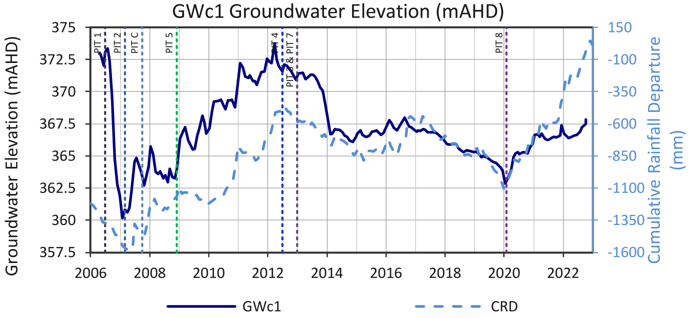
EC Trigger Investigation of GWc1, GWc3, GWc4 and GWc5

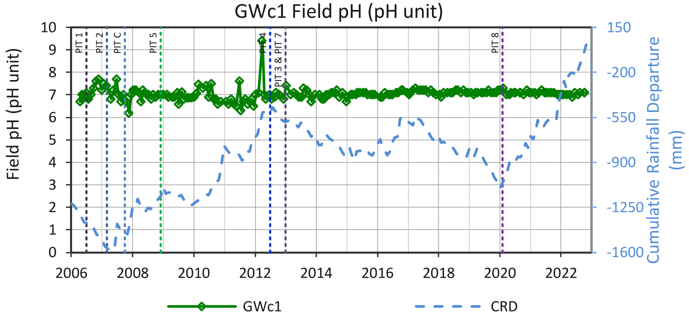
Wilpinjong Coal Mine

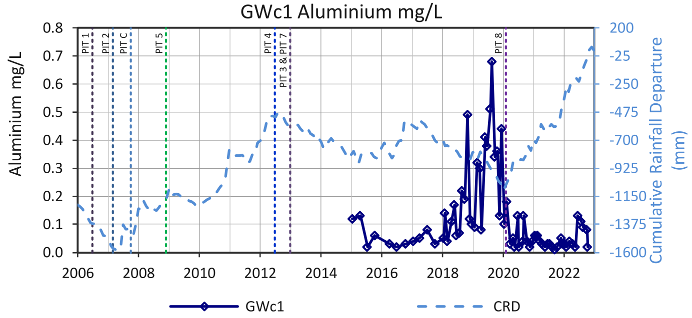
Wilpinjong

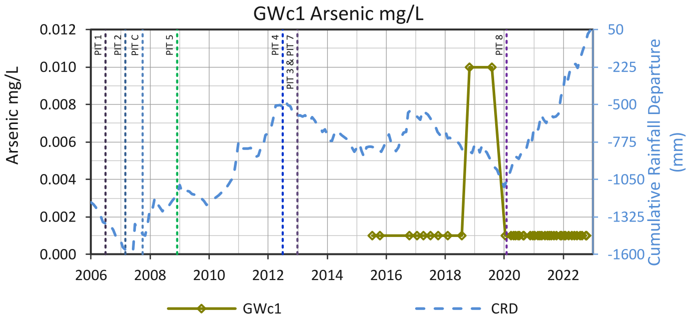
SLR Project No.: 665.10014.01515

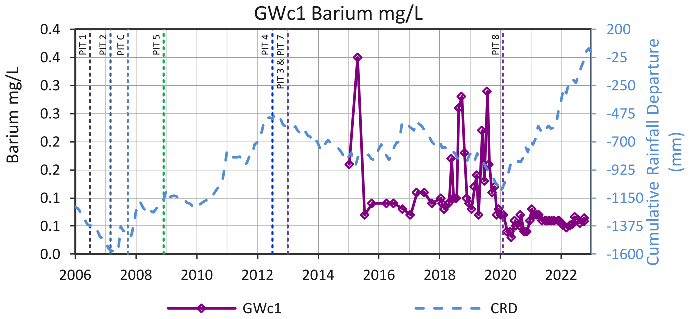
15 December 2023

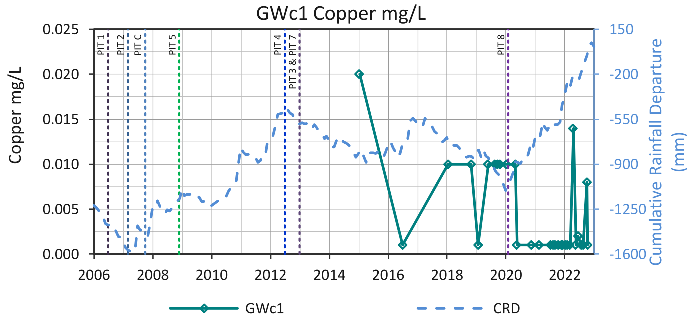

GWc1 Groundwater Elevation (mAHD)
Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
PIT 1
PIT 2
PIT C
PIT 5
PIT 4
PIT 3 & PIT 7
PIT 8
GWc1
CRD

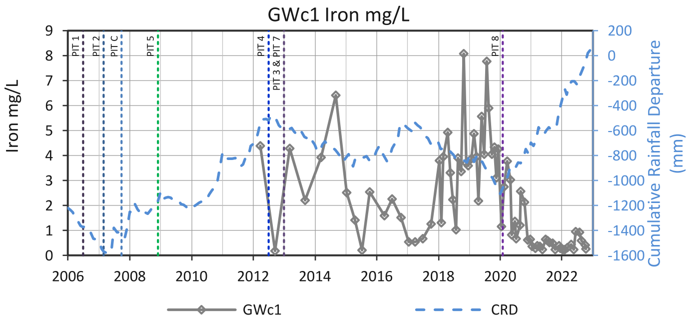

GWc1 Field pH (pH unit)
Field pH (pH unit)
Cumulative Rainfall Departure (mm)
GWc1
CRD

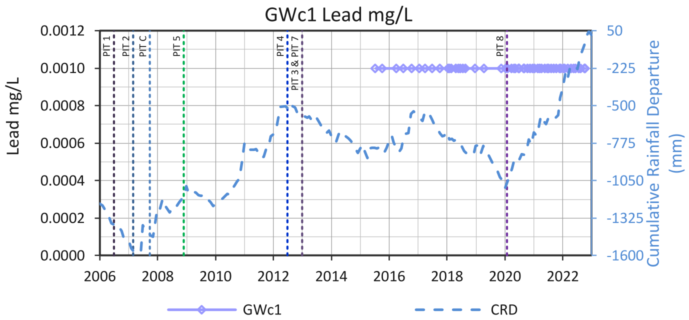

GWc1 Aluminium mg/L
Aluminium mg/L
Cumulative Rainfall Departure (mm)
GWc1
CRD

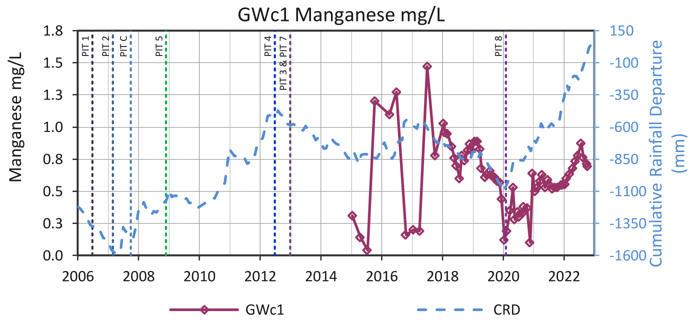

GWc1 Arsenic mg/L
Arsenic mg/L
Cumulative Rainfall Departure (mm)
GWc1
CRD


GWc1 Barium mg/L
Barium mg/L
Cumulative Rainfall Departure (mm)
GWc1
CRD


GWc1 Copper mg/L
Copper mg/L
Cumulative Rainfall Departure (mm)
GWc1
CRD


GWc1 Iron mg/L
Iron mg/L
Cumulative Rainfall Departure (mm)
GWc1
CRD


GWc1 Lead mg/L
Lead mg/L
Cumulative Rainfall Departure (mm)
GWc1
CRD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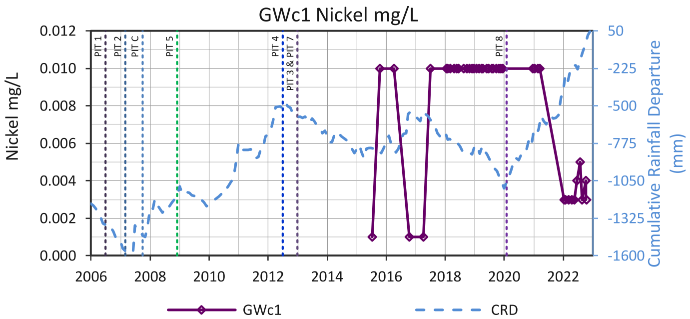
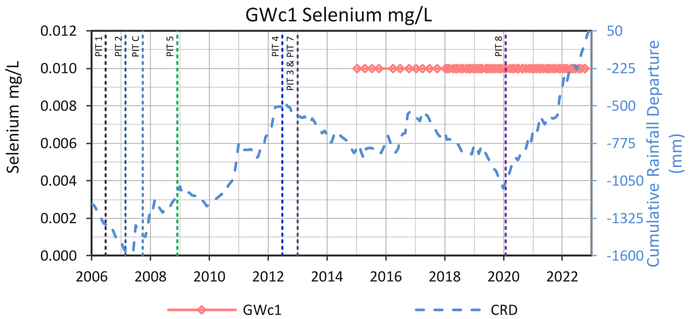
Manganese mg/L
Cumulative Rainfall Departure (mm)
GWc1
CRD


GWc1 Nickel mg/L
Nickel mg/L
Cumulative Rainfall Departure (mm)
GWc1
CRD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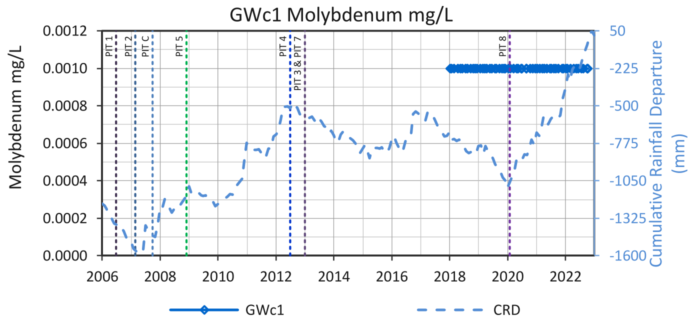
Selenium mg/L
Cumulative Rainfall Departure (mm)
GWc1
CRD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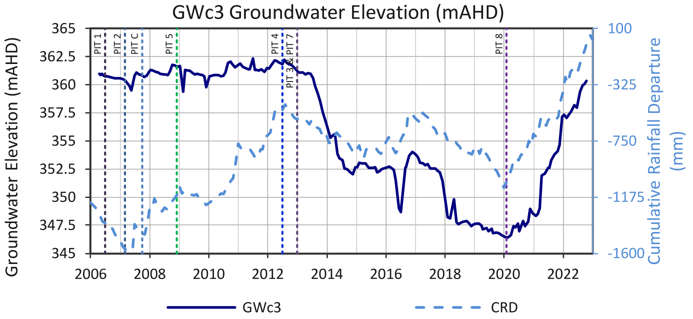
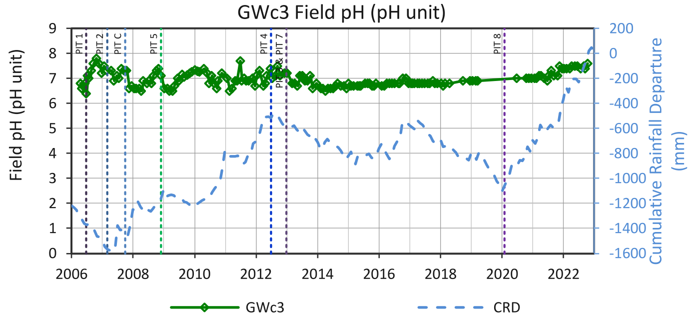
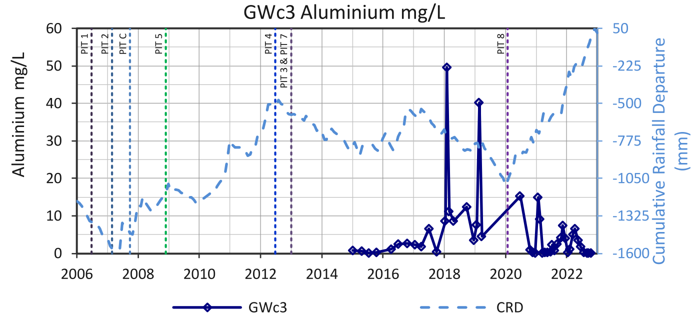
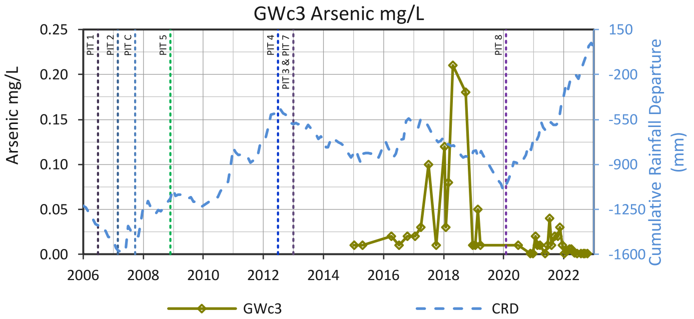
Molybdenum mg/L
Cumulative Rainfall Departure (mm)
GWc1
CRD


GWc3 Groundwater Elevation (mAHD)
Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
PIT 1
PIT 2
PIT C
PIT 5
PIT 4
PIT 3 & PIT 7
PIT 8
GWc3
CRD


GWc3 Field pH (pH unit)
Field pH (pH unit)
Cumulative Rainfall Departure (mm)
PIT 1
PIT 2
PIT C
PIT 5
PIT 4
PIT 3 & PIT 7
PIT 8
GWc3
CRD


GWc3 Aluminium mg/L
Aluminium mg/L
Cumulative Rainfall Departure (mm)
PIT 1
PIT 2
PIT C
PIT 5
PIT 4
PIT 3 & PIT 7
PIT 8
GWc3
CRD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Arsenic mg/L
Cumulative Rainfall Departure (mm)
PIT 1
PIT 2
PIT C
PIT 5
PIT 4
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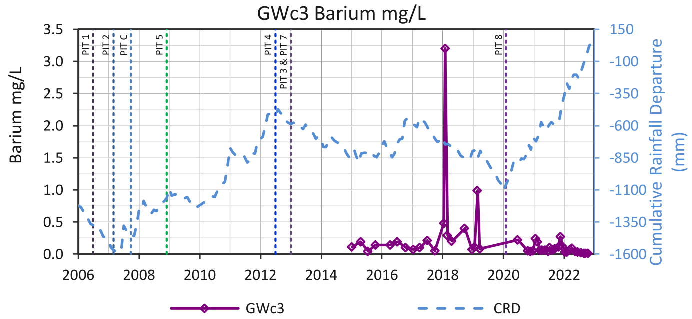
PIT 8
GWc3
CRD


GWc3 Barium mg/L
Barium mg/L
Cumulative Rainfall Departure (mm)
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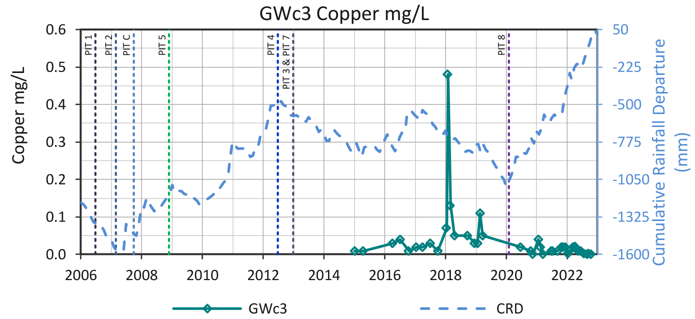
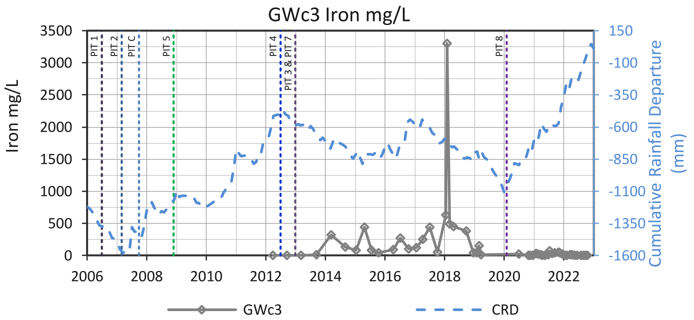
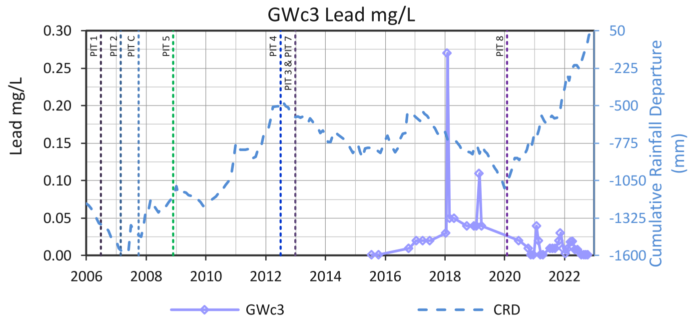
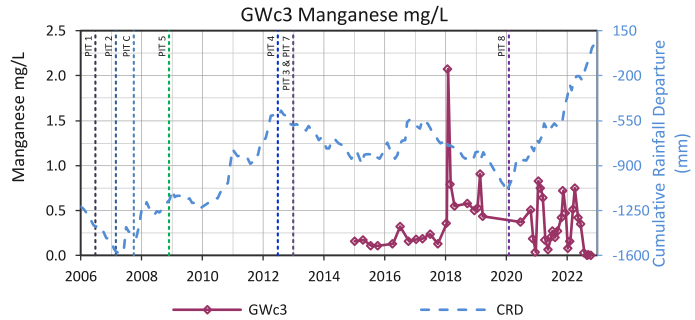
PIT 2
PIT C
PIT 5
PIT 4
PIT 3 & PIT 7
PIT 8
GWc3
CRD


GWc3 Copper mg/L
Copper mg/L
Cumulative Rainfall Departure (mm)
PIT 1
PIT 2
PIT C
PIT 5
PIT 4
PIT 3 & PIT 7
PIT 8
GWc3
CRD


GWc3 Iron mg/L
Iron mg/L
Cumulative Rainfall Departure (mm)
PIT 1
PIT 2
PIT C
PIT 5
PIT 4
PIT 3 & PIT 7
PIT 8
GWc3
CRD


GWc3 Lead mg/L
Lead mg/L
Cumulative Rainfall Departure (mm)
PIT 1
PIT 2
PIT C
PIT 5
PIT 4
PIT 3 & PIT 7
PIT 8
GWc3
CRD


GWc3 Manganese mg/L
Manganese mg/L
Cumulative Rainfall Departure (mm)
PIT 1
PIT 2
PIT C
PIT 5
PIT 4
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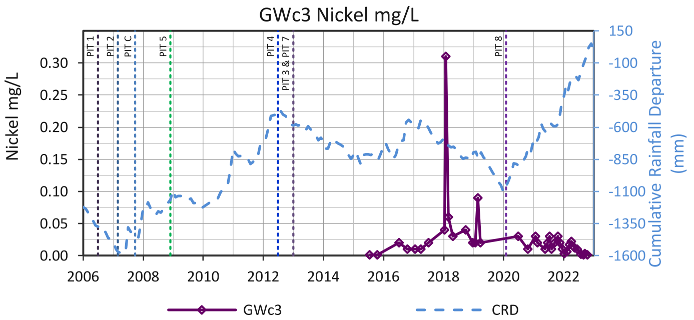
PIT 8
GWc3
CRD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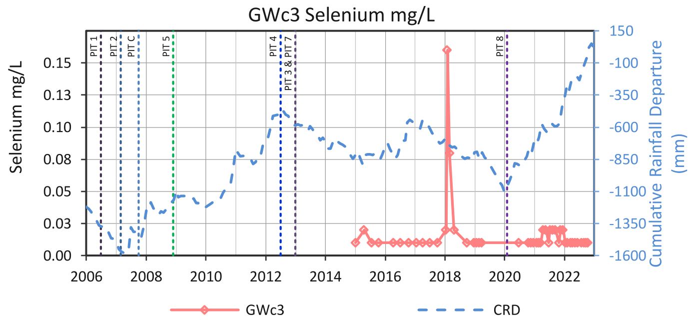
Nickel mg/L
Cumulative Rainfall Departure (mm)
PIT 1
PIT 2
PIT C
PIT 5
PIT 4
PIT 3 & PIT 7
PIT 8
GWc3
CRD


GWc3 Selenium mg/L
Selenium mg/L
Cumulative Rainfall Departure (mm)
PIT 1
PIT 2
PIT C
PIT 5
PIT 4
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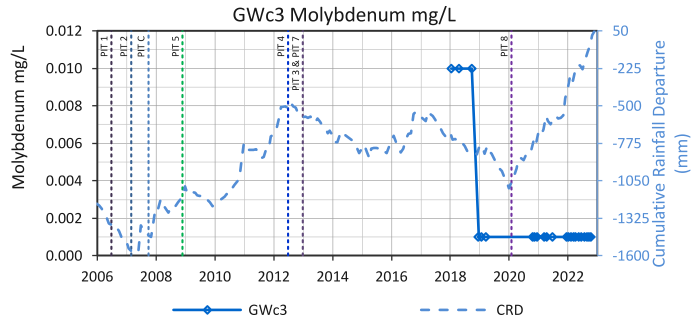
PIT 8
GWc3
CRD


GWc3 Molybdenum mg/L
Molybdenum mg/L
Cumulative Rainfall Departure (mm)
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PIT C
PIT 5
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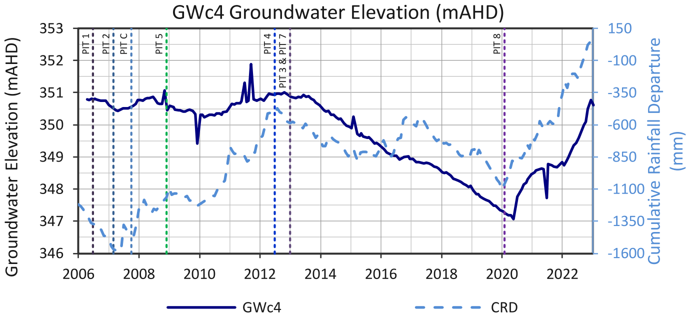
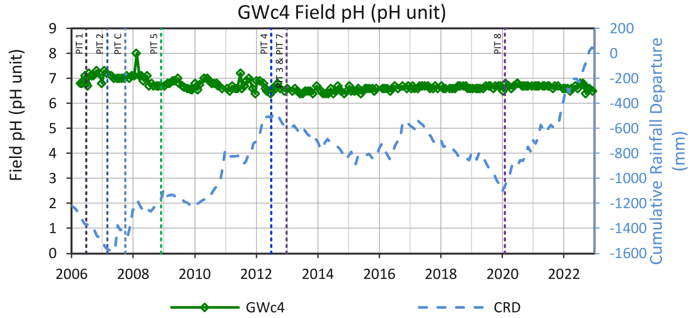
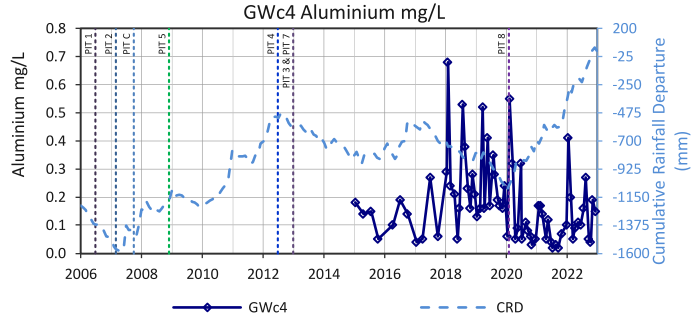
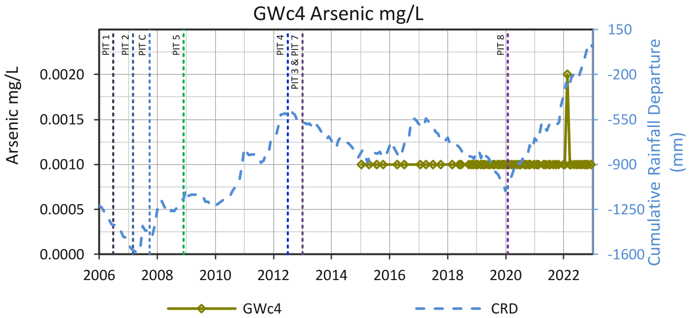
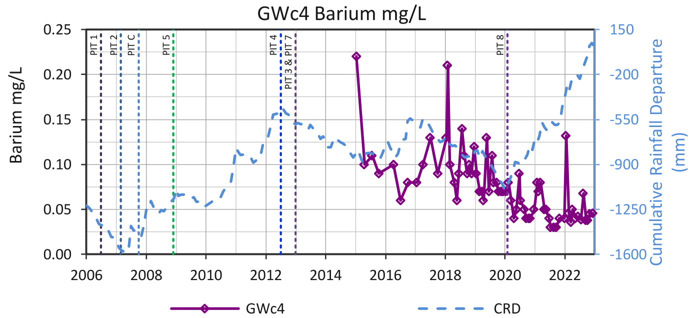
PIT 3 & PIT 7
PIT 8
GWc3
CRD

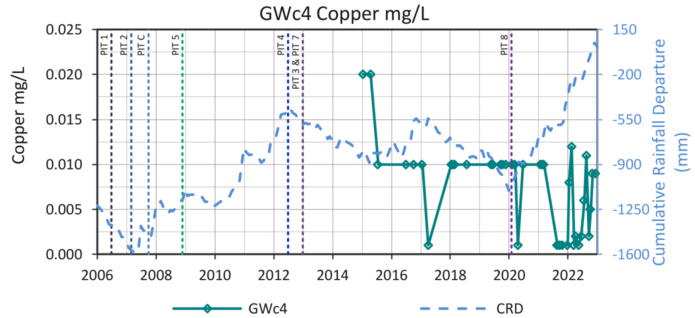

GWc4 Groundwater Elevation (mAHD)
Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
PIT 1
PIT 2
PIT C
PIT 5
PIT 4
PIT 3 & PIT 7
PIT 8
GWc4
CRD

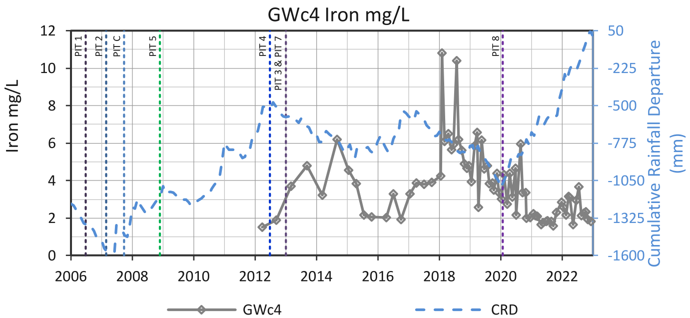

GWc4 Field pH (pH unit)
Field pH (pH unit)
Cumulative Rainfall Departure (mm)
PIT 1
PIT 2
PIT C
PIT 5
PIT 4
PIT 3 & PIT 7
PIT 8
GWc4
CRD

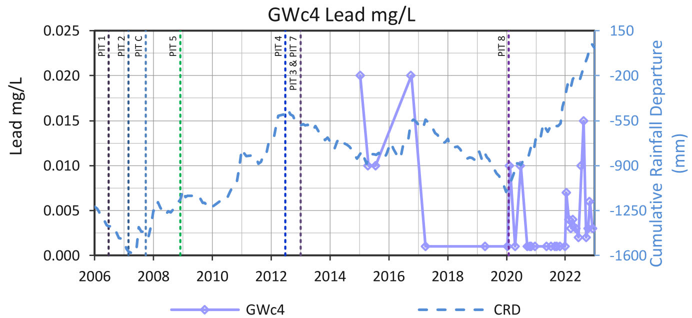

GWc4 Aluminium mg/L
Aluminium mg/L
Cumulative Rainfall Departure (mm)
PIT 1
PIT 2
PIT C
PIT 5
PIT 4
PIT 3 & PIT 7
PIT 8
GWc4
CRD

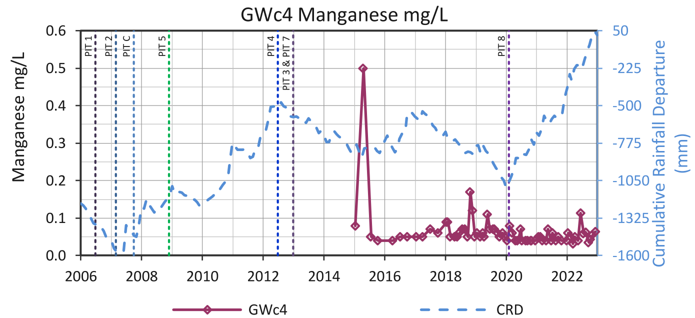

GWc4 Arsenic mg/L
Arsenic mg/L
Cumulative Rainfall Departure (mm)
PIT 1
PIT 2
PIT C
PIT 5
PIT 4
PIT 3 & PIT 7
PIT 8
GWc4
CRD

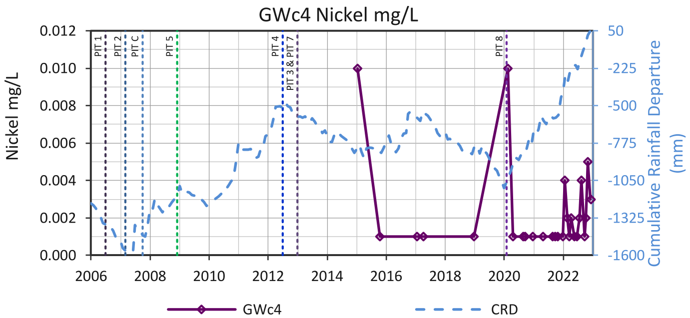

GWc4 Barium mg/L
Barium mg/L
Cumulative Rainfall Departure (mm)
PIT 1
PIT 2
PIT C
PIT 5
PIT 4
PIT 3 & PIT 7
PIT 8
GWc4
CRD

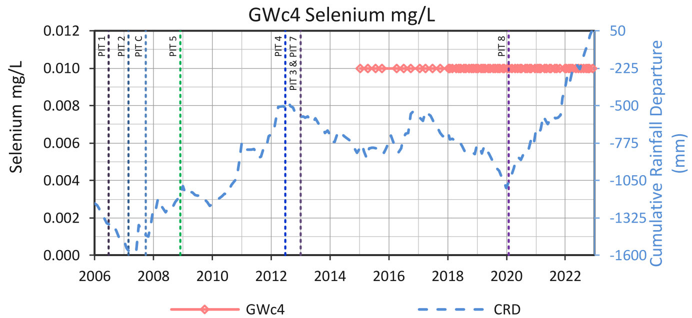

GWc4 Copper mg/L
Copper mg/L
Cumulative Rainfall Departure (mm)
PIT 1
PIT 2
PIT C
PIT 5
PIT 4
PIT 3 & PIT 7
PIT 8
GWc4
CRD

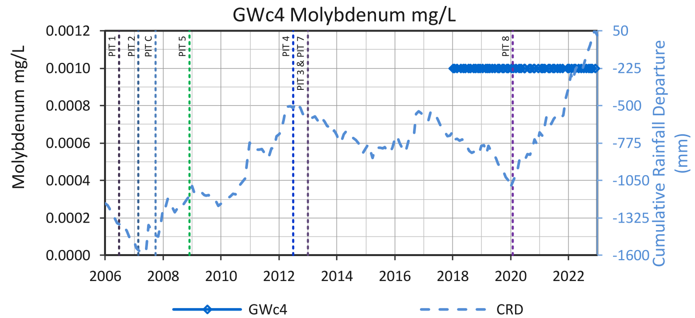

GWc4 Iron mg/L
Iron mg/L
Cumulative Rainfall Departure (mm)
PIT 1
PIT 2
PIT C
PIT 5
PIT 4
PIT 3 & PIT 7
PIT 8
GWc4
CRD

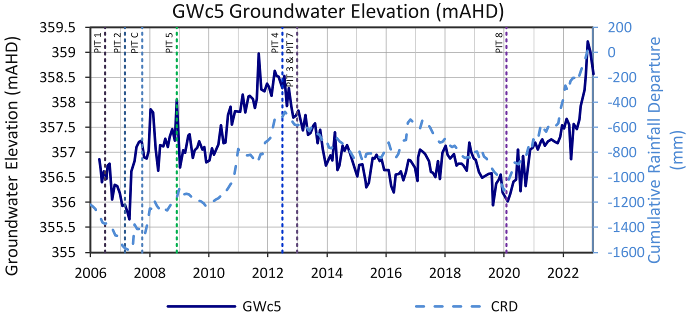

GWc4 Lead mg/L
Lead mg/L
Cumulative Rainfall Departure (mm)
PIT 1
PIT 2
PIT C
PIT 5
PIT 4
PIT 3 & PIT 7
PIT 8
GWc4
CRD

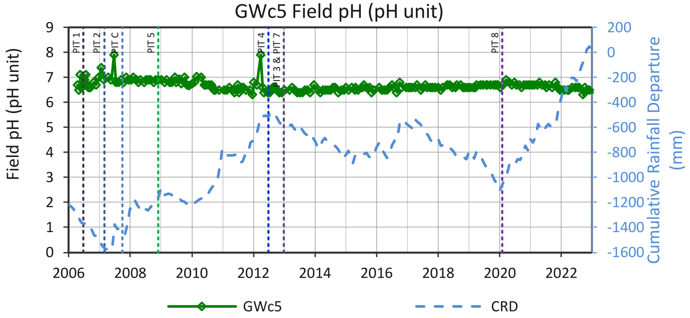

GWc4 Manganese mg/L
Manganese mg/L
Cumulative Rainfall Departure (mm)
PIT 1
PIT 2
PIT C
PIT 5
PIT 4
PIT 3 & PIT 7
PIT 8
GWc4
CRD

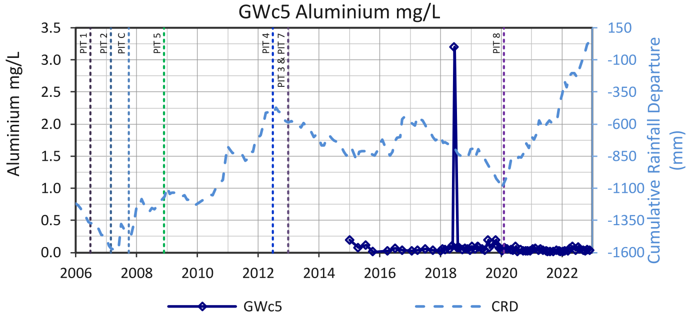

GWc4 Nickel mg/L
Nickel mg/L
Cumulative Rainfall Departure (mm)
PIT 1
PIT 2
PIT C
PIT 5
PIT 4
PIT 3 & PIT 7
PIT 8
GWc4
CRD

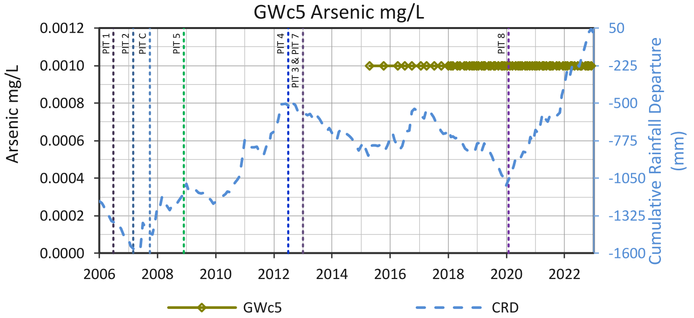

GWc4 Selenium mg/L
Selenium mg/L
Cumulative Rainfall Departure (mm)
PIT 1
PIT 2
PIT C
PIT 5
PIT 4
PIT 3 & PIT 7
PIT 8
GWc4
CRD

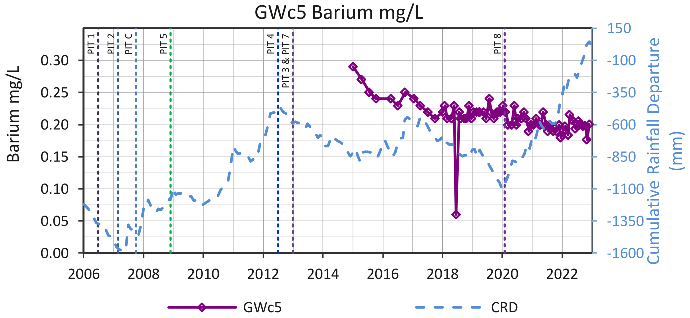

GWc4 Molybdenum mg/L
Molybdenum mg/L
Cumulative Rainfall Departure (mm)
PIT 1
PIT 2
PIT C
PIT 5
PIT 4
PIT 3 & PIT 7
PIT 8
GWc4
CRD

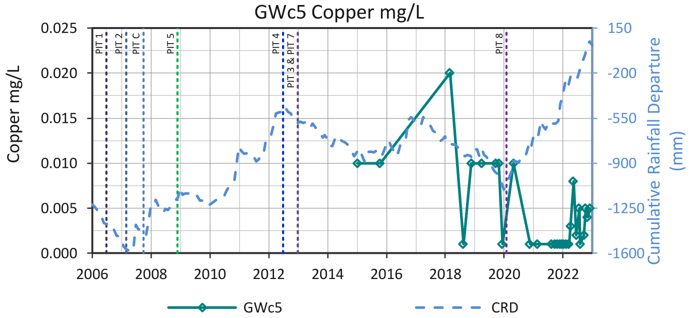

GWc5 Groundwater Elevation (mAHD)
Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
PIT 1
PIT 2
PIT C
PIT 5
PIT 4
PIT 3 & PIT 7
PIT 8
GWc5
CRD

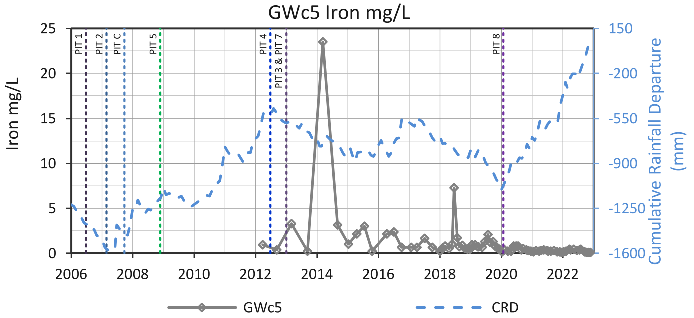

GWc5 Field pH (pH unit)
Field pH (pH unit)
Cumulative Rainfall Departure (mm)
GWc5
CRD

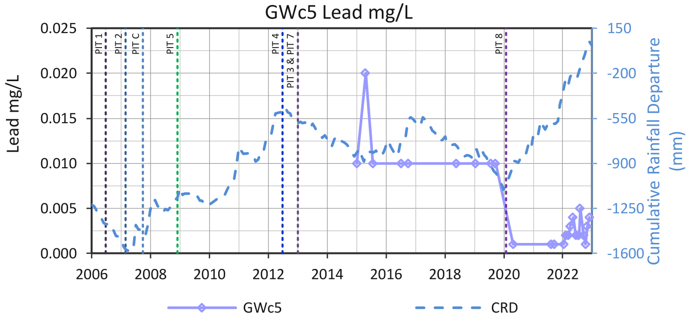

GWc5 Aluminium mg/L
Aluminium mg/L
Cumulative Rainfall Departure (mm)
GWc5
CRD

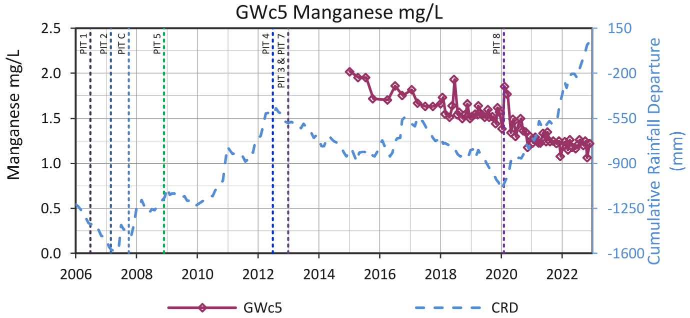

GWc5 Arsenic mg/L
Arsenic mg/L
Cumulative Rainfall Departure (mm)
GWc5
CRD

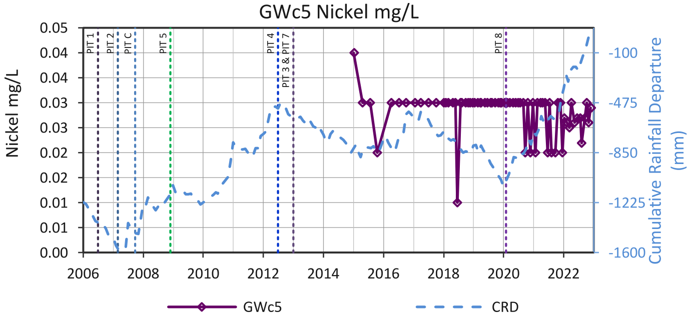

GWc5 Barium mg/L
Barium mg/L
Cumulative Rainfall Departure (mm)
GWc5
CRD

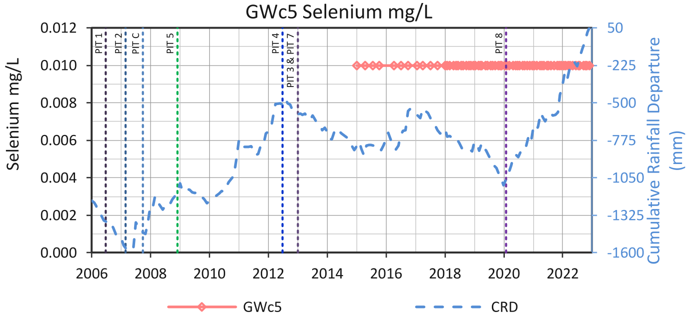

GWc5 Copper mg/L
Copper mg/L
Cumulative Rainfall Departure (mm)
GWc5
CRD

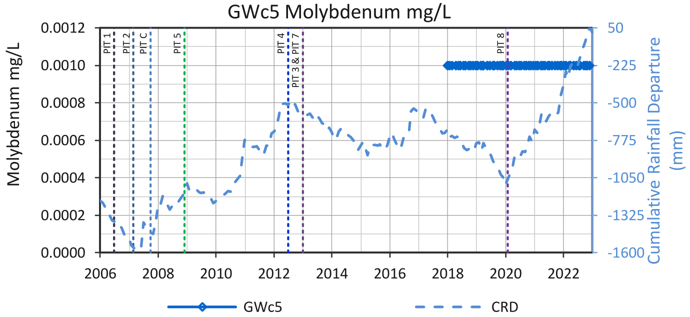

GWc5 Iron mg/L
Iron mg/L
Cumulative Rainfall Departure (mm)
GWc5
CRD


GWc5 Lead mg/L
Lead mg/L
Cumulative Rainfall Departure (mm)
GWc5
CRD


GWc5 Manganese mg/L
Manganese mg/L
Cumulative Rainfall Departure (mm)
GWc5
CRD


GWc5 Nickel mg/L
Nickel mg/L
Cumulative Rainfall Departure (mm)
GWc5
CRD


GWc5 Selenium mg/L
Selenium mg/L
Cumulative Rainfall Departure (mm)
GWc5
CRD


GWc5 Molybdenum mg/L
Molybdenum mg/L
Cumulative Rainfall Departure (mm)
GWc5
CRD

Making Sustainability Happen