Whitehaven

Reporting date: 12 December 2025
Submitted via email to epbcmonitoring@dcceew.gov.au

Environmental Event Report

Narrabri Underground Mine Stage 3 Extension Project

Application number:	EPBC 2019/8427
Licensee/Proponent:	Narrabri Coal Operations Pty Ltd Locked Bag 1002 Narrabri NSW 2390
Licensed Premises/Land:	Narrabri Coal Operations (NCO) 10 Kurrajong Creek Road Baan Baa NSW 2390

a) **Summary of the incident;**

Quarterly groundwater monitoring was completed in accordance with the Groundwater Management Plan[1] (**the plan**); monitoring results for several locations (Table 1) have exceeded the groundwater impact assessment criteria listed in the plan. NCO have complied with the plan requirements and enacted the Trigger Action Response Plan (**TARP**). The TARP lists the following response when monitoring indicates an exceedance of water level and/or quality triggers:

- *Implement incident notification measures.*
  - Notification to NSW Department of Planning, Housing and Infrastructure (DPHI), and the Australian Government DCCEEW was completed on: 12 November 2025.
- *Engage a suitably qualified hydrogeologist to undertake an assessment and report on any identified changes/likely causes and recommendations.*
  - Results from monitoring bores with reported exceedance of trigger levels were provided to Australasian Groundwater & Environmental Consultants Pty Ltd (**AGE**) to undertake a hydrogeological review. The investigation report is provided as Attachment A.

Table 1: Summary of groundwater monitoring trigger value exceedances

Sample Date	Bore ID	Coordinates (MGA55)	Formation	Trigger Type	Trigger Value	Q4 2025 Monitoring Result
4/11/2025	P2	777282; 6616355	Napperby	Water Quality- EC	19342 µS/cm [2]	19460 µS/cm
4/11/2025	P4	777490; 6625553	Napperby	Water Quality- EC	24912 µS/cm [2]	25300 µS/cm
6/11/2025	P10	774063; 6616444	Napperby	Water Quality- EC	9426 µS/cm [3]	14680 µS/cm

[1] Narrabri Mine Groundwater Management Plan rev0A

Sample Date	Bore ID	Coordinates (MGA55)	Formation	Trigger Type	Trigger Value	Q4 2025 Monitoring Result
7/11/2025	P29	778541; 6619978	Napperby	Water Quality- EC	11337 µS/cm [3]	19590 µS/cm
7/11/2025	P47	776166; 6622586	Garrawilla	Water Quality- EC	5970 µS/cm [1]	6120 µS/cm
4/11/2025	P53	776995; 6620655	Garrawilla	Water Quality- EC	1169 µS/cm [3]	2041 µS/cm
7/11/2025	P9	775127; 6620209	Purlawaugh	Water Quality- EC	21190 µS/cm [3]	21900 µS/cm
27/10/2025	P11	774066; 6616447	Purlawaugh	Water Level	269.8mAHD [3]	267.55mAHD
				Water Quality- EC	6546 µS/cm [3]	9316 µS/cm
4/11/2025	P39A	782024; 6620076	Watermark	Water Quality- EC	5970 µS/cm [1]	7020 µS/cm
4/11/2025	P39B	782018; 6620077	Tullamullen Alluvium	Water Quality- EC	6546 µS/cm [3]	12090 µS/cm
5/11/2025	P7	768998; 6624338	Pilliga Sandstone	Water Quality- pH	pH minimum - 6.0	5.08 pH

[1] ANZG (2018) livestock drinking water (beef cattle)
[2] Tier 1- bore specific 80th percentile
[3] Tier 2- bore specific 95th percentile

b) Outcomes of an investigation, including identification of the cause of the incident

AGE was requested to undertake an assessment of the exceedances and report on any identified changes/likely causes and recommendations. The investigation report is attached:

- *Narrabri Coal Mine- Hydrogeological Review of Monitoring Bore Exceedances Q4 2025*

Conclusions and recommendations for individual exceedances are contained within the attached report. A summary of findings and recommendations for further work are included in Table 2. This includes recommendations from the 2024 Annual Review that states that bores with repeated exceedances should consider the following:

- does the conclusion that changes are associated with climatic events remain true; and
- has a new adjusted baseline been established, if so, a review of the baseline data and trigger levels is recommended.
    - New trigger levels have been recommended for several bores (Table 2). The Water Management Plan has been revised to include the new trigger levels; submitted to NSW DPHI for approval on 12 December 2025.

For bores with no current recommendation for further work monitoring should continue with data reviewed quarterly to determine if bore has reached equilibrium or any other changes are noticeable.

Overall, the review indicated that the GWMP was followed and that the exceedances have not resulted in potential risk of environmental impacts to sensitive receptors.

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Table 2: Summary of exceedances and recommendations for further work (Table 8.1 in attached AGE report)

Bore ID	Formation	Exceedance	Likely cause	New baseline / triggers established	Further work required
P2	Napperby	EC	Natural variations / major climate event	Tier 1 22,080 µS/cm Tier 2 22,533 µS/cm	Update triggers
P4	Napperby	EC	Natural variations / major climate event	Tier 1 28,300 µS/cm Tier 2 28,991 µS/cm	Update triggers
P7	Pilliga	pH	Natural variability of formation	N/A	No, continue monitoring
P9	Purlawaugh	EC	Natural variations / major climate event	No	Examine if new baseline can be established
P10	Napperby	EC	Natural variations / major climate event	No	Examine if new baseline can be established
P11	Purlawaugh	EC and water levels	Lateral migration of water and mixing within the formation	No	No
P29	Napperby	EC	Saturation of unsaturated zone	N/A	No
P39A	Watermark	EC	Natural variations / major climate event	Tier 1 7,710 µS/cm Tier 2 8,031 µS/cm	Update triggers
P39B	Alluvium	EC	Natural variations / major climate event	Tier 1 13,662 µS/cm Tier 2 14,198 µS/cm	Update triggers
P47	Garrawilla	EC	Natural variations / major climate event	No	No
P53	Garrawilla	EC	Mixing with other groundwater and/or infiltration of water from REA	N/A	No

c) **Details of the corrective actions that have been, or will be, implemented to address the incident and prevent recurrence;**

- New trigger levels have been recommended for several bores (Table 2). The Water Management Plan has been revised to include the new trigger levels; submitted to NSW DPHI for approval on 12 December 2025.
- The recommendation associated with monitoring bore P53 for additional analysis of rejects material has commenced.

The outcomes of these actions will be summarised within the 2025 Annual Review to be submitted no later than 31 March 2026 (required under condition E11 of SSD-10269) and in the annual report detailing the outcomes of the water monitoring program (required under Condition 13 of EPBC 2019/8427).

d) Details of compliance with requirements of the relevant management plan pertinent to the incident

Water Management Plan- Groundwater Monitoring Program		
Section / Requirement	**Comments**	**Compliant**
4.2 Groundwater monitoring program Monitoring type- Standpipes Quarterly field EC and pH	All required groundwater monitoring wells are sampled quarterly in accordance with groundwater monitoring program.	Yes
5. Trigger Action Response Plan Level 2- Routine monitoring indicates water quality exceeds the EC trigger value over three consecutive monitoring events.	NCO have initiated the required response for a Level 2 TARP trigger.	Yes
6. Incidents and non-compliance As soon as practicable after becoming aware of an exceedance of performance criteria notify DPHI and provide a detailed report within 7 days.	As per table 5.1 TARP - Engage a suitably qualified hydrogeologist to undertake an assessment and report on any identified changes/likely causes and recommendations. - Implement reasonable and feasible remediation measures in accordance with hydrogeologist recommendations and in consultation with DPHI. NCO became aware of the exceedance of performance criteria on 11 November 2025 and provided incident notification on 12 November 2025. A hydrogeologist was engaged to undertake an assessment. There are no remediation measures recommended by the hydrogeologist. Recommendations have been provided in Table 2.	Yes

e) Details of any communication with other stakeholders regarding the incident.

Due to the generally high naturally occurring groundwater salinity in the area, there is limited existing groundwater abstraction in the immediate mining area other than for coal mine dewatering. No vulnerable receptors or active stock/irrigation bores are in the immediate area and therefore no immediate action is required outside of further investigation and monitoring.

The outcomes of the investigation and attached report have been provided to NSW DPHI.

Reported by:

Brent Baker
Environmental Manager

Whitehaven

ATTACHMENT A

Narrabri Coal Mine - Hydrogeological Review of Monitoring Bore Exceedances Q4 2025, Australasian Groundwater & Environmental Consultants

11 December 2025

Narrabri Coal Mine
Kamilaroi Highway
Narrabri NSW 2390

Attention: Brent Baker
via email: BrentBaker@whitehavencoal.com.au

Dear Brent,

Narrabri Coal Mine – Hydrogeological Review of Monitoring Bore Exceedances Q4 2025

1 Introduction

Narrabri Coal Operations Pty Ltd (NCOPL) routinely monitor groundwater levels and quality above and surrounding the Narrabri Coal Mine. Groundwater monitoring campaigns are conducted in accordance with the site Water Management Plan (WMP) [1]. Monitoring results have been reviewed against the 2024 revision of the WMP which has been updated with water level and quality trigger criteria that align with the approved Extraction Plan LW203-206 WMP[2]. Groundwater drawdown trigger levels are based on the latest revision of the site groundwater model[3]. As shown in Figure 2.1 water levels and quality are monitored by a network of standpipe monitoring bores and vibrating wire piezometers (VWPs). Data collected at these monitoring locations is reviewed quarterly by Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) on behalf of NCOPL.

The Narrabri WMP includes Trigger Action Response Plans (TARP) for managing changes in groundwater levels and quality and defines groundwater level and quality triggers. For water levels and bores where water is unsuitable for stock and irrigation a two-tiered trigger system is used;

- Tier 1 trigger provides a method for assessing a gradual change in groundwater quality over the medium term; and
- Tier 2 trigger is intended to detect an event related change over the short term.

Bores P2, P4, P9, P10, P11, P29, P39A, P39B, P47, and P53 were identified as exceeding their Tier 2 water quality electrical conductivity (EC) trigger for three consecutive recordings, P7 exceeded pH trigger lower level and P11 exceeded water level trigger. As per the trigger action response plan (TARP), further review was required. AGE was commissioned by NCOPL to undertake this review of exceedances for Q4 2025.

[1] Narrabri Coal Operations (2022) Stage 3 Groundwater Management Plan, revision date 01 December 2022.

[2] Narrabri Coal Operations (2025) Narrabri Mine Extraction plan water management plan LW203 – LW206, revision date 24 January 2025.

[3] AGE Consultants (2024) Narrabri Coal Mine Groundwater Model – Re-calibration Stage 2 MOD 7 v 01.01.

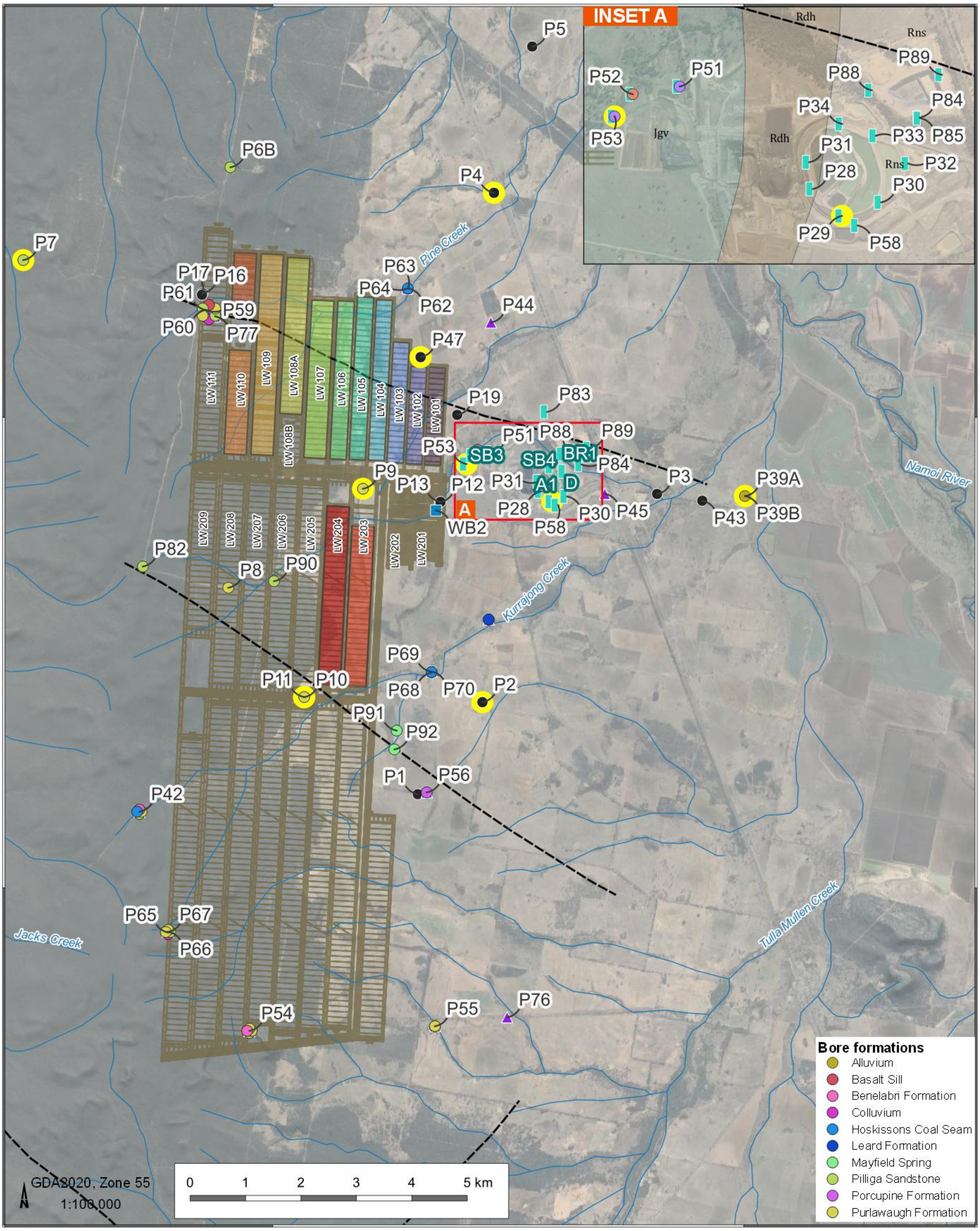
2 Bore locations and construction

Details of bores with recorded exceedances including locations, installation depths, screened intervals and formations are listed in Table 2.1. Further information on the trigger levels and exceedances is listed in Table 3.1, Table 3.2 and Table 3.3.

Table 2.1 Bore construction details of bore with exceedances and nearby bores

Bore ID	Easting	Northing	Total depth (m bgl)	Screen interval (m bgl)	Target formation	Exceedance
P2	777282	6616356	50	44-50	Napperby Formation	Water quality - EC
P4	777491	6625554	30	24-30	Napperby Formation	Water quality - EC
P7	768998	6624340	90	78-90	Pilliga Sandstone	Water quality - pH
P9	775127	6620209	36	24-36	Purlawaugh Formation	Water quality - EC
P10	774064	6616445	130	118-130	Napperby Formation	Water quality - EC
P11	774067	6616449	40	34-40	Purlawaugh Formation	Water quality – EC Water level
P29*	778542	6619979	25	19-25	Napperby Formation	Water quality - EC
P39A	782024	6620078	80	72-80	Watermark Formation	Water quality - EC
P39B	782019	6620079	32	15-30	Tullamullen Alluvium	Water quality - EC
P47	776167	6622587	30.5	8-30.5	Garrawilla Volcanics	Water quality - EC
P53*	776995	6620657	24	18-21	Garrawilla Volcanics	Water quality - EC

Notes: Coordinates are in GDA2020.
m bgl - metres below ground level.
*seepage monitoring bores.



LEGEND

- Drainage
- Minor
- Planned underground mine workings

Monitoring Bores

- Standpipe
- Standpipe - seepage detection
- Production - stock and domestic
- VWP
- Faults

LW101, LW102, LW103, LW104, LW105, LW106, LW107, LW108, LW109, LW110, LW110A, LW111, LW203, LW204

Narrabri Mine Quarterly and Annual Reporting 2025 - 2026 (NAR5027.001)

Groundwater Monitoring Network

AGE

DATE 11/12/2025

FIGURE No: **2.1**

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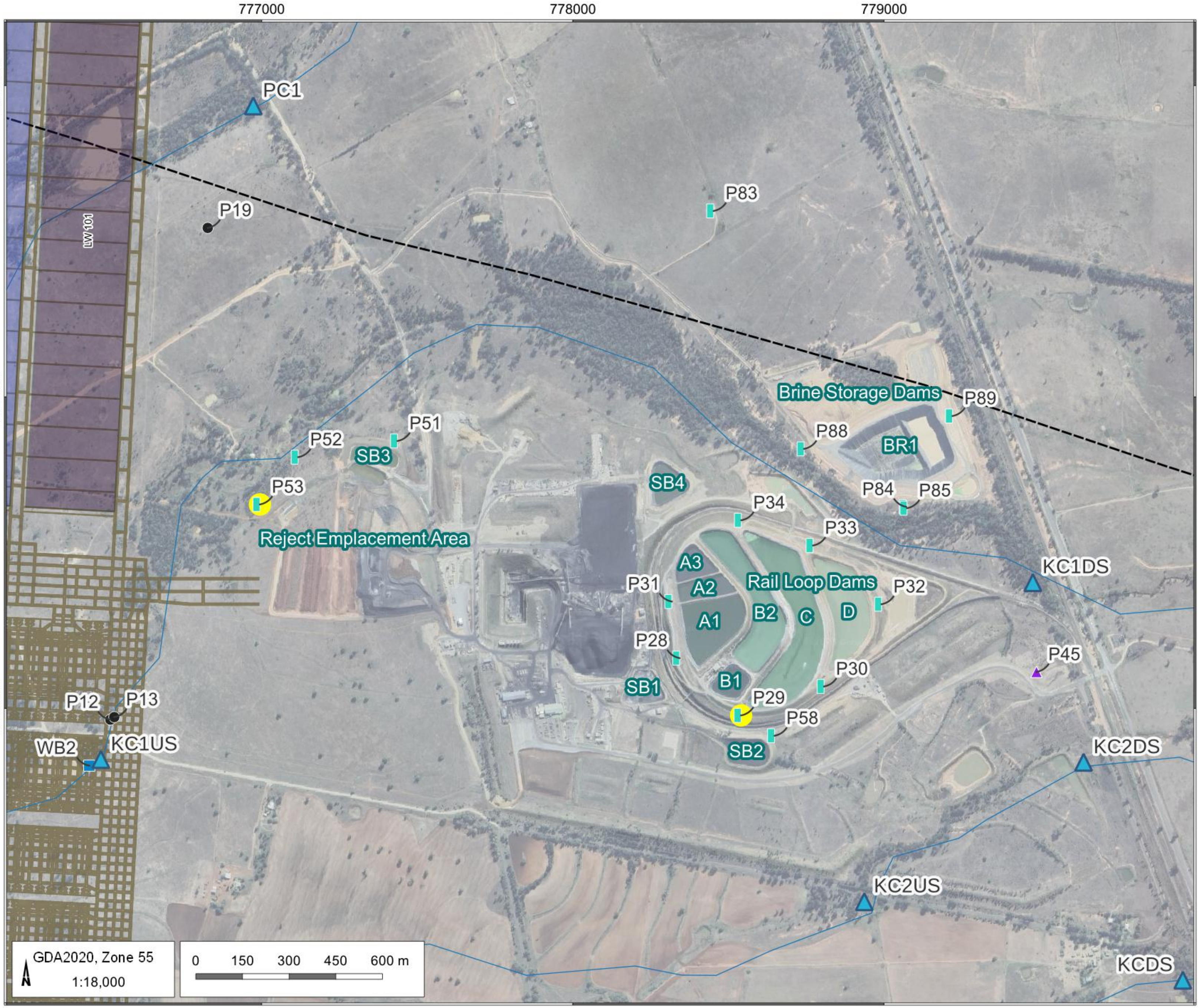

LEGEND
- Major
- Creek
- Underground mine workings
- Standpipe
- Standpipe - seepage detection
- Production - stock and domestic
- VWP
- Q4 Bore with trigger exceedances
- Surface water monitoring locations

Narrabri Mine Quarterly and Annual Reporting 2025-2026 (NAR5027.001)

Reject emplacement area

DATE
11/12/2025

AGE

FIGURE No:
2.2

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3 Trigger Exceedances

Water quality (EC) triggers are defined in the WMP and extraction plans. For datasets with non-normal distribution, a rolling median is calculated from the eight most recent data points and plotted on a time series chart (control chart) and a two-tiered trigger approach is used. Two triggers are then identified as follows:

- Tier 1 – where the rolling EC median[4] exceeds the 80th percentile of long-term data; and
- Tier 2 – where three consecutive EC exceedances of the 95th percentile of the long-term data occur. If this occurs, the TARP (Level 2) will be initiated.

Bores with three consecutive exceedances of their listed EC trigger level are outlined in Table 3.1, pH exceedances in Table 3.2 and water level exceedances in Table 3.3.

Table 3.1 Bores with reportable EC exceedances

Bore ID	Formation	EC trigger (µS/cm)		Three consecutive exceedances (µS/cm)	EC Trend (previous 12 months – between Q1 2025 and Q4 2025)
		Tier 1	Tier 2		
P2	Napperby	19,342	19,731	20,190 (May 2025), 20,150 (Aug 2025), 19,460 (Nov 2025)	Fluctuating between 19,490 and 20,190 µS/cm
P4[1]	Napperby	24,912	25,610	26,100 (May 2025), 26,580 (Aug 2025), 25,300 (Nov 2025)	Overall decreasing trend, rolling median exceeds Tier 1 trigger.
P9	Purlawaugh	20,330	21,190	22,020 (May 2025), 21,400 (Aug 2025), 21,900 (Nov 2025)	Fluctuating between 20,320 and 21,900 µS/cm
P10	Napperby	8,894	9,426	15,120 (May 2025), 13,820 (Aug 2025), 14,680 (Nov 2025)	Overall decreasing trend with short term fluctuations from 15,120 to 13,820 µS/cm
P11	Purlawaugh	6,052	6,546	6,890 (May 2025), 7,470 (Aug 2025), 9,316[2] (Oct 2025)	Increasing trend from 6,590 to 9,316 µS/cm
P29*	Napperby	9,732	11,337	15,610 (May 2025), 17,540 (Aug 2025), 19,590 (Nov 2025)	Increasing from 13,060 to 19,590 µS/cm
P39A	Watermark	5,970		7,680 (May 2025), 7,580 (Aug 2025), 7,020 (Nov 2025)	Decreasing from 7,700 to 7,020 µS/cm
P39B	Alluvium	6,546		1,436 (May 2025), 11,040 (Aug 2025), 12,090 (Nov 2025)	Overall decreasing trend with short term fluctuations 14,360 and 11,040 µS/cm
P47	Garrawilla	5,970		6,430 (May 2025), 6,170 (Aug 2025), 6,120 (Nov 2025)	Overall decreasing trend with minor fluctuations decreasing from 6.430 to 6,120 µS/cm
P53*	Garrawilla	1,107	1,169	1,671 (May 2025), 1,733 (Aug 2025), 2,041 (Nov 2025)	Increasing from 1,301 and 2,041 µS/cm

Notes: *Seepage monitoring bores.
[1] Quarterly monitoring result below Tier 1 trigger; however, rolling median based on last 8 results remains above Tier 1 trigger.
[2] sampled via low flow pump (not routine sampling), no sample available November 2025 due to bore water levels too low from pumped sampling in October.

[4] For datasets with non-normal distribution, a rolling median is calculated from the eight most recent data points and plotted on a time series chart.

Table 3.2 Bores with reportable pH exceedances

Bore ID	Formation	pH (lower) (pH units)	pH (upper) (pH units)	Three consecutive exceedances (µS/cm)	EC Trend (previous 12 months)
P7	Pilliga	6.0	8.5	4.98 (May 2025), 5.01 (Aug 2025), 5.08 (Nov 2025)	Increasing from 4.92 and 5.08

Table 3.3 Bores with reportable water level exceedances

Bore ID	Formation	Tier 1 (m AHD)	Tier 2 (m AHD)	Three consecutive exceedances (m AHD)	Water level trend (previous 12 months)
P11	Purlawaugh	270.4	269.8	268.66 (June 2025), 266.43 (Aug 2025), 265.729 (Oct 2025)	Declining

4 Climate

Monthly rainfall and evaporation totals obtained from Scientific Information for Landowners (SILO) (DES, 2025)[5] are plotted in Figure 4.1. Rainfall and evaporation trends show seasonal fluctuations with rainfall generally highest from November to March. A period of reduced rainfall was recorded from 2017 to the end of 2019 during which evaporation increased. A period of decreased evaporation and increased rainfall followed during the period 2020 to 2023.

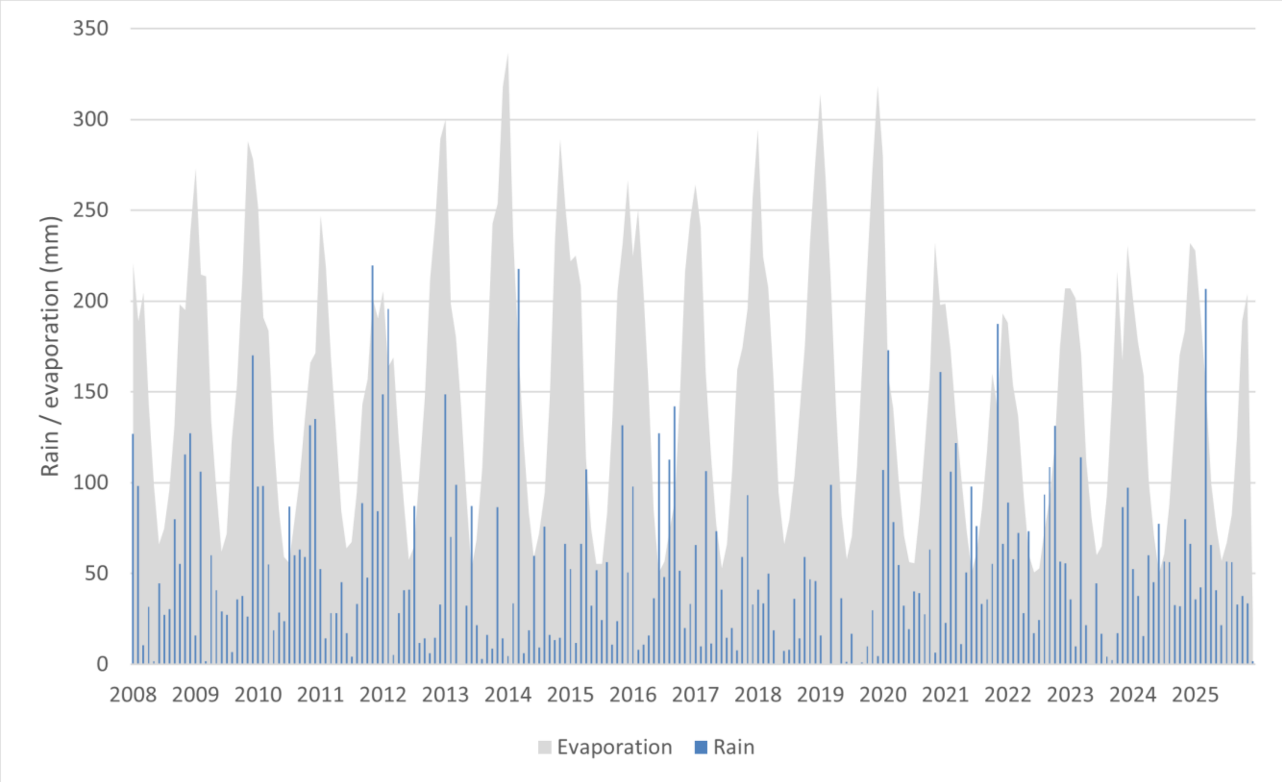


Figure 4.1 Monthly rainfall and evaporation 2018 to 2025

Cumulative rainfall departure (CRD) is calculated to place recent rainfall years into a historical context. The CRD is calculated by subtracting the long-term average monthly rainfall from the actual monthly rainfall, providing a monthly departure from the average. A rising slope in the CRD indicates periods of above-average rainfall, and a falling slope indicates below-average rainfall. CRD for the site is shown in Figure 4.2 using historical rainfall data obtained from the SILO website.

From 2017 to the end of 2019 a falling slope is recorded which coincides with the Tinderbox Drought, the direst three-year period on record for the region. Following this drought the region experienced a period of above average rainfall from early 2020 to 2023. Since then, rainfall fluctuations show similar trends to those experienced before the tinderbox drought (2008 to 2017).

5 Department of Environment and Science. 2025. SILO Australian climate data from 1889 to yesterday, Downloaded from https://www.longpaddock.qld.gov.au/silo/ on 09 September 2025.

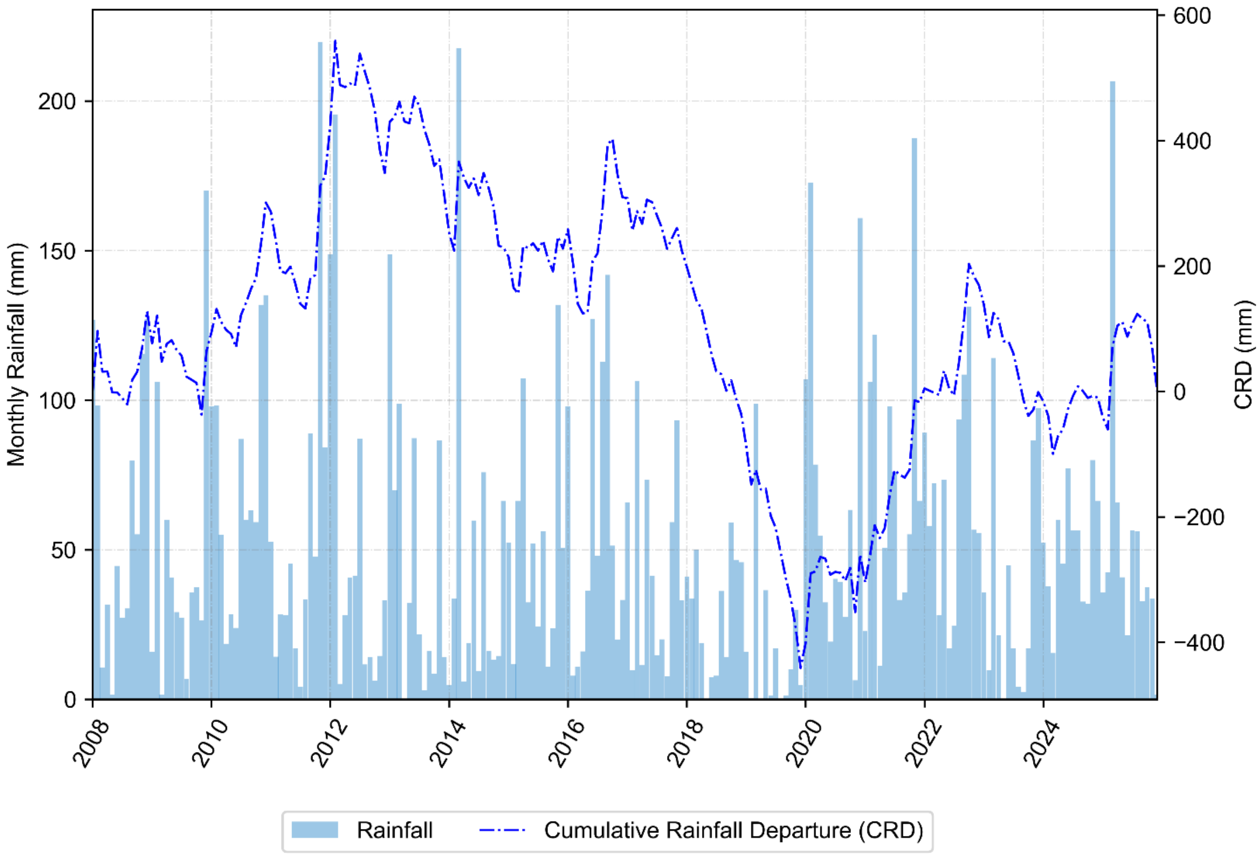


Figure 4.2 Cumulative rainfall departure and monthly rainfall from January 2008 to December 2025

5 Hydrogeological conceptual model

The Narrabri Mine is located within the Mullaley Sub-basin, which forms part of the larger Gunnedah Basin. The western half of the mining lease is also located on the eastern margin of the Surat Basin. Generally, the Surat and Gunnedah Basin stratigraphic units are characterised by a dip to the west at an angle of less than 10 degrees and outcrops along the Namoi River valley. The main stratigraphic units occurring in the vicinity of the Narrabri Mine are illustrated in Figure 5.1 and include the following:

- Quaternary alluvium consisting of unconsolidated clays, silts, sands, and gravels associated with the Namoi River and its tributaries;
- Surat Basin units including;
  - Jurassic Pilliga Sandstone, Purlawaugh Formation and Garrawilla Volcanics.
- Gunnedah Basin Units including;
  - Triassic Napperby Formation and Digby Formation; and
  - Permian Hoskissons Coal Seam, Arkarula Formation, Watermark Formation and Pamboola Formation.

Bores with recorded exceedances reviewed in this report are located within the Tulla Mullen alluvium (tributary of the Namoi River), Pilliga Sandstone, Purlawaugh Formation Garrawilla Volcanics, Watermark Formation, and Napperby Formation.

The Pilliga Sandstone is the youngest consolidated formation in the project area, and ranges in thickness from 0 to 120 m at the far western reach of the project area. The sandstone is predominantly a well sorted, fine to coarse grained quartz sandstone in medium cross beds (AGE, 2020).

The Purlawaugh Formation underlies the Pilliga Sandstone, which is a productive aquifer; and the former is typically comprised of fine grain lithic to labile sandstone and siltstone. The formation is reported to have a lower hydraulic conductivity than the Pilliga Sandstone and acts as an aquitard. The Purlawaugh Formation unconformably overlies the Garrawilla Volcanics, which was eroded by the deposition of the overlying sediments.

The Purlawaugh Formation unconformably overlies the Garrawilla Volcanics, a layer of alkali basalt rocks, trachytes and interbedded pyroclastis. The volcanics form the basal unit of the Surat Basin in the area and unconformably overlie the Triassic formations of the Gunnedah Basin.

The Napperby Formation is comprised of an upwards coarsening sequence of siltstone and sandstone laminate, interbedded with quartzose sandstone beds. The upper part of the Napperby Formation, above the Napperby Sill, has a higher proportion of sandstone. The Napperby Formation is generally unweathered rock with low permeability and is not a productive aquifer.

The Watermark formation consists of a fining-up sequence of intensely bioturbated silty sandstone to siltstone/claystone laminite with marine fossils, overlain by finely laminated siltstone/claystone, then a coarsening-up sequence (Australian Stratigraphic Units Database, 2023).

Recharge to the hydrostratigraphic units occurs through diffuse rainfall recharge as well as limited seepage through the non-perennial Kurrajong Creek and its tributaries when flowing. No aquifer discharge related to baseflow occurs near the mining area as groundwater levels are generally deep and well below the channels of the highly ephemeral creeks. Accordingly, no alluvium is present along these creeks, and they are either entirely disconnected (or possibly only very occasionally connected) to the Namoi Alluvium.

Two water sources dominate the mine area, the Gunnedah-Oxley Basin (GOB) Murray Darling Basin (MDB) Groundwater Source and the Great Artesian Basin (GAB) Southern Recharge Groundwater Source. The GOB MDB groundwater source covers an outcrop area of 1,128,000 hectares and comprises the Permian and Triassic rocks associated with the Gunnedah Basin and the younger Jurassic and Cretaceous rocks associated with the Oxley Basin. The GAB Southern Recharge Groundwater Source includes Cretaceous, Jurassic and Tertiary aged rocks including alluvial sediments and the outcropping Pilliga Sandstone.

Two high-productivity aquifers are located within the region: the Namoi River alluvium to the east and the Pilliga Sandstone to the west (Figure 5.1), all other formations are either considered aquitards or non-productive aquifers.

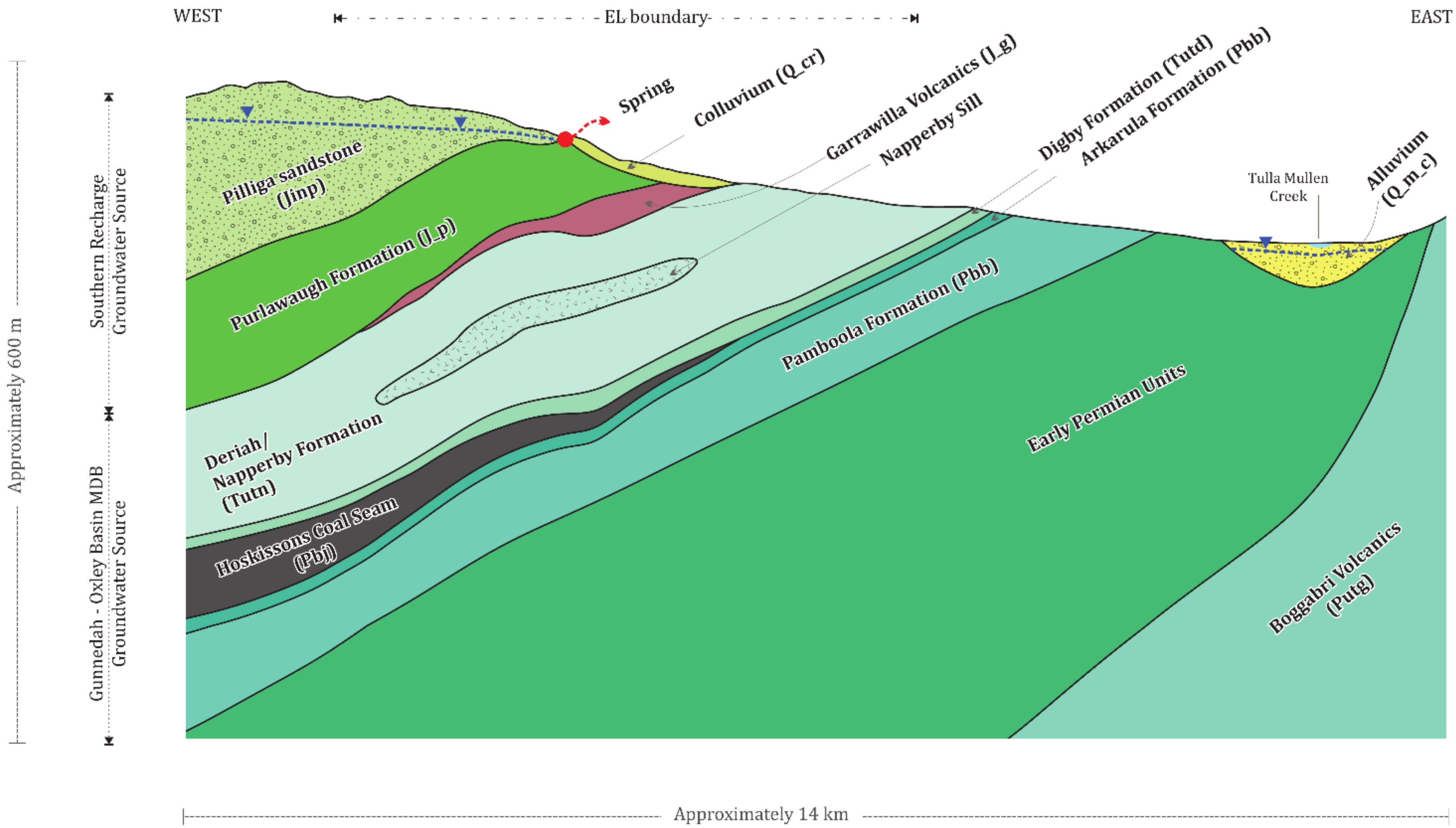


Figure 5.1 Conceptual geological cross section (AGE, 2020)[6]

[6] Australasian Groundwater & Environmental Consultants (AGE) (October 2020). Groundwater Assessment Narrabri Mine Stage 3 Extension Project. Prepared for Narrabri Coal Operations Pty Ltd.

6 Mining progression and infrastructure

Mining at NCO commenced in June 2012 with longwall (LW) 101 (Figure 2.1) and progressed west, in April 2023 the 100 series longwalls were completed. The 200 series commenced in June 2023 with LW 203. Mining progression is outlined in Table 6.1.

A set of water storage dams, the Rail Loop dams (RLDs) are located next to the Coal Handling and Processing Plant (CHPP) (inset Figure 2.1 and Figure 2.2). Typically, water stored in dams D and B1 is fresh (low salinity), water in dams A1, A2, A3, SB1, SB2, SB3 and SB4 are brackish while water quality in dams B2, C and BR1 are saline. Dam D receives water from the Namoi River pump station and the water supply bore.

Table 6.1 Progression of longwall mining

Longwall	Start Date	Completion Date
Longwall 101	6 June 2012	1 June 2013
Longwall 102	22 July 2013	20 January 2014
Longwall 103	3 March 2014	20 October 2014
Longwall 104	1 December 2014	4 August 2015
Longwall 105	10 September 2015	16 May 2016
Longwall 106	20 June 2016	10 March 2017
Longwall 107	19 April 2017	22 July 2018
Longwall 108	16 September 2018	17 November 2019
Longwall 109	6 January 2020	7 November 2021
Longwall 110A	22 December 2020	15 June 2022
Longwall 110B	21 July 2022	17 April 2023
Longwall 203	05 June 2023	12 April 2025
Longwall 204	14 June 2025	28 July 2026*
Longwall 205	11 September 2026*	23 September 2027*
Longwall 206	8 November 2027*	22 October 2028*

Note: *planned extraction.

7 Review of monitoring data

Potential causes of changes in groundwater quality at and around coal mines are both natural and anthropogenic, and typically include:

1. natural: a reduction in recharge (causing less dilution) or an increase in evaporation (causing more concentration) or increase in recharge (causing mobilisation of salts) due to climate factors; and/or
2. anthropogenic/natural: seepage from surface sources of water that have salinity elevated above groundwater levels and likely connected to aquifer systems directly or indirectly through lagged recharge; and/or
3. anthropogenic: groundwater mixing with groundwater from adjacent areas of hydrostratigraphic units due to permitted mine dewatering and/or third-party groundwater users (e.g. irrigation) that may cause changes or reversals in hydraulic gradient; and/or
4. anthropogenic: geochemical solute release due to oxidation and acid-rock drainage.

To determine the possible causes of water quality and level exceedances, this review encompasses the following tasks:

- undertake a first-order data review to identify any unexpected outliers or data errors;
- review results against baseline monitoring for the bore and against historical trends (if available);
- compare with trends in nearby bores within the same aquifer;
- investigate links to operational activities and external influences (e.g. climatic data) including:
  - natural climate factors;
  - seepage from surface sources;
  - mining induced mixing; and
  - solute release.
- assess potential risk of environmental impacts to sensitive receptors; and
- review the current monitoring regime and asses if further work or monitoring is required.

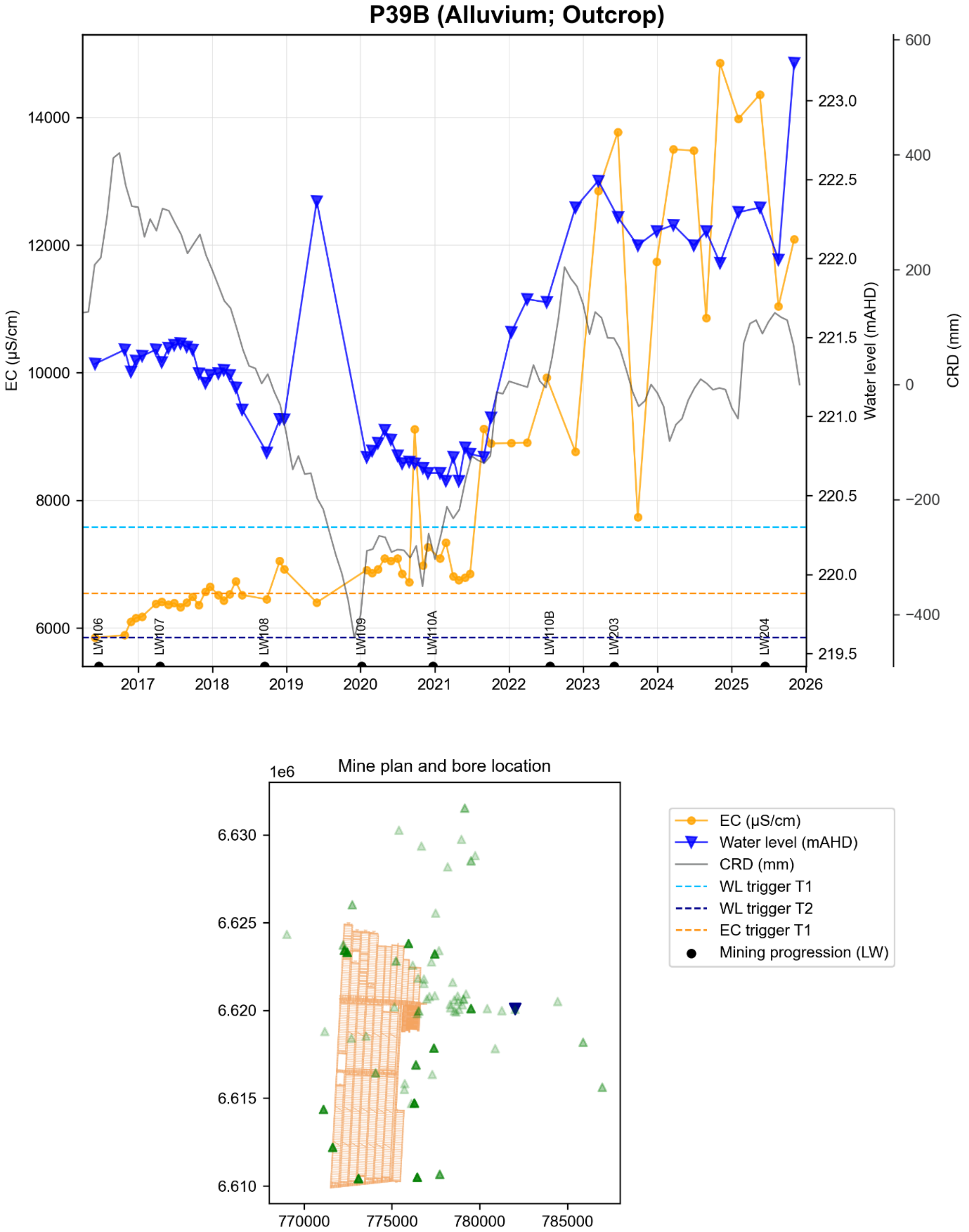
7.1 Alluvial Bores

7.1.1 P39B - water quality - EC exceedance

Bore P39B is installed approximately 6 km east of mining between Tulla Mullen and Kurrajong Creeks from 15 to 30 m bgl. The bore is co-located with bore P39A installed in the Watermark formation from 72 to 78 m bgl. P39B was installed in mid-2016, just prior to the onset of the Tinderbox Drought. From installation to 2021 water levels decreased (about 0.5 to 1 m) while EC increased with some minor fluctuations (Figure 7.1). From 2021 until 2025 water levels have increased (about 1.5 m), during the same time EC values have increased with significant fluctuations. The latest value, recorded in November 2025 of 12,090 μS/cm, supports the fluctuating EC trend.

Groundwater levels recorded at P39A (Watermark) and P39B (Alluvium) (Figure 7.2) have historically remained at similar levels with a slight upwards gradient from the Watermark Formation to the alluvium being recorded prior to 2022. From 2022 onwards, during which groundwater levels were recovering, the hydraulic gradient changed to a downwards gradient from the alluvial bore to the Watermark Formation bore.

Groundwater type based on major and minor ions indicates that the water sampled at P39B plots on the Piper Plot (Figure 7.3) as a Sodium-Chloride (Na-Cl) similar to groundwater samples from the Watermark Formation (bores P43 and P39A) and Pamboola Formation (bore P3). Other alluvial groundwater monitoring bores in the area are located further east (WB7) and southeast (WB5a/b) of P39B these bores are installed in the Namoi Alluvium with major anion and cations indicating a greater relative concentration of Calcium (Ca) compared with Sodium-Potassium (Na-K). Water samples for Namoi alluvium samples indicate a Calcium-Bicarbonate ($Ca\text{-}HCO_3$) or mixed type composition.



* mAHD - metres Australian Height Datum

Australasian Groundwater and Environmental Consultants Pty Ltd
Water Level plots

Figure 7.1 P39B EC field and laboratory measurements plotted with water levels

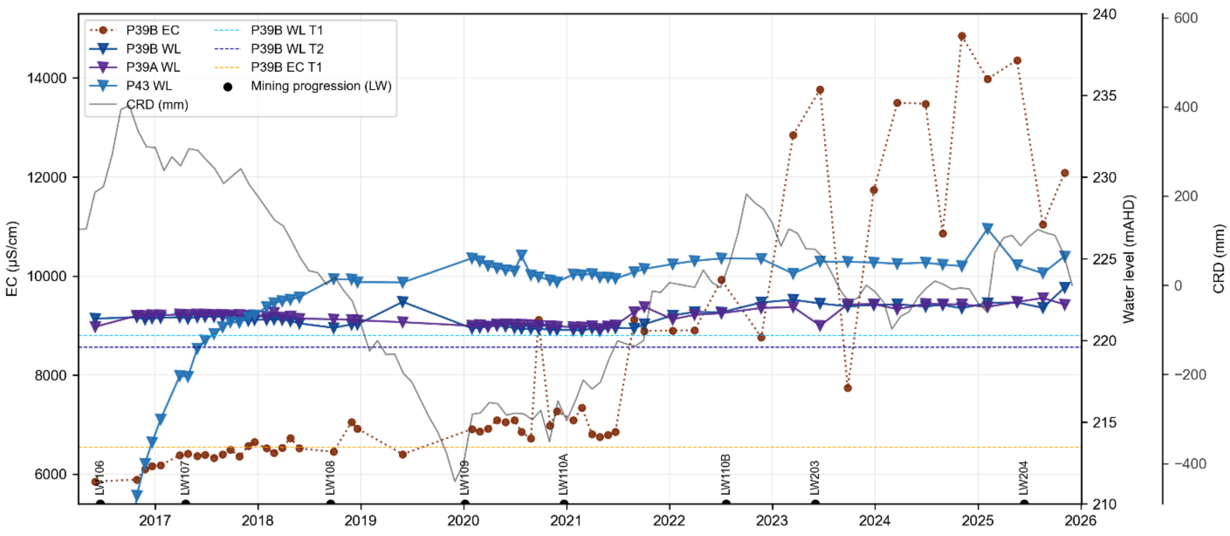


Figure 7.2 P39A and B and P43 groundwater elevations with P39A EC

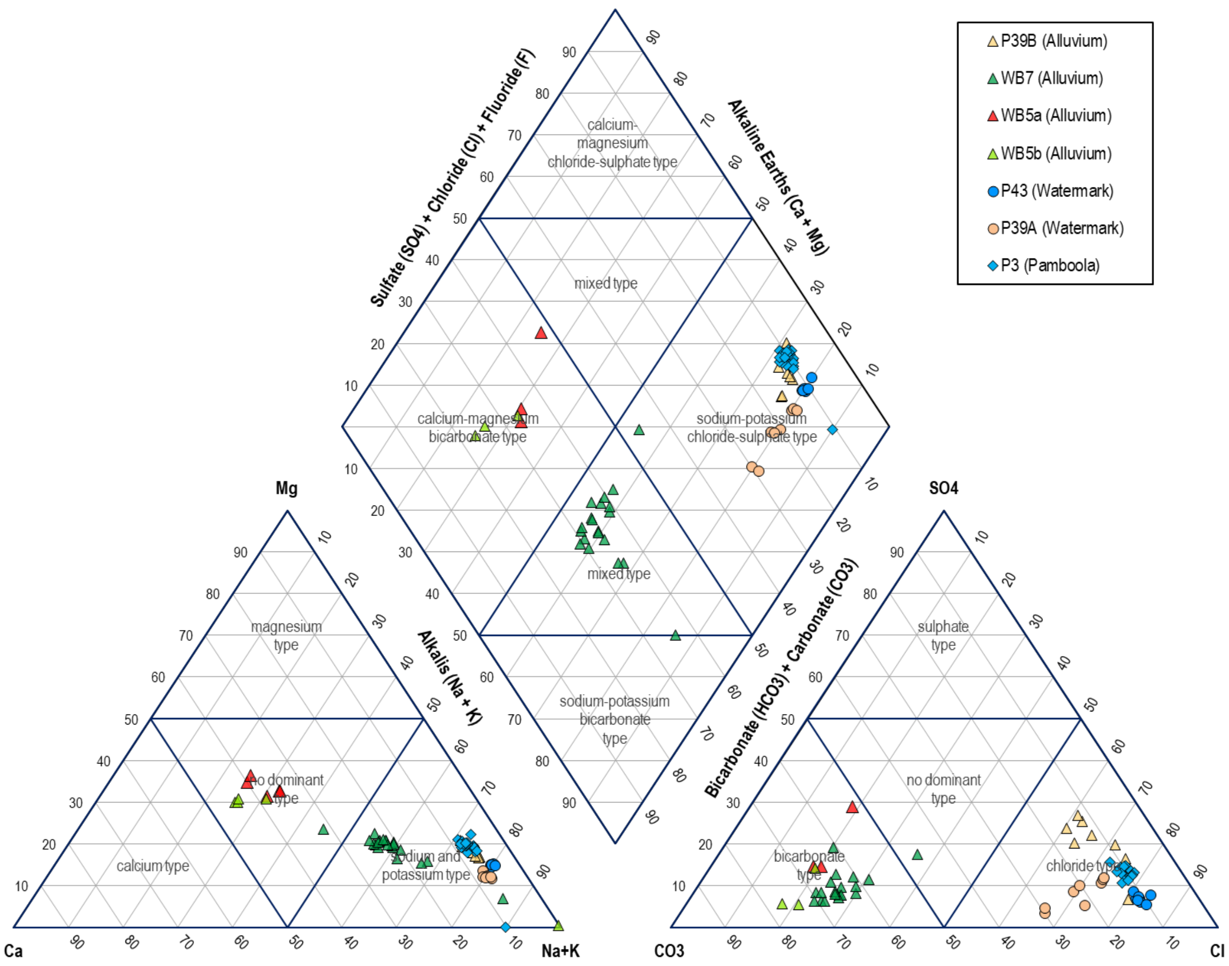


Figure 7.3 P39B and surrounds Piper Plot

7.1.1.1 Natural climate factors

The bore is installed in the alluvium associated with Tulla Mullen Creek which is a laterally unconfined, continuous channel, with low sinuosity (relatively straight) and a fine-grained bed. Rainfall remained above average from the end of the Tinderbox Drought until mid-2022; however, as can be seen by the hydrograph in Figure 7.1, the groundwater level did not commence recovering until the start of 2021. The two-year lag from the end of the Tinderbox Drought to the commencement of groundwater recovery is attributed to slow infiltration due to the fine-grained sediment of the Tulla Mullen Creek beds. Two periods of EC increases are observed, one whereby EC increases steadily during a period of decreasing water levels, these decreasing water levels are likely associated with the Tinderbox drought with a lag attributed to the slow infiltration and recovery. The second period of EC increases is more rapid and is associated with recovering water levels. The initial increase in salinity during the groundwater decline is likely caused by a reduction in recharge and dilution leaving remaining water to be more concentrated. During the drought, hot and dry conditions cause accumulation of salts in the soils and subsurface when groundwater levels increase salts are mobilised and groundwater salinity increases.

7.1.1.2 Seepage from surface sources

A comparison of Digital Earth Australia's (DEA) Landsat landcover classification[7] for the year 2019 (drought conditions) and 2022 (post drought conditions) is shown in Figure 7.4. During the Tinderbox Drought much of the surrounding landcover was classified as bare surface while after the drought was classified as herbaceous to woody natural vegetation. Persistent water, represented by varying shades of blue in the images shows an increase in persistent surface water post-drought with several surface water bodies present that were not present during the drought.

No surface water quality data is available for Tulla Mullen Creek or nearby dams therefore seepage from other surface water storage or Tulla Mullen Creek is a possible cause, but no conclusion can be made.

[7] DEA Landsat Landcover provides annual land cover classifications for Australia using the Food and Agriculture Organisation's (FAO) Land Cover Classification System (LCCS) taxonomy Version 2 (Di Gregorio and Jansen, 1998; 2005) https://knowledge.dea.ga.gov.au/data/product/dea-land-cover-landsat/.

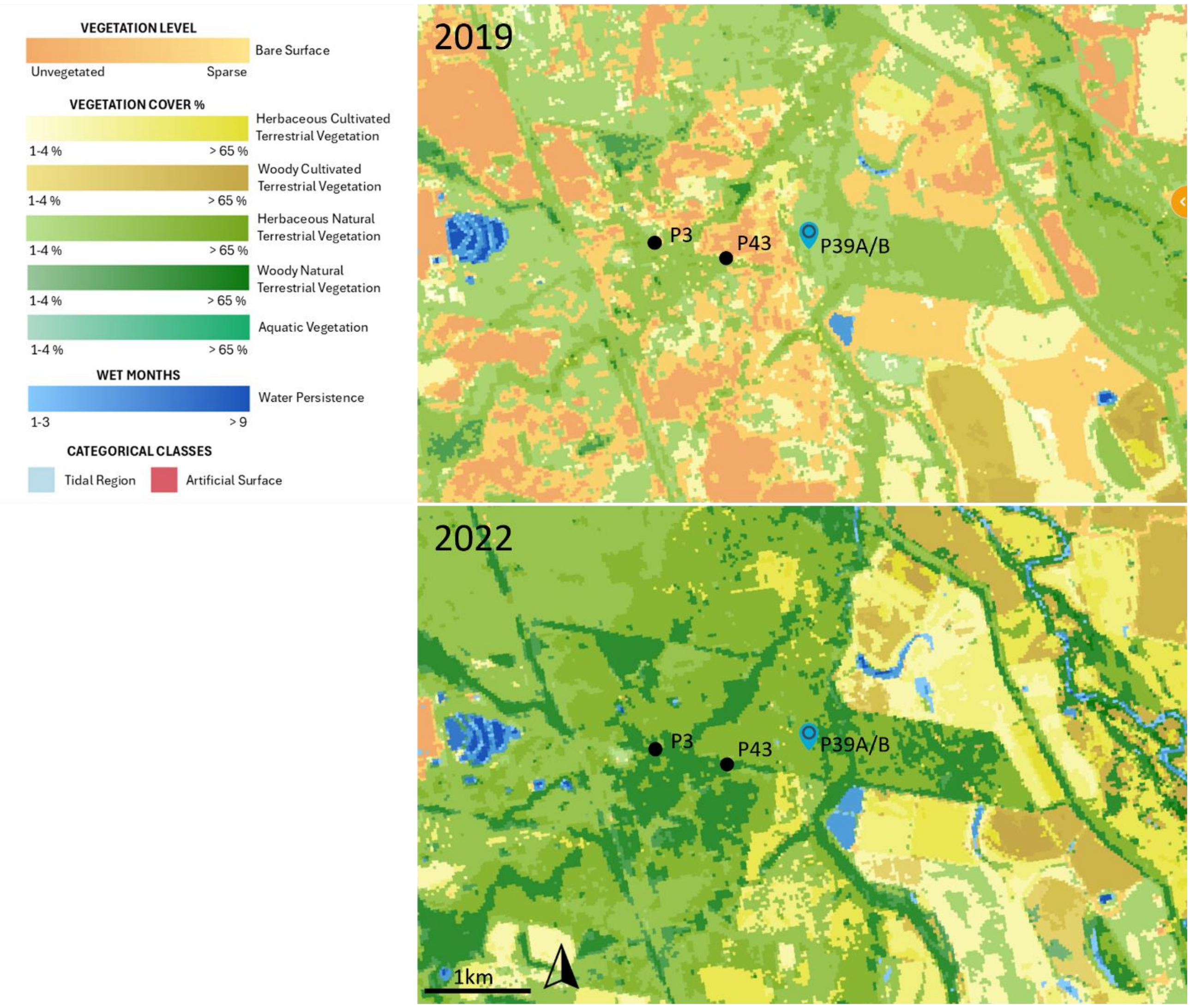


Figure 7.4 DEA Landsat Landcover 2019 and 2022 comparison

7.1.1.3 Mining-induced mixing

Groundwater levels recorded at bores P3 (Pamboola), P43 (Watermark), P39A (Watermark) and P39B (Alluvium) either remain stable (P3 and P43) or fluctuate with changes in rainfall (P39A and B). The lack of mining-induced depressurisation indicates that there is likely limited interconnectivity between the alluvium and the deeper coal seams and that mining-induced mixing is not a likely cause of elevated EC.

7.1.1.4 Solute release

The bores are located approximately 3 km to the west of the rail loop dams and 7 km from active underground mining, lateral migration of solutes from the dam complex is considered unlikely. Bores located between the dam complex and bore P39B do not show a similar increasing EC trend.

7.1.2 Conclusion and recommendations

The steady increase in EC observed during the Tinderbox Drought is likely due to reduced recharge from rainfall and diminished contributions from the Kurrajong and Tulla Mullen Creeks. Following the drought, as groundwater levels began to recover, EC values rise more sharply and exhibited greater fluctuations. This post-drought increase is potentially attributed to the mobilisation of salts that had accumulated in the unsaturated zone during the dry period, which were subsequently flushed into the aquifer as recharge resumed.

Trends observed in the EC and groundwater level data indicate that the likely cause of EC increases is due to two significant climate events, the Tinderbox Drought from 2017 to 2020 followed by a period of increased rainfall from 2020 to late 2022. During prolonged above-average rainfall, accumulated and concentrated salts (as a result of preceding dry spells) seep from near-surface strata to deeper strata within the unsaturated zone into saturated hydrostratigraphic units due to increased recharge or seepage from surface runoff drainage lines.

Given the natural causes of these mechanisms, no immediate action is required.

7.1.3 Potential impacts

Increases in EC are a likely result of long-term natural conditions with no mining-induced impacts likely. Before the increase in EC in 2021 background EC measurements ranged from 6,000 to 7,000 µS/cm with values now ranging from 8,000 to 14,000 µS/cm. Background salinity indicates saline water; however, within the acceptable ranges for most livestock eg TDS of 4,000 to 5,000 mg/L (2,680 to 3,350 µS/cm) for cattle and 4,000 to 10,000 mg/L (2,680 to 6,700 µS/cm) for sheep[8]. The increase in salinity may result in loss of production and a decline in livestock condition and heath.

7.2 Pilliga Sandstone Bores

7.2.1 P7 - water quality - pH exceedance

Bore P7, installed from 78 to 90 m bgl in the Pilliga Sandstone, has recorded stable water levels and EC measurements for the past 5 years. From mid-2020 pH levels have decreased and have dropped below the minimum pH threshold of 6 (Figure 7.5). Laboratory (lab) pH measurements decreased from 2022 to 2025; however, are more consistent with historical ranges. A report prepared by CSIRO for the gas industry social and environmental research alliance (GISERA) discuss distinct spatial zonation within the Pilliga Sandstone Raiber et al (2022). Characteristics of the Pilliga sandstone within this zone include low EC (less than 150 µS/cm), low pH (less than 6) and generally low major ion concentrations.

[8] ANZG. 2023. Livestock drinking water guidelines. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra.

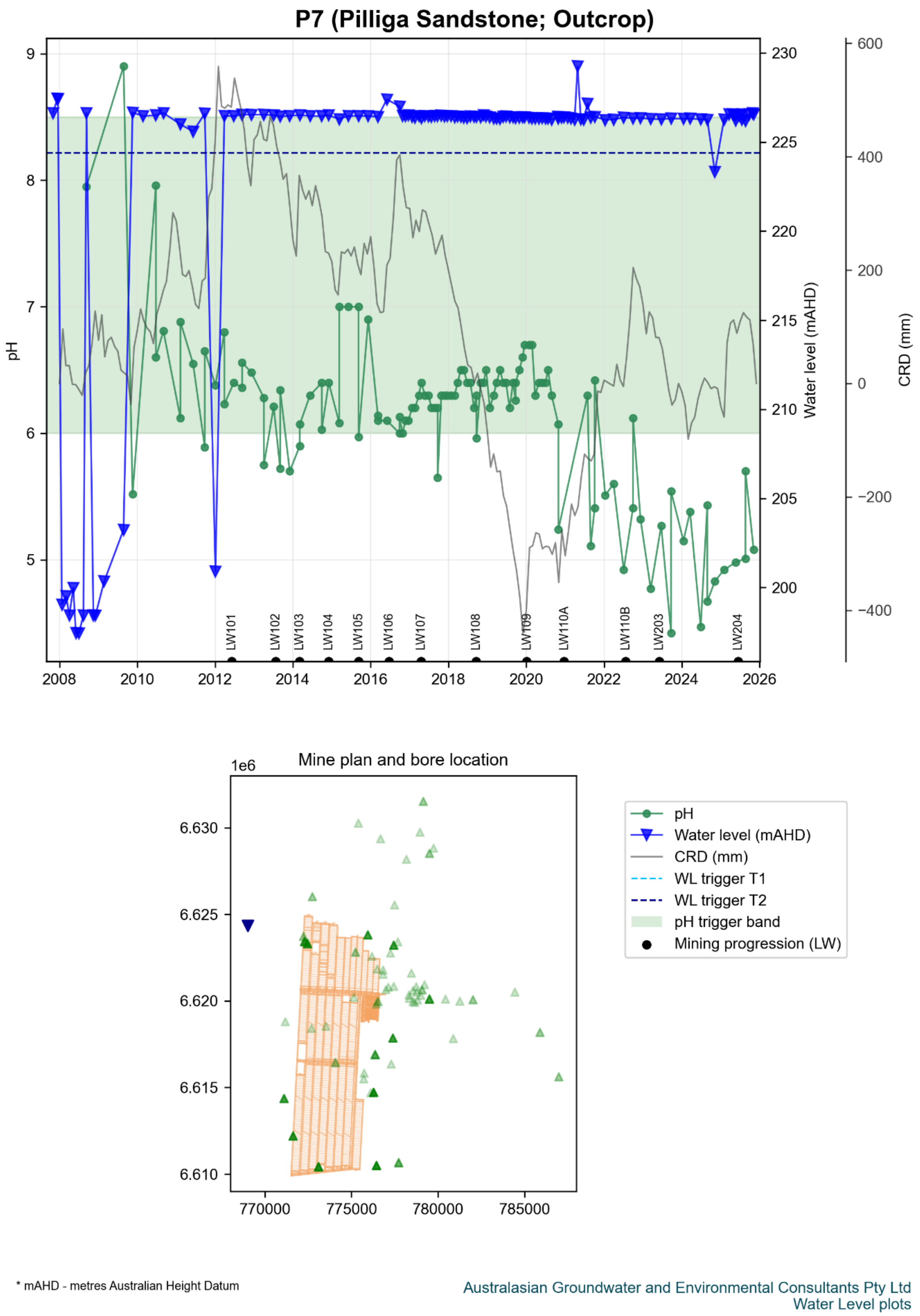


Figure 7.5 P7 pH field and laboratory measurements plotted with water levels

7.2.1.1 Natural climate factors

The decrease in pH coincides with the end of the Tinderbox Drought; however, no changes in water levels or EC are recorded at the same time. The increase in precipitation provides a possible source of acidity from soils during recharge. This is unlikely as soil types mapped in the area are Sodosols which are not strongly acidic and water levels are unaffected by climate variations.

Changes in pH are likely due to natural fluctuations; however, further monitoring is required to confirm this. There appears to be drift/error in the field measurements, laboratory measurements do not record similar drift and fluctuations.

7.2.1.2 Seepage from surface sources

No surface water is located near this bore therefore seepage from surface sources is unlikely.

7.2.1.3 Mining-induced mixing

Groundwater chemistry recorded at bore P7 plots as a sodium-chloride (Na-Cl) type water (Figure 7.6), a linear mixing trend in the anions is visible with a relative increase in bicarbonate. The linear mixing trend does not coincide with the decreasing field pH trend.

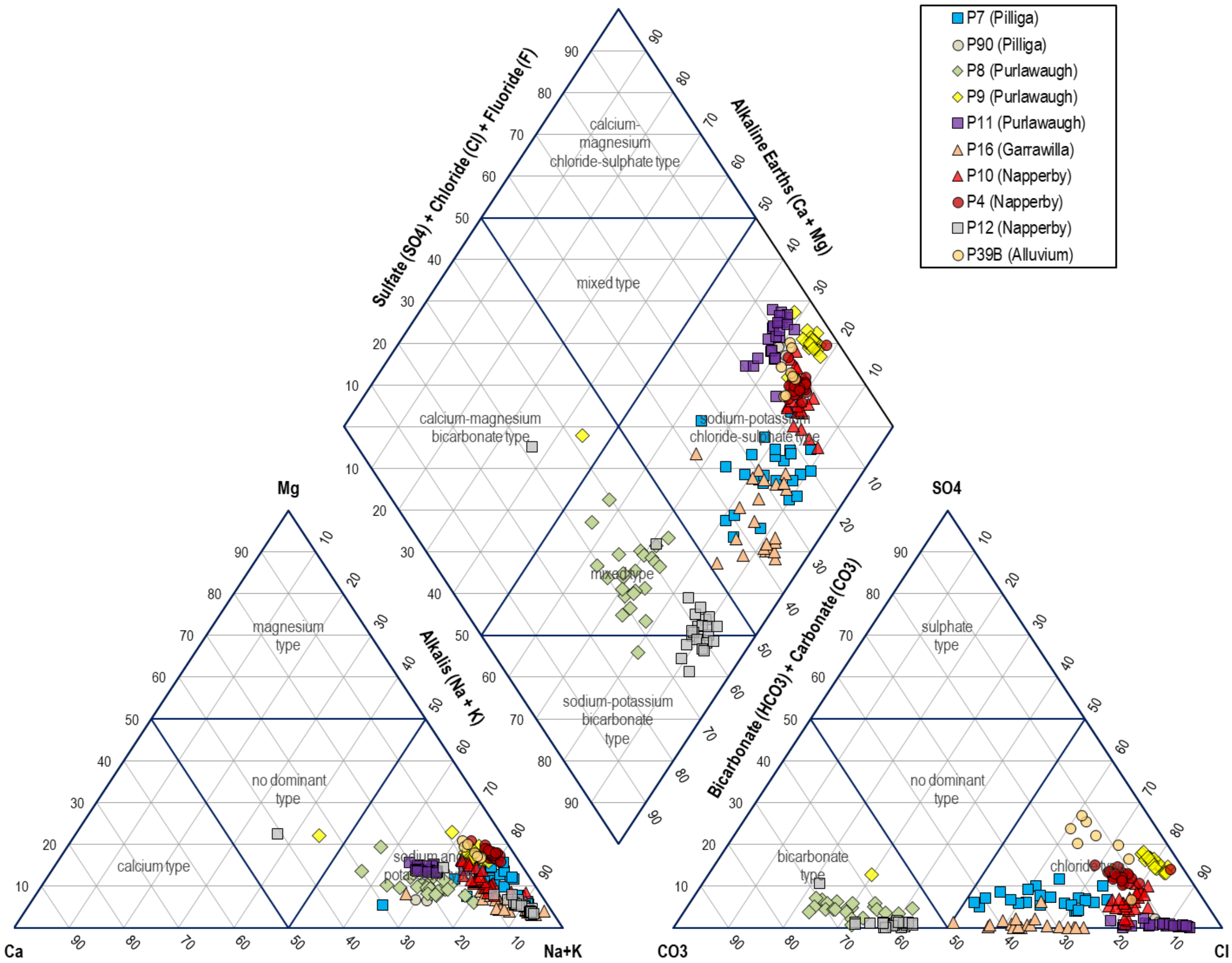


Figure 7.6 P7 and surrounding bores Piper Plot

7.2.1.4 Solute release

Pilliga Sandstone is not predicted to have significant impacts from mining in part due to the presence of multiple formations between the Hoskissons Coal and the Pilliga Sandstone including the Digby, Napperby, Garrawilla Volcanics and Purlawaugh formation (AGE, 2020). Groundwater samples collected underground from LW203 (located approximately 7.6 km southeast of P7) records pH from 5.3 to 7.7. Although pH measurements are similar to those recorded at P7, bore P90, also installed in the Pilliga Sandstone, and located closer to LW203 (approximately 1.4 km west) records pH measurements from 6.6 to 8.0 indicating that solute release from active mining is unlikely.

7.2.2 Conclusion and recommendations

Groundwater within the Pilliga at P7 has low baseline pH, decreases in pH subsequently trigger the lower trigger level (pH 6.0) with small decreases in pH. Multiple monitoring bores within the mining area have also recorded a decreasing pH trend with associated variable fluctuations. Sensor drift for field equipment is a possible means for the decreasing field trend; however, in most cases have an associated decreasing pH recorded in laboratory measurements, indicating that the decreasing trend is real. The timing of the decreasing pH across the site with the end of the Tinderbox drought indicates causes are likely attributable to changes in recharge. Additionally, reported pH in this zone of the Pilliga Sandstone is generally lower than 6 and as such recorded pH are within expected ranges for this zone.

7.2.3 Potential impacts

Hydrochemical studies conducted by Raiber et al[9]found that water of the Pilliga Sandstone often records pH lower than 6. Hierarchical cluster analysis (HCA) identified a cluster predominantly comprising bores sampled within the Pilliga region, exhibiting an average pH of 5.9. Considering the naturally low pH and baseline conditions, further reductions in pH are not anticipated to exert a significant impact on the groundwater system.

7.3 Purlawaugh Formation Bores

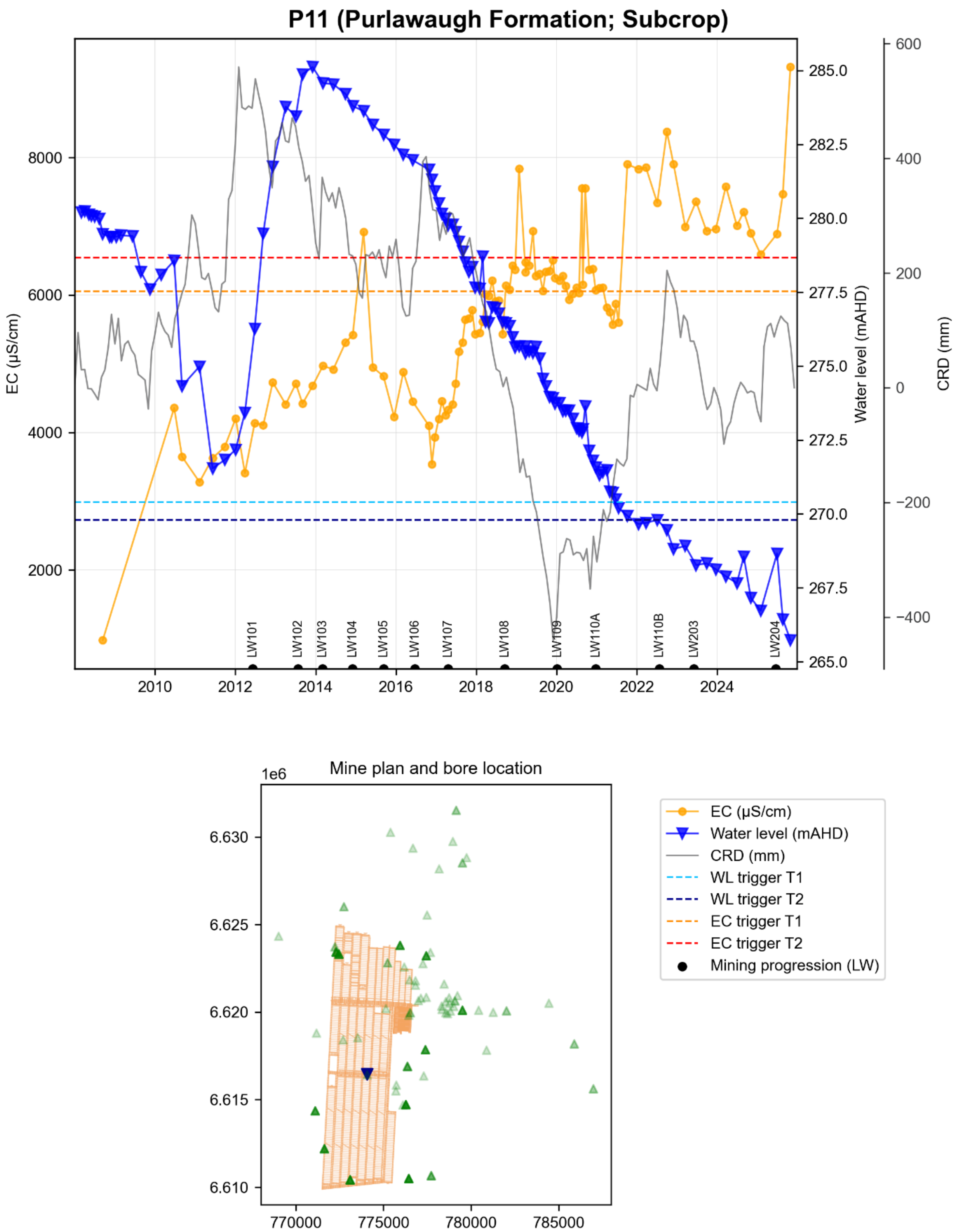
7.3.1 P11 - water quality and levels - EC and water level exceedance

Bore P11 is located next to P10 south of LW 205, the bore is installed in the Purlawaugh Formation at 44 to 50 m bgl. Prior to mining commencing in 2012 groundwater EC at P11 fluctuated between 1,000 to 4,000 µS/cm (Figure 7.7). EC values have fluctuated since installation with broad fluctuating trends spanning ~6-year periods. A steep increase is recorded during the Tinderbox Drought from 2017 to 2019, before decreasing. In late 2021, EC value jumped from 5,601 to 7,902 µS/cm then commenced trending down. The water levels at P11 have shown decreasing trends since 2014 and are now lower than those in the nested bore, P10.

P11 has exceeded its Tier 2 water level trigger since 2022, this trigger is based on the latest groundwater model predictions and is adjusted each year there is predicted drawdown. Figure 7.7 shows only the Tier 1 trigger (fixed) and Tier 2 trigger for 2025.

Other bores installed in the Purlawaugh formation include P8 which is installed from 57 to 63 m bgl above the planned LW 206 and P9 which is installed from 24 to 36 m bgl immediately south of LW 105. Bores P8 and P9 show stable trends prior to mining. A mining-related depressurisation is observed in bore P9 in which groundwater levels decline in 2015 when mining of LW105 commenced (Figure 7.8). Contrary to the behaviour observed in bores P8 and P9, the water levels prior to mining at P11 appear to respond to changes in rainfall with an approximate two-year lag.

[9] Raiber, M., Martinez, J., Suckow, A., Deslandes, A., & Gerber, C. 2022. Assessment of the influence of geological structures on aquifer connectivity in the Pilliga Forest, NSW – an integrated hydrogeological, geophysical, hydrochemical and environmental tracer approach. A technical report from GSIRO to GISERA.



* mAHD - metres Australian Height Datum

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Water Level plots

Figure 7.7 P11 EC field measurements plotted with water levels

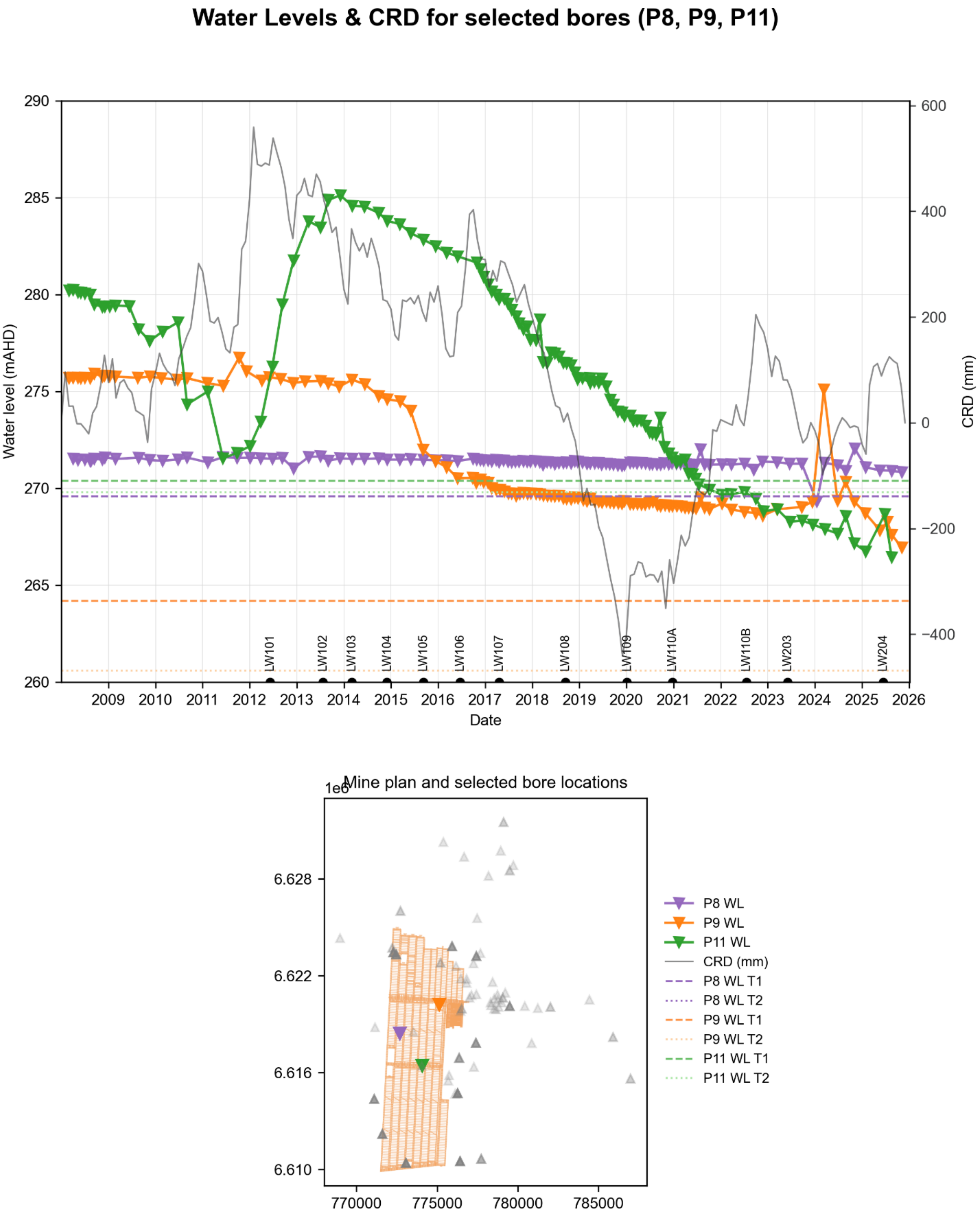


Figure 7.8 Groundwater levels for Purlawaugh Formation bores P8, P9, and P11

7.3.1.1 Natural climate factors

The gradual EC increase recorded between 2017 and 2020 is possibly associated with a reduction in recharge from precipitation and freshwater recharge from Kurrajong Creek during the Tinderbox Drought. P11 is a relatively shallow bore, and groundwater levels since 2021 indicate an ongoing decline. Ongoing depressurisation observed below previous 2011 low point has occurred since mid-2013. This is unlikely to be a result of the longwall mining as the northern 100 panels are approximately 4 to 5 km away.

7.3.1.2 Seepage from surface sources

The nearest surface water features are the Longsight dams; these dams are for stock watering and are located 2.6 km south of the bore, given the distance and purpose they are unlikely a cause of elevated EC.

7.3.1.3 Mining-induced mixing

In January 2017 the vertical hydraulic gradient between P11 (shallow) and P10 (deep) switched from downward to upward due to the decline in water level at P11 (Figure 7.8). The changes or reversals in hydraulic gradient could be causing groundwater mixing that has resulted in EC changes at P11.

Chemical composition of solutes at P11 indicates a sodium-chloride (Na-Cl) type water (Figure 7.10), which is similar to bores P9 (Purlawaugh), P2 (Napperby), and P10 (Napperby). The HCO_3/Cl mass ratio at P11 (Figure 7.9) decreases over time, indicating a change in overall chemistry and likely mixing with water more strongly dominated by chloride. Therefore, lateral migration of groundwater from adjacent areas of the Purlawaugh Formation is a possible cause of the EC change.

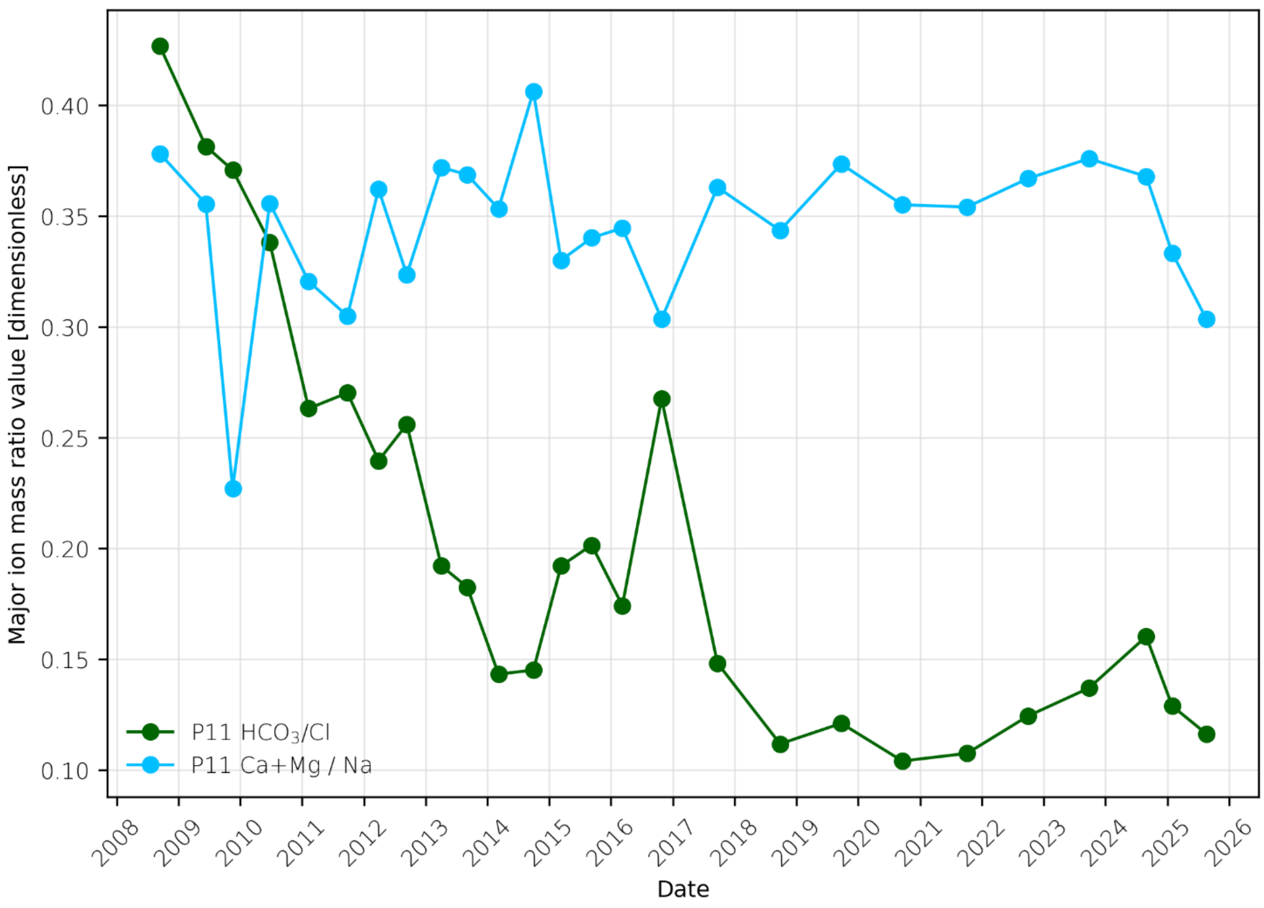


Figure 7.9 Ratios of bicarbonate to chloride and calcium + magnesium to sodium bore P11

Although the lower Napperby Formation has higher salinity and could be migrating upwards since 2017 due to the vertical hydraulic gradient, it is not likely to be the source of change at P11. This is because the calcium + magnesium to sodium (Ca+Mg/Na) mass ratio at P11 shows minimal correlation with time, and is a higher value (at about 0.35; Figure 7.9) than that at P10 (0.24; Figure 7.23).

7.3.1.4 Solute release

Nearby Purlawaugh Formation bores P9 and P8 are located immediately south of LW 105, and above the planned LW 206, respectively. Bore P8 (Purlawaugh), located further to the west of P11, has groundwater that plots between mixed type and Na-HCO_3 type (Figure 7.10). Given the proximity of P9 bore to active mining and water level decline at the onset of mining of LW 105 it is interesting to note the relatively minimal increase in salinity with levels having risen from 20,000 to 22,660 µS/cm from late 2015 until now, and minimal change in sulfate-chloride mass ratio from 0.21 in 2010 to 0.32 in 2023. By contrast, the sulfate-chloride mass ratio at P11 has not significantly changed over time and remains low. If water mixing is occurring from longwall mining in the north, a more significant change in water quality at P11 would be expected. In addition, the hydraulic gradient at P11 indicates flow toward the mining zone, indicating that there is no viable pathway for solutes to reach P11, if they were being produced.

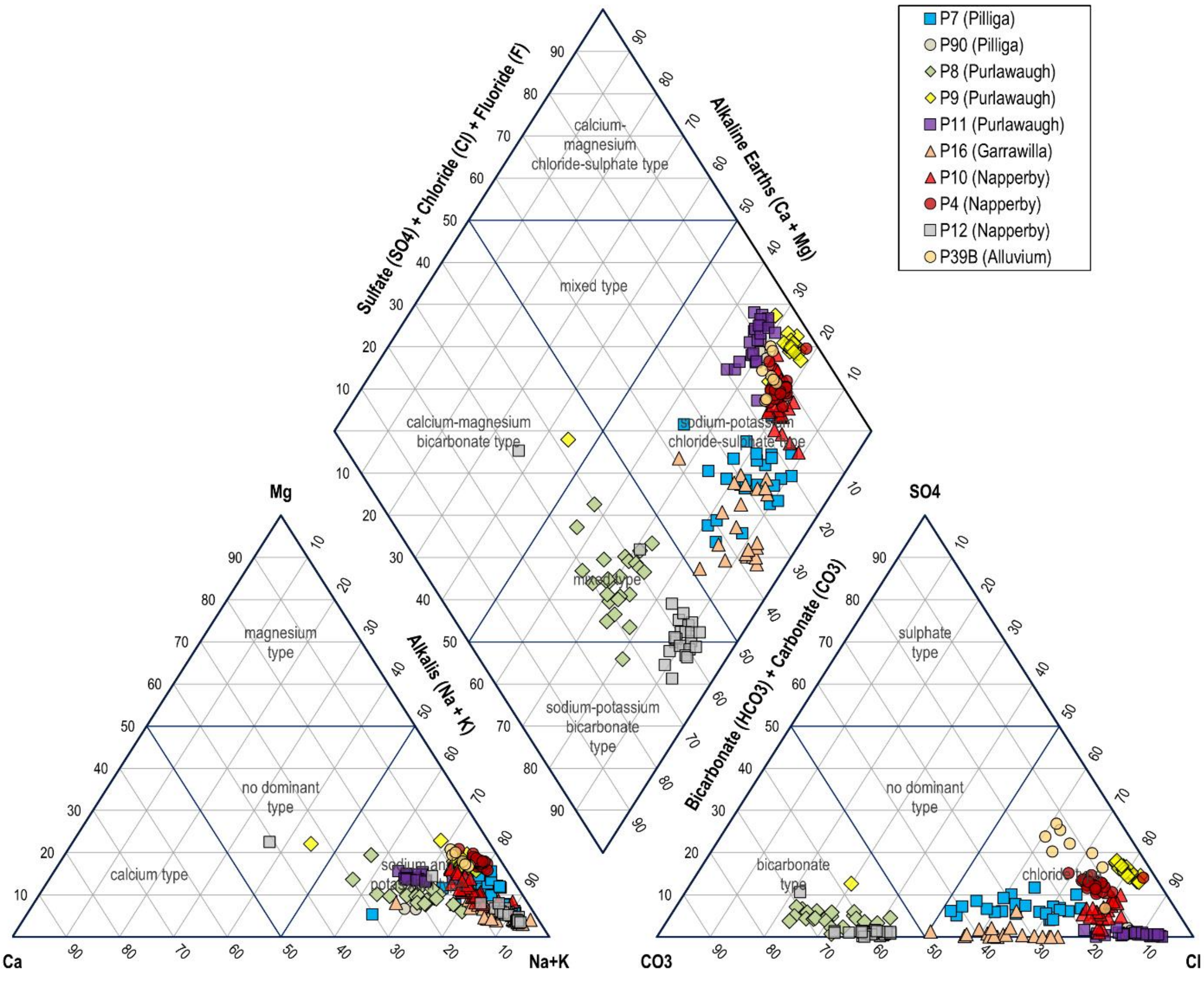
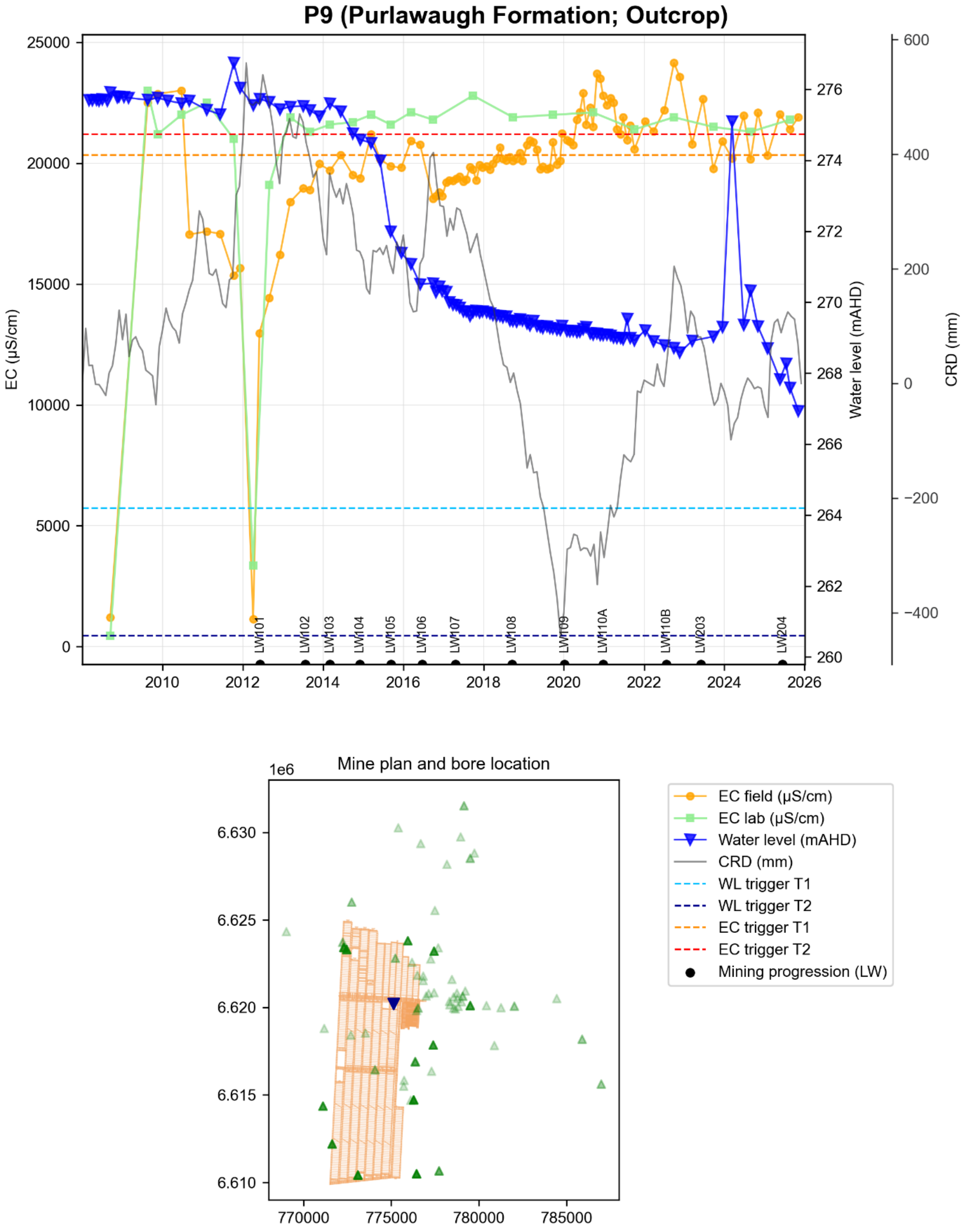


Figure 7.10 Purlawaugh bore Piper Plot with surrounding bores

7.3.2 P9 – water quality – EC exceedance

Bore P9 is located between LW203 and LW105, the bore is installed in the Purlawaugh Formation at 24 to 36 m bgl. Prior to mining commencing in 2012 groundwater EC at P11 fluctuated between 15,360 to 23,010 µS/cm (Figure 7.11). EC values have fluctuated since installation with a steep rising EC trend recorded during the tinderbox drought from 2017 to 2019. Since the end of the drought EC values have fluctuated between approximately 20,000 and 24,000 µS/cm. Depressurisation associated with mining was recorded in 2015 (Figure 7.8) no significant changes in EC were recorded at this time.



* mAHD - metres Australian Height Datum

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Water Level plots

Figure 7.11 P9 EC field and laboratory measurements plotted with water levels

7.3.2.1 Natural climate factors

Significant fluctuations in EC observed at site P9 prior to the commencement of mining in 2012 suggest naturally variable salinity within the Purlawargh Formation. These variations are likely driven by environmental factors such as precipitation and temperature. In contrast, laboratory measurements consistently report EC values around 22,000 µS/cm, indicating a high baseline salinity under controlled conditions. The absence of any upward trend in lab EC over time supports the interpretation that the variability seen in field measurements reflects natural environmental fluctuations rather than anthropogenic influence.

7.3.2.2 Seepage from surface sources

Bore P9 is located 3.2 km west and hydraulically downgradient of the RLD complex as such the surface water provides a potential source for elevated EC. Bore P12 and P13 (installed in the Napperby Formation and Garrawilla Volcanics, respectively) are located between P9 and the potential source. Neither of these bores indicated elevated EC. Water from P9 plots as a Na-Cl type (Figure 7.10) with no mixing lines evident in the Piper plot. Seepage from surface storage is not a likely cause of an increase in salinity.

7.3.2.3 Mining-induced mixing

Stable laboratory EC measurements and lack of any mixing trend in the Piper plot indicates that no mixing with other water is occurring.

7.3.2.4 Solute release

In coal mine environments, acid-rock drainage is commonly linked to elevated sulfate levels resulting from the oxidation of reduced sulfides during dewatering. However, sulfate concentrations may also rise due to natural processes such as evaporation. To differentiate between these mechanisms, the sulfate-to-chloride mass ratio serves as a useful indicator. Ratios of sulfate to chloride show a generally stable trend (Figure 7.12), in 2015 when depressurisation was recorded a small increase in the ratio of SO_4 to Cl; however, remains stable over time.

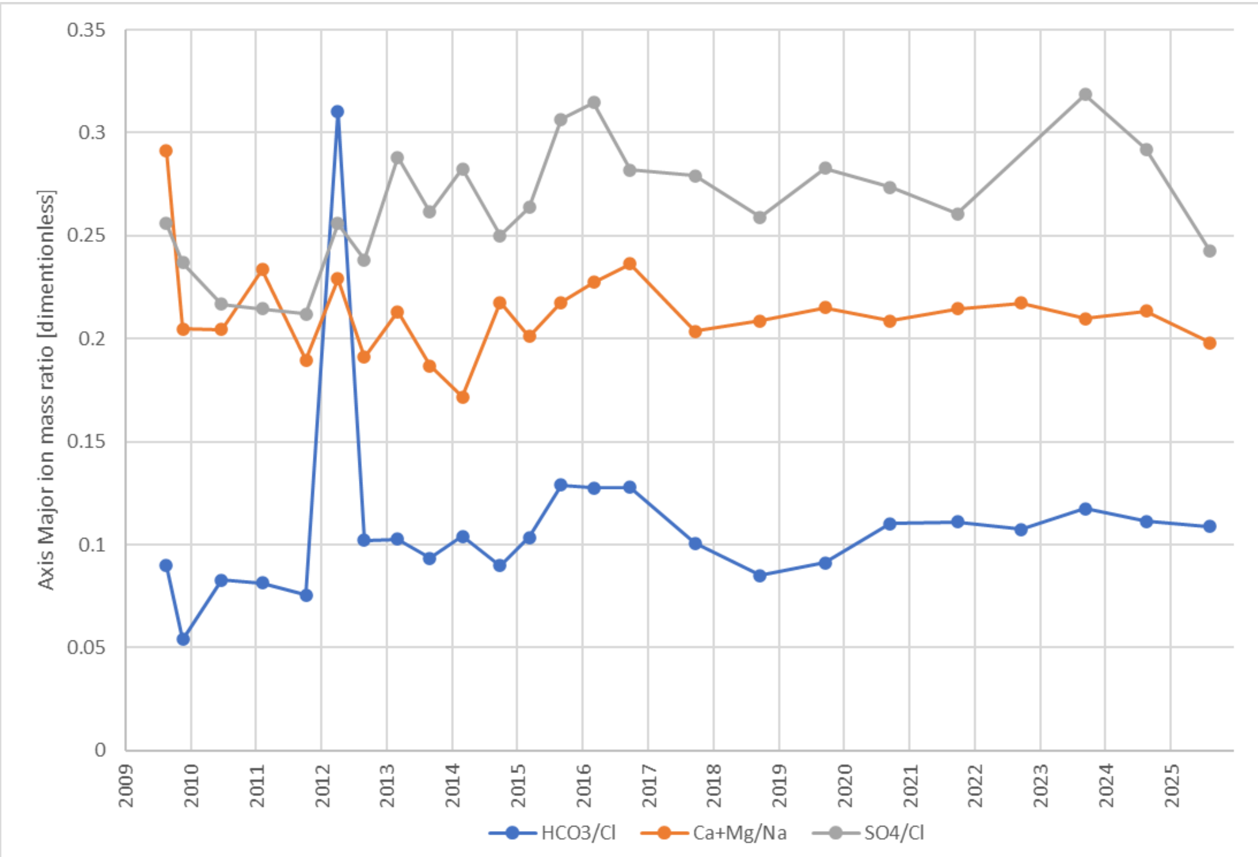


Figure 7.12 Ratios of bicarbonate to chloride, calcium + magnesium to sodium and Sulfate to Chloride bore P9

7.3.3 Conclusion and recommendations

Given the decreasing HCO_3/Cl mass ratio over time and overall changing chemistry (increasing relative concentration of Cl), the most likely cause of groundwater quality changes at P11 is due to lateral migration within the Purlawaugh Formation. Depressurisation observed from 2013 to 2022 are likely due to an overall decreasing rainfall and subsequently recharge. This observed decline is unlikely related to mining due to the timing of the decline and proximity of the bore to active mining at the time of the observed decline. Other bores in the same formation (P9) located near to LW105 shows a distinctive decline that is associated with mining.

A bore census was conducted in early 2025 to determine if any pumping was occurring in the area surrounding P11, no significant groundwater pumping was observed. During the bore census a down hole camera survey was conducted of the bore to determine if the bore was compromised. The survey indicated that that bore is intact and not damaged.

The EC measured in the lab for P9 indicates a stable baseline EC at approximately 22,000 µS/cm, given the natural fluctuations a review of the trigger value is recommended.

7.3.4 Potential impacts

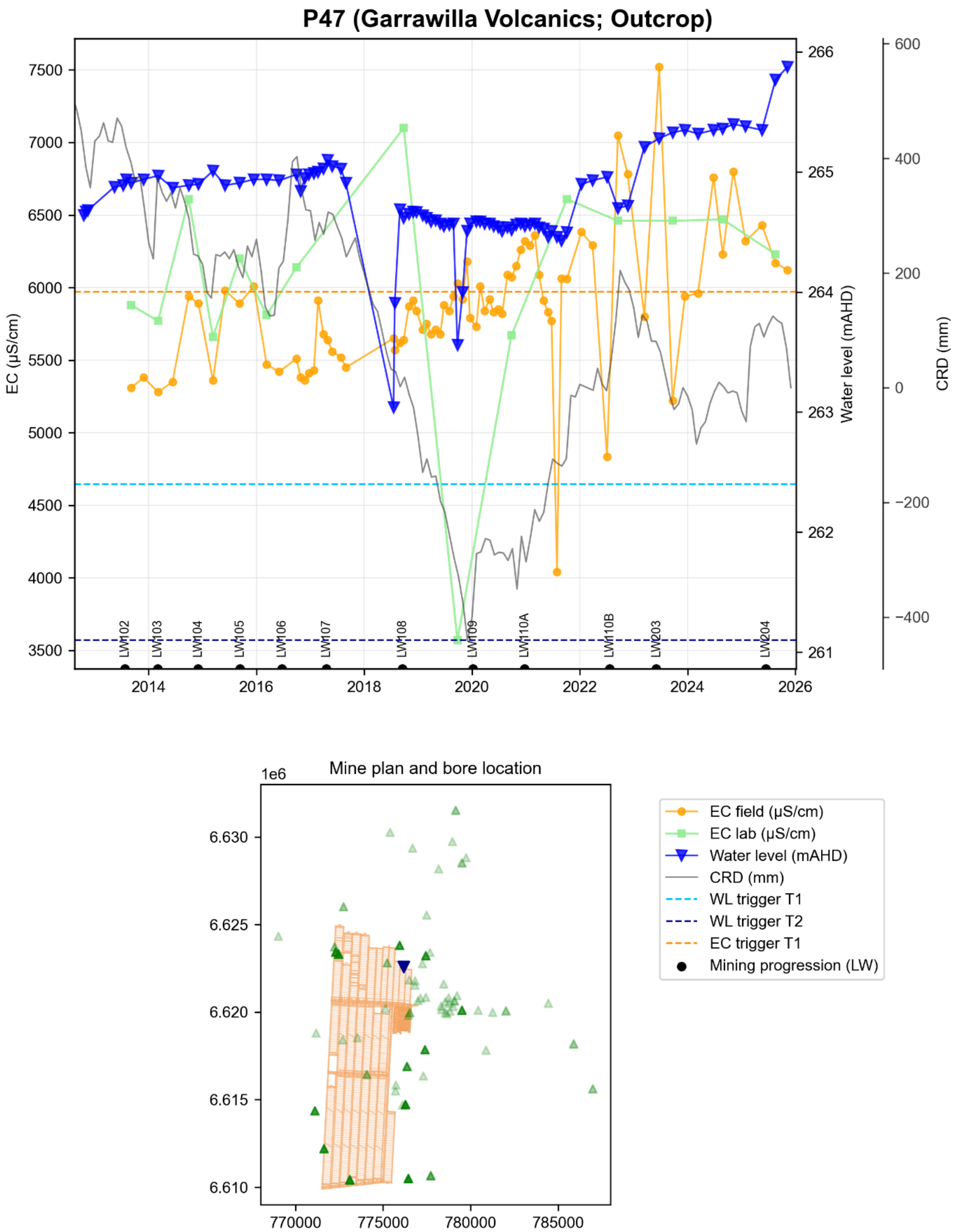
The decreasing water levels recorded at P11 are not consistent with other bores installed in the Purlawaugh formation indicating that drawdown is localised around P11 and not associated with mining.

The naturally elevated EC observed at site P9, combined with the absence of nearby sensitive environmental receptors, suggests that the elevated field EC levels are unlikely to result in significant environmental impacts.

7.4 Garrawilla Volcanics Bores

7.4.1 P47 - water quality - EC exceedance

Bore P47 has exceeded its ANZG (stock) trigger level of 5,790 µS/cm (Figure 7.13), this bore has also seen a correlating increase in water levels. EC values recorded since 2021 have fluctuated with up to 2,000 µS/cm differences recorded between consecutive measurements. The reasons for the water level increase and fluctuating EC measurements are not yet well understood, historically the bore has a subdued response to variations in climate.



* mAHD - metres Australian Height Datum

Australasian Groundwater and Environmental Consultants Pty Ltd
Water Level plots

Figure 7.13 P47 EC field and laboratory measurements plotted with water levels

7.4.1.1 Natural climate factors

EC measurements have increased since records began in 2013; however, the first significant increase in EC occurred from 2018 to 2022 when water levels declined. The declining water level trend is likely due to the Tinderbox Drought with a delayed recharge response. From 2022 water levels commenced recovering, during this time EC lab measurements stabilised; however, field measurements, along with temperature fluctuated from 4,000 to 7,500 µS/cm. The fluctuating EC and temperature measurements observed from 2022 (Figure 7.14) indicate natural fluctuations are causing the EC variability.

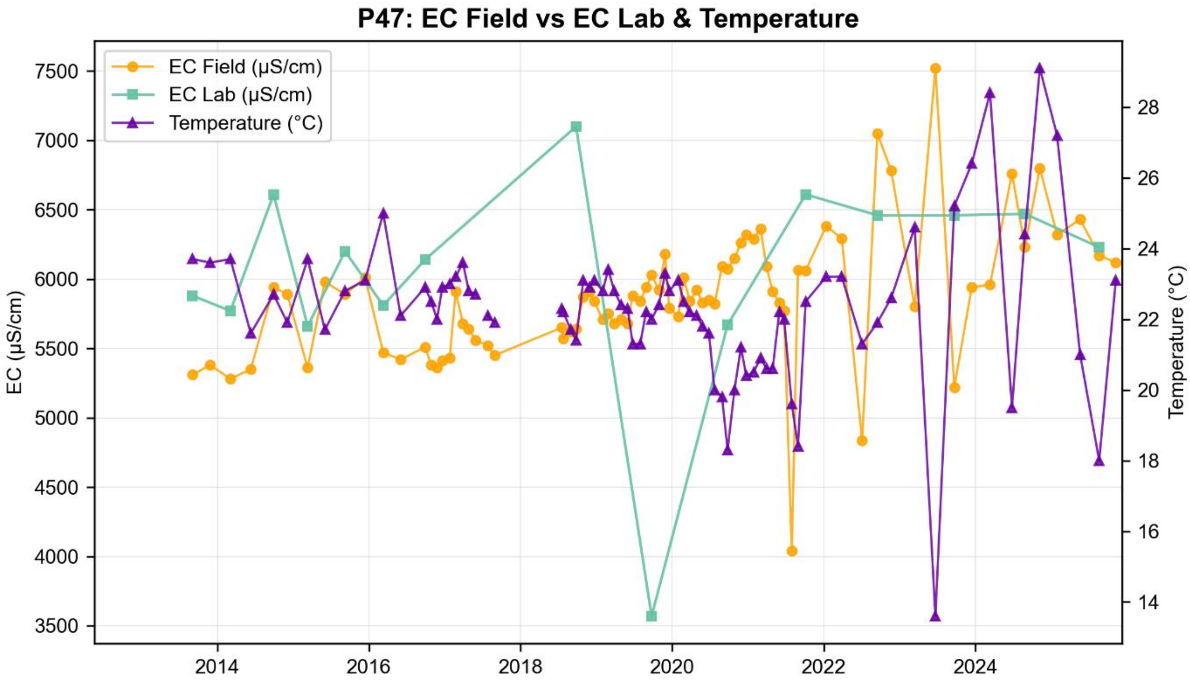


Figure 7.14 P47 EC and temperature measurements

7.4.1.2 Seepage from surface sources

Bore P47 is located 1 km south of Pine Creek and 2.1 km north of surface water storage, seepage from surface water is unlikely to cause the increasing EC recorded.

7.4.1.3 Mining-induced mixing

Groundwater chemistry indicates water sampled at P47 is a Na-Cl type, no mixing trends are identified in the data therefore mixing with other groundwater sources nearby is unlikely.

7.4.1.4 Solute release

Bore P47 is located immediately north of LW102 which was mined from July 2013 to January 2014, monitoring commenced around the same time therefore no pre-mining data is available for this bore.

7.4.2 Conclusion and recommendations

P47 shows no signs of mining-related depressurisation while some response to changing rainfall is observed with an approximate one-year lag in response to increasing recharge. During the Tinderbox Drought EC measurements increased steadily, when groundwater levels commenced recovering larger increases with greater fluctuations in EC and temperature were recorded. The larger increases in EC are likely due to the mobilisation of salts in the subsurface that accumulated during the drought and mobilised during periods of increased recharge. As such, the observed EC is considered due to natural climate variations.

Continued monitoring is recommended with a review of baseline groundwater quality parameters once EC and pH measurements stabilise.

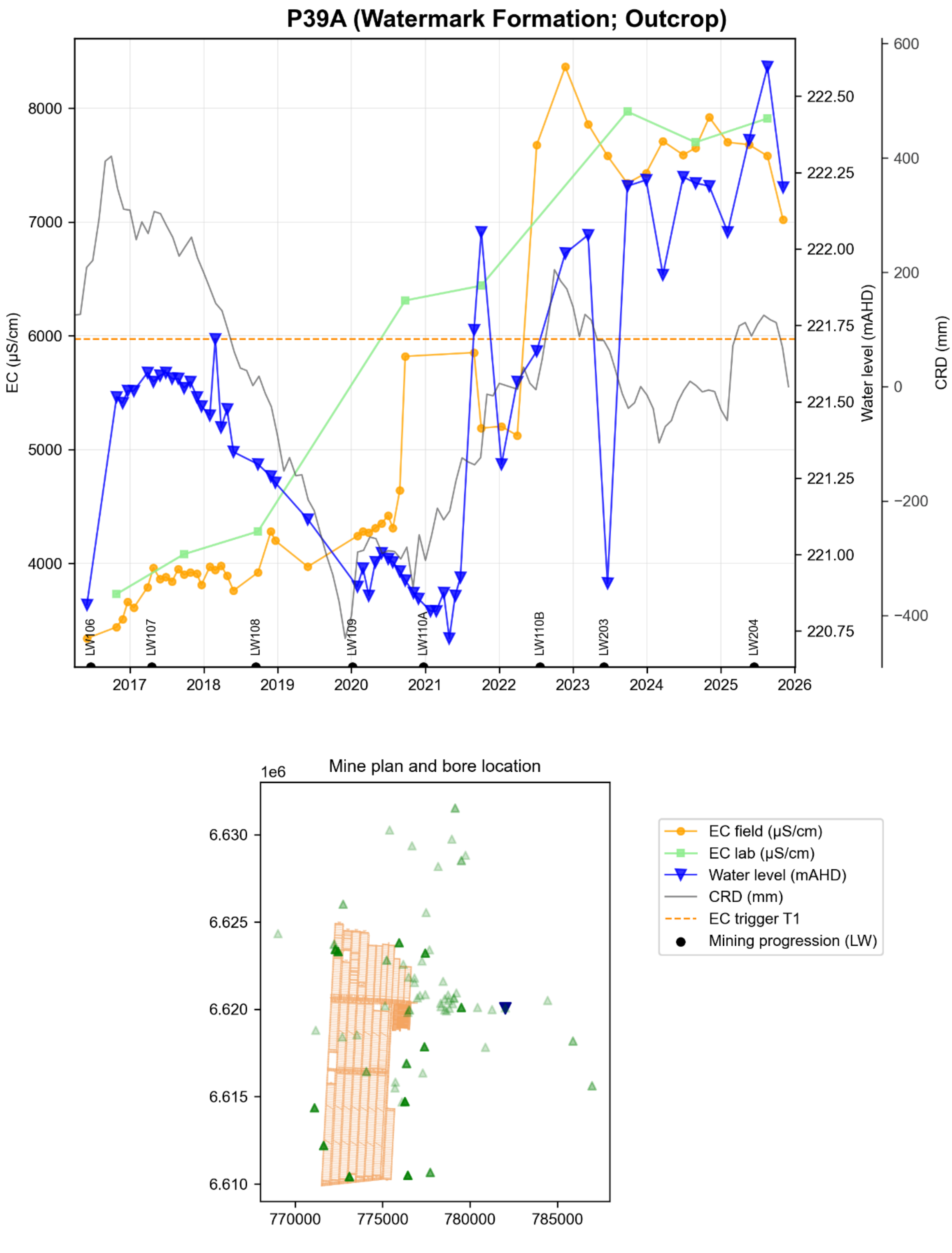
7.4.3 Potential impacts

Increases in salinity are not considered significant and field measured EC fluctuates around the trigger level for this bore.

7.5 Watermark Formation Bores

7.5.1 P39A - water quality - EC exceedance

Bore P39A is installed approximately 6 km east of mining between Tulla Mullen and Kurrajong Creeks from 72 to 78 m bgl. The bore was installed just prior to the Tinderbox Drought and as with bore P39B demonstrates a lag from the end of the Tinderbox Drought to groundwater level recovery, as groundwater levels commenced recovering the EC values show a sharp increase with large (~3,000 µS/cm) fluctuations (Figure 7.15).



* mAHD - metres Australian Height Datum

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Water Level plots

Figure 7.15 P39A EC field and laboratory measurements plotted with water levels

7.5.1.1 Natural climate factors

The steady increase in EC observed during the Tinderbox Drought is likely due to reduced recharge from rainfall and diminished contributions from the Kurrajong and Tulla Mullen Creeks. As with P39B, following the drought, as groundwater levels began to recover, EC values rise more sharply and exhibited greater fluctuations. This post-drought increase is attributed to the mobilisation of salts that had accumulated in the unsaturated zone during the dry period.

Water levels recorded at P39B (alluvium) and P39A (Watermark Formation) are similar, have similar fluctuations to changes in climate and EC trends, the natural climate factors influencing P39B appears to be also influencing water recorded at P39A.

7.5.1.2 Seepage from surface sources

Nearby surface water storage located northeast and southeast of the bore may contribute to elevated salinity; however, no surface water quality is available to cross reference.

7.5.1.3 Mining-induced mixing

No mixing trends are identified with other nearby formations, water type plots as Na-Cl type (Figure 7.3).

7.5.1.4 Solute release

The bore is located approximately 7 km east of active mining and 3 km east of rail loop dams, as such, solute release from these sources are unlikely without observable trends in bores located nearby.

7.5.2 Conclusion and recommendations

Mechanisms for change with the Watermark bores appear to be the same as with other formations experiencing EC exceedances. Groundwater EC trends are similar to those recorded in the Napperby formation, as such, recommendations are the same as for Napperby which include continued monitoring followed by a review of EC baseline once bores have reached a new equilibrium.

7.5.3 Potential impacts

EC measurements at bores P43 and P39A indicate the presence of naturally saline groundwater. As such, further increases in salinity are unlikely to result in significant impacts to the system.

7.6 Napperby Formation Bores

Three Napperby Formation bores have exceeded water quality (EC) triggers, these are shown together in Figure 7.16 and are further discussed in sections below.

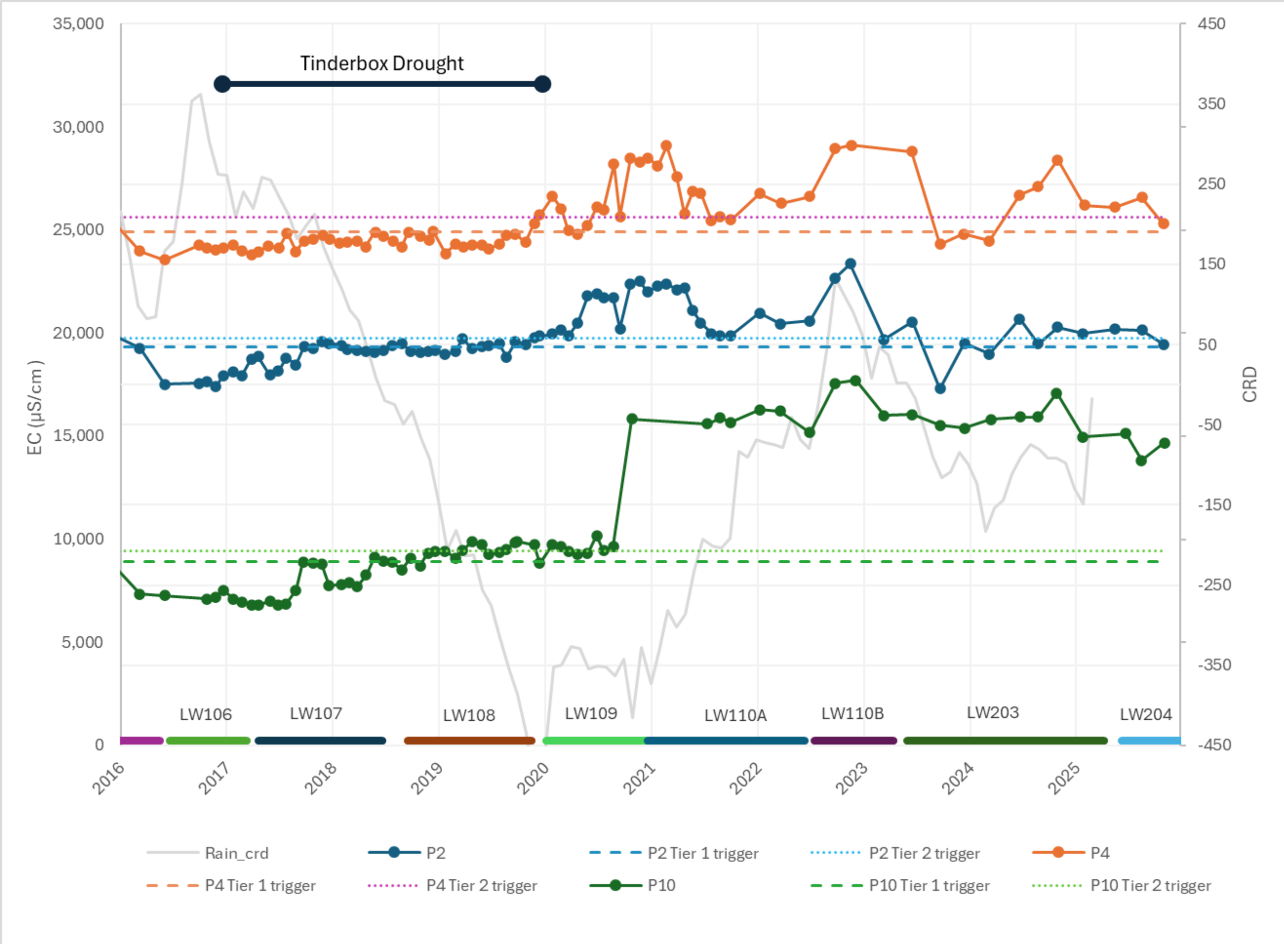


Figure 7.16 Napperby Formation bores EC comparison

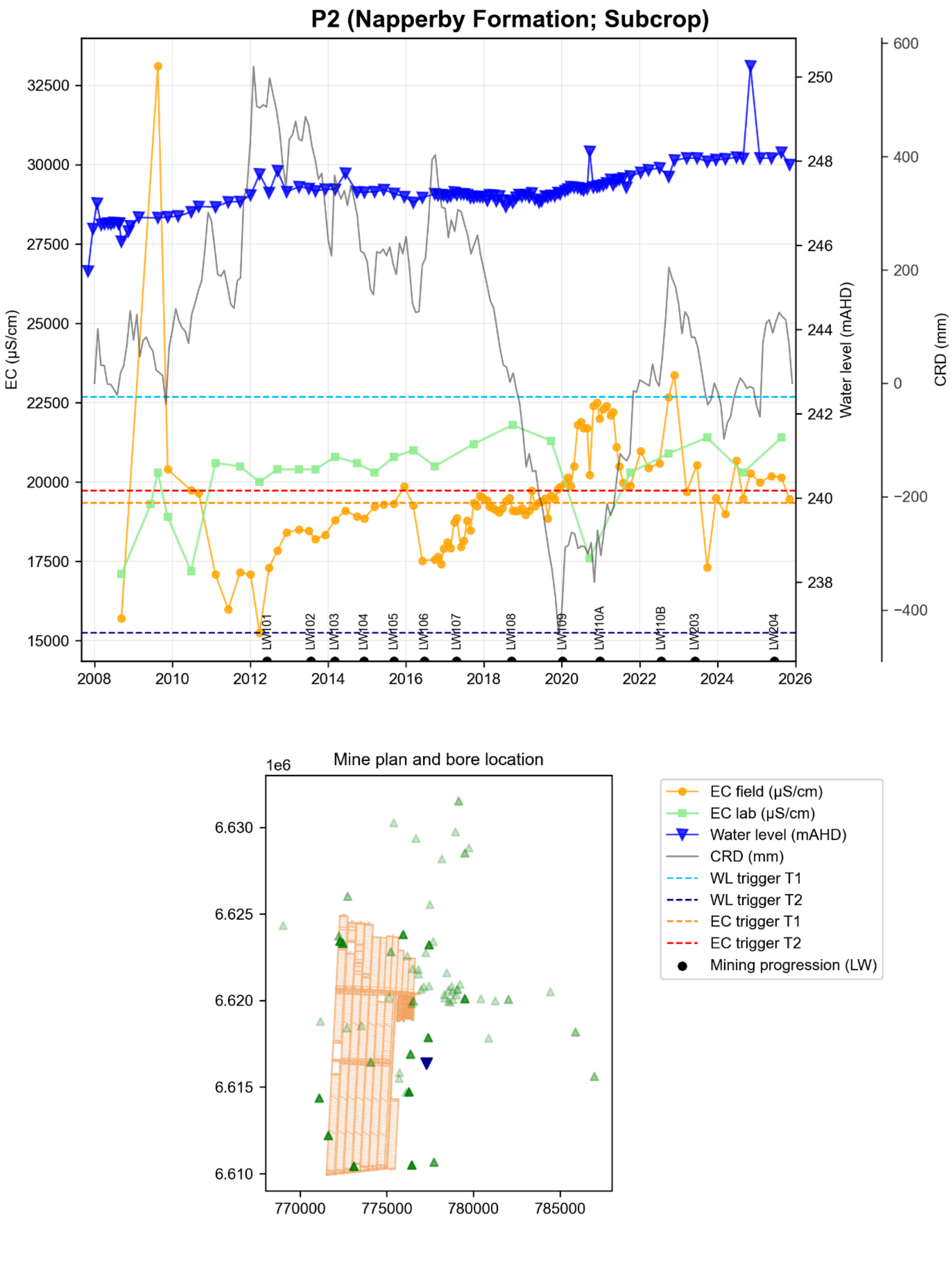
7.6.1 P2 - water quality - EC exceedance

Bore P2, installed from 44 to 50 m bgl in the Napperby Formation and located southeast of the mine. The bore has historically high recorded EC values which is typical of this formation. Since recording commenced in 2010 (pre-mining) to the commencement of the Tinderbox drought in 2017 the EC measurements have fluctuated between 15,000 µS/cm and 20,000 µS/cm (Figure 7.17). In Q4 2025 EC values were below the Tier 2 trigger; however, the rolling median remains above the Tier 1 trigger.

In 2017, EC values at P2 began to steadily increase, rising from 17,000 µS/cm to 22,000 µS/cm. In late 2021, EC values saw a rapid increase, reaching 23,370 µS/cm by November 2022. After this peak, most of the Napperby Formation monitoring bores experienced a decrease in EC during 2023. This decreasing coincided with lower-than-average rainfall during that period. At P2, the decline in EC was followed by a slight increase in 2024 with values now appearing to stabilise.

Groundwater levels have increased by approximately 1 m since late 2019 and appeared to stabilise at approximately 27.9 m bgl with minimal fluctuations after 2023, indicating no depressurisation. Water level increases show moderate correlation but are generally stable prior to the drought.

The nearby bore P69 has recorded similar trends since it was constructed in 2023, the water level has increased by 0.30 m, while the EC fluctuates between 16,880 µS/cm and 20,560 µS/cm, the latest result being 17,290 µS/cm recorded in November 2025. In contrast, the bore P10 has had erratic groundwater levels since 2020 and significant variations in EC which have been attributed to a mixing process within the Napperby Formation.



* mAHD - metres Australian Height Datum

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Water Level plots

Figure 7.17 P2 EC field and laboratory measurements plotted with water levels

7.6.1.1 Natural climate factors

Groundwater levels recorded at P2 show a subdued response to changes in rainfall indicating a reduced effect of recharge on the system. Chloride mass balance (CMB) methods for calculating recharge support this with an average recharge for the Napperby Formation of 2.0 mm/year[10], the Bioregional Assessment estimated 0.1 to 4.3 mm/year[11].

During periods of relatively stable groundwater levels and rainfall (2008 to 2017) EC shows minimal short term fluctuations; however, from 2020, when rainfall increases post drought and groundwater levels commence recovery there is a shift in temperature and EC (Figure 7.18). Initially temperature decreases and a spike in field EC is observed, the temperature adjust lab measurement shows a decrease in EC, this could be due to sample storage and transport; however, a similar trend is also recorded at bore P4 (Figure 7.21).

From 2020 until the latest sampling in November 2025 field temperature and EC show erratic fluctuations. The fluctuations in EC are attributed to the variable temperatures; lab measurements show stable EC around 21,000 µS/cm.

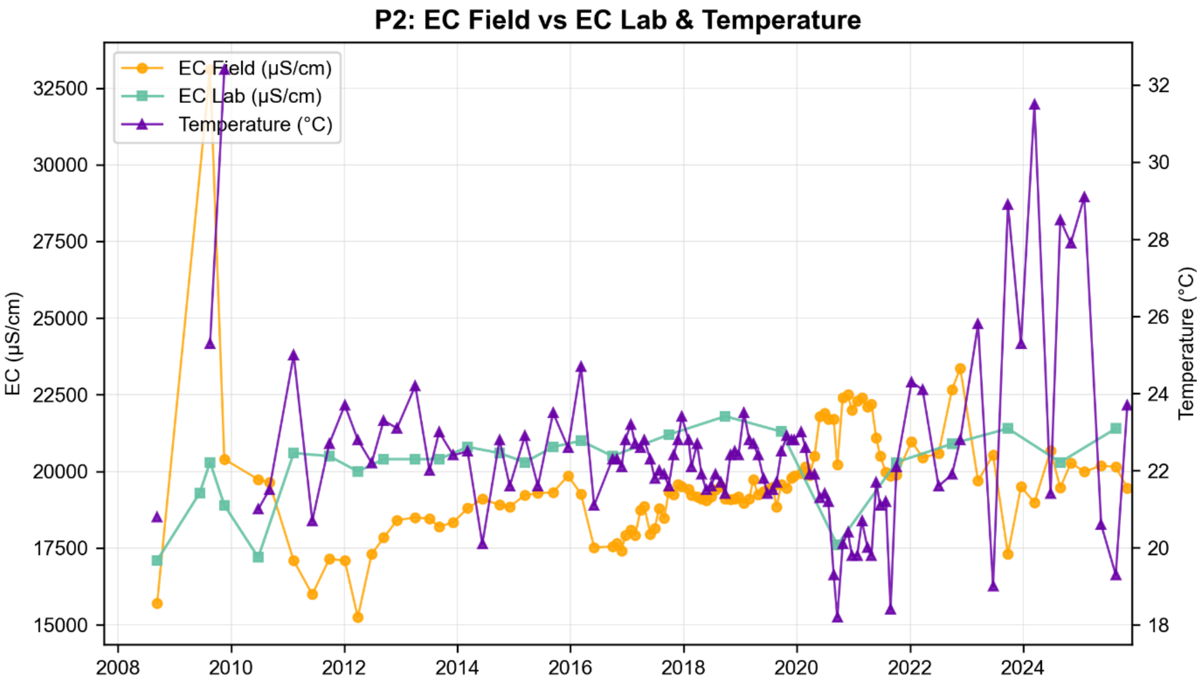

Figure 7.18 P2 EC and temperature measurements

7.6.1.2 Seepage from surface sources

Bore P2 is located between two dams, no hydrochemistry data is available for these dams; however, as the purpose is for stock and irrigation the salinity is expected to be low. As can be seen in Figure 7.19 no water was present in the southern dam during the Tinderbox drought, whereas water is present post drought. Seepage from the dams is unlikely given that P2 is installed at 44 m bgl within the very tight Napperby Formation.

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[10] AGE (2020) Groundwater Assessment - Narrabri Underground Mine Stage 3 Extension Project – v06.02.

[11] Bioregional Assessment Programme, 2016a. Namoi hydraulic conductivity measurements. Bioregional Assessment Source Dataset in AGE (2020).

Figure 7.19 Comparison of the area surrounding P2 between 2018 and 2023

7.6.1.3 Mining-induced mixing

Numerical modelling[12] indicates maximum drawdown in the Napperby to be above longwall panels thereby creating a groundwater gradient towards mining. EC exceedances are therefore not directly related to mining progression.

7.6.1.4 Solute release

Bore P2 is located west and hydraulically upgradient of mining, solute release from mining is considered unlikely.

7.6.2 P4 - water quality - EC exceedance

Bore P4 is installed from 24 to 30 m bgl in the Napperby Formation and is located approximately 3 km north of the mine near Pine Creek. EC measurements show a gradual increase during the Tinderbox Drought from 2017 to 2020 after which EC measurements fluctuated up to ~3,000 µS/cm with an overall increasing trend (Figure 7.20). Trends observed in bores P2, P4 and P10 have similar behaviour with the timing of changes, different depending on the depth at which bores are installed (Figure 7.16).

[12] AGE (2020) Groundwater Assessment - Narrabri Underground Mine Stage 3 Extension Project – v06.02.

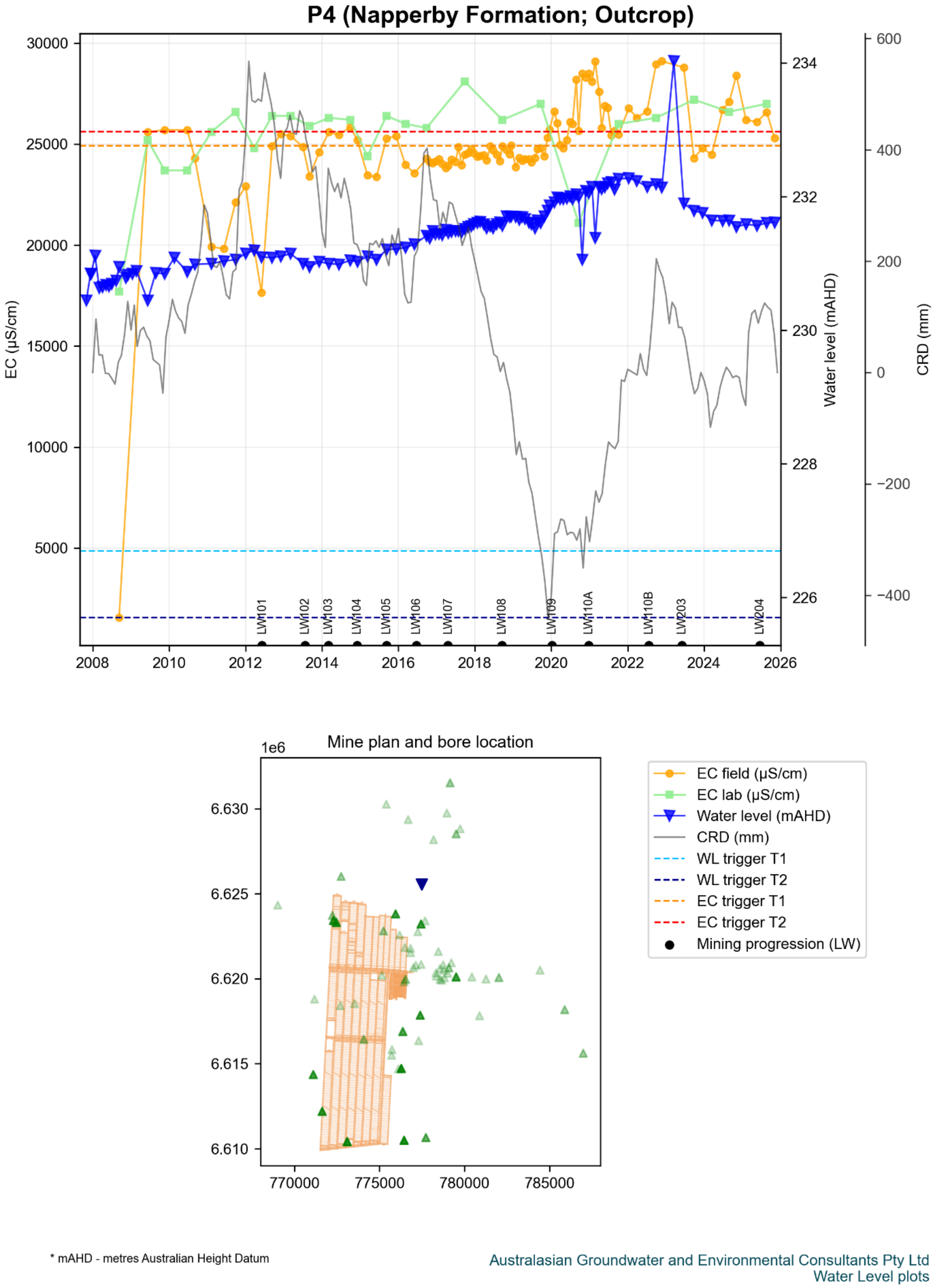


Figure 7.20 P4 EC field and laboratory measurements plotted with water levels

7.6.2.1 Natural climate factors

As with bores P2 (Section 7.6.1) and P10 (Section 7.6.3), changes in trends coincide with the Tinderbox Drought and subsequent period of above average rainfall. A similar EC trend to P2 is observed whereby a drop in temperature coincides with a decrease in lab EC and an increase in field EC. Following this initial trend EC fluctuates consistent with fluctuations in temperature, while lab EC remains consistent at approximately 21,000 µS/cm.

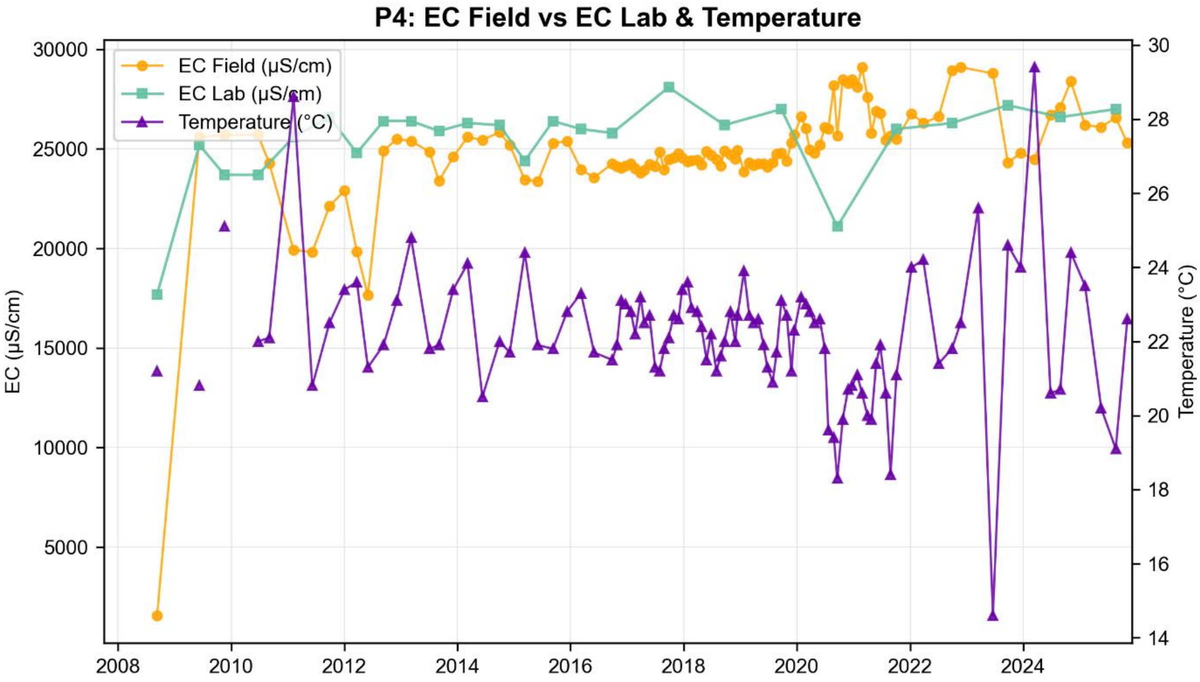


Figure 7.21 P4 EC and temperature measurements

7.6.2.2 Seepage from surface sources

Bore P4 is located approximately 300 m west of Pine Creek, the creek is an unlikely source of elevated salinity given the elevated natural salinity of water within the Napperby Formation.

7.6.2.3 Mining-induced mixing

Numerical modelling[13] indicates maximum drawdown in the Napperby to be above longwall panels thereby creating a groundwater gradient towards mining. No depressurisation is currently at P4 evident rather an overall increasing trend is observed from 2008 to 2022 despite drought conditions. EC exceedances are therefore not directly related to mining progression.

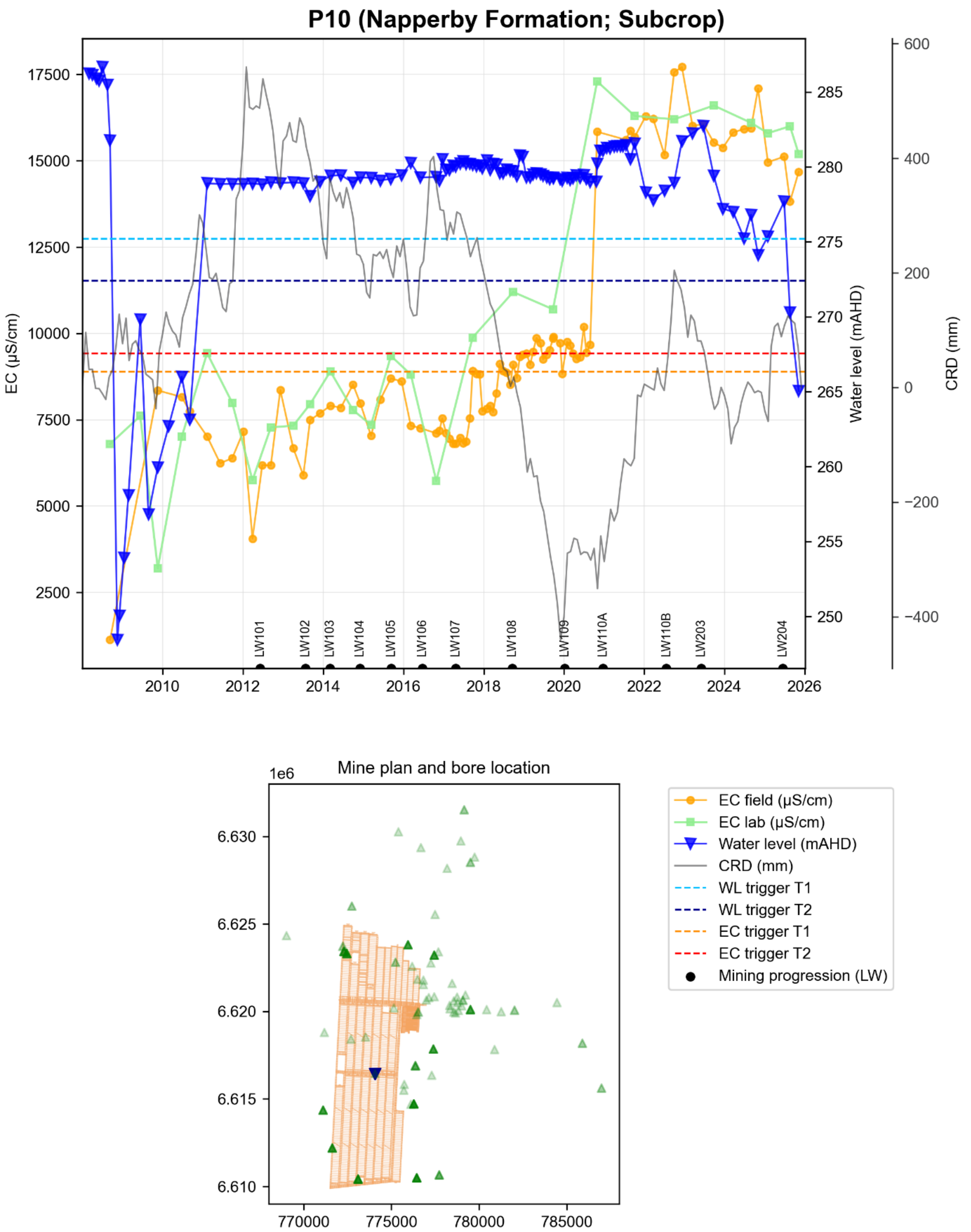
7.6.2.4 Solute release

As with P2, no regional or localised seepage from creek flow is expected.

[13] AGE (2020) Groundwater Assessment - Narrabri Underground Mine Stage 3 Extension Project – v06.02.

7.6.3 P10 - water quality - EC exceedance

Bore P10 is located south of planned LW 205 and north of Kurrajong Creek; the bore is installed in the Napperby Formation from 118 to 130 m bgl and is immediately adjacent to bore P11, which is installed in the shallower Purlawaugh Formation at 44 to 50 m bgl. Groundwater EC values are naturally high in the Napperby Formation at P10 (Figure 7.22), having fluctuated between 4,000 and 8,000 µS/cm from 2010 (installation pre-mining) to 2017. In 2017, P10 groundwater EC values began to steadily increase from 7,000 to 10,000 µS/cm, and in late 2021 values increased rapidly and have remained at elevated levels since.



* mAHD - metres Australian Height Datum

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Water Level plots

Figure 7.22 P10 EC field and laboratory measurements plotted with water levels

7.6.3.1 Natural climate factors

The gradual EC increase recorded between 2017 and 2020 is possibly associated with a reduction in recharge from precipitation and freshwater recharge from Kurrajong Creek during the Tinderbox Drought. However, with P10 being a deep bore, and the groundwater being naturally saline, immediate responses to a reduction in current recharge are only one possibility for the change in EC. In October 2020, just prior to the commencement of mining LW110A (December 2020) the groundwater levels recorded at P10 increased by 1.2 m from 279.0 to 280.2 m AHD at the same time EC increased from 9,670 to 15,841 µS/cm.

7.6.3.2 Seepage from surface sources

Nearby surface water testing at Kurrajong Creek shows no increases in groundwater salinity or possible contribution to changes in the underlying groundwater. In addition, there are no other surface sources adjacent to P10; therefore, this potential cause is dismissed.

7.6.3.3 Mining-induced mixing

Groundwater levels have been erratic at P10 since 2020, when EC changed significantly (Figure 7.22). In addition, in January 2017 the vertical hydraulic gradient between P10 (deep) and P11 (shallow) switched from downward to upward. Therefore, changes or reversals in hydraulic gradient could be causing groundwater mixing that has resulted in EC changes.

Chemical analysis of water from P10 indicates a Na-Cl type water chemistry throughout its record. Changes in chemistry over time could provide insight to the source of the higher EC water at P10. Ion-ion ratio plots indicate a decrease in the bicarbonate to chloride mass ratio, with a concurrent increase in the calcium + magnesium to sodium mass ratio (Figure 7.10). This indicates that the water at P10 is becoming more sodium-chloride dominated with time (Figure 7.23).

Bore P2, located 3.2 km to the east of P10, also plots as a Na-Cl type, indicating that this is a typical water composition for that formation. In addition, the EC at P2 is 20,190 µS/cm, which means there is naturally saline water in the formation that is greater than the Tier 2 value at P10. Therefore, the exceedance at P10 could be the result of groundwater mixing within the Napperby Formation.

7.6.3.4 Solute release

Acid-rock drainage in coal mine settings is typically associated with an increase in sulfate concentration, as reduced sulfides become oxidised because of dewatering. However, sulfate concentration can increase due to evaporation or other natural causes. One metric of sulfate release that distinguishes oxidation from evaporative concentration is the sulfate-chloride mass ratio. If this ratio does not increase above background concentrations, it indicates that sulfide oxidation is less likely to be the cause of groundwater quality changes. This is the case at P10, where the sulfate-chloride mass ratio has increased from about 0.10 in 2010 to about 0.18 in 2023 (Figure 7.23), but has remained well below the baseline value, which is approximately 0.23 to 0.43 in bore P8, and approximately 0.21 to 0.32 in bore P9. In addition, the hydraulic gradient at P10 indicates flow toward the mining zone, indicating that there is no viable pathway for solutes to reach P10, if they were being produced.

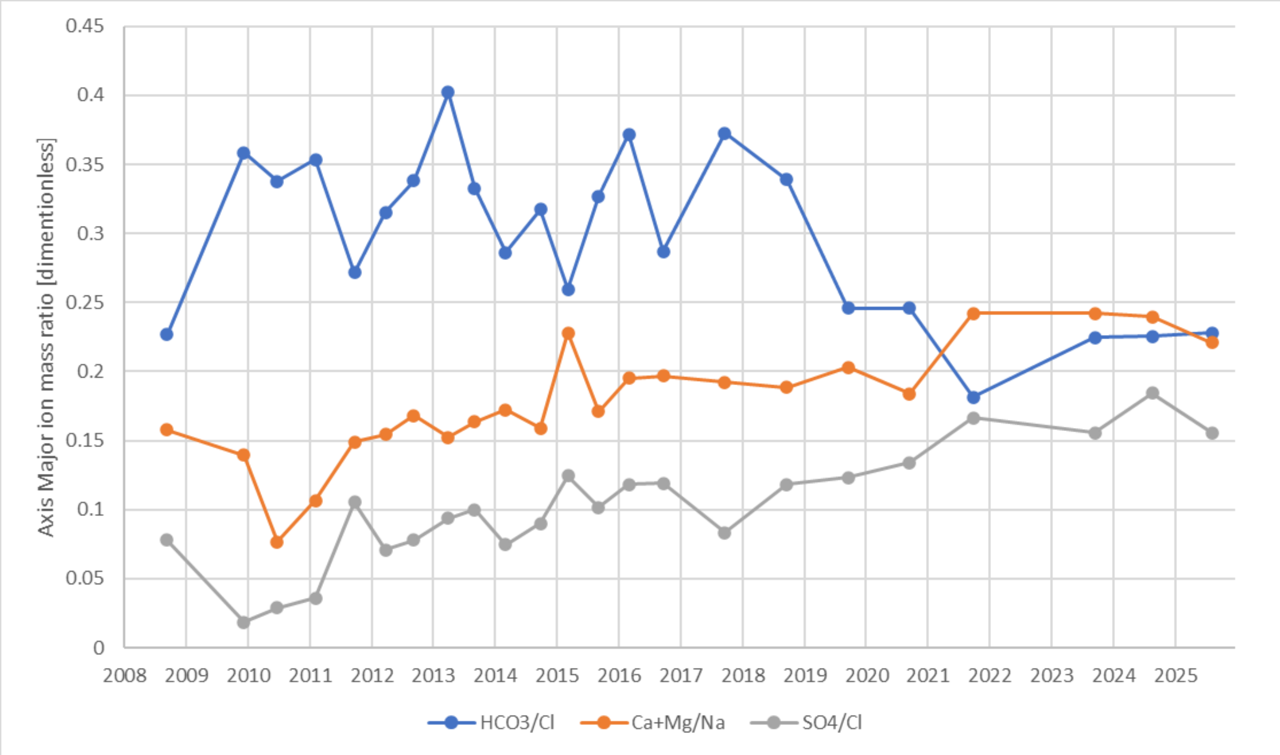


Figure 7.23 P10 HCO3/Cl, Ca+Mg/Na and SO4/Cl ratios

7.6.4 Conclusion and recommendations

Groundwater EC observed values within Napperby Formation bores P2, P4 and P10 have been historically high. EC increases appear to show a staggered response to the Tinderbox Drought with shallow bore P4 (24-30 m bgl) demonstrating changes in EC sooner after the end of the Tinderbox drought compared with the deeper bores of P2 (44-50 m bgl) and P10 (118-130 m bgl) thereby indicating that changes in salinity are a natural response to the mobilisation of salts after the end of the drought. The delayed response is associated with the tight Napperby Formation and depths for recharge to reach the bore depths. Given the distance the bores are located from active mining at the time of EC increases and the lack of depressurisation, impact from mining is an unlikely cause of EC exceedances.

It is recommended to continue monitoring and reevaluate baseline trigger levels once bores each a new equilibrium post drought.

7.6.5 Potential impacts

Salinity in groundwater within the Napperby Formation is naturally high therefore values resulting in EC elevations are unlikely to cause impacts to any sensitive environmental receptors or groundwater users.

7.7 Seepage Monitoring

7.7.1 P29 - water quality - EC exceedance

Bore P29 is a seepage monitoring bore located south of the rail loop dams (Figure 2.2), the bore is installed in Napperby Formation from 19 to 25 m bgl. The monitoring bore was installed in 2012 when the dams were installed. EC values initially declined after installation to mid-2015. Since 2015 values have fluctuated with an overall increase concurrent with an increase in water levels (Figure 7.24).

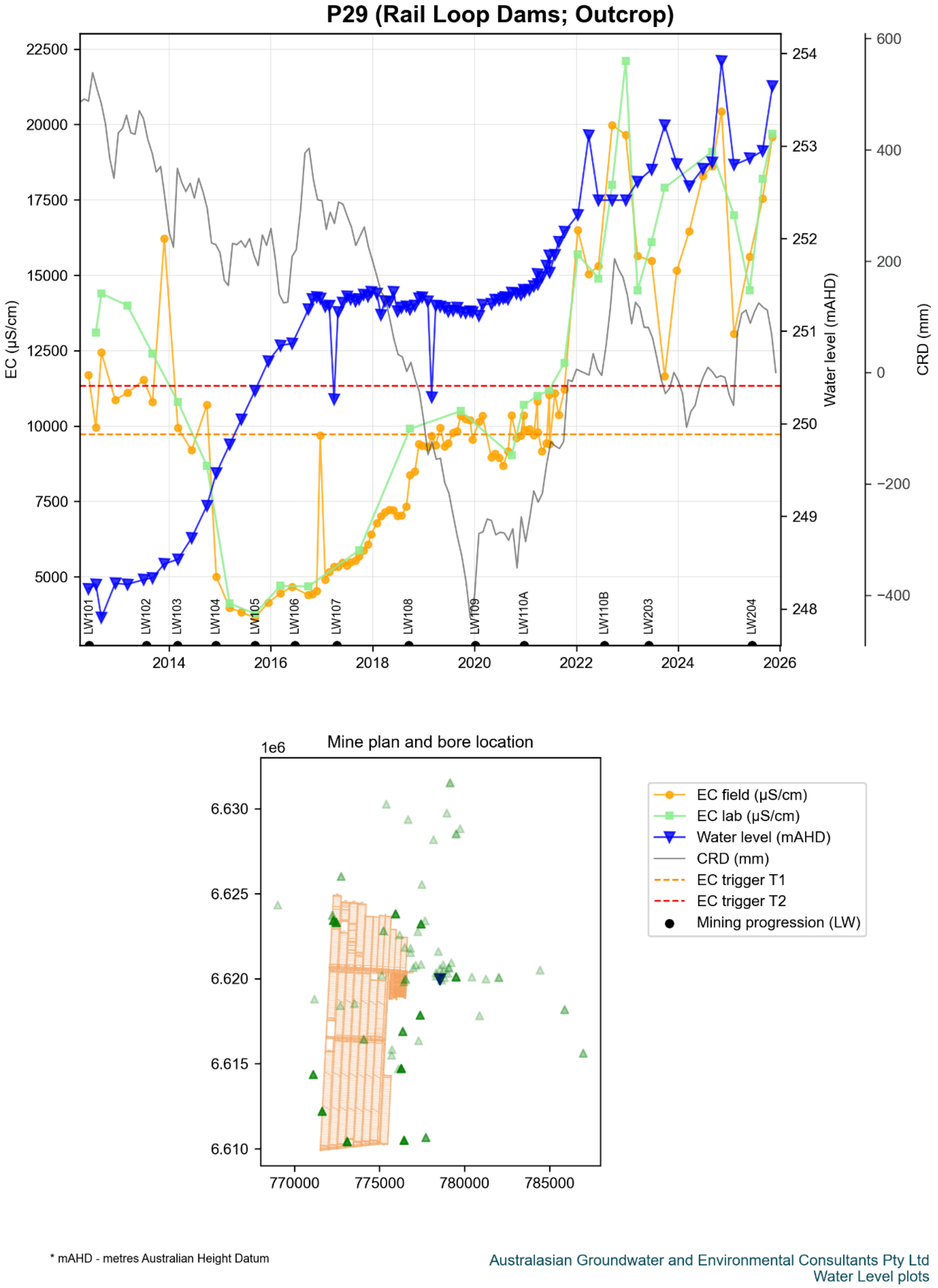


Figure 7.24 P29 EC field and laboratory measurements plotted with water levels

7.7.1.1 Natural climate factors

Surrounding seepage monitoring bores installed in the Napperby Formation (Figure 7.25) do not follow similar EC trends of P29. P30, located about 280 m to the east of P29 and adjacent to storage dams D and C shows a declining EC trend (Figure 7.25), although the two bores now currently have similar EC of about 17,000 µS/cm. The minimal correlation between bores and rainfall trends indicates natural climate variations are unlikely causing increasing trends in EC.

Bores P31 and P32 have a stable and low EC trend with minor fluctuations consistent with variations in average rainfall.

Further soil samples were collected in January 2025 to determine if saturation of previously unsaturated soils is a possible cause for increased salinity. Sample S1 was collected from the top 1 m of soil next to bore P29, sample S2 was collected south of BR1. Sodium Absorption Ratio (SAR) is a measure of the relative concentration of sodium compared to calcium and magnesium in soil solution. When the SAR is high, the water can increase the exchangeable sodium percentage (ESP) of the soil. Sample S1 has a SAR ranged from 4.94 to 7.47 while SAR for sample S2 ranged from 0.54 to 1.99. SAR of 6 to 8 is considered medium sodium hazard while less than 3 is considered ideal. Given the high SAR in soils near P29 the elevated EC could be attributed to mobilisation of salts and minerals present in the previously unsaturated soils.

7.7.1.2 Seepage from surface sources

As stated above, the high EC values at P29 and the changes over time indicate seepage from the rail loop dams as a possible cause of changes. Dams B2 and C have average EC values exceeding 20,000 µS/cm and are a viable source of the increased EC at P29.

The major ion water quality data from bore P29 and other seepage monitoring bores are plotted in Figure 7.26. Chemistry of recent P29 plots as a Na-Cl type water; whereas water from the dams B1, A1 and C plot as a $Na-HCO_3$ type. A linear mixing trend towards $Na-HCO_3$ types has been identified in historical data, the reasons for this is unknown.

The dam water is alkaline (Figure 7.26), having a pH consistently over 8, and often over 9. From 2012 until late 2021 pH measured at P29 ranged from 7.1 to 8.8, since EC began increasing over its trigger in November 2021 pH has commenced declining from approximately 8 to 6.5. Although this could indicate that the influences acting on water at P29 is not seepage from nearby dams this does not consider any buffering properties of the soil.

7.7.1.3 Mining-induced mixing

Mixing with water from adjacent areas of hydrostratigraphic units due to changes in hydraulic gradient are not likely to be the cause of EC increase at P29, due to the recorded increases in water levels, no depressurisation is recorded due to nearby mining.

7.7.1.4 Solute release

The hydraulic gradient at P29 indicates flow toward the mining zone, indicating that there is no viable pathway for solutes to reach P29, if they were being produced.

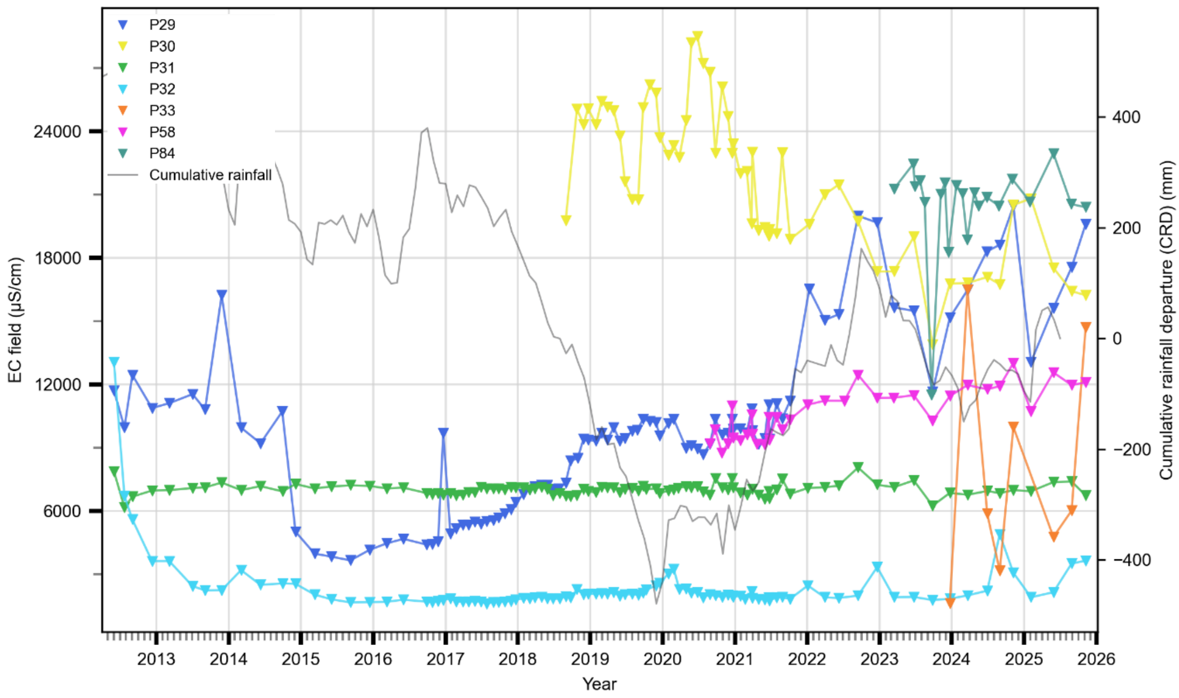


Figure 7.25 Seepage monitoring bore EC (anomalous data removed) and locations

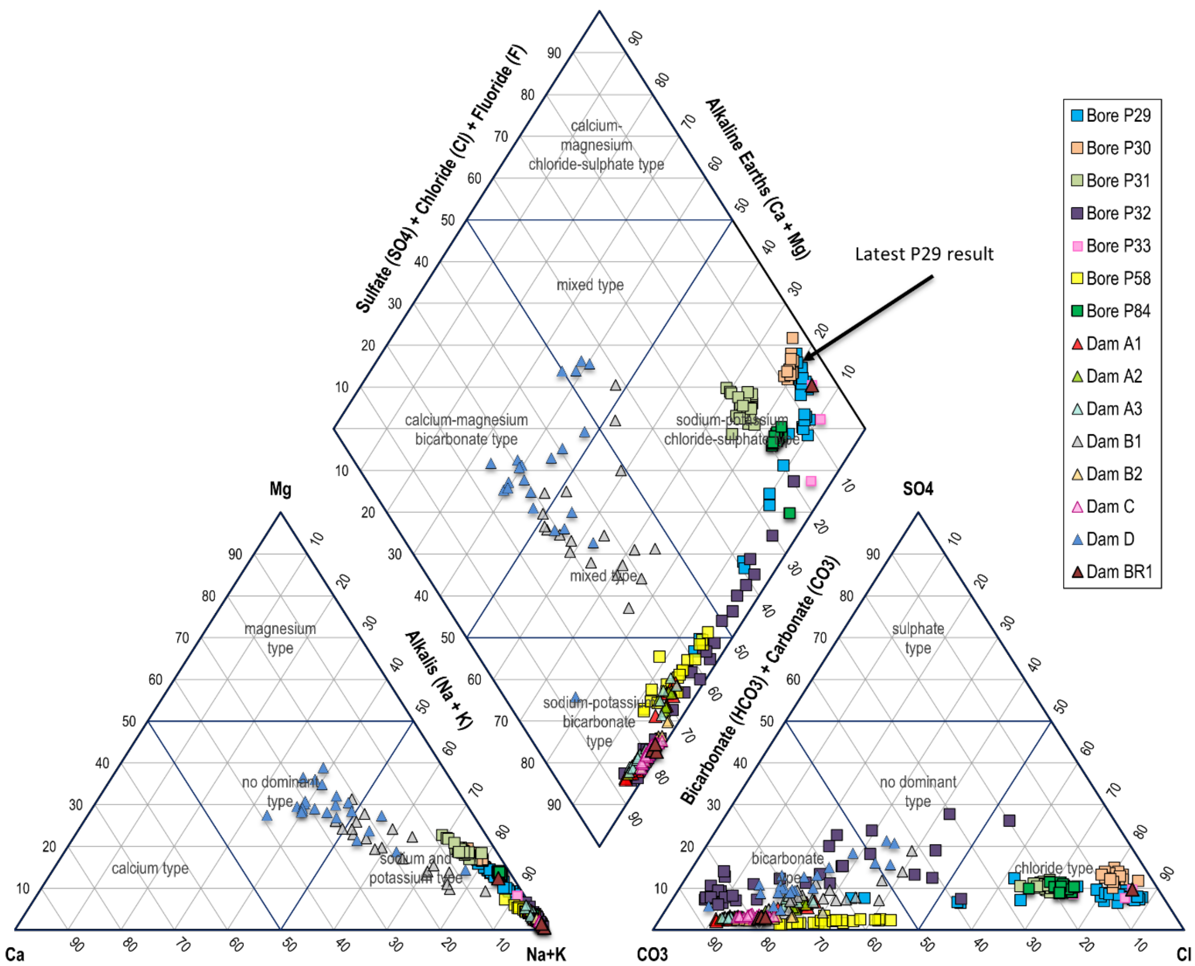
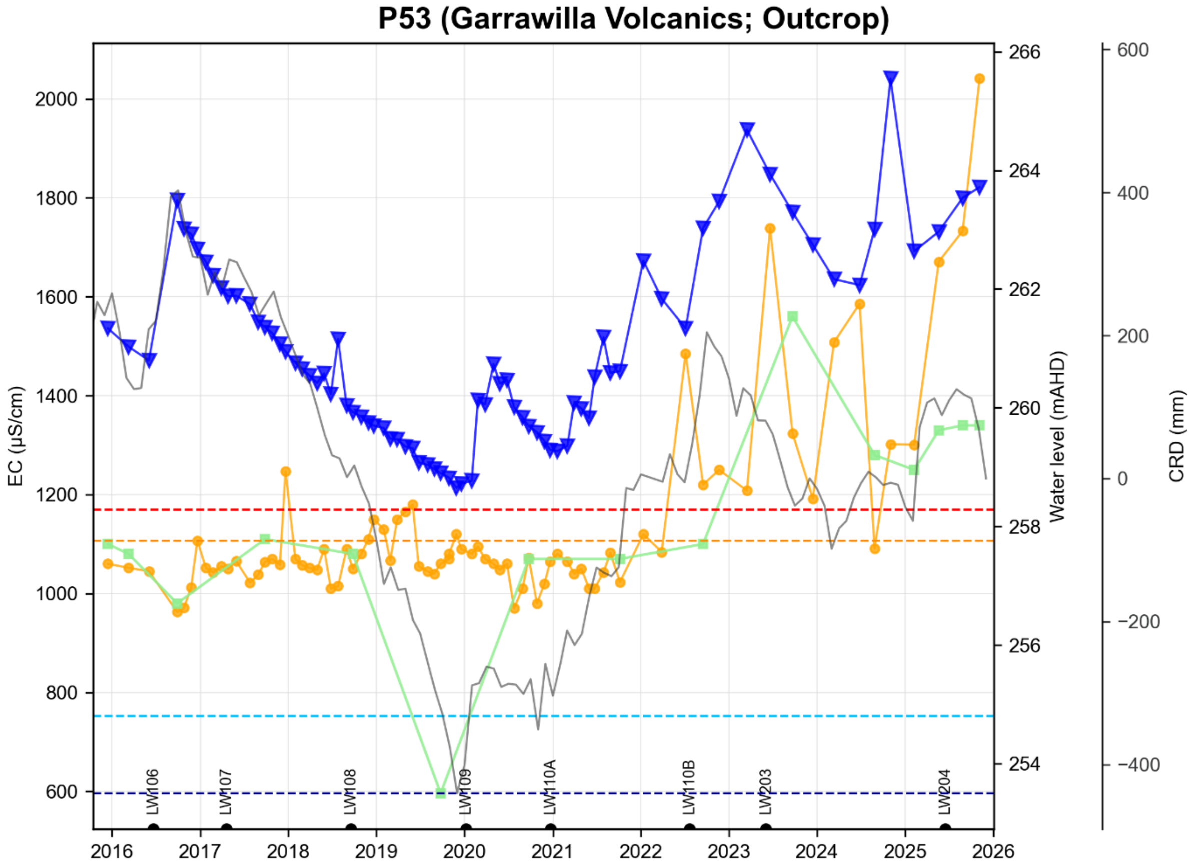
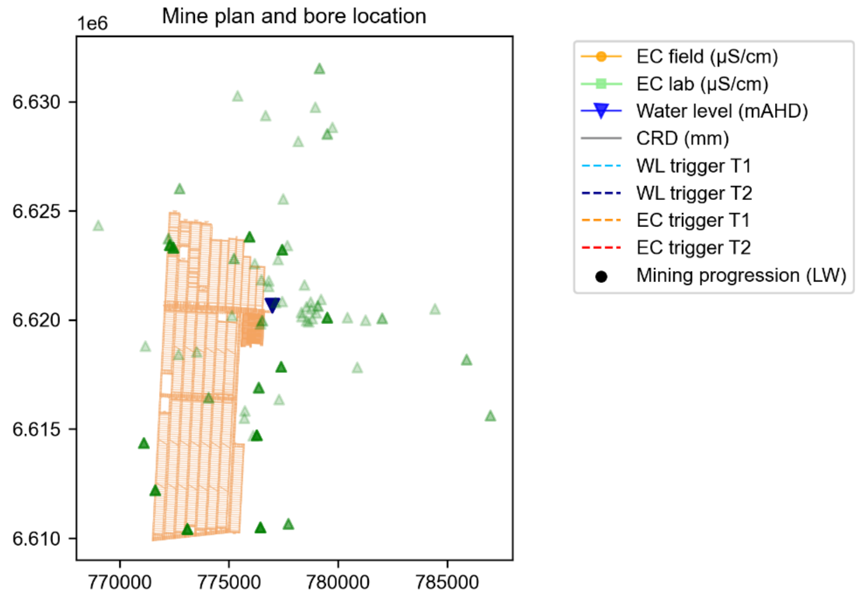


Figure 7.26 Piper diagram for monitoring bores P29 and surrounding sites, including rail loop dams B1, A1 and C

7.7.2 P53 - water quality - EC exceedance

Bore P53 is one of three Reject Emplacement Area (REA) monitoring bores and is located adjacent to a tributary to Kurrajong Creek (Figure 2.2). In late 2021 EC values began to increase, with fluctuation up to ~700 µS/m (Figure 7.27). Concurrently, water levels in P53 increased up to mid-2022, and have since declined.





* mAHD - metres Australian Height Datum

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Water Level plots

Figure 7.27 P53 EC field and laboratory measurements plotted with water levels

7.7.2.1 Natural climate factors

Both P53 and adjacent bore P52 had increased water levels consistent with changes in rainfall from 2020 to 2023, and during this time P53 groundwater increased in salinity, while that of P52 decreased. This may indicate that natural climate factors are not likely to be the cause of EC change at P53, as a consistent EC compared to past values (e.g. 1,100 µS/cm) would be expected due to the water level increase. Alternatively, the increase in EC at P53 may be a very delayed response to decreased recharge as a result of the Tinderbox Drought. However, given the shallow depth of P53, and the decrease in salinity at P52, this scenario is also considered unlikely.

7.7.2.2 Seepage from surface sources

No surface water data for major ions is available for the nearby creek or reject emplacements. The EC records for the creek monitoring location on the adjacent drainage line (KC1US) range from: 54 to 148 µS/cm. Therefore, it is not possible that mixing with naturally present groundwater below the creek is the cause of the exceedance.

Sediment dam SB3 is located immediately south of P51 and 400 m northeast of P53. Sampling throughout 2025 record a field EC ranging from 4,860 to 9,930 µS/cm. Recent groundwater levels recorded at P51 and P53 indicate a groundwater flow direction from P53 to P51 therefore seepage from SB3 is an unlikely cause of elevated salinity at P53.

It is not possible to determine with certainty if mixing with leachate from the REA interstitial water is occurring. It is a plausible process given the observations at P53 and further data collection is needed for better understanding. HCO_3/Cl ratios for P53 (Figure 7.28) shows the ratio of HCO_3 to Cl decreases from 2022 indicating more relative chloride present during the period of higher EC. This indicates that the water is becoming a more chloride type water, water from mine inflows and Hoskissons coal is more bicarbonate type (Figure 7.29), if changes in water quality was due to water contamination from the REA it would be expected to see the water becoming more Bicarbonate dominate with time and increasing EC, ratios of HCO3/Cl (Figure 7.28) show bore P53 becoming more Cl with time.

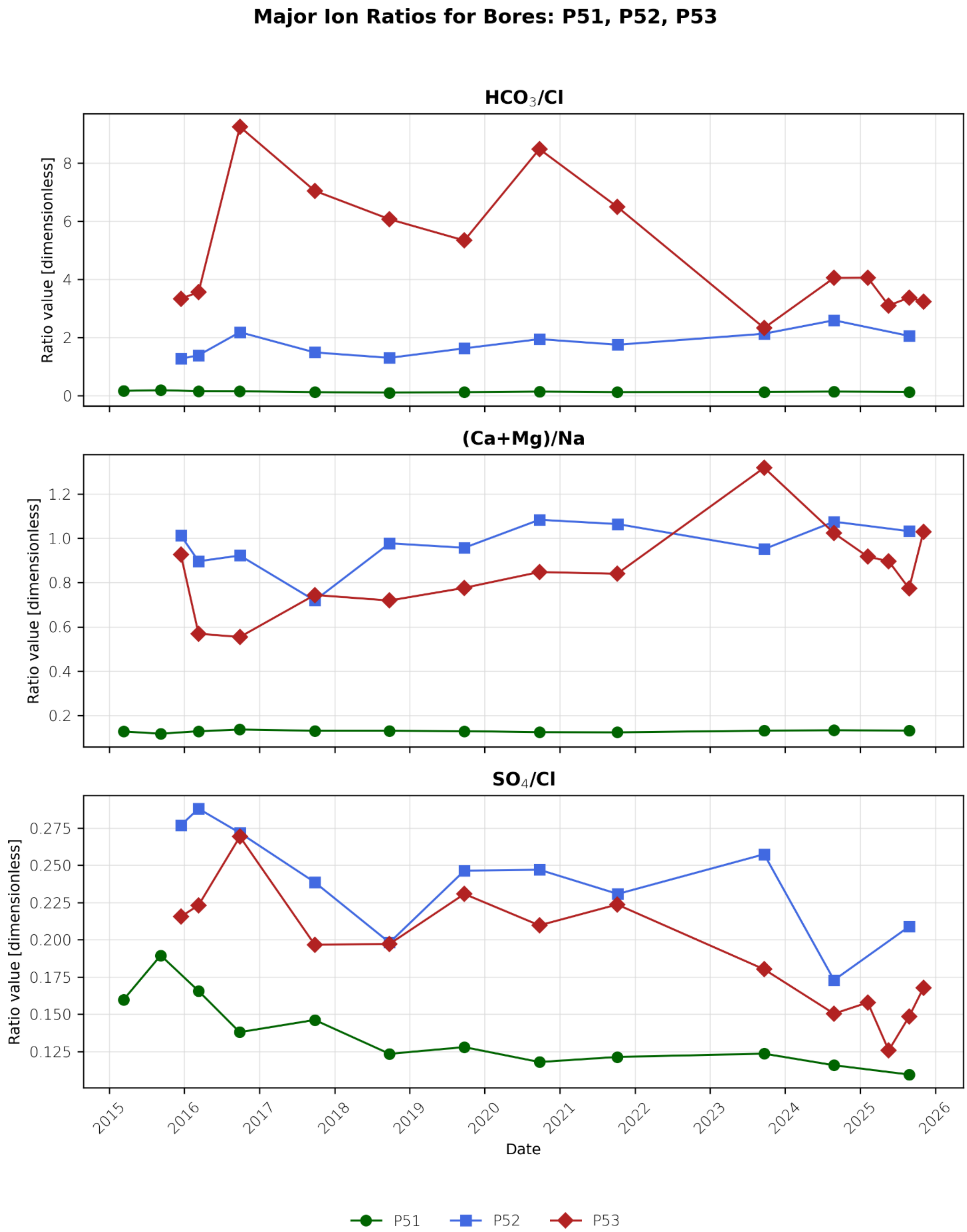

Figure 7.28 Major ion ratios for bores P51, P52 and P53

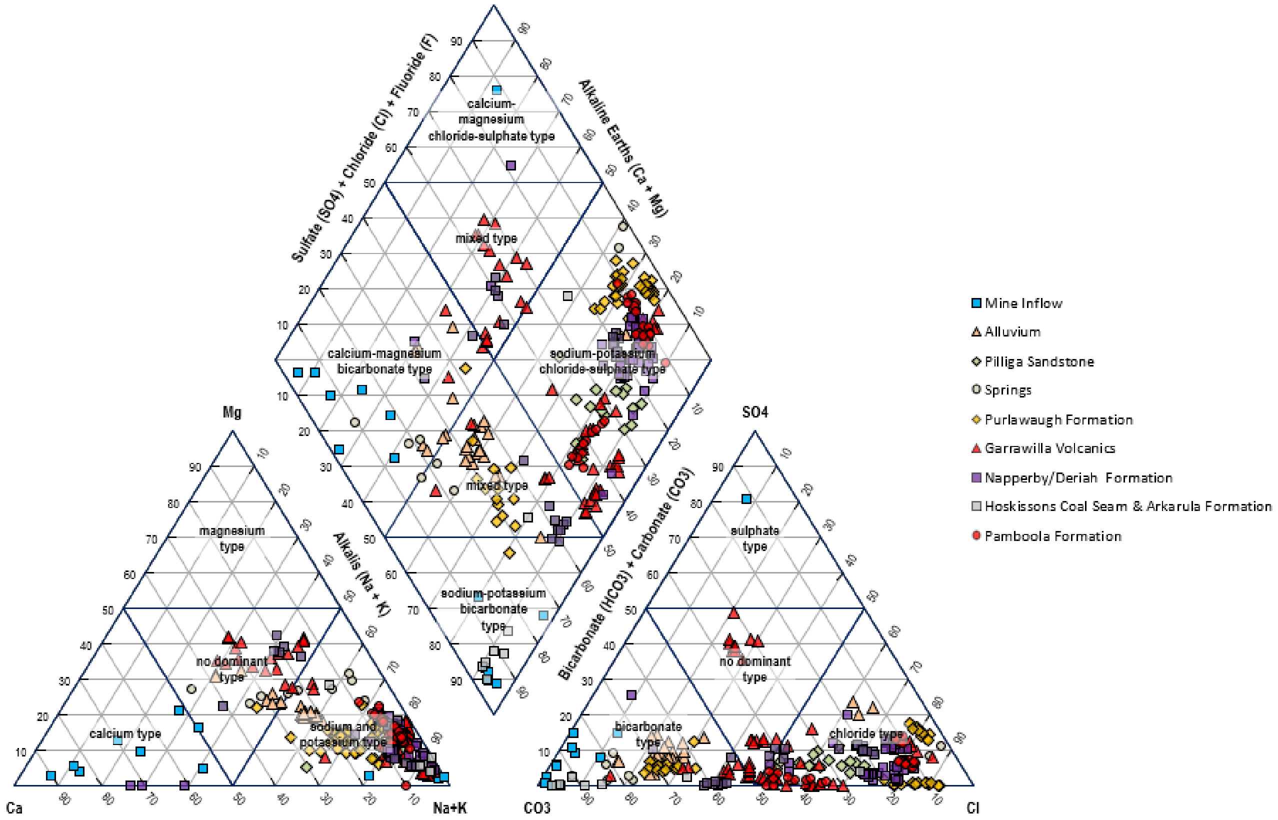

Figure 7.29 Piper plot grouped by formation

7.7.2.3 Mining-induced mixing

Water chemistry recorded at P53 is mixed type for cations, and bicarbonate-dominated for anions (Figure 7.30) P53 plots similar to P52 although P52 has higher relative portions of chloride. A linear mixing trend in the anions is visible with an increase in relative chloride. This trend, coupled with the higher EC recorded in P52 (2,000-2,400 µS/cm) indicates possible mixing with P52, possibly caused by changing water flow paths.

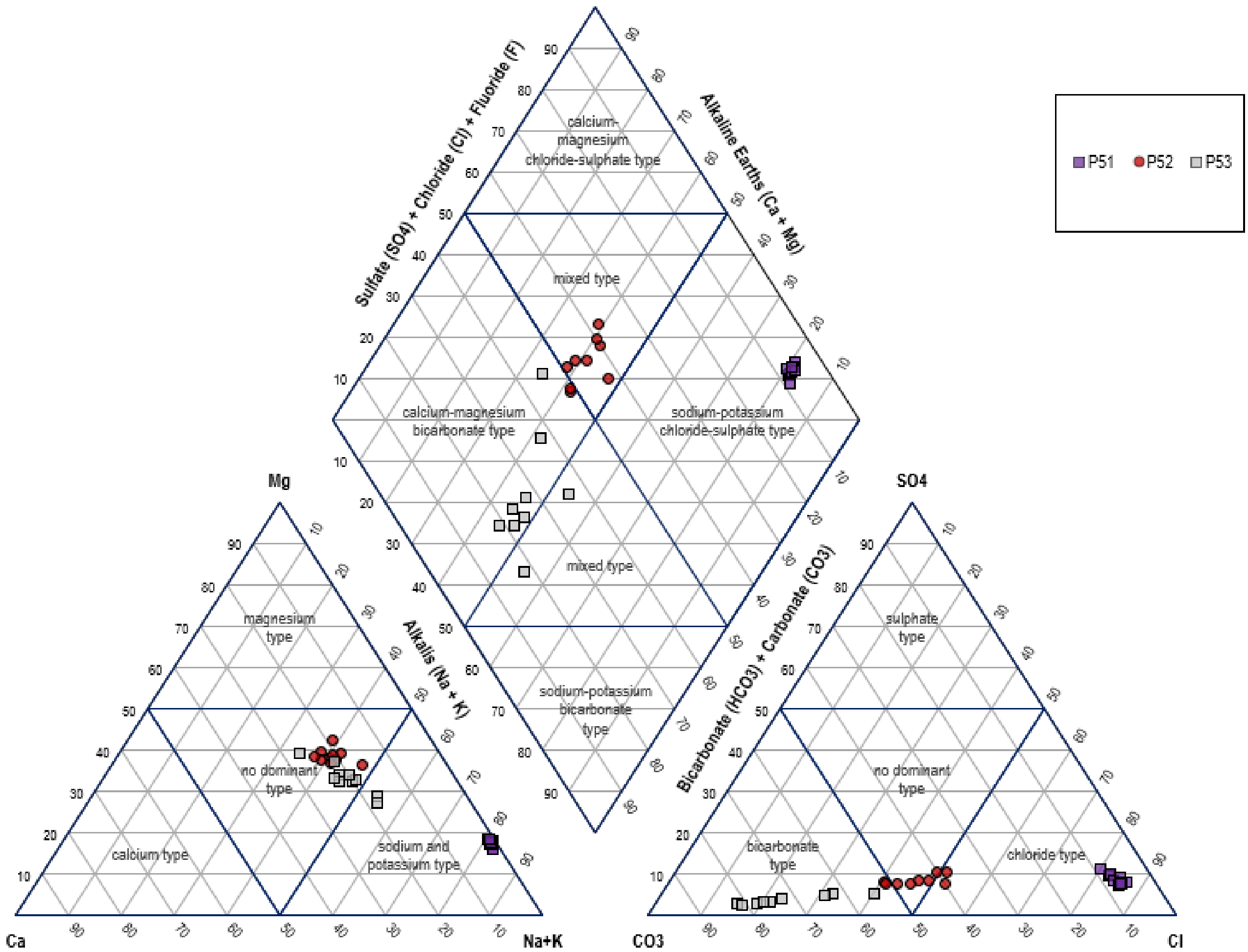

Figure 7.30 Piper plot REA bores P51, P52 and P53

7.7.2.4 Solute release

The hydraulic gradient at P53 indicates flow toward the mining zone, indicating that there is no viable pathway for solutes to reach P53, if they were being produced.

7.7.3 Conclusion and recommendations

Saturation of previously unsaturated soils is considered the most likely cause of elevated EC at P29, the lack of mixing trend indicates the source of water leading to elevated groundwater levels is not sourced from nearby highly saline Na-HCO_3 water as is characterised by water stored in nearby surface water dams.

The sources of increases in EC recorded at P53 and linear mixing trends apparent in the Piper Plots are unclear, continued monitoring is recommended.

7.7.4 Potential impacts

No sensitive environmental receptors are located nearby and other bores surrounding the RLD show no signs of seepage. Therefore, no significant environmental impacts are expected from the elevated EC measurements.

8 Conclusions

Conclusions and recommendations for individual exceedances are included in each section. A summary of findings, comparison with previous findings and recommendations for further work are included in Table 8.1. This includes recommendations from annual reporting that states that bores with recorded exceedances should consider the following:

- does the conclusion that changes are associated with these climatic events remain true; and
- has a new adjusted baseline been established, if so, a review of the baseline data and trigger levels is recommended.

For bores with no current recommendation for further work monitoring should continue with data reviewed quarterly to determine if bore has reached equilibrium or any other changes are noticeable.

Table 8.1 Summary of exceedances and further work

Bore ID	Formation	Exceedance	Likely cause	New baseline / triggers established	Further work required
P2	Napperby	EC	Natural variations / major climate event	Tier 1 22,080 µS/cm Tier 2 22,533 µS/cm	Update triggers
P4	Napperby	EC	Natural variations / major climate event	Tier 1 28,300 µS/cm Tier 2 28,991 µS/cm	Update triggers
P7	Pilliga	pH	Natural variability of formation	N/A	No, continue monitoring
P9	Purlawaugh	EC	Natural variations / major climate event	No	Examine if new baseline can be established
P10	Napperby	EC	Natural variations / major climate event	No	Examine if new baseline can be established
P11	Purlawaugh	EC and water levels	Lateral migration of water and mixing within the formation	No	No
P29	Napperby	EC	Saturation of unsaturated zone	N/A	No
P39A	Watermark	EC	Natural variations / major climate event	Tier 1 7,710 µS/cm Tier 2 8,031 µS/cm	Update triggers
P39B	Alluvium	EC	Natural variations / major climate event	Tier 1 13,662 µS/cm Tier 2 14,198 µS/cm	Update triggers
P47	Garrawilla	EC	Natural variations / major climate event	No	No
P53	Garrawilla	EC	Mixing with other groundwater and/or infiltration of water from REA	N/A	Review against geochemistry

Yours faithfully,

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Australasian Groundwater and
Environmental Consultants Pty Ltd