Australasian Groundwater & Environmental Consultants

Report on

Ulan Coal Mine Annual Groundwater Review 2023

Prepared for
Ulan Coal Mines Pty Limited

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Australasian Groundwater and Environmental Consultants Pty Ltd

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Ulan Coal Mine
Annual Groundwater Review 2023

1 Introduction

Ulan Coal Mine Complex (Ulan Coal Mine) is operated by Ulan Coal Mines Pty Limited (UCMPL). The Ulan Coal Mine is located in the Mid-Western Region of New South Wales near the village of Ulan, approximately 38 km north-northeast of Mudgee. Ulan Coal Mine was first assessed under Part 3A of the *Environmental Planning & Assessment Act 1979* (EP&A Act) and was granted approval in May 1981. UCMPL sought to consolidate all previous approvals to a single approval, which was granted as Project Approval (PA08_0184) on 15 November 2010. Routine groundwater monitoring is undertaken at Ulan Coal Mine as part of the conditions of PA08_0184, which was last updated in March 2022 (MOD 7). The groundwater monitoring program is outlined in the Ulan Groundwater Monitoring Program[1] (GWMP) that was last approved in May 2019. The GWMP program has been reviewed and updated annually since 2019 pending approval by DPE (formerly DPIE and now DCCEEW).

Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) were commissioned by UCMPL to prepare the Ulan Coal Mine Annual Groundwater Review 2023 (this Report). The Report has been prepared to address requirements in the GWMP, Conditions 2 and 3, Schedule 5 of PA08_0184 and the Statement of Commitments (SoC) listed in Appendix 9 Sections 6.4.1 to Section 6.4.6 of PA08_0184.

[1] Ulan Coal. (2019). *Groundwater Monitoring Program*. Prepared by Glencore. Document number: ULNCX-111515275-1643.

2 Objectives and scope of work

The GWMP incorporates monitoring in accordance with the conditions of approval at the Ulan Coal Mine site, and on private properties adjacent to Ulan Coal Mine. Tasks undertaken over the 2023 monitoring period included:

- manual measurement of groundwater levels in the monitoring network;
- downloading of electronic water level loggers; and
- collection of groundwater samples for field and laboratory analysis.

The objective of this Report is to review and present the groundwater monitoring results and analyses for the 2023 monitoring period to ensure compliance with the Groundwater Monitoring Program and the relevant Project Approval PA 08_0184 conditions.

3 Project Approval conditions

Condition 39 of PA 08_0184 requires that Ulan Coal Mine conducts a groundwater monitoring program whilst Appendix 9 lists the commitments made by UCMPL.

Commitments specific to groundwater are stipulated under Sections 6.4.1 to 6.4.6 of Appendix 9 of the Project Approval.

Table 3.1 details the PA 08_0184 conditions and commitments relevant to this Report, a short summary of findings from this review, and reference to the sections of this review where full details are provided.

Table 3.1 Project Approval conditions

Project Approval conditions	2023 Annual groundwater review
39. The Groundwater Monitoring Program must include:	
a) a program to augment the baseline data over the life of the project;	**Section 6** Ulan Coal Mine has four active monitoring networks: the North Monitoring Network (NMN), Bobadeen Monitoring Network (BMN), Pleuger Monitoring Network (PMN) and the Private Bore monitoring network. Groundwater monitoring in these networks adds to the baseline data of the project.
b) groundwater assessment criteria, including trigger levels for investigating any potentially adverse groundwater impacts;	**Section 6.3** Ulan Coal Mine has established groundwater quality and level triggers for NMN and the Private Bore network in accordance with its Surface Water and Groundwater Response Plan (SWGWRP). Observed drawdown results are tabulated and compared to the latest numerical groundwater model predicted drawdowns and water quality triggers based on regularly-updated datasets.
c) a program to monitor and/or validate: • groundwater inflows to the open cut and underground mining operations;	**Section 8.1**
• a program to monitor and/or validate the impacts of the project on the: – alluvial aquifers – Triassic aquifers – coal seam aquifers – interburden aquifers	**Section 6** Monitoring bores in the NMN, BMN and PMN have been installed to monitor the Triassic, coal seam and interburden aquifers. The site monitoring program and monitoring bore details are outlined in the GWMP. Additional bores have been installed to monitor groundwater conditions in Jurassic aquifers.
– baseflows to the Goulburn and Talbragar Rivers and associated creeks;	**Section 7.5**
– any groundwater bores, springs and seeps on privately-owned land; and	**Section 7.4** A total of 36 private bores were visited in 2023 for groundwater level, pH, and electrical conductivity (EC).
– The 'Drip'.	**Section 7.5** Analysis of the water quality results indicate The Drip water quality exhibits a major ion composition common to some Triassic bores away from the cliff exposure, but not all. Minor fluctuations in groundwater pore pressure in surficial strata monitored nearby to The Drip is attributed to natural climate variability and no mining related impacts have been observed.

Project Approval conditions	2023 Annual groundwater review
• the seepage/leachate from any tailings dams, water storages or backfilled voids on site.	**Section 7.2 and Section 0** Monitoring of potential seepage from Bobadeen Dam and the Bobadeen Irrigation Scheme is captured by the BMN. Several BMN bores were dry in 2023 and only three reported groundwater levels while only two reported field water quality. Seepage from backfilled voids, namely East Pit, is captured by the PMN. PMN bores showed stable trends through the period of record including 2023.
6.4.1 The GWMP will include: • Continued measurement of groundwater levels, pressures and water quality within the existing regional network of monitoring bores and an expanded network as underground mining progresses to the north and west, specifically considering:	**Section 7** Where access allowed, or access was not restricted due to wet weather and roads becoming inaccessible, the NMN, BMN, PMN and Private bores were monitored during 2023 at the frequency outlined in the GWMP. Three sites in the NMN were not accessible in 2023.
– depressurisation monitoring of at least three multi-level piezometer strings equipped with vibrating wire transducers (or equivalent) and distributed within the Permian-Triassic strata;	**Section 6.2.2 and Section 7.1.1.5** In 2023, 12 of the 16 VWP sites listed in the GWMP reported data. Two of the sites are faulty and two sites have been undermined. The currently monitored NMN intersects all key hydrogeological units. VWPs and monitoring bores are progressively installed as the mine moves north and west.
– strata hydraulic conductivity measurement on rock core obtained at these above noted piezometer locations;	Hydraulic conductivity measurements on rock core from hole DDH561 was provided in the Ulan Coal Mine Annual Review 2018 (AGE, 2018[2]).
– daily or more frequent monitoring of pore pressures and piezometric elevations by installed auto recorders in selected new piezometers.	**Section 6.2.2 and Section 7.1.1.5** Several VWP installations are in place and recording across the site within and outside of the project approval boundary and six-hour intervals.
• Groundwater monitoring will include: ○ monthly monitoring of basic water quality parameters pH and EC in pumped mine water.	**Section 0** Pumped groundwater quality is sampled from the PMN and pumped into the mine water system. No adverse water quality impacts were identified.
– six-monthly monitoring of pH and EC in the regional monitoring network.	**Section 7.1.2** Regional groundwater quality monitoring was completed in the NMN which covers areas within and outside the Project Approval boundary. Two bores reported pH trigger exceedances and four reported EC trigger exceedances.
– annual measurement of total dissolved solids (TDS) and speciation of water samples in selected piezometers to support identification of mixing of groundwater types.	**Section 7.1.2** Annual groundwater samples for speciation were collected from the NMN and The Drip.
– graphical plotting of basic water quality parameters and identification of trend lines and statistics including mean and standard deviation calculated quarterly. Comparison of trends with rainfall and any other identifiable processes that may influence such trends.	**Appendix A, Appendix B, Appendix C and Appendix D** Timeseries charts are presented for: • NMN bores in Appendix A; • NMN VWP sensors in Appendix B; • PMN in Appendix C; and • Private Bores in Appendix D.

[2] Australasian Groundwater and Environmental Consultants Pty Ltd (AGE). (2018). *Ulan Mine Annual Groundwater Review for Period 2018*. Prepared for Glencore Coal Assets Australia – Ulan Coal Mine. Project No. G1844O. March 2019.

Project Approval conditions	2023 Annual groundwater review
• The monitoring network and monitoring programme will be reviewed on an annual basis to determine ongoing suitability and any proposed changes will be discussed in the annual review of monitoring results.	The groundwater monitoring network at Ulan Coal Mine is extensive and a program is in place to install groundwater monitoring infrastructure as the mine progresses.
6.4.2 The results of groundwater monitoring and a comparison of measured and predicted impacts will be reported in the annual review required by the Project Approval conditions.	**Section 7.1 and Appendix E** The 2023 observed groundwater drawdown was compared to predicted (from the most up-to-date numerical model which is pending approval). Review indicates the observed drawdowns are less than model predictions for all NMN bores and nearly all VWP sensors during 2023. Discrepancies and exceedances are discussed in this Report.
6.4.3 Impacts on the privately owned licensed bores identified as being potentially affected, will be assessed by monitoring and in the event that any utilised privately owned bore is significantly adversely affected, an alternative water supply will be provided by UCMPL until such time as the bore is re-established or replaced, or appropriate compensation established, in accordance with Project Approval requirements.	**Section 7.4** Ulan Coal Mine continues to monitor private bores annually (when accessible) or more frequently if requested by a landholder. Not all private bores could be measured in 2023. None of the private bores that were within the 2 m predicted drawdown contour exceeded their predicted drawdown in 2023 but three bores outside the 2 m drawdown zone did exceed their predicted drawdown.
6.4.4 The groundwater monitoring results will be analysed (graphically and statistically) as new results become available i.e., quarterly or six-monthly. In addition, a monitoring review and verification process will be established as part of the Water Management Plan process, to verify regional groundwater losses as necessary to refine groundwater mitigation strategies.	**Section 7, Appendix A, Appendix B, Appendix C, Appendix D and Appendix E** Groundwater levels and water quality are reviewed by Ulan Coal Mine staff as they occur. An annual groundwater review is completed to identify any adverse impacts that will help refine the GWMP. Any data anomalies or trends are reported in the annual review (this Report) and investigated following completion of the review.
6.4.5 Identification of any changes or long-term trends in groundwater outside the predicted impacts will result in an investigation to determine if the trend is a result of the Project operations and if so, identify management strategies to be implemented to address the identified issues as per UCMPL's Internal TARP process.	**Section 7.1, Appendix A, Appendix B, Appendix C, Appendix D and Appendix E** Groundwater levels within the NMN generally matched predicted trends for the majority of bores. Conservatism in 2023 model predictions is apparent in comparisons across most bores. Some shallow VWP sensors were noted as showing slight but persistent declines and further review is recommended (a number of these trends were reported in the 2022 Annual Review and addressed afterwards).
6.4.6 Review of depressurisation of coal measures and comparison of responses with aquifer model predictions will be completed every two years. Expert review will be undertaken by a suitably qualified hydrogeologist and reported in accordance with the process set out in the Water Management Plan.	**Section** Error! Reference source not found.**, Appendix B and Appendix E** Review of observed vs modelled coal seam depressurisation is currently undertaken annually as part of this Report and presented in Appendix E. The evaluation identified instances of the observed rate of depressurisation in VWP sensors exceeding modelled rates (compared to the latest numerical model), which are discussed in Section 7.1, and recommendations for further investigation are made, where appropriate.

4 Background

4.1 Geology

Ulan Coal Mine is located within the western limit of the Sydney Basin, at the southern end of the Gunnedah Sub-basin. The stratigraphic sequence across the mine area comprises Permian Illawarra Coal Measures, Triassic Narrabeen Group, and Jurassic Pilliga Sandstone (Table 4.1). Tertiary volcanics and Quaternary sediments are also present in localised areas around the site. The Permian and Triassic formations are largely stratified and dip uniformly towards the north-east at a shallow angle of between 1 and 3 degrees.

Table 4.1 Summary site stratigraphy

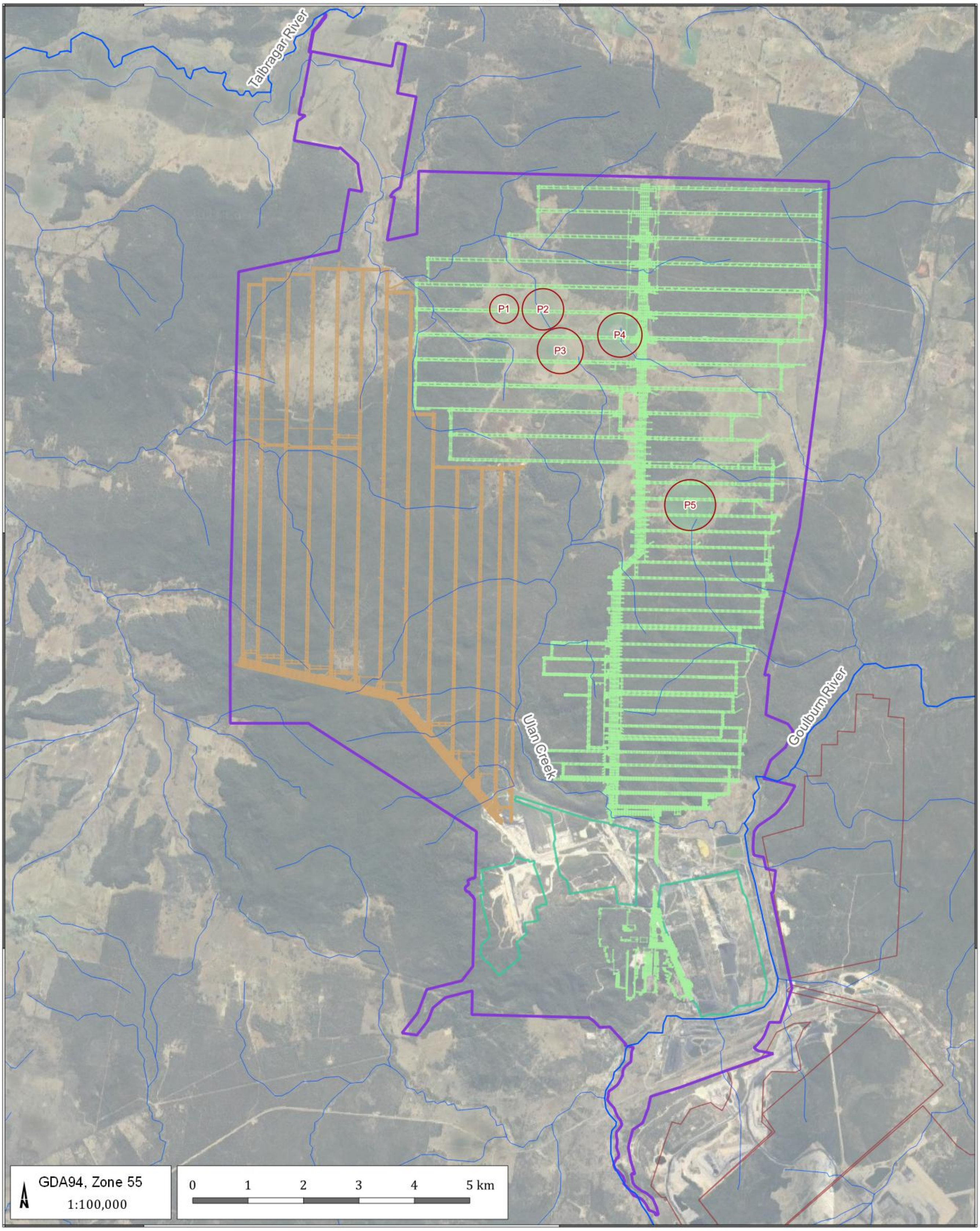
Age	Unit	Description
Quaternary	-	Alluvium/colluvium – comprising soil, silt, clay, sand and gravel
Tertiary	Older alluvium, Volcanics	Alluvium – mainly palaeochannels Volcanic – mainly weathered basalts
Jurassic	Pilliga Sandstone Purlewaugh Siltstone	Coarse grained quartzose sandstone, lithic sandstone, conglomerates, claystone and shale
Triassic	Wollar Sandstone (Narrabeen Group equivalent)	Quartzose and lithic sandstone, conglomerates and claystone
Permian	Illawarra Coal Measures	Interbedded claystones, siltstones, sandstones (fine to coarse grained) and coal seams

4.2 Mine activities

The Ulan Coal Mine has a long history of open cut and underground mining dating back to the 1920s. Currently, mining using conventional longwall mining methods is active within Ulan Underground (formerly referred to as Ulan No. 3) and Ulan West Underground (Ulan West) (Figure 4.1). Mining (longwall) was first introduced in 1986 with the commencement of Ulan No. 3 and then at Ulan West around 2012 (First Workings). Secondary extraction at Ulan West began in May 2014 and is currently approved to 2033. Approval of Modification 4 (MOD4) to PA 08_0184 was granted in 2019 and allows for the extension of some existing longwall panels within the approved mine area. Since that time and due to increased risk of roof instability, there has been a decision made to relocate some of the first workings for longwall panels LW32 and LW33 and relocate installation roadway on the eastern end of LW32 and LW33 to the west by approximately 415 m. There is a modification currently pending submission to modify PA 08_0184 to facilitate extensions to several longwall panels at Ulan West and Ulan Underground operations.

West Pit Open Cut was mined until 2008. The excavation of the Ulan West Box Cut commenced in 2011. Mining in the Open Cut Extension began in 2012 and only operated periodically until 2016 when it entered care and maintenance. Mining in the area is also approved until 2033. East Pit was used for coarse rejects during construction and is currently used for tailings and water storage. Tailings were also stored in the South 5 Tailings Dam until around 2011 when it was decommissioned and later rehabilitated. Tailings from the Open Cut Extension went to TD1 and TD2 in East Pit and coarse rejects to the Barrier Pit. Tailings from current underground operations are also deposited in TD2 and TD4, which is within the existing East Pit void, and is currently under construction.

There are several water storage dams at Ulan Coal Mine including East Pit, North West Sediment Dam (NWSD), Bobadeen Dam, and Rowans Dam that store mine water and surface water runoff from mining areas. Water encountered in the underground workings is pumped directly to either Bobadeen Dam or NWSD and then treated at the Bobadeen Water Treatment Facility (WTF) or NWSD WTF prior to blending and discharge off site. Raw water is either used for operations or irrigation. Potable water is produced at the NWSD and used across UCMPL for operational needs.



LEGEND

- Major drainage
- Minor drainage
- Ulan West Mine Plan
- Ulan Underground Mine Plan
- Bobadeen Irrigation System (P1 - P5)
- 2023 Approved Ulan Mine project boundary
- Ulan Open Cut
- Moolarben Mine Plan

Ulan Annual Groundwater Review 2023 (UCM5036.001)

Mine area

AGE

DATE 21/03/2024

FIGURE No: **4.1**

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
G:\Projects\UCM5036.001 Ulan Annual Review 2023\3_GIS\Workspaces\Figure 4.1 - Mine area\Figure 4.1 - Mine Plan.qgz

5 Rainfall data

Daily rainfall data has been collected at Ulan Coal Mine (UCM) since 2013. Table 5.1 presents the UCM 2023 monthly rainfall and long-term average SILO rainfall data for the area. Rainfall patterns recorded at UCM during 2023 were compared with long-term averages derived from SILO data[3]. Monthly averages were exceeded in two months of 2023 (April and November) and where as low as 8% of long-term averages (May). Overall, 2023 was dryer than average, with total rainfall being 61% of the long-term mean annual rainfall. The total annual rainfall in 2023 of 416 mm is in the bottom 10th percentile for the long-term record (i.e. 90% of years record higher total rainfall).

Table 5.1 Monthly rainfall data

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
SILO long-term average monthly rainfall (mm)												
72.8	65.6	57.1	43.2	46.2	51.6	52.8	46.3	51.2	57.9	64.1	69.1	677.9
Ulan Coal Mine 2023 rainfall (mm)												
61.9	20.9	53.2	46.7	3.7	30.7	21.4	24.7	16.6	11.2	79.1	45.7	415.8
2023 % of long-term average												
85	32	93	108	8	60	41	53	32	19	123	66	61

[3] To obtain robust long-term climate information, rainfall data was sourced from the Scientific Information for Land Owners (SILO) database. SILO is operated by the Queensland Department of Environment and Science, with data contributions from the Australian Bureau of Meteorology. SILO generates a climate dataset via interpolation between neighboring weather stations to produce a continuous daily time series. The SILO dataset was for latitude -32.25 and longitude 149.70 from 1889 to present.

6 Monitoring network

Groundwater monitoring at Ulan Coal Mine (UCM) is undertaken in accordance with the GWMP with the last approved being version 7.0, approved in May 2019. Several revisions have been made since, which were submitted to DPE (formerly DPIE) for review and approval. Information relating to Ulan Coal Mine's groundwater monitoring activities in 2023 are provided in this section. Full details of the groundwater monitoring program and network including monitoring and sampling frequency, sample method and trigger levels for water levels, and water quality are outlined in the GWMP.

6.1 Monitoring bores

The monitoring bore network at UCM has been installed over several different campaigns since 1991. Full details of the groundwater monitoring network are detailed in the GWMP and locations of groundwater sample sites are shown in Figure 6.1. UCM has four active monitoring networks: the North Monitoring Network (NMN), Bobadeen Monitoring Network (BMN), Pleuger Monitoring Network (PMN), and a series of private bores.

The NMN is the largest monitoring network with bores intersecting all key hydrogeological units except alluvium. The NMN comprises:

- thirty-eight monitoring standpipes at eighteen locations from which groundwater level and quality data are collected annually or more-frequently;
- data loggers have been installed in R753A, PZ10B, and PZ09D to collect continuous water level data; and
- (originally) 16 vibrating wire piezometer (VWP) array locations with multiple sensors installed to collect groundwater pressure data for the target strata (two sites have since been undermined).

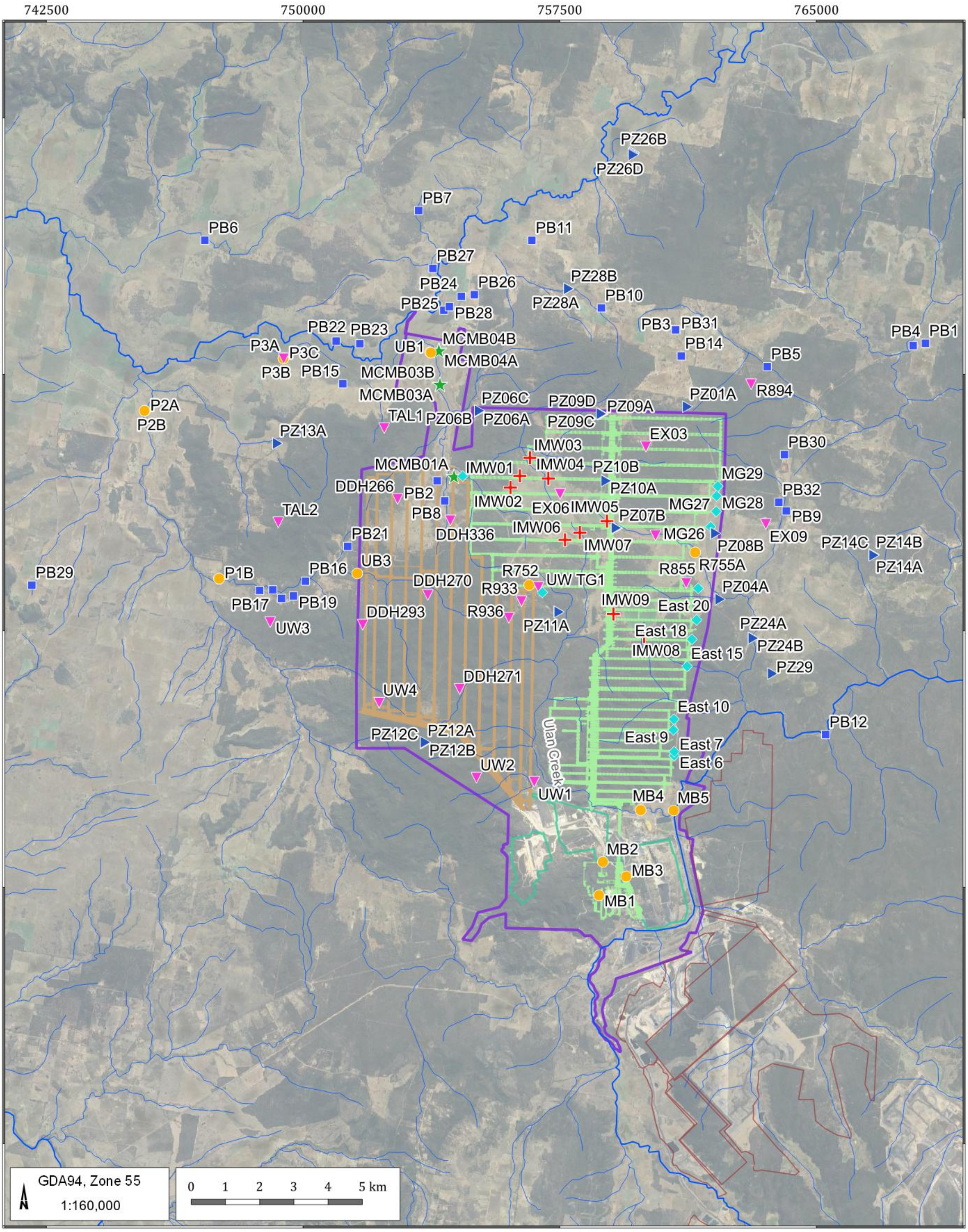
Six additional monitoring bores were constructed during 2020 to provide groundwater monitoring points nearby Mona Creek. Groundwater level data collected from these bores since 2020 are included in this review (Section 7.1.1.6).

Six new monitoring sites were proposed in 2022 consisting of six VWP sites and four monitoring bores. To-date, three of the VWP sites have been installed with the remaining planned for 2024.

The BMN comprises nine open standpipes (labelled IMW01 to IMW09) in the vicinity of the Bobadeen Irrigation Scheme (BIS) installed for the purpose to monitor UCM's pivot irrigation impacts. The shallow monitoring bores intersect the BIS and unconsolidated sediments within the upper catchments of Mona Creek, Ulan Creek, and Spring Gully Creek and monitor seepage from the BIS.

The PMN comprises active and decommissioned bores used to dewater the underground workings at UCM. The current GWMP list 17 PMN bores that are to be measured weekly (MG27, MG23, MG22), fortnightly (East 20, MG26, MG28, MG29, UW TG1, and Ritz) or monthly (East 7, East 9, East 10, East 15, East 18, and MG21). The GWMP also lists bores MG26, MG28, MG29, and UW TG1 as required for real time monitoring.

Where requested, private landholder bores are also monitored annually, or at request by the landholder, and where access is granted. In 2023, 36 private bores were visited for the purpose of data collection with 21 of those being required in the GWMP.



LEGEND

- Major drainage
- Minor drainage
- Ulan West Mine Plan
- Ulan Underground Mine Plan
- Ulan Open Cut
- Moolarben Mine Plan
- 2023 Approved Ulan Mine project boundary

Monitoring bores

- Private bores
- Monitoring bore
- BMN bores
- MCMB bores
- NMN - bores
- PMN - bores
- VWP

Ulan Annual Groundwater Review 2023 (UCM5036.001)

Groundwater monitoring network

AGE

DATE 21/03/2024

FIGURE No: **6.1**

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;

G:\Projects\UCM5036.001 Ulan Annual Review 2023\3_GIS\Workspaces\Figure 6.1 - Groundwater monitoring network\Figure 6.1 - Groundwater monitoring network.qgz

6.2 Network status and condition

6.2.1 Monitoring bores

6.2.1.1 NMN

Nearly all NMN bores were accessible for groundwater level monitoring during 2023. The exceptions were sites PZ13, PZ25, and PZ26 due to access restrictions. These three bores either have been, or are planned to be, removed from the GWMP. Water quality sampling (pH and electrical conductivity (EC)) was performed at all accessible NMN bores with sufficient water for sampling, with five sites not able to be measured at some point in 2023 due to dry bore conditions or insufficient water.

6.2.1.2 BMN

Six of the nine BMN monitoring bores were recorded as dry in across all of 2023 and a further one was recorded as dry for Q3 and Q4. Only three bores reported groundwater levels at some time in 2023 and only two reported water quality data (pH and EC).

6.2.1.3 PMN

Monitoring was undertaken at PMN bores throughout 2023 with groundwater level measurements taken at East 7, East 9, East 10, East 15, East 18, MG21, MG22, MG23 and MG27. Groundwater quality sampling was undertaken at East 20, MG23, MG26, MG28, MG29, Ritz, UW TG1 and UW TG6. Water quality data was not available from East 20 after June 2022 and only two sample collections were made at Ritz due to operational restrictions.

6.2.1.4 Private bores

Annual groundwater level measurements were collected at 32 private bores and water quality sampling was undertaken at 36 private bores. These include bores recognised in the current GWMP as well as others. Installed headworks (i.e., pumps) limited access to water level measurements and sampling in some instances.

6.2.2 VWPs

There were 12 of the 16 NMN VWPs listed in the GWMP that reported data in 2023. Sites DDH266 and DDH271 were damaged or exhibiting faults and are due to be, or have been, undermined. Sites EX01 and R753A where been decommissioned in 2022 due to their location above the mine plan. Continuous data from all sensors at sites DDH270, EX03, PZ29 (The Drip), TAL-1, UW1, UW2, UW3, UW4, and R894 was available in 2023 and partial data was available from sites EX06 (some sensors undermined), EX09, and TAL-2

6.3 Trigger levels

6.3.1 Site monitoring bores (NMN and BMN)

The Environmental Assessment (EA) for Ulan Coal Mine predicts complete dewatering of Triassic strata above all mine longwall panels, with depressurisation extending up to 5 km from the mine. Subsequently, trigger levels are not required to be developed for Ulan Coal Mine groundwater monitoring locations above the mined longwall panels as the majority of these monitoring bores are predicted to become dry within the life of the mine. These monitoring locations include some NMN bores and VWPs, and all PMN and BMN locations. Groundwater level triggers for NMN bores are based on the predictions of numerical modelling. As per the GWMP, the numerical groundwater model is reviewed and assessed for accuracy and calibration every two years and, where necessary, updated. The latest model (updated in 2022) represents the state-of-the-art modelling techniques and is the most-accurate model to-date.

This model was used in 2023 to update groundwater trigger levels (AGE 2023[4]) and is used in this assessment. The GW model will again be reviewed and assessed for accuracy and calibration in 2024.

Groundwater levels for those NMN sites located outside of the immediate mine footprint (PZ01, PZ04, PZ06, PZ08, PZ09, PZ12, PZ13, PZ14, PZ24, PZ26, PZ28, R755A, PZ29, R894, TAL1, TAL2, UW2 and UW3) are compared against model predictions in accordance with the Surface Water and Groundwater Response Plan (SWGWRP) to identify any deviations. Any lowering of groundwater levels beyond SWGWRP trigger levels will require investigation into the potential cause and implications. Groundwater level triggers were recently updated in AGE (2023[4]) based on the latest numerical model.

The SWGWRP further specifies water quality (pH and EC) Stage 1 triggers as three consecutive measurements of >95% baseline data (and < 5% baseline data for pH) and Stage 2 triggers as one exceedance of historical maximum (and minimum for pH) for NMN monitoring bores. These values were also derived in AGE (2023[4]) from the historic data set. Accordingly, 2023 groundwater quality data has been reviewed against these updated criteria to identify changes in groundwater quality which may require further investigation.

6.3.2 Site monitoring bores (PMN)

Groundwater is extracted from PMN dewatering bores to lower groundwater levels to allow for safe underground mining. Abstracted groundwater is then used for irrigation, site use, or treated prior to discharge from site. Triggers are not required for these bores.

6.3.3 Private bores

Trigger levels for the private bores have been developed based on predicted drawdown from the numerical model, per the SWGWRP. This includes private bores that are predicted to experience groundwater level drawdown greater than 2 m as the result of mining operations, and those which are not.

Groundwater level and groundwater quality results collected in 2023 from the private bore monitoring network (where access permits data collection) have been compared against trigger levels derived in accordance with the SWGWRP.

The SWGWRP trigger level criteria are as follows:

- for EC and pH: three consecutive measurements of >95% baseline data (Stage 1) or ±10% deviation from baseline data (Stage 2) for those bores within the predicted 2 m drawdown area;
- for EC and pH: three consecutive measurements of >95% baseline data (Stage 1) or ±15% deviation from baseline data (Stage 2) for those bores outside the predicted 2 m drawdown area; and
- for groundwater level: greater depressurisation than that predicted by numerical groundwater modelling and/or complaint received from private landholder.

[4] Australasian Groundwater and Environmental Consultants Pty Ltd (AGE). (2023). *Ulan NMN Trigger Derivation*. Prepared for Glencore Coal Assets Australia – Ulan Coal Mine. Project No. UCM5020.001.

7 Monitoring results

The sections below present the 2023 monitoring results for each monitoring network and stratigraphic unit present at Ulan Coal Mine (refer to Table 4.1 for units).

7.1 NMN

During the 2023 monitoring period, where access and groundwater conditions permitted, groundwater levels were monitored on a quarterly basis, field water quality was sampled bi-annually, and a full suite of water chemistry samples was collected annually.

Hydrographs for NMN monitoring bores and VWPs are presented in Appendix A and Appendix B, respectively. Comparisons with the model predictions are discussed in the following sections with tabulated total observed and total predicted drawdown presented in Appendix E.

7.1.1 Groundwater levels

7.1.1.1 Tertiary basalt

Monitoring bore R752 intersects Tertiary basalt. Quarterly water level readings were not available in R752 in 2023 because the bore was dry or inaccessible (Table 7.1). Dry conditions also excluded water quality sampling from this bore in 2023.

Table 7.1 Tertiary groundwater levels

Site		Quarter 1	Quarter 2	Quarter 3	Quarter 4
R752	mAHD	-	-	-	-
	mBRP	dry	dry	-	dry

Notes: mBRP = metres below reference point
mAHD = metres Australian height datum

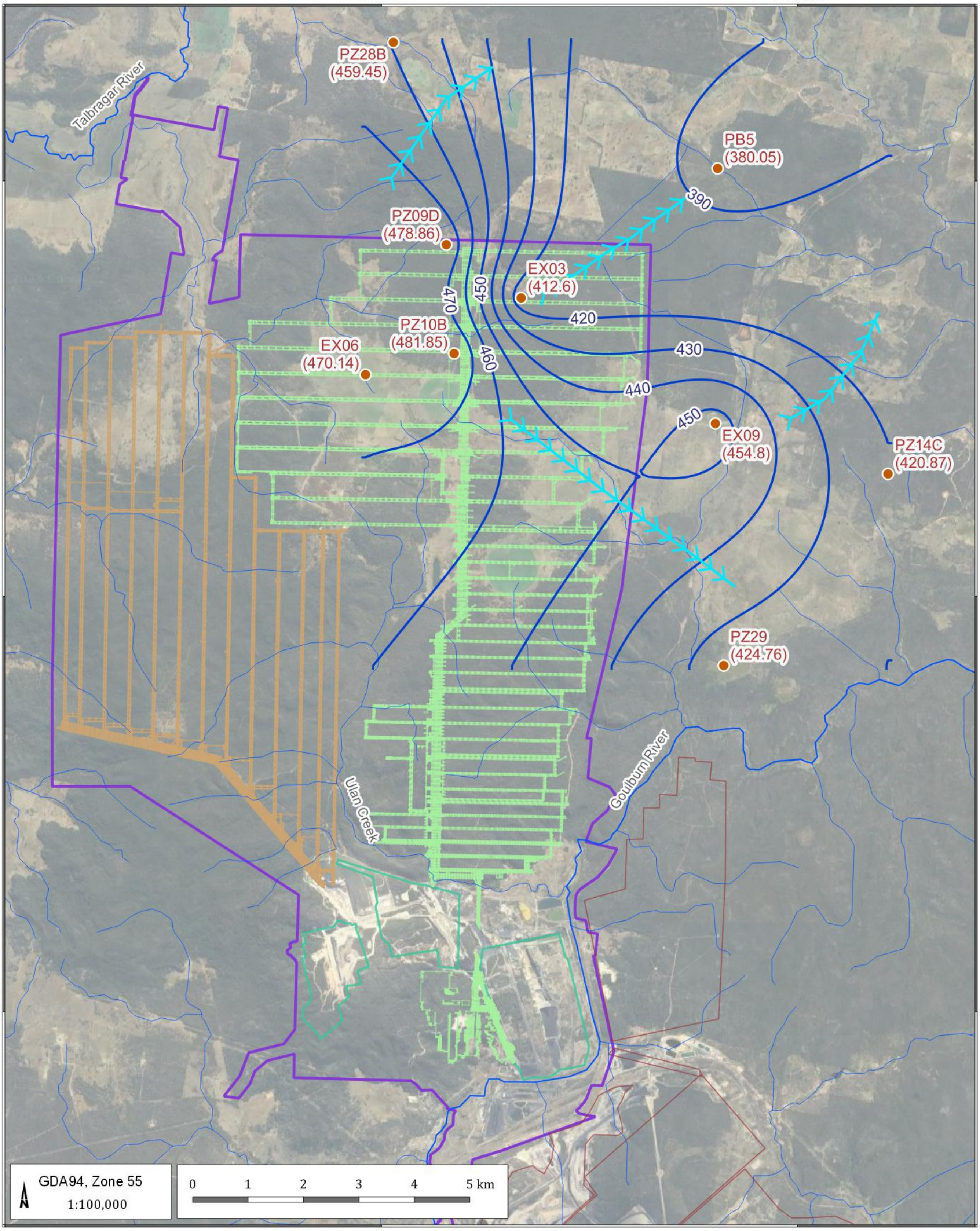
7.1.1.2 Jurassic sediments

Quarterly groundwater levels for 2023 are presented in Table 7.2 and interpolated groundwater level contours are shown in Figure 7.1. Water level data shows that during 2023:

- PZ09D, PZ10B, PZ14C, and PZ28B report relatively stable trends consistent with historical records.
- PZ10B shows the most variability (less than 10 m) but an overall stable long-term trend.
- PZ26D has no recent data available due to site access restrictions.

Groundwater drawdown exceedances were calculated by comparing the observed groundwater level to the minimum level predicted by the model, as adopted in AGE (2023[4]). No water level exceedances were observed in 2023 for the Jurassic bores.

Saturation within the Jurassic strata varies across the region and in some places may not be considered a single, continuous aquifer. This is mentioned as a possible explanation for the wide variability in groundwater levels (over 100 m) observed in Figure 7.1.



LEGEND

- Monitoring bore (groundwater level, mAHD)
- Major drainage
- Minor drainage
- Interpolated groundwater contour (mAHD)
- Flow direction
- Ulan West Mine Plan
- Ulan Underground Mine Plan
- Ulan Open Cut
- Moolarben Mine Plan

Ulan Annual Groundwater Review 2023
(UCM5036.001)

Interpolated groundwater contours - Jurassic

AGE

DATE
21/03/2024

FIGURE No:
7.1

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
G:\Projects\UCM5036.001 Ulan Annual Review 2023\3_GIS\Workspaces\Figure 7.X - Interpolated groundwater contours\Figure 7.X - Interpolated groundwater contours.qgz

Table 7.2 Jurassic groundwater levels (mBRP and mAHD)

Site		Quarter 1	Quarter 2	Quarter 3	Quarter 4
PZ09D	mAHD	-	-	478.45	478.64
	mBRP	NM	NM	62.14	61.95
PZ10B[1]	mAHD	480.20	-	477.94	479.31
	mBRP	33.90	-	36.16	34.79
PZ14C	mAHD	421.03	420.98	420.86	421.10
	mBRP	33.53	33.58	33.70	33.46
PZ26D	mAHD	-	-	-	-
	mBRP	NA	NA	NA	NA
PZ28B	mAHD	459.49	459.47	-	459.36
	mBRP	15.70	15.72	-	15.83

Notes: [1] Within mine footprint, no trigger level set
NA = no access
NM = not measured

7.1.1.3 Triassic sediments

The Triassic sediments directly overlie the Permian coal measures, including those currently being mined. Table 7.3 presents the 2023 results of groundwater level measurements at NMN monitoring bores screened in this stratigraphy. Overall, measured 2023 groundwater levels were fairly stable with seven of the 14 Triassic bores recording a slight drop in groundwater level over 2023 (0.13 m to 0.35 m). Two bores (PZ12C and PZ14B) recorded a rise in groundwater level and the remaining five bores did not have groundwater level data in for the full year. Despite the observed decline, no Triassic bores exceeded the prescribed groundwater trigger levels.

Table 7.3 Triassic groundwater levels (mBRP and mAHD)

Site		Quarter 1	Quarter 2	Quarter 3	Quarter 4
PZ01A	mAHD	415.05	415.03	414.58	414.67
	mBRP	119.20	119.22	119.67	119.58
PZ04A	mAHD	396.70	396.64	396.50	396.50
	mBRP	44.04	44.10	44.24	44.24
PZ06C	mAHD	430.29	430.11	430.17	429.94
	mBRP	20.43	20.61	20.55	20.78
PZ07C[1]	mAHD	-	-	-	-
	mBRP	dry	dry	dry	dry
PZ08C	mAHD	-	-	-	-
	mBRP	dry	dry	dry	dry
PZ09C	mAHD	421.21	420.84	420.77	421.01
	mBRP	119.83	120.20	120.27	120.03
PZ10A	mAHD	-	-	348.55	348.35
	mBRP	dry	dry	165.25	165.45
PZ11B	mAHD	-	-	397.26	397.26
	mBRP	dry	dry	79.20	79.20

Site		Quarter 1	Quarter 2	Quarter 3	Quarter 4
PZ12C	mAHD	509.94	509.95	509.98	510.11
	mBRP	60.66	60.65	60.62	60.49
PZ14B	mAHD	395.97	395.95	396.66	397.20
	mBRP	58.13	58.15	57.44	56.90
PZ24B	mAHD	398.75	398.74	398.59	398.62
	mBRP	22.20	22.21	22.36	22.33
PZ26C	mAHD	-	-	-	-
	mBRP	NA	NA	NA	NA
PZ28A	mAHD	427.60	427.30	427.56	427.45
	mBRP	47.83	48.13	47.87	47.98
R755A	mAHD	387.90	-	387.65	387.67
	mBRP	74.52	NM	74.77	74.75

Notes: [1] Within mine footprint, no trigger level set
NA = no access
NM = not measured

Groundwater levels in PZ01A, PZ04A, PZ06C, PZ09C, PZ24B, PZ28A, and R755A all showed slight declines in 2023, which are predicted by the most-recent model given the proximity of these bores to the active mining area and expectation of mining-induced subsidence and associated dewatering.

PZ07C (located directly above the central section of the underground mine) was recorded as "dry" at the conclusion of 2021 monitoring and continued to be recorded as dry through 2023. Complete dewatering of this bore is predicted by the modelling. PZ08C and PZ26C where reported as dry throughout 2023 and PZ10A, PZ11B, and R755A were also reported as dry at times in 2023.

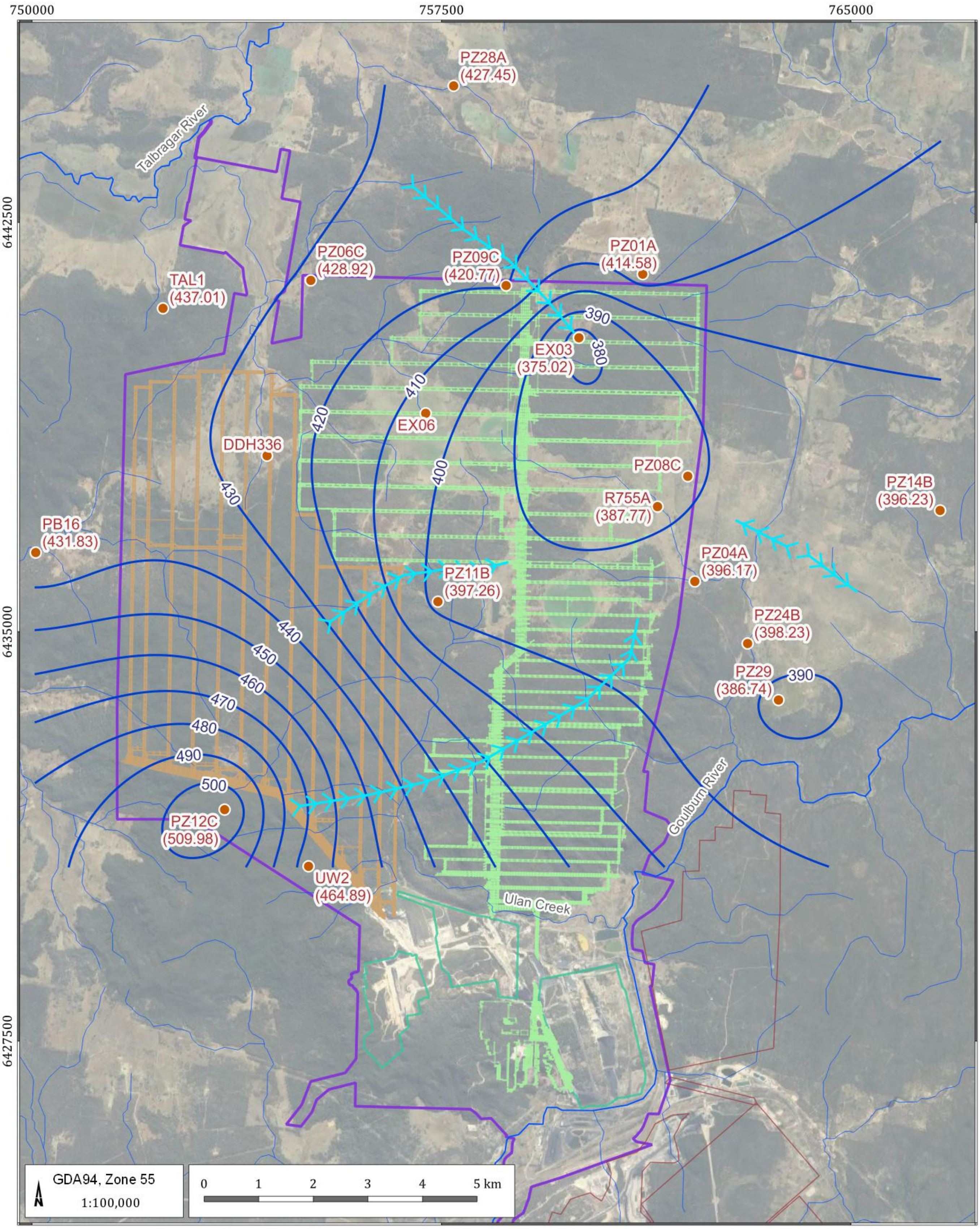
Exceedances were calculated by comparing the observed groundwater level to the minimum groundwater level predicted by the latest version of the numerical model. No Triassic bores exceeded the prescribed groundwater levels in 2023, however PZ08C was reported as "dry" in 2023, making it unreasonable to calculate total drawdown. The deepest predicted groundwater level in PZ08C (111.33 mBRP) is near the total bore depth (130 mBRP) and so "dry" conditions are reasonable considering uncertainty in bore depth and predicted drawdown.

PZ08C was identified as exceeding its prescribed groundwater level trigger in 2022, which it had also done in 2021 and 2020 (based on historical modelling). There is no groundwater level data from PZ08C since Q1 2022, but the historic data shows an obvious declining trend since 2016. The exceedance was investigated in AGE (2021[5]) and AGE (2023[6]) with the cause of the more rapid decline than model prediction was attributed to groundwater abstraction in MG26 (a nearby dewatering bore), which was not simulated in the MOD4 groundwater model but has been included in the updated model that provided the updated triggers. Although the bottom of PZ08C is below the prescribed trigger level, it is within 10 m and given uncertainty in actual (vs reported) bore depth, reference point level, and the potential for silting at the bottom of the bore, "dry" conditions in PZ08C may be concordant with the predicted impacts and therefore, the trend in PZ08C is not considered an ongoing exceedance.

Figure 7.2 shows the interpolated groundwater contours from monitoring bores in the Triassic sediments. The contours show depressed groundwater levels nearby to the mine (EX03) which is expected due to fracturing in the Triassic above mine panels.

[5] Australasian Groundwater and Environmental Consultants Pty Ltd (AGE). (2021). *Ulan Groundwater Exceedance Review 2020*. Prepared for Glencore Coal Assets Australia – Ulan Coal Mine. Project No. G1985L. October 2021.

[6] Australasian Groundwater and Environmental Consultants Pty Ltd (AGE). (2023). *Ulan 2022 groundwater exceedance investigation.* Prepared for Glencore Coal Assets Australia – Ulan Coal Mine. Project No. UCM5027.001. July 2023.



LEGEND

- Monitoring bore (groundwater level, mAHD)
- Major drainage
- Minor drainage
- Interpolated groundwater contour (mAHD)
- Flow direction
- Ulan West Mine Plan
- Ulan Underground Mine Plan
- Ulan Open Cut
- Moolarben Mine Plan

Ulan Annual Groundwater Review 2023
(UCM5036.001)

Interpolated groundwater contours - Triassic

AGE

DATE
21/03/2024

FIGURE No:
7.2

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
G:\Projects\UCM5036.001 Ulan Annual Review 2023\3_GIS\Workspaces\Figure 7.X - Interpolated groundwater contours\Figure 7.X - Interpolated groundwater contours.qgz

7.1.1.4 Permian coal measures

Table 7.4 presents the data for 2023 groundwater level measurements for monitoring bores intersecting the Ulan Seam and the underlying Permian coal measures. Five of the 14 Permian bores were not accessible in 2023 for groundwater level measurements. Drawdown over 2023 was observed in all nine Permian bores and ranged from 0.16 m (PZ11A) to 25.8 m (PZ09B). This reflects long-term trends associated with mine-related dewatering.

Water level behaviour observed in other bores is as follows:

- Bores PZ06A, PZ06B, PZ09A, and PZ09B exhibit steady drawdown since 2016 with considerably accelerated drawdown since 2022. Exceedances in PZ06B and PZ09B were investigate in 2023 and attributed to omissions in the MOD4 model that have been remedied in the updated model.
- PZ24A exhibits steady drawdown since 2016, an accelerated rate from 2021 to 2022, and a subdued rate in 2023.
- PZ14A, PZ12B, PZ11A, and PZ07B exhibit near-stable to slightly declining trends since 2016. PZ12B was also investigated in 2023 and attributed to model omissions.
- PZ07A is reported as having a blockage in the casing that has prevented GWL measurement since 2019.
- PZ08B was reported as dry through much of the period of record (only four measurements since 2016) and recorded no groundwater level data in 2023.
- PZ12A has been reported as “dry” since 2017.
- No groundwater level data has been collected from PZ13A in several years due to access restrictions.
- Monitoring bores PZ25A and PZ25B, which are recognised in the GWMP, no longer exist and have been removed from the GWMP (pending approval).

Declining groundwater levels in these strata are expected as the process of underground mining reduces groundwater pressures within the target coal seam (Ulan Seam) and hydraulically connected aquifers (Permian coal measures). Whilst some bores recorded considerable drawdown in 2023 and over the period of record, no concerns are raised as these are expected to be dewatered as the mining operations expand. None of the Permian bores that had groundwater level data in 2023 exceeded the prescribed trigger values derived from the latest numerical model.

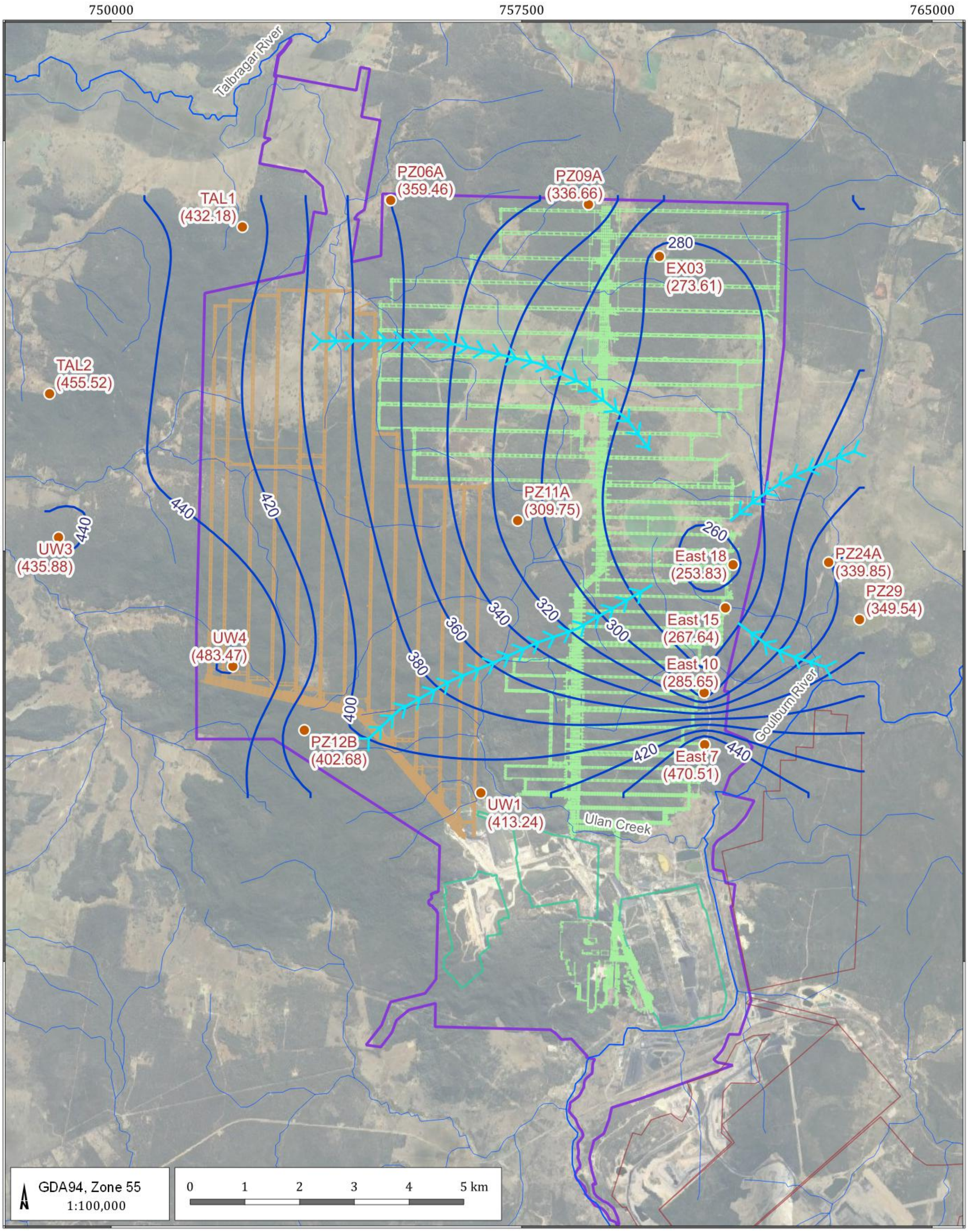
Figure 7.3 shows groundwater contours developed from water level data in Permian bores and indicates that groundwater is flowing towards the underground mine and that drawdown is occurring within the Ulan Seam towards the active mine area, as predicted within the EA.

Table 7.4 Permian coal measures groundwater levels (mBRP and mAHD)

Site		Quarter 1	Quarter 2	Quarter 3	Quarter 4
PZ06A	mAHD	366.46	364.81	362.61	360.66
	mBRP	84.25	85.90	88.10	90.05
PZ06B	mAHD	339.37	337.91	331.35	330.07
	mBRP	111.43	112.89	119.45	120.73
PZ07A[1]	mAHD	-	-	-	-
	mBRP	NM	NM	NM	NM
PZ07B[1]	mAHD	254.69	255.33	254.13	254.34
	mBRP	247.90	247.26	248.46	248.25
PZ08B	mAHD	-	-	-	-
	mBRP	dry	dry	dry	dry
PZ09A	mAHD	344.73	343.07	340.64	337.64
	mBRP	197.11	198.77	201.20	204.20

Site		Quarter 1	Quarter 2	Quarter 3	Quarter 4
PZ09B	mAHD	317.48	312.26	295.86	291.68
	mBRP	224.08	229.30	245.70	249.88
PZ11A[1]	mAHD	309.89	309.87	309.03	309.73
	mBRP	166.84	166.86	167.70	167.00
PZ12A	mAHD	-	-	-	-
	mBRP	dry	dry	dry	dry
PZ12B	mAHD	402.81	402.77	402.30	402.61
	mBRP	168.49	168.53	169.00	168.69
PZ13A	mAHD	-	-	-	-
	mBRP	NA	NA	NA	NA
PZ14A	mAHD	421.00	420.95	420.73	420.92
	mBRP	32.80	32.85	33.07	32.88
PZ24A	mAHD	304.14	304.07	301.88	300.73
	mBRP	116.98	117.05	119.24	120.39
PZ26A	mAHD	-	-	-	-
	mBRP	NA	NA	NA	NA
PZ26B	mAHD	-	-	-	-
	mBRP	NA	NA	NA	NA

Notes: [1] Within mine footprint, no trigger level set
NA = no access
NM = not measured



LEGEND

- Monitoring bore (groundwater level, mAHD)
- Major drainage
- Minor drainage
- Interpolated groundwater contour (mAHD)
- Flow direction
- Ulan Underground Mine Plan
- Ulan West Mine Plan
- Ulan Open Cut
- Moolarben Mine Plan

Ulan Annual Groundwater Review 2023 (UCM5036.001)

Interpolated groundwater contours - Permian

AGE

DATE 21/03/2024

FIGURE No: **7.3**

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
G:\Projects\UCM5036.001 Ulan Annual Review 2023\3_GIS\Workspaces\Figure 7.X - Interpolated groundwater contours\Figure 7.X - Interpolated groundwater contours.qgz

7.1.1.5 Porewater pressure (VWPs)

Porewater pressure is monitored in numerous VWP sensor arrays installed in the vicinity of Ulan Coal Mine. The VWP sensor arrays are installed in a single borehole to measure changes in groundwater pressure over time at a specific depth. Details on sensor depths are provided in the GWMP[1] and in Appendix E. Where necessary, a comparison between observed porewater pressures and model predictions from the latest numerical model has been made and provided in the following paragraphs. Hydrographs for 2023 observed porewater pressure are presented in Appendix B and total cumulative drawdown and trigger levels (were prescribed) are presented in Appendix E. Comments on VWP data are presented in the following paragraphs.

DDH270 is located in the western section of the approved mine boundary and comprises three sensors at depths of 76 mBGL (Triassic), 165 mBGL (Permian), and 171 mBGL (Permian). Data from the DDH270 VWP array was unavailable from early 2014 until late 2019, with access restored in 2020. Since 2007, the 76 m and 171 m sensors showed continuous decline, with the 165 m sensor maintaining near-constant pressure head. The 76 m and 171 m sensors recorded an overall decline of approximately 30 m and 20 m, respectively, with the 76 m sensor recording nearly 20 m of decline since 2021. DDH270 is within the mine footprint and thus does not have porewater pressure decline triggers assigned. The behaviour observed is representative of what is expected from the numerical model.

EX03 is located in the northeast of the mine footprint and this array consists of seven sensors (three in Jurassic strata, two in Triassic, and two in Permian). The 242 m Permian sensor stopped reporting data in 2022. Most sensors are relatively stable or minimally variable throughout the period of record. The notable exception is the 297 m (Permian) sensor, which has shown a gradual decline since late 2019 of approximately 30 m, and a sharp drop in early 2023 The behaviour in this sensor is likely related to nearby mining activity in the Ulan Underground LW30. The 48 m (Jurassic) and 160 m (Triassic) sensors show a slow rise (approx. 5 m) until mid 2022, then a slow decline back to the previous range. This behaviour is likely due to natural variability in the groundwater regime (e.g. climate driven). Given the location of this VWP, the deeper sensors are very likely to be impacted by the extraction and dewatering of LW31 and are behaving as predicted.

EX06 has eight sensors (two Jurassic, four Triassic, and two Permian) but six of them have ceased recording data in 2021 when the site was undermined. The shallowest two sensor are reporting data but given the underlying disturbance at the site, the data may not be a reliable representation of groundwater conditions more broadly.

EX09 has seven sensors (three Jurassic and four Triassic) and is located approximately 2 km east of Ulan Coal Mine. Continuous data was only available for five sensors in 2023. Data since mid-2020 for these sensors shows a slight overall declining trend, as predicted and due to proximity of nearby mining. The largest decline is observed in the 301 m sensor (Triassic). EX09 has no sensors installed into Permian strata.

PZ29 (The Drip) is located outside of the mine footprint, approximately 1.3 km north of The Drip and contains eight sensors (one Jurassic, four Triassic, and three Permian). Throughout the full period of record (since 2016), many of the sensors show a relatively stable trend but in recent years a slight declining trend has been observed in some sensors. The two sensors completed into the Goulburn Seam (143 m) and Ulan Seam (243 m) show overall declines since 2017 and the Ulan Seam 243 m sensor recorded a 4.0 m decline in 2023 and an approximately 38 m decline since 2017 (these declines are predicted by the model). Drawdown over 2023 was less than 1 m in the five Triassic sensors and total cumulative drawdown for these sensors ranged from less than 1 m to approximately 4 m. Although the groundwater level change is minimal, the modelling also predicts minimal drawdown (less than 5 m) for the shallow sensors and three of the four Triassic sensors exceeded the predicted drawdown, but all by less than 1.25 m. The declining trends in these sensors was investigated by AGE (2023[7]) and attributed to climate variability.

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[7] Australasian Groundwater and Environmental Consultants Pty Ltd (AGE). (2023). *Ulan 2022 groundwater exceedance investigation.* Prepared for Glencore Coal Assets Australia – Ulan Coal Mine. Project No. UCM5027.001. July 2023.

PZ29 is discussed in more detail in Section 7.5 but depressurisation at depth, particularly in the Ulan Seam, is expected given the nearby cumulative mining activity occurring at Ulan and Moolarben Mines and is predicted by the model. Drawdown in the Triassic strata is also predicted by the model and the discrepancy in magnitude may be influenced by discrepancies between the simulated mining progression timeline and the actual progression, or by external (non-mining) climate / weather variability. This is recommended for investigation.

R894 is situated northeast of the project boundary and contains four sensors at 90 m, 119 m, 219 m, and 255 mBGL. Data gaps exist in the record between 2017 and late 2019 and continuous data was recorded since 2020. Recent data shows a small declining trend (< 2 m) at all depths except for the 90 m sensor. The 90 m sensor continues to record a large increase in pressure head (over 100 m) which is not reflective of groundwater conditions and indicates that the 90 m sensor may be malfunctioning.

TAL-1 has five sensors installed (two Triassic and three Permian) and is located 1 km north of the mine footprint. Porewater pressure trends in three of the five sensors show an overall slight decline that becomes more pronounced toward the end of 2022 then begins to flatten through 2023. The 97 m (Permian) sensor had shown an inclining trend between 2016 and 2022 but then begins to decline in late 2022 through 2023. The Ulan Seam 140 m sensor shows a sharp decline at the end of 2021 then a variable but overall, slightly declining trend through 2023, which is related to mining activity. Considerable depressurisation of the all sensors is predicted by the numerical model and no TAL-1 sensors exceeded these predictions drawdowns.

TAL-2 is located 2.7 km west of the mine footprint and has four sensors installed (all Permian with one in the Ulan Seam). Whilst historically there were large disruptions to data collection, since repairs in 2018, data collection had been mostly uninterrupted until mid-2022 when access to the site was lost. In early 2023, access was restored, and data is available through mid-2023. All sensors in TAL-2 show overall declines, ranging from 1 m (50 m sensor) to 16 m (128 m sensor). Drawdown is predicted for all of the TAL-2 sensors, but the 50 m sensor exceeded its predicted drawdown by less than 0.07 m. This exceedance is considered within the uncertainty of the model and measurement error and so does not warrant further investigation (but will be tracked in future reviews). TAL-2 is discussed further in Section 7.6.

UW1 is located at the southern end of the mine footprint and has four sensors installed (all Permian with one in the Ulan Seam). Groundwater pressures in these sensors show a punctuated drop in 2015 but are relatively stable to slightly inclining since then and throughout 2023. UW1 was not included in the model so no trigger levels are prescribed.

UW2 is located 500 m from the southwestern boundary of the mine footprint and contains three sensors (one Triassic and two Permian). There was limited data recorded in 2020 and 2021 in two of the three sensors but all three have recorded data from mid-2022 through 2023. Data for all three show a relatively stable trend overall and minimal change (less than 1 m) in 2023. No sensors exceeded their trigger levels.

UW3 is located 2.5 km west of the mine footprint and has four sensors (all Permian with one in the Ulan Seam). Porewater pressure readings have been stable in all three Permian sensors since mid-2019 but the 60 m and 75 m are beginning to show a consistent declining trend (overall cumulative decline of 1.9 m and 3.1 m). Pressure in the 98 m sensor (Ulan Seam) has been increasing from 2019 into 2022 but has been relatively stable since mid-2022. No sensors exceeded the overall adopted trigger level.

UW4 is in the southwestern corner of the mine footprint and has three sensors (all Permian with one in the Ulan Seam). Pressure head at all sensors has been relatively stable since 2017 with the 41 m and 63 m sensors (both Permian) showing some small variability since 2020. UW4 was not included in the model so not trigger levels are prescribed.

Porewater pressure trends in TAL-1, TAL-2, and UW4 were investigated in AGE (2023[6]) and attributed to groundwater response to climate variability.

7.1.1.6 Mona Creek monitoring bores

The Mona Creek monitoring bores are a group of six monitoring bores that were installed nearby to Mona Creek in the northern extent of the Ulan site boundary. More details are available in AGE (2021[8]). The bores are distributed across three locations that consist of two nested monitoring bores at each site, with one bore installed into unconsolidated sediments (colluvium) and the other into Triassic sandstone.

Groundwater level data was collected from the Mona Creek monitoring bores quarterly in 2023 and is presented in Table 7.5. Monitoring bore MCMB01B, installed into Triassic sandstone, remained dry throughout 2021, 2022, and 2023. Groundwater levels in MCMB01A (unconsolidated sediments) declined over Q1, Q2, and Q3 but recovered slightly into Q4. MCMB03A GWLs declined from Q1 to Q2 and was reported “dry” by Q4. The remaining three bores recorded declining groundwater levels over 2023 of around 1 m.

Trigger levels are yet to be derived for the Mona Creek monitoring bores, but the bores have been simulated in the latest numerical model. If these monitoring sites are added to the NMN within the next update of the GWMP, groundwater level triggers will need to be derived by statistical analysis or by evaluation against the latest groundwater model results.

Table 7.5 Mona Creek monitoring bore groundwater levels (mBRP)

Site	Quarter 1	Quarter 2	Quarter 3	Quarter 4
MCMB01A	3.41	5.97	7.05	6.05
MCMB01B	dry	dry	dry	dry
MCMB03A	12.97	13.22	dry	dry
MCMB03B	13.24	13.25	14.10	14.15
MCMB04A	4.07	4.54	5.24	5.43
MCMB04B	4.07	4.54	5.37	5.42

7.1.2 Groundwater quality

Field water quality parameters (pH and EC) are measured on a semi-annual basis and a laboratory analysis suite (e.g., ions, metals) is sampled annually. Graphs presenting 2023 time series of NMN sites sampled for EC, pH, TDS, nutrients and dissolved metals, are presented in Appendix A and major ion concentrations are represented visually in a Piper plot in Figure 7.4.

[8] Australasian Groundwater and Environmental Consultants Pty Ltd (AGE). (2021). *Ulan Coal Mine – Mona Creek Monitoring Bore Installations*. Prepared for Glencore Coal Assets Australia – Ulan Coal Mine. Project No. G1985H. June 2021.

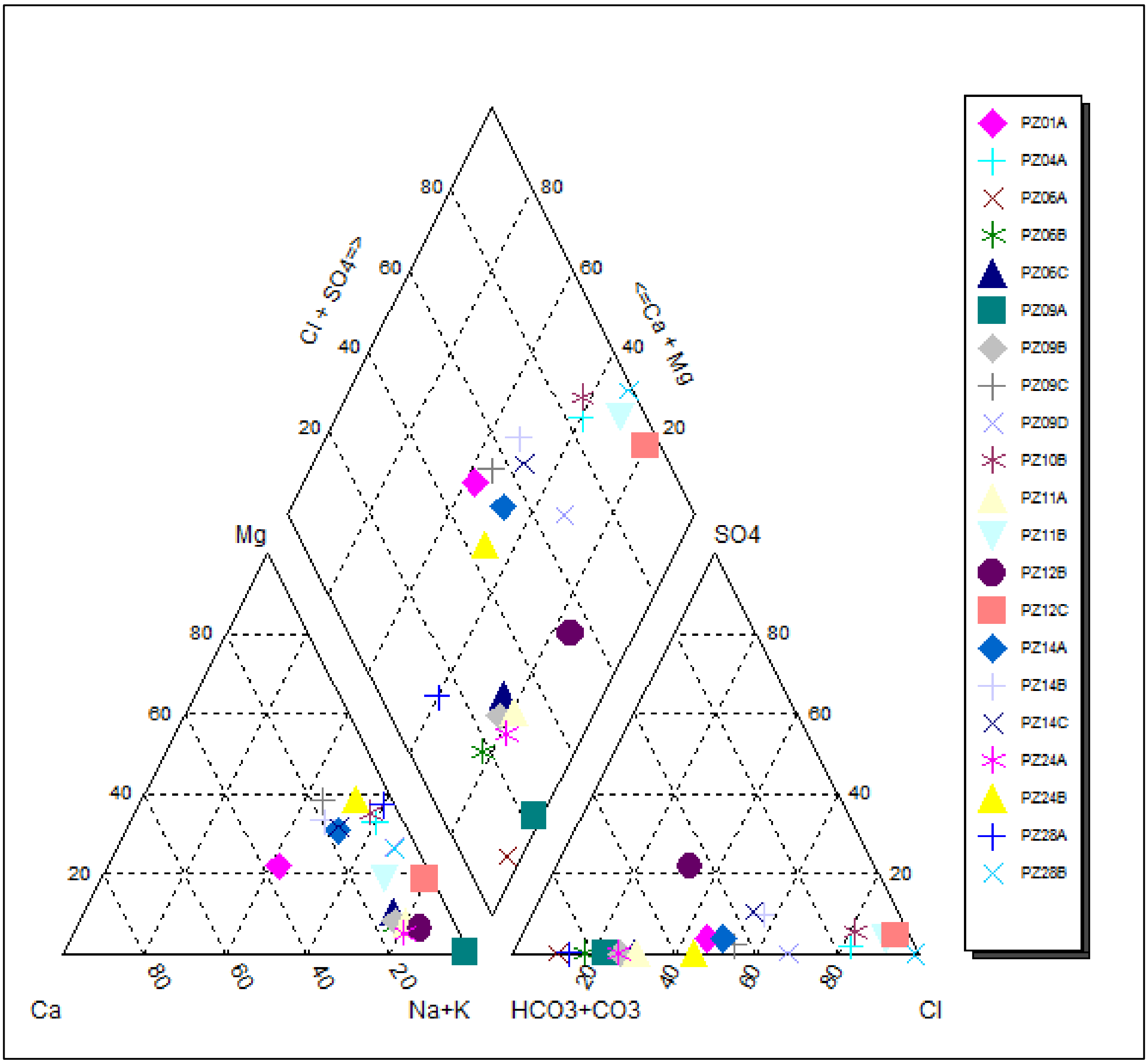


Figure 7.4 Piper of NMN bore data (only included bores with sufficient data for plotting)

7.1.2.1 Physical parameters – pH and EC

Table 7.6 and Table 7.7 present the field water quality results for EC and pH, respectively, for the NMN monitoring bores collected in 2023. Exceedances are routinely re-derived from the historic data record per the requirements in SWGWRP and last updated in AGE (2023[4]). In 2023, five bores exceeded their respective Stage 2 EC triggers, and one bore exceeded the Stage 2 pH trigger. Trigger exceedances are denoted in Table 7.6 and Table 7.7 by red cells for high pH or high EC exceedances and blue cells for low pH exceedances.

Table 7.6 NMN field measurements and trigger values for pH

Station	Trigger values				Measured values 2023	
	Historic min	5th %ile	95th %ile	Historic max	Quarter 1	Quarter 3
Tertiary volcanics						
R752	6.73	6.90	7.59	7.70	-	-
Jurassic strata						
PZ09D	6.79	6.87	8.14	8.20	7.38	-

Station	Trigger values				Measured values 2023	
	Historic min	5th %ile	95th %ile	Historic max	Quarter 1	Quarter 3
PZ10B	5.76	5.88	7.82	9.15	5.96	6.21
PZ14C	6.29	6.37	7.14	7.28	6.65	7.13
PZ26D	6.90	6.93	9.93	10.36	-	-
PZ28B	7.27	7.28	9.60	9.66	8.28	7.27
Triassic strata						
PZ01A	5.85	6.02	7.10	7.59	7.15	6.05
PZ04A	5.30	5.30	6.87	7.76	6.07	5.40
PZ06C	6.72	7.00	10.30	10.40	7.00	7.10
PZ07C	4.98	5.72	8.04	8.20	-	-
PZ08C	6.39	6.43	8.11	8.14	-	-
PZ09C	6.48	6.50	8.70	8.80	6.77	6.78
PZ10A	6.57	7.17	10.15	11.00	-	-
PZ11B	5.53	5.60	6.80	6.93	6.75	-
PZ12C	4.30	4.37	6.83	7.59	5.57	6.75
PZ14B	6.52	6.56	12.28	12.70	6.70	6.73
PZ24B	6.17	7.29	10.03	10.20	6.91	6.55
PZ26C	9.00	9.00	12.25	12.80	-	-
PZ28A	8.48	8.76	9.60	9.60	9.43	8.90
R755A	6.20	6.23	6.51	6.53	-	-
Permian strata						
PZ06A	6.87	8.00	8.60	8.60	7.17	7.67
PZ06B	7.10	7.15	7.78	8.00	**7.07**	7.13
PZ07A	10.75	11.05	11.80	11.80	-	-
PZ07B	5.34	5.68	8.96	9.15	-	-
PZ08B	NT	NT	NT	NT	-	-
PZ09A	8.75	8.98	9.61	9.70	9.10	9.19
PZ09B	7.46	7.47	8.44	9.85	8.07	8.03
PZ11A	6.46	6.49	6.95	6.98	**7.08**	6.75
PZ12A	NT	NT	NT	NT	-	-
PZ12B	6.05	6.07	6.83	7.08	6.44	6.32
PZ13A	NT	NT	NT	NT	6.92	6.83
PZ14A	6.68	6.70	10.10	10.40	7.59	7.49
PZ24A	7.10	7.21	9.65	9.80	-	-
PZ26A	9.70	9.72	9.90	9.90	-	-
PZ26B	8.40	8.42	11.61	12.12	7.17	7.67

Notes: ND = No Data.
NT = no trigger set
= Stage 2 EC or high-pH exceedance.
= Stage 2 low-pH exceedance.
999 and 999 = Stage 1 exceedances

Table 7.7 NMN field measurements and trigger values for EC

Station	Trigger value (µS/cm)		Measured value 2023 (µS/cm)	
	95th %ile	Historic max	Quarter 1	Quarter 3
Tertiary volcanics				
R752	1234	1300	-	-
Jurassic strata				
PZ09D	1620	1710	-	1467
PZ10B	3984	4043	2945	2692
PZ14C	1353	1400	1163	1266
PZ26D	3856	4025	-	-
PZ28B	2772	2800	2643	**2801**
Triassic strata				
PZ01A	620	750	484.3	504
PZ04A	404	420	194.5	201.8
PZ06C	461	509	**580**	**631**
PZ07C	707	717	-	-
PZ08C	1301	1305	-	-
PZ09C	753	880	574	578
PZ10A	876	970	-	-
PZ11B	230	242	-	195
PZ12C	212	220	160	193
PZ14B	2060	2060	1352	1413
PZ24B	313	376	**471**	**601**
PZ26C	389	405	-	-
PZ28A	528	583	570	**688**
R755A	917	938	-	-
Permian strata				
PZ06A	1652	1680	1608	**1733**
PZ06B	1261	1270	1071	1038
PZ07A	1559	1559	-	-
PZ07B	2683	2756	-	-
PZ08B	NT	NT	-	-
PZ09A	1050	1050	926	933
PZ09B	1241	1270	1228	1174
PZ11A	846	848	844	845
PZ12A	NT	NT	-	-
PZ12B	542	547	521	448
PZ13A	NT	NT	1153	1170
PZ14A	1195	1210	905	884
PZ24A	906	956	-	-

Station	Trigger value (µS/cm)		Measured value 2023 (µS/cm)	
	95th %ile	Historic max	Quarter 1	Quarter 3
PZ26A	1430	1430	-	-
PZ26B	1429	1430	1608	1733

Notes: ND = No Data.
NT = no trigger set
= Stage 2 EC or high-pH exceedance.
= Stage 2 low-pH exceedance.
999 and 999 = Stage 1 exceedances

A summary of the average 2023 EC and pH and standard deviation for the stratigraphic units represented in the NMN is presented in Table 7.8. Table 7.8 also presents the historic average derived from all NMN sites and the standard deviation value. EC and pH results for 2023 where similar (within 1 standard deviation) to 2022 with pH and EC for all stratigraphic units lower in 2023 than 2022 (not shown).

Overall, the 2023 average values for EC and pH do not represent notable change compared to historical averages and are within the historic range, as defined by the standard deviation. This acknowledged, there are recorded exceedances in some bores as outlined in the SWGWRP (see Table 7.6 and Table 7.7).

Table 7.8 NMN field water quality data statistics for 2023

Parameter	Statistic	Jurassic sediments	Triassic sediments	Permian coal measures
EC (µS/cm)	Historic average* (standard deviation)	2137 (978)	538 (446)	1058 (431)
	2023 average (standard deviation)	2140 (738)	552 (350)	1030 (321)
pH (pH unit)	Historic average* (standard deviation)	7.61 (1.06)	7.32 (1.58)	8.00 (1.41)
	2023 average (standard deviation)	6.98 (0.73)	6.86 (0.98)	7.43 (0.81)

Note: * historic stats cover 2016 - 2022

7.1.2.2 Major ions and alkalinity

The proportions of the major anions and cations were used to determine the hydro-chemical facies of the groundwaters sampled over the 2023 monitoring period. The anion-cation balances for the 2023 samples are shown on the Piper diagram in Figure 7.4. In summary, Permian water quality tends to be higher in Na+K and carbonates (HCO3 + CO3) than Triassic or Jurassic waters and the predominant hydro-chemical facies are relatively unchanged, with the 2023 results indicating the:

- Jurassic sediments exhibit Na-Mg-Cl and Na-Mg-Cl-HCO3 type water;
- Triassic sediments exhibit Na-Cl, Na-HCO3-Cl, Na-Mg-Cl, Na-Mg-Cl-HCO3, Na-Mg-HCO3-Cl, Na-Mg-HCO3-CO3 type water; and
- Permian coal measures, including the Ulan Seam, exhibit Na-HCO3, Na-HCO3-Cl, Na-HCO3-CO3-Cl, Na-Mg-Cl-HCO3, and Na-HCO3-Cl-SO4 type water.

7.1.2.3 Metals

A total of 22 NMN bores were sampled and analysed for dissolved metals (Ag, Al, As, B, Ba, Cd, Cr, Cu, Fe, Hg, Li, Mn, Mo, Ni, Pb, Se, Sr, and Zn) in 2023. The analytical suite collected is in accordance with the SWGWRP for water quality testing. The 2023 results were compared to the historic dataset, which is presented as time-series plots in Appendix A. The results of this comparison, and general observations are:

- All 22 bores were capable of being sampled in 2023 (i.e. had sufficient water).
- All bores recorded concentrations below the limit of reporting (LOR) for Ag, Cd, Mo, and Se.
- Visual inspection of trends shows that 2023 results are generally consistent with historical data for nearly all bores and analytes. Exceptions are that Ba in some Permian bores (namely PZ09B and PZ06B) show a slight increasing trend and Mn in PZ24B was considerably higher than previous values.
- Al concentrations remained significantly higher in PZ12C than all other bores, but 2023 concentrations were consisted with historic values.
- Concentrations of Ba, Li, Mn, and Sr where above LOR in all 22 bores sampled. All readings were below 1 mg/L except Ba in PZ06B and PZ09B, which reported concentrations of 1.01 mg/L and 1.08 mg/L, respectively.
- Al, As, B, Cr, Cu, Hg, and Pb were reported above the LOR in only a handful of bores (less than 5) and concentrations were largely below 0.05 mg/L (exception is Al in PZ12C – discussed in previous bullet)
- 2023 average concentrations (across all bores) were further compared to historic average values which showed that:
  - Average 2023 values were less than historic averages for As, B, Cr, Cu, Li, and Ni;
  - Average 2023 values were above, but within 10% of, historic averages for Sr and Zn
  - Average 2023 values were above, but within 200% (double) of, historic averages for Al, Ba, Fe, and Mn

The metal results, especially those reporting considerably higher concentrations in 2023 compared to historic averages, should be reviewed to greater detail in a separate investigation and the development of site-specific criteria should be considered. This would include evaluation against an array of nationally recognised water quality standards and regional groundwater quality.

7.2 BMN

The BMN is located within the Bobadeen Irrigation Scheme to monitor shallow groundwater response to irrigation. BMN monitoring bores are shallow, with depths ranging between 1 mBGL (IMW08) to 11.4 mBGL (IMW05) total depth. During the 2023 monitoring period, BMN monitoring bores were monitored on a quarterly basis. Groundwater level measurements were attempted from all BMN bores throughout the year, but six of the nine bores were reported as dry throughout the entire year and the remaining three bores were reported as dry (or failed to return a measurement) at some stage during 2023. Only two bores had sufficient water for water quality sampling in 2023.

7.2.1 Groundwater levels

Quarterly groundwater level readings (in mAHD) for each of the BMN bores are presented in Table 7.9. In 2023, six of the nine BMN bores were dry at each of the quarterly sampling rounds and all nine did not report readings for Q4.

Table 7.9 BMN water level data 2023 (mAHD)

Station	Quarter 1	Quarter 2	Quarter 3	Quarter 4
IMW01	dry	dry	dry	dry
IMW02	480.33	479.48	dry	dry
IMW03	dry	dry	dry	dry
IMW04	dry	dry	dry	dry
IMW05	476.83	477.93	477.58	ND

Station	Quarter 1	Quarter 2	Quarter 3	Quarter 4
IMW06	-	468.34	467.89	ND
IMW07	dry	dry	dry	dry
IMW08	dry	dry	dry	dry
IMW09	dry	dry	dry	dry

Note: "ND" = no data available

7.2.2 Groundwater quality

Quarterly groundwater quality readings (pH and EC) were made from all BMN monitoring bores with sufficient water during 2023 and are presented in Table 7.10. Due to insufficient water for sampling, only IMW05 and IMW06 recorded values. These values ranged from 7.13 to 8.42 for pH and 800 to 1997 µS/cm for EC, with no apparent trends over the year.

Table 7.10 BMN field parameters (pH/EC)

Station	Q1 pH (-) EC (µS/cm)	Q2 pH (-) EC (µS/cm)	Q3 pH (-) EC (µS/cm)	Q4 pH (-) EC (µS/cm)
IMW01	dry	dry	dry	dry
IMW02	IW	IW	dry	dry
IMW03	dry	dry	dry	dry
IMW04	dry	dry	dry	dry
IMW05	7.58 800	7.27 1247	8.06 1086	IW
IMW06	7.69 1708	7.13 1997	8.42 1362	IW
IMW07	dry	dry	dry	dry
IMW08	dry	dry	dry	dry
IMW09	dry	dry	dry	dry

Note: "IW" = insufficient water to sample

A summary of the 2023 average EC and pH and standard deviation for BMN bores is presented in Table 7.11 which also presents the historic averages and standard deviations derived from the GWMP and data collected since 2020. The 2023 averages fall within one standard deviation of historical EC and pH values, with EC being slightly lower and pH slightly higher than historic averages. However, we advise caution against interpretation of trends given the limited data available in 2023 (two bores). The near-neutral pH and relatively low EC may be attributed to lower salinity associated with surface water infiltration in the area.

Table 7.11 BMN field water quality statistics for 2023

Parameter	Statistic	Values
EC (µS/cm)	Historic average (standard deviation)*	1506 (1211)
	2023 average (standard deviation)	1367 (393)
pH (pH unit)	Historic average (standard deviation)*	7.17 (0.91)
	2023 average (standard deviation)	7.69 (0.44)

Note: * historic values calculated on 2015 through 2022 period or record

7.3 PMN

7.3.1 Groundwater levels

Monthly groundwater level elevations at six decommissioned dewatering bores within the PMN (East 7, East 9, East 10, East 15, East 18, and MG21) are presented in Table 7.12. The groundwater hydrograph presented in Figure 7.5 shows most groundwater levels were relatively stable over the long term with East 7 and East 9 showing some small variability, which is likely attributable to climate patterns. No data was collected from any PMN bores in June 2023 due to resource limitations.

Table 7.12 PMN water level data 2023 (mAHD)

Month (2023)	Bore groundwater level (mAHD)					
	East 7	East 9	East 10	East 15	East 18	MG 21
Jan	309.70	309.62	286.00	268.06	254.23	246.05
Feb	309.39	309.26	285.99	268.05	254.20	245.94
Mar	308.91	309.21	285.91	268.08	254.22	245.72
Apr	308.86	309.19	285.85	268.06	254.22	245.70
May	307.49	307.60	285.99	268.05	254.19	245.67
Jun	ND	ND	ND	ND	ND	ND
Jul	305.74	305.80	285.81	267.98	254.05	241.22
Aug	304.99	304.85	285.78	268.03	253.97	241.69
Sep	304.96	304.78	285.77	268.02	253.90	241.71
Oct	ND	304.09	285.61	267.89	253.89	241.62
Nov	ND	303.92	285.56	267.87	253.84	241.68
Dec	ND	303.74	285.65	267.83	253.81	243.23

Note: ND = No Data.

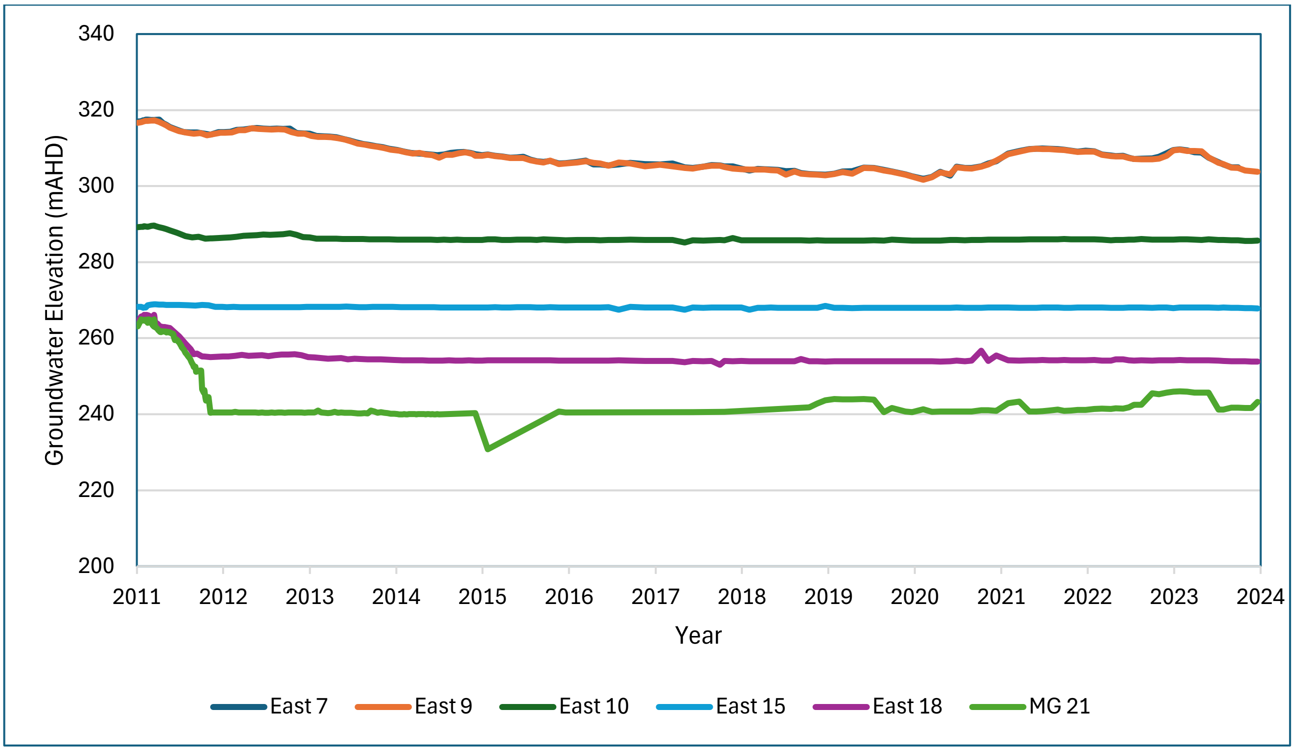


Figure 7.5 PMN groundwater hydrograph

7.3.2 Groundwater quality

The PMN comprises eight dewatering bores sampled for groundwater quality (East 20, MG23, MG26, MG27, MG28, MG29, Ritz, and UW TG1). Groundwater quality was sampled fortnightly from these bores and the 2023 results are summarised in Table 7.13. Graphs for 2023 for the analytes are presented in Appendix C.

Table 7.13 PMN average water quality for 2023

Parameter	East 20	MG 23	MG 26	MG 28	MG 29	Ritz	UW TG1
pH	6.24	6.65	6.81	7.06	7.40	ND	6.87
Electrical Conductivity (µS/cm)	1951	1579	1176	1024	948	ND	810
Iron – Dissolved (mg/L)	79.1	23.0	4.6	2.7	1.3	ND	5.2
Iron – Total (mg/L)	87.5	24.7	5.1	3.0	1.9	ND	6.2
Manganese – Dissolved (mg/L)	16.1	4.0	0.5	0.1	0.3	ND	0.7
Manganese – Total (mg/L)	17.1	4.2	0.5	0.1	0.3	ND	0.7
Sulphate (mg/L)	841.2	500.3	196.6	95.6	30.2	ND	80.1
Suspended Solids (mg/L)	14.2	14.5	6.7	5.7	4.3	ND	11.7
Total Alkalinity as $CaCO_3$ (mg/L)	56.5	198.5	307.5	332.7	366.2	ND	234.6

Note: ND = No Data.

7.4 Private bores

7.4.1 Groundwater levels

Monitoring of the private bores is conducted annually, dependent on access by private landholders and additional access constraints. During the 2023 monitoring period, 21 private bores within the current GWMP were measured for groundwater levels. An additional 11 private bores, not in the current GWMP, were also visited and groundwater levels were recorded.

The updated modelling of impacts from the approved mining at Ulan indicates that seven private bores are predicted to experience total groundwater level drawdowns greater than 2 m. These bores are listed in Table 7.14. No exceedance of these bores occurred in 2023. Three additional private bores recorded cumulative groundwater level declines in 2023 that exceeded the predicted declines and are also listed in Table 7.14. The groundwater level hydrographs for private bores are presented in Appendix D along with time-series plots of EC and pH.

Bores PB20 and PB32 could not be measured in 2023 so cumulative drawdown could not be calculated. PB09 has recently been equipped, preventing measuring of groundwater depth. PB08, which had been included in previous reports, has been undermined and removed from further discussion. The remaining five bores report cumulative drawdown less than that predicted by the numerical model. PB33 reported a cumulative rise in groundwater level between 2017 (first measurement) and 2023 of just over 1 m.

Bores PB11, PB12 and PB18 recorded cumulative drawdown as of 2023 that exceeded that predicted by the latest numerical model. Cumulative drawdown was calculated as the difference between the first recorded groundwater level and 2023 levels. PB11 recorded 11.23 m of drawdown between 2010 and 2023 and was predicted to only record 10.65 m. PB12 and PB18 recorded much less drawdown (0.74 and 1.76, respectively) but still exceeded predictions. The groundwater level from 2023 for PB12 is commensurate to results recorded in 2015, 2018, and 2019 which were comparably dry years, whereas the initial measurement was taken in 2010, which was close to the average rainfall, indicating that this bore is climatically impacted. Departures in private bores will be investigated.

Table 7.14 Summary of impacted private bores and bores exceeding predicted drawdown

Site ID	Ground elevation (mAHD)	Total depth (mbgl)	Screened strata	Predicted drawdown (m)	Cumulative 2023 drawdown (m)
Bores within 2 m predicted drawdown contours					
PB08*	436.0	ND	67	133.93	NM
PB09*	477.1	150	Triassic	6.45	NM
PB16	470.1	ND	Coal	24.91	2.73
PB17	445.1	>30	Coal	43.26	1.76
PB20	494.8	ND	Triassic	14.30	NM
PB21	491.8	ND	Triassic	25.60	0.30
PB32	453.0	55	Coal	14.66	NM
PB33	450.2	65	Coal	12.45	-1.02
Bores exceeding predicted drawdown					
PB11	469.9	ND	Triassic†	0.58	11.23
PB12	376.1	24.4	Triassic	0.11	0.74
PB18	444.9	ND	Triassic†	0.01	1.76

Notes: * see discussion preceding table
† inferred from geologic maps
ND = No Data
NM = not measured in 2023

7.4.2 Groundwater quality

During 2023, 21 private bores identified in the GWMP were sampled for field water quality (pH and/or EC). An additional 15 private bores, yet to be added to the GWMP, were also visited and had pH and EC measured (note that sampling of bores for water quality may be available even if groundwater level cannot be measured). Measured pH was acidic to slightly alkaline, ranging from pH 4.66 (PB17) to pH 8.00 (PB42), and EC was fresh to saline, ranging from 400 µS/cm (PB30) to 5220 µS/cm (PB37). The groundwater pH and EC graphs for each private bore monitored in 2023 are presented in Appendix D.

Exceedances for private bores were derived previously in AGE (2021[5]) but given that water quality exceedances are based on the full historic data record, pH and EC exceedances were re-calculated for this report as the historic (through 2022) minimum (pH only), 5th percentile (pH only), 95th percentile (pH and EC), and maximum (pH and EC) values.

Stage 2 trigger exceedances in pH were observed only at PB19 in 2023, with the 2023 value of 5.22 being less than the historic minimum value of 5.30. Six private bores had 2023 readings that exceeded the Stage 1 trigger values but as these were not part of three consecutive exceedances, they are not discussed further.

Stage 2 exceedances in EC were observed in seven private bores with 2023 values ranging from 101% to 178% of historic maximum (see Table 7.15). Two private bores exceeded Stage 1 triggers but as these were not part of three consecutive Stage 1 exceedances, they are not discussed further.

Table 7.15 Private bores exceeding Stage 2 EC triggers

Bore Number	Stage 1 trigger (95th percentile)	Stage 2 trigger (historic maximum)	2023 reading	Percent exceedance
PB10	759	765	895	117%
PB11	872	900	1604	178%
PB16	436	445	584	131%
PB19	686	762	810	106%
PB24	2156	2351	2510	107%
PB28	3155	3180	3184	100%
PB29	4718	4894	4922	101%

7.5 The Drip

The Drip is located east of Ulan within a Triassic sandstone gorge along the Goulburn River and is recognised for its cultural significance and potential to sustain groundwater dependent ecosystems (GDEs). Due to the incised nature of the gorge, it acts as a discharge area for the Triassic sandstone.

VWP site PZ29 monitors groundwater pressures nearby to The Drip (Figure 6.1). The porewater pressure trends have been generally stable for over five years but there has been a slight observed decline (less than 1 m) in the Triassic sensors in the past few years. However, compared to historic declines in the deeper strata, these declines are more likely related to natural variations rather than mining related drawdown. The Triassic strata sensor in bore PZ24 (closer to the mine) does not show similar declines suggesting the behaviour in the shallow sensors is unrelated to mining (see Section 7.6).

7.5.1 Groundwater and surface water quality assessment

The Triassic sandstone has been documented as having confined groundwater conditions within the region. Previous studies have conceptualised that the weathered sequences near the cliff face of The Drip and at surface act as shallow perched groundwater systems. Groundwater monitoring and management commitments require that Ulan Coal Mine collect field data to assess this assumption and subsequently model predictions. This includes water quality testing of water expressed at The Drip and installation of VWP sensors (PZ29). The purpose of this data collection is to assist in characterising the nature of The Drip and its true mode(s) of recharge. This distinction is important for predicting the potential for impacts on The Drip

In 2023, samples from The Drip returned an EC between 390 µS/cm and 655 µS/cm with the lowest EC values recorded at Lower Drip 2, which was consistently around 400 µS/cm through 2023, and the highest values recorded at the West Drip site and Lower Drip 1 site, which exceeded 600 µS/cm at different times in the year. The laboratory results also indicate slightly alkaline pH, typically between pH 8.1 and 8.7 (similar to results from 2022). Highest pH values were recorded at West Drip site and lowest recorded in East Drip site. The average pH across the sampling locations was 8.4.

The anion-cation balance of The Drip from 2023 groundwater quality data is shown circled on the Piper diagram in Figure 7.6 and compared to NMN Triassic water quality. As shown in Figure 7.6, samples from The Drip in 2023 were predominant in magnesium and sodium. An overall Mg-Na-HCO_3-Cl water type was determined for each of the five sampling locations for The Drip.

The Drip samples were also tested for metals, with the results summarised below:

- dissolved arsenic, boron, iron, manganese, and selenium concentrations were below the limit of reporting;
- Aluminium, lithium, manganese, and zinc concentrations were all below 0.02 mg/L
- Barium concentrations were all below 0.036 mg/L and strontium were below 0.15 mg/L

The Drip water quality exhibits major ion proportions consistent with some, and dissimilar to other, Triassic screened bores. Numerous samples from The Drip demonstrate comparable major ion composition to Triassic sediment samples. However, variability exists in major ion composition from Triassic samples that are not wholly reflected in samples from The Drip, such as the comparably elevated Ca levels in PZ01A, PZ08C and PZ14B, and lower Mg concentrations in PZ04A, PZ06C, PZ12C and PZ24B, or the dissimilar speciation results of PZ06C and PZ28A.

The differences in major ion proportions between Triassic bores and The Drip suggests the influence of differing recharge sources and varying water-rock interactions / residence times between the two groundwater systems. Extensive geochemical analysis would assist to better characterise the nature of The Drip, by methods such as isotopic tracing and/or geochemical signature interpretation.

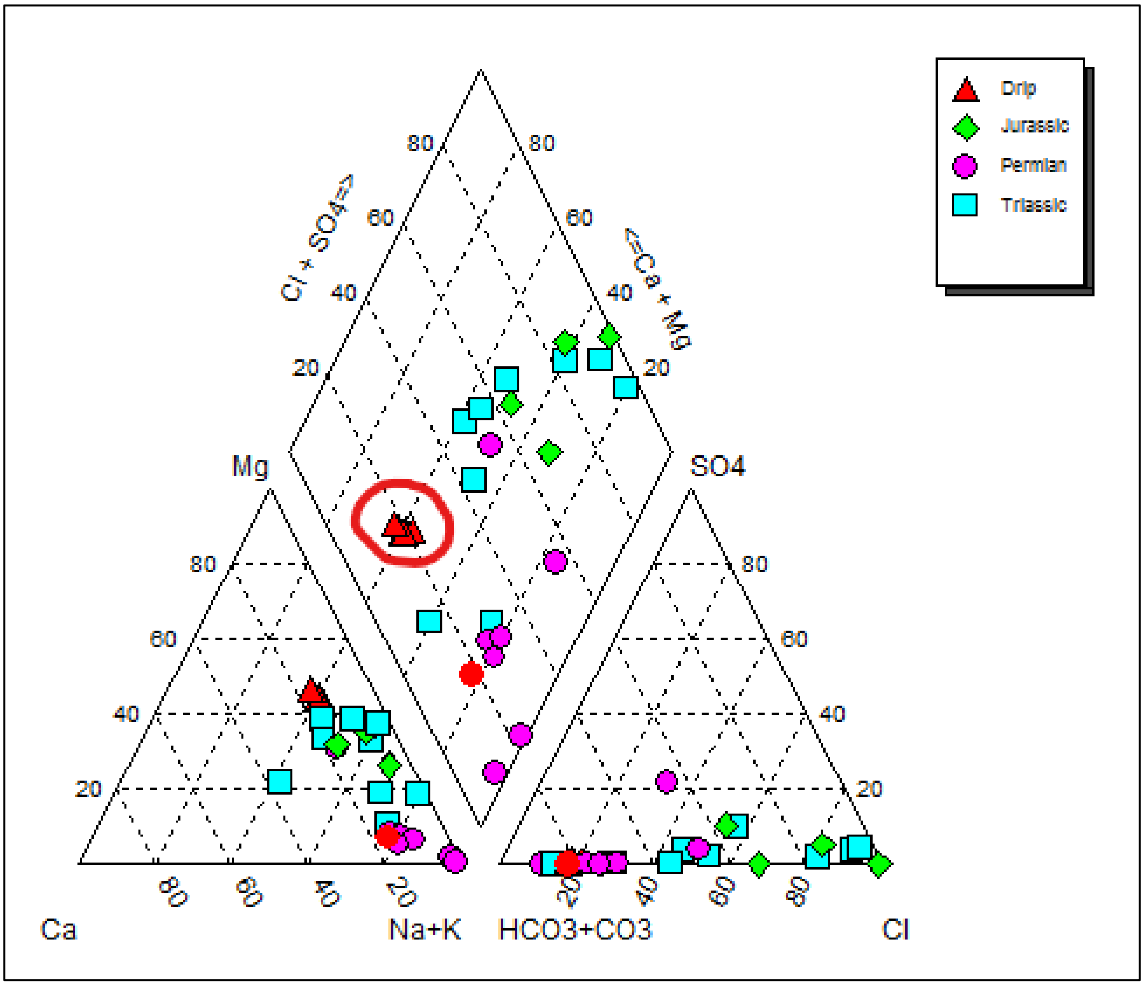


Figure 7.6 Piper plot of NMN bores by strata and samples from The Drip (average of 2023 data)

7.6 Baseflow assessment

Discharge into surface water systems such as the Goulburn River is generally assumed to be comprised of two components: 1) quickflow sourced from direct rainfall, catchment runoff, and interflow through the soil profile; and 2) baseflow sourced primarily from groundwater discharge.

The GWMP requires an assessment that potential impacts on groundwater baseflow volumes to surface water features are consistent with the predictions made in the EA. The GWMP states that this task will be undertaken via two processes:

- comparison of predicted and measured strata depressurisation across the respective catchments, which will be completed as per previous annual reviews; and
- review of flow gauging data.

A baseflow separation analysis was completed by AGE in 2019[9]. The analysis concluded that any actual baseflow loss in the Goulburn River resulting from Ulan Coal Mine operations are consistent with predictions made in the approved groundwater model. A baseflow separation analysis has not been conducted for the Talbragar River due to the absence of gauge flow data for this watercourse.

7.6.1 Groundwater depressurisation

VWP site PZ29 was installed 1.3 km north of The Drip for the purpose of assessing groundwater gradients and trends around The Drip. The time series data from the VWP is presented in Figure 7.7. The porewater pressure trends in the Jurassic zone have been stable for over five years but Triassic sensors have been recording slight declines since 2016 (2 to 5 m cumulative). As discussed in section 7.1.1.5 above, these declines are likely related to long-term climate variations rather than mining related drawdown, as no declines were observed in other, nearby, Triassic sensors (see Figure 7.8). The Ulan Seam (243 m) sensor recorded a pressure head decline of just under 5 m in 2023 and an overall decline of 36 m since 2016. The Interburden (183 m) sensor recorded a decline of approximately 1 m over 2023 but little overall decline. The discordance between the Ulan Seam sensor and the next-shallowest sensor highlights the limited vertical hydraulic connectivity between the Ulan Seam and overlying Triassic strata. No mining related depressurisation has been identified in the Triassic nearby The Drip (as measured at PZ29 and PZ24B – although PZ24B has recorded just over 1 m of cumulative drawdown since 2016) and therefore, the Ulan Coal Mine does not appear to be impacting groundwater flow in Triassic or Jurassic strata or at The Drip.

The cumulative drawdown exceeded model predictions in PZ29 only in the 143 m sensor, by 2.6 m. Depressurisation at depth, particularly in the Ulan Seam, is expected due to the nearby cumulative mining activity occurring at Ulan and Moolarben mines. The difference in observed and modelled porewater pressure results at PZ29 may be further influenced by the simulated mining progression timelines separately at Ulan and Moolarben.

[9] Australasian Groundwater and Environmental Consultants Pty Ltd (AGE). (2019). *Goulburn River Baseflow*. Prepared for Glencore Coal Assets Australia – Ulan Coal Mine. Project No. G1844O. March 2019.

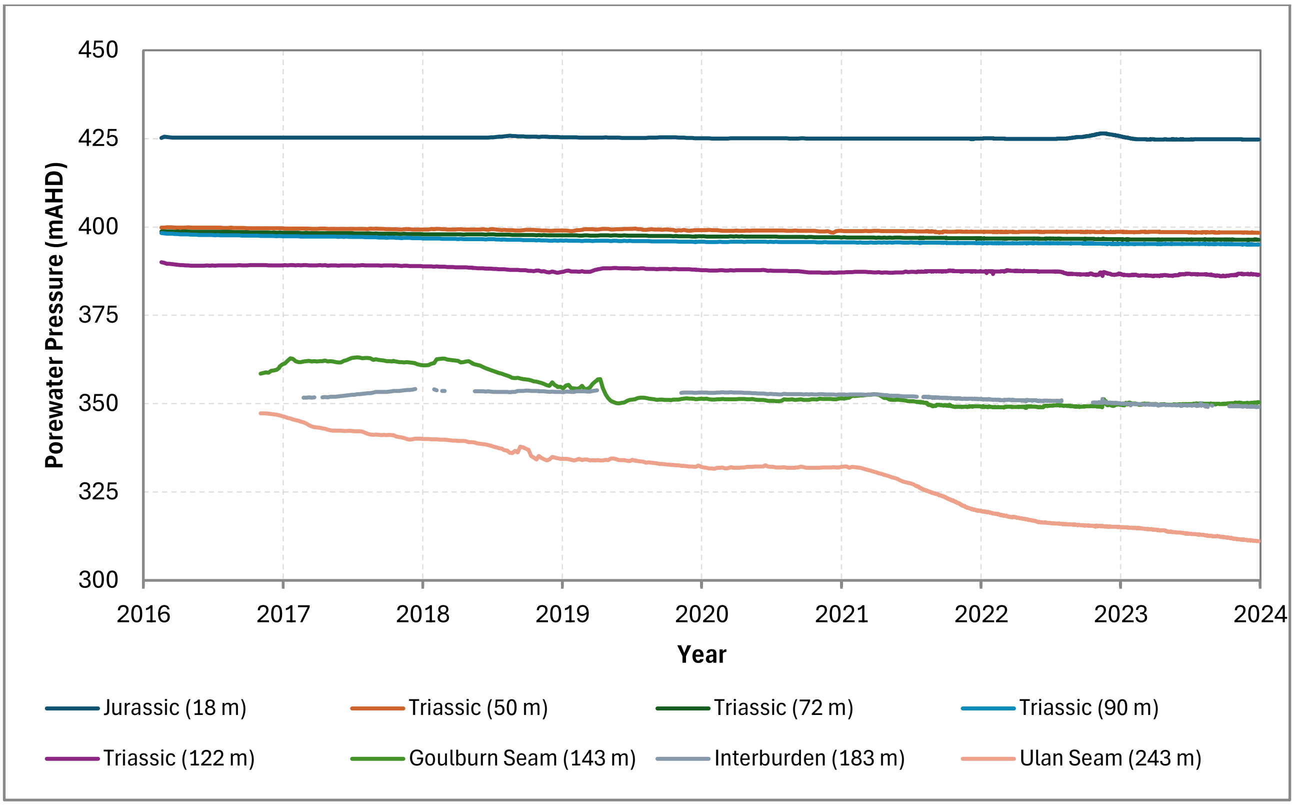


Figure 7.7 PZ29 porewater pressure

Monitoring site PZ24 is located around 2 km north of the Goulburn River and 1 km north of PZ29. The site has two monitoring bores, PZ24A and PZ24B, installed in the Permian coal measures and the Triassic sandstone, respectively. Figure 7.8 shows the groundwater hydrograph and, similarly to PZ29, there a small amount (approximately 1 m) of groundwater level drawdown in the Triassic Sandstone (PZ24B). Drawdown in PZ24B is predicted by the latest numerical model to be 5.5 m over the full life of the mine. These declines were also investigated in AGE (2023[10]) and attributed to climate variability.

PZ24A has experienced gradual drawdown consistent with the Ulan Seam sensor in PZ29, which is expected due to active mining and dewatering of the working seam. Throughout 2023, the observed annual decline in PZ24A (3.41 m) is less than the observed decline over 2021 (8.95 m) and the total observed decline (28.61 m) is still less than the adopted exceedance trigger level (28.69 m).

[10] Australasian Groundwater and Environmental Consultants Pty Ltd (AGE). (2023). *Ulan 2022 groundwater exceedance investigation.* Prepared for Glencore Coal Assets Australia – Ulan Coal Mine. Project No. UCM5027.001. July 2023.

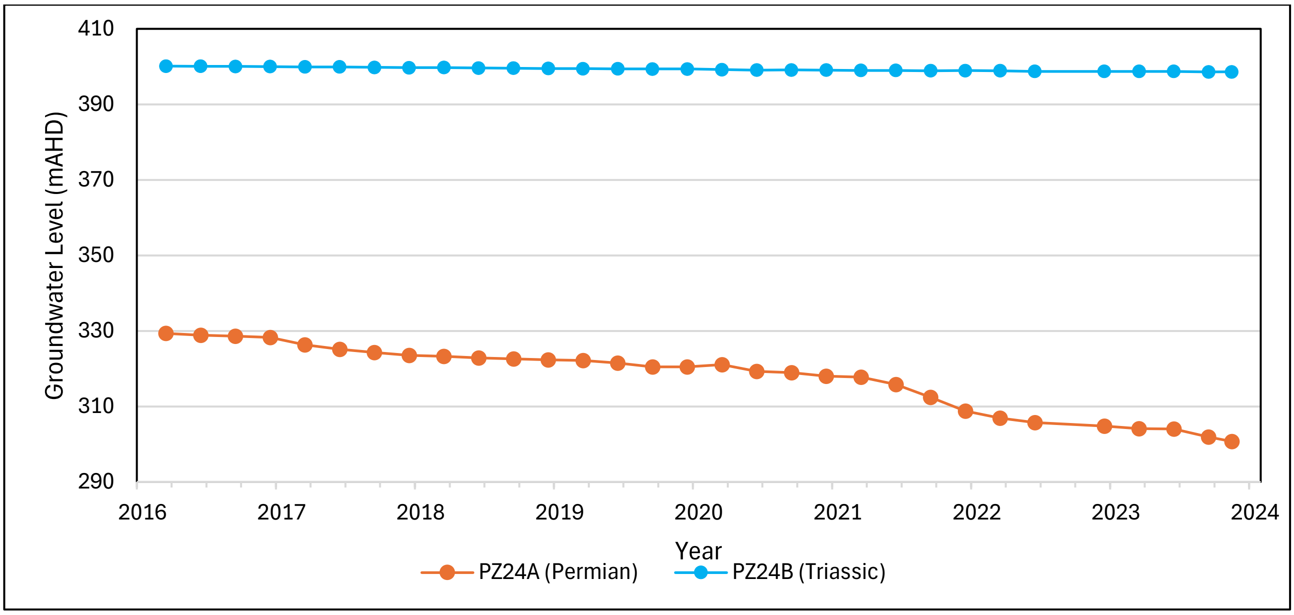


Figure 7.8 PZ24A and PZ24B groundwater levels

The 2023 observations from PZ29 and PZ24 show that significant strata depressurisation is observed in the Permian strata, which is expected due the active mining and dewatering of the working seam. The largest response to date has occurred in 2021 and steady decline has been observed prior to and since. There is also notably depressurisation occurring in the Triassic groundwater system at both PZ29 or PZ24B. The observations in the deeper strata generally agree with the predictions generated by the groundwater model but the timing and magnitude of depressurisation in the shallower strata is not entirely in line with model predictions. This could be due to small inaccuracies in the model compared to reality (e.g. actual vs. simulated mine progression at both Ulan and Moolarben mines) or variability in climate over the past few decades.

Although groundwater depressurisation has been observed in the Triassic Sandstone in the area of PZ29, it is relatively minor and has been reviewed previously in AGE (2023[4]) and attributed to climate variation. The Goulburn River flows through Triassic strata near this location and so the small long-term depressurisation may have the potential to impact baseflow in the future. While this depressurisation is very unlikely to be caused by mining impacts, it may warrant additional review in order to better understand the impacts of (natural) strata depressurisation on baseflow.

Ulan Coal Mine also monitors water levels within the Triassic and Permian strata in the Talbragar River catchment at two VWP sites: TAL-1 (Figure 7.9) and TAL-2 (Figure 7.10). Review of 2023 water levels identified that at TAL-1, most sensors begin 2022 relatively stable but start to show marked declines toward the end of the year. This trend continued through the beginning of 2023 after which these sensors either levelled off (28 m sensor) or the rate of decline lessened. The overall decline between 2022 and 2023 was 2 to 3 m for the Triassic sensors and 3 to 4 m for the Permian sensors. The deeper of the two Permian sensors (97 m) recorded a consistent upward trend since early 2018 but plateaued in early 2022 and then began showing a similar decline into early 2023. The Ulan Seam (140 m) data recorded a sharp drop in the beginning of 2022 and three “bumps” since then (related to mining). Overall, all sensors in TAL-1 record cumulative drawdown considerably less than what is predicted by the latest numerical model.

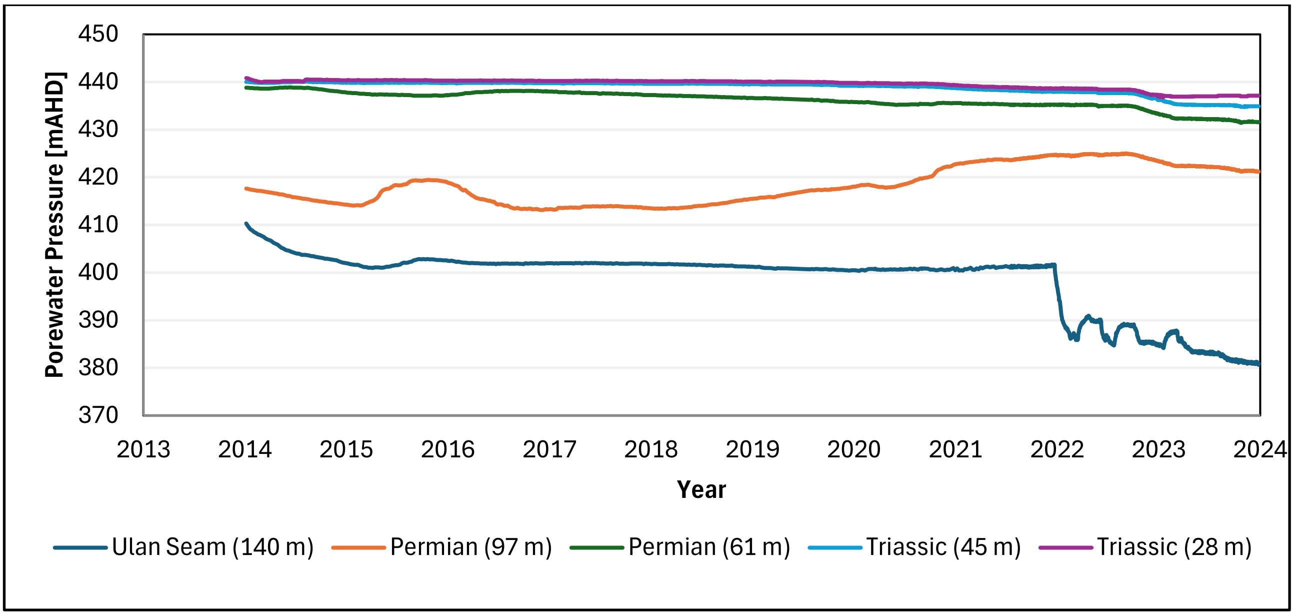


Figure 7.9 TAL-1 groundwater levels

Access restriction prevented data being collected from TAL-2 in mid-2022 but this was resolved in early 2023 and data is available for all sensors through mid-2023. The shallowest sensor (50 m) has a small gap in 2023 but otherwise reports data over the full period of record (2015 through 2023). The Ulan Seam sensor (128 m) showed an obvious decline through 2022, similar to what is observed in sensors in TAL-1 and maintained a less-drastic decline through mid-2023. The deeper Permian sensors (110 m and 90 m) record overall declines of a few meters over the period of record. The shallowest sensor (50 m) recorded an overall decline of 0.96 m, which is just over the predicted decline of 1.03 m but not enough to warrant further discussion. None of the other sensors in TAL-2 exceeded the predicted total drawdown triggers.

The nature of the trends observed from 2022 through 2023 in the shallower sensors of TAL-1 and TAL-2 may be due to a combination of factors including mining impacts (as are predicted) and similar mechanisms as affecting PZ29 and PZ24B (climate variability). Given the location of TAL-1 and TAL-2, it is unlikely that any identified behaviour is impacting baseflows greater than what has already been predicted by the numerical model and accounted for by Ulan's water management plans. As more flow data becomes available, a baseflow separation analysis will be undertaken.

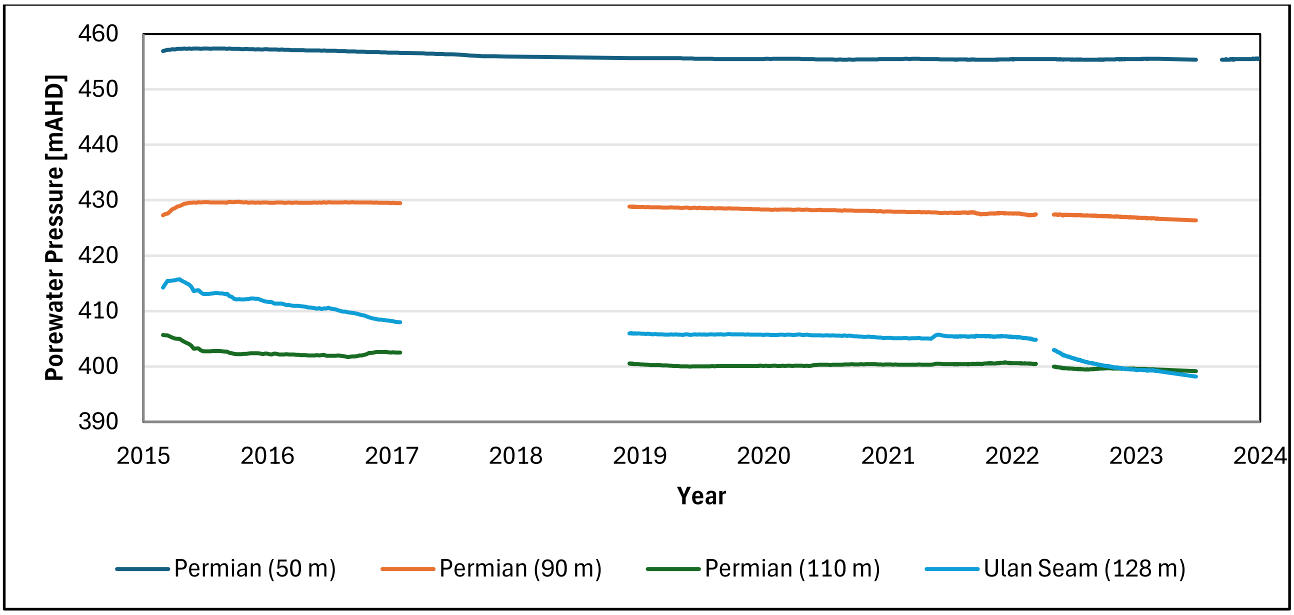


Figure 7.10 TAL-2 groundwater levels

8 Site water management

Ulan Coal Mine distributes abstracted water via a series of pipes and pumps to various locations around the site. Groundwater inflow to the underground workings is managed by pumping from dewatering bores for Ulan West and Ulan Underground. Discharge volumes are measured daily from the dewatering system which comprises the Ulan Underground system (East 20, MG22, MG23, MG26, MG27, MG28, MG29, Ritz and LW A & B) and Ulan West (UW Tailgate 1, UW Boxcut, and abstraction bore UWTG6).

Abstraction from Ulan West and Ulan Underground mine water systems are pumped to the NWSD and Bobadeen Dam. Water is treated and used to supply water for site use. Excess water is released into Ulan Creek (LDP6 and LDP19) or used for the Bobadeen Irrigation Scheme. Ulan Creek discharges into the Goulburn River and ultimately past surface water monitoring point SW02. Groundwater inflow volumes are discussed in Section 8.1, BIS volumes are discussed in Section 8.2, and Goulburn River stream flow is discussed in Section 8.4.

8.1 Groundwater inflows

Abstracted water volumes at Ulan Coal Mine during 2023 were comprised of Ulan West (approximately 33%) and Ulan Underground (66%) extractions. Daily extracted water volume ranged between 12.1 ML/day and 16.8 ML/day, with a combined average of 14.6 ML/day. The total volume extracted during 2023 was 5.3 GL. The mine inflows where slightly less than 2022 values and are within approved groundwater license allocations.

8.2 Bobadeen Irrigation Scheme (BIS)

Land above Ulan Underground is irrigated with treated mine water as part of the BIS. The BIS has been operational since 2003 and includes five central pivots (P1 to P5 in Figure 6.1). The rate of water pumped to the pivots is monitored and recorded at station Farm 1 and Farm 2. Figure 8.1 shows the monthly irrigation volumes during 2023. Significantly more mine water was irrigated in 2023 (1363 ML) than in previous years (410 ML in 2022, 654 ML in 2021). The majority of pumping in 2023 occurred in the first five and last two months of the calendar year. As discussed in Section 7.2, even with the irrigation occurring, groundwater levels remained low in the majority of BMN monitoring bores with six of the nine bores recorded as dry throughout 2023. This implies high evapotranspiration rates, soil moisture deficits, and efficient water use.

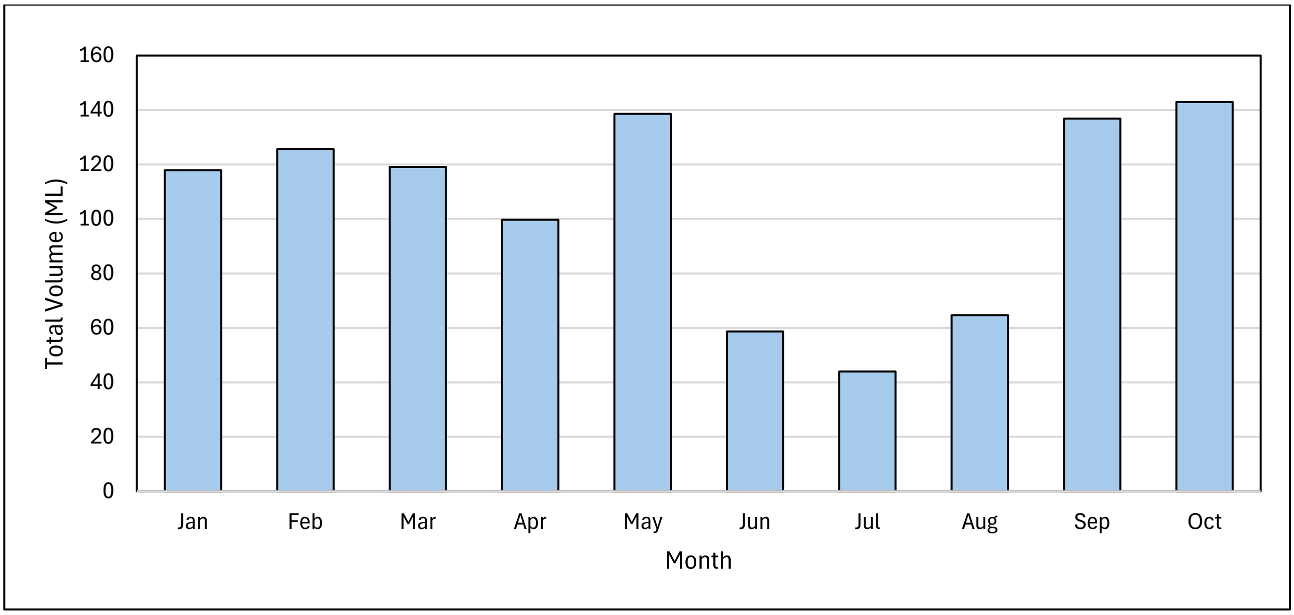


Figure 8.1 Bobadeen irrigation volumes 2023

8.3 Ulan Creek discharge (LDP6 and LDP19)

The Ulan Coal Mine Complex is located at the headwaters of both the Goulburn River system and the Talbragar River system. The Talbragar River flows in a south-westerly direction beyond the northern extent of Ulan Coal Mine. Mona Creek and Cockabutta Creek are ephemeral tributaries of the Talbragar River system. Ulan Creek, a tributary of the Goulburn River, currently experiences perennial flow due to controlled discharge of treated water from Bobadeen Dam (LDP6) and the NWSD (LDP19). During the 2023 monitoring period, Ulan Coal Mine discharged a total of 7,729 ML between LDP6 and LDP19. Total daily discharge ranged from 3.5 ML/day to 29.7 ML/day, with an average of 21.2 ML/day. This put UCMPL in compliance with the cumulative discharge limit of 30 ML/day between LDP6 and LDP19 throughout 2023. Monthly discharge from LDP6 and LDP19 is presented in Figure 8.2.

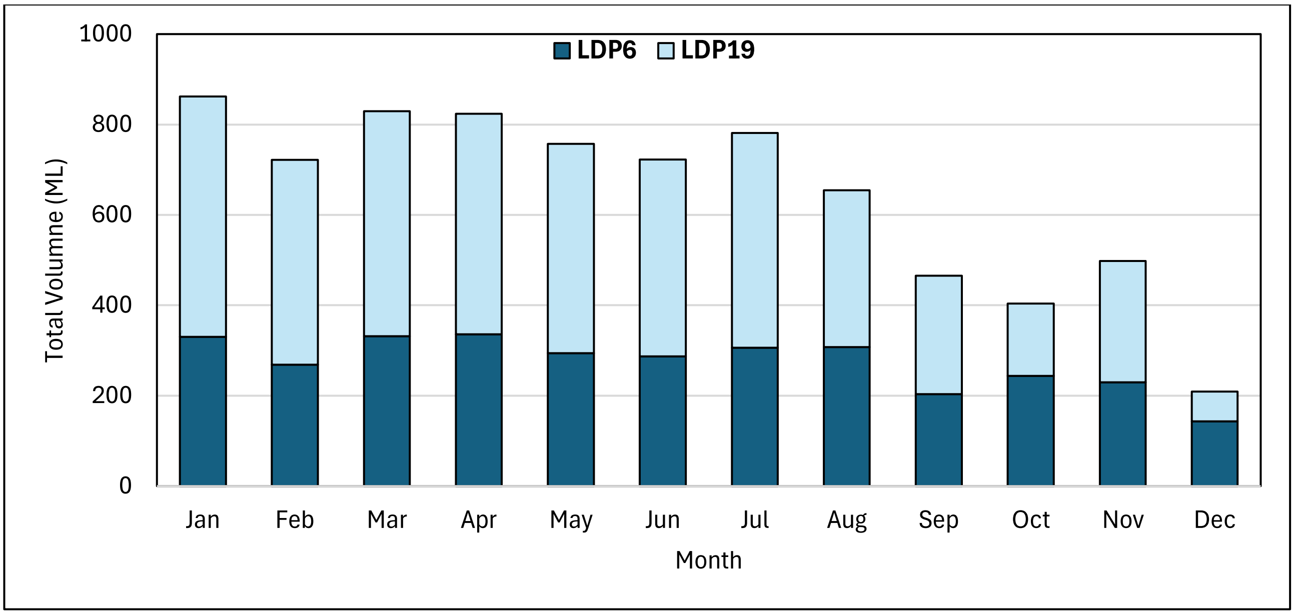


Figure 8.2 LDP6 and LDP19 discharge volumes 2023

8.4 Goulburn River stream flow (SW02)

Ulan Coal Mine measures stream flow in the Goulburn River as part of the management plan. During the 2023 monitoring period, stream flow was measured at monitoring point SW02, which is located downstream of Ulan Coal Mine and downstream of the Ulan Creek confluence. Both catchment runoff, and Ulan Coal Mine and Moolarben Coal Mine (MCO) discharge, contribute to stream flow measured at SW02. Measured flow ranged between 6.5 ML/day and 230.8 ML/day, with an average flow of 41.8 ML/day in 2023. The highest monthly total flow occurred in January (2,835 ML) and the lowest occurred in December (398 ML).

Goulburn River EC and pH is also recorded at SW02. During the year, EC ranged between 439 µS/cm and 1,084 µS/cm with a mean of 680 µS/cm, and pH ranged between pH 7.43 and pH 8.35 with a mean of 7.93. Graphs and time series of Goulburn River flow (ML/day), average daily EC and average daily pH measured at SW02 are shown in Figure 8.4 and Figure 8.4. EC (and to a lesser extent pH) is often correlated to stream flow, with lower EC occurring during high flow events and higher EC after persistent low discharge periods hence EC is consistently higher (greater than 700 µS/cm) in late 2023 when flow is overall low.

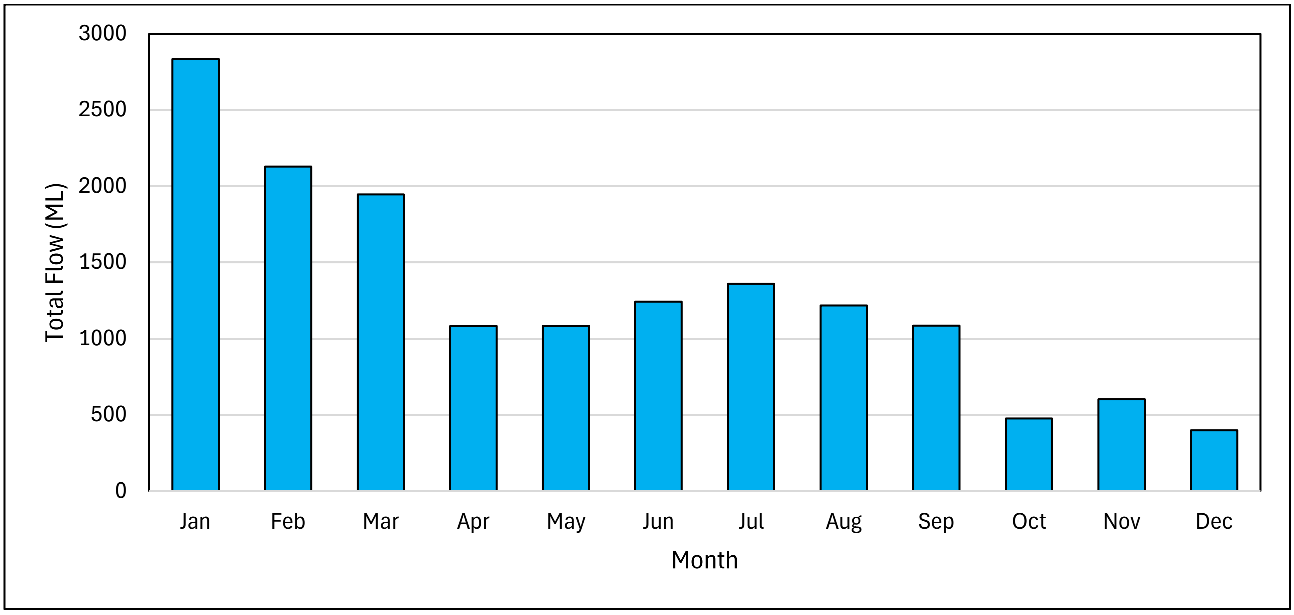


Figure 8.3 Goulburn River monthly downstream flow measured at SW02 for 2023

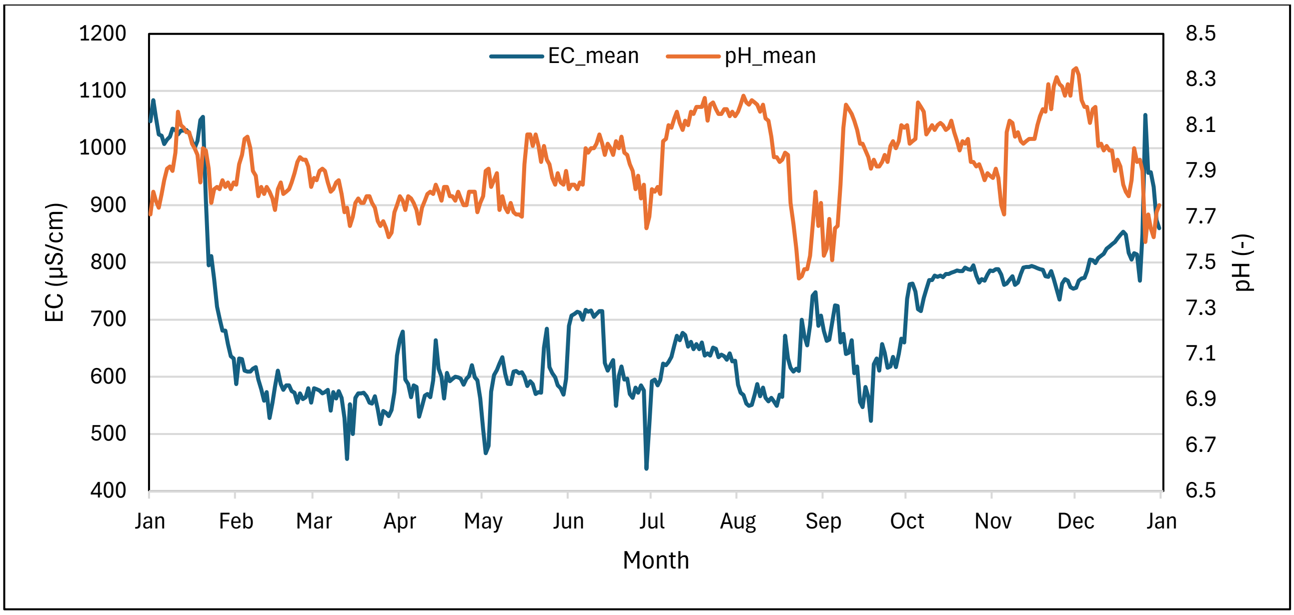


Figure 8.4 Goulburn River average daily EC and average daily pH measured at SW02 for 2023

9 Summary

Groundwater monitoring was conducted in accordance with the GWMP during 2023 and compared to the recent derivation of groundwater level and groundwater quality triggers for NMN bores. NMN bores intersecting Jurassic sediments recorded varied trends and most of the VWPs intersecting Jurassic sediment showed very little overall change in 2023. No drawdown exceedances were identified in Jurassic bores or VWP sensors intersecting Jurassic strata.

Some of the monitoring bores and VWPs intersecting Triassic units recorded slight groundwater level declines over 2023, which added to cumulative declines, but none of the NMN bores recorded drawdowns that exceeded the groundwater trigger levels. Drawdown is predicted at a number of Triassic bores and VWP sites, but the observed decline may also be due to climate variability.

About two-thirds of the Permian bores were accessible in 2023 for groundwater level measurements and drawdown over 2023 was observed in all bores and ranged from 0.16 m (PZ11A) to 25.8 m (PZ09B). This reflects long-term trends associated with mine-related dewatering and is predicted by the numerical model. No Permian bores exceeded their groundwater trigger levels.

Porewater pressure data was reviewed from VWP sensor sites with a focus on trends and cumulative drawdown. Review found that several shallow sensors are recording small but consistent declines over the period of record (often less than a few meters). These trends may be related to climate variability (which is not modelled) but should be investigated further to fully understand the nature of the behaviour.

Many of the deeper sensors within or near the mine footprint recorded large depressurisation, which is predicted by the numerical model and expected due to mining, and only one site recorded cumulative drawdown that exceeded the predicted drawdown. PZ29 had four sensors exceeding the predicted drawdown. The trends causing these exceedances were investigated in 2023 and attributed to climate variability.

Six bores comprising the Mona Creek monitoring network were measured for groundwater levels in 2023. MCMB01B was recorded as “dry” throughout 2023 but the remaining bores recorded groundwater levels and showed generally small declines over 2023. Trigger levels have not been set for these bores.

Groundwater levels were measured in 32 private bores during 2023, 21 of which are required by the GWMP. Groundwater level declines were observed in 13 private bores (only eight are listed in the GWMP) and ranged from less than 1 m to 11 m and three of the bores exceeded their predicted drawdowns. Declines for bores within the 2 m drawdown zone were less than the predicted impacts for all bores.

Groundwater quality triggers for NMN bores were also re-derived recently and 2023 EC and pH data were compared against these triggers. Five of the NMN bores exceeded Stage 2 triggers for EC and two exceeded Stage 2 trigger for pH. A few bores exceeded Stage 1 trigger values but, as these were not a third consecutive exceedance, further consideration was not necessary. Average EC and pH from all bores across main strata units were in line with historic values indicating no major change to groundwater quality overall.

Groundwater quality exceedances were also evaluated in private bores with trigger values derived as part of this report from the full record. Stage 2 EC exceedances were identified in eight bores in the network and pH exceedances were identified in seven bores (six of the seven record pH between 6.7 and 7.8).

This review also investigated trends in dissolved metals and found elevated results for the dissolved metals compared to baseline. The historical and baseline data should be reviewed in greater detail together with an array of nationally recognised water quality standards and the development of site-specific criteria.

Water levels in Triassic and Permian units are monitored at key locations (PZ24, PZ29, TAL-1 and TAL-2) to inform ongoing assessment of baseflows to the Talbragar and Goulburn Rivers. Minor strata depressurisation was observed in the Triassic units in PZ24 and PZ29, which the Goulburn River flows over, which may indicate the potential for impacts to baseflow, albeit minor and very likely within the limits predicted by the numerical model. However, the noted declining trends in Triassic sensor may warrant further investigation into how it relates to baseflow.

Water quality at The Drip continues to exhibit a major ion composition comparable to some Triassic bore samples, but noticeably independent of the full range. This suggests the influence of an alternative water source mixing with Triassic sediments to recharge The Drip. Given that The Drip seep has a local recharge source compared to the regional Triassic aquifer, and no mining related depressurisation has been recorded in the Triassic nearby The Drip (as measured at PZ29), Ulan Coal Mine does not appear to be impacting groundwater flow at The Drip.

10 Recommendations

10.1 Monitoring

- Investigate the nature and cause of the slight but persistent declines in VWP sensors in EX09, PZ29, and R894. The declines are likely to be related to climate variability, but this should be reviewed in a broader context.
- Investigate trends in dissolved metals.
- Review of cumulative mining progression timelines in the current groundwater model against observed piezometer results to verify if cumulative mining truly progressed in line with the model (Note: model recalibration is scheduled for 2024).
- Update triggers for private bore water quality (pH and EC) based on full historic record and drawdown based on updated model.
- Establish trigger protocol for dissolved metals using the full record and recognised water quality standards (by strata of individual bores).

10.2 Infrastructure

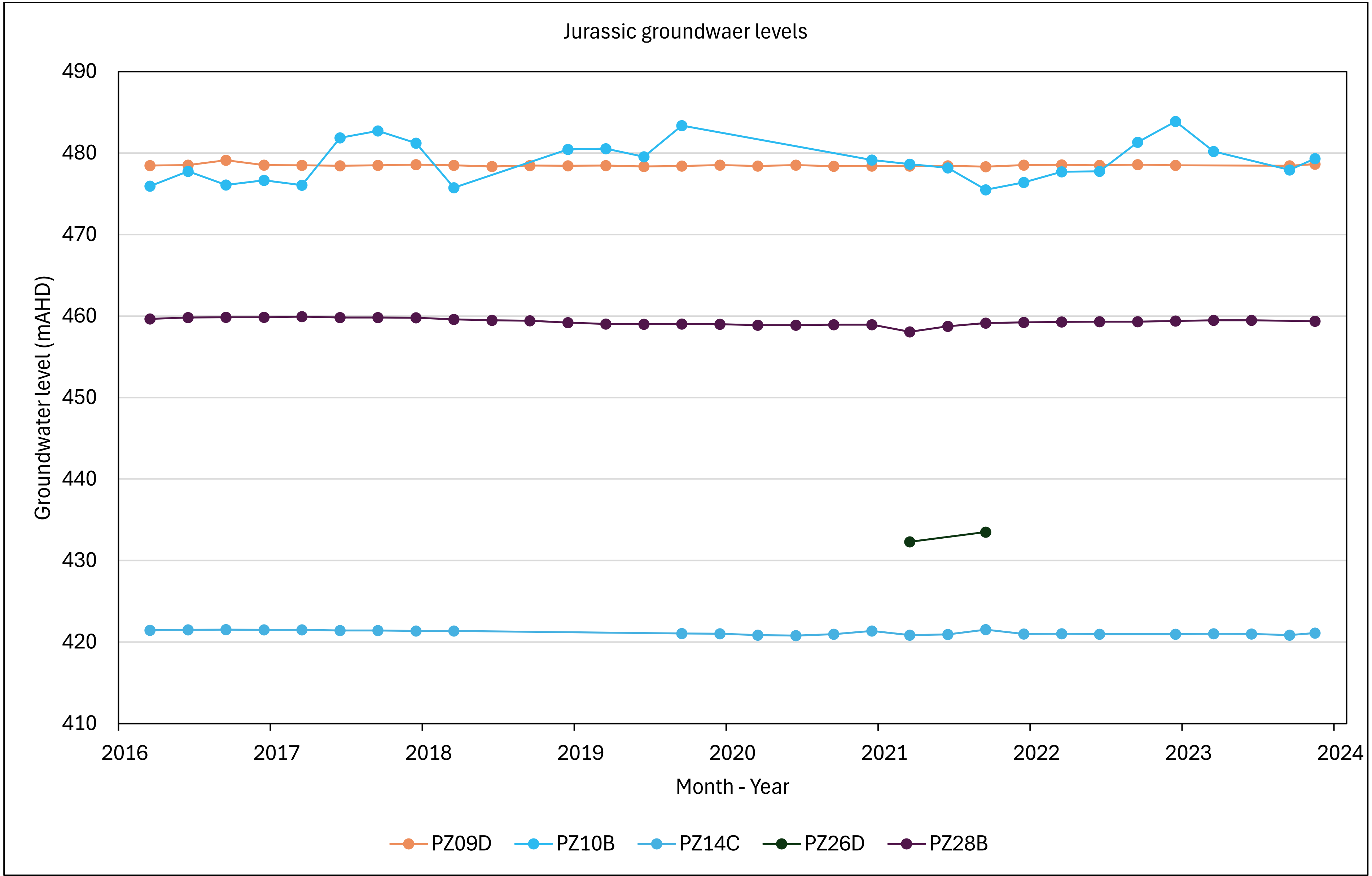
- Sites EX03, EX06, and DDH271 have been undermined and should be removed from the GWMP.

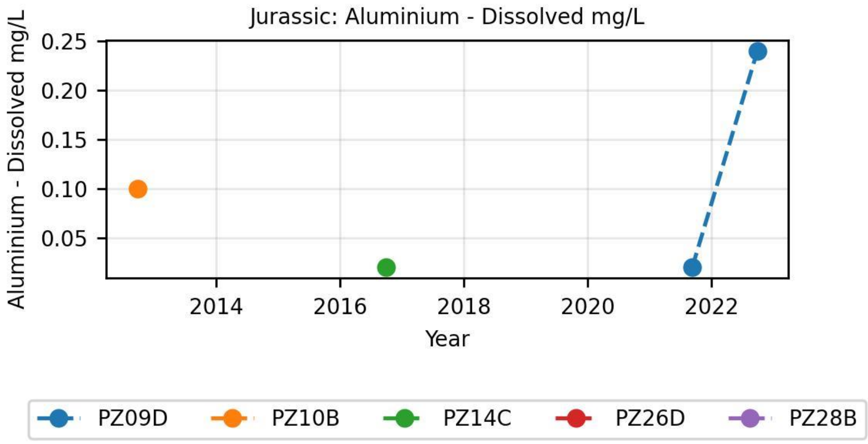
10.3 Exceedance investigations

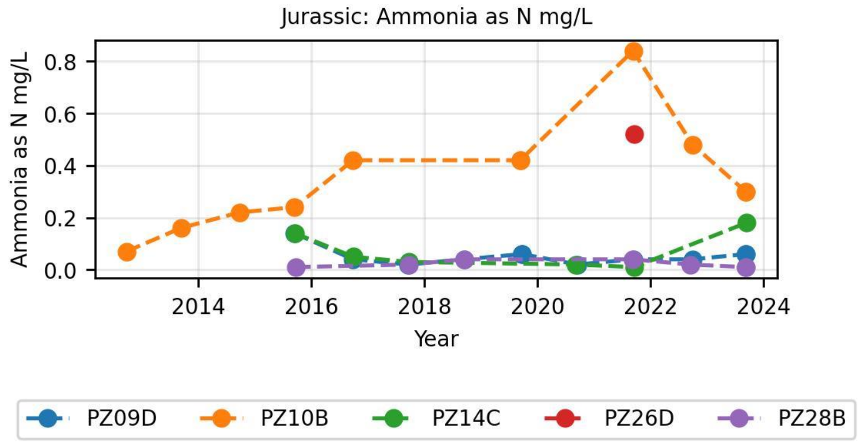
- Investigate groundwater level and groundwater quality exceedances in private bores.
- Investigate groundwater quality exceedances in NMN bores PZ28B, PZ06C, PZ24B, PZ28A, PZ06C, and PZ11A, as compared to recently derived trigger values and in the context of regional water level trends.

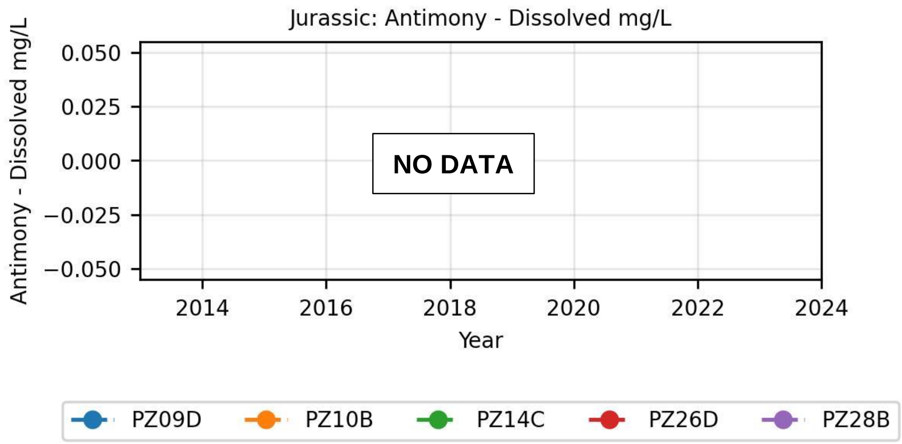
Appendix A

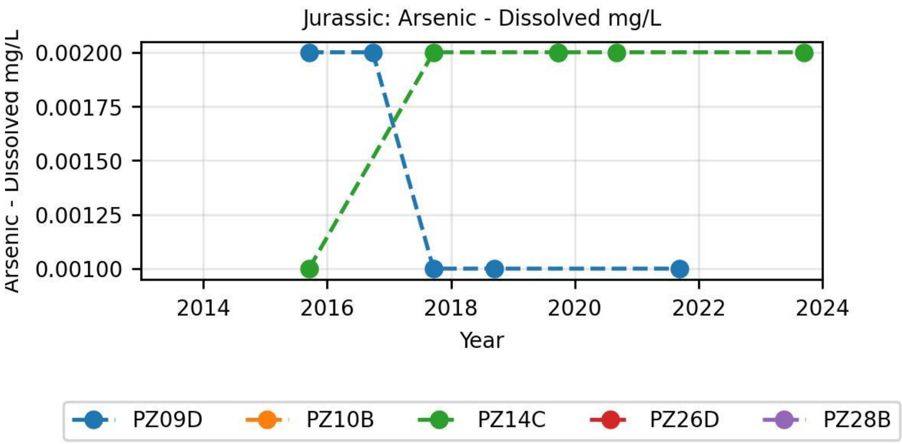
North Monitoring Network Hydrographs (GWL and lab WQ)

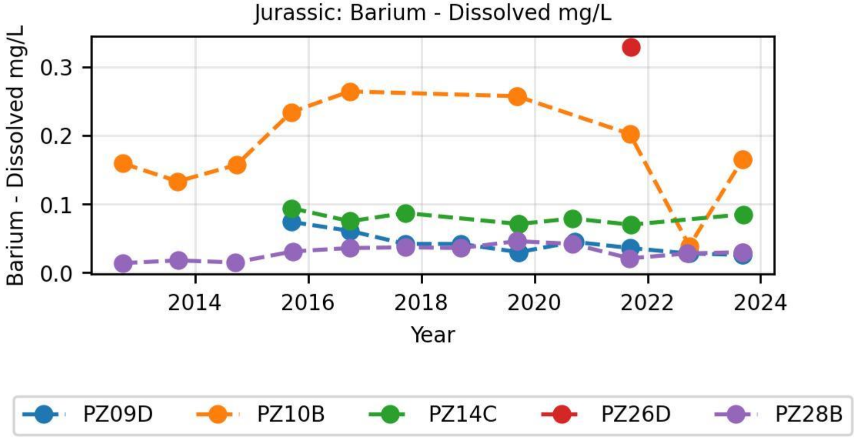

Jurassic groundwaer levels
490
480
470
460
450
440
430
420
410
Groundwater level (mAHD)
2016
2017
2018
2019
2020
2021
2022
2023
2024
Month - Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B

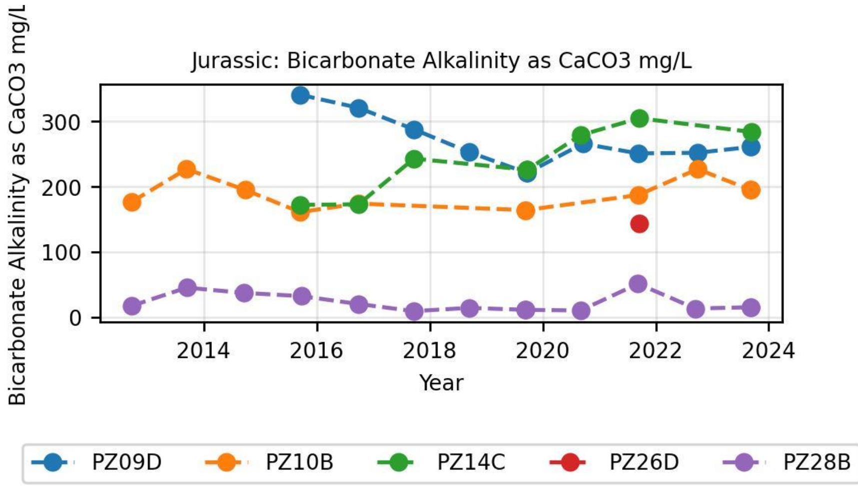

Jurassic: Aluminium - Dissolved mg/L
Aluminium - Dissolved mg/L
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B

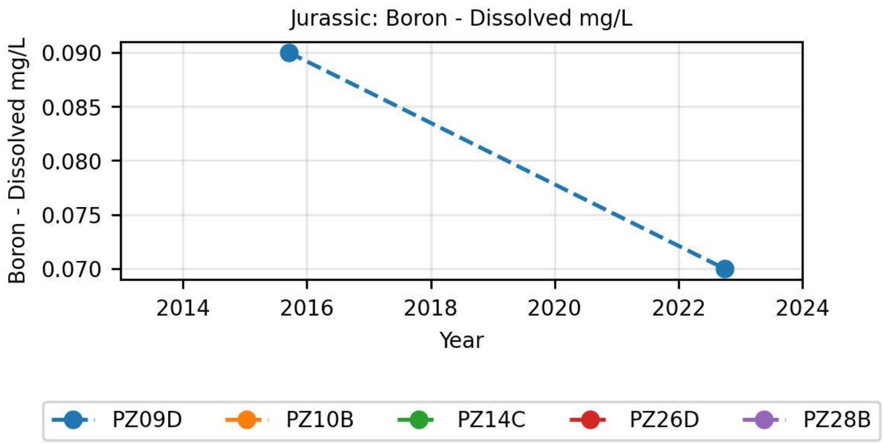

Jurassic: Ammonia as N mg/L
Ammonia as N mg/L
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B

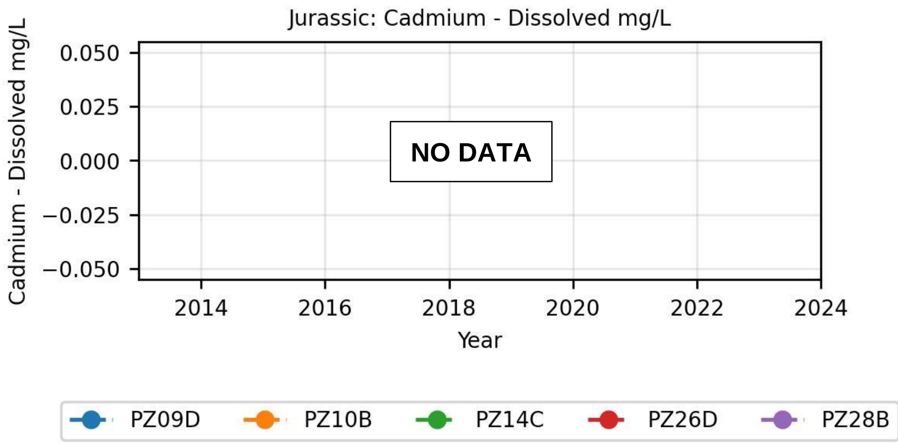

Jurassic: Antimony - Dissolved mg/L
Antimony - Dissolved mg/L
NO DATA
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B

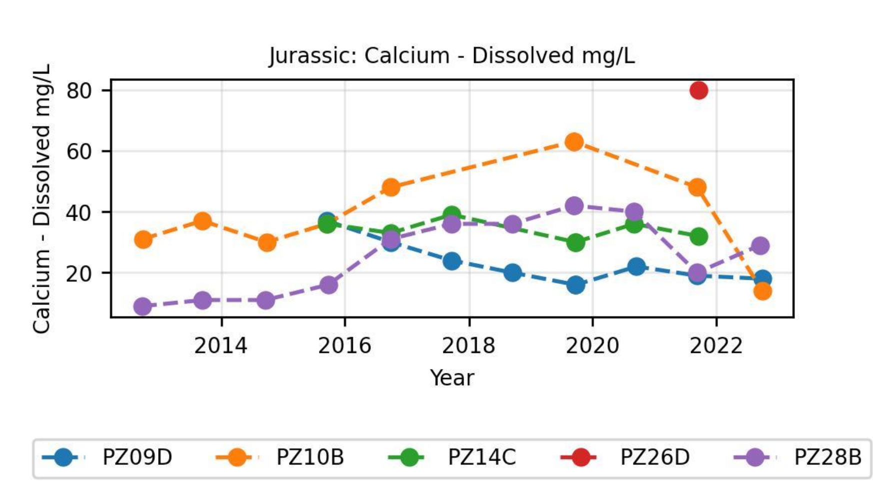

Jurassic: Arsenic - Dissolved mg/L
Arsenic - Dissolved mg/L
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B

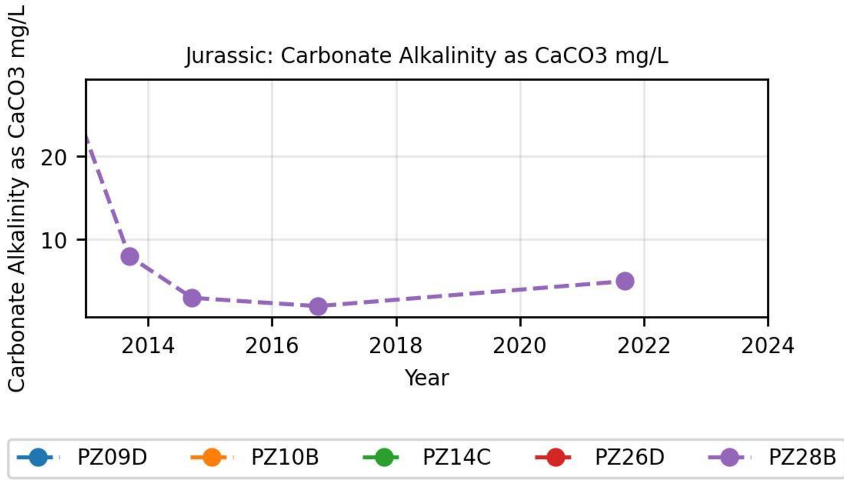

Jurassic: Barium - Dissolved mg/L
Barium - Dissolved mg/L
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B

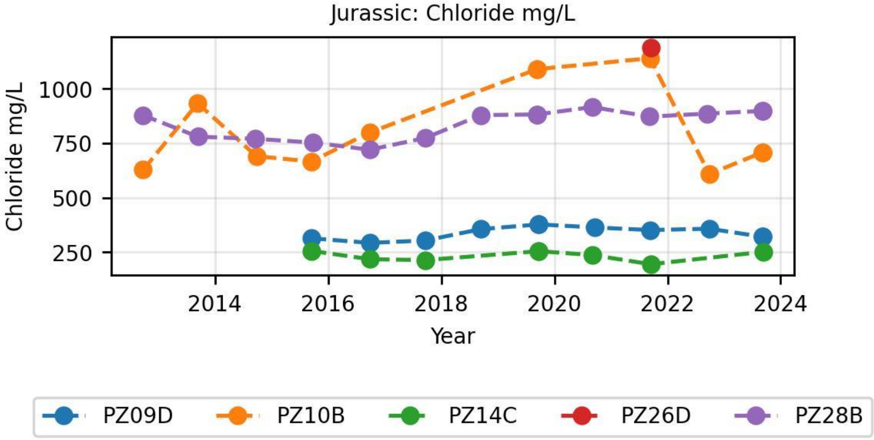

Jurassic: Bicarbonate Alkalinity as CaCO3 mg/L
Bicarbonate Alkalinity as CaCO3 mg/L
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B

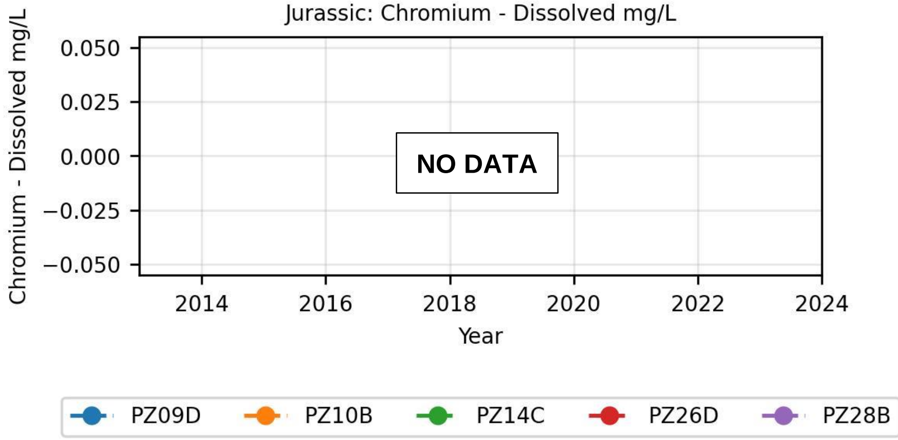

Jurassic: Boron - Dissolved mg/L
Boron - Dissolved mg/L
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B

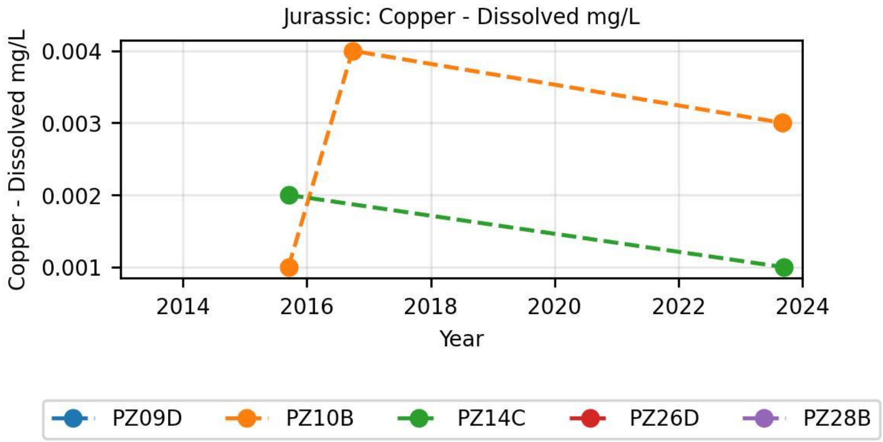

Jurassic: Cadmium - Dissolved mg/L
Cadmium - Dissolved mg/L
NO DATA
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B


Jurassic: Calcium - Dissolved mg/L
Calcium - Dissolved mg/L
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B

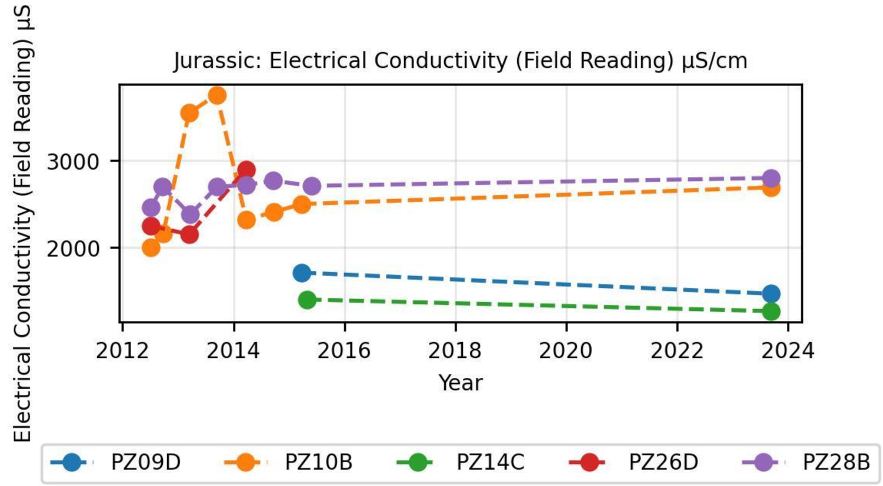

Jurassic: Carbonate Alkalinity as CaCO3 mg/L
Carbonate Alkalinity as CaCO3 mg/L
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B


Jurassic: Chloride mg/L
Chloride mg/L
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B

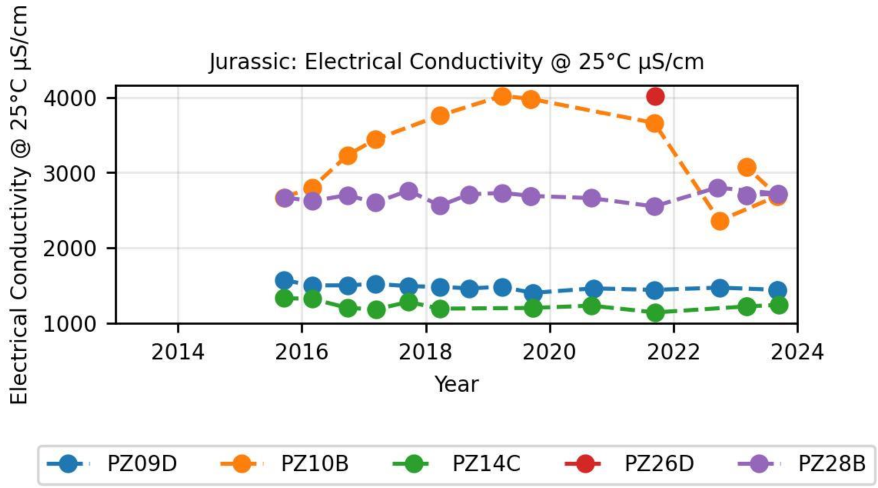

Jurassic: Chromium - Dissolved mg/L
Chromium - Dissolved mg/L
NO DATA
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B



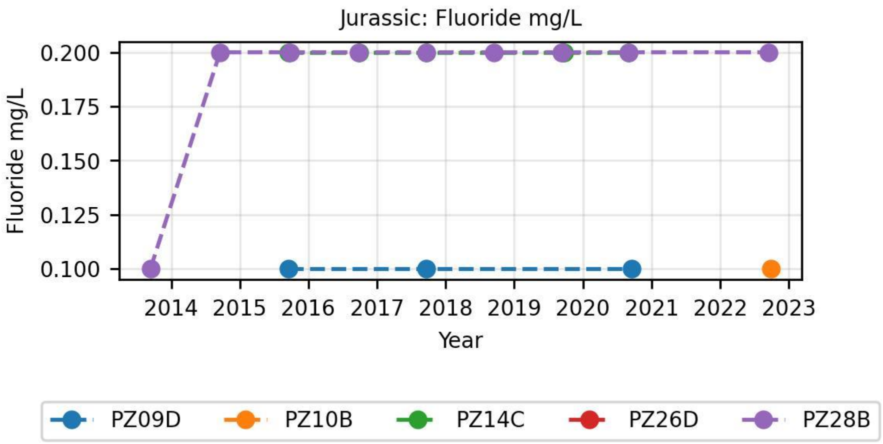
Jurassic: Copper - Dissolved mg/L
Copper - Dissolved mg/L
0.004
0.003
0.002
0.001
2014
2016
2018
2020
2022
2024
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B



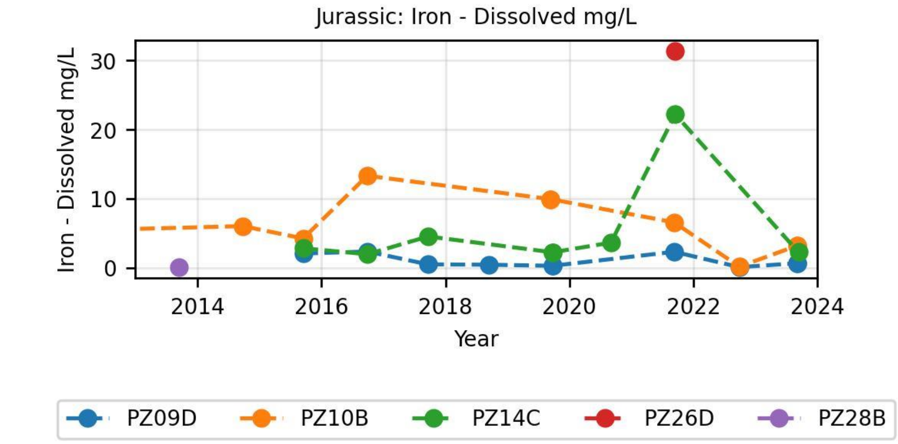
Jurassic: Electrical Conductivity (Field Reading) µS/cm
Electrical Conductivity (Field Reading) µS
3000
2000
2012
2014
2016
2018
2020
2022
2024
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B



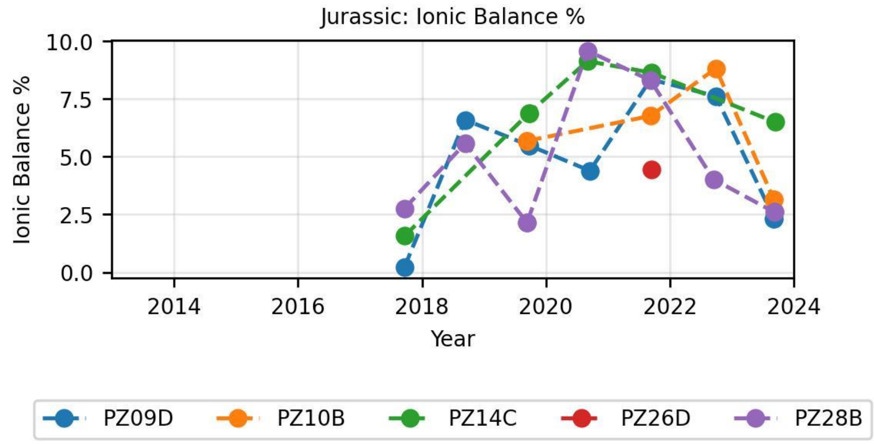
Jurassic: Electrical Conductivity @ 25°C µS/cm
Electrical Conductivity @ 25°C µS/cm
4000
3000
2000
1000
2014
2016
2018
2020
2022
2024
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B



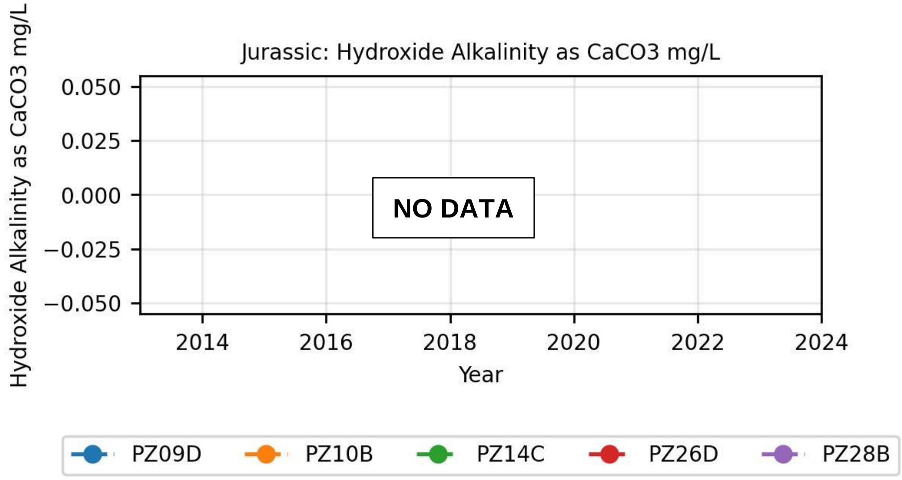
Jurassic: Fluoride mg/L
Fluoride mg/L
0.200
0.175
0.150
0.125
0.100
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B



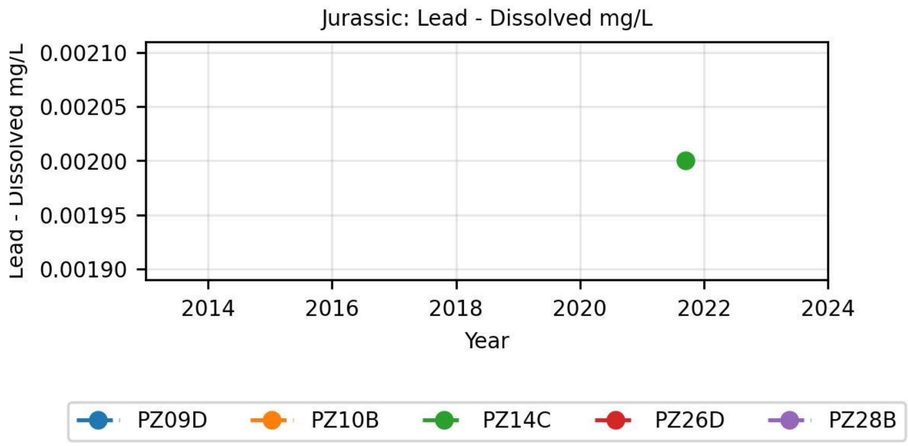
Jurassic: Iron - Dissolved mg/L
Iron - Dissolved mg/L
0
10
20
30
2014
2016
2018
2020
2022
2024
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B



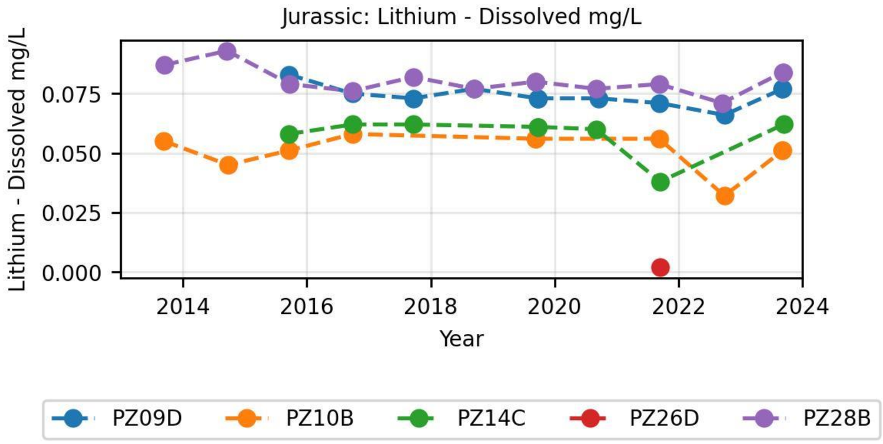
Jurassic: Ionic Balance %
Ionic Balance %
0.0
2.5
5.0
7.5
10.0
2014
2016
2018
2020
2022
2024
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B



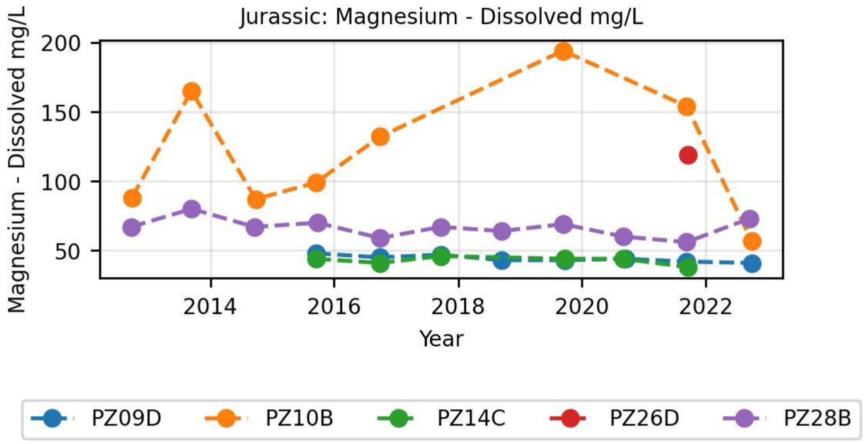
Jurassic: Hydroxide Alkalinity as CaCO3 mg/L
Hydroxide Alkalinity as CaCO3 mg/L
0.050
0.025
0.000
−0.025
−0.050
NO DATA
2014
2016
2018
2020
2022
2024
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B



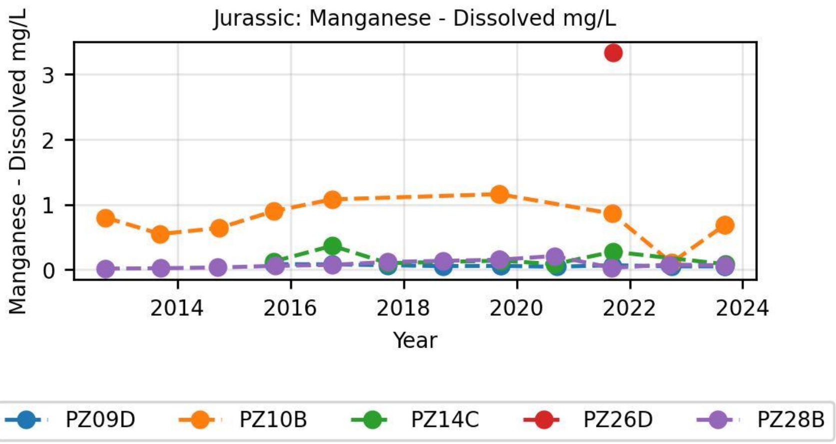
Jurassic: Lead - Dissolved mg/L
Lead - Dissolved mg/L
0.00210
0.00205
0.00200
0.00195
0.00190
2014
2016
2018
2020
2022
2024
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B



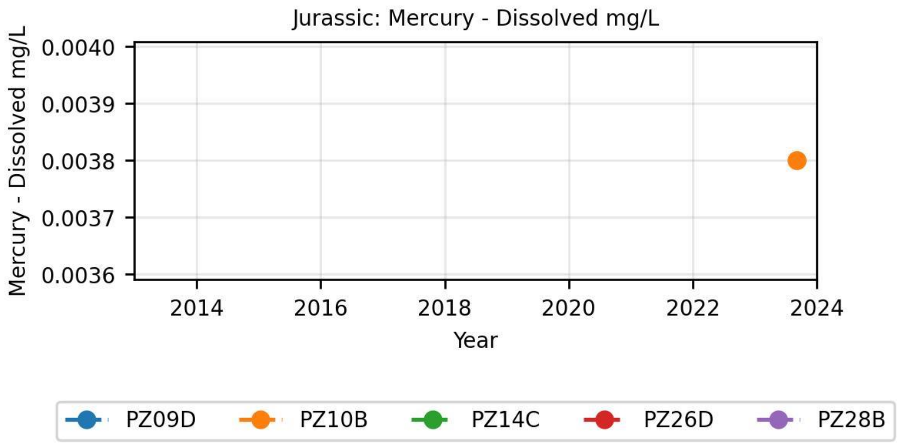
Jurassic: Lithium - Dissolved mg/L
Lithium - Dissolved mg/L
0.000
0.025
0.050
0.075
2014
2016
2018
2020
2022
2024
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B



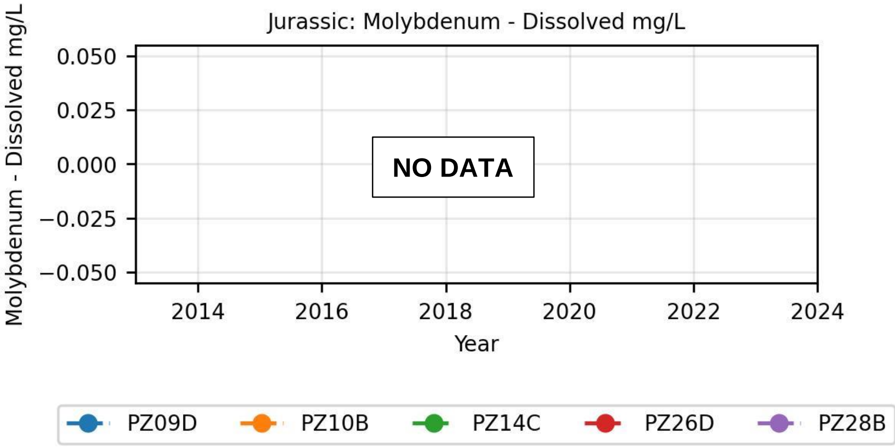
Jurassic: Magnesium - Dissolved mg/L
Magnesium - Dissolved mg/L
50
100
150
200
2014
2016
2018
2020
2022
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B

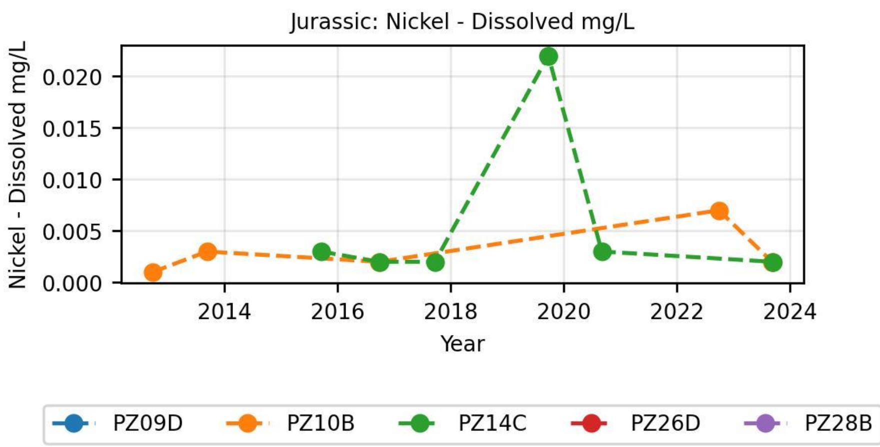


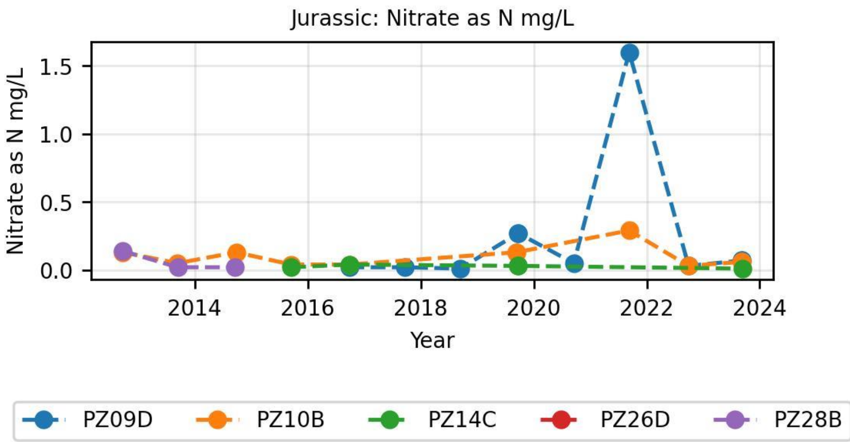
Jurassic: Manganese - Dissolved mg/L
Manganese - Dissolved mg/L
0
1
2
3
2014
2016
2018
2020
2022
2024
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B

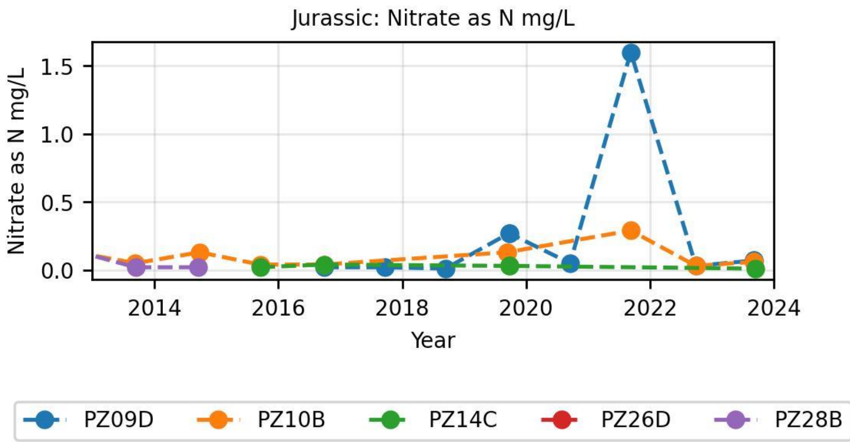


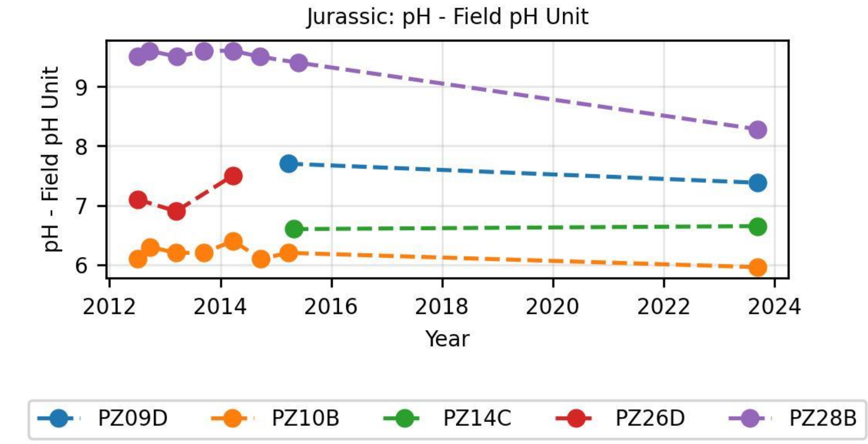
Jurassic: Mercury - Dissolved mg/L
Mercury - Dissolved mg/L
0.0036
0.0037
0.0038
0.0039
0.0040
2014
2016
2018
2020
2022
2024
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B

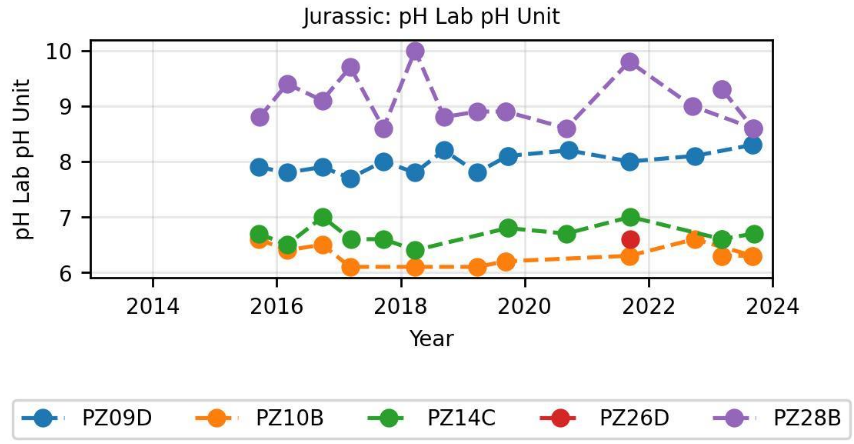

Jurassic: Molybdenum - Dissolved mg/L
Molybdenum - Dissolved mg/L
0.050
0.025
0.000
−0.025
−0.050
NO DATA
2014
2016
2018
2020
2022
2024
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B

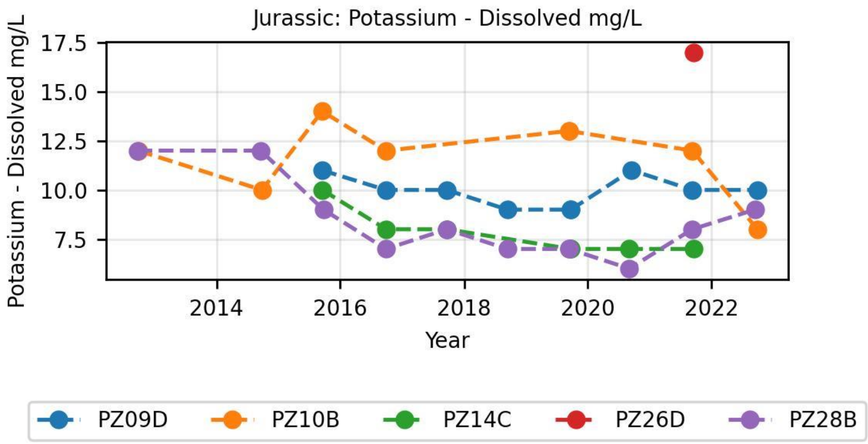

Jurassic: Nickel - Dissolved mg/L
Nickel - Dissolved mg/L
0.020
0.015
0.010
0.005
0.000
2014
2016
2018
2020
2022
2024
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B

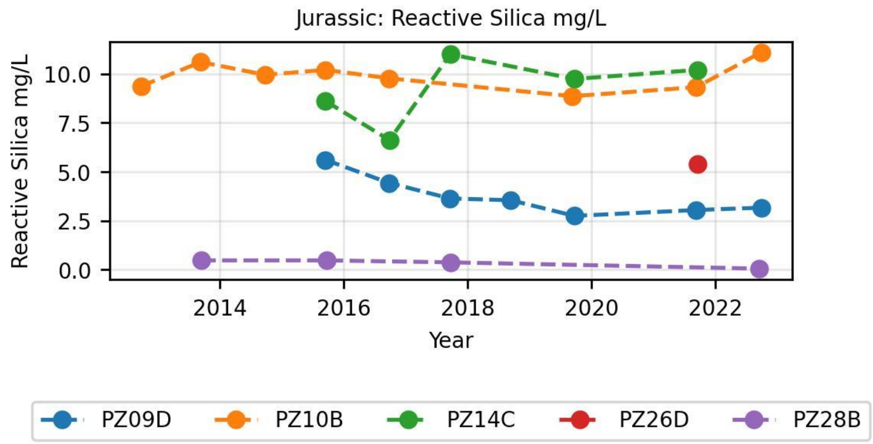

Jurassic: Nitrate as N mg/L
Nitrate as N mg/L
1.5
1.0
0.5
0.0
2014
2016
2018
2020
2022
2024
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B

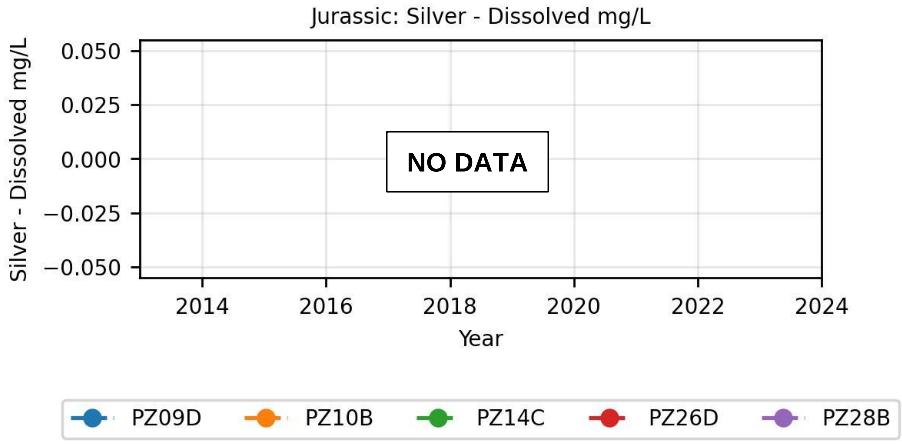

Jurassic: Nitrate as N mg/L
Nitrate as N mg/L
1.5
1.0
0.5
0.0
2014
2016
2018
2020
2022
2024
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B


Jurassic: pH - Field pH Unit
pH - Field pH Unit
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B

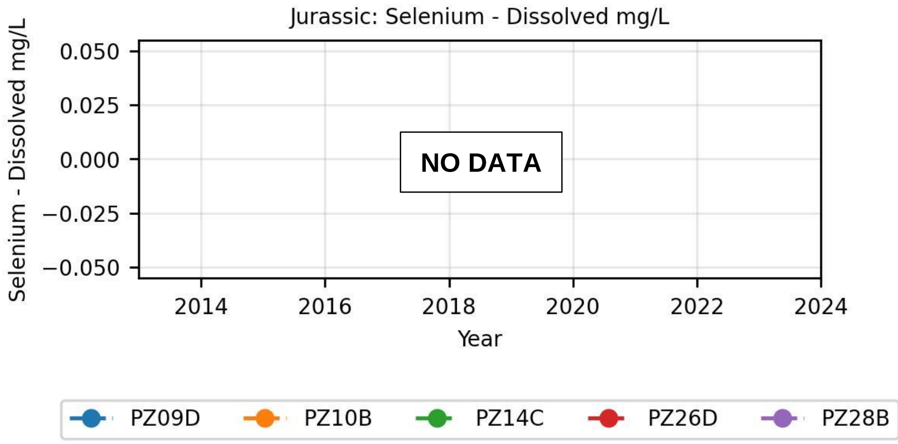

Jurassic: pH Lab pH Unit
pH Lab pH Unit
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B


Jurassic: Potassium - Dissolved mg/L
Potassium - Dissolved mg/L
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B

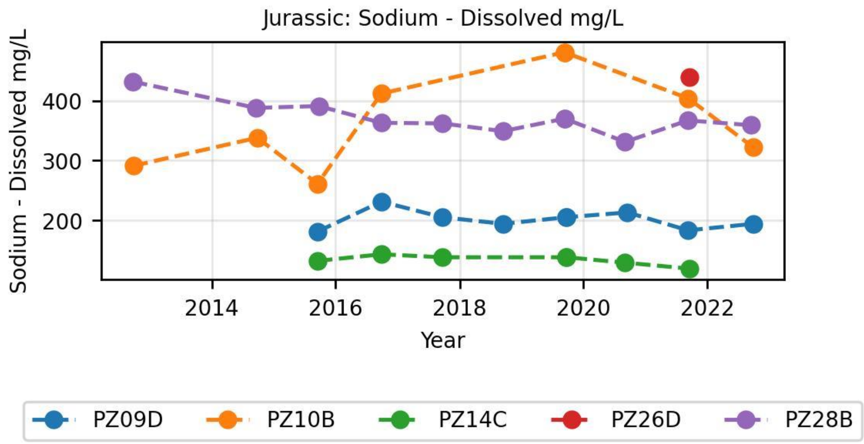

Jurassic: Reactive Silica mg/L
Reactive Silica mg/L
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B



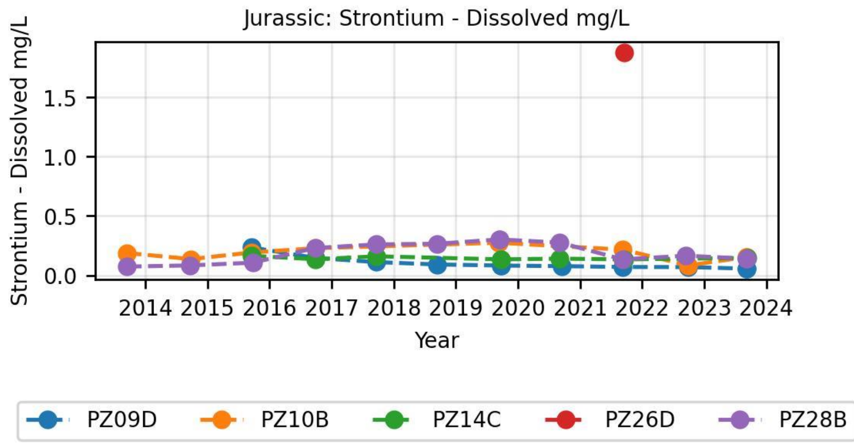
Jurassic: Silver - Dissolved mg/L
Silver - Dissolved mg/L
0.050
0.025
0.000
−0.025
−0.050
NO DATA
2014
2016
2018
2020
2022
2024
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B



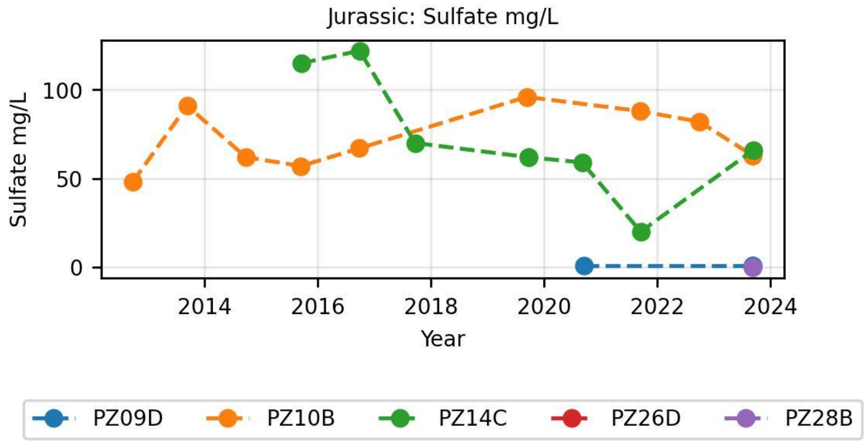
Jurassic: Selenium - Dissolved mg/L
Selenium - Dissolved mg/L
0.050
0.025
0.000
−0.025
−0.050
NO DATA
2014
2016
2018
2020
2022
2024
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B



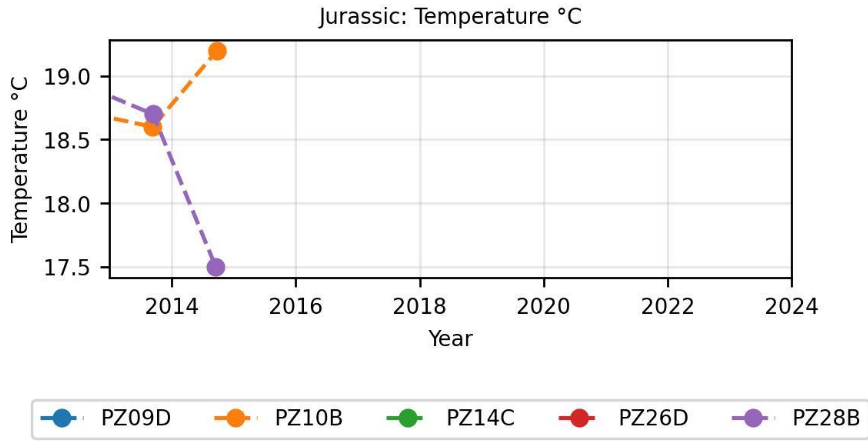
Jurassic: Sodium - Dissolved mg/L
Sodium - Dissolved mg/L
400
300
200
2014
2016
2018
2020
2022
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B



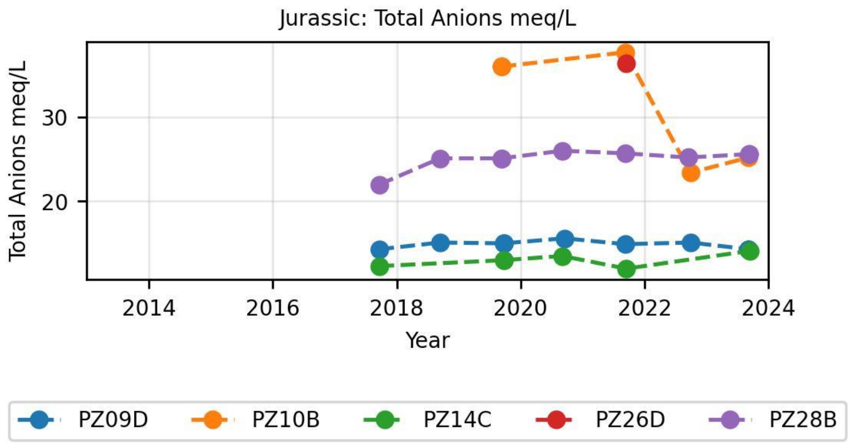
Jurassic: Strontium - Dissolved mg/L
Strontium - Dissolved mg/L
1.5
1.0
0.5
0.0
2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B



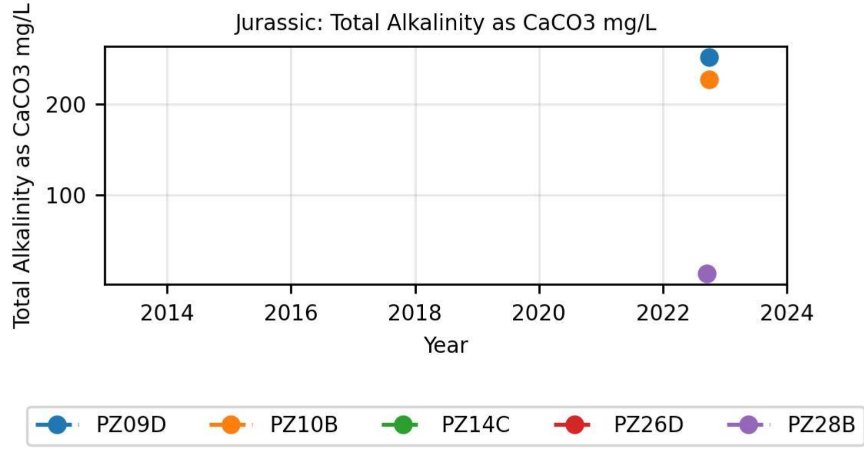
Jurassic: Sulfate mg/L
Sulfate mg/L
0
50
100
2014
2016
2018
2020
2022
2024
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B



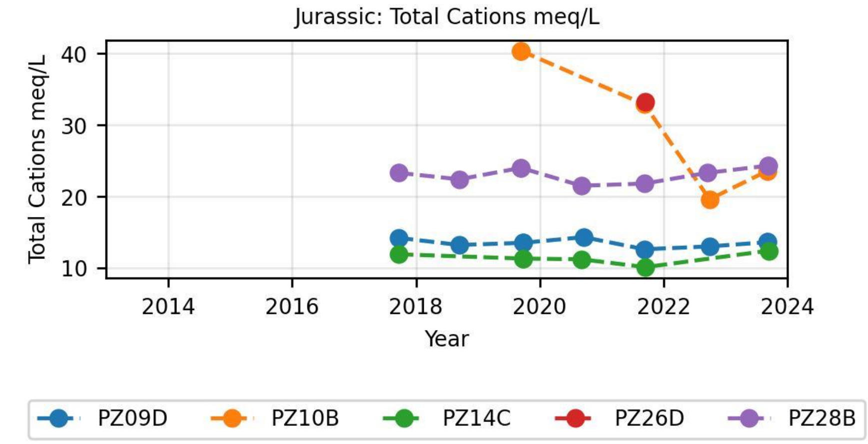
Jurassic: Temperature °C
Temperature °C
17.5
18.0
18.5
19.0
2014
2016
2018
2020
2022
2024
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B

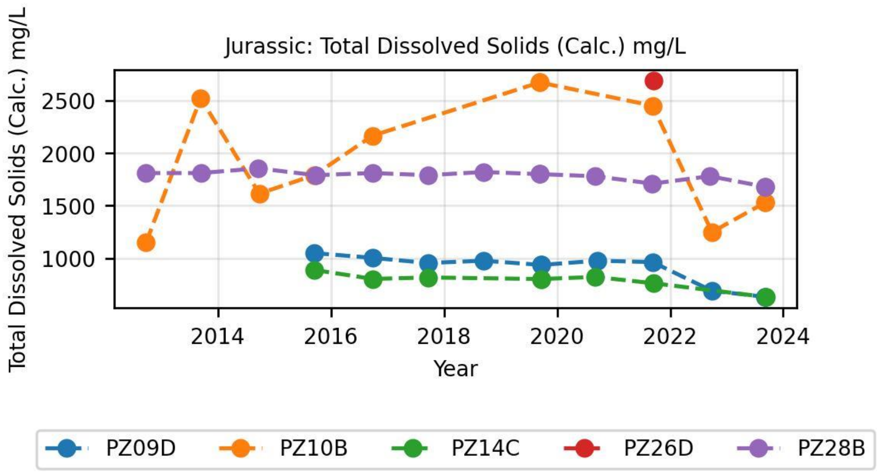


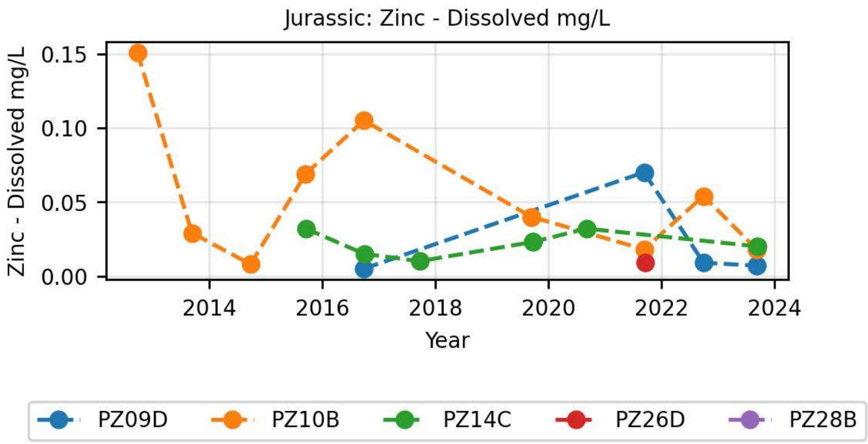
Jurassic: Total Anions meq/L
Total Anions meq/L
20
30
2014
2016
2018
2020
2022
2024
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B

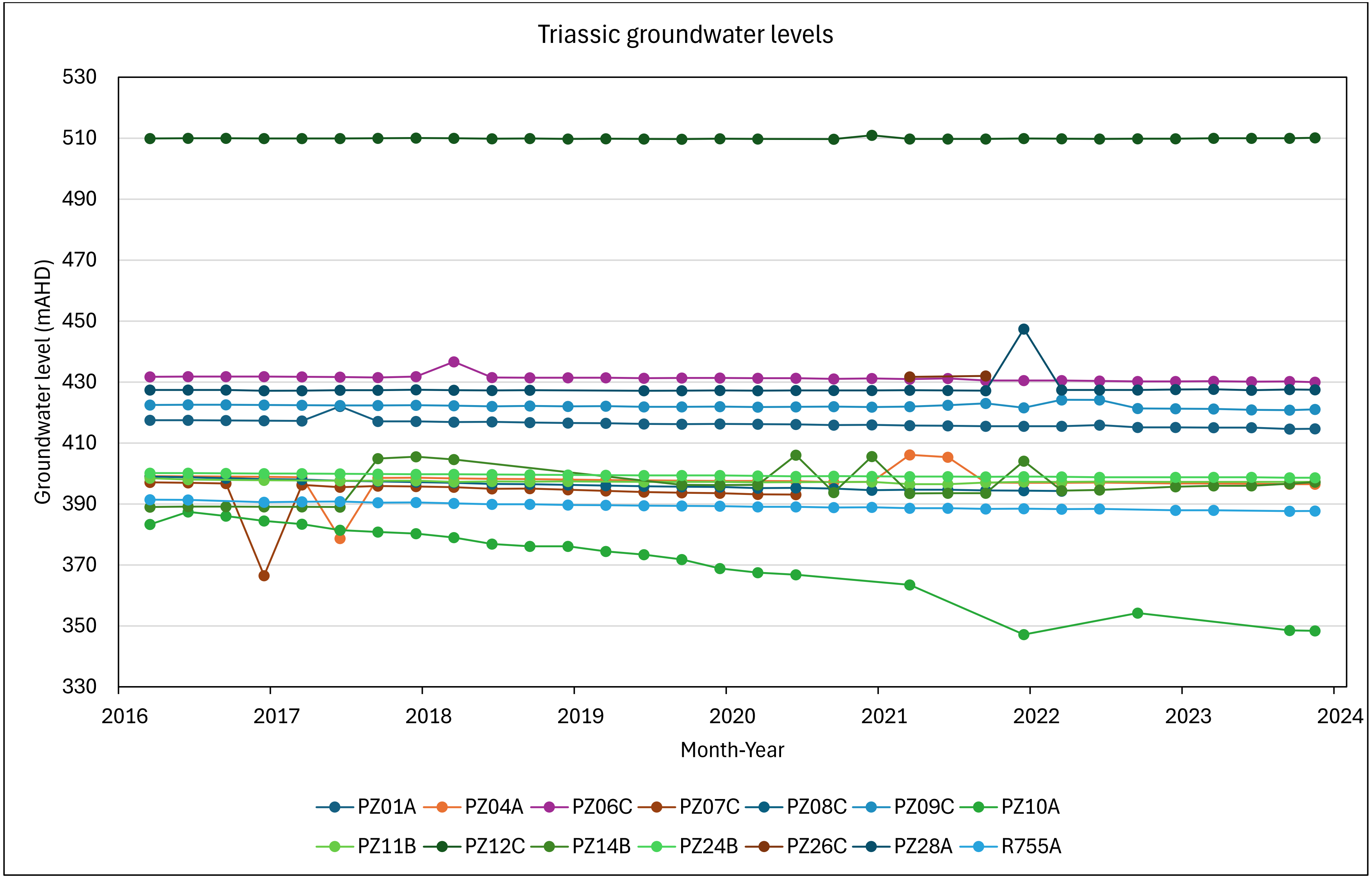


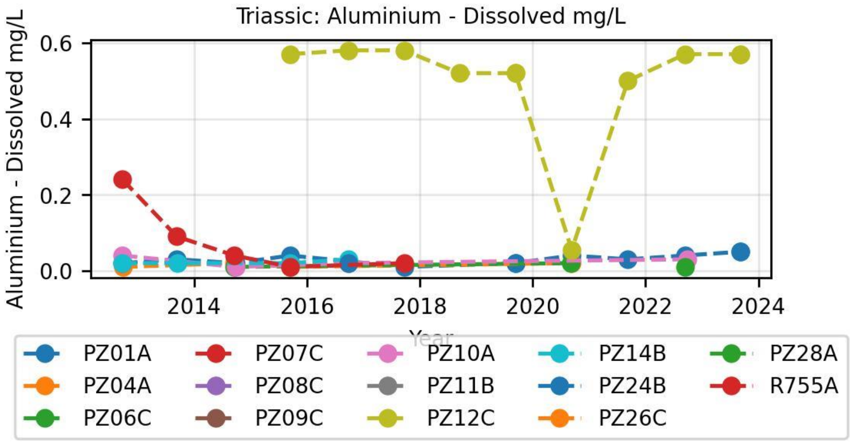
Jurassic: Total Alkalinity as CaCO3 mg/L
Total Alkalinity as CaCO3 mg/L
100
200
2014
2016
2018
2020
2022
2024
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B

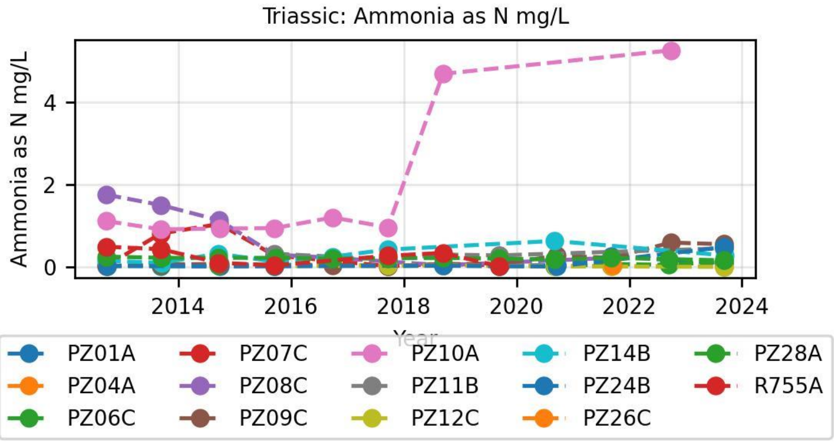

Jurassic: Total Cations meq/L
Total Cations meq/L
40
30
20
10
2014
2016
2018
2020
2022
2024
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B

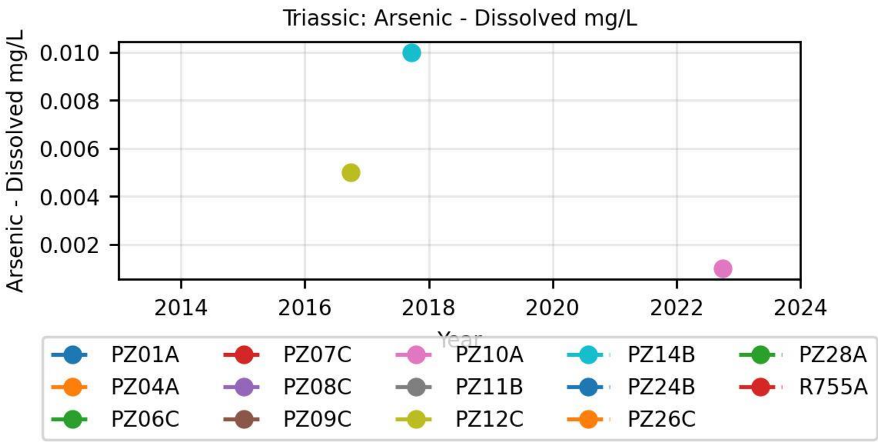

Jurassic: Total Dissolved Solids (Calc.) mg/L
Total Dissolved Solids (Calc.) mg/L
2500
2000
1500
1000
2014
2016
2018
2020
2022
2024
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B

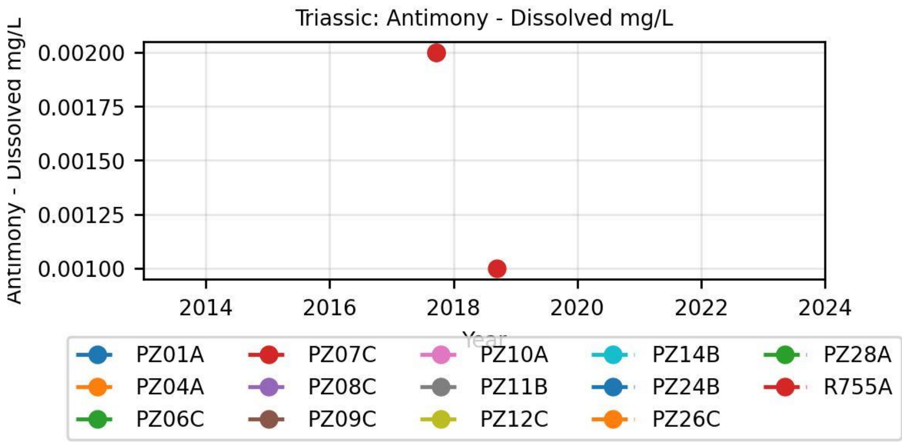

Jurassic: Zinc - Dissolved mg/L
Zinc - Dissolved mg/L
0.15
0.10
0.05
0.00
2014
2016
2018
2020
2022
2024
Year
PZ09D
PZ10B
PZ14C
PZ26D
PZ28B

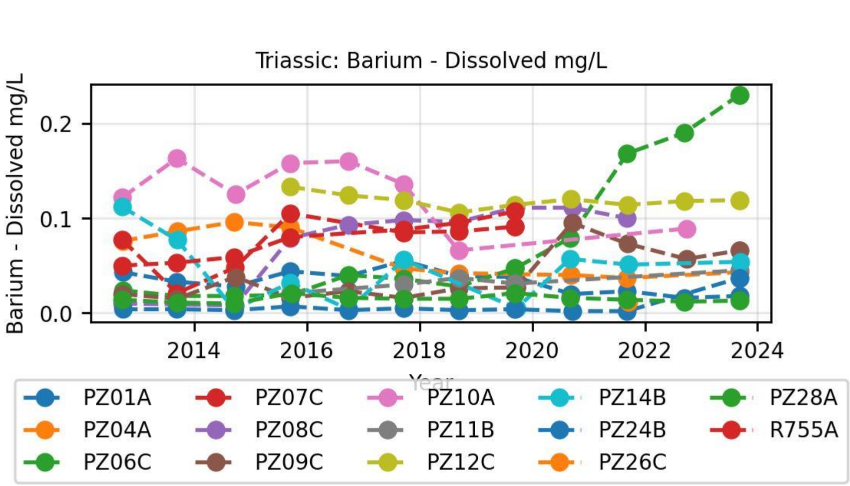

Triassic groundwater levels
530
510
490
470
450
430
410
390
370
350
330
Groundwater level (mAHD)
2016
2017
2018
2019
2020
2021
2022
2023
2024
Month-Year
PZ01A
PZ04A
PZ06C
PZ07C
PZ08C
PZ09C
PZ10A
PZ11B
PZ12C
PZ14B
PZ24B
PZ26C
PZ28A
R755A

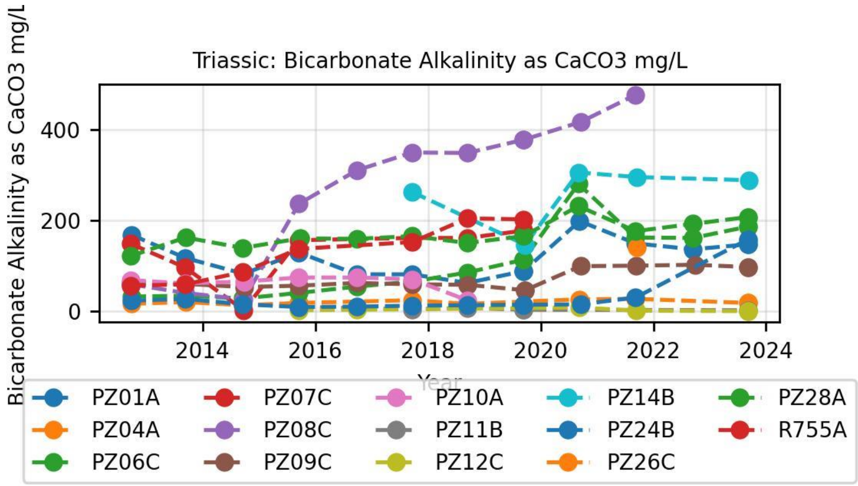

Triassic: Aluminium - Dissolved mg/L
Aluminium - Dissolved mg/L
0.0
0.2
0.4
0.6
2014
2016
2018
2020
2022
2024
Year
PZ01A
PZ04A
PZ06C
PZ07C
PZ08C
PZ09C
PZ10A
PZ11B
PZ12C
PZ14B
PZ24B
PZ26C
PZ28A
R755A

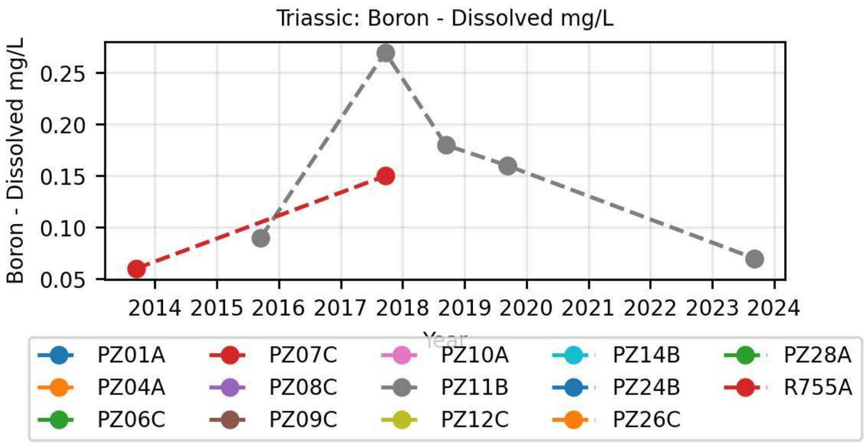

Triassic: Ammonia as N mg/L
Ammonia as N mg/L
0
2
4
2014
2016
2018
2020
2022
2024
Year
PZ01A
PZ04A
PZ06C
PZ07C
PZ08C
PZ09C
PZ10A
PZ11B
PZ12C
PZ14B
PZ24B
PZ26C
PZ28A
R755A

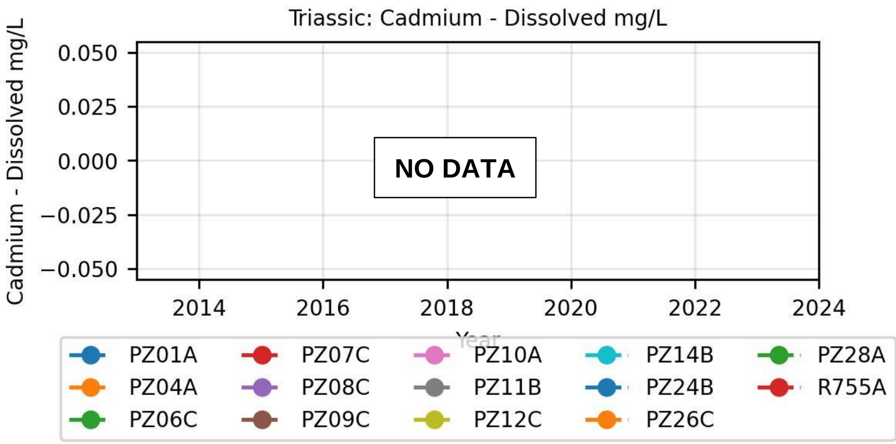

Triassic: Arsenic - Dissolved mg/L
Arsenic - Dissolved mg/L
0.002
0.004
0.006
0.008
0.010
2014
2016
2018
2020
2022
2024
Year
PZ01A
PZ04A
PZ06C
PZ07C
PZ08C
PZ09C
PZ10A
PZ11B
PZ12C
PZ14B
PZ24B
PZ26C
PZ28A
R755A

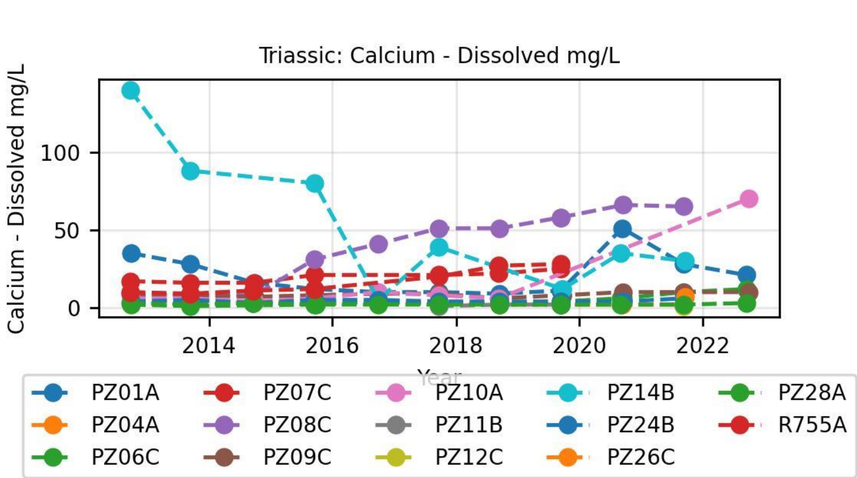

Triassic: Antimony - Dissolved mg/L
Antimony - Dissolved mg/L
0.00100
0.00125
0.00150
0.00175
0.00200
2014
2016
2018
2020
2022
2024
Year
PZ01A
PZ04A
PZ06C
PZ07C
PZ08C
PZ09C
PZ10A
PZ11B
PZ12C
PZ14B
PZ24B
PZ26C
PZ28A
R755A

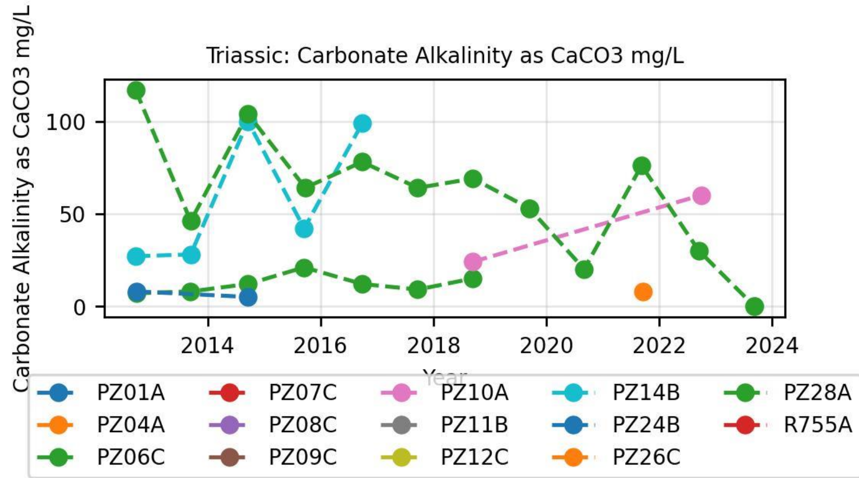

Triassic: Barium - Dissolved mg/L
Barium - Dissolved mg/L
0.0
0.1
0.2
2014
2016
2018
2020
2022
2024
Year
PZ01A
PZ04A
PZ06C
PZ07C
PZ08C
PZ09C
PZ10A
PZ11B
PZ12C
PZ14B
PZ24B
PZ26C
PZ28A
R755A

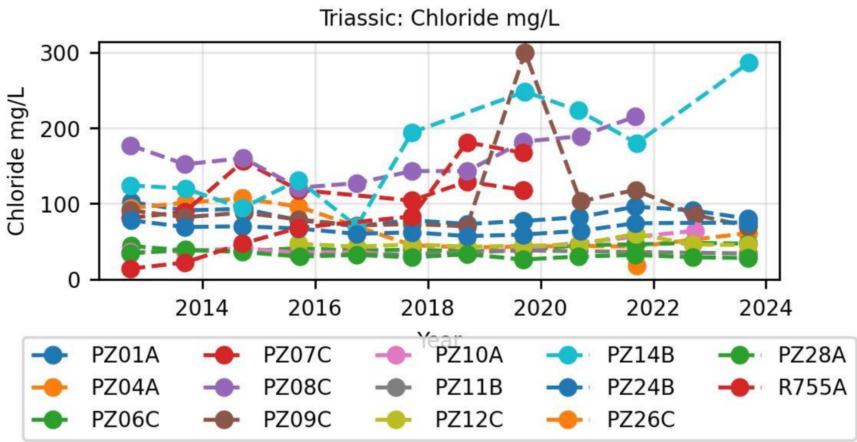

Triassic: Bicarbonate Alkalinity as CaCO3 mg/L
Bicarbonate Alkalinity as CaCO3 mg/L
0
200
400
2014
2016
2018
2020
2022
2024
Year
PZ01A
PZ04A
PZ06C
PZ07C
PZ08C
PZ09C
PZ10A
PZ11B
PZ12C
PZ14B
PZ24B
PZ26C
PZ28A
R755A

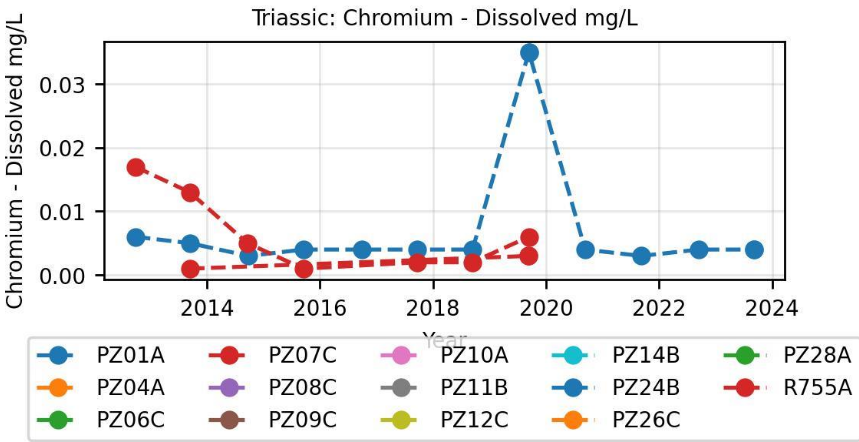

Triassic: Boron - Dissolved mg/L
Boron - Dissolved mg/L
0.05
0.10
0.15
0.20
0.25
2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024
Year
PZ01A
PZ04A
PZ06C
PZ07C
PZ08C
PZ09C
PZ10A
PZ11B
PZ12C
PZ14B
PZ24B
PZ26C
PZ28A
R755A

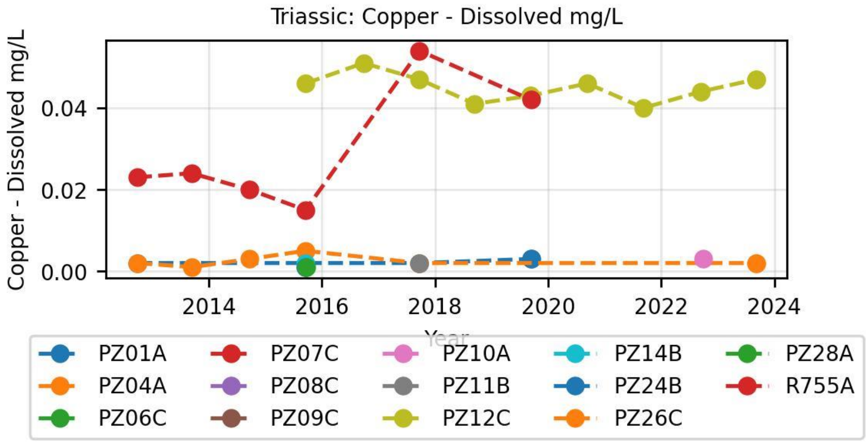

Triassic: Cadmium - Dissolved mg/L
Cadmium - Dissolved mg/L
0.050
0.025
0.000
−0.025
−0.050
NO DATA
2014
2016
2018
2020
2022
2024
Year
PZ01A
PZ04A
PZ06C
PZ07C
PZ08C
PZ09C
PZ10A
PZ11B
PZ12C
PZ14B
PZ24B
PZ26C
PZ28A
R755A

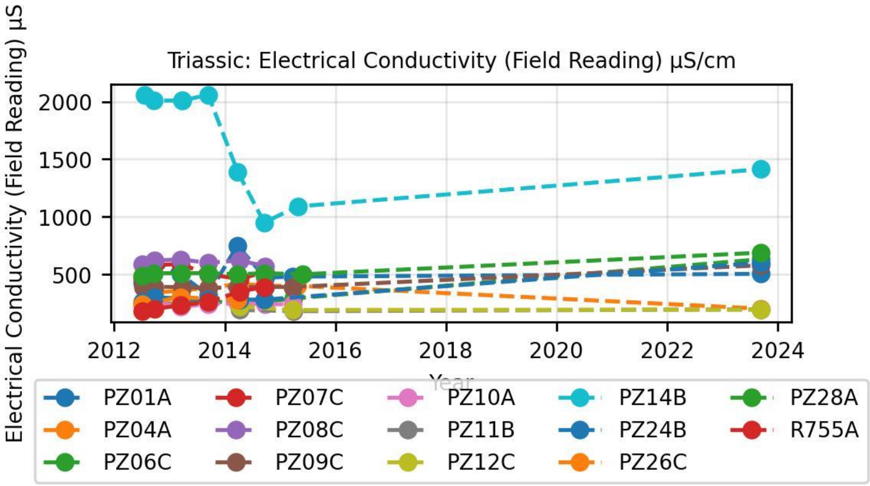

Triassic: Calcium - Dissolved mg/L
Calcium - Dissolved mg/L
0
50
100
2014
2016
2018
2020
2022
Year
PZ01A
PZ07C
PZ10A
PZ14B
PZ28A
PZ04A
PZ08C
PZ11B
PZ24B
R755A
PZ06C
PZ09C
PZ12C
PZ26C

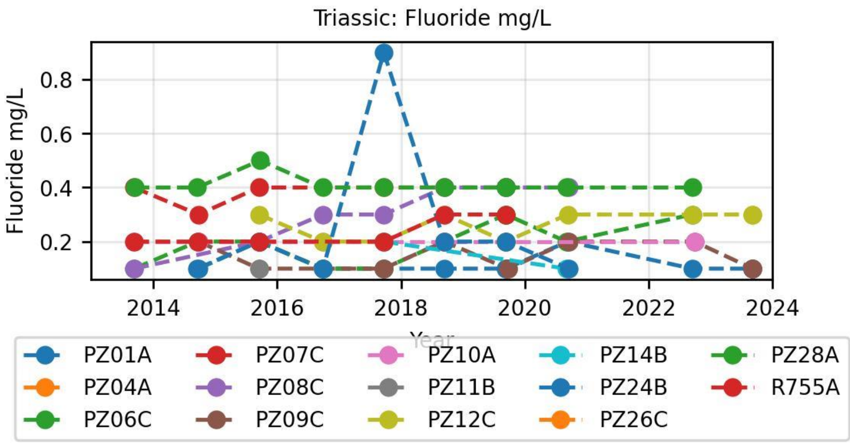

Triassic: Carbonate Alkalinity as CaCO3 mg/L
Carbonate Alkalinity as CaCO3 mg/L
0
50
100
2014
2016
2018
2020
2022
2024
Year
PZ01A
PZ07C
PZ10A
PZ14B
PZ28A
PZ04A
PZ08C
PZ11B
PZ24B
R755A
PZ06C
PZ09C
PZ12C
PZ26C

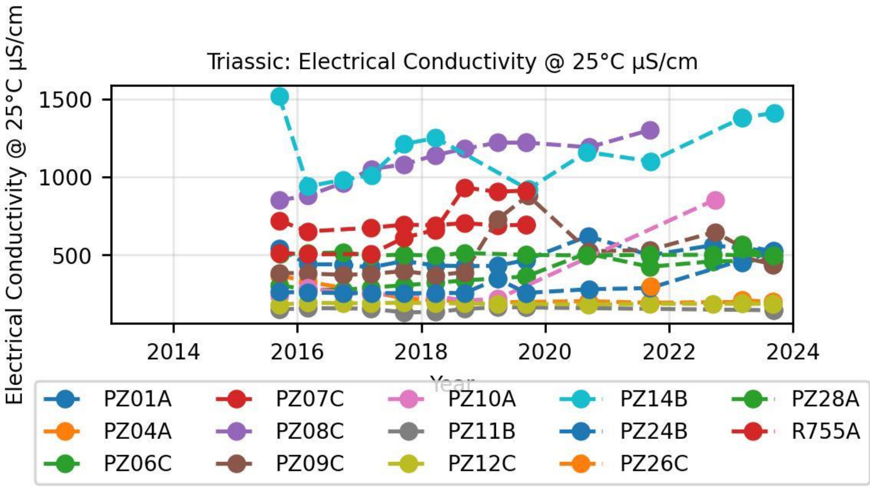

Triassic: Chloride mg/L
Chloride mg/L
0
100
200
300
2014
2016
2018
2020
2022
2024
Year
PZ01A
PZ07C
PZ10A
PZ14B
PZ28A
PZ04A
PZ08C
PZ11B
PZ24B
R755A
PZ06C
PZ09C
PZ12C
PZ26C

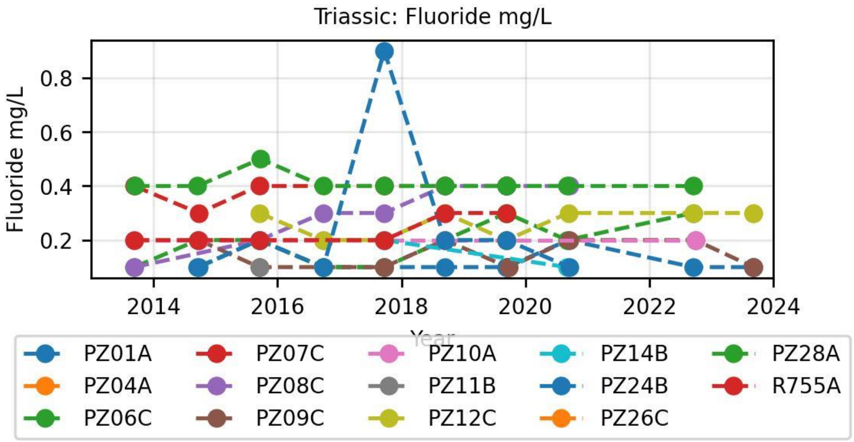

Triassic: Chromium - Dissolved mg/L
Chromium - Dissolved mg/L
0.00
0.01
0.02
0.03
2014
2016
2018
2020
2022
2024
Year
PZ01A
PZ07C
PZ10A
PZ14B
PZ28A
PZ04A
PZ08C
PZ11B
PZ24B
R755A
PZ06C
PZ09C
PZ12C
PZ26C

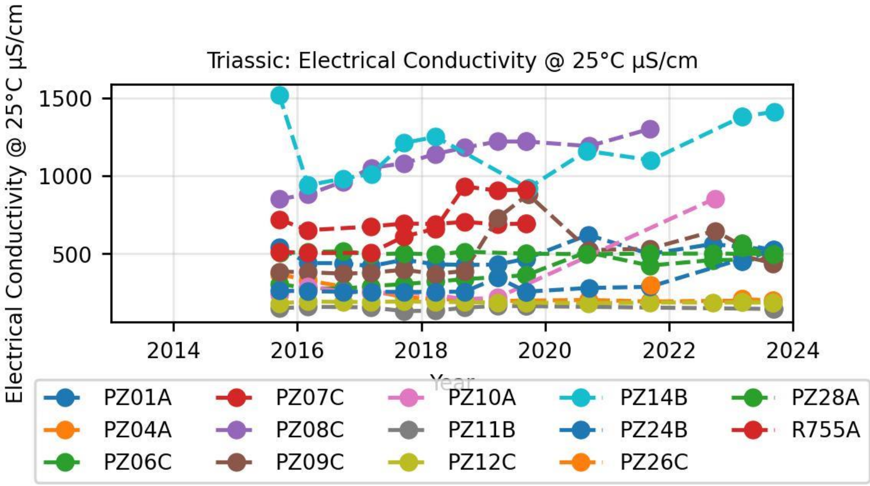

Triassic: Copper - Dissolved mg/L
Copper - Dissolved mg/L
0.04
0.02
0.00
2014
2016
2018
2020
2022
2024
Year
PZ01A
PZ04A
PZ06C
PZ07C
PZ08C
PZ09C
PZ10A
PZ11B
PZ12C
PZ14B
PZ24B
PZ26C
PZ28A
R755A

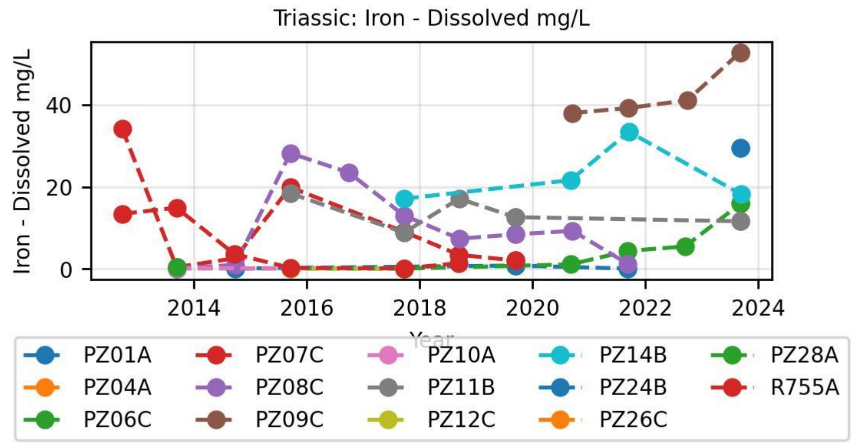

Triassic: Electrical Conductivity (Field Reading) µS/cm
Electrical Conductivity (Field Reading) µS
2000
1500
1000
500
2012
2014
2016
2018
2020
2022
2024
Year
PZ01A
PZ04A
PZ06C
PZ07C
PZ08C
PZ09C
PZ10A
PZ11B
PZ12C
PZ14B
PZ24B
PZ26C
PZ28A
R755A

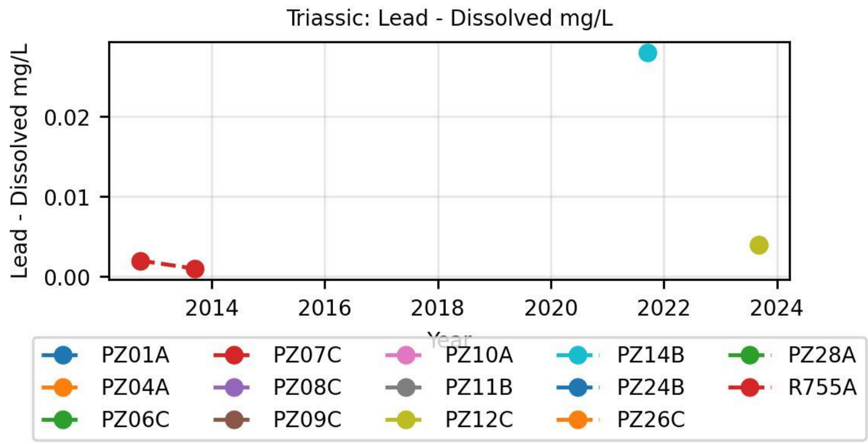

Triassic: Fluoride mg/L
Fluoride mg/L
0.8
0.6
0.4
0.2
2014
2016
2018
2020
2022
2024
Year
PZ01A
PZ04A
PZ06C
PZ07C
PZ08C
PZ09C
PZ10A
PZ11B
PZ12C
PZ14B
PZ24B
PZ26C
PZ28A
R755A

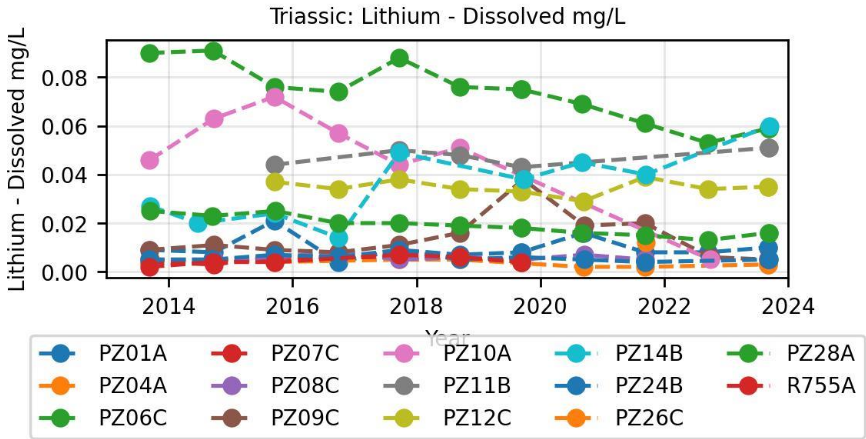

Triassic: Electrical Conductivity @ 25°C µS/cm
Electrical Conductivity @ 25°C µS/cm
1500
1000
500
2014
2016
2018
2020
2022
2024
Year
PZ01A
PZ04A
PZ06C
PZ07C
PZ08C
PZ09C
PZ10A
PZ11B
PZ12C
PZ14B
PZ24B
PZ26C
PZ28A
R755A

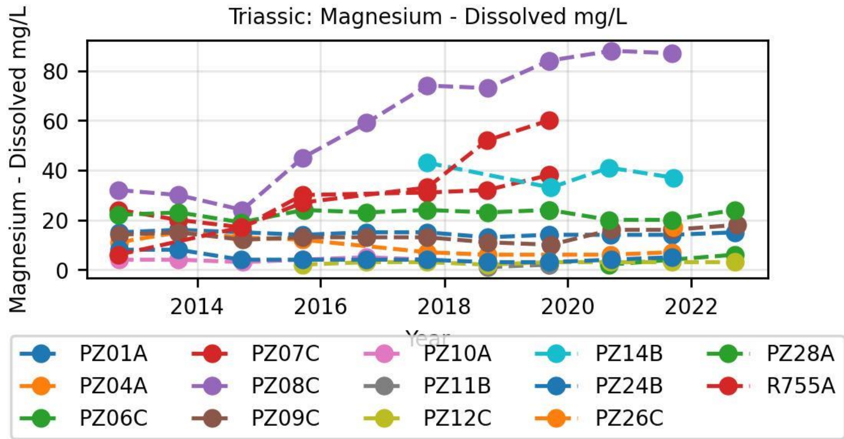

Triassic: Fluoride mg/L
Fluoride mg/L
0.2
0.4
0.6
0.8
2014
2016
2018
2020
2022
2024
Year
PZ01A
PZ04A
PZ06C
PZ07C
PZ08C
PZ09C
PZ10A
PZ11B
PZ12C
PZ14B
PZ24B
PZ26C
PZ28A
R755A

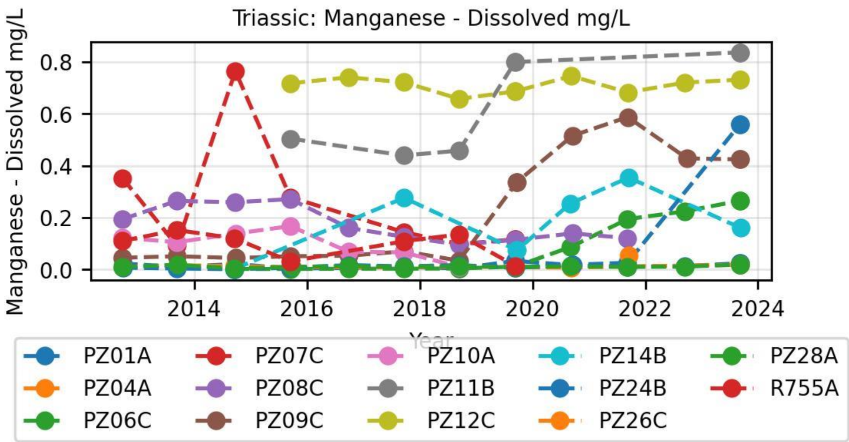

Triassic: Electrical Conductivity @ 25°C µS/cm
Electrical Conductivity @ 25°C µS/cm
500
1000
1500
2014
2016
2018
2020
2022
2024
Year
PZ01A
PZ04A
PZ06C
PZ07C
PZ08C
PZ09C
PZ10A
PZ11B
PZ12C
PZ14B
PZ24B
PZ26C
PZ28A
R755A

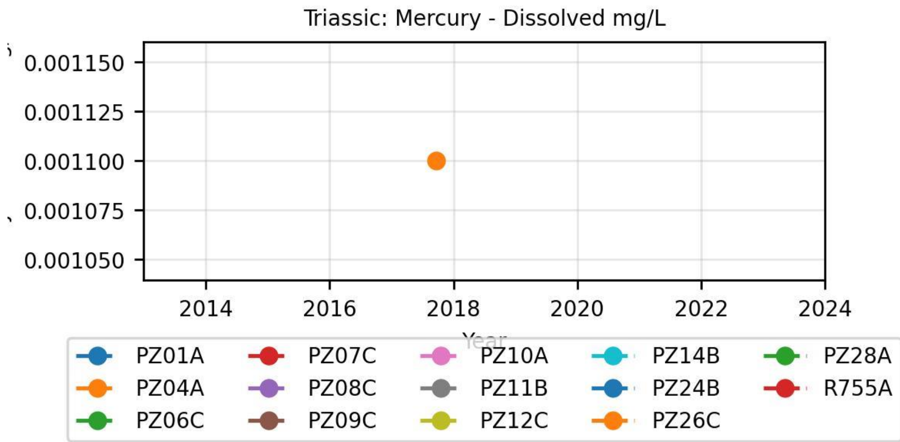

Triassic: Iron - Dissolved mg/L
Iron - Dissolved mg/L
0
20
40
2014
2016
2018
2020
2022
2024
Year
PZ01A
PZ04A
PZ06C
PZ07C
PZ08C
PZ09C
PZ10A
PZ11B
PZ12C
PZ14B
PZ24B
PZ26C
PZ28A
R755A

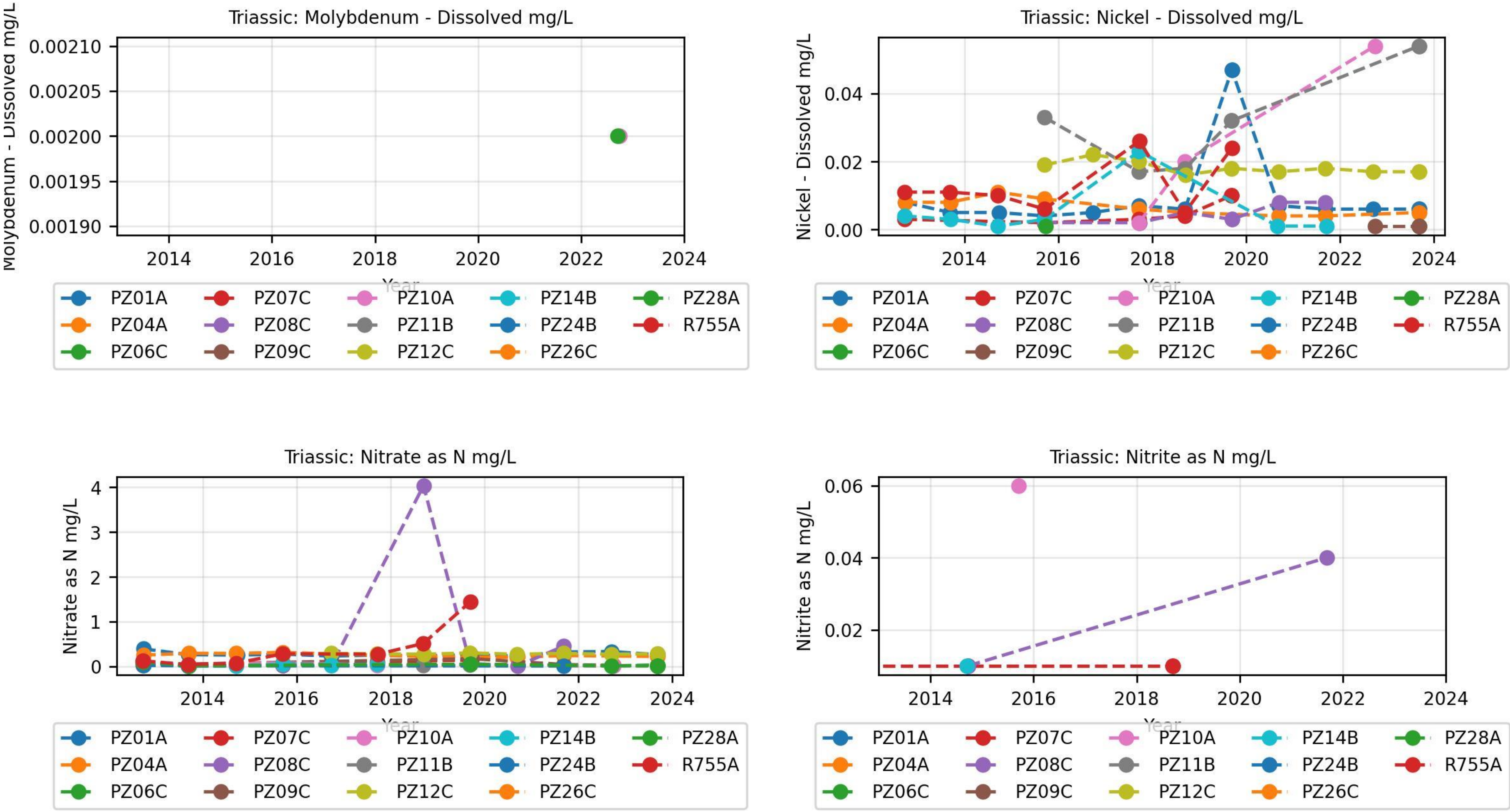

Triassic: Lead - Dissolved mg/L
Lead - Dissolved mg/L
0.00
0.01
0.02
2014
2016
2018
2020
2022
2024
Year
PZ01A
PZ04A
PZ06C
PZ07C
PZ08C
PZ09C
PZ10A
PZ11B
PZ12C
PZ14B
PZ24B
PZ26C
PZ28A
R755A

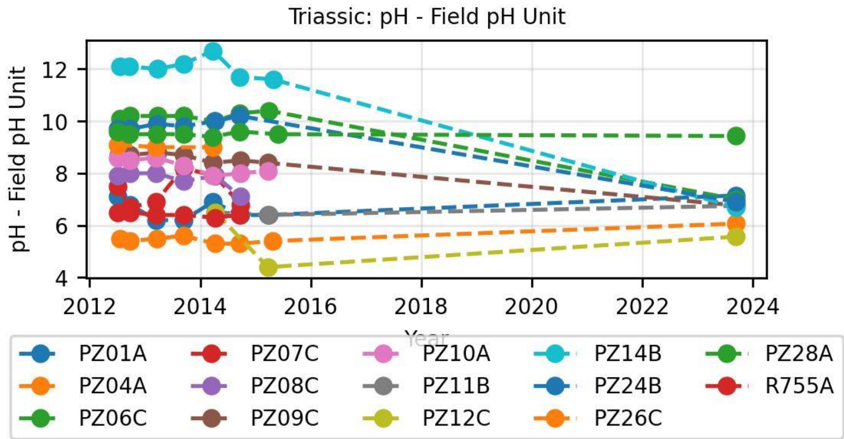

Triassic: Lithium - Dissolved mg/L
Lithium - Dissolved mg/L
0.00
0.02
0.04
0.06
0.08
2014
2016
2018
2020
2022
2024
Year
PZ01A
PZ04A
PZ06C
PZ07C
PZ08C
PZ09C
PZ10A
PZ11B
PZ12C
PZ14B
PZ24B
PZ26C
PZ28A
R755A

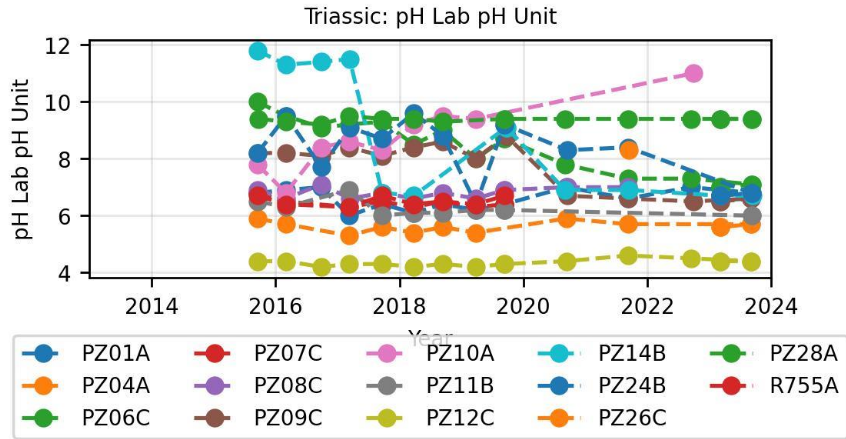

Triassic: Magnesium - Dissolved mg/L
Magnesium - Dissolved mg/L
0
20
40
60
80
2014
2016
2018
2020
2022
Year
PZ01A
PZ04A
PZ06C
PZ07C
PZ08C
PZ09C
PZ10A
PZ11B
PZ12C
PZ14B
PZ24B
PZ26C
PZ28A
R755A

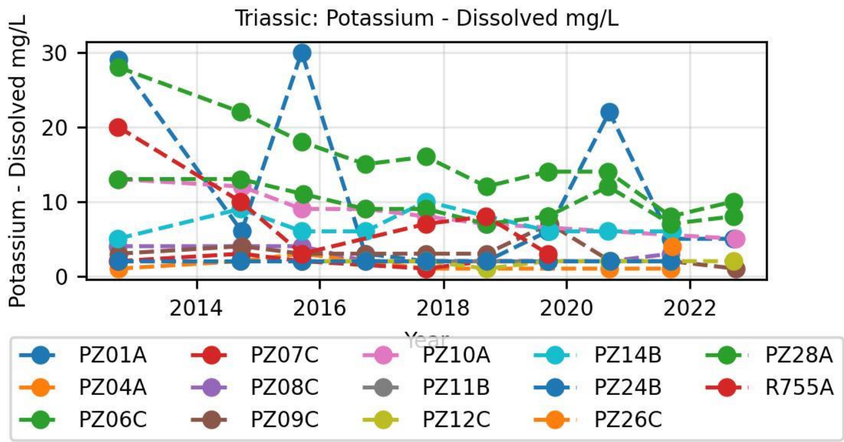

Triassic: Manganese - Dissolved mg/L
Manganese - Dissolved mg/L
0.0
0.2
0.4
0.6
0.8
2014
2016
2018
2020
2022
2024
Year
PZ01A
PZ04A
PZ06C
PZ07C
PZ08C
PZ09C
PZ10A
PZ11B
PZ12C
PZ14B
PZ24B
PZ26C
PZ28A
R755A

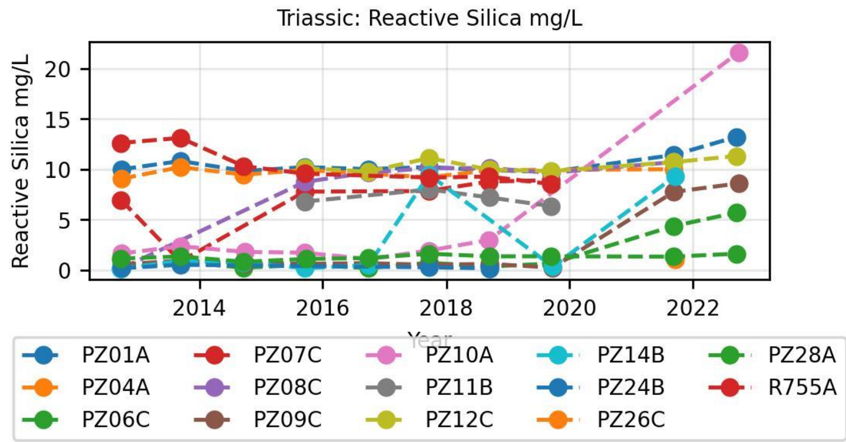

Triassic: Mercury - Dissolved mg/L
0.001050
0.001075
0.001100
0.001125
0.001150
2014
2016
2018
2020
2022
2024
Year
PZ01A
PZ04A
PZ06C
PZ07C
PZ08C
PZ09C
PZ10A
PZ11B
PZ12C
PZ14B
PZ24B
PZ26C
PZ28A
R755A

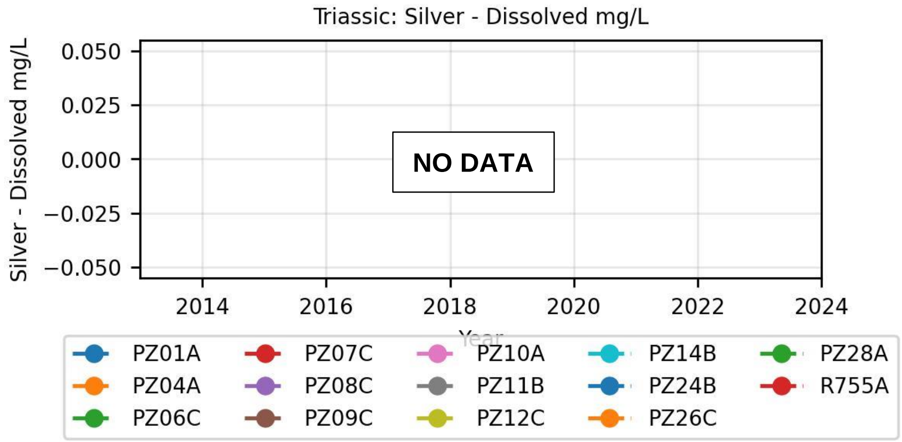

Triassic: Molybdenum - Dissolved mg/L
Molybdenum - Dissolved mg/L
Triassic: Nickel - Dissolved mg/L
Nickel - Dissolved mg/L
Triassic: Nitrate as N mg/L
Nitrate as N mg/L
Triassic: Nitrite as N mg/L
Nitrite as N mg/L
Year
PZ01A
PZ04A
PZ06C
PZ07C
PZ08C
PZ09C
PZ10A
PZ11B
PZ12C
PZ14B
PZ24B
PZ26C
PZ28A
R755A

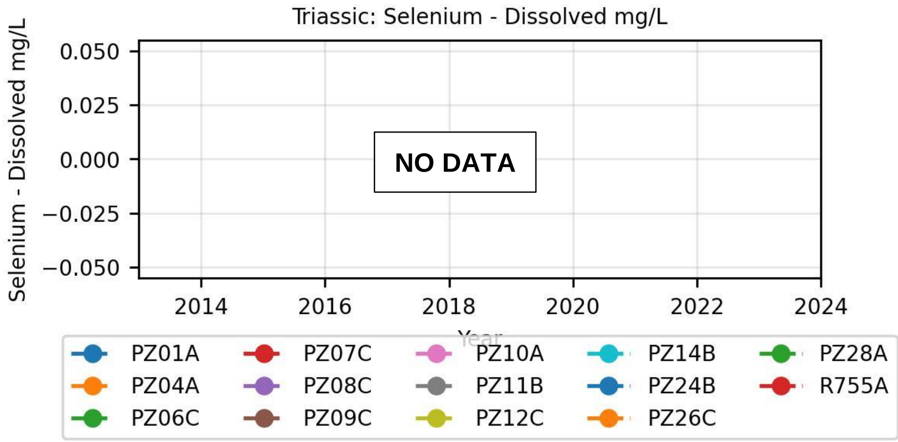

Triassic: pH - Field pH Unit
pH - Field pH Unit
Year
PZ01A
PZ04A
PZ06C
PZ07C
PZ08C
PZ09C
PZ10A
PZ11B
PZ12C
PZ14B
PZ24B
PZ26C
PZ28A
R755A

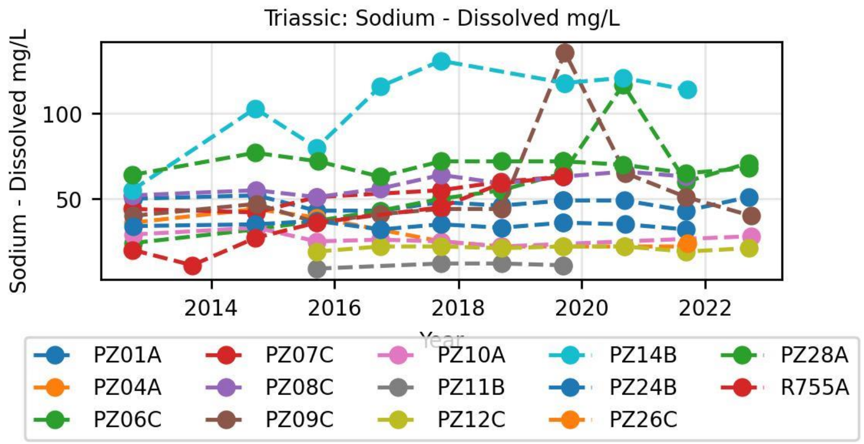

Triassic: pH Lab pH Unit
pH Lab pH Unit
Year
PZ01A
PZ04A
PZ06C
PZ07C
PZ08C
PZ09C
PZ10A
PZ11B
PZ12C
PZ14B
PZ24B
PZ26C
PZ28A
R755A

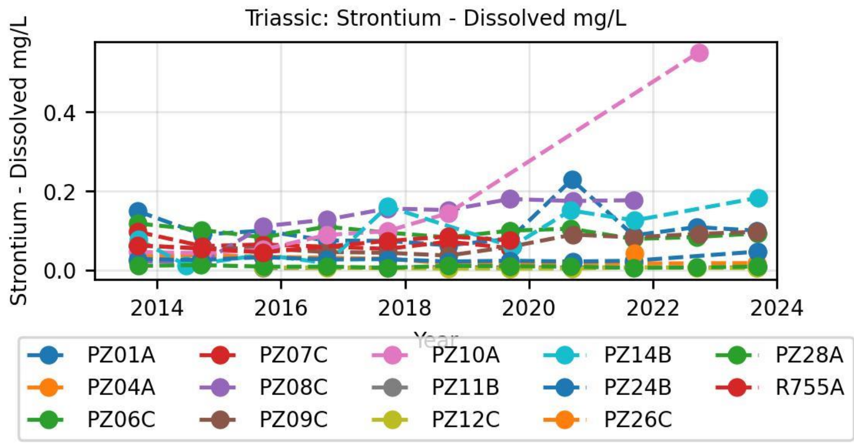

Triassic: Potassium - Dissolved mg/L
Potassium - Dissolved mg/L
Year
PZ01A
PZ04A
PZ06C
PZ07C
PZ08C
PZ09C
PZ10A
PZ11B
PZ12C
PZ14B
PZ24B
PZ26C
PZ28A
R755A

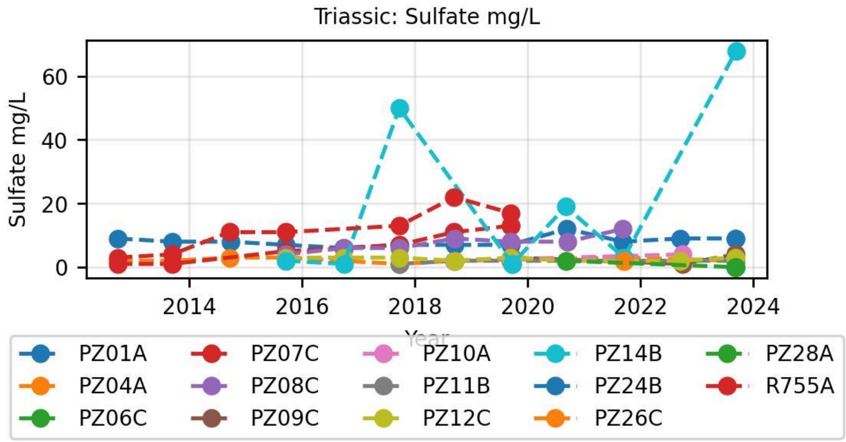

Triassic: Reactive Silica mg/L
Reactive Silica mg/L
Year
PZ01A
PZ04A
PZ06C
PZ07C
PZ08C
PZ09C
PZ10A
PZ11B
PZ12C
PZ14B
PZ24B
PZ26C
PZ28A
R755A

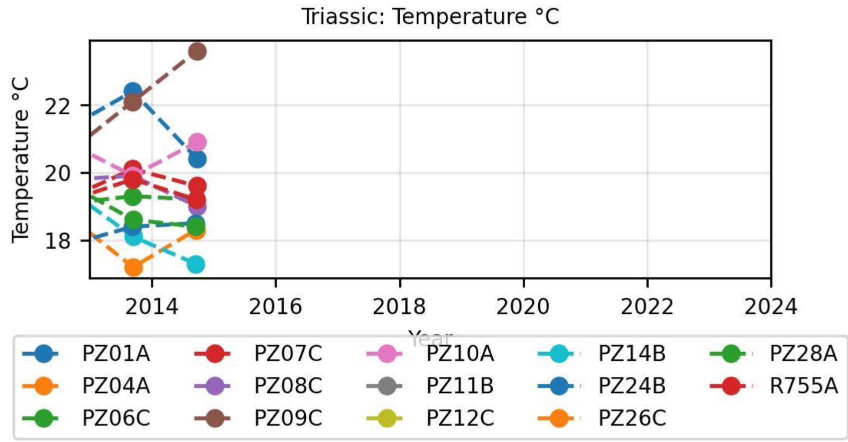

Triassic: Silver - Dissolved mg/L
Silver - Dissolved mg/L
0.050
0.025
0.000
−0.025
−0.050
NO DATA
2014
2016
2018
2020
2022
2024
Year
PZ01A
PZ04A
PZ06C
PZ07C
PZ08C
PZ09C
PZ10A
PZ11B
PZ12C
PZ14B
PZ24B
PZ26C
PZ28A
R755A

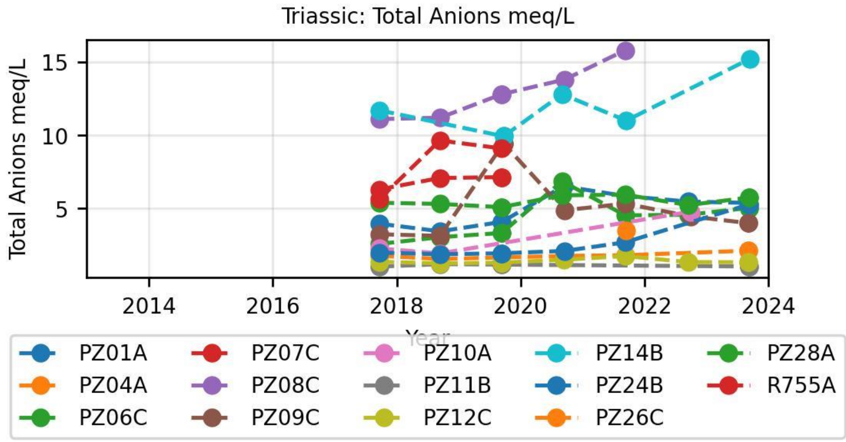

Triassic: Selenium - Dissolved mg/L
Selenium - Dissolved mg/L
0.050
0.025
0.000
−0.025
−0.050
NO DATA
2014
2016
2018
2020
2022
2024
Year
PZ01A
PZ04A
PZ06C
PZ07C
PZ08C
PZ09C
PZ10A
PZ11B
PZ12C
PZ14B
PZ24B
PZ26C
PZ28A
R755A

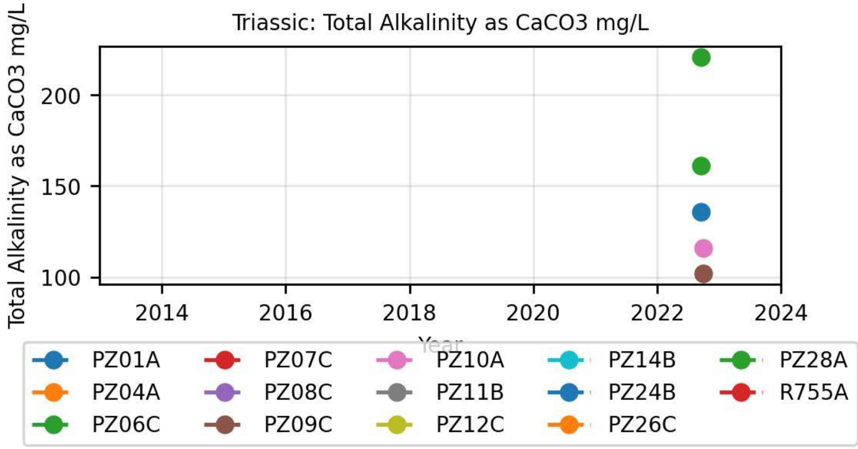

Triassic: Sodium - Dissolved mg/L
Sodium - Dissolved mg/L
100
50
2014
2016
2018
2020
2022
Year
PZ01A
PZ04A
PZ06C
PZ07C
PZ08C
PZ09C
PZ10A
PZ11B
PZ12C
PZ14B
PZ24B
PZ26C
PZ28A
R755A

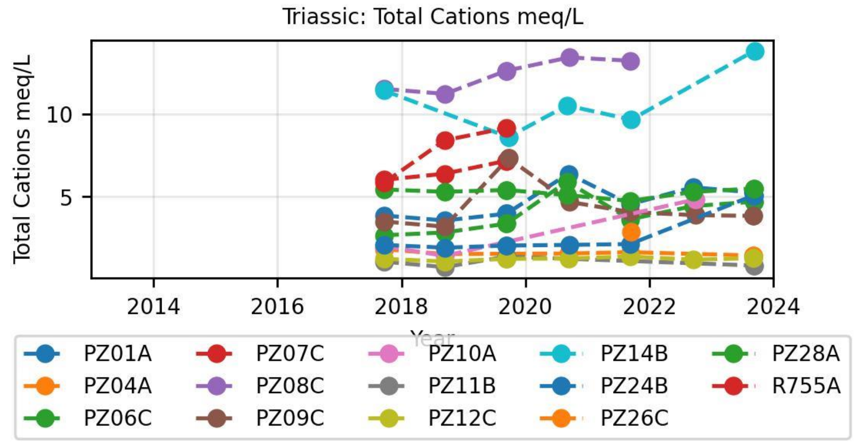

Triassic: Strontium - Dissolved mg/L
Strontium - Dissolved mg/L
0.4
0.2
0.0
2014
2016
2018
2020
2022
2024
Year
PZ01A
PZ04A
PZ06C
PZ07C
PZ08C
PZ09C
PZ10A
PZ11B
PZ12C
PZ14B
PZ24B
PZ26C
PZ28A
R755A

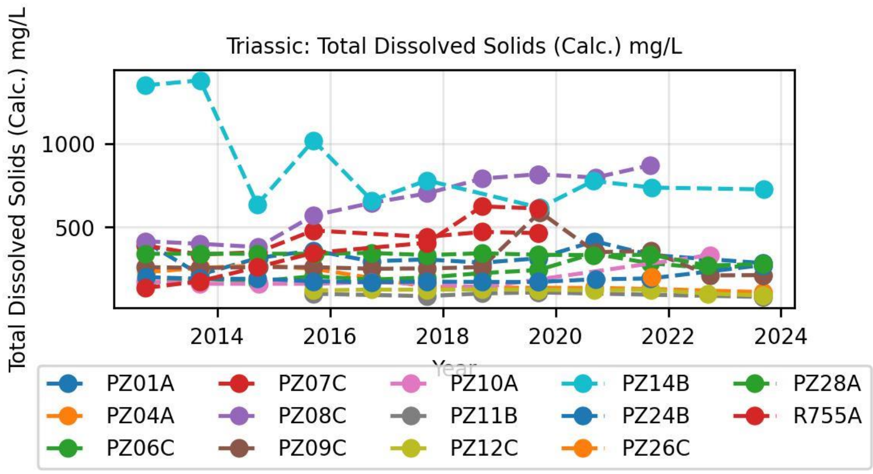

Triassic: Sulfate mg/L
Sulfate mg/L
60
40
20
0
2014
2016
2018
2020
2022
2024
Year
PZ01A
PZ04A
PZ06C
PZ07C
PZ08C
PZ09C
PZ10A
PZ11B
PZ12C
PZ14B
PZ24B
PZ26C
PZ28A
R755A

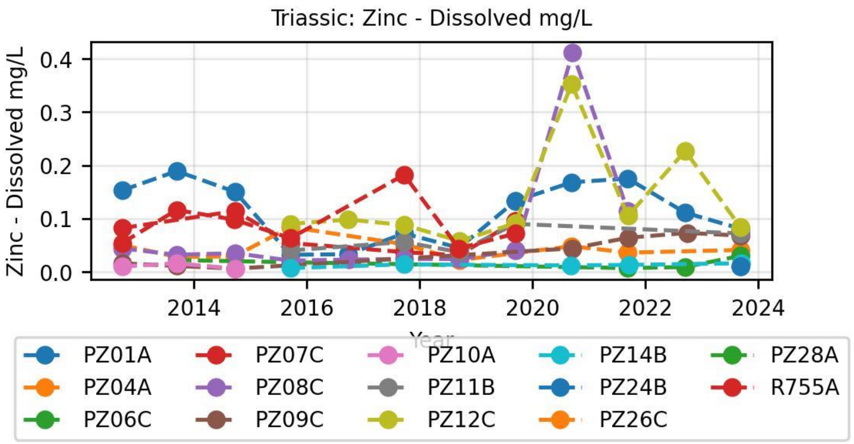

Triassic: Temperature °C
Temperature °C
22
20
18
2014
2016
2018
2020
2022
2024
Year
PZ01A
PZ04A
PZ06C
PZ07C
PZ08C
PZ09C
PZ10A
PZ11B
PZ12C
PZ14B
PZ24B
PZ26C
PZ28A
R755A

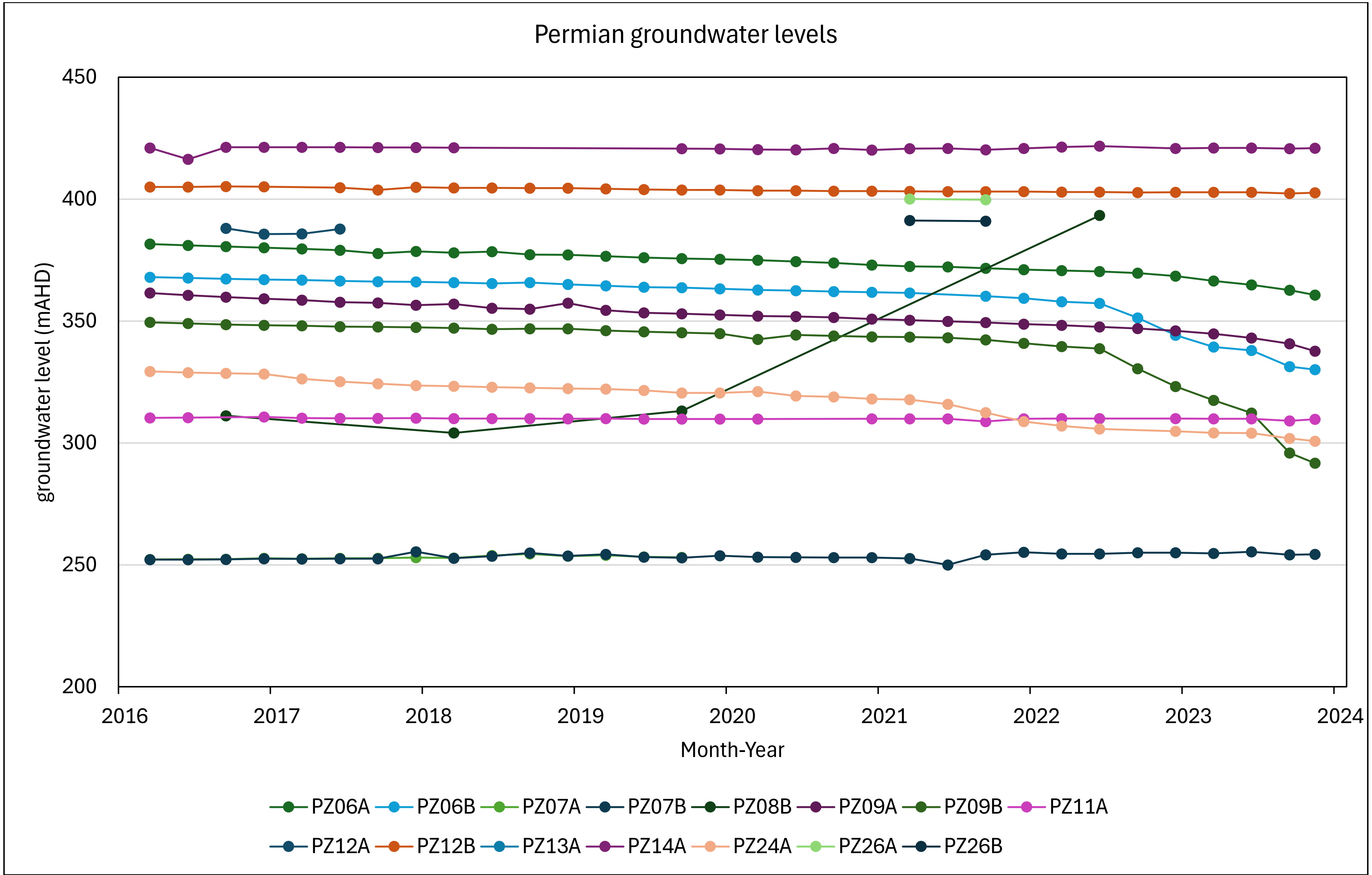

Triassic: Total Anions meq/L
Total Anions meq/L
15
10
5
2014
2016
2018
2020
2022
2024
Year
PZ01A
PZ04A
PZ06C
PZ07C
PZ08C
PZ09C
PZ10A
PZ11B
PZ12C
PZ14B
PZ24B
PZ26C
PZ28A
R755A

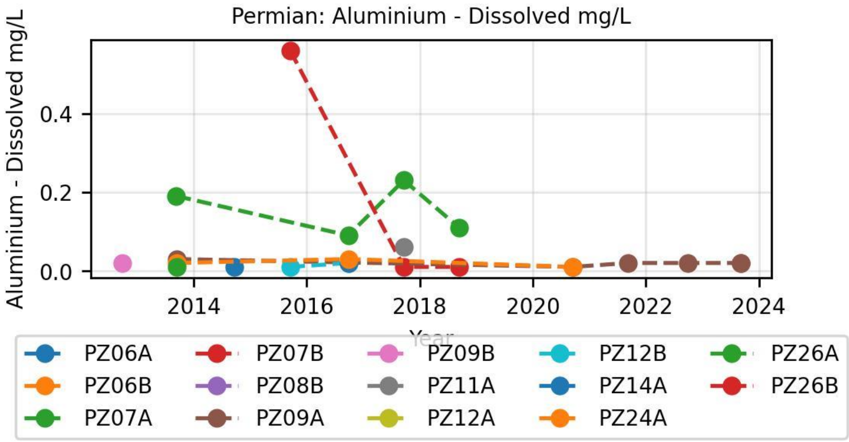

Triassic: Total Alkalinity as CaCO3 mg/L
Total Alkalinity as CaCO3 mg/L
200
150
100
2014
2016
2018
2020
2022
2024
Year
PZ01A
PZ04A
PZ06C
PZ07C
PZ08C
PZ09C
PZ10A
PZ11B
PZ12C
PZ14B
PZ24B
PZ26C
PZ28A
R755A

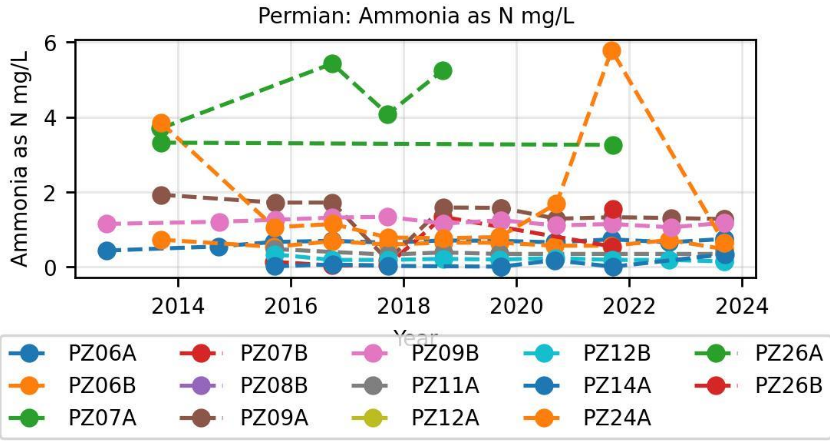

Triassic: Total Cations meq/L
Total Cations meq/L
10
5
2014
2016
2018
2020
2022
2024
Year
PZ01A
PZ04A
PZ06C
PZ07C
PZ08C
PZ09C
PZ10A
PZ11B
PZ12C
PZ14B
PZ24B
PZ26C
PZ28A
R755A

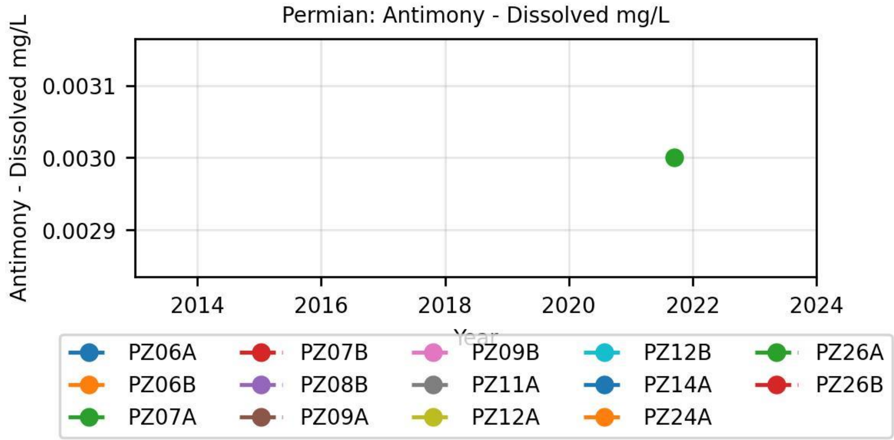

Triassic: Total Dissolved Solids (Calc.) mg/L
Total Dissolved Solids (Calc.) mg/L
1000
500
2014
2016
2018
2020
2022
2024
Year
PZ01A
PZ04A
PZ06C
PZ07C
PZ08C
PZ09C
PZ10A
PZ11B
PZ12C
PZ14B
PZ24B
PZ26C
PZ28A
R755A

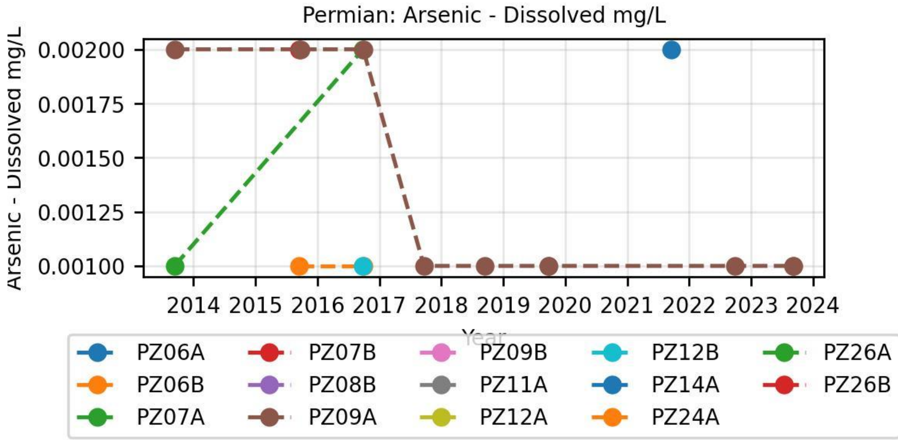

Triassic: Zinc - Dissolved mg/L
Zinc - Dissolved mg/L
0.4
0.3
0.2
0.1
0.0
2014
2016
2018
2020
2022
2024
Year
PZ01A
PZ04A
PZ06C
PZ07C
PZ08C
PZ09C
PZ10A
PZ11B
PZ12C
PZ14B
PZ24B
PZ26C
PZ28A
R755A

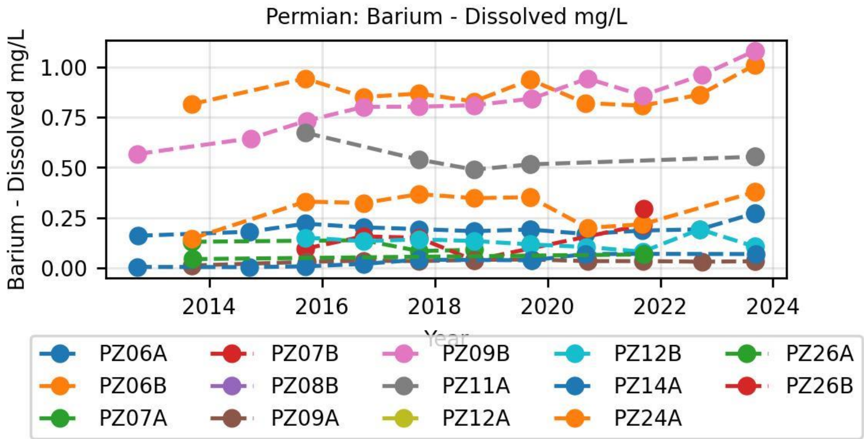

Permian groundwater levels
450
400
350
300
250
200
groundwater level (mAHD)
2016
2017
2018
2019
2020
2021
2022
2023
2024
Month-Year
PZ06A
PZ06B
PZ07A
PZ07B
PZ08B
PZ09A
PZ09B
PZ11A
PZ12A
PZ12B
PZ13A
PZ14A
PZ24A
PZ26A
PZ26B

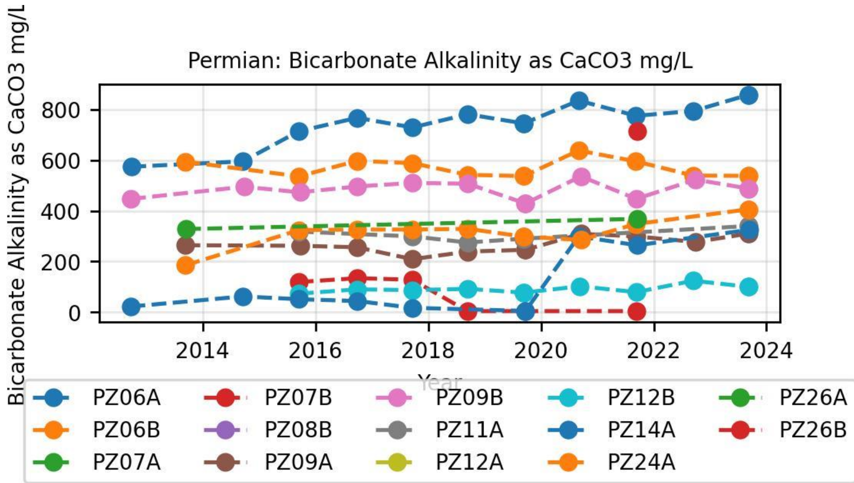

Permian: Aluminium - Dissolved mg/L
Aluminium - Dissolved mg/L
0.0
0.2
0.4
2014 2016 2018 2020 2022 2024
Year
PZ06A PZ07B PZ09B PZ12B PZ26A
PZ06B PZ08B PZ11A PZ14A PZ26B
PZ07A PZ09A PZ12A PZ24A

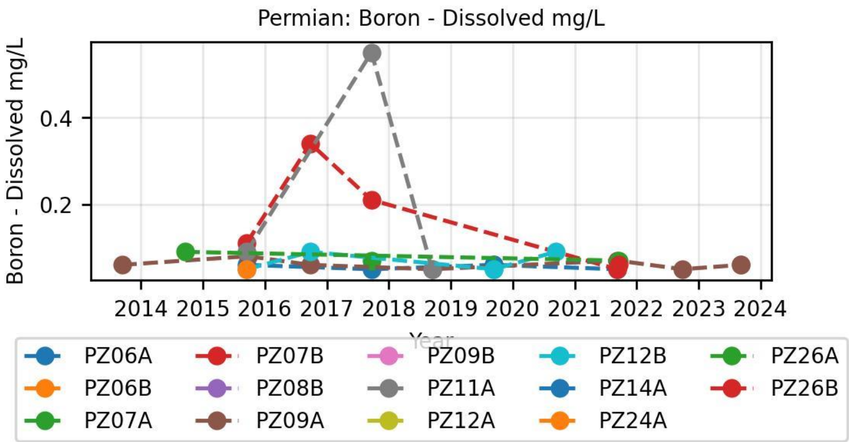

Permian: Ammonia as N mg/L
Ammonia as N mg/L
0
2
4
6
2014 2016 2018 2020 2022 2024
Year
PZ06A PZ07B PZ09B PZ12B PZ26A
PZ06B PZ08B PZ11A PZ14A PZ26B
PZ07A PZ09A PZ12A PZ24A

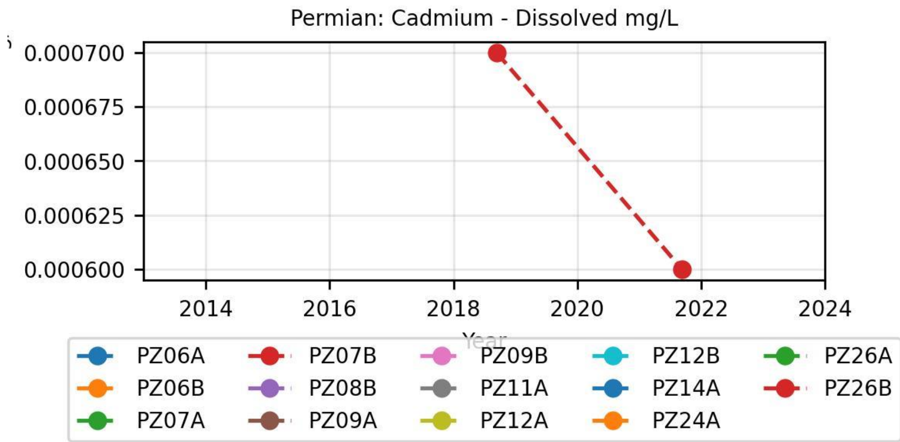

Permian: Antimony - Dissolved mg/L
Antimony - Dissolved mg/L
0.0029
0.0030
0.0031
2014 2016 2018 2020 2022 2024
Year
PZ06A PZ07B PZ09B PZ12B PZ26A
PZ06B PZ08B PZ11A PZ14A PZ26B
PZ07A PZ09A PZ12A PZ24A

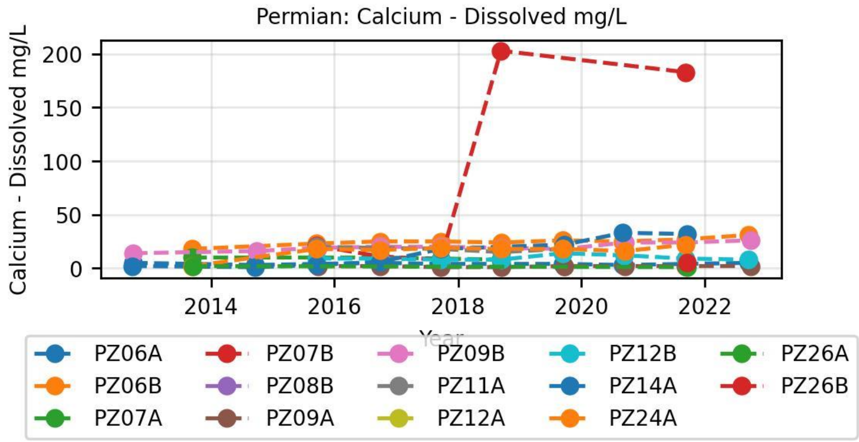

Permian: Arsenic - Dissolved mg/L
Arsenic - Dissolved mg/L
0.00100
0.00125
0.00150
0.00175
0.00200
2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024
Year
PZ06A PZ07B PZ09B PZ12B PZ26A
PZ06B PZ08B PZ11A PZ14A PZ26B
PZ07A PZ09A PZ12A PZ24A

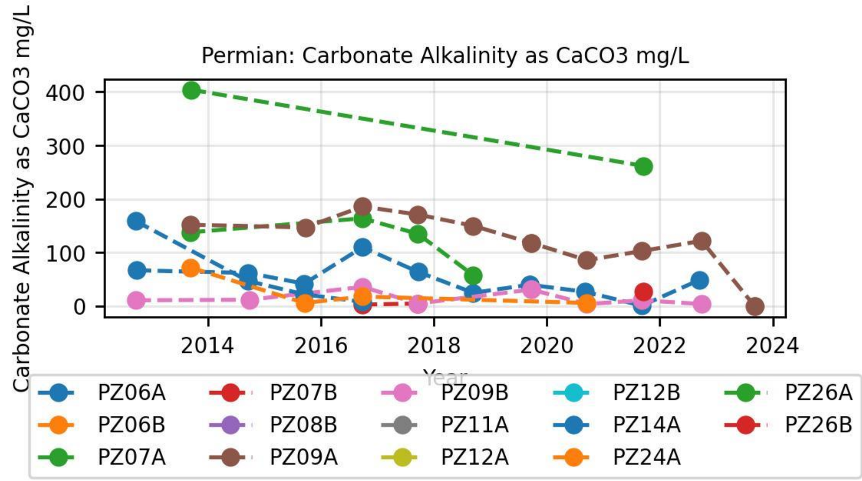

Permian: Barium - Dissolved mg/L
Barium - Dissolved mg/L
1.00
0.75
0.50
0.25
0.00
2014
2016
2018
2020
2022
2024
Year
PZ06A
PZ06B
PZ07A
PZ07B
PZ08B
PZ09A
PZ09B
PZ11A
PZ12A
PZ12B
PZ14A
PZ24A
PZ26A
PZ26B

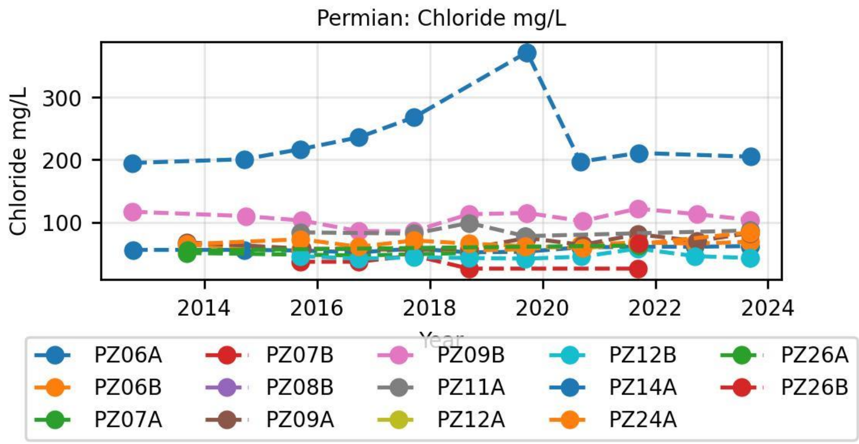

Permian: Bicarbonate Alkalinity as CaCO3 mg/L
Bicarbonate Alkalinity as CaCO3 mg/L
800
600
400
200
0
2014
2016
2018
2020
2022
2024
Year
PZ06A
PZ06B
PZ07A
PZ07B
PZ08B
PZ09A
PZ09B
PZ11A
PZ12A
PZ12B
PZ14A
PZ24A
PZ26A
PZ26B

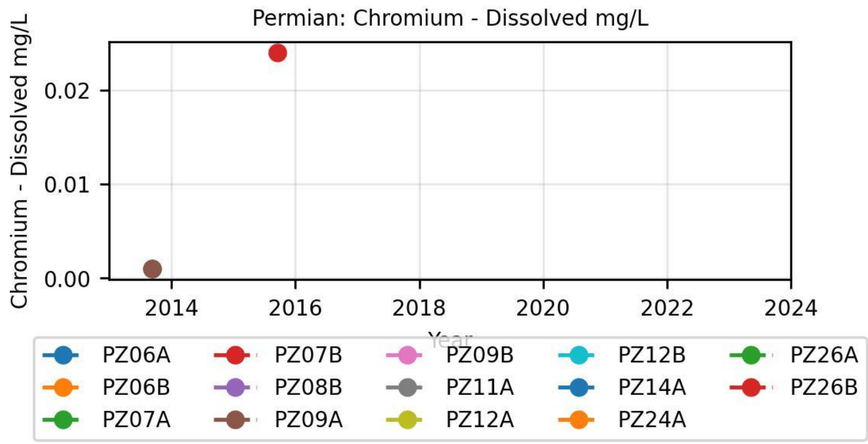

Permian: Boron - Dissolved mg/L
Boron - Dissolved mg/L
0.4
0.2
2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024
Year
PZ06A
PZ06B
PZ07A
PZ07B
PZ08B
PZ09A
PZ09B
PZ11A
PZ12A
PZ12B
PZ14A
PZ24A
PZ26A
PZ26B

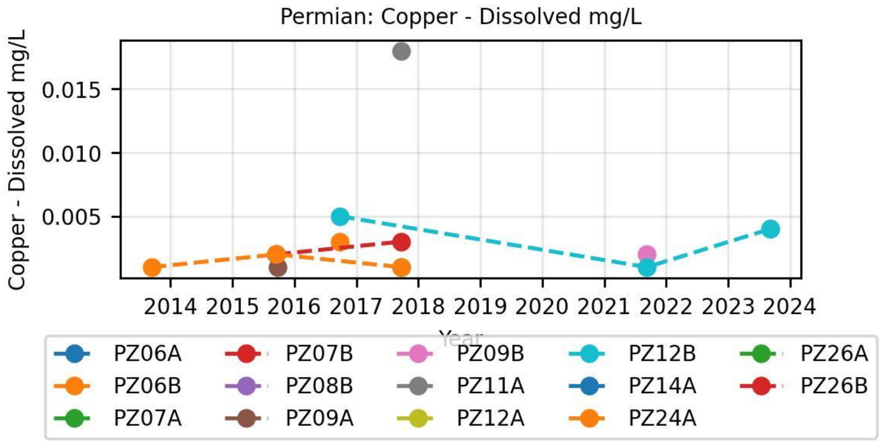

Permian: Cadmium - Dissolved mg/L
0.000700
0.000675
0.000650
0.000625
0.000600
2014
2016
2018
2020
2022
2024
Year
PZ06A
PZ06B
PZ07A
PZ07B
PZ08B
PZ09A
PZ09B
PZ11A
PZ12A
PZ12B
PZ14A
PZ24A
PZ26A
PZ26B

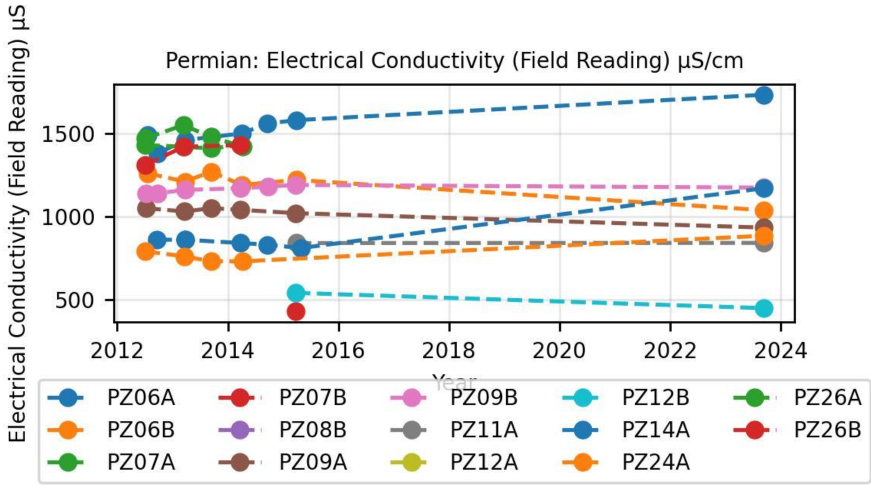

Permian: Calcium - Dissolved mg/L
Calcium - Dissolved mg/L
200
150
100
50
0
2014
2016
2018
2020
2022
Year
PZ06A
PZ07B
PZ09B
PZ12B
PZ26A
PZ06B
PZ08B
PZ11A
PZ14A
PZ26B
PZ07A
PZ09A
PZ12A
PZ24A

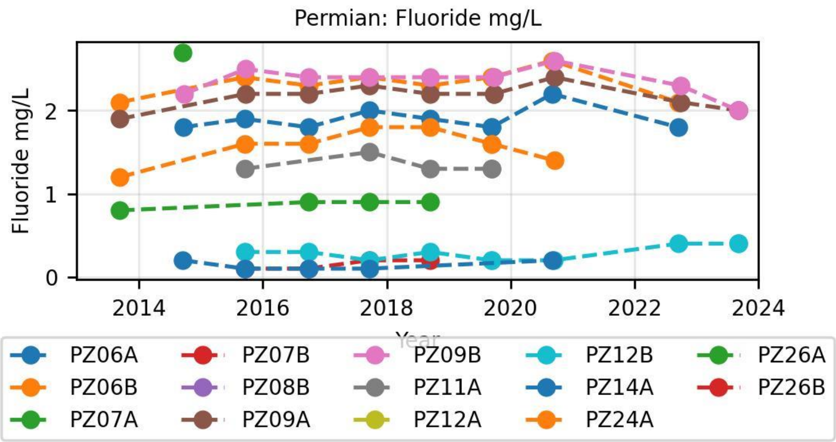

Permian: Carbonate Alkalinity as CaCO3 mg/L
Carbonate Alkalinity as CaCO3 mg/L
400
300
200
100
0
2014
2016
2018
2020
2022
2024
Year
PZ06A
PZ07B
PZ09B
PZ12B
PZ26A
PZ06B
PZ08B
PZ11A
PZ14A
PZ26B
PZ07A
PZ09A
PZ12A
PZ24A

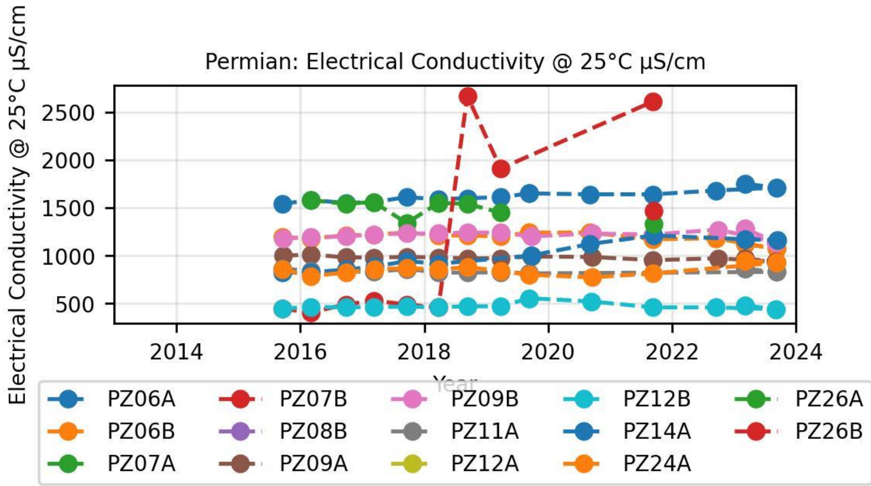

Permian: Chloride mg/L
Chloride mg/L
300
200
100
2014
2016
2018
2020
2022
2024
Year
PZ06A
PZ07B
PZ09B
PZ12B
PZ26A
PZ06B
PZ08B
PZ11A
PZ14A
PZ26B
PZ07A
PZ09A
PZ12A
PZ24A

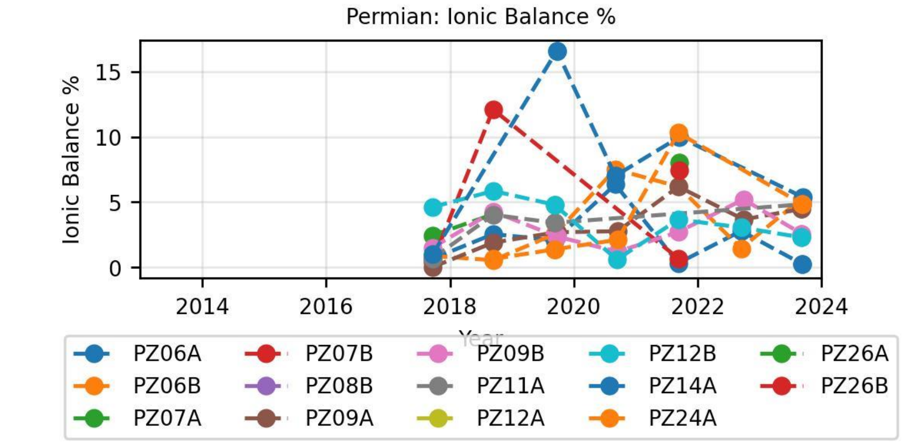

Permian: Chromium - Dissolved mg/L
Chromium - Dissolved mg/L
0.02
0.01
0.00
2014
2016
2018
2020
2022
2024
Year
PZ06A
PZ07B
PZ09B
PZ12B
PZ26A
PZ06B
PZ08B
PZ11A
PZ14A
PZ26B
PZ07A
PZ09A
PZ12A
PZ24A

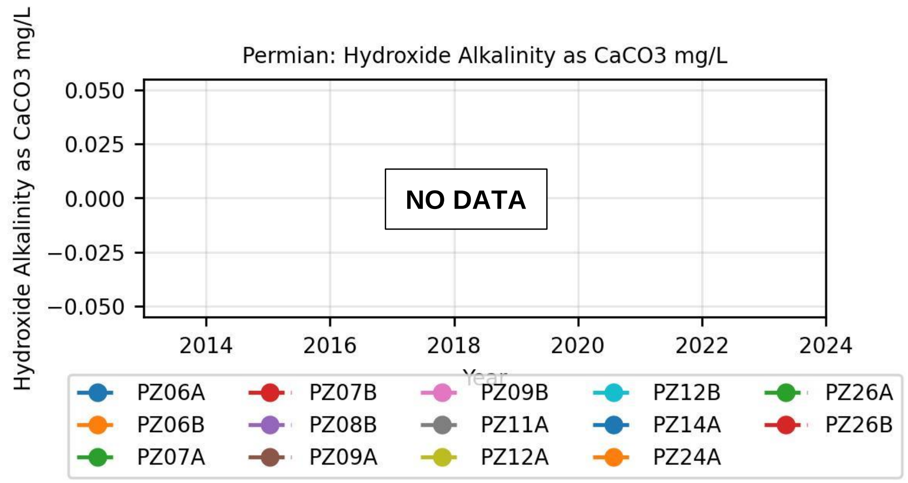

Permian: Copper - Dissolved mg/L
Copper - Dissolved mg/L
0.015
0.010
0.005
2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024
Year
PZ06A PZ07B PZ09B PZ12B PZ26A
PZ06B PZ08B PZ11A PZ14A PZ26B
PZ07A PZ09A PZ12A PZ24A

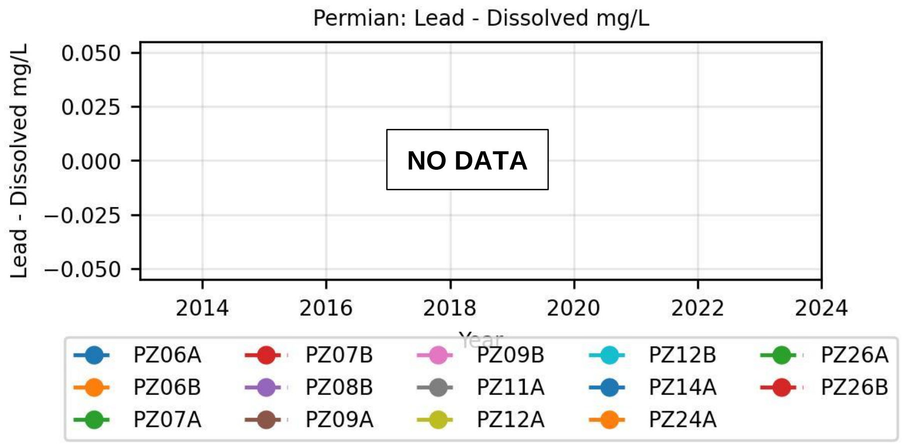

Permian: Electrical Conductivity (Field Reading) µS/cm
Electrical Conductivity (Field Reading) µS
1500
1000
500
2012 2014 2016 2018 2020 2022 2024
Year
PZ06A PZ07B PZ09B PZ12B PZ26A
PZ06B PZ08B PZ11A PZ14A PZ26B
PZ07A PZ09A PZ12A PZ24A

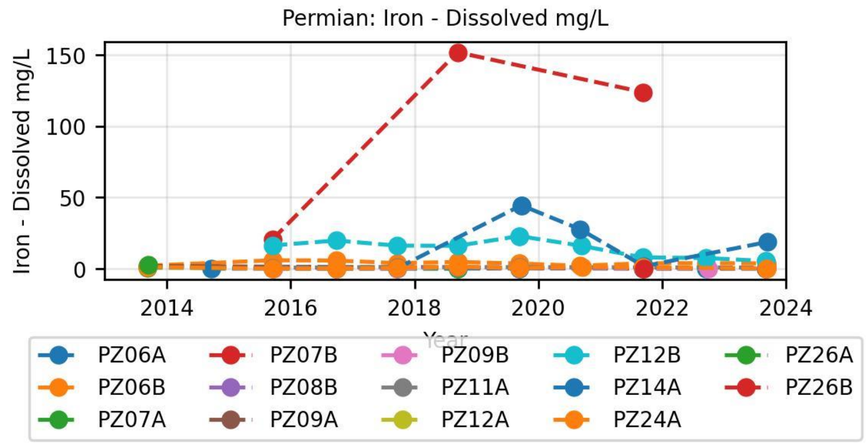

Permian: Fluoride mg/L
Fluoride mg/L
2
1
0
2014 2016 2018 2020 2022 2024
Year
PZ06A PZ07B PZ09B PZ12B PZ26A
PZ06B PZ08B PZ11A PZ14A PZ26B
PZ07A PZ09A PZ12A PZ24A

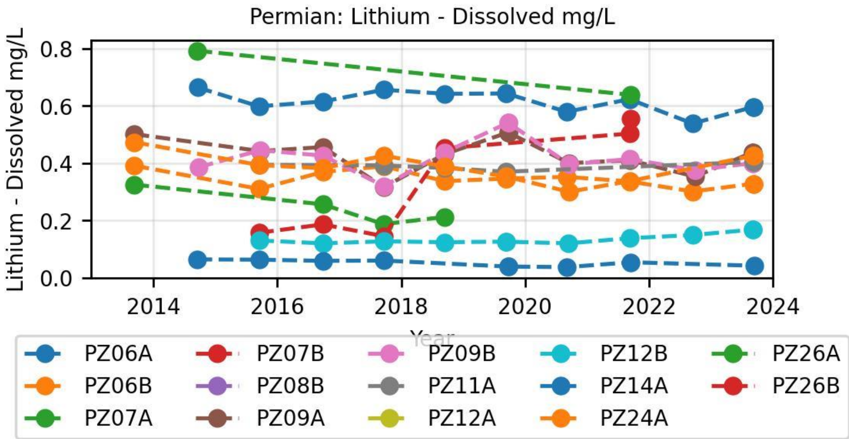

Permian: Electrical Conductivity @ 25°C µS/cm
Electrical Conductivity @ 25°C µS/cm
2500
2000
1500
1000
500
2014 2016 2018 2020 2022 2024
Year
PZ06A PZ07B PZ09B PZ12B PZ26A
PZ06B PZ08B PZ11A PZ14A PZ26B
PZ07A PZ09A PZ12A PZ24A

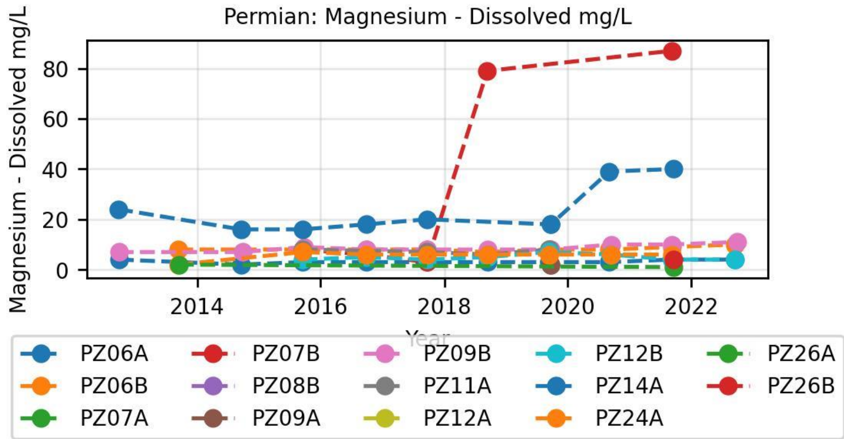

Permian: Ionic Balance %
Ionic Balance %
Year
PZ06A
PZ06B
PZ07A
PZ07B
PZ08B
PZ09A
PZ09B
PZ11A
PZ12A
PZ12B
PZ14A
PZ24A
PZ26A
PZ26B

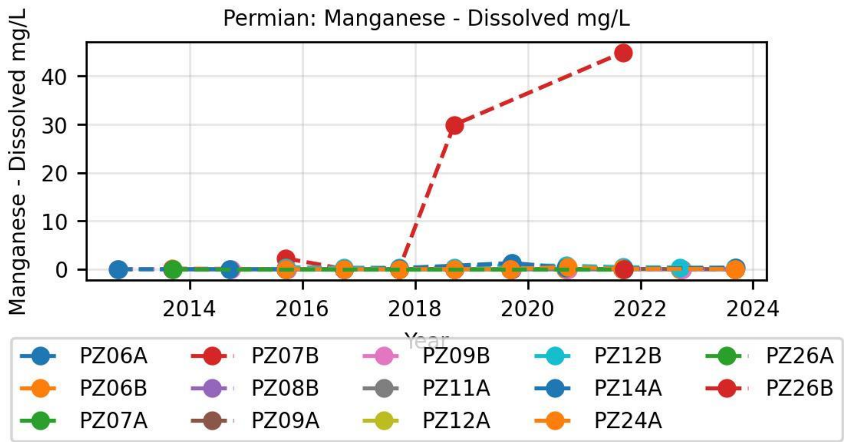

Permian: Hydroxide Alkalinity as CaCO3 mg/L
Hydroxide Alkalinity as CaCO3 mg/L
NO DATA
Year
PZ06A
PZ06B
PZ07A
PZ07B
PZ08B
PZ09A
PZ09B
PZ11A
PZ12A
PZ12B
PZ14A
PZ24A
PZ26A
PZ26B

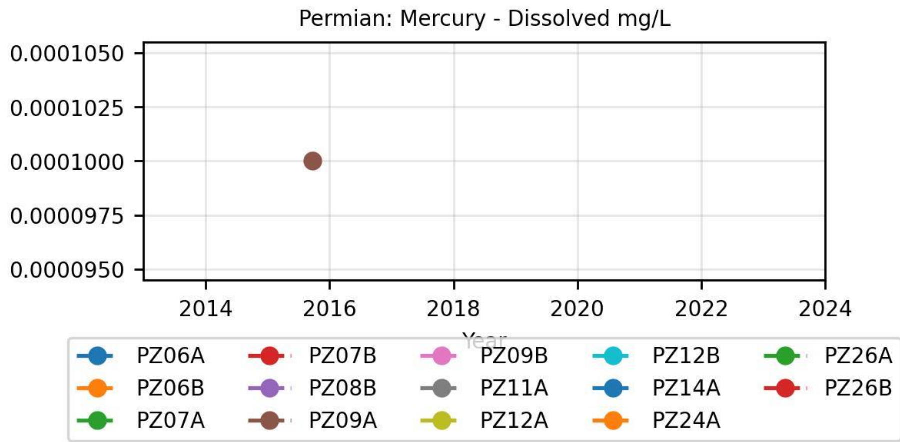

Permian: Lead - Dissolved mg/L
Lead - Dissolved mg/L
NO DATA
Year
PZ06A
PZ06B
PZ07A
PZ07B
PZ08B
PZ09A
PZ09B
PZ11A
PZ12A
PZ12B
PZ14A
PZ24A
PZ26A
PZ26B

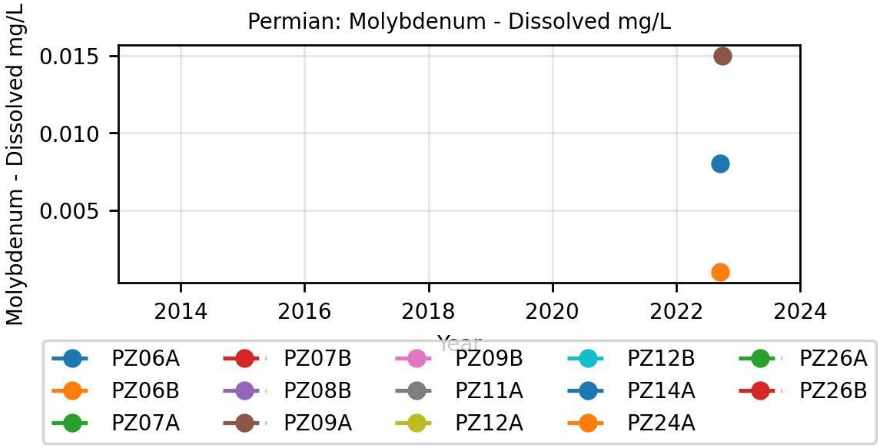

Permian: Iron - Dissolved mg/L
Iron - Dissolved mg/L
Year
PZ06A
PZ06B
PZ07A
PZ07B
PZ08B
PZ09A
PZ09B
PZ11A
PZ12A
PZ12B
PZ14A
PZ24A
PZ26A
PZ26B

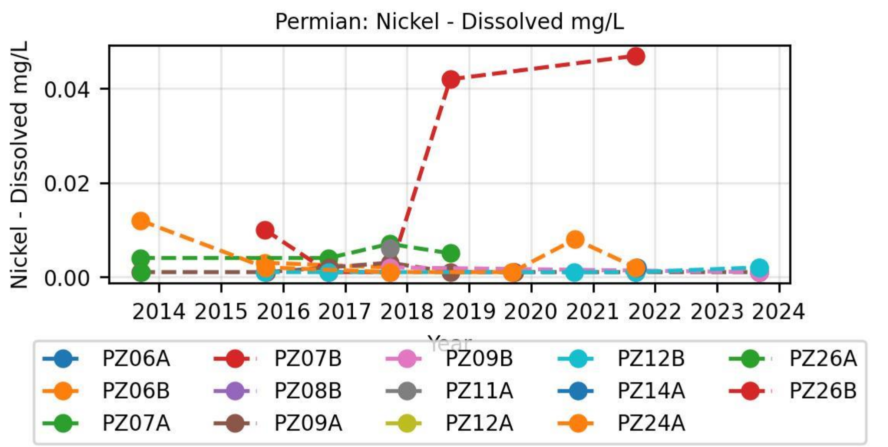

Permian: Lithium - Dissolved mg/L
Lithium - Dissolved mg/L
0.0
0.2
0.4
0.6
0.8
2014
2016
2018
2020
2022
2024
Year
PZ06A
PZ06B
PZ07A
PZ07B
PZ08B
PZ09A
PZ09B
PZ11A
PZ12A
PZ12B
PZ14A
PZ24A
PZ26A
PZ26B

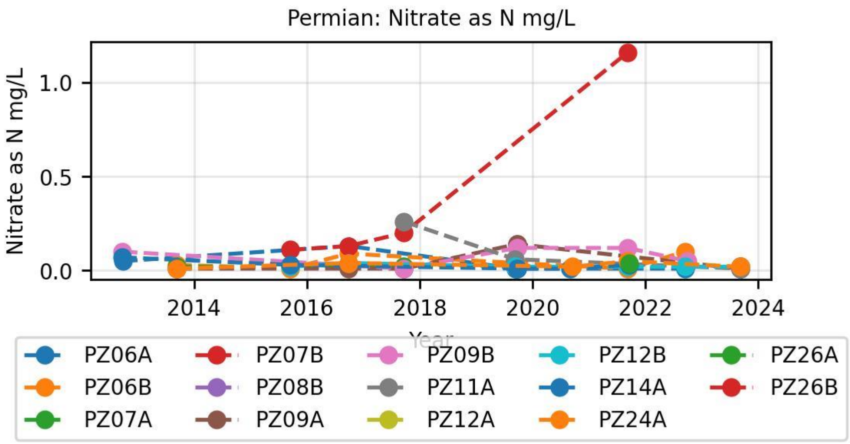

Permian: Magnesium - Dissolved mg/L
Magnesium - Dissolved mg/L
0
20
40
60
80
2014
2016
2018
2020
2022
Year
PZ06A
PZ06B
PZ07A
PZ07B
PZ08B
PZ09A
PZ09B
PZ11A
PZ12A
PZ12B
PZ14A
PZ24A
PZ26A
PZ26B

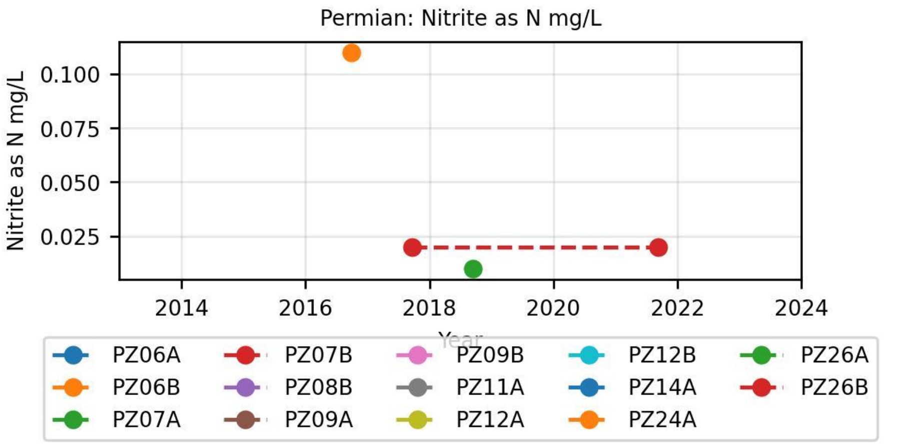

Permian: Manganese - Dissolved mg/L
Manganese - Dissolved mg/L
0
10
20
30
40
2014
2016
2018
2020
2022
2024
Year
PZ06A
PZ06B
PZ07A
PZ07B
PZ08B
PZ09A
PZ09B
PZ11A
PZ12A
PZ12B
PZ14A
PZ24A
PZ26A
PZ26B

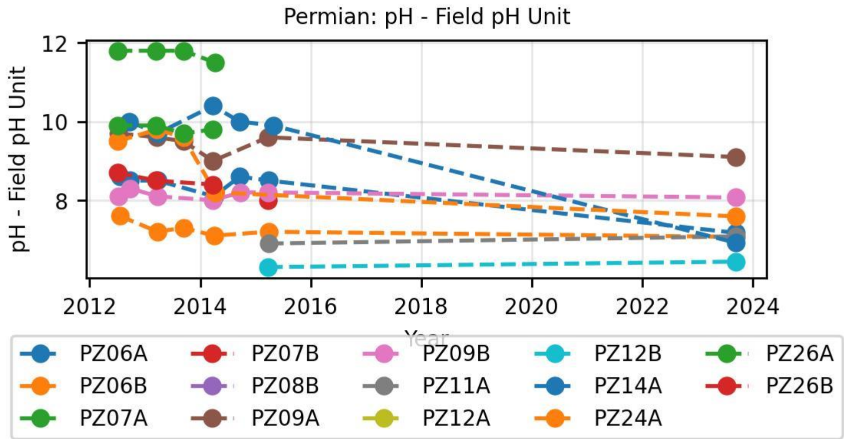

Permian: Mercury - Dissolved mg/L
0.0000950
0.0000975
0.0001000
0.0001025
0.0001050
2014
2016
2018
2020
2022
2024
Year
PZ06A
PZ06B
PZ07A
PZ07B
PZ08B
PZ09A
PZ09B
PZ11A
PZ12A
PZ12B
PZ14A
PZ24A
PZ26A
PZ26B

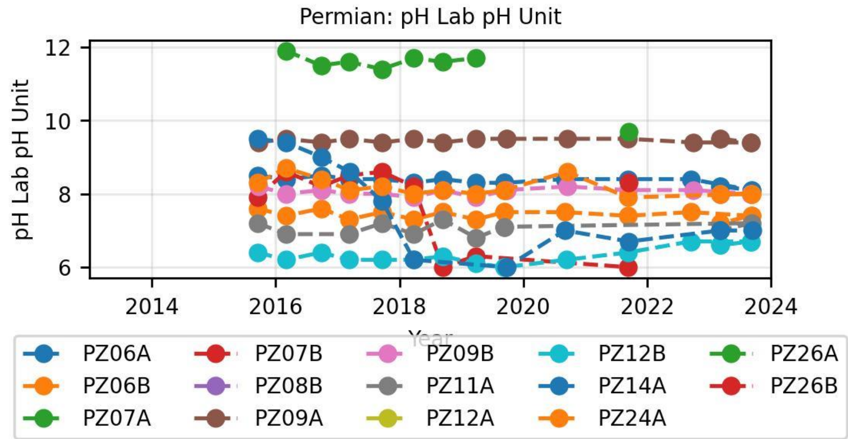

Permian: Molybdenum - Dissolved mg/L
Molybdenum - Dissolved mg/L
0.015
0.010
0.005
2014
2016
2018
2020
2022
2024
Year
PZ06A
PZ06B
PZ07A
PZ07B
PZ08B
PZ09A
PZ09B
PZ11A
PZ12A
PZ12B
PZ14A
PZ24A
PZ26A
PZ26B

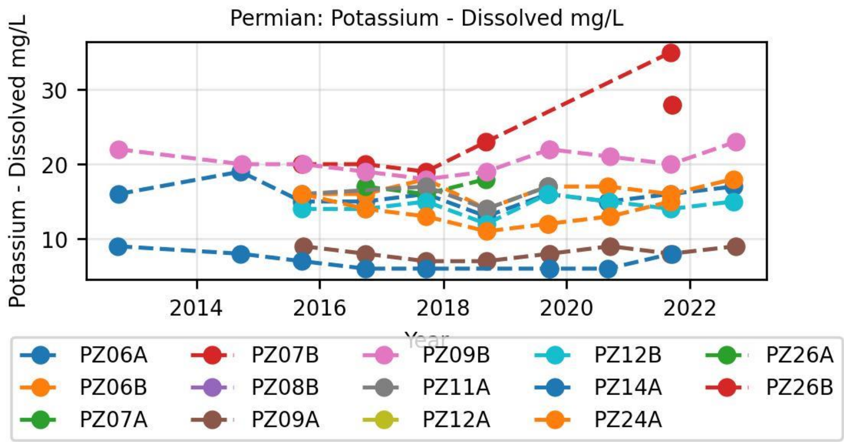

Permian: Nickel - Dissolved mg/L
Nickel - Dissolved mg/L
0.04
0.02
0.00
2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024
Year
PZ06A
PZ06B
PZ07A
PZ07B
PZ08B
PZ09A
PZ09B
PZ11A
PZ12A
PZ12B
PZ14A
PZ24A
PZ26A
PZ26B

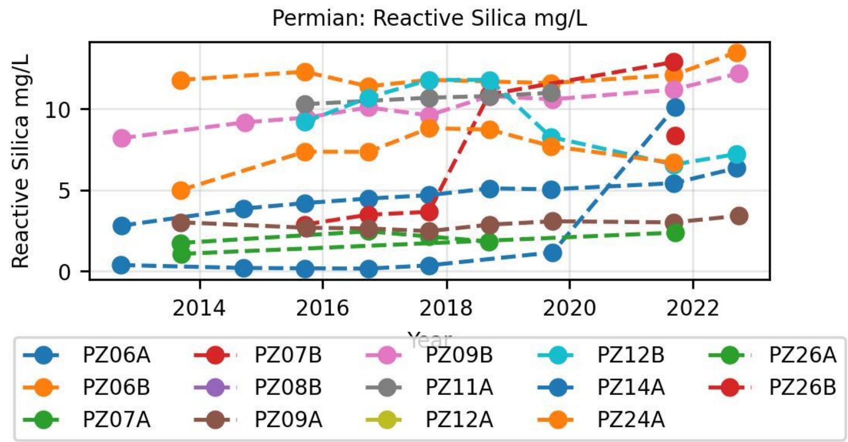

Permian: Nitrate as N mg/L
Nitrate as N mg/L
1.0
0.5
0.0
2014
2016
2018
2020
2022
2024
Year
PZ06A
PZ06B
PZ07A
PZ07B
PZ08B
PZ09A
PZ09B
PZ11A
PZ12A
PZ12B
PZ14A
PZ24A
PZ26A
PZ26B

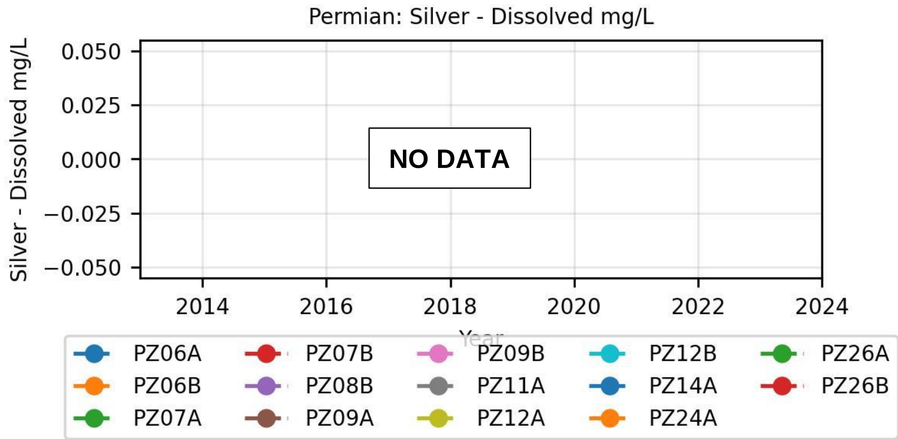

Permian: Nitrite as N mg/L
Nitrite as N mg/L
0.100
0.075
0.050
0.025
2014
2016
2018
2020
2022
2024
Year
PZ06A
PZ06B
PZ07A
PZ07B
PZ08B
PZ09A
PZ09B
PZ11A
PZ12A
PZ12B
PZ14A
PZ24A
PZ26A
PZ26B

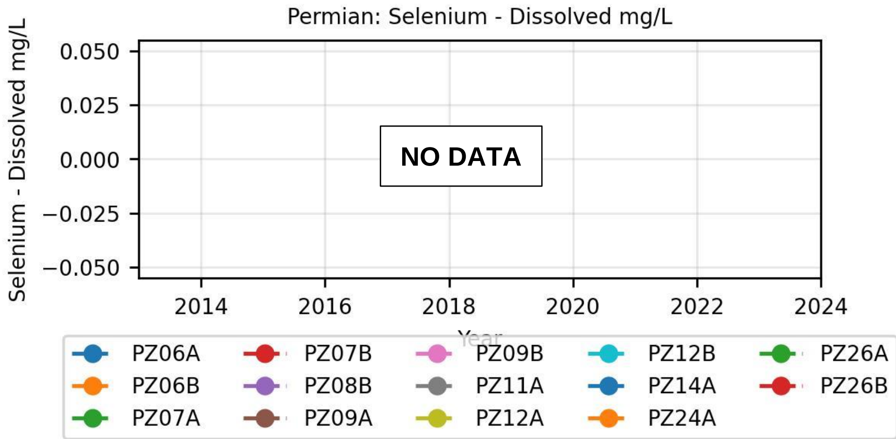

Permian: pH - Field pH Unit
pH - Field pH Unit
Year
PZ06A PZ07B PZ09B PZ12B PZ26A
PZ06B PZ08B PZ11A PZ14A PZ26B
PZ07A PZ09A PZ12A PZ24A

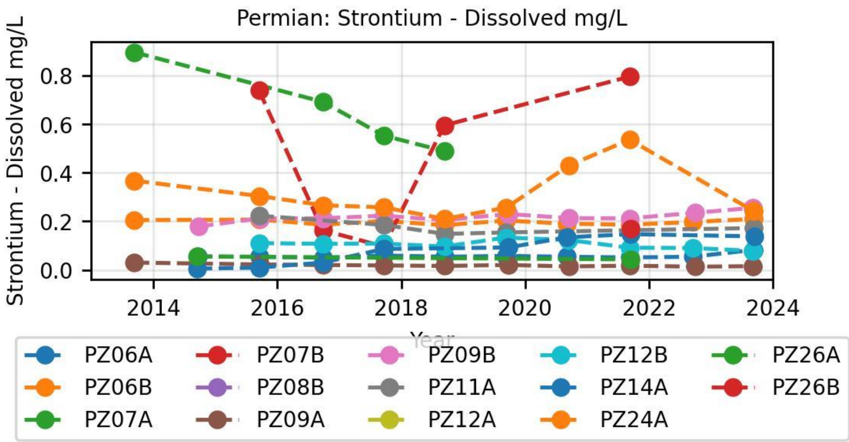

Permian: pH Lab pH Unit
pH Lab pH Unit
Year
PZ06A PZ07B PZ09B PZ12B PZ26A
PZ06B PZ08B PZ11A PZ14A PZ26B
PZ07A PZ09A PZ12A PZ24A

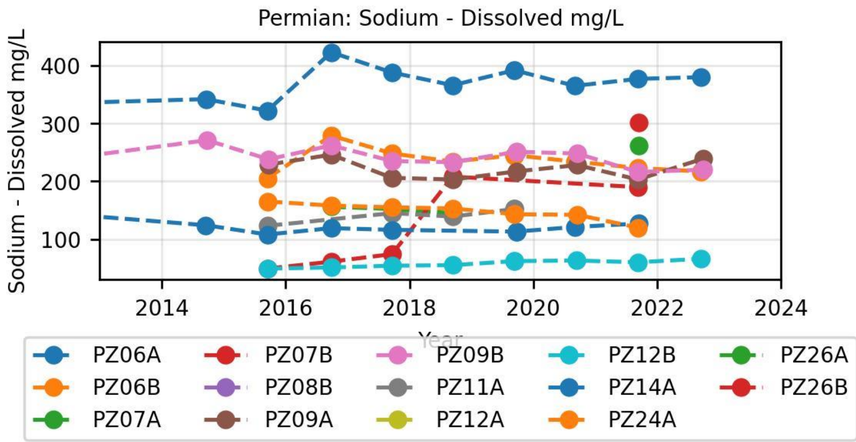

Permian: Potassium - Dissolved mg/L
Potassium - Dissolved mg/L
Year
PZ06A PZ07B PZ09B PZ12B PZ26A
PZ06B PZ08B PZ11A PZ14A PZ26B
PZ07A PZ09A PZ12A PZ24A

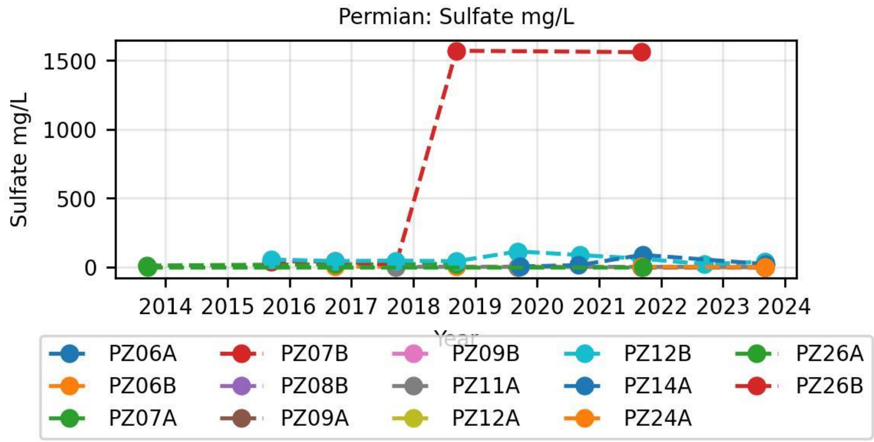

Permian: Reactive Silica mg/L
Reactive Silica mg/L
Year
PZ06A PZ07B PZ09B PZ12B PZ26A
PZ06B PZ08B PZ11A PZ14A PZ26B
PZ07A PZ09A PZ12A PZ24A

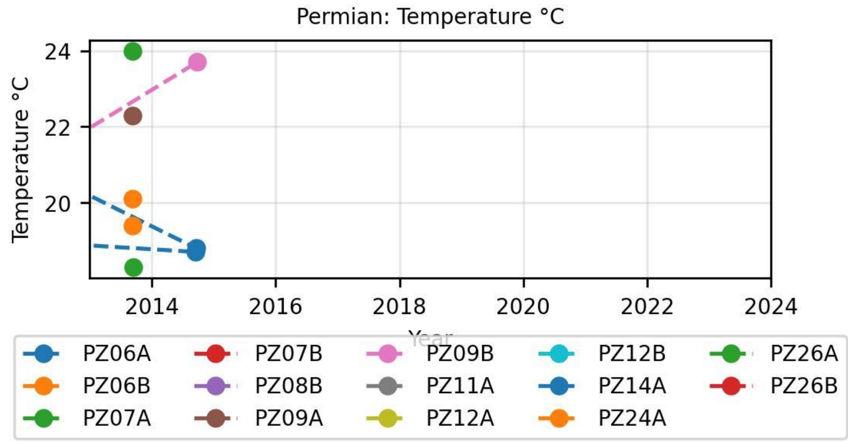

Permian: Silver - Dissolved mg/L
Silver - Dissolved mg/L
0.050
0.025
0.000
−0.025
−0.050
2014
2016
2018
2020
2022
2024
Year
NO DATA
PZ06A
PZ06B
PZ07A
PZ07B
PZ08B
PZ09A
PZ09B
PZ11A
PZ12A
PZ12B
PZ14A
PZ24A
PZ26A
PZ26B

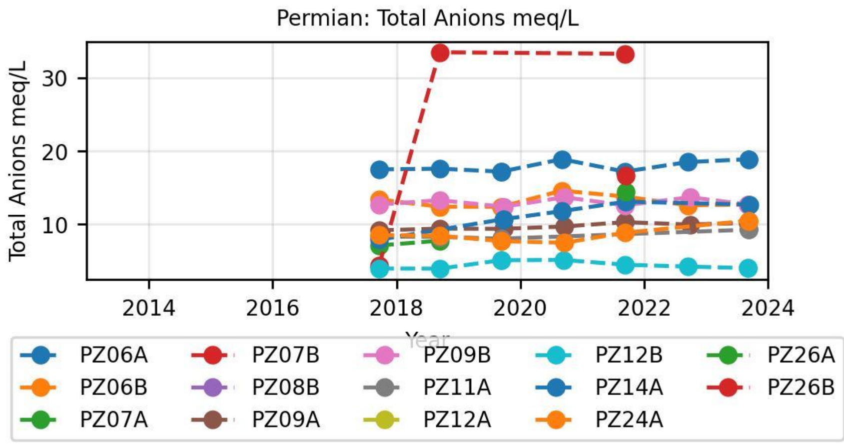

Permian: Selenium - Dissolved mg/L
Selenium - Dissolved mg/L
0.050
0.025
0.000
−0.025
−0.050
2014
2016
2018
2020
2022
2024
Year
NO DATA
PZ06A
PZ06B
PZ07A
PZ07B
PZ08B
PZ09A
PZ09B
PZ11A
PZ12A
PZ12B
PZ14A
PZ24A
PZ26A
PZ26B

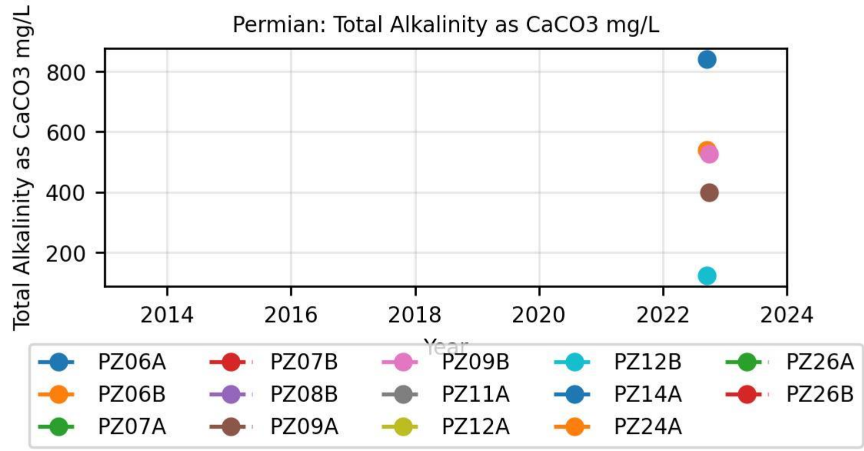

Permian: Strontium - Dissolved mg/L
Strontium - Dissolved mg/L
0.8
0.6
0.4
0.2
0.0
2014
2016
2018
2020
2022
2024
Year
PZ06A
PZ06B
PZ07A
PZ07B
PZ08B
PZ09A
PZ09B
PZ11A
PZ12A
PZ12B
PZ14A
PZ24A
PZ26A
PZ26B

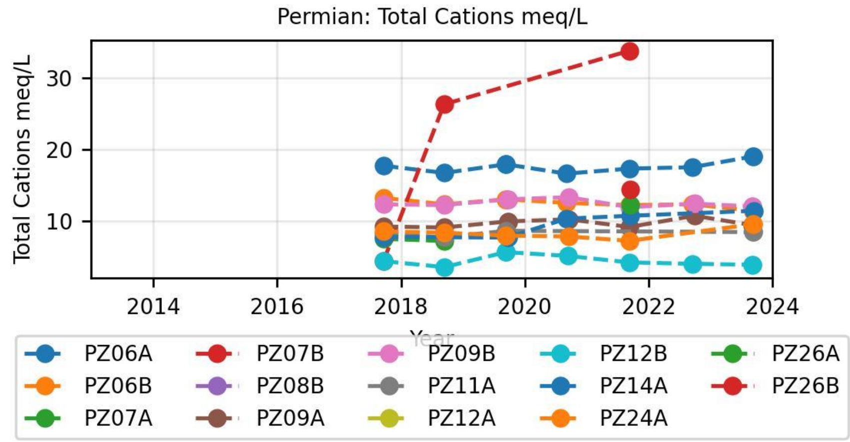

Permian: Sodium - Dissolved mg/L
Sodium - Dissolved mg/L
400
300
200
100
2014
2016
2018
2020
2022
2024
Year
PZ06A
PZ06B
PZ07A
PZ07B
PZ08B
PZ09A
PZ09B
PZ11A
PZ12A
PZ12B
PZ14A
PZ24A
PZ26A
PZ26B

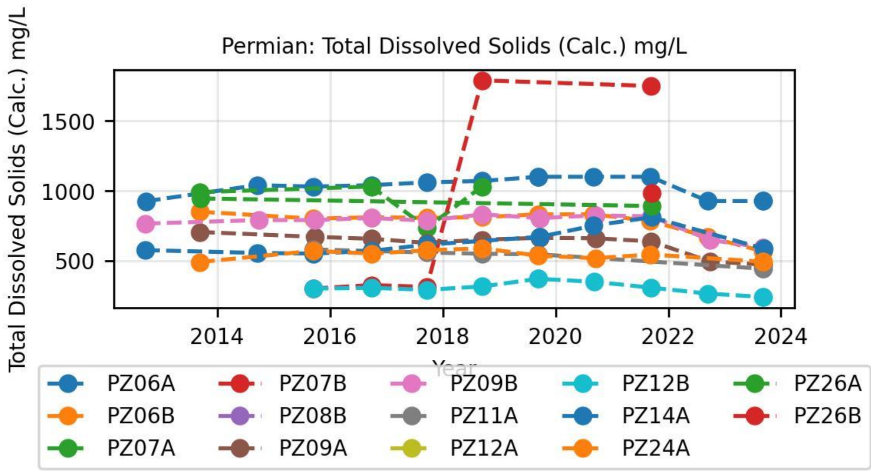

Permian: Sulfate mg/L
Sulfate mg/L
1500
1000
500
0
2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024
Year
PZ06A
PZ06B
PZ07A
PZ07B
PZ08B
PZ09A
PZ09B
PZ11A
PZ12A
PZ12B
PZ14A
PZ24A
PZ26A
PZ26B

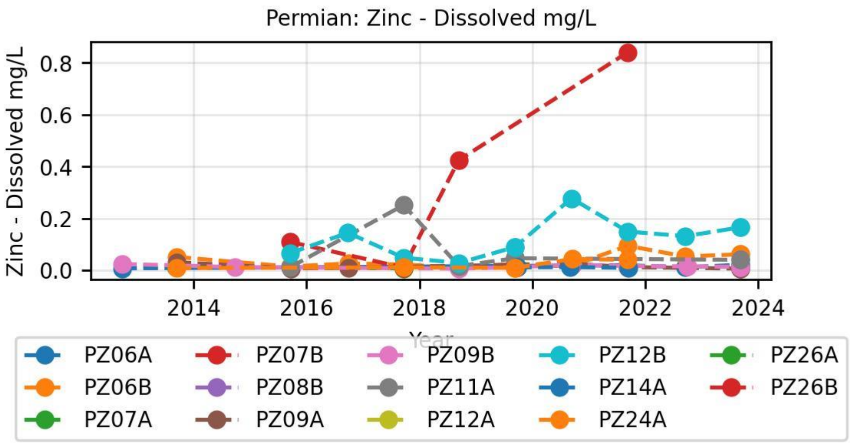

Permian: Temperature °C
Temperature °C
24
22
20
2014
2016
2018
2020
2022
2024
Year
PZ06A
PZ06B
PZ07A
PZ07B
PZ08B
PZ09A
PZ09B
PZ11A
PZ12A
PZ12B
PZ14A
PZ24A
PZ26A
PZ26B


Permian: Total Anions meq/L
Total Anions meq/L
30
20
10
2014
2016
2018
2020
2022
2024
Year
PZ06A
PZ06B
PZ07A
PZ07B
PZ08B
PZ09A
PZ09B
PZ11A
PZ12A
PZ12B
PZ14A
PZ24A
PZ26A
PZ26B


Permian: Total Alkalinity as CaCO3 mg/L
Total Alkalinity as CaCO3 mg/L
800
600
400
200
2014
2016
2018
2020
2022
2024
Year
PZ06A
PZ06B
PZ07A
PZ07B
PZ08B
PZ09A
PZ09B
PZ11A
PZ12A
PZ12B
PZ14A
PZ24A
PZ26A
PZ26B

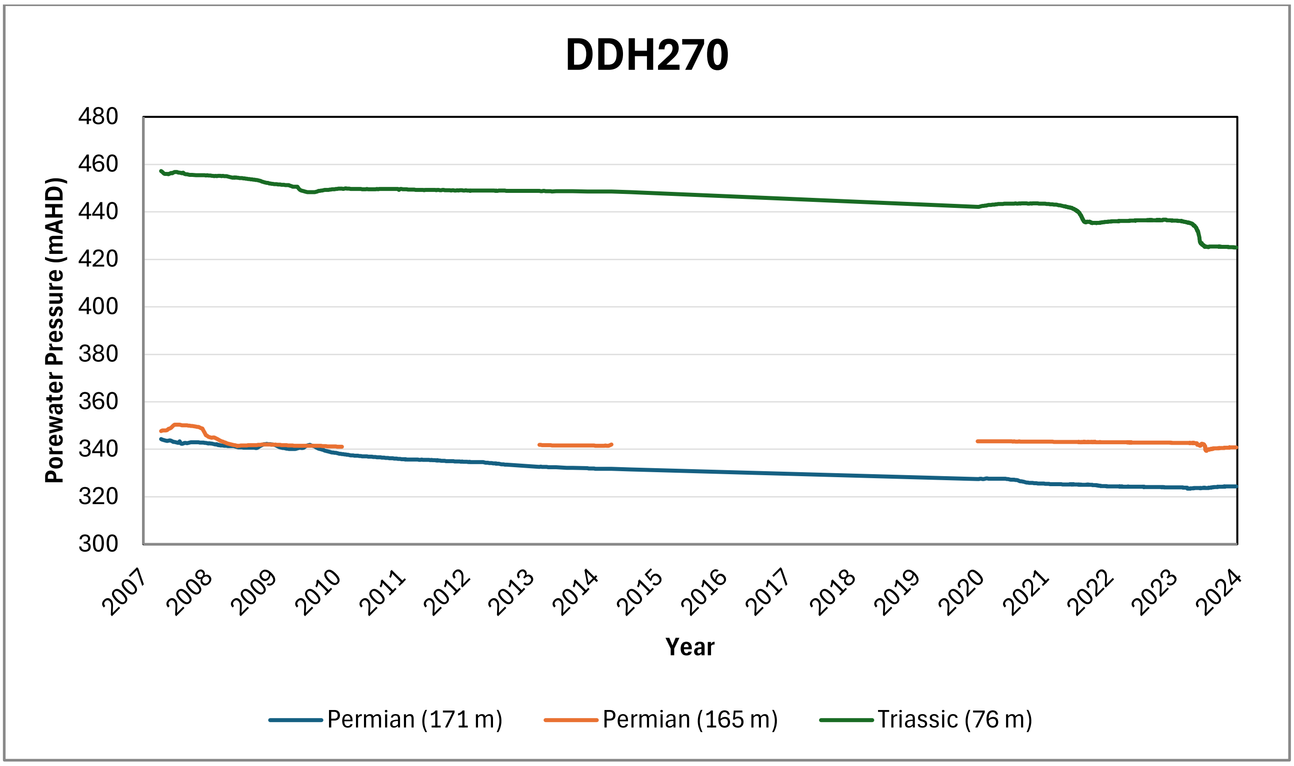

Permian: Total Cations meq/L
Total Cations meq/L
30
20
10
2014
2016
2018
2020
2022
2024
Year
PZ06A
PZ06B
PZ07A
PZ07B
PZ08B
PZ09A
PZ09B
PZ11A
PZ12A
PZ12B
PZ14A
PZ24A
PZ26A
PZ26B


Permian: Total Dissolved Solids (Calc.) mg/L
Total Dissolved Solids (Calc.) mg/L
1500
1000
500
2014
2016
2018
2020
2022
2024
Year
PZ06A
PZ06B
PZ07A
PZ07B
PZ08B
PZ09A
PZ09B
PZ11A
PZ12A
PZ12B
PZ14A
PZ24A
PZ26A
PZ26B

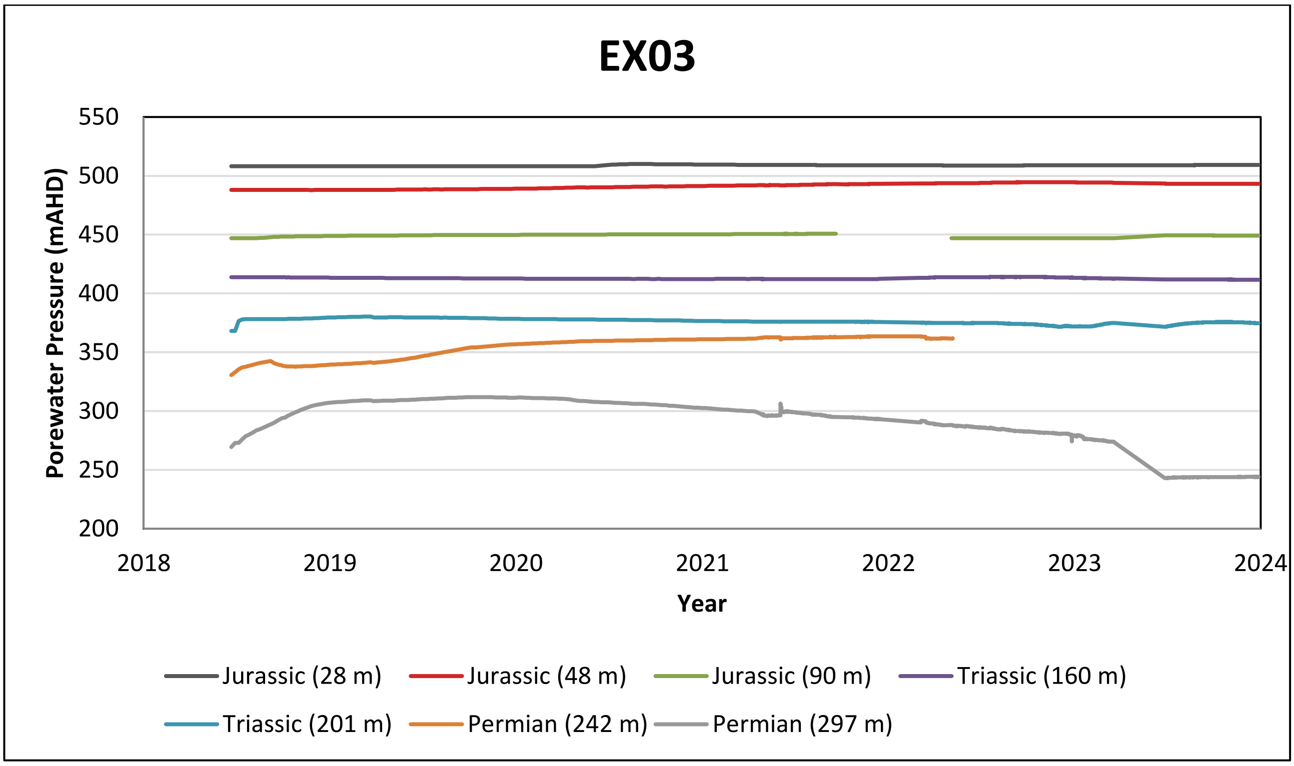

Permian: Zinc - Dissolved mg/L
Zinc - Dissolved mg/L
0.8
0.6
0.4
0.2
0.0
2014
2016
2018
2020
2022
2024
Year
PZ06A
PZ06B
PZ07A
PZ07B
PZ08B
PZ09A
PZ09B
PZ11A
PZ12A
PZ12B
PZ14A
PZ24A
PZ26A
PZ26B

Appendix B

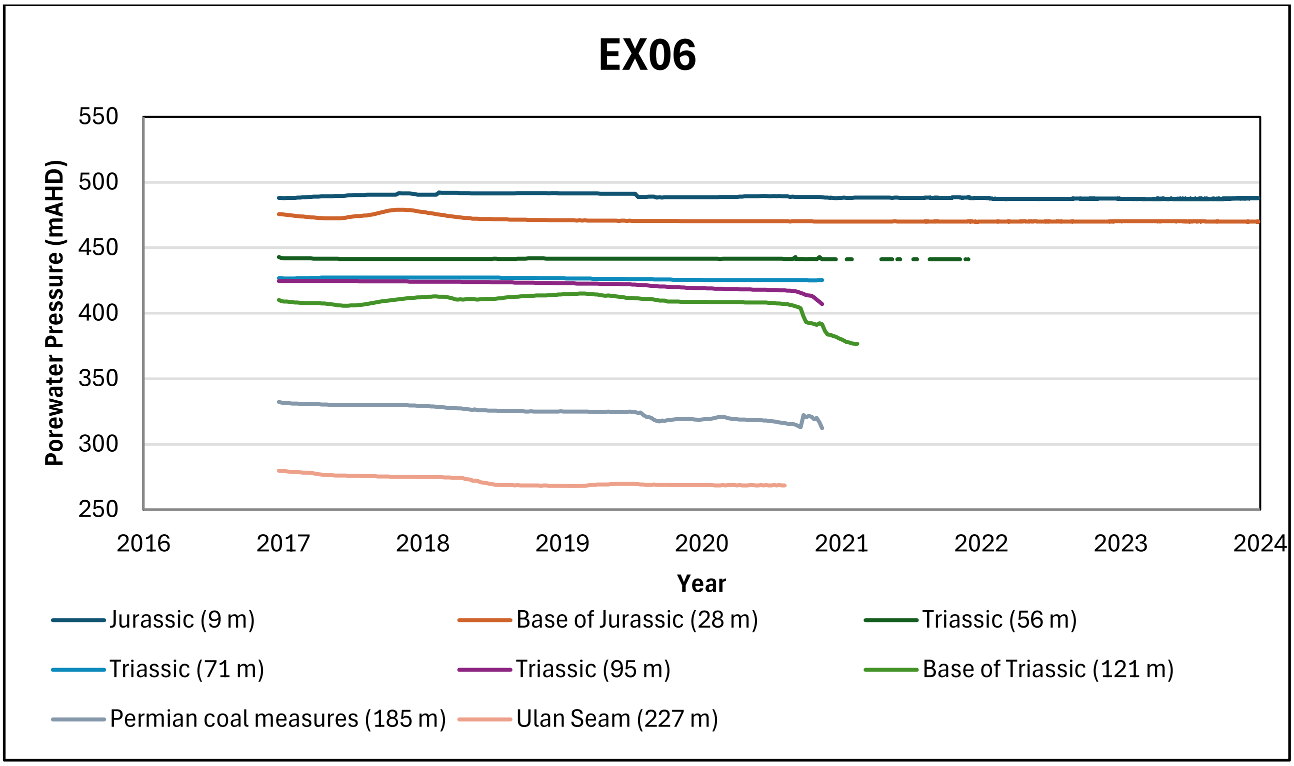
North Monitoring VWP hydrographs

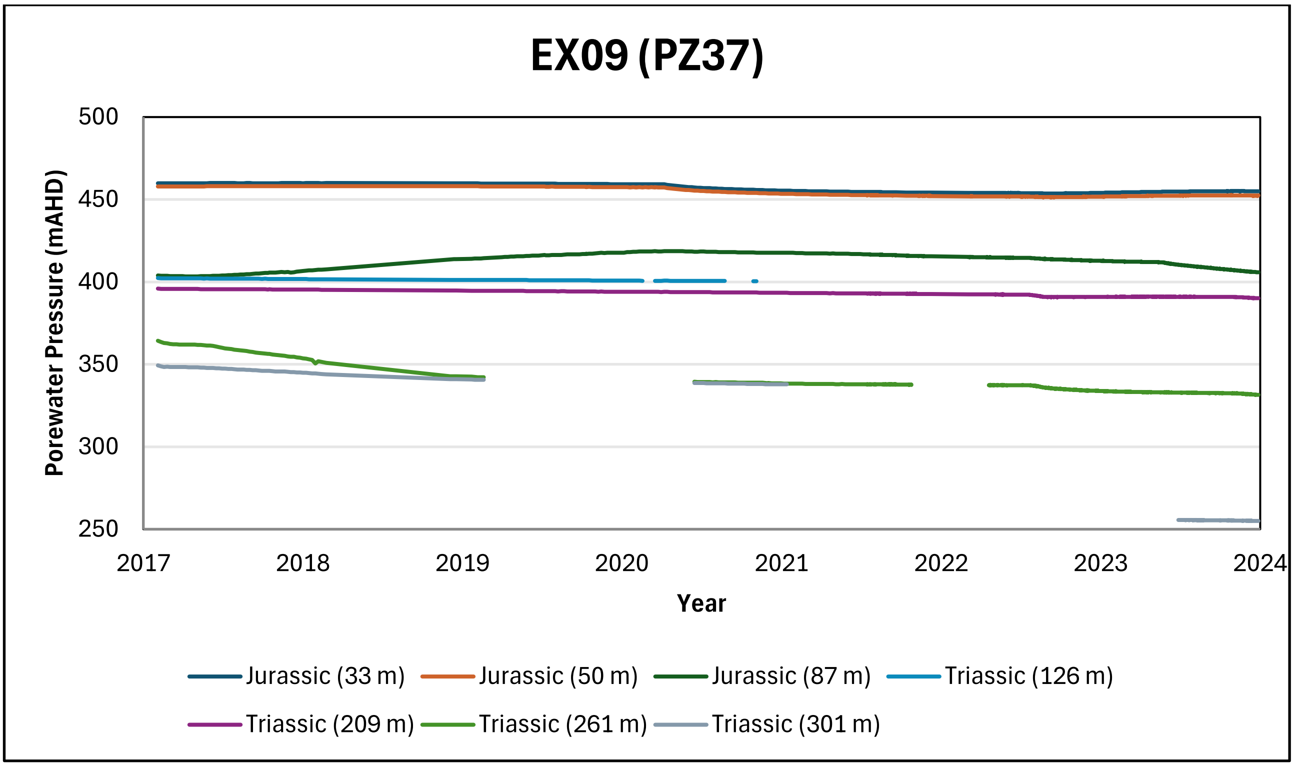


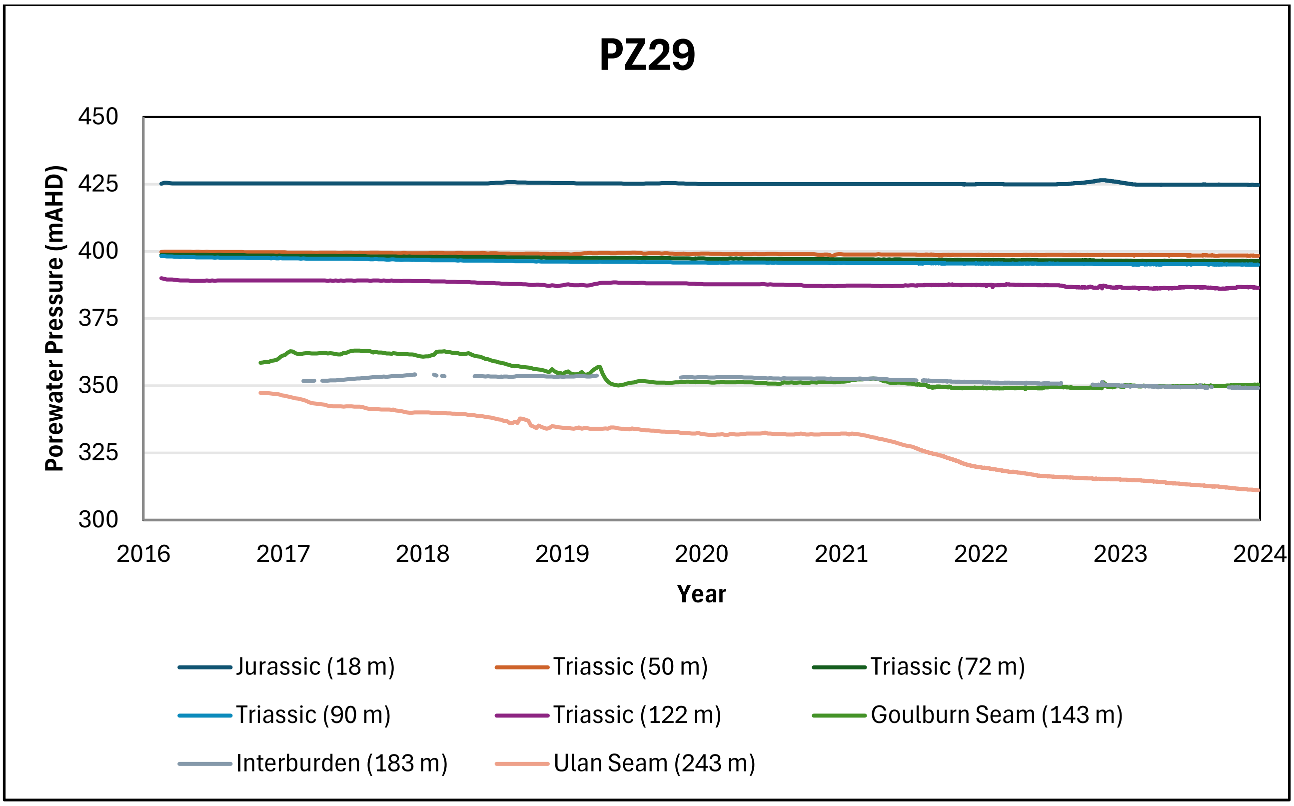
DDH270
Porewater Pressure (mAHD)
480
460
440
420
400
380
360
340
320
300
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
Year
Permian (171 m)
Permian (165 m)
Triassic (76 m)

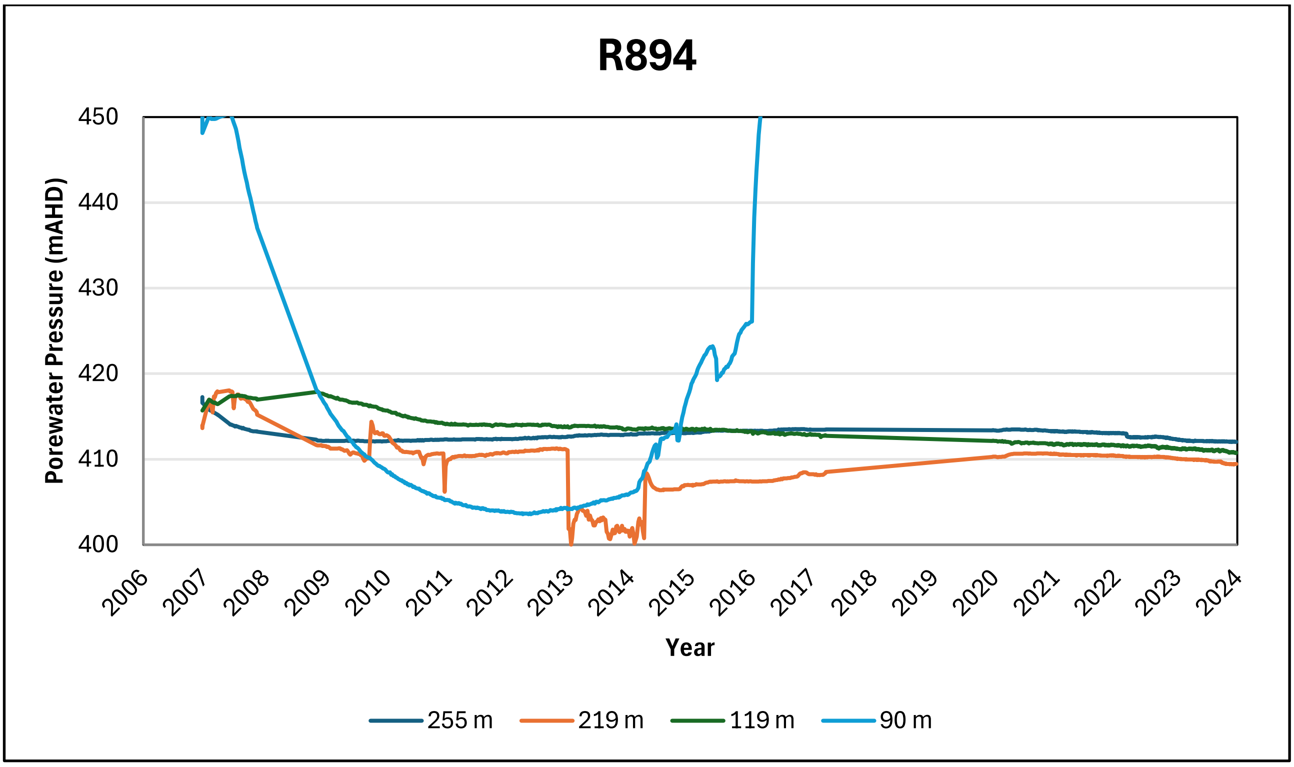


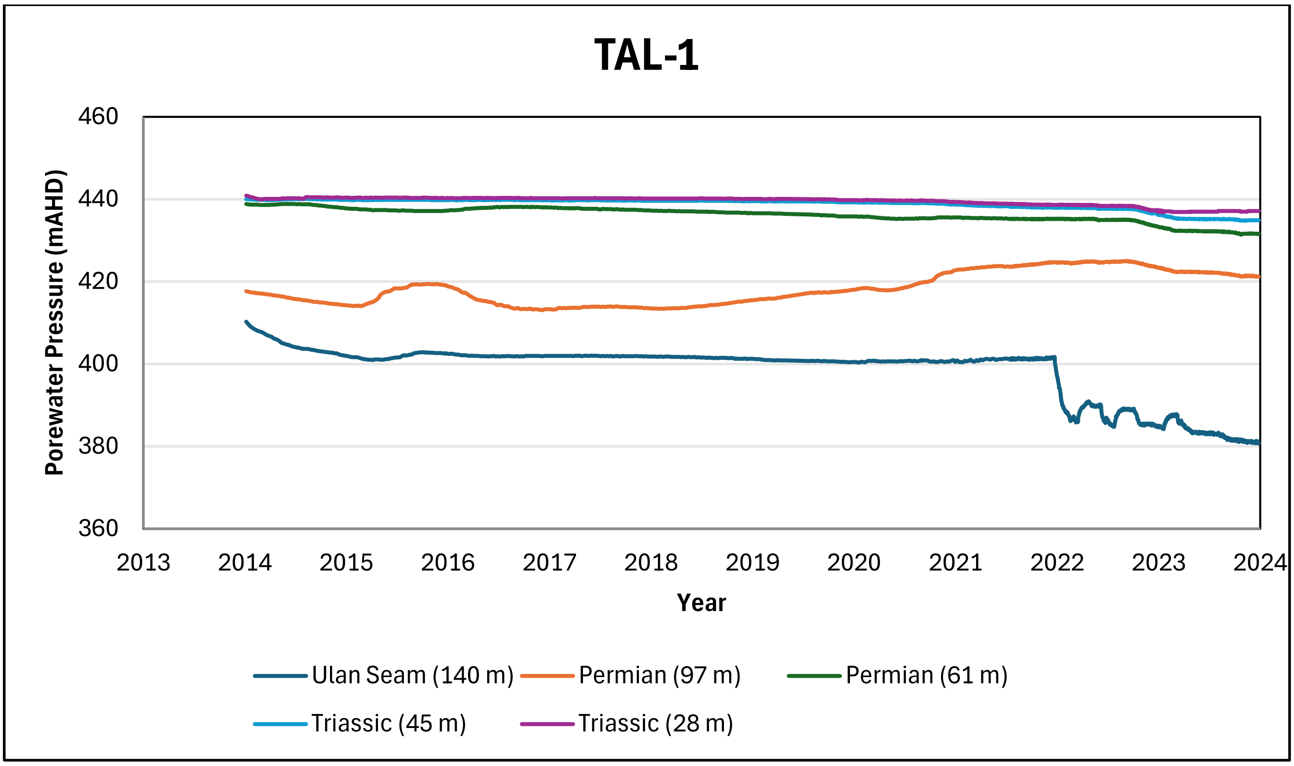
EX03
Porewater Pressure (mAHD)
550
500
450
400
350
300
250
200
2018
2019
2020
2021
2022
2023
2024
Year
Jurassic (28 m)
Jurassic (48 m)
Jurassic (90 m)
Triassic (160 m)
Triassic (201 m)
Permian (242 m)
Permian (297 m)

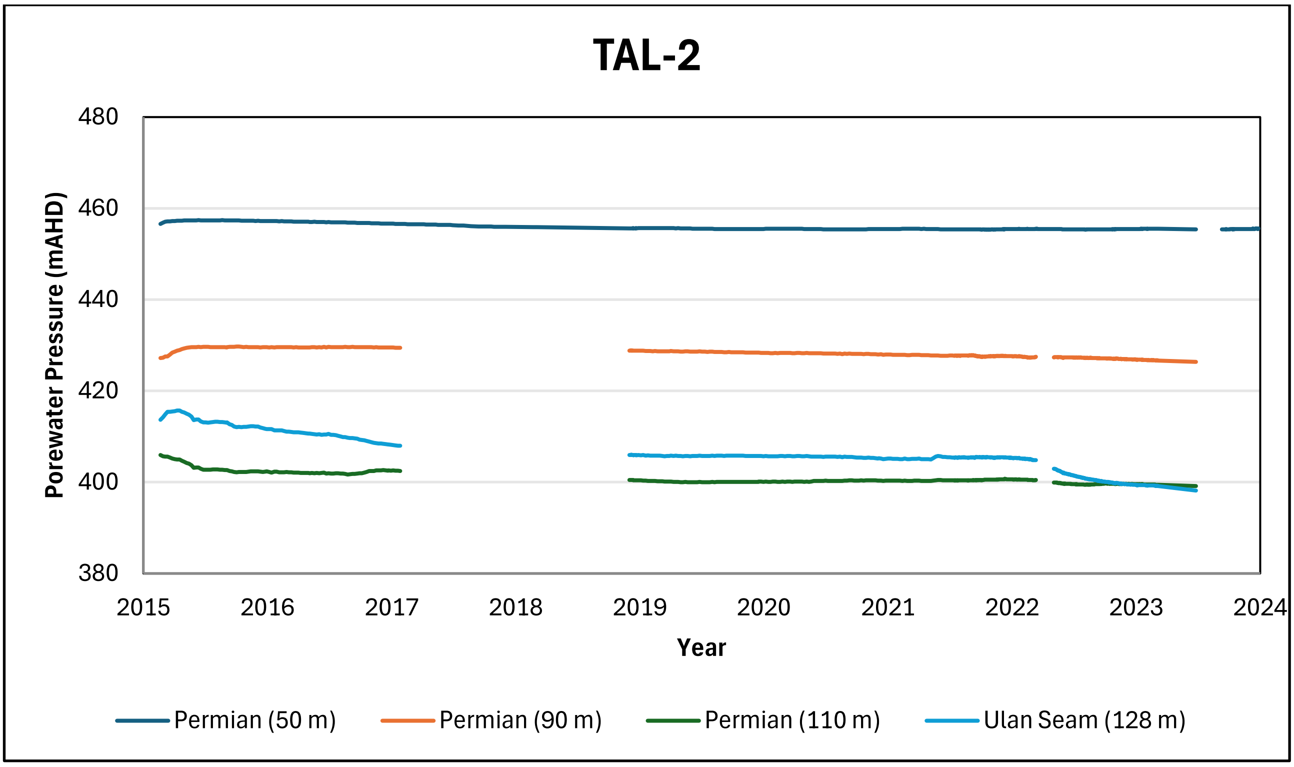

EX06
550
500
450
400
350
300
250
Porewater Pressure (mAHD)
2016
2017
2018
2019
2020
2021
2022
2023
2024
Year
Jurassic (9 m)
Base of Jurassic (28 m)
Triassic (56 m)
Triassic (71 m)
Triassic (95 m)
Base of Triassic (121 m)
Permian coal measures (185 m)
Ulan Seam (227 m)

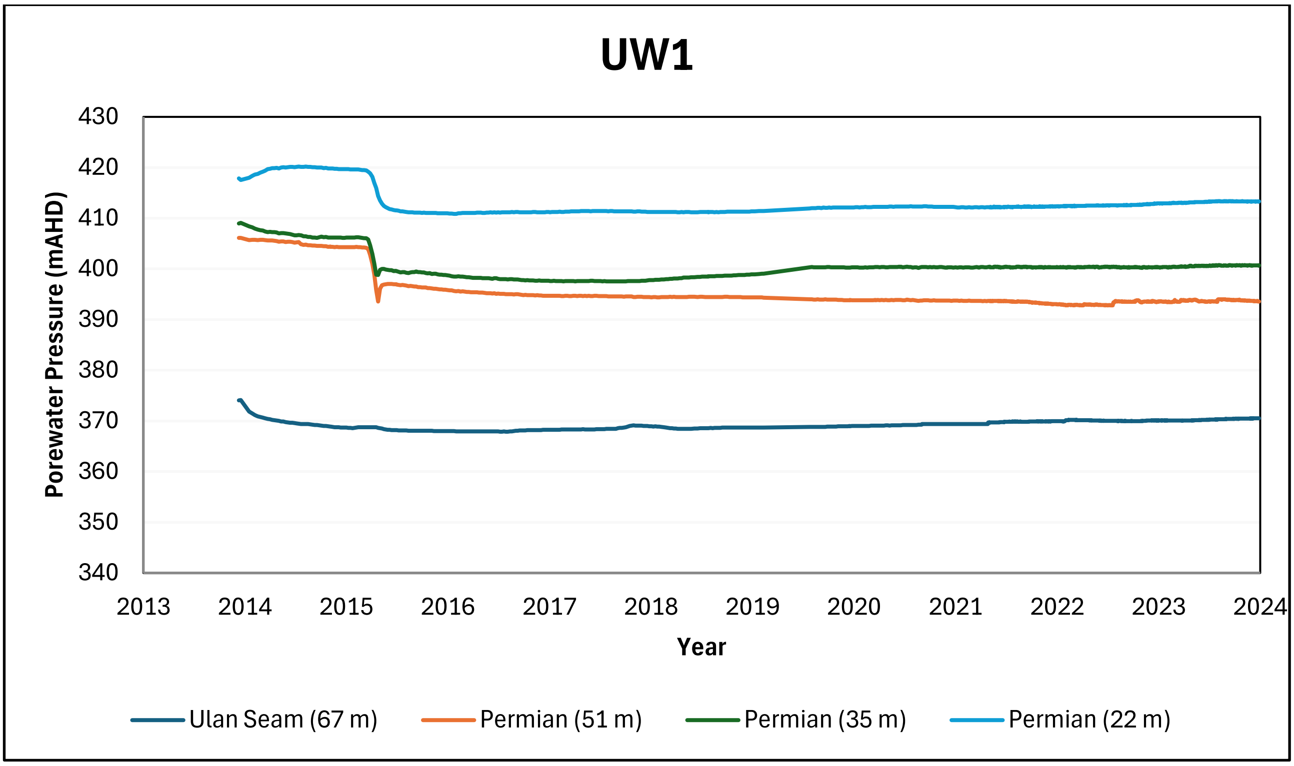

EX09 (PZ37)
500
450
400
350
300
250
Porewater Pressure (mAHD)
2017
2018
2019
2020
2021
2022
2023
2024
Year
Jurassic (33 m)
Jurassic (50 m)
Jurassic (87 m)
Triassic (126 m)
Triassic (209 m)
Triassic (261 m)
Triassic (301 m)

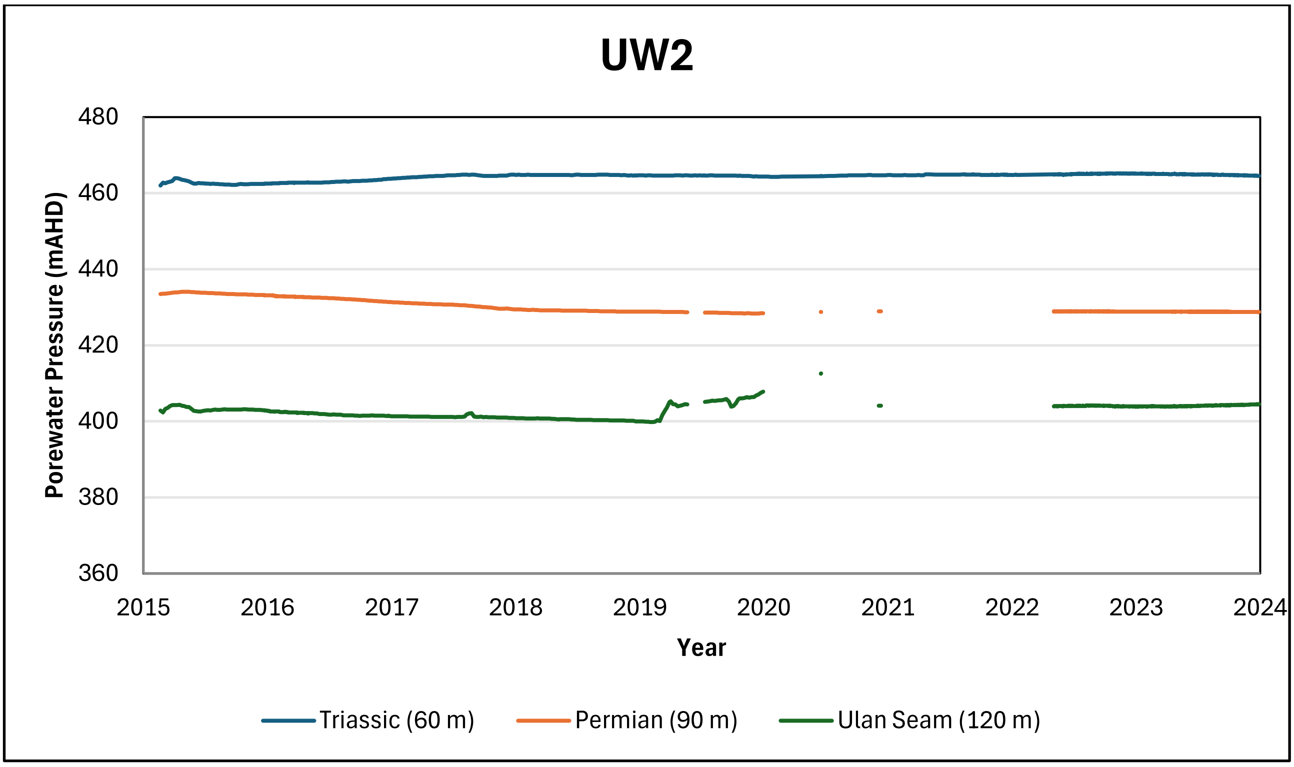

PZ29
Porewater Pressure (mAHD)
450
425
400
375
350
325
300
2016
2017
2018
2019
2020
2021
2022
2023
2024
Year
Jurassic (18 m)
Triassic (50 m)
Triassic (72 m)
Triassic (90 m)
Triassic (122 m)
Goulburn Seam (143 m)
Interburden (183 m)
Ulan Seam (243 m)

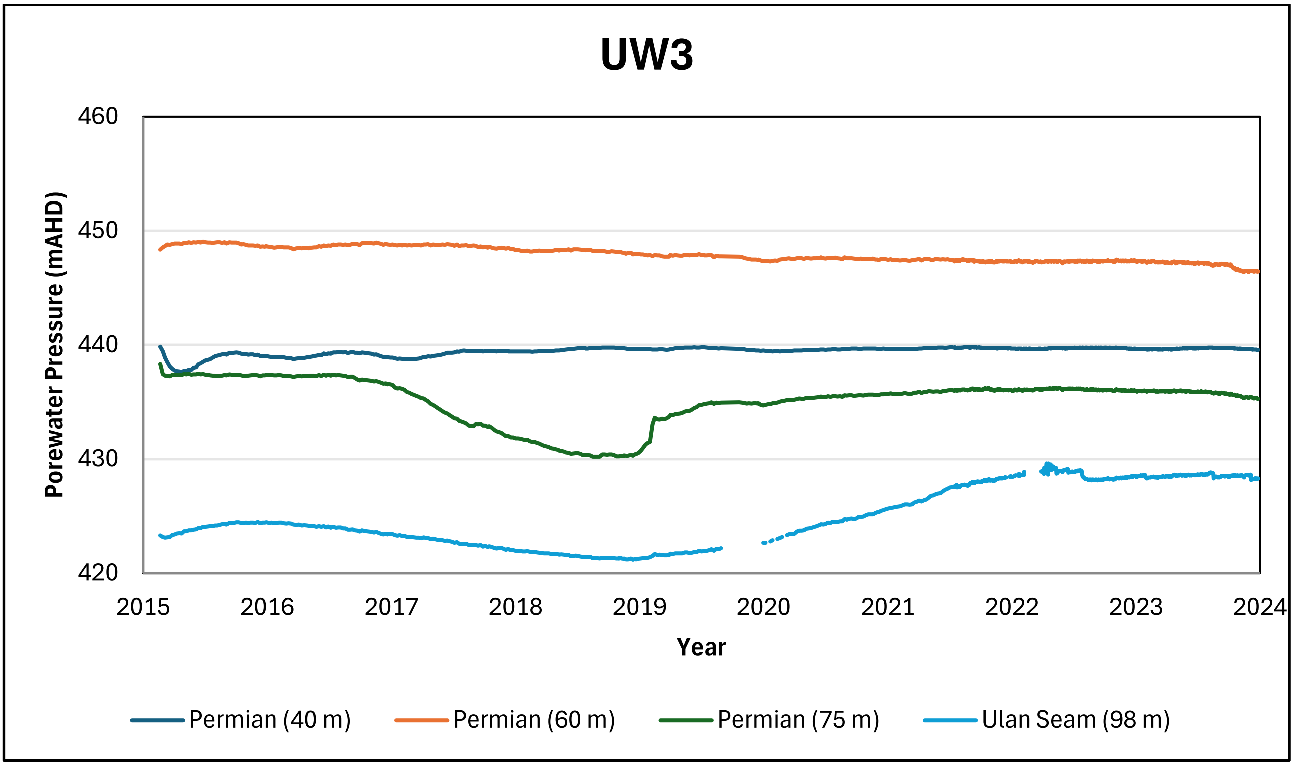

R894
Porewater Pressure (mAHD)
450
440
430
420
410
400
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
Year
255 m
219 m
119 m
90 m

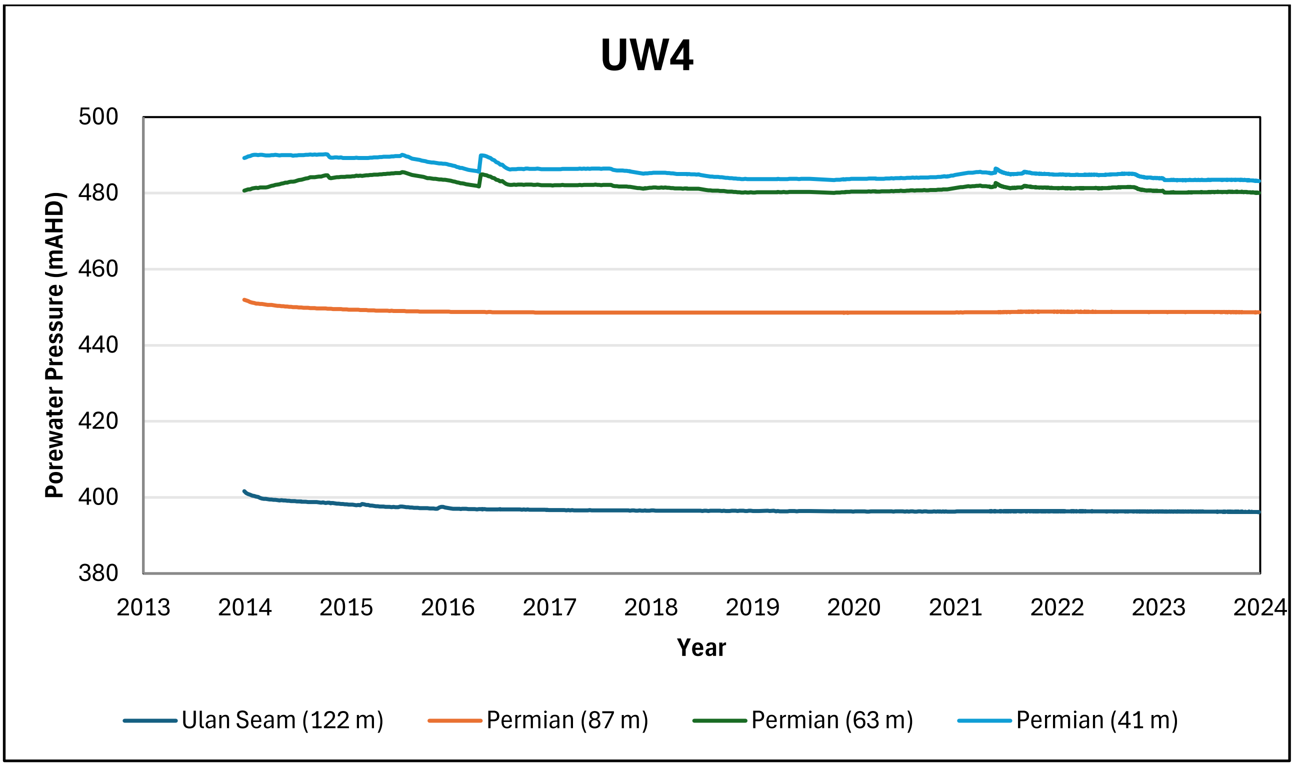

TAL-1
Porewater Pressure (mAHD)
460
440
420
400
380
360
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
Year
Ulan Seam (140 m)
Permian (97 m)
Permian (61 m)
Triassic (45 m)
Triassic (28 m)


TAL-2
Porewater Pressure (mAHD)
480
460
440
420
400
380
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
Year
Permian (50 m)
Permian (90 m)
Permian (110 m)
Ulan Seam (128 m)


UW1
Porewater Pressure (mAHD)
430
420
410
400
390
380
370
360
350
340
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
Year
Ulan Seam (67 m)
Permian (51 m)
Permian (35 m)
Permian (22 m)

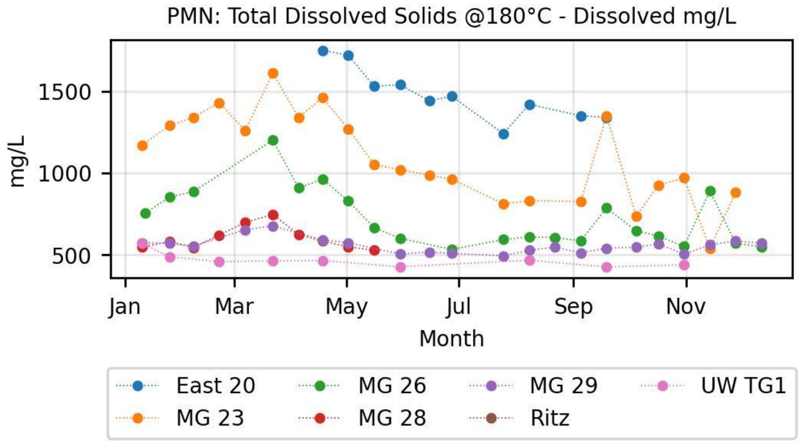

UW2
Porewater Pressure (mAHD)
480
460
440
420
400
380
360
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
Year
Triassic (60 m)
Permian (90 m)
Ulan Seam (120 m)

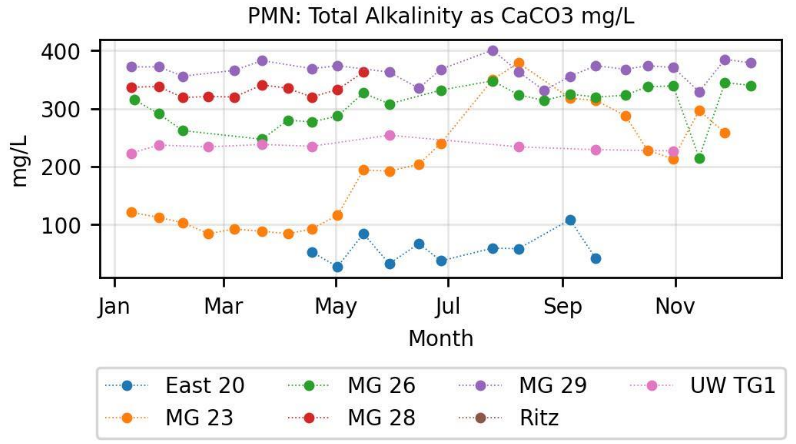

UW3
Porewater Pressure (mAHD)
460
450
440
430
420
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
Year
Permian (40 m)
Permian (60 m)
Permian (75 m)
Ulan Seam (98 m)

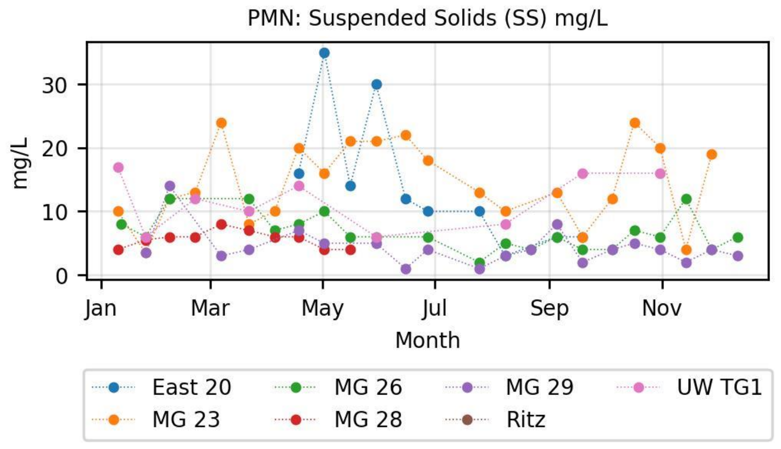

UW4
Porewater Pressure (mAHD)
500
480
460
440
420
400
380
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
Year
Ulan Seam (122 m)
Permian (87 m)
Permian (63 m)
Permian (41 m)

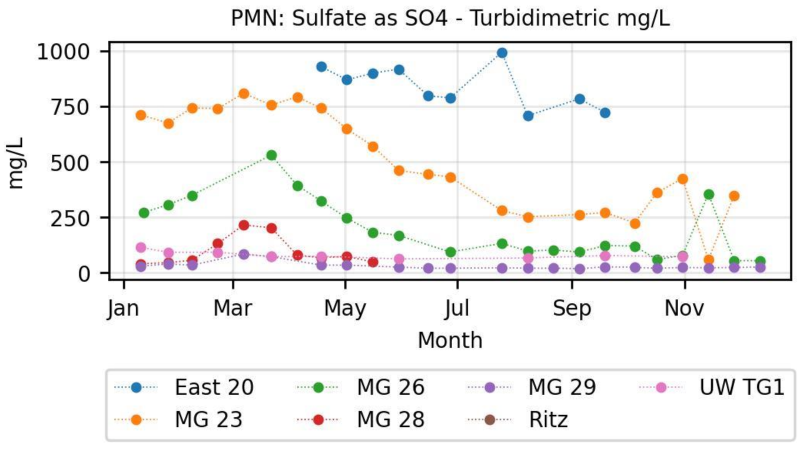
Appendix C

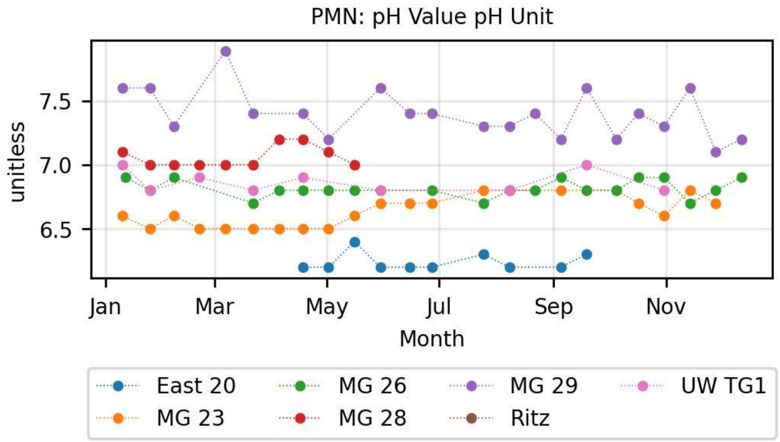
Pleuger Monitoring Network hydrographs

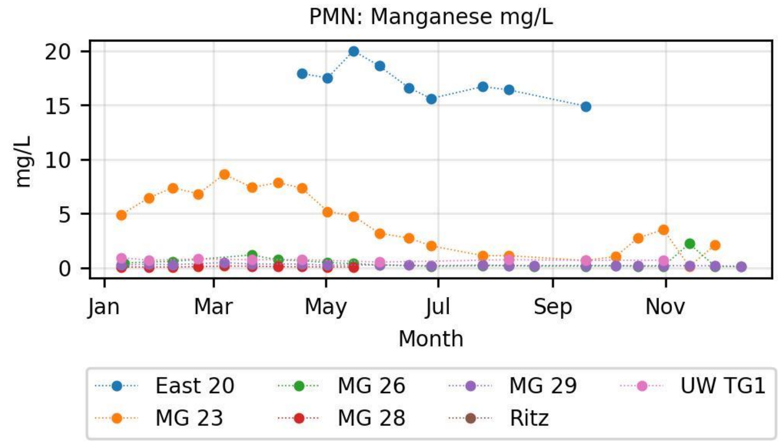

PMN: Total Dissolved Solids @180°C - Dissolved mg/L
mg/L
Month
East 20
MG 23
MG 26
MG 28
MG 29
Ritz
UW TG1

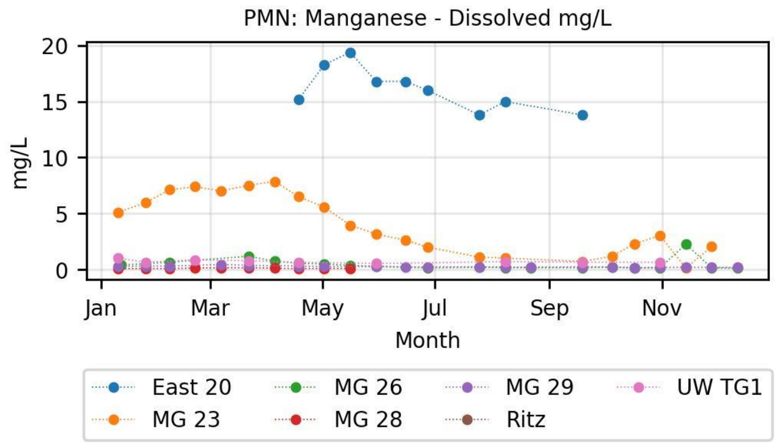

PMN: Total Alkalinity as CaCO3 mg/L
mg/L
Month
East 20
MG 23
MG 26
MG 28
MG 29
Ritz
UW TG1

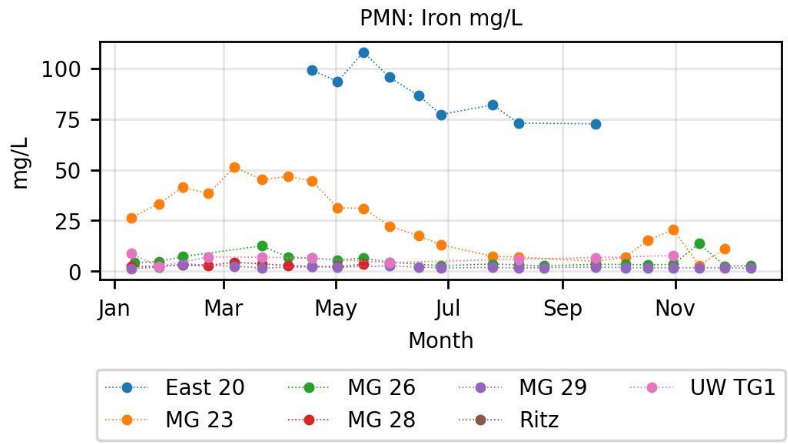

PMN: Suspended Solids (SS) mg/L
mg/L
Month
East 20
MG 23
MG 26
MG 28
MG 29
Ritz
UW TG1

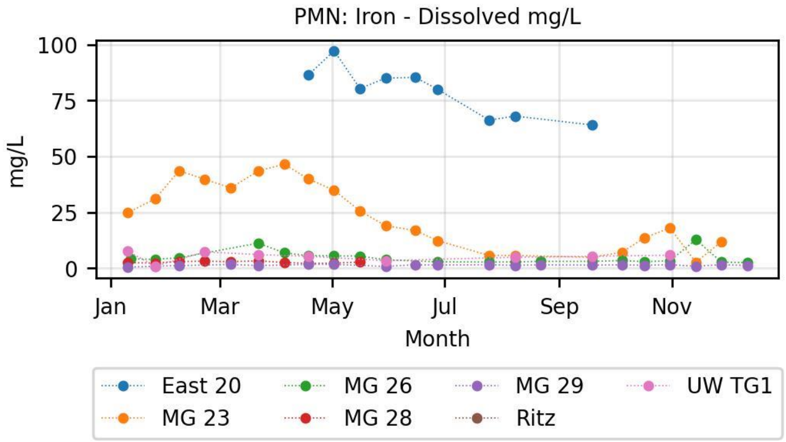

PMN: Sulfate as SO4 - Turbidimetric mg/L
mg/L
Month
East 20
MG 23
MG 26
MG 28
MG 29
Ritz
UW TG1

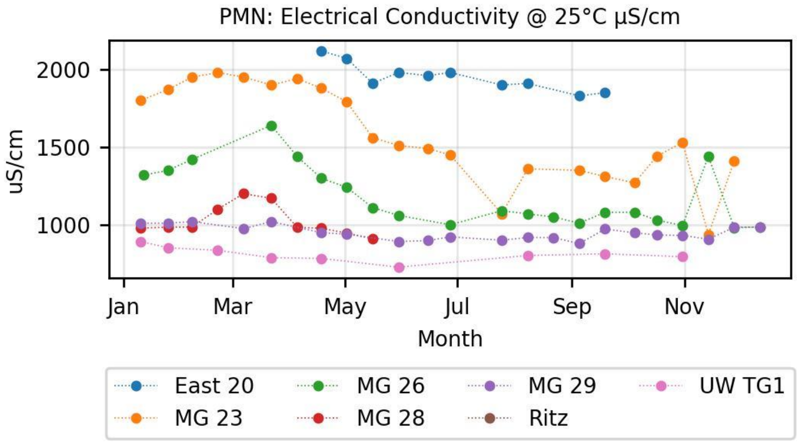

PMN: pH Value pH Unit
unitless
Month
East 20
MG 23
MG 26
MG 28
MG 29
Ritz
UW TG1


PMN: Manganese mg/L
mg/L
Month
East 20
MG 23
MG 26
MG 28
MG 29
Ritz
UW TG1


PMN: Manganese - Dissolved mg/L
mg/L
Month
East 20
MG 23
MG 26
MG 28
MG 29
Ritz
UW TG1


PMN: Iron mg/L
mg/L
Month
East 20
MG 23
MG 26
MG 28
MG 29
Ritz
UW TG1

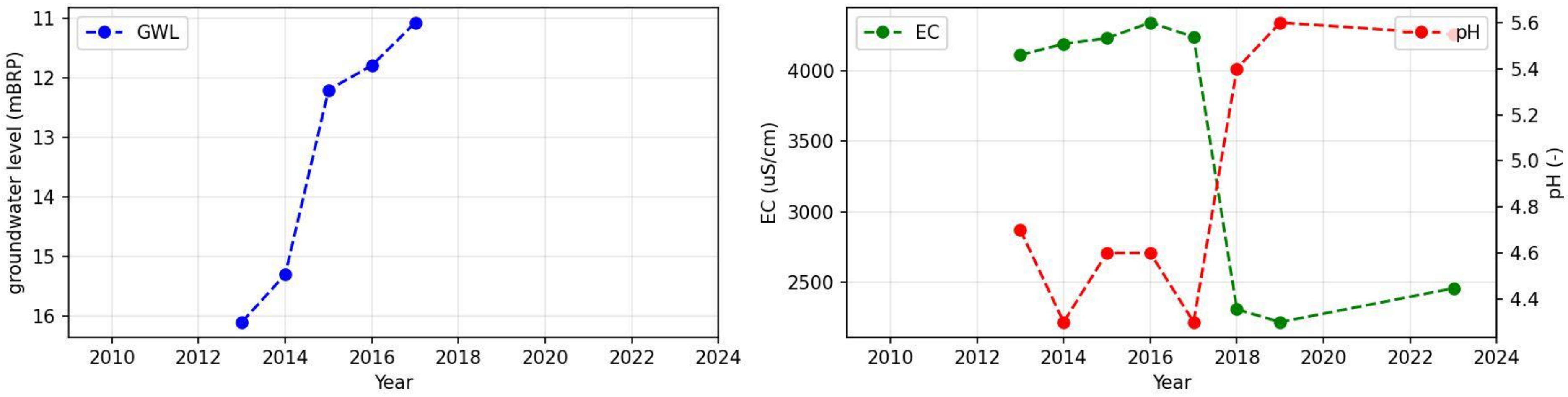

PMN: Iron - Dissolved mg/L
mg/L
100
75
50
25
0
Jan
Mar
May
Jul
Sep
Nov
Month
East 20
MG 23
MG 26
MG 28
MG 29
Ritz
UW TG1


PMN: Electrical Conductivity @ 25°C µS/cm
uS/cm
2000
1500
1000
Jan
Mar
May
Jul
Sep
Nov
Month
East 20
MG 23
MG 26
MG 28
MG 29
Ritz
UW TG1

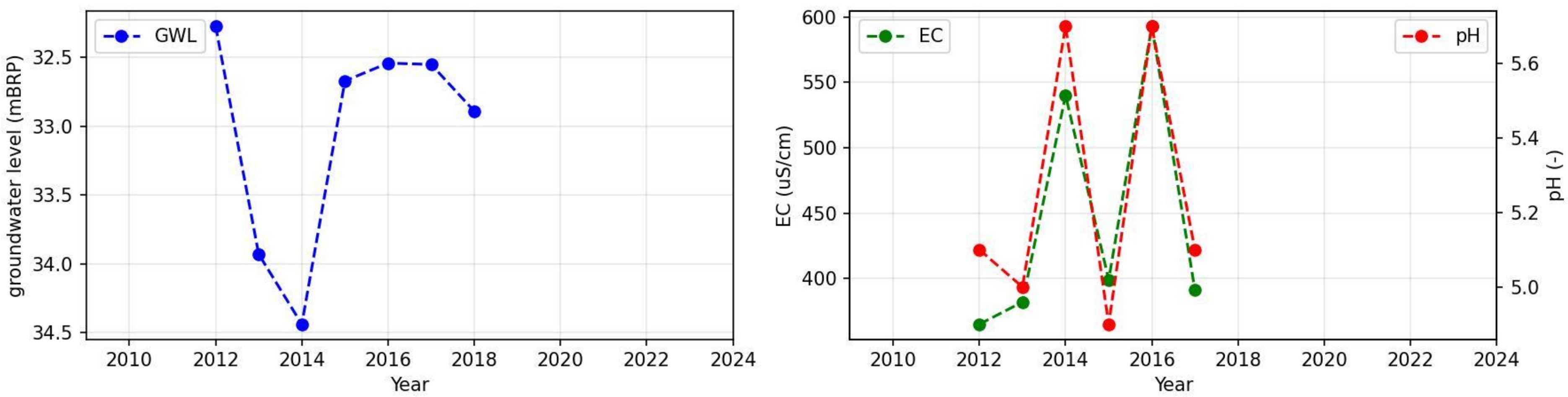
Appendix D

Private Monitoring Bore Network hydrographs

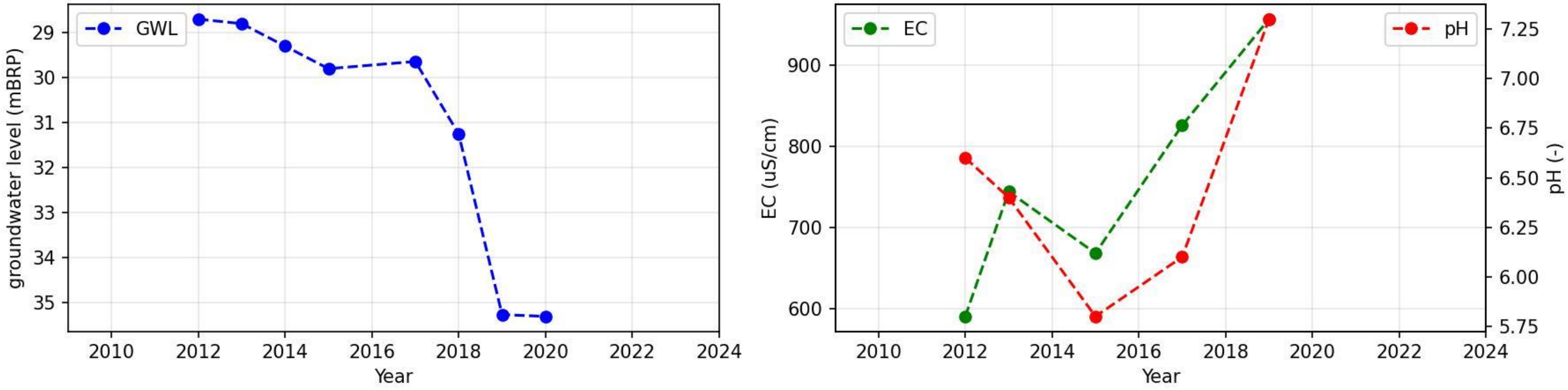
Private bore PB01



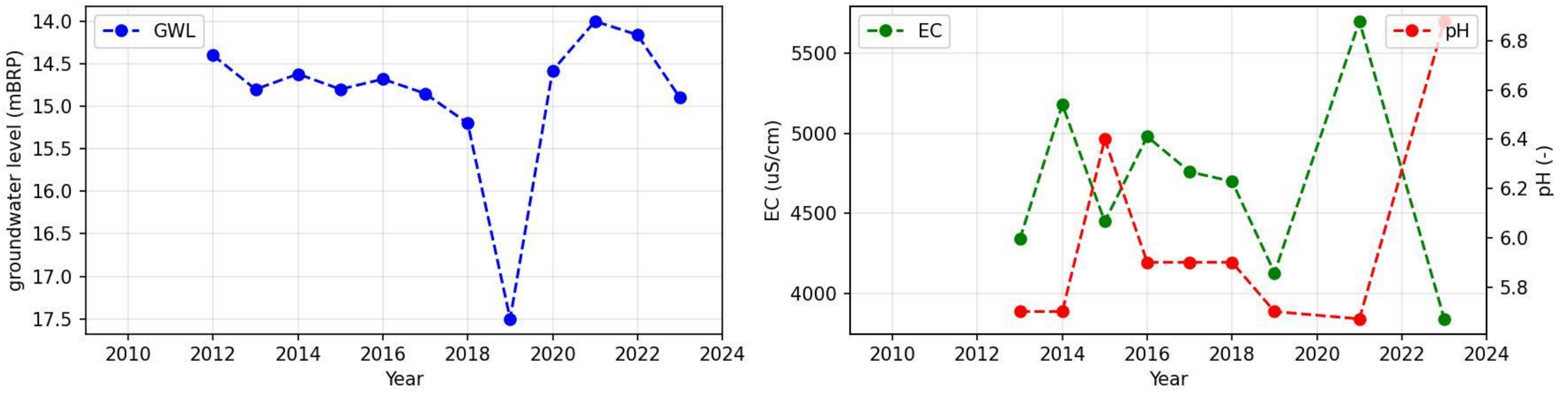
Private bore PB02



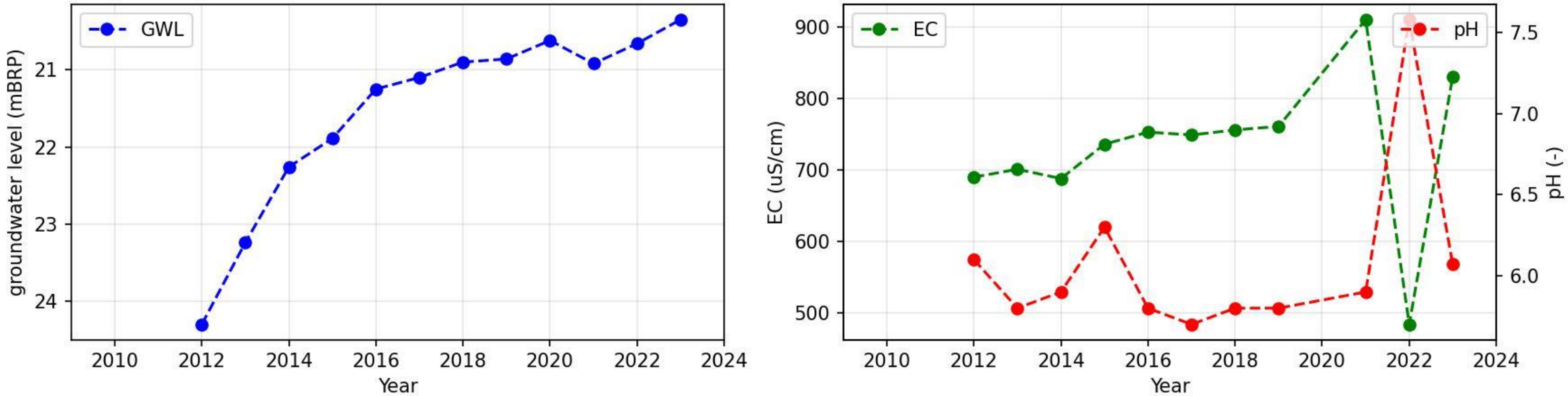
Private bore PB03



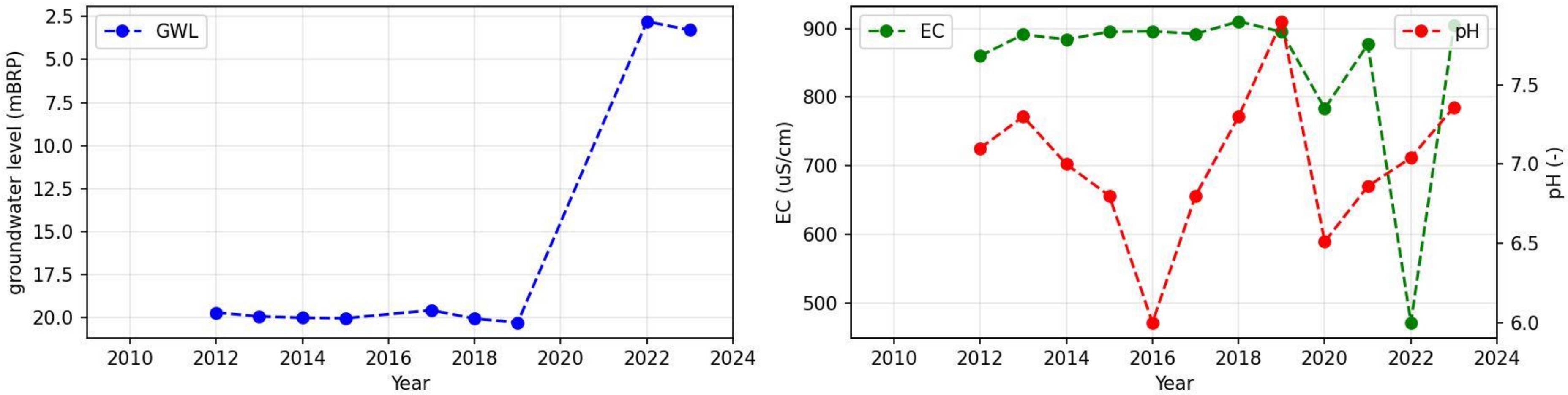
Private bore PB04



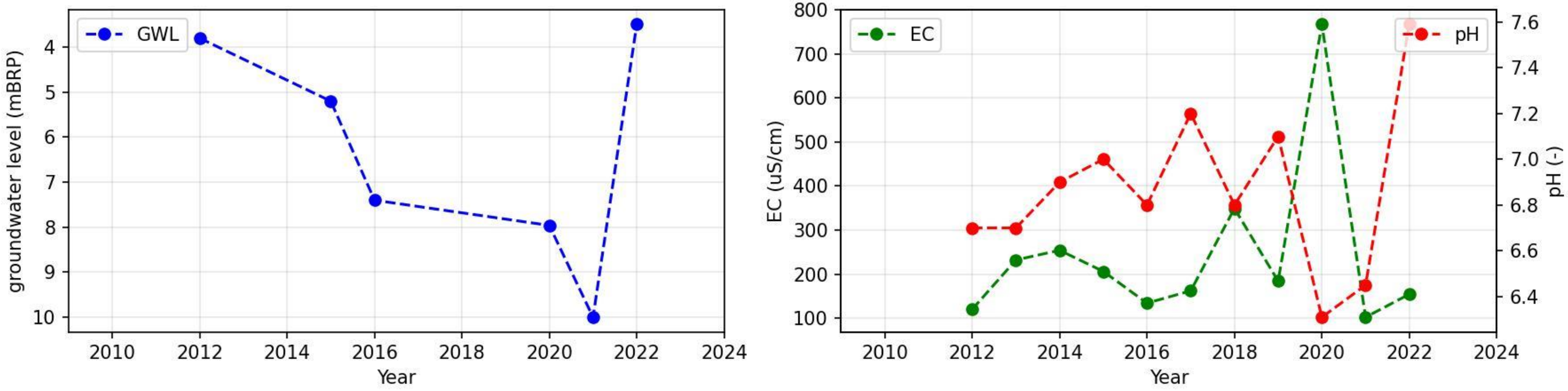
Private bore PB05



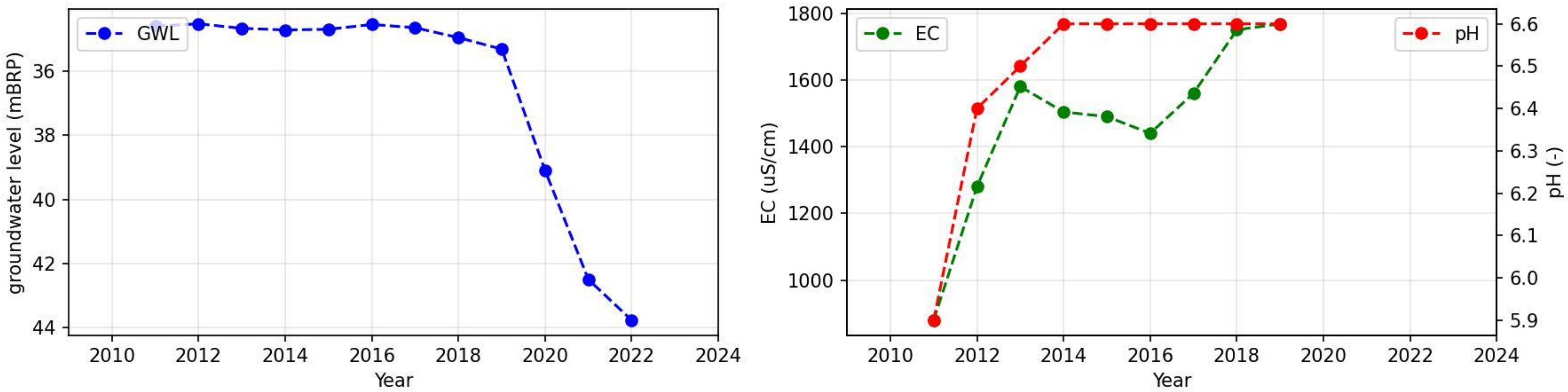
Private bore PB06



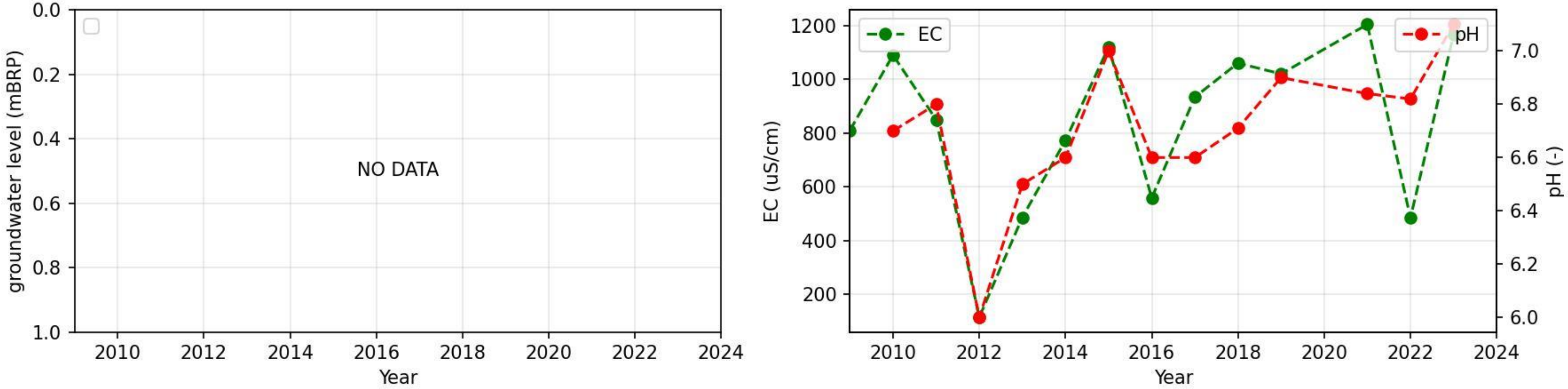
Private bore PB07



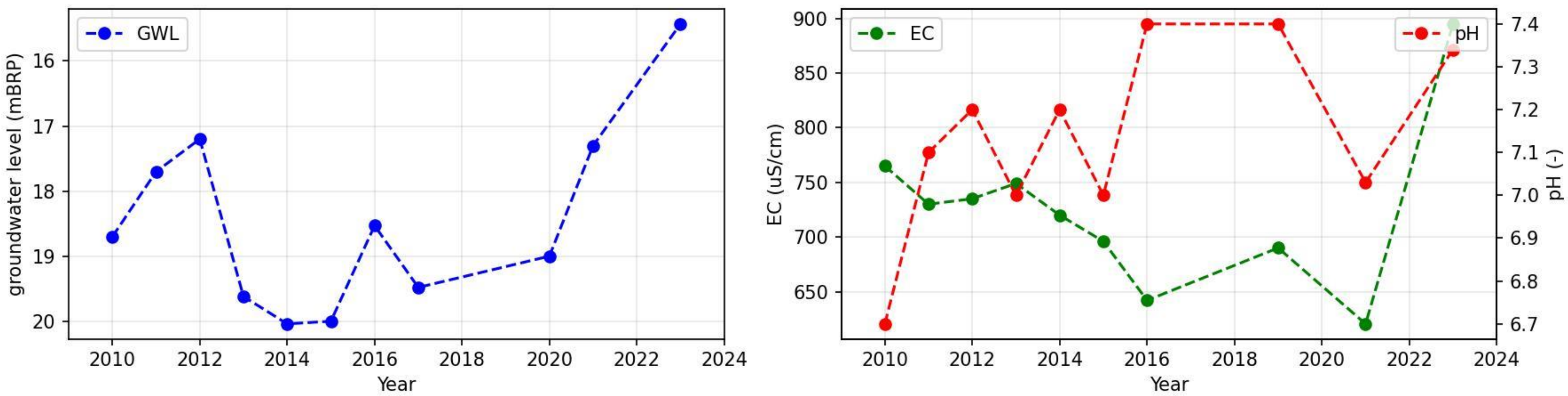
Private bore PB08



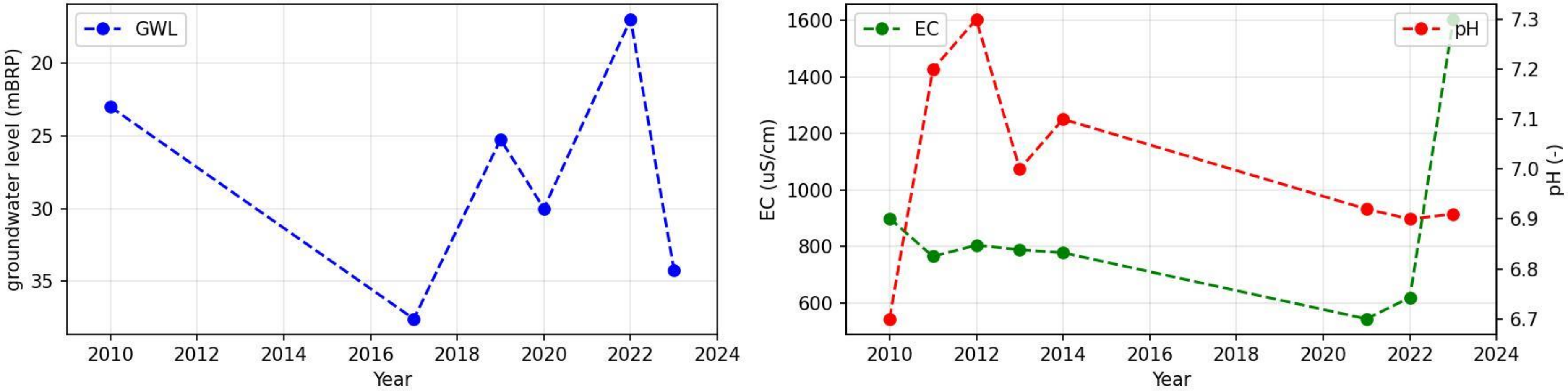
Private bore PB09



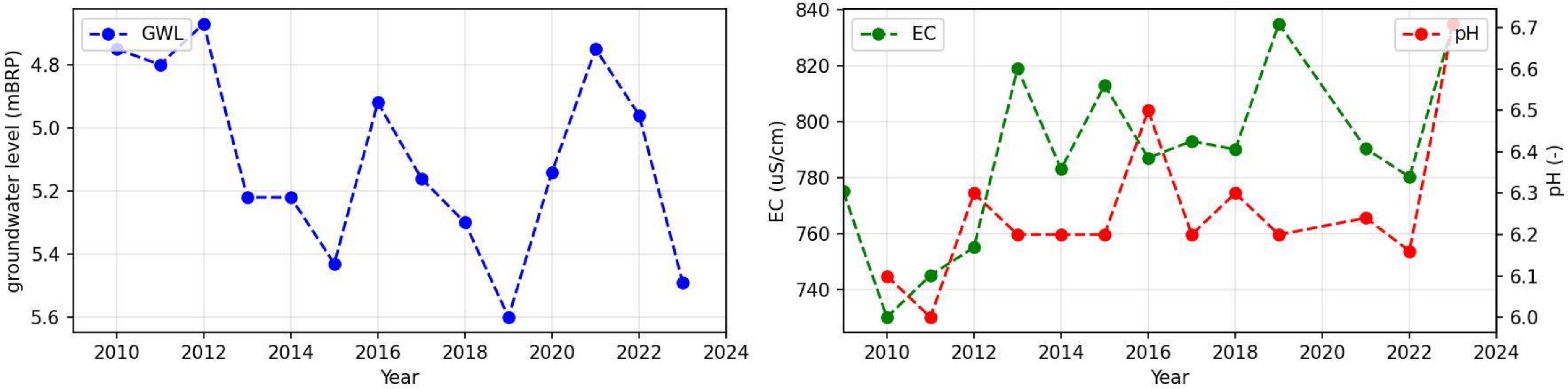
Private bore PB10

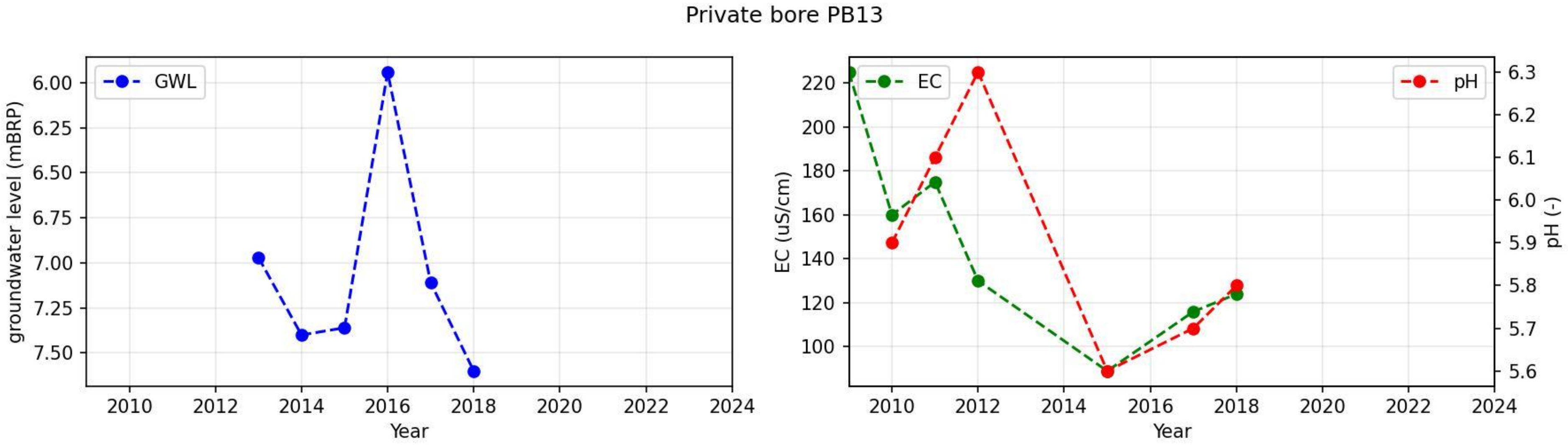


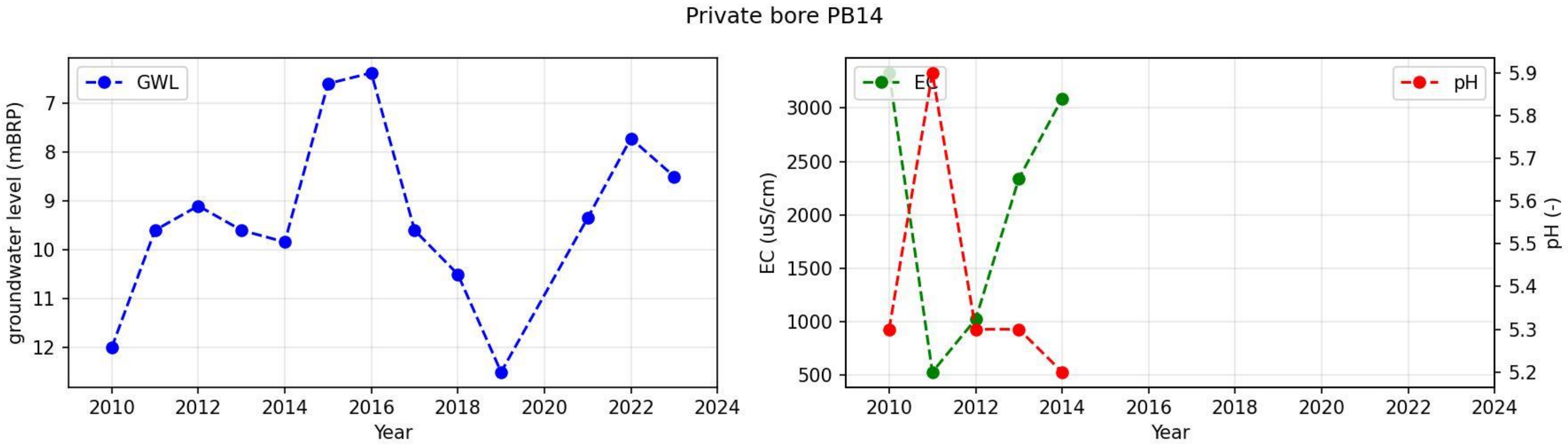
Private bore PB11

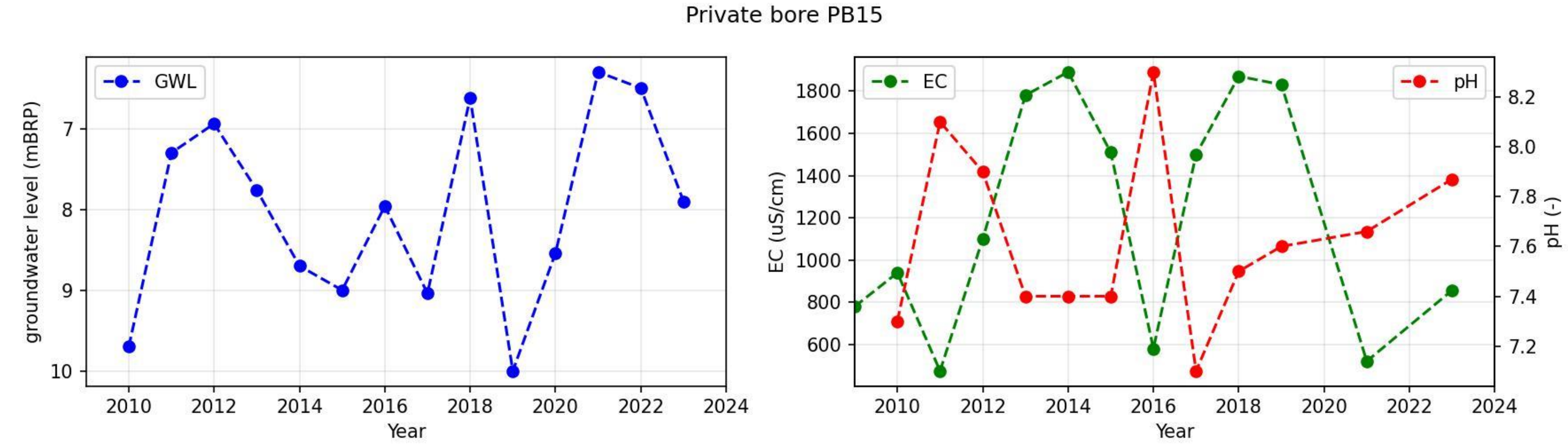


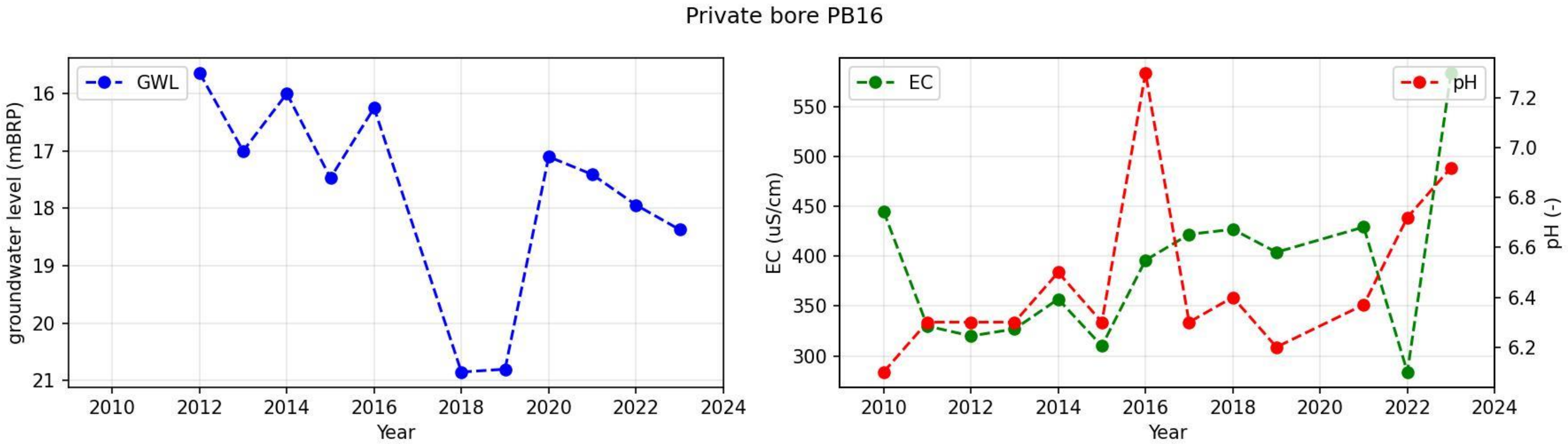
Private bore PB12

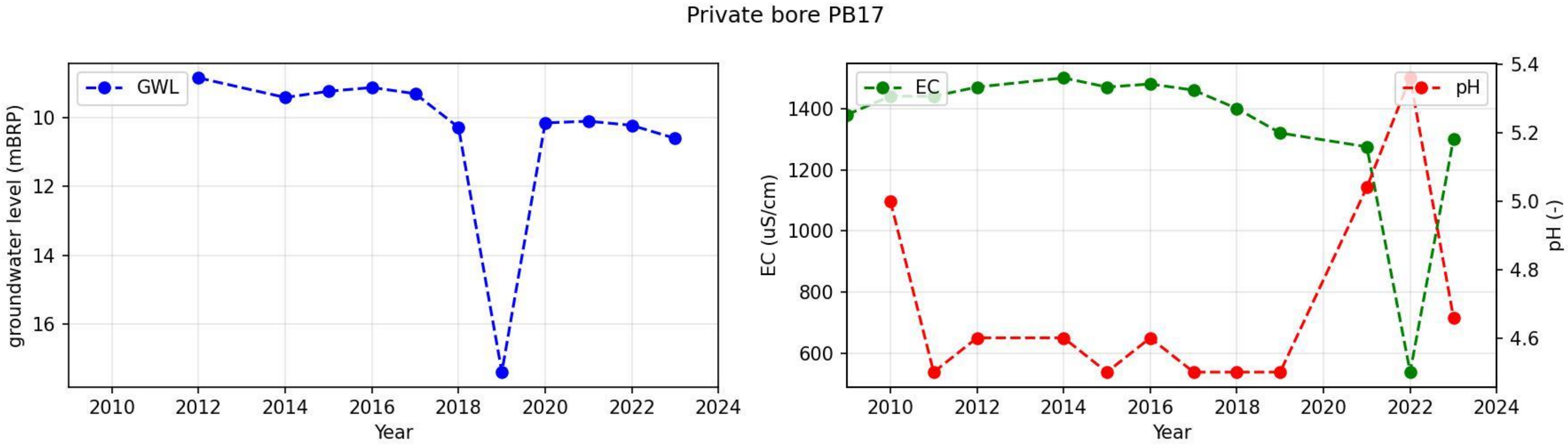


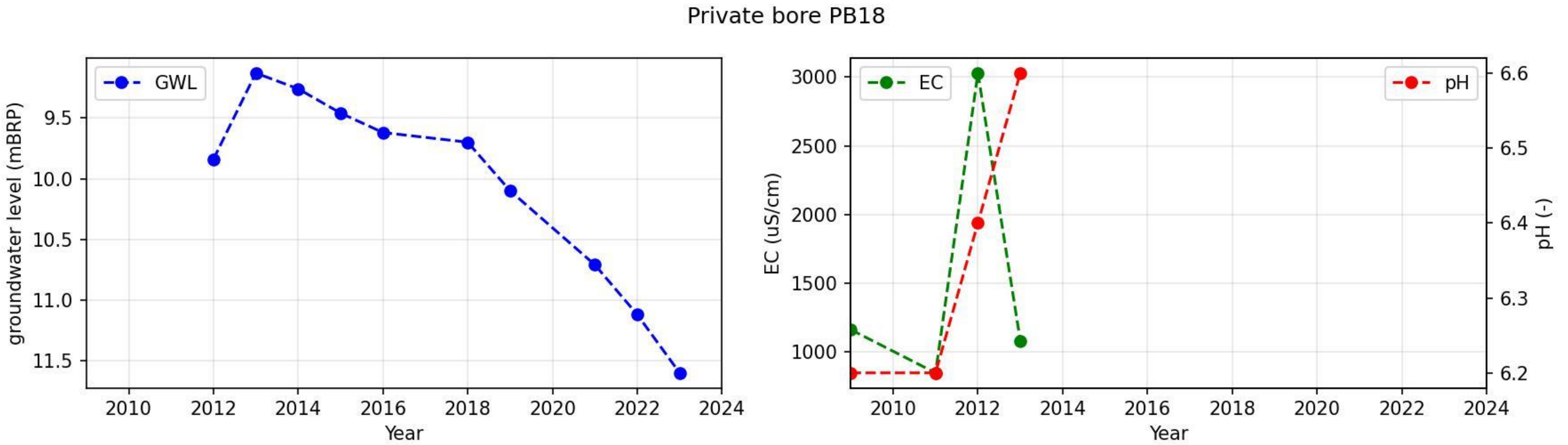

Private bore PB13
GWL
groundwater level (mBRP)
6.00
6.25
6.50
6.75
7.00
7.25
7.50
2010
2012
2014
2016
2018
2020
2022
2024
Year
EC
pH
EC (uS/cm)
220
200
180
160
140
120
100
pH (-)
6.3
6.2
6.1
6.0
5.9
5.8
5.7
5.6


Private bore PB14
GWL
groundwater level (mBRP)
7
8
9
10
11
12
2010
2012
2014
2016
2018
2020
2022
2024
Year
EC
pH
EC (uS/cm)
3000
2500
2000
1500
1000
500
pH (-)
5.9
5.8
5.7
5.6
5.5
5.4
5.3
5.2

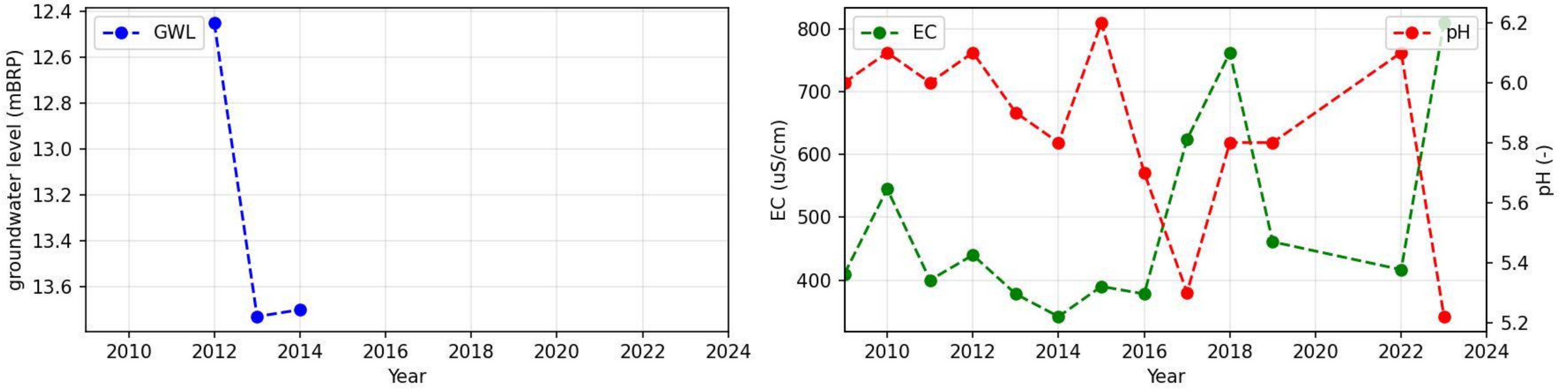

Private bore PB15
GWL
groundwater level (mBRP)
7
8
9
10
2010
2012
2014
2016
2018
2020
2022
2024
Year
EC
pH
EC (uS/cm)
1800
1600
1400
1200
1000
800
600
pH (-)
8.2
8.0
7.8
7.6
7.4
7.2


Private bore PB16
GWL
groundwater level (mBRP)
16
17
18
19
20
21
2010
2012
2014
2016
2018
2020
2022
2024
Year
EC
pH
EC (uS/cm)
550
500
450
400
350
300
pH (-)
7.2
7.0
6.8
6.6
6.4
6.2

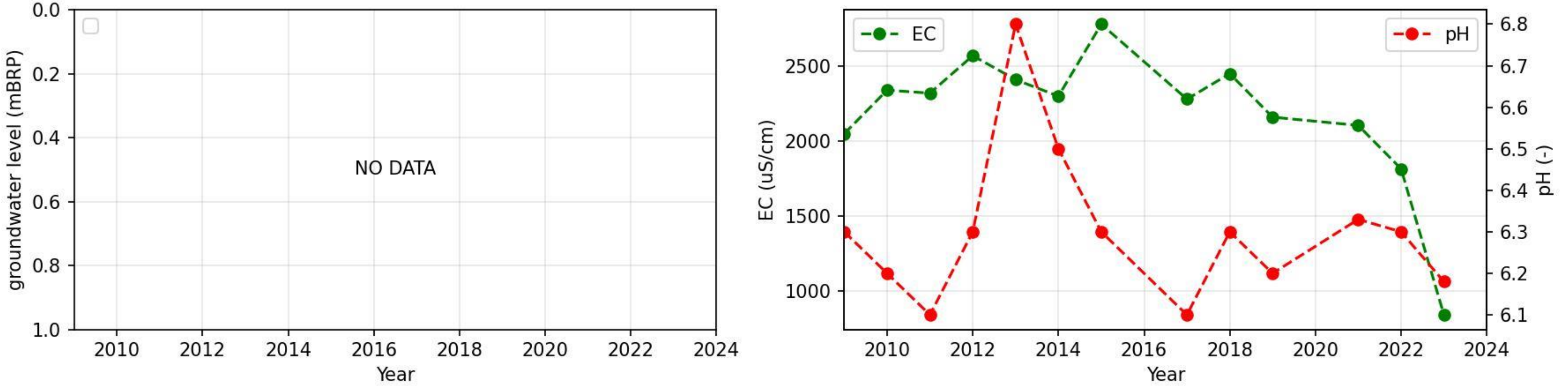

Private bore PB17
GWL
groundwater level (mBRP)
Year
EC
pH
EC (uS/cm)
pH (-)

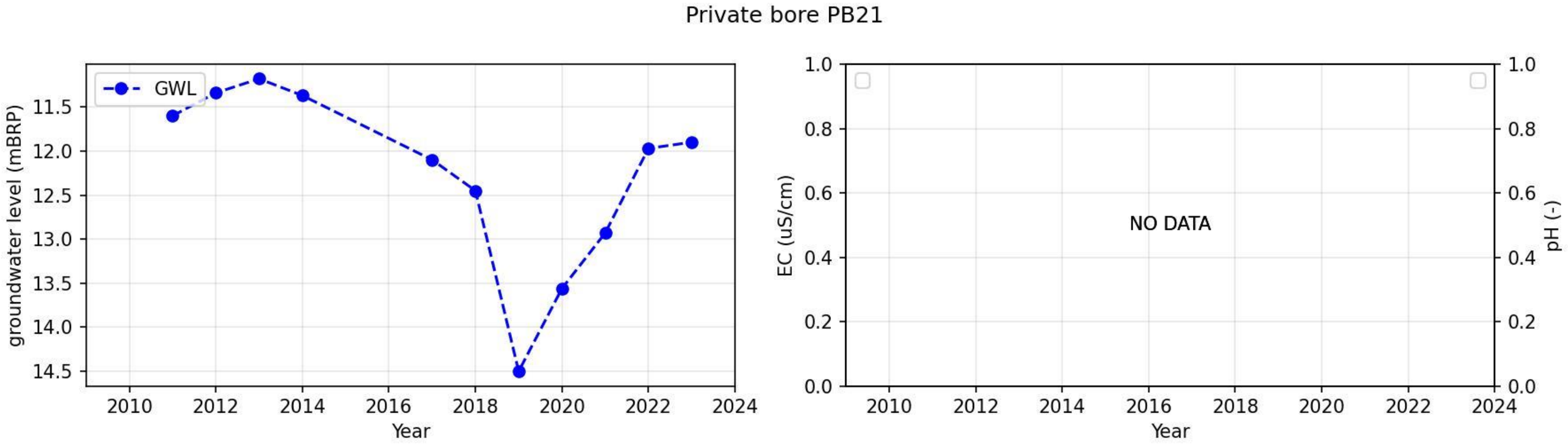

Private bore PB18
GWL
groundwater level (mBRP)
Year
EC
pH
EC (uS/cm)
pH (-)

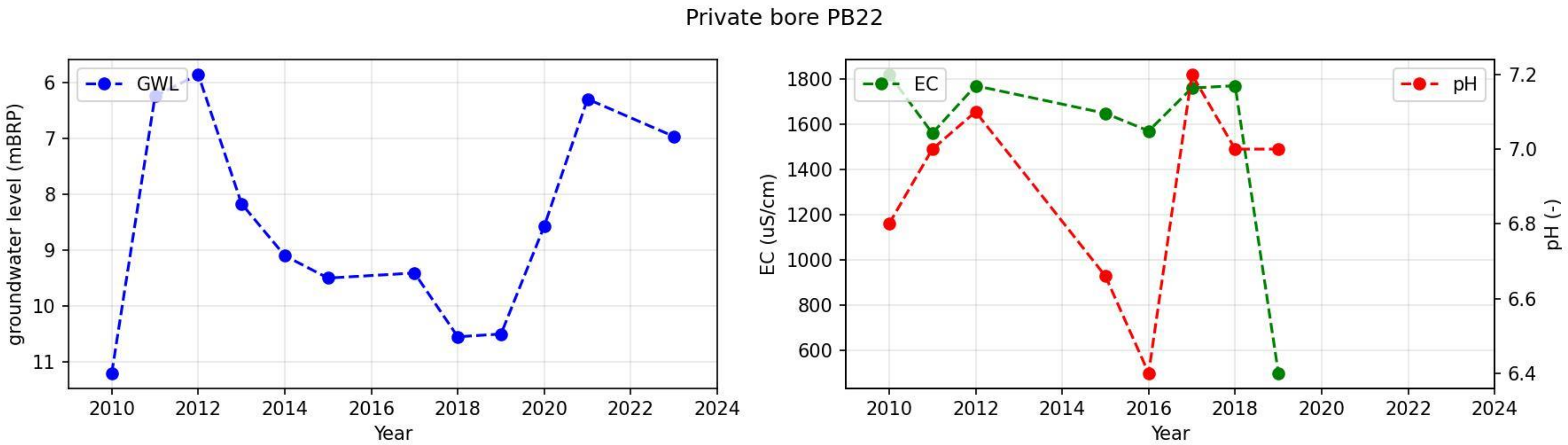
Private bore PB19



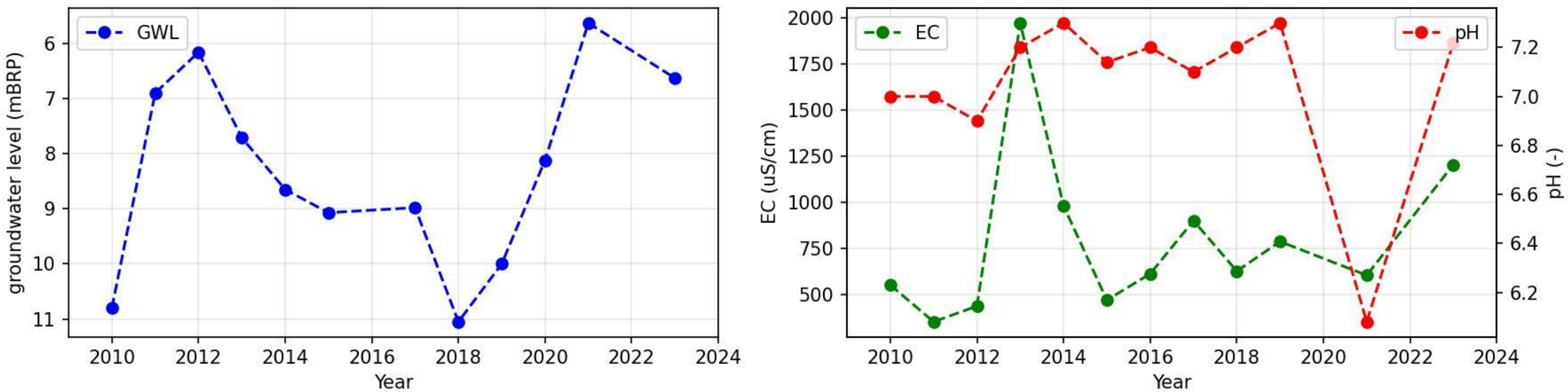
Private bore PB20



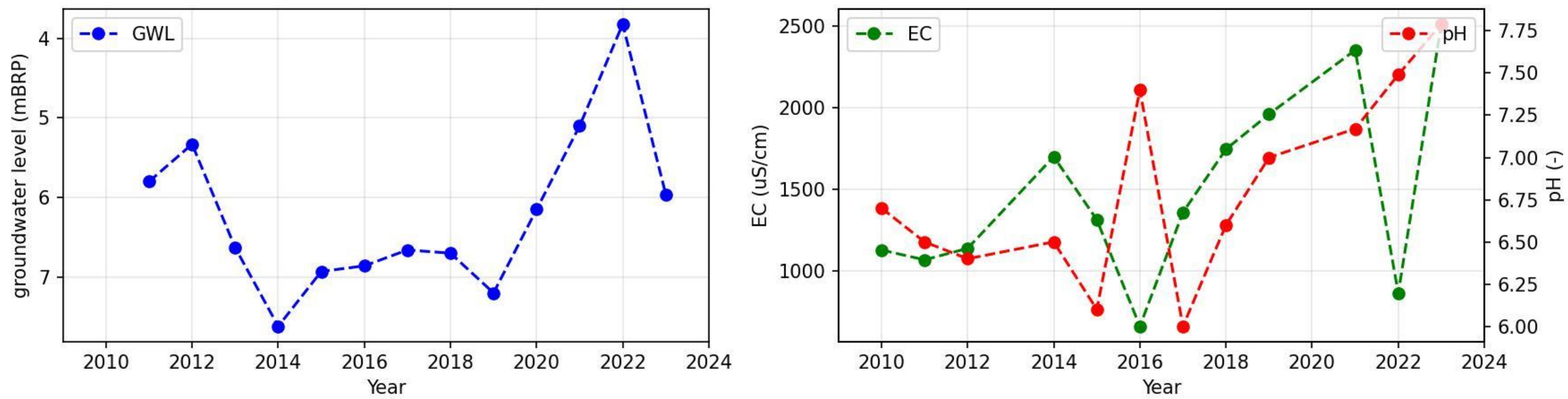

Private bore PB21
GWL
groundwater level (mBRP)
Year
NO DATA
EC (uS/cm)
pH (-)


Private bore PB22
GWL
groundwater level (mBRP)
Year
EC
pH
EC (uS/cm)
pH (-)

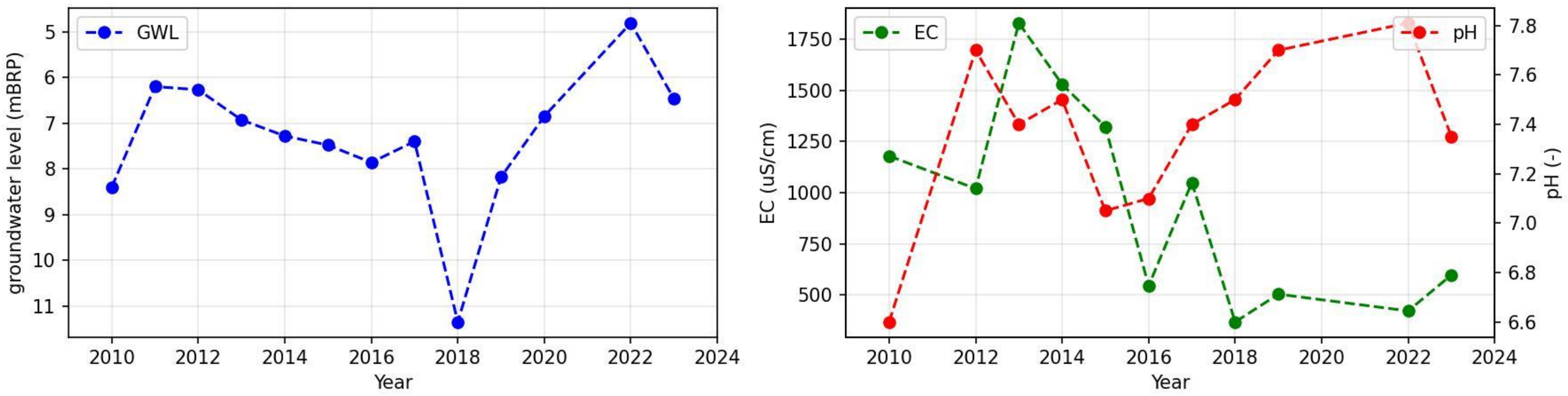
Private bore PB23



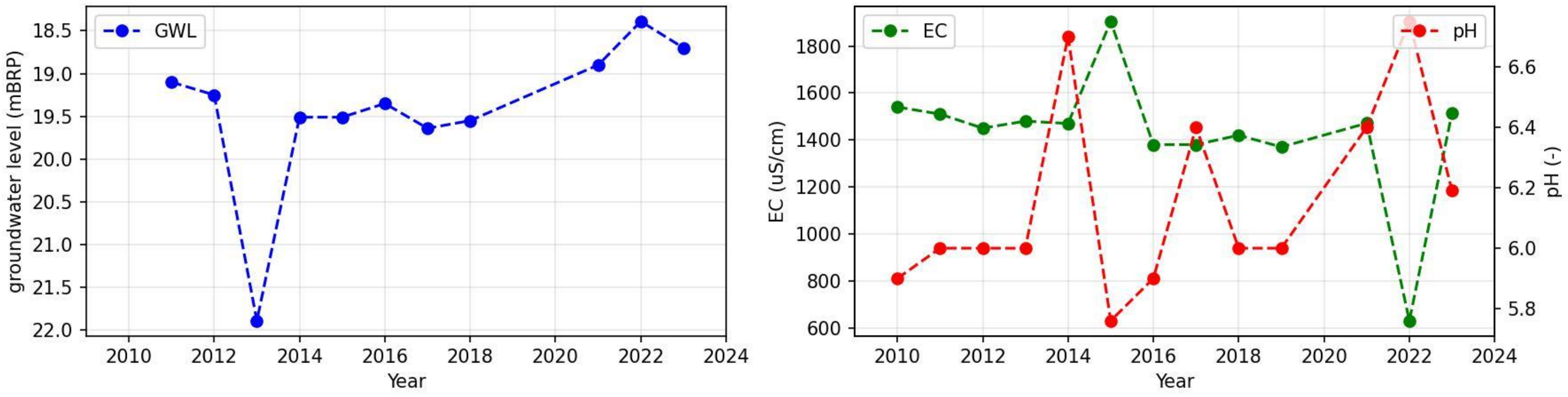
Private bore PB24



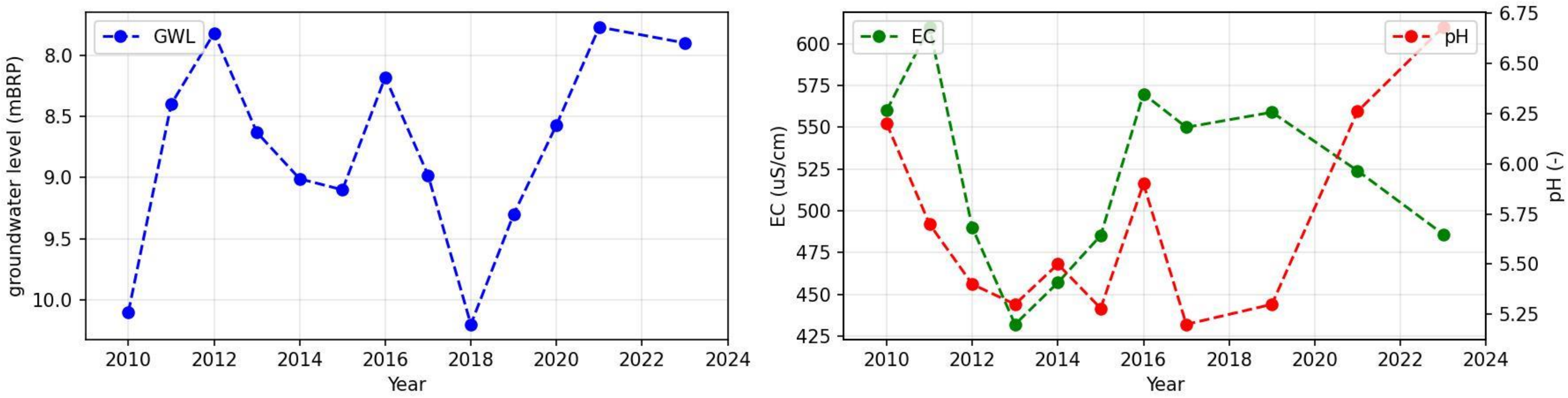
Private bore PB25



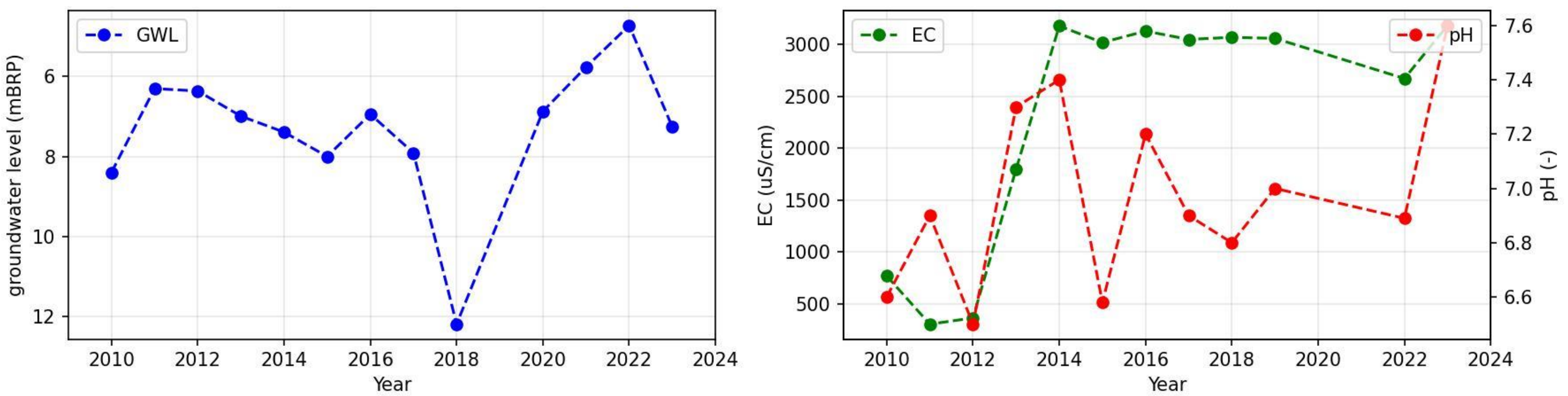
Private bore PB26



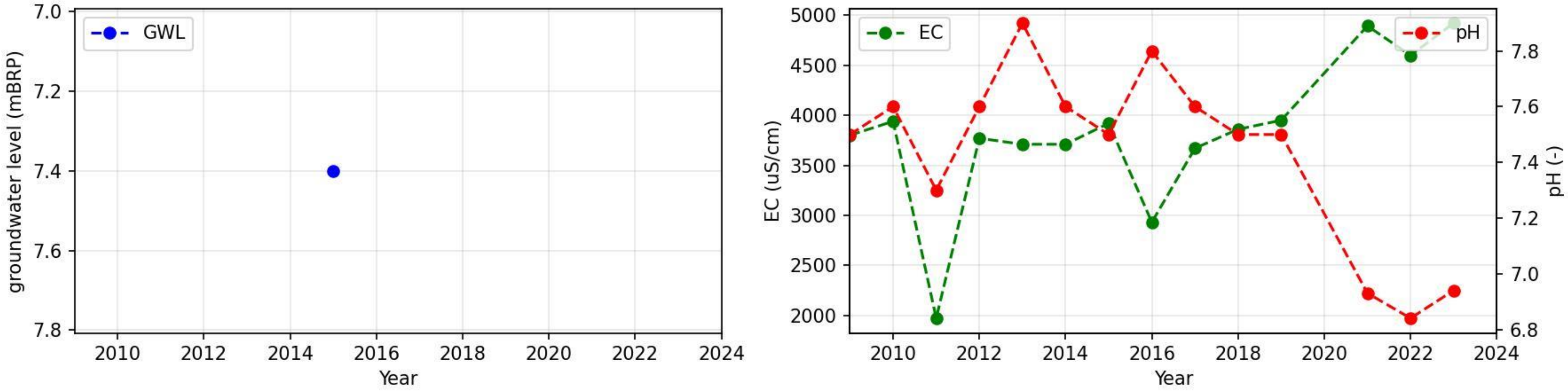
Private bore PB27



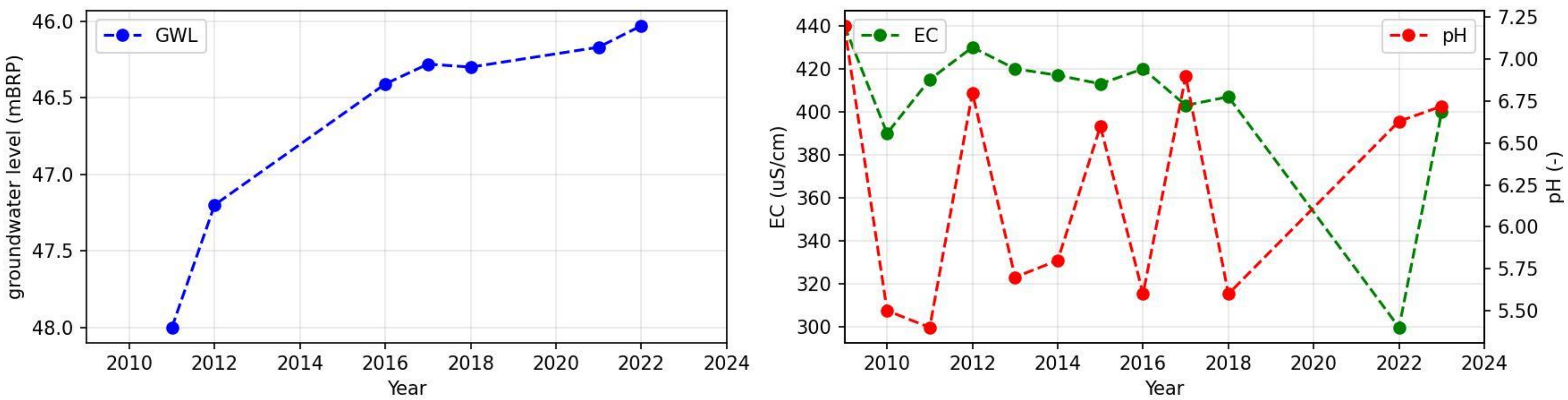
Private bore PB28



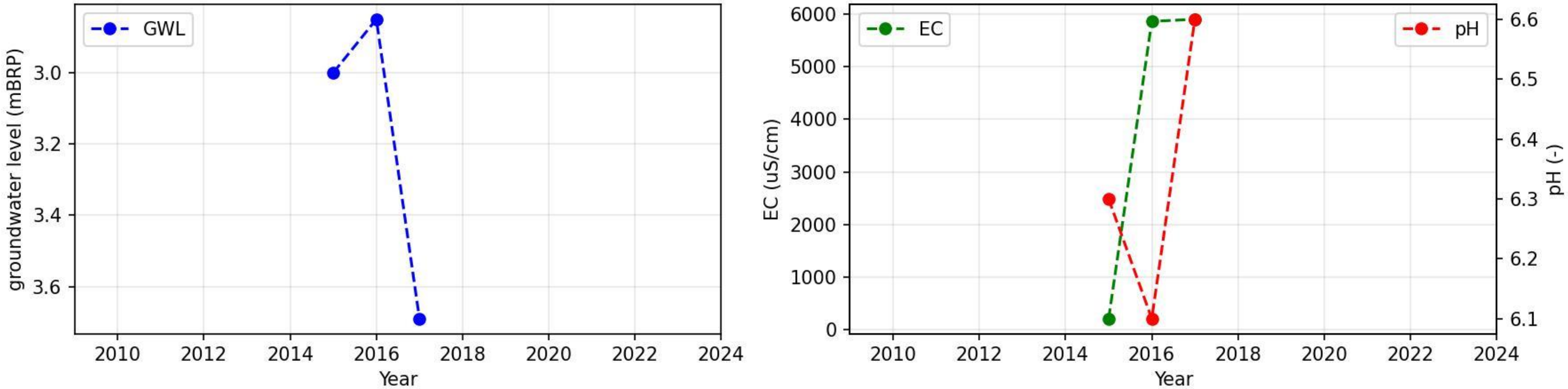
Private bore PB29



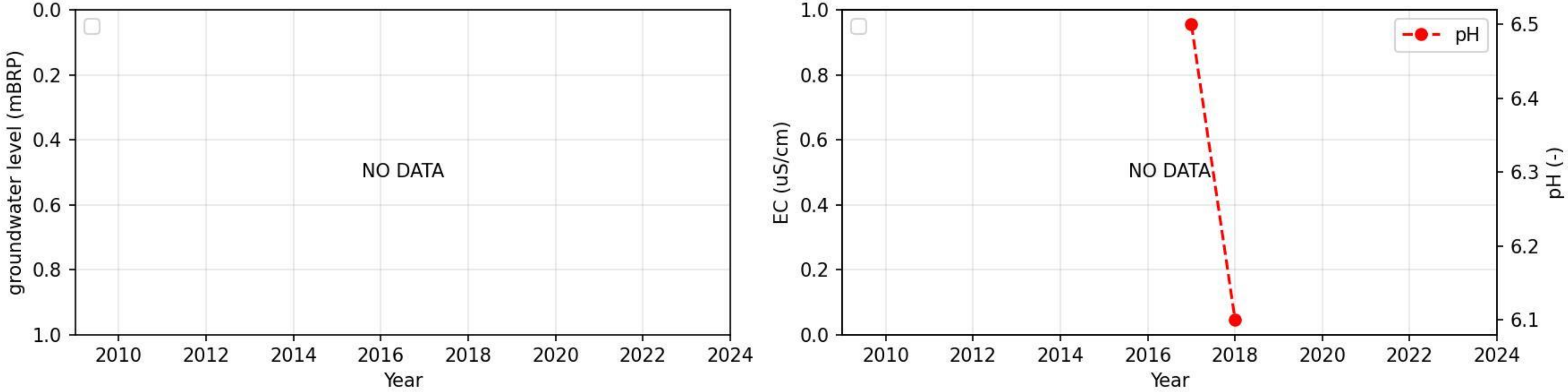
Private bore PB30



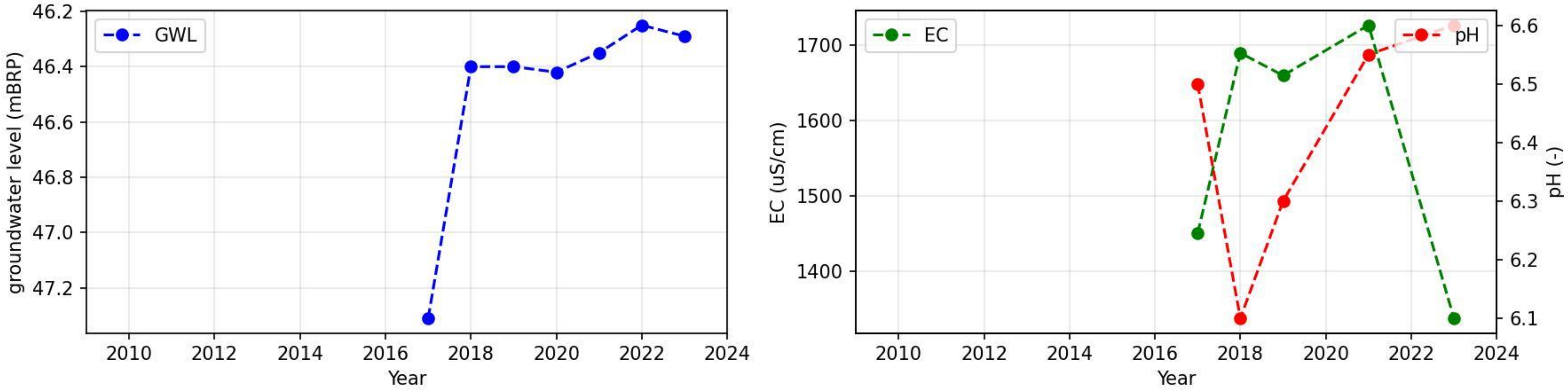
Private bore PB31



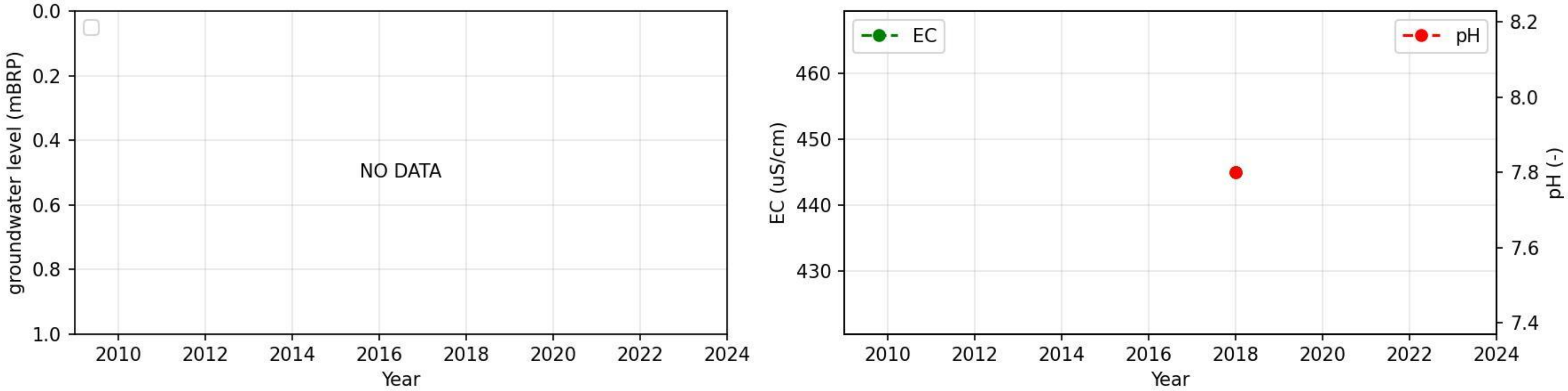
Private bore PB32



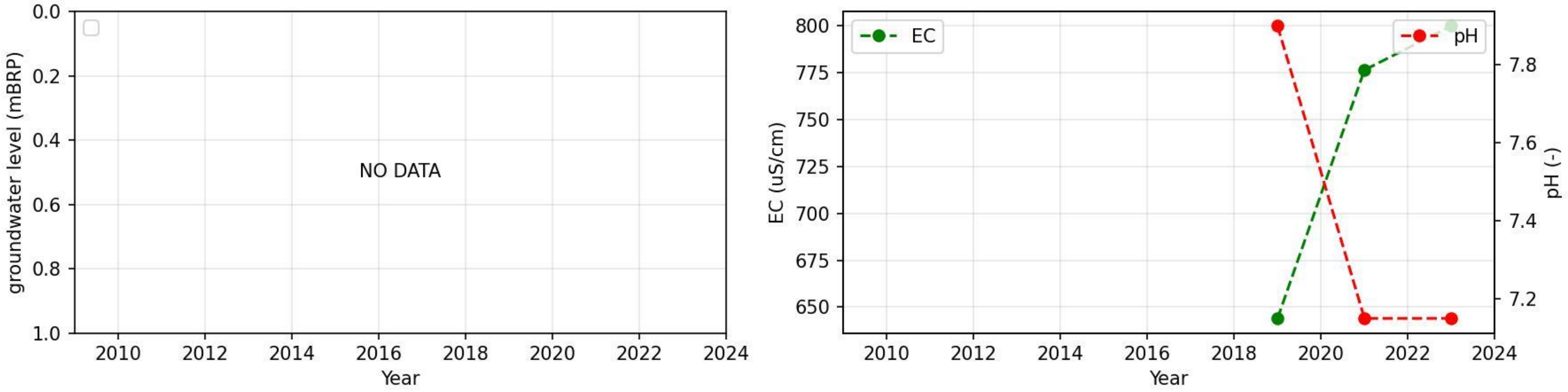
Private bore PB33



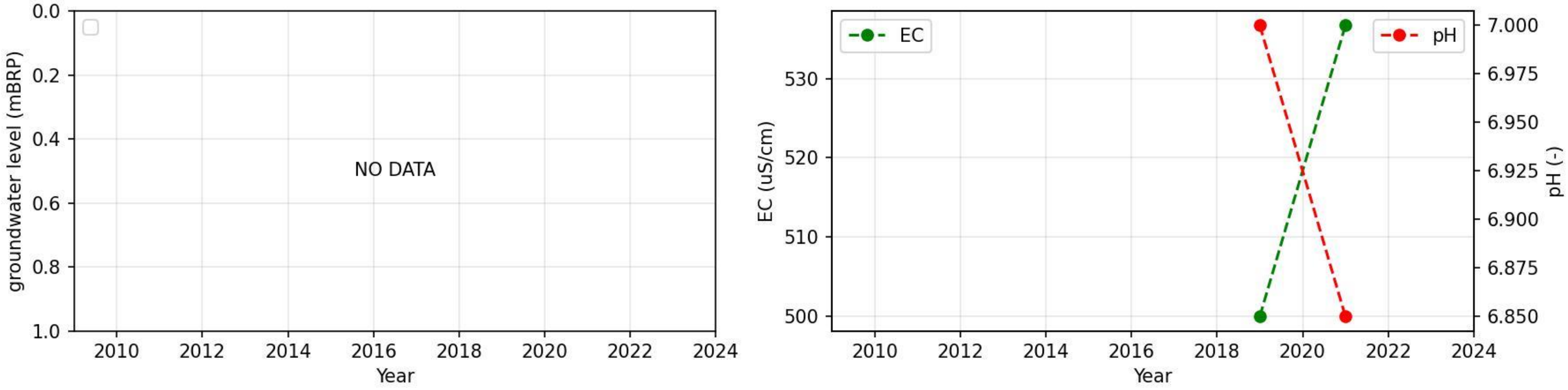
Private bore PB34



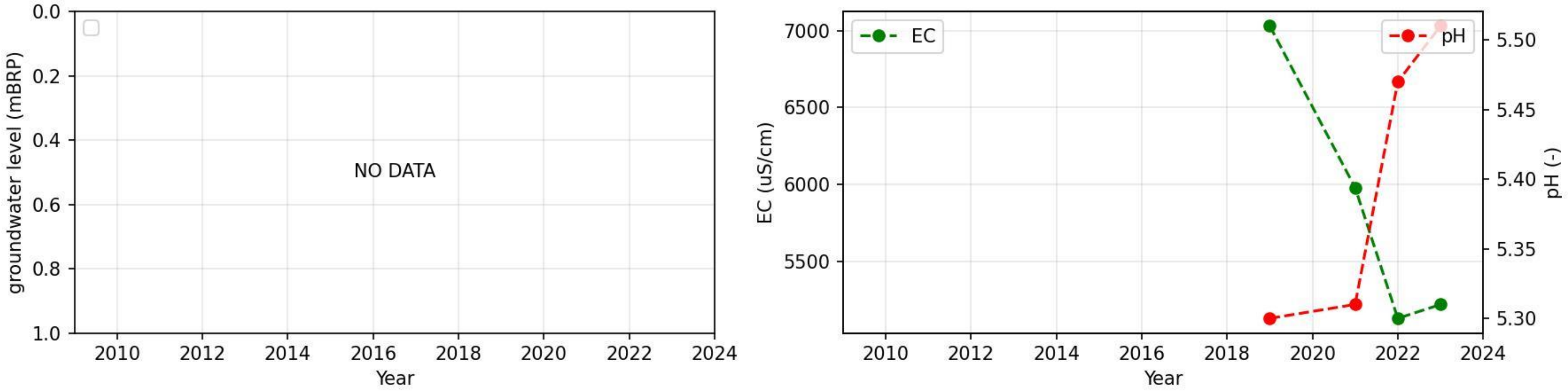
Private bore PB35



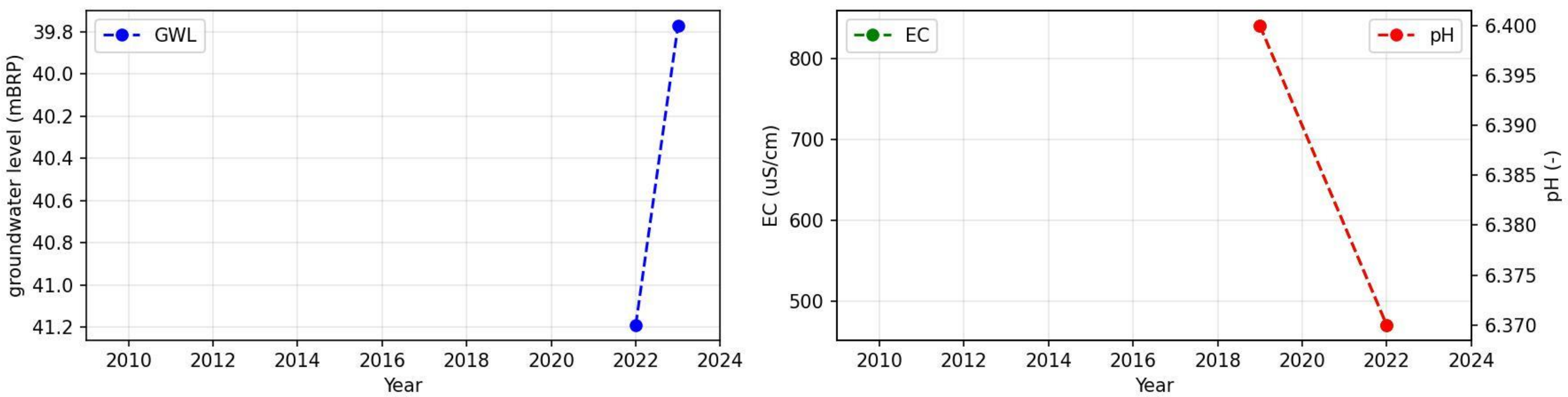
Private bore PB36



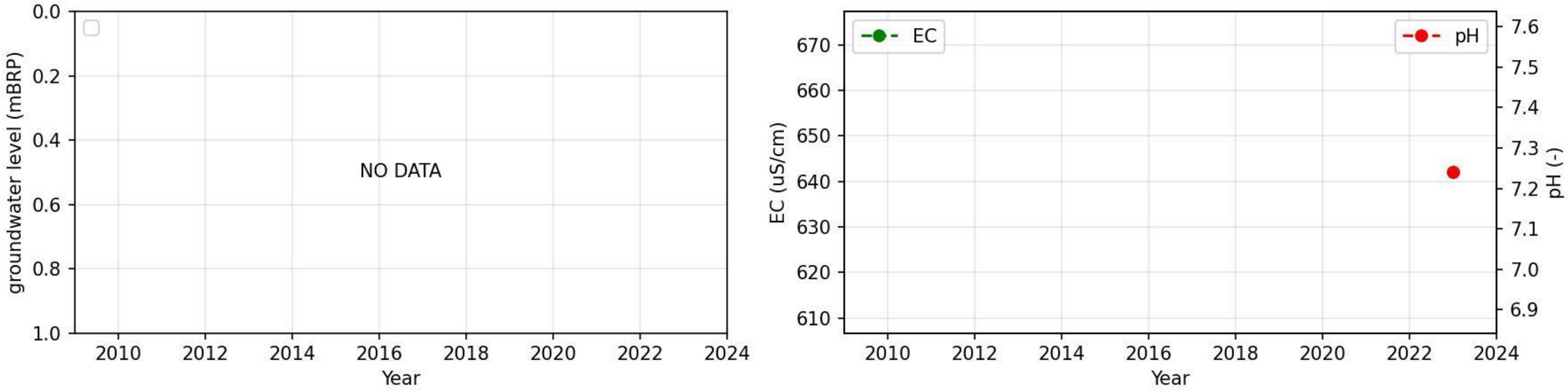
Private bore PB37



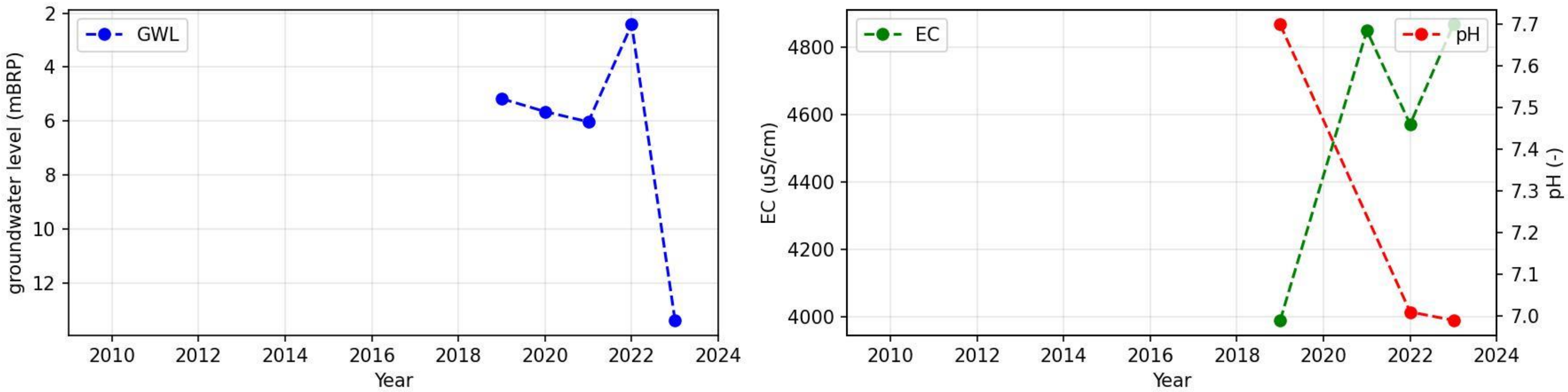
Private bore PB38

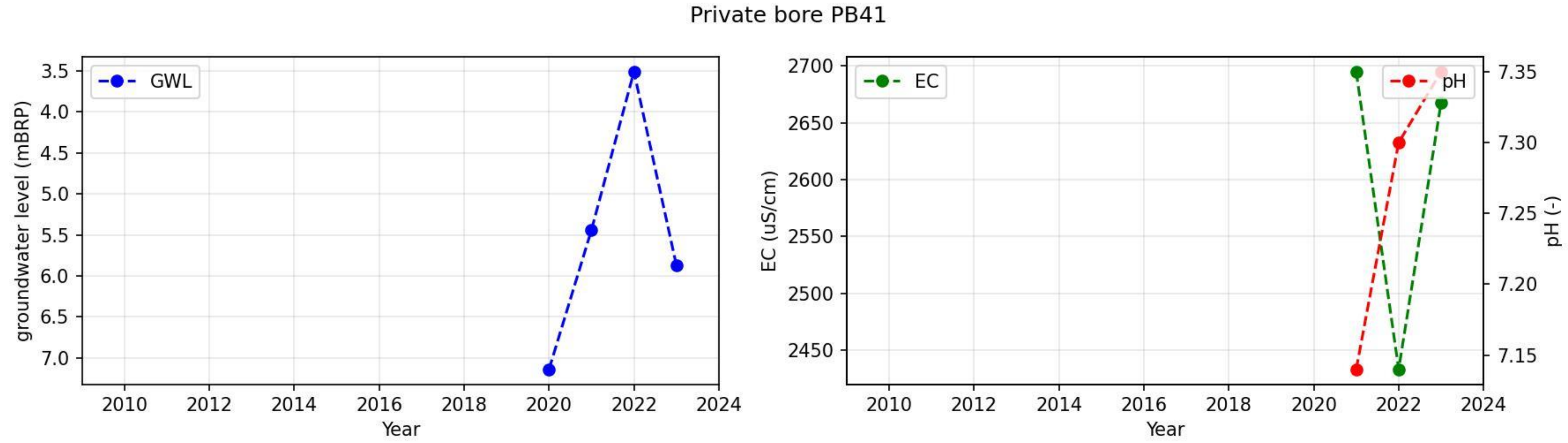


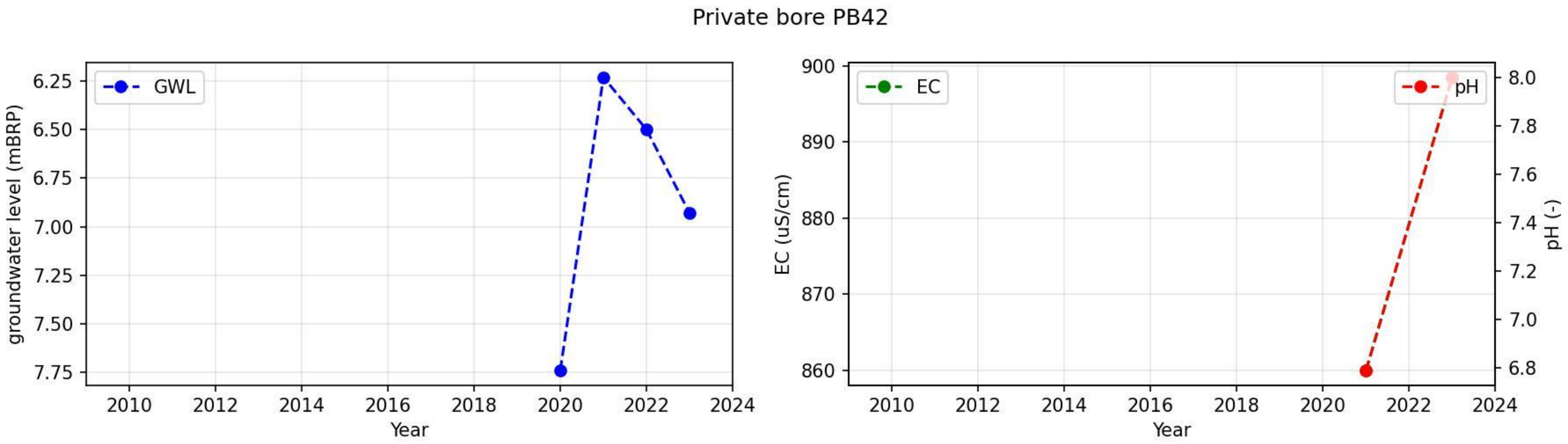
Private bore PB39



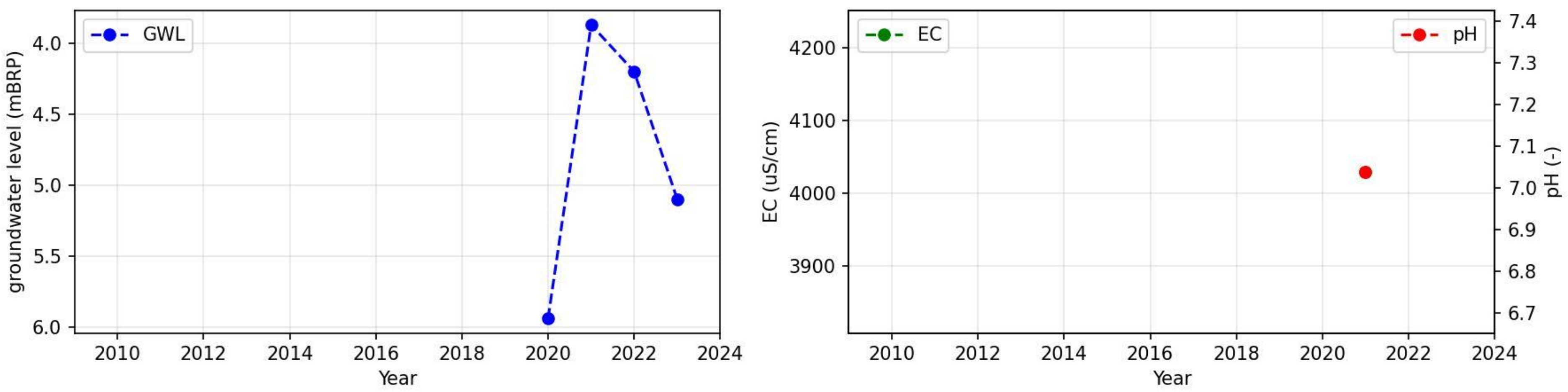
Private bore PB40



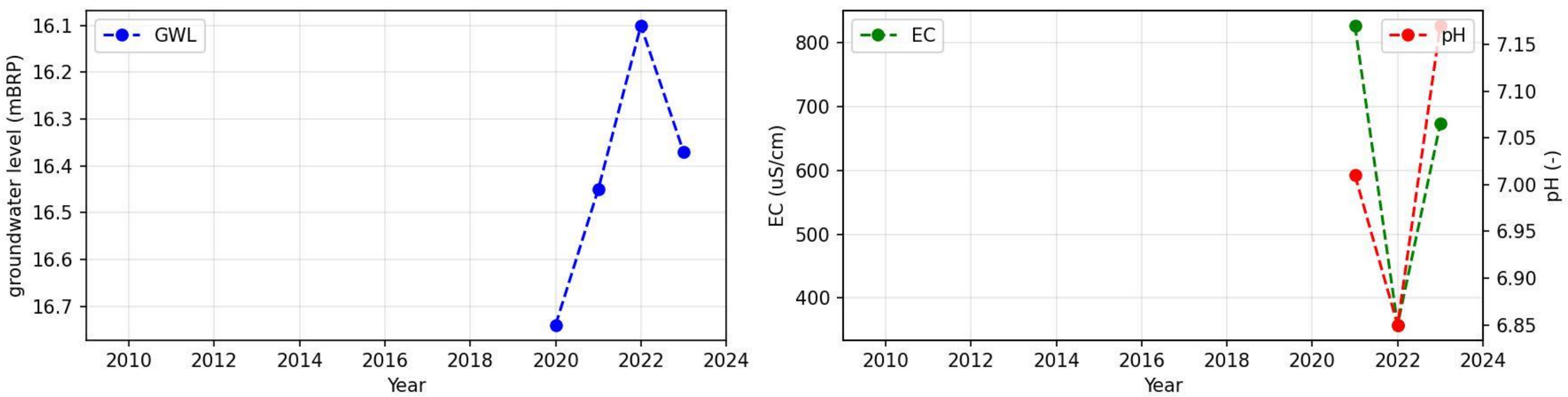

Private bore PB41
GWL
groundwater level (mBRP)
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
2010
2012
2014
2016
2018
2020
2022
2024
Year
EC
pH
EC (uS/cm)
2700
2650
2600
2550
2500
2450
pH (-)
7.35
7.30
7.25
7.20
7.15
2010
2012
2014
2016
2018
2020
2022
2024
Year


Private bore PB42
GWL
groundwater level (mBRP)
6.25
6.50
6.75
7.00
7.25
7.50
7.75
2010
2012
2014
2016
2018
2020
2022
2024
Year
EC
pH
EC (uS/cm)
900
890
880
870
860
pH (-)
8.0
7.8
7.6
7.4
7.2
7.0
6.8
2010
2012
2014
2016
2018
2020
2022
2024
Year

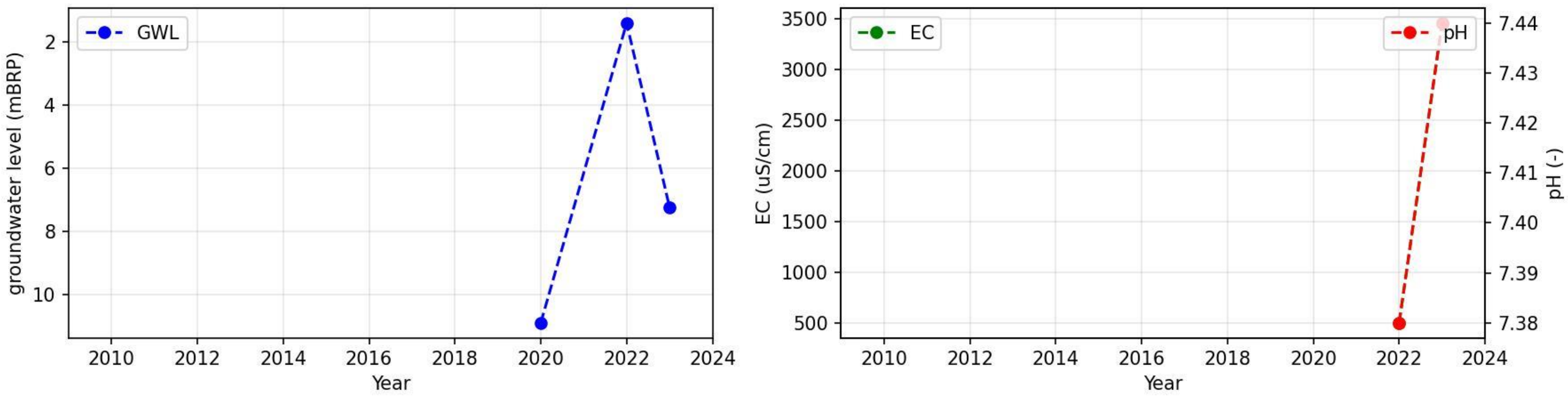
Private bore PB43



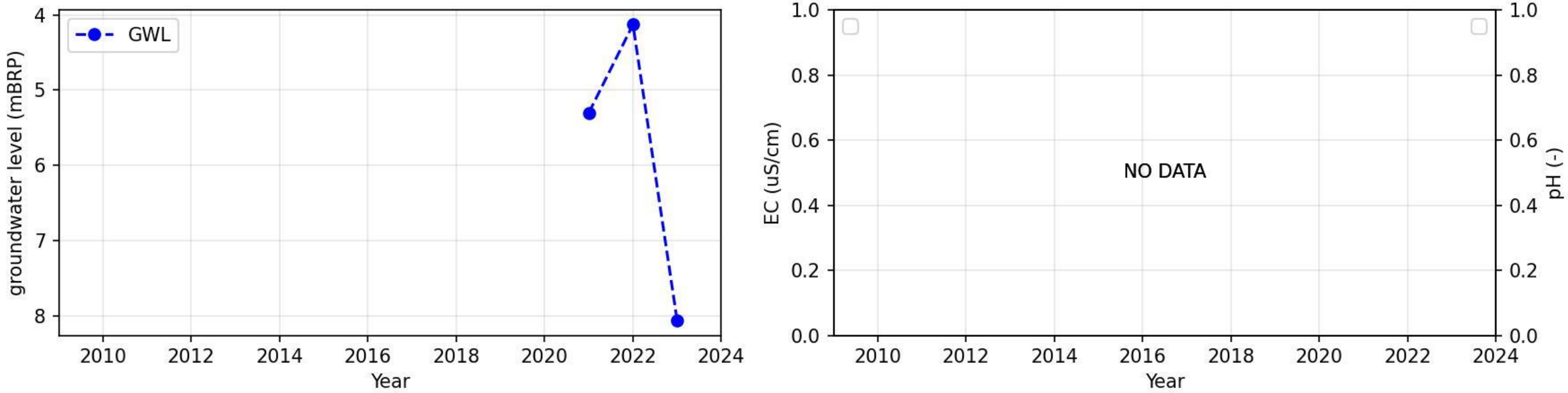
Private bore PB44

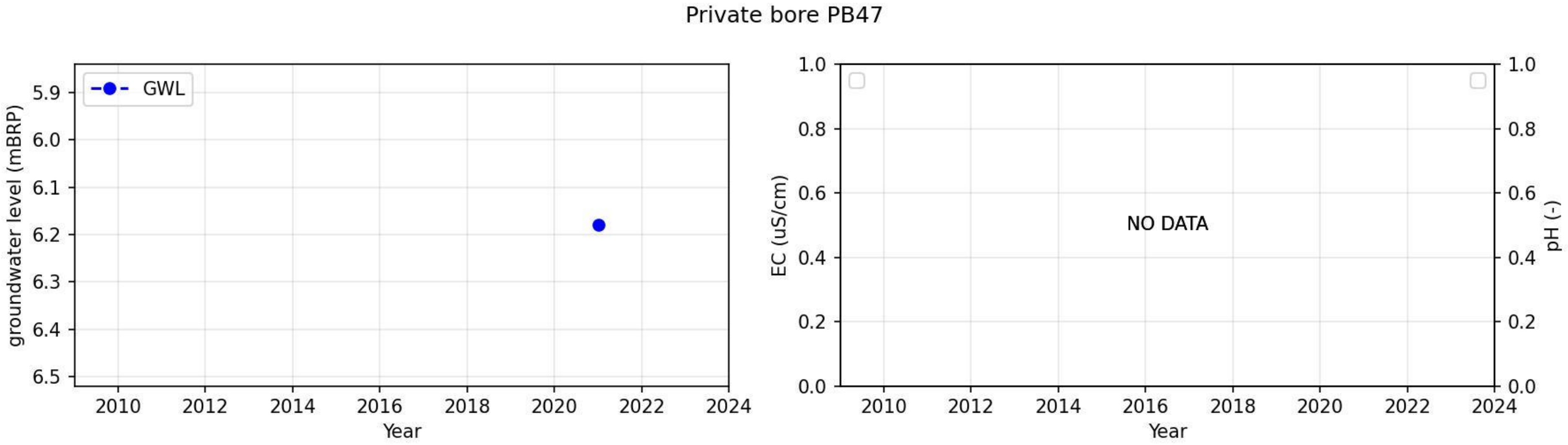


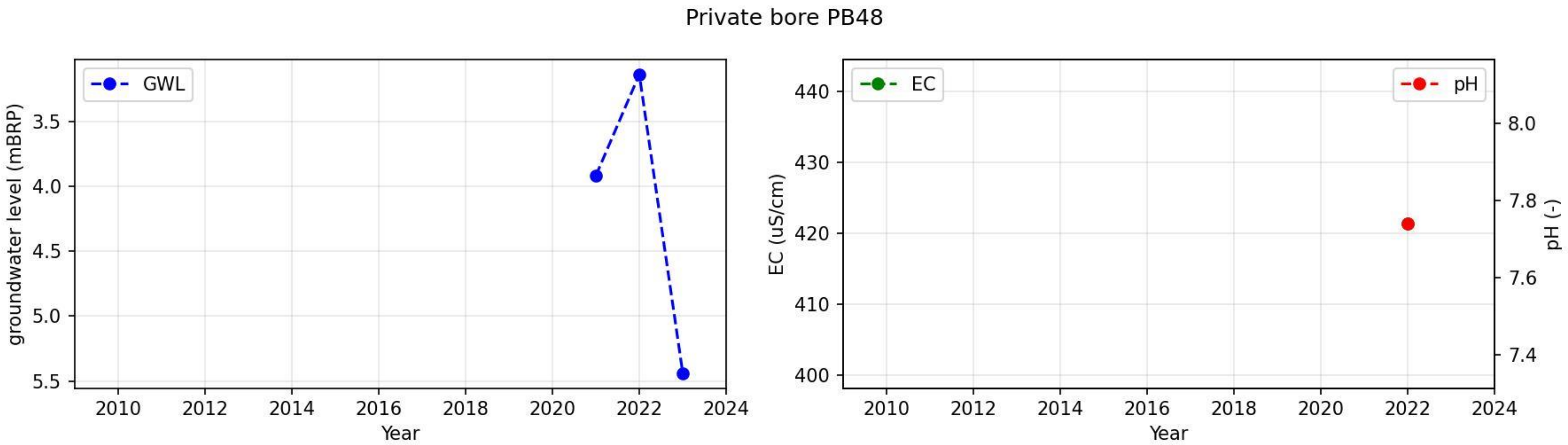
Private bore PB45



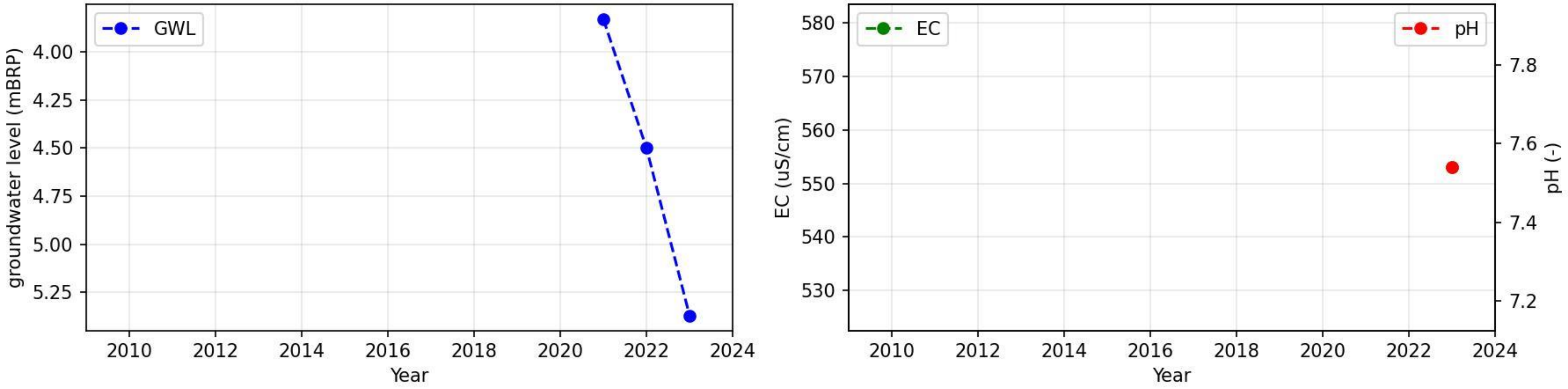
Private bore PB46



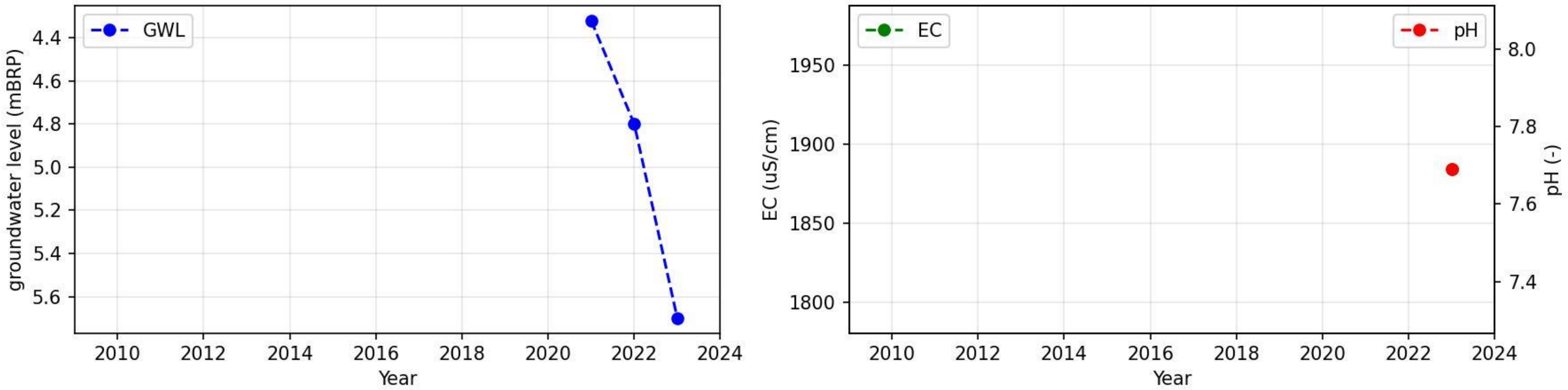

Private bore PB47
GWL
groundwater level (mBRP)
5.9
6.0
6.1
6.2
6.3
6.4
6.5
2010
2012
2014
2016
2018
2020
2022
2024
Year
EC (uS/cm)
pH (-)
1.0
0.8
0.6
0.4
0.2
0.0
NO DATA


Private bore PB48
GWL
groundwater level (mBRP)
3.5
4.0
4.5
5.0
5.5
2010
2012
2014
2016
2018
2020
2022
2024
Year
EC
pH
EC (uS/cm)
440
430
420
410
400
pH (-)
8.0
7.8
7.6
7.4

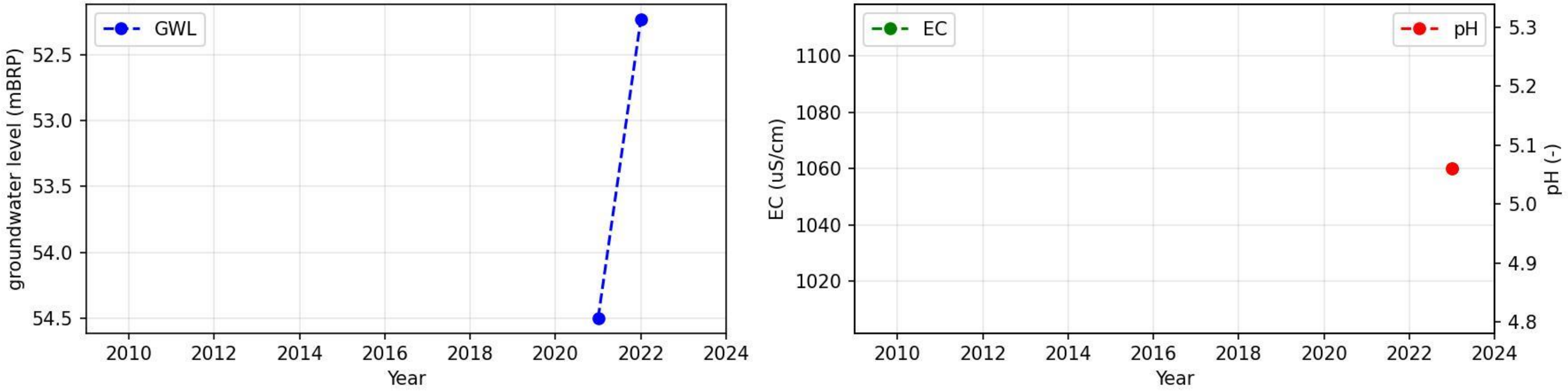
Private bore PB49



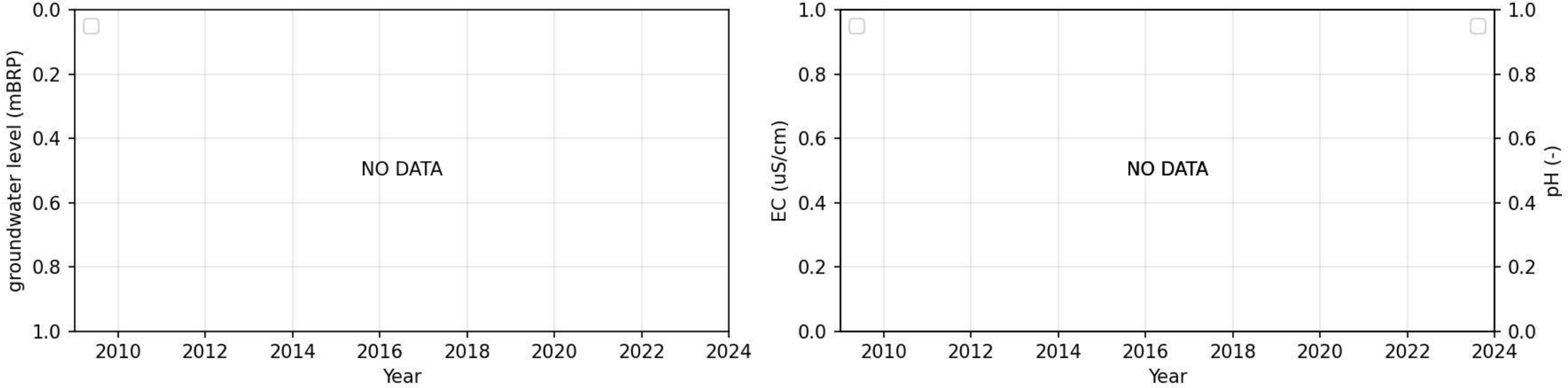
Private bore PB50



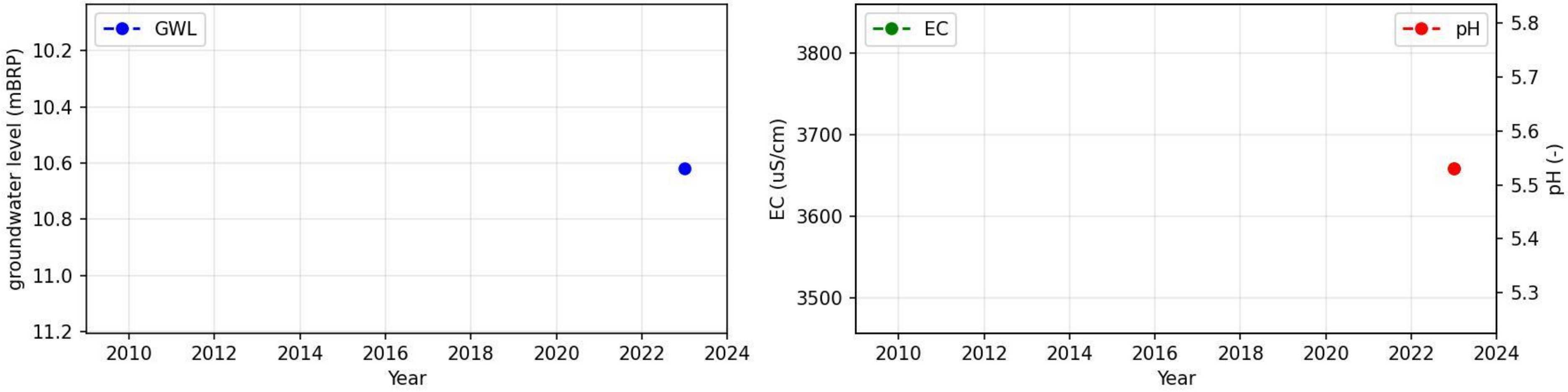
Private bore PB51



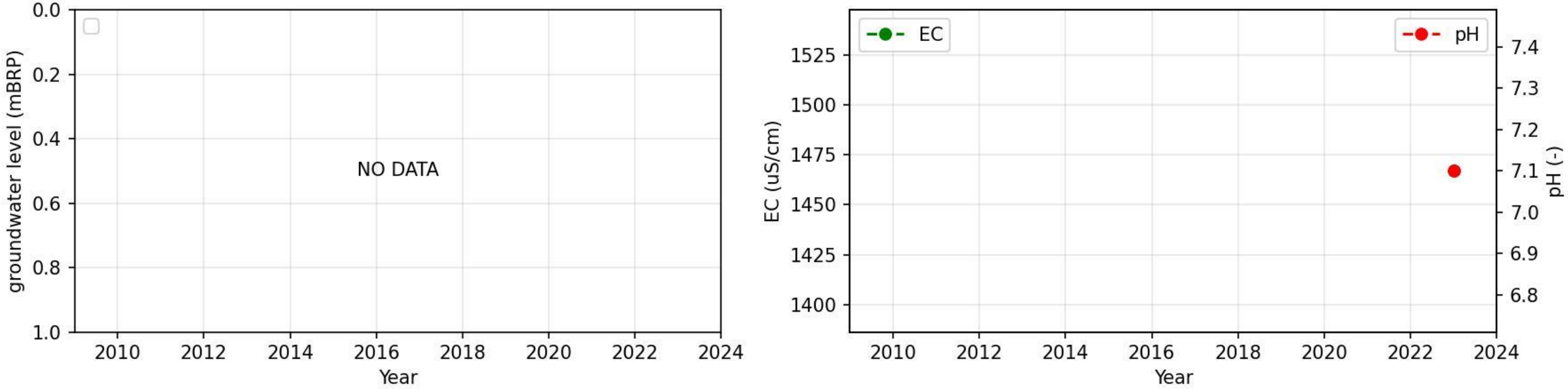
Private bore PB52

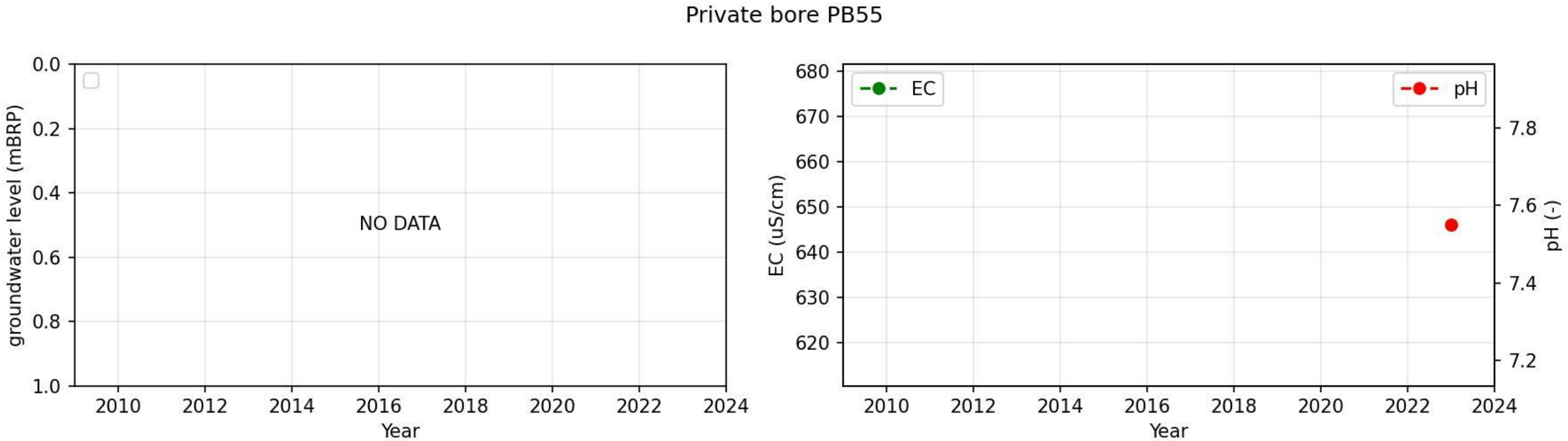


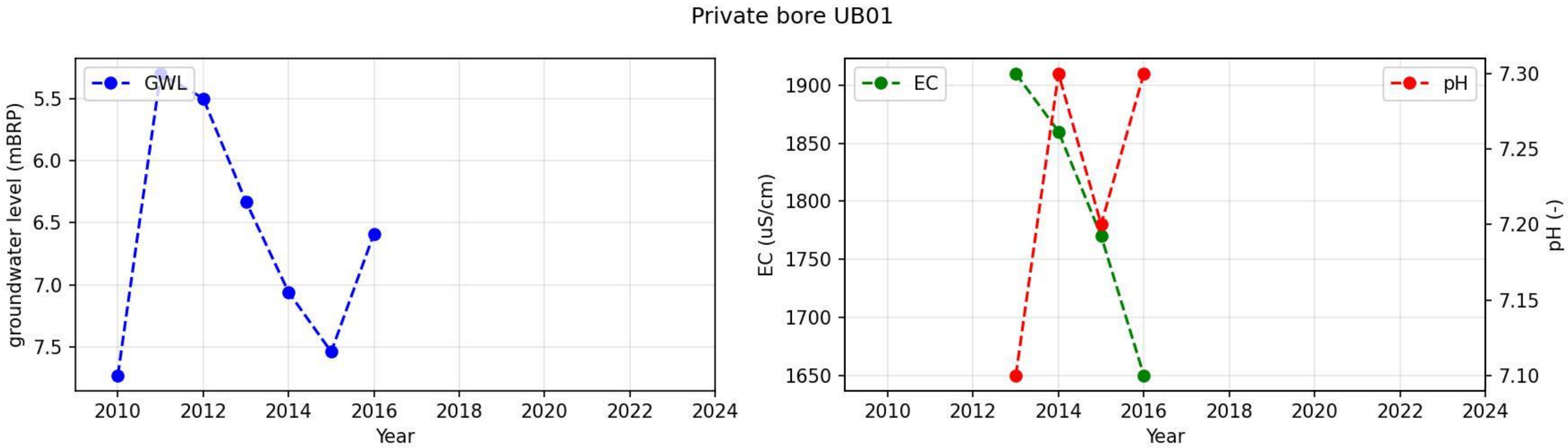
Private bore PB53



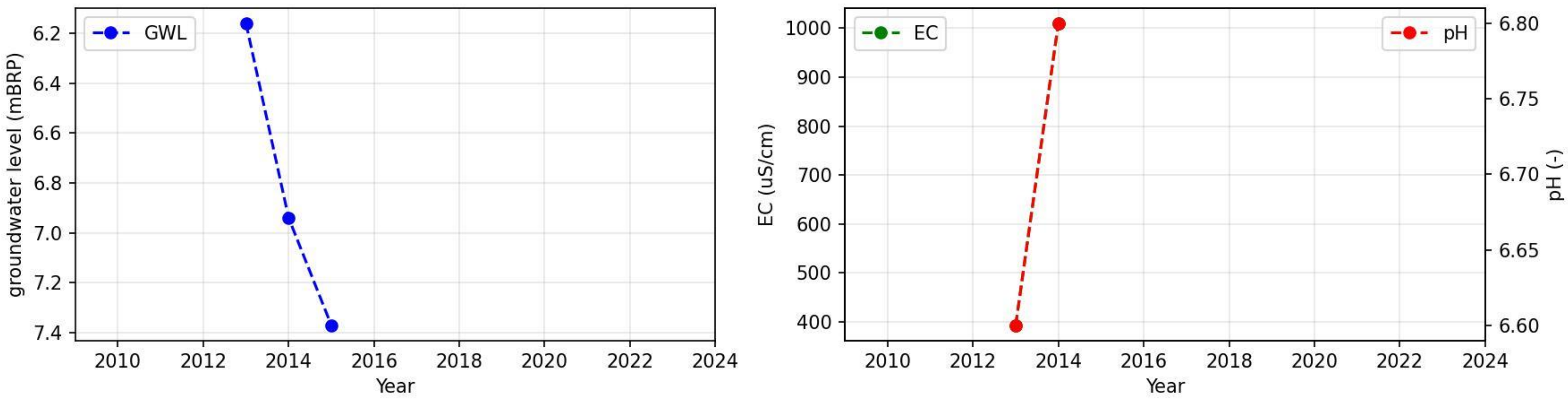
Private bore PB54



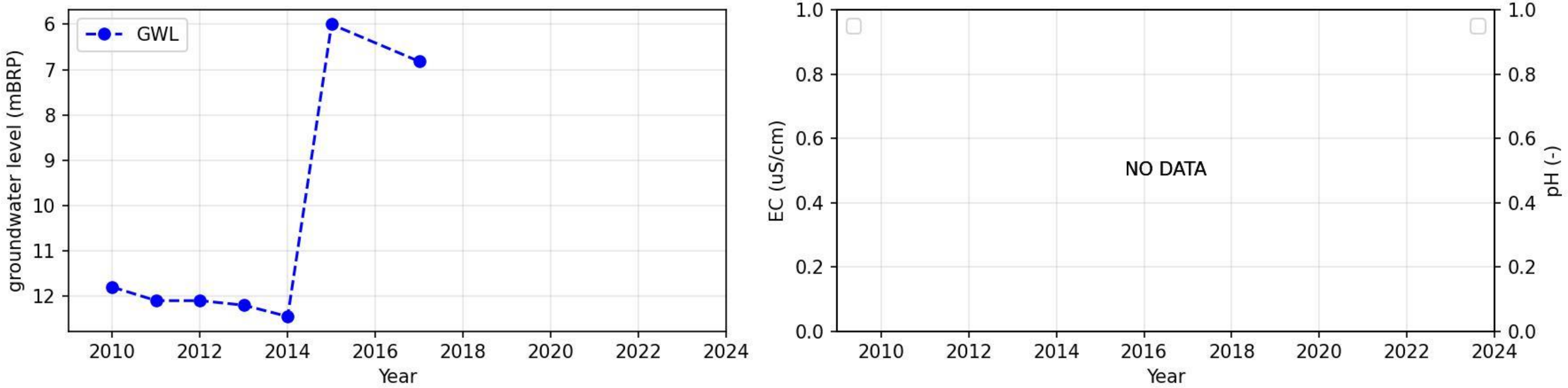

Private bore PB55
groundwater level (mBRP)
0.0
0.2
0.4
0.6
0.8
1.0
NO DATA
2010
2012
2014
2016
2018
2020
2022
2024
Year
EC
pH
680
670
660
650
640
630
620
EC (uS/cm)
7.8
7.6
7.4
7.2
pH (-)
2010
2012
2014
2016
2018
2020
2022
2024
Year


Private bore UB01
GWL
groundwater level (mBRP)
5.5
6.0
6.5
7.0
7.5
2010
2012
2014
2016
2018
2020
2022
2024
Year
EC
pH
1900
1850
1800
1750
1700
1650
EC (uS/cm)
7.30
7.25
7.20
7.15
7.10
pH (-)
2010
2012
2014
2016
2018
2020
2022
2024
Year

Private bore UB02



Private bore UB03



Appendix E

Groundwater model (updated MOD4) level predictions vs observed

Table E 1 NMN predicted vs observed water levels – 2023

Bore ID	Predicted drawdown[1] (m)	Cumulative drawdown as of 2023[2] (m)	Cumulative drawdown per total predicted (%)	Groundwater trigger level[3] (mAHD)	2023 groundwater level[4] (mAHD)
PZ01A	48.82	2.76	6	368.61	414.67
PZ04A	13.91	12.25	88	394.84	396.50
PZ06A	151.71	36.82	24	245.77	360.66
PZ06B	151.65	66.41	44	244.82	330.07
PZ06C	43.21	1.72	4	388.45	429.94
PZ08B	203.96	-	ND	99.79	-
PZ08C	41.24	-	ND	370.67	-
PZ09A	189.48	-51.91	-27	96.25	337.64
PZ09B	203.65	92.68	46	180.71	291.68
PZ09C	51.01	1.13	2	371.13	421.01
PZ09D	0.95	-0.95	-100	476.74	478.64
PZ12A	21.67	-	ND	379.27	-
PZ12B	24.08	2.83	12	381.36	402.61
PZ12C	6.08	-0.44	-7	503.60	510.11
PZ13A	70.17	-	ND	343.71	-
PZ14A	3.61	-43.65	-1210	373.66	420.92
PZ14B	3.34	-7.86	-236	386.00	397.20
PZ14C	2.83	0.75	26	419.01	421.10
PZ24A	159.20	27.21	17	168.74	300.73
PZ24B	5.48	3.42	62	396.55	398.62
PZ25A	22.02	-	ND	346.69	-
PZ25B	21.75	-	ND	346.95	-
PZ26A	82.77	-	ND	181.77	-
PZ26B	82.95	-	ND	321.36	-
PZ26C	0.65	-	ND	429.39	-
PZ26D	0.34	-	ND	429.37	-
PZ28A	7.18	-0.27	-4	420.00	427.45
PZ28B	2.39	-21.74	-909	435.23	459.36

Notes: [1] predicted drawdown from the updated numerical model; trigger equals predicted drawdown plus 15% buffer

ND = No data for 2023

[2] total drawdown as measured by difference between the first measured groundwater level and the Q4 2023 groundwater level

[3] groundwater elevation after total predicted drawdown

[4] from Q4

Table E 2 NMN VWP predicted vs Q4 2023 observed water levels

NMN: vibrating wire piezometers		Model predicted drawdown[1] (m)	2023 observed cumulative drawdown (m)
DDH266*	Triassic (84 m)		-
	Ulan Seam (189 m)		-
	Lower Permian (192 m)		-
DDH270	Triassic (76 m)	NT	31.26
	Permian (165 m)	NT	7.13
	Permian (171 m)	NT	19.61
EX03	Jurassic (28 m)	NT	-0.95
	Jurassic (48 m)	NT	-5.26
	Jurassic (90 m)	NT	-2.01
	Triassic (160 m)	NT	2.22
	Triassic (201 m)	NT	-5.92
	Permian (242 m)	NT	-
	Permian (297 m)	NT	1.35
EX06	Jurassic (9 m)	NT	0.30
	Base of Jurassic (28 m)	NT	5.74
	Triassic (56 m)	NT	-
	Triassic (71 m)	NT	-
	Triassic (95 m)	NT	-
	Base of Triassic (121 m)	NT	-
	PCM (185 m)	NT	-
	Ulan Seam (227 m)	NT	-
EX09	Jurassic (33 m)	NT	4.77
	Jurassic (50 m)	NT	5.52
	Jurassic (87 m)	NT	-1.91
	Triassic (126 m)	NT	-
	Triassic (209 m)	NT	5.73
	Triassic (261 m)	NT	32.85
	Triassic (301 m)	NT	94.26
PZ29	Jurassic (18 m)	0.91	0.46
	Triassic (50 m)	0.91	1.50
	Triassic (72 m)	1.08	2.33
	Triassic (90 m)	2.98	3.25
	Triassic (122 m)	4.02	3.54

NMN: vibrating wire piezometers		Model predicted drawdown[1] (m)	2023 observed cumulative drawdown (m)
	Goulburn Seam (143 m)	5.54	8.09
	Interburden (183 m)	104.36	2.58
	Ulan Seam (243 m)	147.16	36.16
TAL-1	Triassic (28 m)	128.49	3.73
	Triassic (45 m)	128.49	5.11
	Permian (61 m)	128.47	7.19
	Permian (97 m)	123.57	-3.58
	Ulan Seam (140 m)	120.64	29.44
TAL-2	Permian (50 m)	0.96	1.03
	Permian (90 m)	16.67	1.16
	Permian (110 m)	47.10	15.69
	Ulan Seam (128 m)	60.04	6.91
UW1	Permian (22 m)	NM	4.56
	Permian (35 m)	NM	8.28
	Permian (51 m)	NM	12.53
	Ulan Seam (67 m)	NM	3.55
UW2	Triassic (60 m)	6.16	-2.54
	Permian (90 m)	6.16	4.75
	Ulan Seam (120 m)	11.11	-1.66
UW3	Permian (40 m)	6.02	0.27
	Permian (60 m)	6.02	1.91
	Permian (75 m)	9.60	3.06
	Ulan Seam (98 m)	52.35	-4.99
UW4	Permian (41 m)	NM	6.03
	Permian (63 m)	NM	0.63
	Permian (87 m)	NM	3.31
	Ulan Seam (122 m)	NM	5.51
R894	90 m	8.22	-
	119 m	15.23	4.93
	219 m	13.12	4.19
	255 m	33.31	5.24

Notes: [1] predicted drawdown from the updated numerical model; trigger equals predicted drawdown plus 15% buffer

NM = not modelled.

NT = no trigger

= *cumulative* observed drawdown exceeds modelled drawdown.