GROUNDWATER
RESOURCE MANAGEMENT

# ANNUAL HYDROLOGICAL REPORT FY2025

# WORSLEY ALUMINA REFINERY

# WORSLEY

Prepared for

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# Report Distribution

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| | | | | |

## LICENSE COMPLIANCE SUMMARY

Groundwater and other surface water sampling completed at Worsley Operations is legislated via Ministerial Statement 1237 (MS1237) and the Worsley Surface Water Licence (SWL6801141(5)). The Worsley Water Management Plan (WMP) summarises the commitments.

MS1237 condition B16-2 requires Worsley Alumina to update and submit the Water Management Plan (WMP version 6.0) and MS1237 condition C1-1 requires Worsley Alumina to not commence ground disturbing activities within the proposal area until the CEO of DWER has confirmed in writing that the management plan meets the requirements of the relevant conditions or as otherwise agreed by the CEO. Confirmation that the WMP met the requirements of the relevant conditions was received from DWER on 11 Feb 2025.

An assessment of compliance to the Refinery surface water license compliance is shown below.

### Table I: License Compliance Summary

| License Requirement | Compliance |
|---|---|
| A base flow release as per license requirements | Complied |
| The volume of water taken in any year shall not exceed 5,400,000 kL | Complied |
| The licensee shall record meter readings monthly from the Freshwater Lake pump station and forward the meter readings, monthly usage and annual volume of water drawn to the Department of Water and Environmental Regulation by 30 September | Complied |
| The licensee shall undertake monitoring for each parameter and at the frequency identified in Surface Water Monitoring commitment S1 | Complied |
| Water quality is to be compared with the Australian & New Zealand (ANZECC) 2000 Guidelines for Fresh and Marine water quality – Aquatic Ecosystems (SW Australia – Upland Rivers) | Complied |

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# 1.0 INTRODUCTION

This review covers South32 Worsley Alumina Pty Ltd (WAPL) water monitoring for the period July 2024 to June 2025. The review has been prepared in accordance with the Alumina Refinery (Worsley) Agreement Act 1973 (WA) (as amended), and the Worsley Surface Water License SWL68041(5) condition R1, issued under the Rights in Water & Irrigation Act (1914) and Ministerial Statement 1237.

Groundwater and other surface water sampling completed at Worsley Operations is legislated via Ministerial Statement 1237 (MS1237) and the Worsley Surface Water Licence (SWL6801141(5)). The Worsley Water Management Plan (WMP) summarises the commitments.

## 1.1 License Commitments

The WAPL Refinery Surface Water license SWL6804(5) November 2015 states conditions relating to the extraction and use of water sourced from the Fresh Water Lake (FWL), including the metering and monitoring of nominated sampling points against listed parameters (Appendix A).

Conditions for annual reporting stated in the license include:

W4) The Licensee shall ensure that;

a) The transitional water release strategy agreed upon is implemented and an average flow of 35 m3/h should be released for the period 15th Dec to the 15th February each year, starting with lower flows from 15th November increasing to 35 m3/h average by 15th December continued until 15th February, then stepping down to no release by 15th March;
*b)* The volume of water taken or released each year is measured and reported to the Department;
*c)* The volume of water taken in the term of the license shall not exceed 26,000,000 kL;
*d)* The volume of water taken in any year shall not exceed 5,400,000 kL.

M2) The licensee shall record meter readings monthly and forward the meter readings, monthly usage and annual volume of water drawn to the Department of Water by 30 September each year.

R1) Annual reporting of the monitoring data including trend analysis is to be included as part of Annual Environmental Review and Annual Hydrological Monitoring Review prepared by WAPL for the Environmental Management Liaison group (EMLG) associated with WAPL's mining and refinery operations in Boddington and Collie.

In 2021, DWER recommended a new transitional water release strategy which came into effect on 30 September 2021. The water license has not yet been updated to reflect this new strategy.

The updated water release strategy states that an average of 35 $m^3$/h should be released for the period 15$^{th}$ September to the 31st October, decreasing to 28 $m^3$/h to be released for the period 1$^{st}$ November to the 11$^{th}$ November, decreasing again to 21 $m^3$/h to be released for the period 12$^{th}$ November to the 22$^{nd}$ November, 14 $m^3$/h from 23$^{rd}$ November to 3$^{rd}$ December and lastly 7 $m^3$/h from 4$^{th}$ December to 14$^{th}$ December.

# 2.0 Climate/Rainfall

The WAPL Refinery Lease Area is situated in a typical Mediterranean climatic region, comprising cool wet winters and hot dry summers. Maximum average monthly temperatures for the Refinery range from 15 °C in July to 34 °C in February and minimum monthly average temperatures range from 6 °C in July to 19 °C in February.

Meteorological data has been collected onsite since 1980. The current meteorological station was installed onsite and commenced collecting meteorological data in December 2015. The station is a continuous monitoring meteorological station mounted on a 30 m tower that records data from 8 sensors including rainfall, temperatures at 2 m, 6 m and 30 m above ground surface, humidity, solar radiation, wind speed and wind direction data from the same 30 m tower. Rainfall is recorded continuously from a tipping bucket rain gauge. Evaporation is measured daily using a class “A” evaporation pan with bird guard.

Long-term average (LTA) rainfall and evaporation data were obtained from the SILO rainfall dataset (Queensland Department of Environment and Science). SILO contains reconstructed climate data across Australia and are based on Bureau of Meteorology (BoM) meteorological stations with missing data infilled based on surrounding BoM stations. The SILO database also contains meteorological data on spatial grids across Australia based on surrounding BoM meteorological station and using mathematical interpolation techniques.

Based on the SILO dataset (-33.25°S and 116.05°N), the LTA annual rainfall for the refinery is about 941 mm (2000-2025). The median rainfall (50% probability of exceedance) is 999.1 mm. Since the climate in the region has been affected by a long-term drying trend, only the last 20 years of rainfall is considered.

LTA potential evaporation was also obtained from the SILO database. Evaporation rates were based on the “synthetic estimate” values which are estimated Class A pan evaporation rates derived from climate variables including temperature, humidity, windspeed and radiation. The average yearly evaporation rates are 1,473 mm (2000-2025). Average annual evaporation rates exceed rainfall by a factor of 1.6.

Rainfall during the current review period was lower than the updated LTA with 790.0 mm recorded to 30 June 2025 (Table 1). Actual evaporation during the review period was higher than the LTA with 1,975.7 mm, recorded to 30 June 2025 (Table 1).

## Table 1: Evaporation and Rainfall

| Month | Evaporation (mm) | | Rainfall (mm) | |
|---|---|---|---|---|
| | FY2025 | LTA | FY2025 | LTA |
| July | 59.5 | 49.1 | 213.0 | 215.1 |
| August | 70.0 | 57.2 | 224.0 | 156.6 |
| September | 111.8 | 77.3 | 62.0 | 115.3 |
| October | 155.4 | 117.5 | 76.0 | 46.3 |
| November | 205.5 | 160.5 | 23.5 | 36.3 |
| December | 289.2 | 210.0 | 22.0 | 22.9 |
| January | 287.6 | 231.65 | 4.0 | 19.5 |
| February | 237.3 | 194.1 | 3.5 | 13.5 |
| March | 243.9 | 165.4 | 1.5 | 19.6 |
| April | 149.7 | 97.8 | 17.5 | 45.6 |
| May | 115.2 | 64.7 | 36.5 | 115.6 |
| June | 50.6 | 47.3 | 106.5 | 135.0 |
| Total | 1,975.7 | 1,472.6 | 790.0 | 941.3 |

# 3.0 SURFACE WATER MONITORING PROGRAMME

The surface monitoring program comprises the following.

- Water abstraction volumes, release volumes and water levels as measured from the Freshwater Lake (FWL).
- Automatic measurements of flow rates and water quality downstream of the FWL at the Augustus River Gauging Station (ARGS).
- Measurements of surface water quality at the FWL, ARGS and adjacent Hamilton River.

Surface water monitoring locations are shown in Figure 1. The Hamilton sampling point is situated about 6.5 km south of the WAPL boundary and not shown on the map. Surface water sampling locations are summarised in Table 2.

### Table 2: Surface water monitoring locations

| Monitoring station | Easting | Northing |
|---|---|---|
| Augustus River Gauging station (ARGS) | 409,060 | 6,323,871 |
| Hamilton River sampling point (HAR1) | 411,538 | 6,313,821 |
| Freshwater Lake pump intake (FWL) | 409,753 | 6,323,475 |

Coordinates in MGA GDA94 Zone 50

## 3.1 Freshwater Lake

The FWL is used as the primary source of fresh water for the Refinery. This water is used for both plant process make-up and for domestic requirements onsite, including fire water, garden reticulation and dust suppression. The lake has a maximum capacity of 6,080 ML. The dead storage of the lake is about 1,000 ML, giving the FWL an available storage capacity of approximately 5,000 ML.

In addition to the FWL, water is also abstracted from the Wellington Dam, but this information is not presented in this report since water abstraction from Wellington Dam does not form part of the license conditions.

In accordance with the DWER license conditions, (W4), WAPL is obliged to release water from the FWL to the Augustus River each year. This water is required to meet riparian rights and for ecological function. The revised scheduled release from DWER came into effect on 30 September 2021. A transitional release is required whereby the release of water starts on 15 September with 35 kL/h, decreasing until 7 kL/h by 15 December. The recommended schedule and flow rates are presented in Table 3:

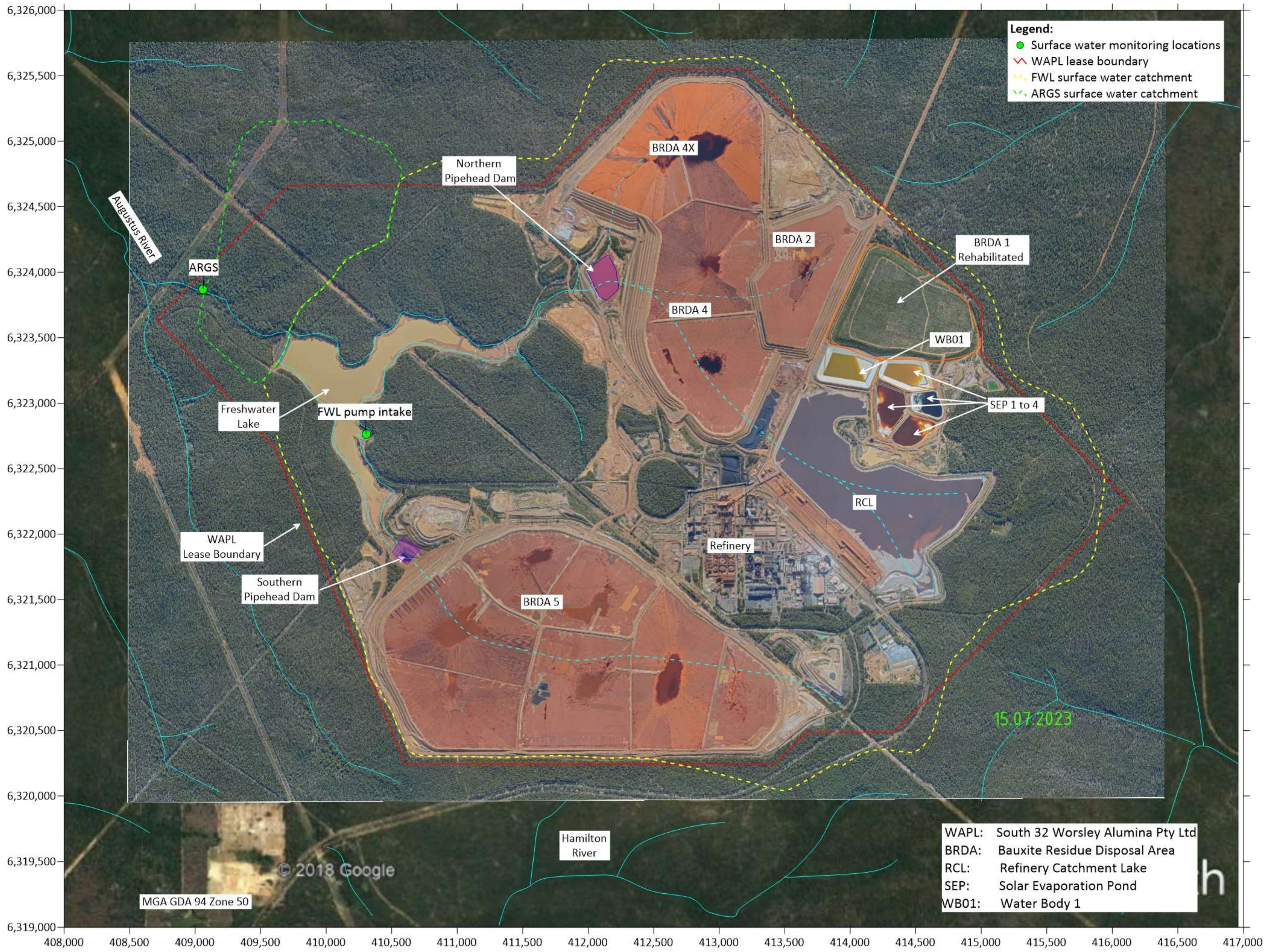


Figure 1: Surface water monitoring locations

### Table 3: DWER proposed schedule for FWL release

| Schedule | Rate (kL/hr) |
|---|---|
| 15 September to31 October | 35 |
| 1 November to 11 November | 28 |
| 12 November to 22 November | 21 |
| 23 November to 3 December | 14 |
| 4 December to 14 December | 7 |

Water is normally released to the Augustus River using a mobile surface pump equipped with a flow meter. Since FY24, releases have been directed through a turbidity treatment plant located at the base of the FWL dam wall. This plant was commissioned following elevated turbidity levels recorded at the FWL pump intake in FY23, which prevented downstream discharge at that time.

The installation of the turbidity plant enabled continued water releases to the Augustus River during the FY24 and FY25 reporting periods. Water is gravity-fed to the unit via a pipe positioned within the spillway, before passing through the turbidity plant for treatment. The treated water is then discharged into the Augustus River. An automated turbidity logger, installed within the unit, continuously measures the turbidity levels of released water.

## 3.2 Surface water flow rates and quality

The Augustus River Gauging Station (ARGS) is a nominated monitoring point in accordance with Surface Water License SWL68041(5). The site comprises a V-notch weir to measure flow depths across the river. An automated multiparameter sonde is installed at the ARGS to measure flow depths and water quality parameters. The multiparameter sonde comprises an Aqua TROLL 600 (In-Situ) and is equipped to measure water depth, temperature, electrical conductivity (EC), Dissolved Oxygen (DO), pH, oxidation-reduction potential (ORP) and turbidity. The sonde is programmed to continuously measuring these parameters at 5-minute intervals.

Water flow rates can be determined by the following equation, considering the geometrical considerations of the V-notch weir.

$$Q = 4.86833 \times 10^{-8} \times D^{2.4802}$$

Where *D* is the flow depth and *Q* is the flow rate in $m^3/s$.

## 3.3 Surface water quality

The ARGS is the nominated surface water sampling point in accordance with Surface Water License SWL68041(5). In addition, surface water samples are also collected from the FWL at the pump intake location and at the Hamilton River (Figure 1).

The FWL sampling, conducted at the pump inlet, allows for the measurement of water quality to assess the suitability of the water for release to the Augustus River as per license conditions.

Hamilton River (HAR1) is used as a reference site and forms part of an offsite catchment zone, reflecting natural flow and water quality conditions. HAR was removed from the license conditions in FY18, but it is still monitored to align with the Worsley Water Management Plan.

Water quality parameters measured at the ARGS, FWL and HAR 1 comprises:

- Monthly laboratory analysis for pH, EC, sodium (Na) and Chloride (Cl).
- Monthly field analysis for pH, EC, dissolved oxygen (DO), turbidity and temperature.
- Bi-yearly analysis for alkalinity (total), bicarbonate, carbonate, calcium, potassium, sulphate, aluminium, iron and magnesium.

Water samples were sent to a NATA accredited water quality testing laboratory for analysis and results are presented in Section 5.

## 3.4 Wastewater storage facilities

There are several wastewater storage facilities which are used in the management of affected water at the site and these are summarised below (Figure 1). For the FY24 reporting period, water samples were collected from all the wastewater storage facilities, which informed potential hydraulic connection between the storage facilities and the surface and groundwater receptors. These were described in more detail in the FY24 hydrology review.

*Pipe Head Dams (NPHD and SPHD)*

The PHDs are located downstream of the Bauxite Residue Disposal Areas (BRDAs) and upstream of the FWL. The NPHD receives residue liquor from the northern BRDAs while the SPHD receives liquor from BRDA5.

The purpose of the PHDs is to collect residue liquors from the BRDAs for pumping back to the RCL. The residue liquors typically have a pH of approximately 12. An extensive chemical grout curtain has been installed below the PHD's earth embankment to prevent the downstream migration of the high pH residue liquor.

Four groundwater depression bores have been installed on the upstream face of the NPHD. The purpose of the bores is to lower the groundwater level and reverse the natural groundwater flow direction with the aim of preventing seepage towards the lower parts of the catchment. The water pumped from these bores is also redirected into the RCL. Similarly, liquor pumps located within the SPHD containment area maintain the liquor level below the ambient groundwater levels such that groundwater flow is towards the SPHD containment area.

Several issues were identified with the operation of the PHDs during the FY24 reporting period and these are described in more detail in the FY24 hydrology reviews. Section 6 provides an update of these issues.

*Refinery Catchment Lake (RCL)*

The RCL is located to the northeast of the refinery (Figure 1) and receives wastewater, liquor and rainfall runoff from the refinery. In addition, the RCL receives process cooling water from the plant and residue liquor from the PHDs. Water stored in the lake is reused in the process plant and recirculated for cooling at the process plant and powerhouse.

Water Body 1 (WB01) is a lined balancing pond for pumping of caustic process water during periods of high water levels in the RCL. The stored water is held within the pond and released to the RCL on an as-needed basis. WB01 also receive return liquor from the Bauxite Residue Disposal Areas (BRDAs) 4 and 2 decant structures.

*Solar Evaporation Ponds (SEPs)*

The SEPs are located to the north of the RCL (Figure 1). SEP 1, 2A and 4 are lined with High Density Polyethylene (HDPE) while SEP 3 is lined with a PVC liner. SEP 1 and SEP 4 are used to store un-neutralised acid wastes. SEP3 was in operation from 1984 through to 1989 and stored neutralised waste from May 1984 to January 1986. It was then used to store un-neutralised waste acid between January 1986 and August 1989. Since August 1989, SEP3 has been used to store alkaline waste (pH 10) formed through the mixing of oxalate waste. SEP2A was commissioned in 1989 and stored un-neutralised acid wastes. SEP2A was relined in 2021 and now is approved to store oxalate in accordance with recent license amendments.

## 3.5 FY25 surface water monitoring issues

*FWL turbidity levels*

Persistent high turbidity levels continued to be measured at the FWL during the reporting period, though turbidity levels decreased since December 2024. The high turbidity prohibited the direct release of FWL water to the downstream Augustus River and WAPL continued to use the turbidity treatment plant at the base of the FWL dam wall to treat the high turbidity water before being released into the Augustus River.

As described in the FY24 hydrology review WAPL initiated several work packages aimed to control sediment release to the FWL including upgrading the existing sediment ponds in the area. These works resulted in a decrease in turbidity levels between December 2024 and June 2025, though turbidity values remain above 20 NTU for most months. Turbidity levels are expected to continue to improve for the FY26 period, provided that the sediment control works remain effective during the period.

*FWL water levels*

FWL water levels decreased below the gauging minimum level of 228.37 m AHD in May 2025. Additional gauging levels were deployed to measure water levels below that minimum level.

*ARGS monitoring station*

There were issues with the Augustus River Gauging Station (ARGS) for the period July to September 2024 and May to June 2025, resulting in some data loss. These issues have since been resolved.

# 4.0 WATER ABSTRACTION, LEVELS AND FLOWS

## 4.1 Freshwater Lake

The total water pumped from the FWL during this reporting period (1 July 2024 to 30 June 2025) totalled 2,663,191 kL (Table 4), which is less than the license maximum limit of 5,400,000 kL per annum. The FY25 abstraction represent 49% of the maximum abstraction limit.

The abstraction volumes were about 1.4 times the FY24 water abstraction rates, which was mainly attributed to decreased pumping of make-up water from the Wellington Dam.

The total water abstraction since 1 November 2015 was 19,935,665 kL, which is 76.7% of the 10-year license allowance of 26,000,000 kL (Table 4). Note that the existing water license will expire in November 2025.

### Table 4: Monthly and Yearly FWL Abstraction

| Month | Monthly abstraction (kL) | | Year | Yearly abstraction (kL) |
|---|---|---|---|---|
| | FY24 | FY25 | | |
| July | 125,365 | 117,963 | Nov 2015 to Jul 2016 | 2,106,971 |
| August | 84,562 | 91,720 | FY17 | 1,883,701 |
| September | 114,049 | 26,671 | FY18 | 1,728,359 |
| October | 115,371 | 65,132 | FY19 | 2,060,286 |
| November | 110,268 | 105,060 | FY20 | 1,574,342 |
| December | 136,322 | 125,569 | FY21 | 1,291,809 |
| January | 157,576 | 144,952 | FY22 | 1,370,073 |
| February | 138,171 | 332,302 | FY23 | 3,387,299 |
| March | 322,551 | 602,431 | FY24 | 1,869,634 |
| April | 362,333 | 574,554 | FY25 | 2,663,191 |
| May | 96,921 | 389,731 | Total | 19,935,665 |
| June | 106,142 | 87,106 | | |
| Total | 1,869,634 | 2,663,191 | | |

Long-term FWL water levels have fluctuated because of seasonal rainfall. For FY23, water levels fluctuated between 232.1 m AHD and 237.8 m AHD reaching a peak in August 2023 (Figure 2). For FY24 and FY25, water levels were significantly lower compared to the previous years because large abstractions during the latter part of FY23 and FY24. The water levels reached a peak of 235.0 m in October 2024 and then decreased rapidly through March to June 2025.

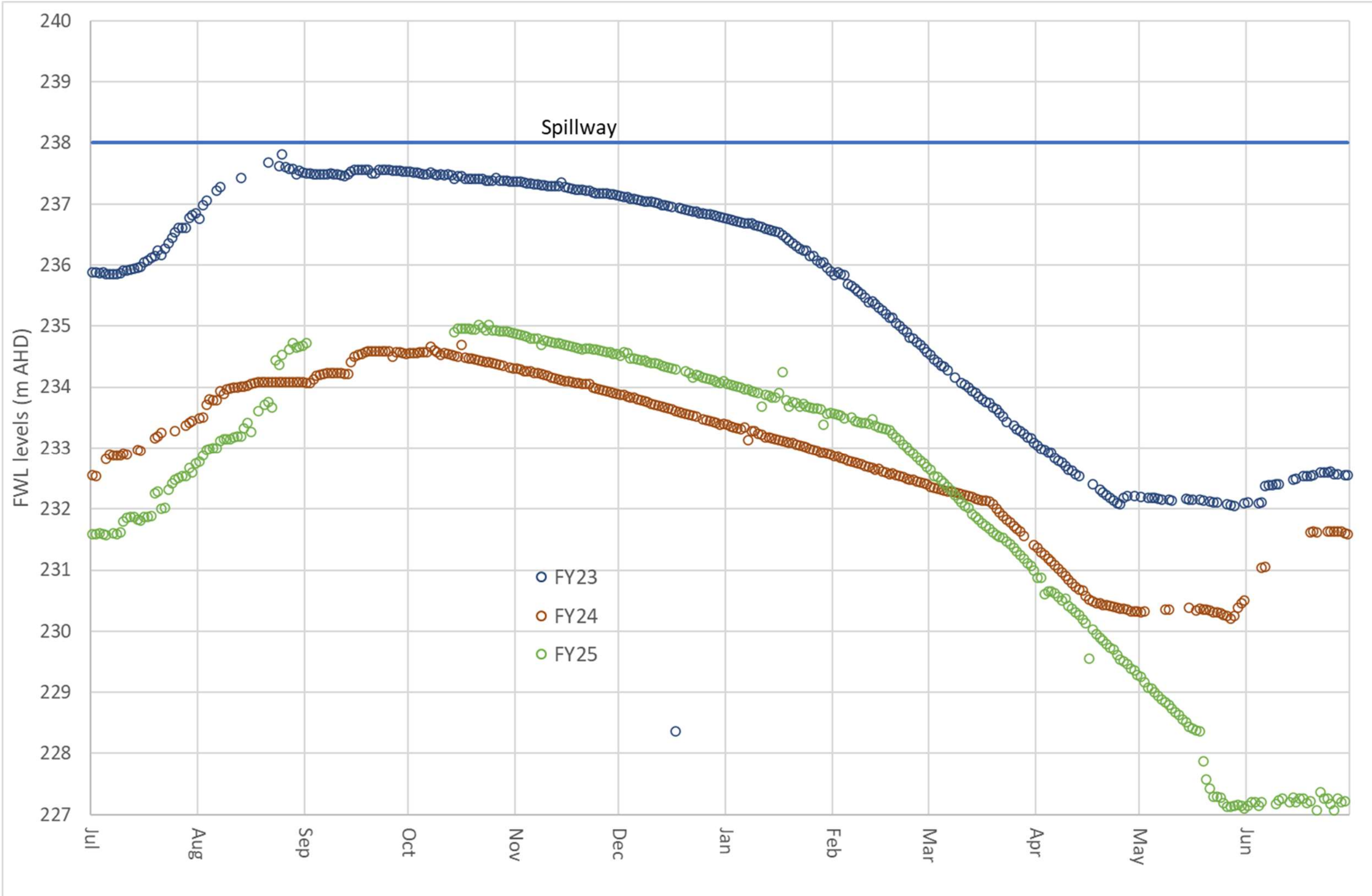


Figure 2: Freshwater Lake Levels

## 4.2 Augustus River Gauging Station

During the FY25 reporting period, measured flow rates were generally similar to the FY23 period and higher than the FY24 period, noting that flows were lower in FY24 due to lower rainfall.

The average monthly flow rates for the FY23, FY24 and FY25 periods are presented in Table 5. Flow rates were higher for all months compared to FY24 except for May and June 2025 where FY25 flow rates were lower.

### Table 5: Monthly Average Flow at ARGS

| Month | ARGS average monthly flow rates (kL/hr) | | |
|---|---|---|---|
| | FY23 | FY24 | FY25 |
| July | 64.14 | 37.96 | 44.86 |
| August | 106.53 | 48.97 | 112.14 |
| September | 54.81 | 48.34 | 62.65 |
| October | 22.81 | 43.80 | 30.04 |
| November | 19.25 | 31.16 | 34.96 |
| December | 12.72 | 15.98 | 8.19 |
| January | 9.15 | 2.01 | 3.81 |
| February | 4.28 | NM | 0.30 |
| March | 4.27 | NM | 0.32 |
| April | 10.99 | NM | 0.45 |
| May | 11.41 | 19.43 | 2.10 |
| June | 20.24 | 22.30 | 7.63 |

**NM: Not measured**

## 4.3 Freshwater Lake Release

As discussed in earlier hydrological review reports, persistent high turbidity levels in the FWL prevented the direct release of FWL water to the downstream Augustus River. Instead, water was released after treatment by a turbidity treatment plant at the base of the FWL dam wall. Flow rates, pH and turbidity levels were measured at the discharge location of the treatment plant using a flow meter and water quality sonde.

In addition to the pumped release, natural seepage is also occurring through the base of the FWL. This seepage rate is estimated to be about 10 kL/hr.

In previous hydrology reviews, FWL release was reported at the dam wall (pre-FY24) and at the turbidity plant (FY24), with seepage represented by an assumed rate. For the FY25 review period, release estimates have been expanded to include flow data from the Augustus River Gauging Station (ARGS). The use of ARGS data provides a more accurate representation of total water release to the environment, as these flow rates also incorporate a quantitative estimate of seepage from the FWL.

Table 6 presents the DWER guideline release rates, the pumped release rates from the turbidity plant, and the observed release rates at the ARGS. The table also includes back-calculated gains and losses, determined as the difference between pumped release rates and ARGS release rates. Gains are primarily attributed to seepage from the FWL, while losses are likely associated with channel storage (filling of the riverbed, banks, and floodplain) and infiltration of released water into the riverbed, both immediately following pumped releases and along the reach between the turbidity plant and the ARGS.

A total of 74.7 ML of water was released from the FWL via the turbidity plant to the downstream Augustus River during the period 15 September 2024 to 14 December 2024. This release volume exceeds the DWER guideline limit of 57 ML for the same period.

However, only 68.3 ML was recorded at the ARGS over the same period. The lower volume is likely due to channel storage, where a portion of the released water fills the riverbed, banks, and floodplain, as well as the time lag between release at the turbidity plant and subsequent passage past the ARGS.

## Table 6: FY24 FWL release rates (kL/hr)

| Schedule | DWER guidelines | Pump rates: Turbidity plant | ARGS flow rates | Losses/Gains |
|---|---|---|---|---|
| 15 September to 31 October | 35 | 27.1 | 35.5 | +8.4 |
| 1 November to 11 November | 28 | 61.7 | 38.8 | -22.9 |
| 12 November to 22 November | 21 | 66.2 | 38.4 | -27.8 |
| 23 November to 3 December | 14 | 34.0 | 22.7 | -11.3 |
| 4 December to 14 December | 7 | 0.0 | 6.3 | +6.3 |

Figure 3 shows the cumulative flow rates at the ARGS compared to DWER guidelines. The figure shows that flow rates at the ARGS closely match the DWER releases guideline, which implies that FWL releases met the release requirements.

Note that Figure 3 differs from the figures presented in previous hydrology reviews. Earlier reviews reported release rates at the FWL/turbidity plant together with an assumed seepage rate, whereas Figure 3 in this report represents downstream environmental flows as measured at the ARGS.

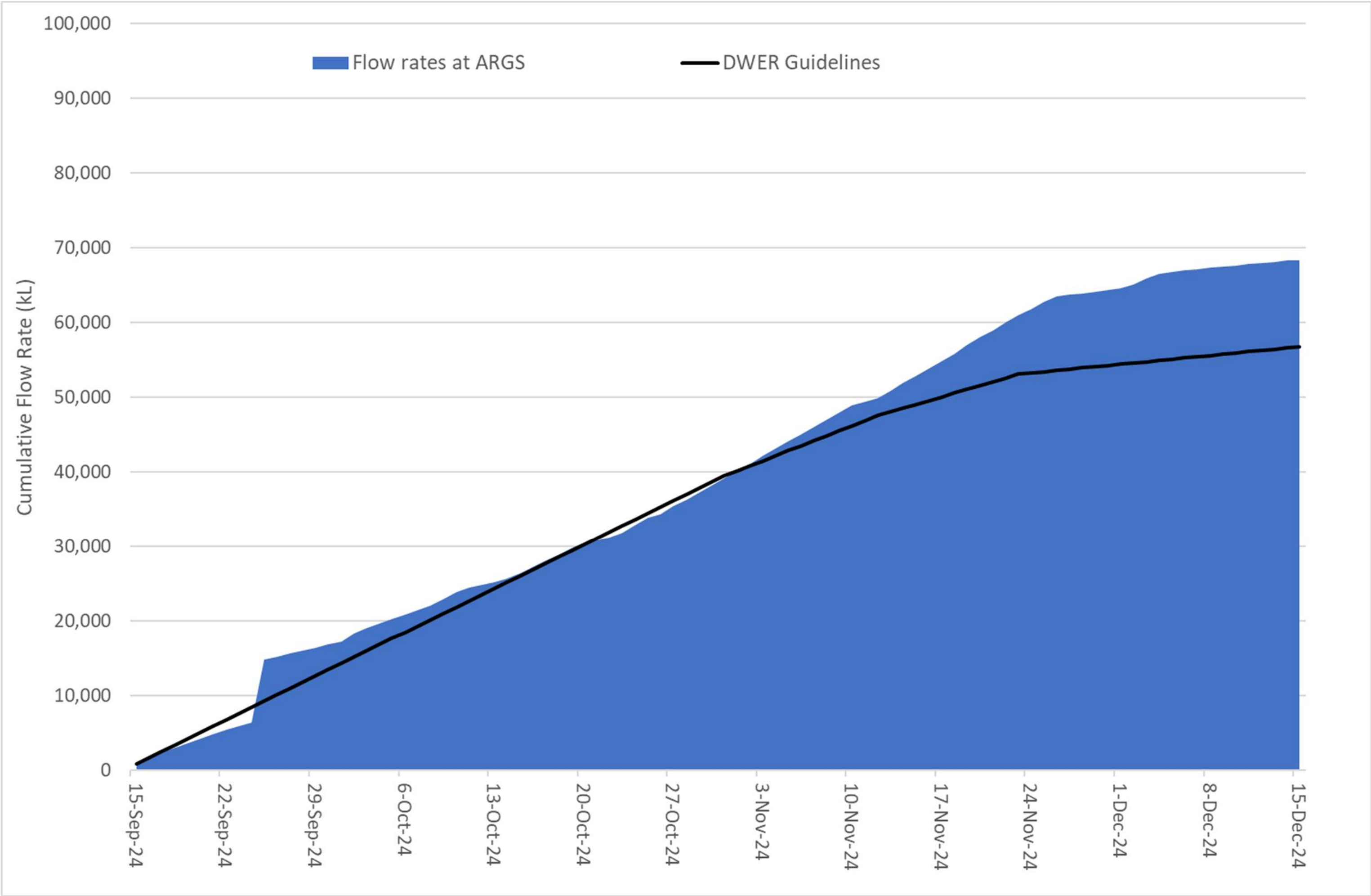


Figure 3: Flow rates at the ARGS during the release period

# 5.0 SURFACE WATER QUALITY

Surface water quality results were compared to the ANZECC default trigger values for south-west Australia for slightly disturbed ecosystems (ANZECC, 2000). Water quality results were compared to physical and chemical stressors (Table 3.3.6 of ANZECC), salinity and turbidity (Table 3.3.6 of ANZECC) and toxicants (Table 3.4.1 of ANZECC).

Freshwater lake water quality was compared to "Freshwater Lakes and Reservoirs" criteria while water quality at the Augustus River Gauging Station was compared to the "Upland River" criteria.

## 5.1 Freshwater Lake Water Quality

Monthly laboratory water quality results are provided in Table 7 while field analysis results are provided in Table 8. Quarterly water quality results are presented in Table 9.

Quarterly trends of analysed parameters are shown in Figure 4. These parameters provide an indication of potential anomalous changes in FWL water quality.

Elevated turbidity levels in the FWL persisted during the review period (except in February, April and June 2025) with values higher than the ANZECC guidelines set at 20 NTU. As described in the F24 hydrology review, WAPL investigated the cause of the high turbidity levels in the FWL and determined that the turbidity was caused due to a combination of upstream construction works and ineffective existing sedimentation ponds which are situated between the construction works and the FWL. Although several actions were already undertaken to improve the FWL water quality, persistent high turbidity continued through the FY25 period.

The high turbidity levels necessitated the implementation of a turbidity treatment plant in FY25 to allow FWL release as per DWER guidelines, addressed earlier in the report.

Apart from turbidity, monitoring results during this review period are comparable to previous review periods and baseline data. The slight increasing trend in EC, TDS, Na and Cl since January 2022 has reverted in FY25, decreasing to October 2024 and then increasing again to June 2025. This fluctuation is likely the result of actions implemented during FY24 and FY25 to limit upstream inflows from construction areas, thereby allowing good quality forest runoff to enter the FWL. The higher EC measurements in April, May and June is attributed to low FWL levels and water volumes, which resulted in increased evapoconcentration effects. The trends in the water quality are still well within the historical water quality ranges.

Apart from turbidity and one pH reading on 28 May 2025, the measurements are within the range presented within the ANZECC 2000 guidelines for South-Western Australia aquatic ecosystems guideline values for lakes, reservoirs and wetlands.

## Table 7: Monthly FWL Water Quality (Laboratory)

| Month | EC (µS/cm) | pH | Na (mg/L) | Cl (mg/L) | Al (mg/L) (total) |
|---|---|---|---|---|---|
| **ANZECC** | **ND** | **ND** | **ND** | **ND** | **0.08** |
| 17 Jul 2024 | 251 | 7.43 | 42 | 60 | NM |
| 13 Aug 2024 | 227 | 7.52 | 39 | 40 | 0.08 |
| 9 Sep 2024 | 210 | 7.45 | 35 | 38 | NM |
| 15 Oct 2024 | 206 | 7.52 | 35 | 58 | NM |
| 12 Nov 2024 | 222 | 7.43 | 36 | 44 | 0.06 |
| 9 Dec 2024 | 220 | 7.58 | 39 | 40 | NM |
| 14 Jan 2025 | 221 | 7.49 | 40 | 44 | NM |
| 11 Feb 2025 | 247 | 7.76 | 41 | 44 | 0.02 |
| 17 Mar 2025 | 259 | 7.63 | 42 | 44 | NM |
| 22 Apr 2025 | 268 | 7.57 | 43 | 49 | NM |
| 28 May 2025 | 261 | 7.59 | 42 | 54 | <0.01 |
| 24 Jun 2025 | 268 | 7.38 | 41 | 52 | <0.01 |

ND: Not determined, NM: Not measured

## Table 8: Monthly FWL Water Quality (Field)

| Month | EC (µS/cm) | pH | DO (ppm) | Turbidity (NTU) | Temperature (°C) |
|---|---|---|---|---|---|
| **ANZECC** | **300-1,500** | **6.5-8.0** | **<7.3*** | **20** | **ND** |
| 17 Jul 2024 | 180 | ND | 9.39 | 203 | 14.3 |
| 13 Aug 2024 | 165 | ND | 9.02 | 264 | 14.8 |
| 9 Sep 2024 | 127 | 7.22 | 10.36 | 184 | 16.2 |
| 15 Oct 2024 | 195 | 7.58 | 9.80 | 95 | 20.1 |
| 12 Nov 2024 | 202 | 7.73 | 9.01 | 101 | 20.8 |
| 9 Dec 2024 | 221 | 7.51 | 8.72 | 64 | 23.0 |
| 14 Jan 2025 | 245 | 7.43 | 8.83 | 39 | 24.8 |
| 11 Feb 2025 | 275 | 7.24 | 8.41 | 5 | 23.5 |
| 17 Mar 2025 | 273 | 7.08 | 8.74 | 66 | 24.7 |
| 22 Apr 2025 | 234 | 7.51 | 9.08 | 18 | 19.6 |
| 28 May 2025 | 220 | 8.01 | 9.84 | 47 | 16.1 |
| 24 Jun 2025 | unreliable | 5.41 | 9.95 | 4 | 15.0 |

NM: Not measured, ND: Not determined

*ANZECC refers to DO>90% which is equivalent to about >7.3 ppm

## Table 9: Quarterly FWL Water Quality

| Parameter | Unit | 13 Aug 2024 | 12 Nov 2024 | 11 Feb 2025 | 28 May 2025 | 24 Jun 2025 |
|---|---|---|---|---|---|---|
| Total alkalinity | mg/L | 32 | 29 | 33 | 32 | 34 |
| Bicarbonate | mg/L | 32 | 29 | 33 | 32 | 34 |
| Carbonate | mg/L | <1 | <1 | <1 | <1 | <1 |
| Calcium | mg/L | 4 | 4 | 5 | 5 | 5 |
| Iron | mg/L | 0.09 | 0.05 | <0.05 | <0.05 | <0.05 |
| Magnesium | mg/L | 3 | 3 | 3 | 4 | 5 |
| Potassium | mg/L | 1 | 1 | 1 | 1 | 2 |
| Sulphate | mg/L | 16 | 14 | 15 | 16 | 16 |
| TDS (calculated) | mg/L | 148 | 144 | 160 | 170 | 174 |

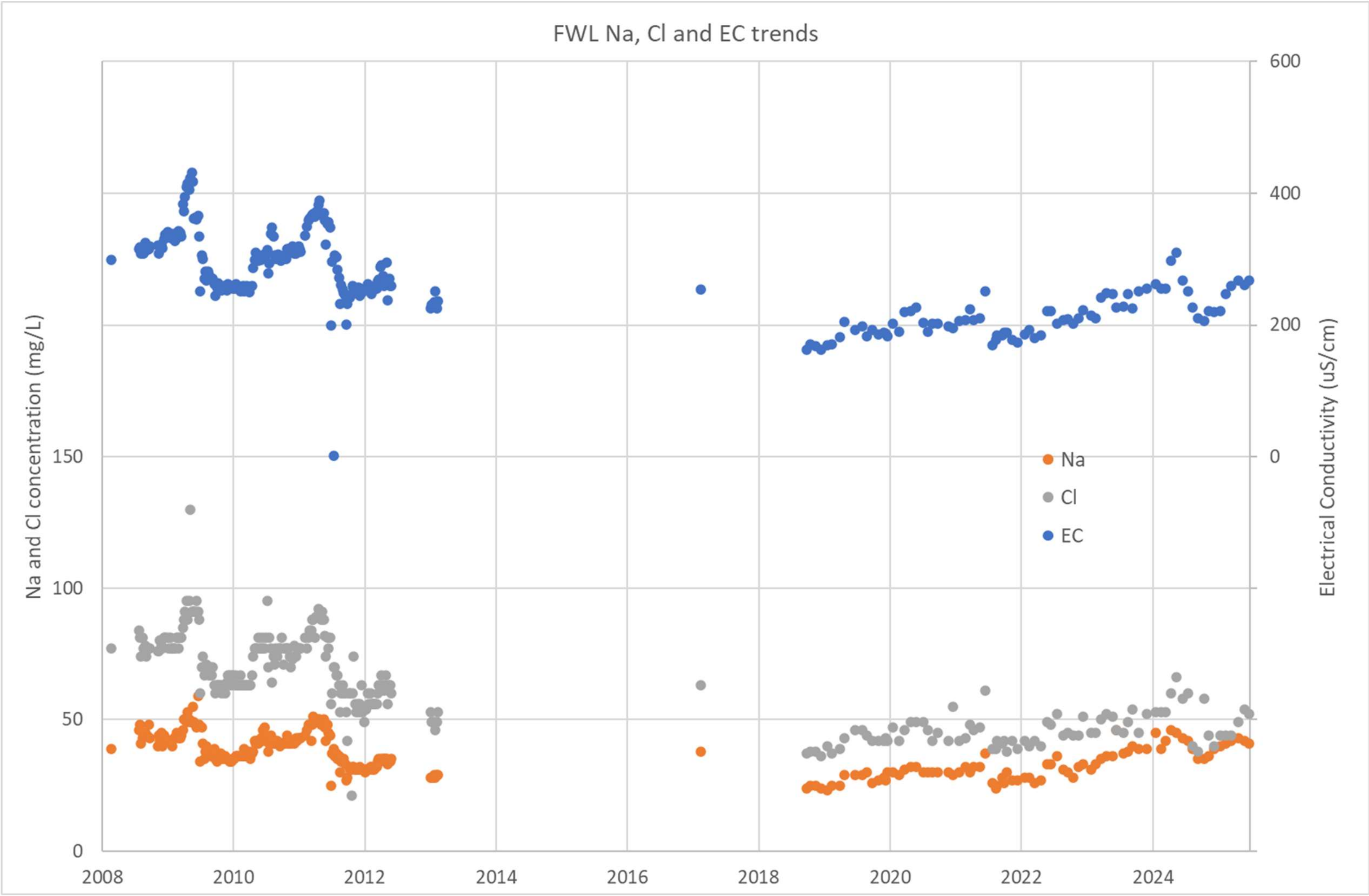


Figure 4: FWL long-term water quality trends

## 5.2 Augustus River Water Quality

Augustus River water quality samples are taken from the ARGS.

Monthly laboratory water quality results are provided in Table 10 while field analysis results are provided in Table 11. Quarterly water quality results are presented in Table 12.

All parameters were within the ANZECC guidelines, except dissolved oxygen (DO) for the months January to March 2025, where dissolved oxygen was below 7.3 ppm. This lower DO levels, which occurred during the summer period, are explained by the higher temperatures and reduced flow rates, hence less mixing of flowing water.

Long-term trends of analysed parameters are shown in Figure 5. The results show a continuous gradual downward trend since 2011, likely the result of continuous release of water from the FWL in accordance with the license conditions. In FY24, there were a slight reversal of these trends with increases in EC and Cl, but concentrations stabilised and then decreased during the FY25 period. Water quality concentrations have remained well within the historical ranges.

### Table 10: Monthly ARGS Water Quality

| Month | EC (µS/cm) | pH | Na (mg/L) | Cl (mg/L) | Al (mg/L) |
|---|---|---|---|---|---|
| **ANZECC** | **ND** | **ND** | **ND** | **ND** | **0.08** |
| 17 Jul 2024 | 276 | 6.57 | 41 | 87 | NM |
| 13 Aug 2024 | 216 | 6.84 | 34 | 47 | <0.01 |
| 9 Sep 2024 | 179 | 6.79 | 28 | 42 | NM |
| 15 Oct 2024 | 225 | 6.76 | 35 | 71 | NM |
| 12 Nov 2024 | 241 | 7.17 | 38 | 53 | <0.01 |
| 9 Dec 2024 | 239 | 6.93 | 40 | 50 | NM |
| 14 Jan 2025 | 237 | 7.04 | 40 | 58 | NM |
| 11 Feb 2025 | 274 | 7.22 | 42 | 63 | <0.01 |
| 17 Mar 2025 | 280 | 7.01 | 42 | 58 | NM |
| 22 Apr 2025 | 265 | 7.00 | 41 | 59 | NM |
| 28 May 2025 | 251 | 6.97 | 42 | 70 | <0.01 |
| 24 Jun 2025 | 258 | 7.01 | 35 | 59 | <0.01 |

ND: Not determined, NM: Not measured

## Table 11: Monthly ARGS Water Quality (Field)

| Month | EC (µS/cm) | pH | DO (ppm) | Turbidity (NTU) | Temperature (°C) |
|---|---|---|---|---|---|
| **ANZECC** | **300** | **6.5-8.0** | **<7.3** | **20** | **ND** |
| 17 Jul 2024 | 185 | | 7.80 | 5.4 | 9.9 |
| 13 Aug 2024 | 155 | | 7.57 | 6.0 | 13.6 |
| 9 Sep 2024 | 125 | 6.57 | 10.18 | 4.3 | 12.7 |
| 15 Oct 2024 | 198 | 6.20 | 7.51 | 4.3 | 16.7 |
| 12 Nov 2024 | 203 | 6.99 | 8.10 | 2.7 | 17.6 |
| 26 Nov 2024 | 207 | 6.72 | 7.91 | 4.2 | 17.9 |
| 9 Dec 2024 | 249 | 6.75 | 8.20 | 11.0 | 25.0 |
| 14 Jan 2025 | 263 | 6.60 | 5.86 | 15.0 | 24.2 |
| 11 Feb 2025 | 273 | 7.09 | 6.06 | 10.3 | 21.7 |
| 17 Mar 2025 | 259 | 6.56 | 4.90 | 9.3 | 19.2 |
| 22 Apr 2025 | 209 | 7.31 | 7.75 | 3.5 | 15.2 |
| 28 May 2025 | 169 | 7.53 | 8.71 | 7.8 | 9.0 |
| 24 Jun 2025 | 186 | 6.70 | 10.05 | 5.4 | 12.4 |

## Table 12: Quarterly ARGS Water Quality

| Parameter | Unit | 13 Aug 2024 | 12 Nov 2024 | 11 Feb 2025 | 28 May 2025 | 24 June 2025 |
|---|---|---|---|---|---|---|
| Total alkalinity | mg/L | 12 | 27 | 32 | 18 | 16 |
| Bicarbonate | mg/L | 12 | 27 | 32 | 18 | 16 |
| Carbonate | mg/L | <1 | <1 | <1 | <1 | <1 |
| Calcium | mg/L | 4 | 4 | 4 | 4 | 4 |
| Iron | mg/L | 0.19 | <0.05 | 0.33 | <0.05 | 0.30 |
| Magnesium | mg/L | 5 | 3 | 6 | 5 | 5 |
| Potassium | mg/L | 1 | 1 | 2 | 2 | 2 |
| Sulphate | mg/L | 12 | 12 | 4 | 13 | 12 |
| TDS (calculated) | mg/L | 140 | 157 | 178 | 163 | 168 |

Data logger results for FY25 are presented in Figures 6, 7 and 8. Note the missing data for the period July 2024 to September 2024 and then May and June 2025. These data losses were caused by instrument error which has since been resolved.

Figure 6 shows that the EC varies between 150 and 300 µS/cm with lower EC values occurring in the wet winter months and the higher EC values occurring in the dryer summer months. These trends fall within the expected range and there are no deleterious trends in EC values.

pH ranges between 6.0 and 7.1 and there were no deleterious trends.

There was one spike of elevated NTU measured during October 2024, which was likely caused by fouling. The sensor was subsequently removed, cleaned and recalibrated in late October 2024 and turbidity levels were lower in subsequent measurements.

# Surface Water Quality

The turbidity levels during the release period shows some variability, ranging between <5 and 40 NTU with occasional spikes of higher turbidity, but average turbidity levels remained below 20 NTU.

Average EC, pH and turbidity measurements are within the range presented within the ANZECC 2000 guidelines for South-Western Australia aquatic ecosystems guideline values for upland rivers.

## Surface Water Quality

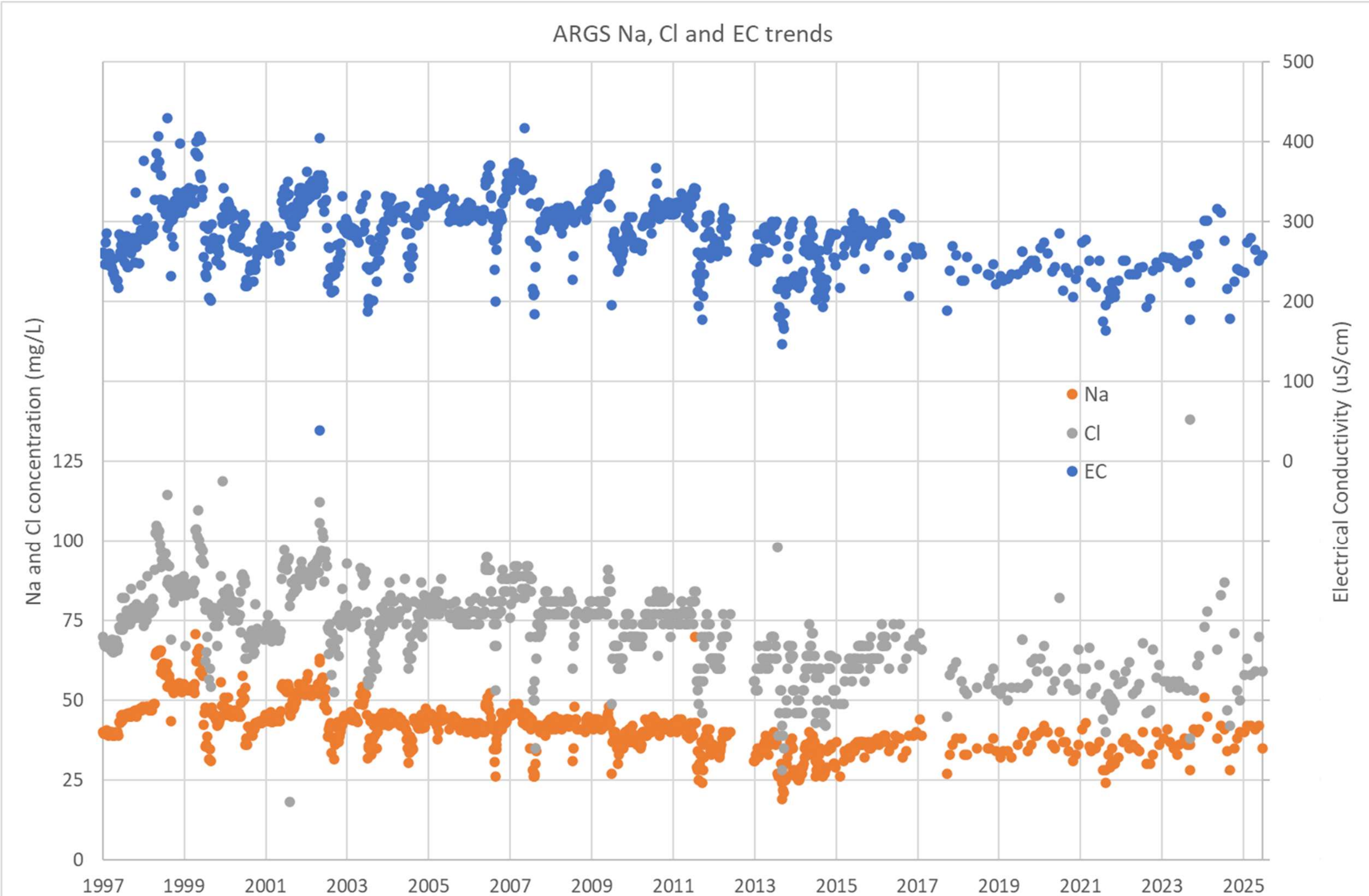


Figure 5: ARGS Long-term water quality trends

# Surface Water Quality

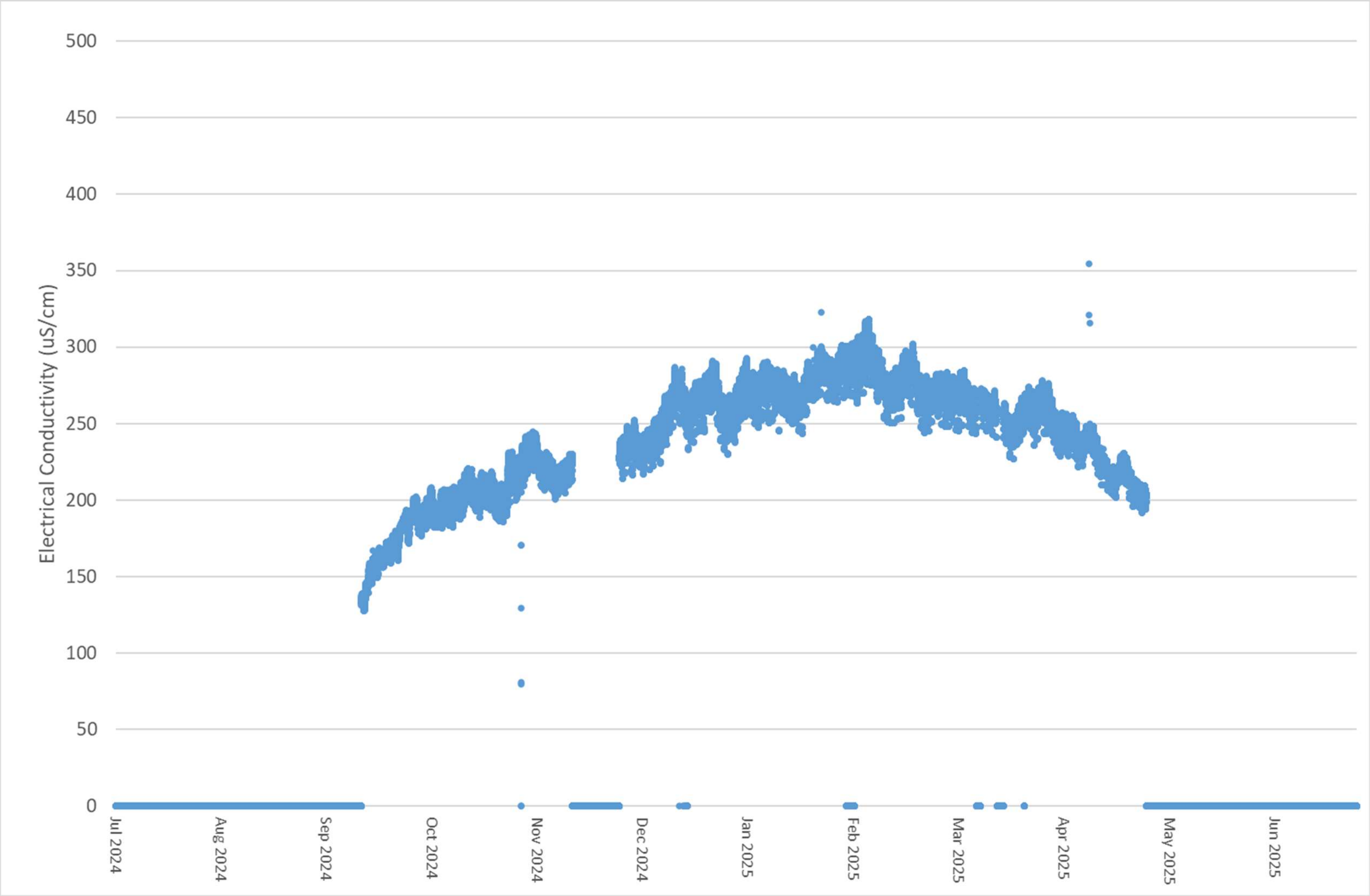


Figure 6: ARGS EC logger data: FY25

# Surface Water Quality

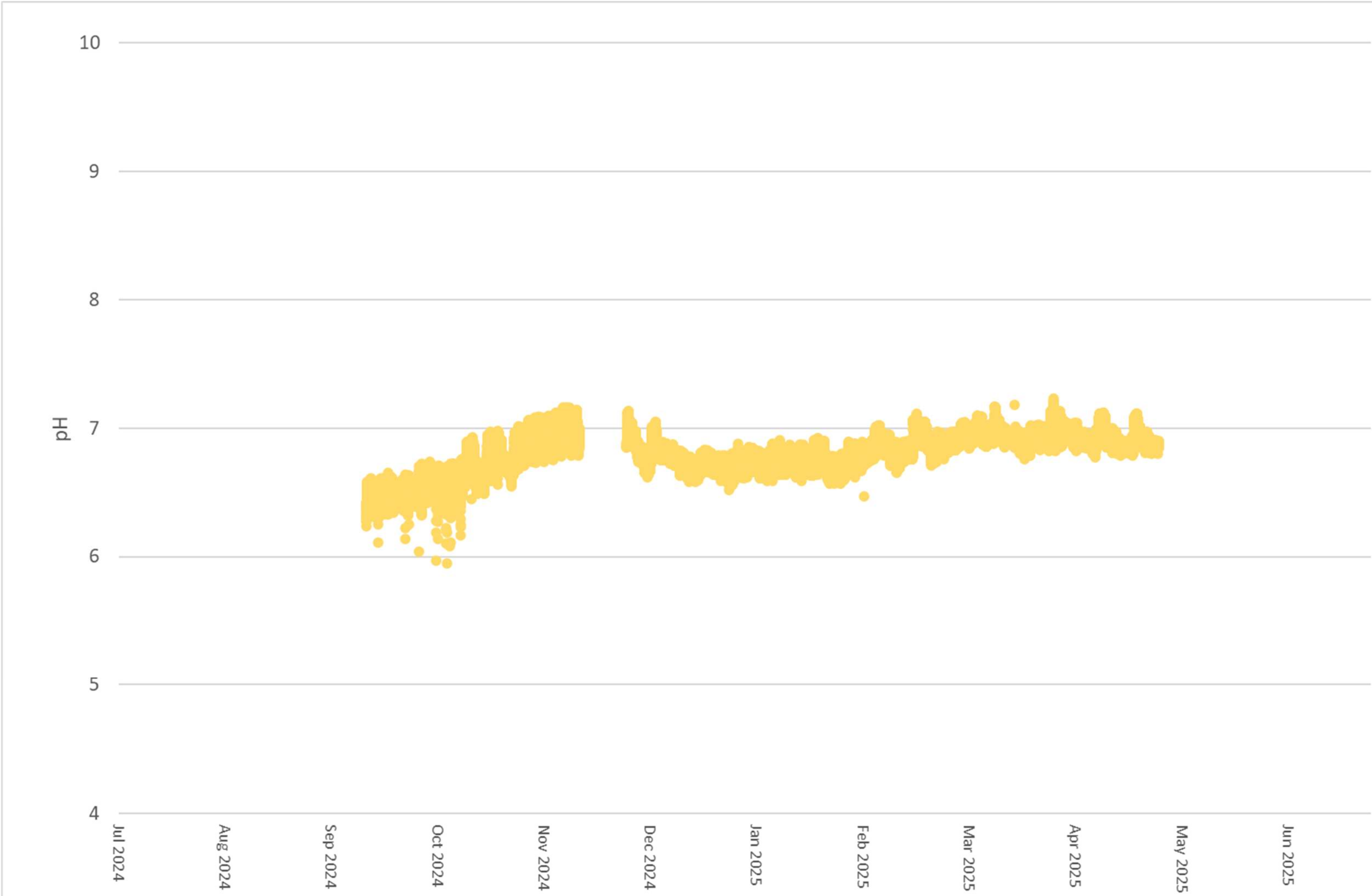


Figure 7: ARGS pH logger data: FY25

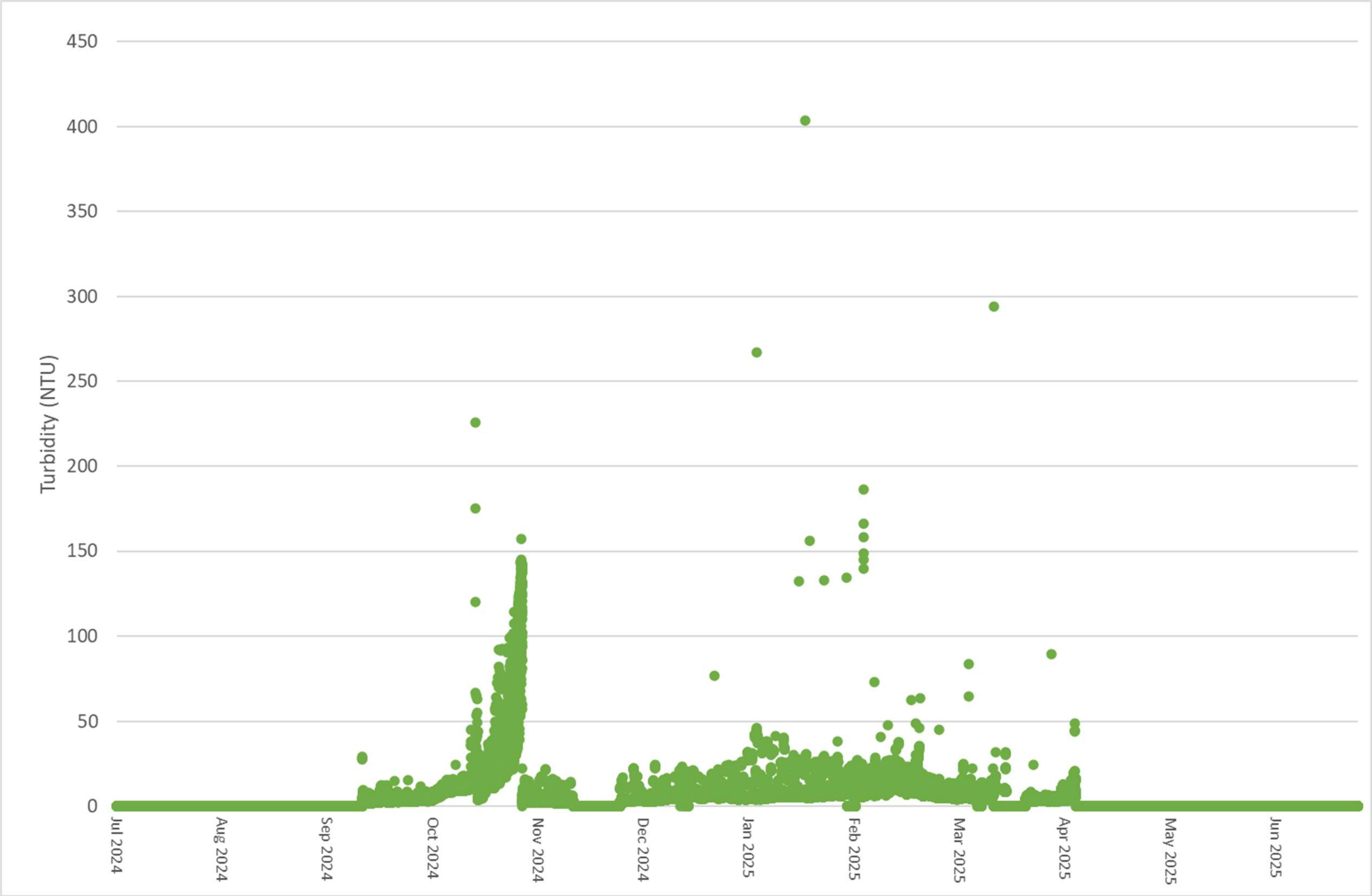


Figure 8: ARGS turbidity logger data: FY25

## 5.3 Hamilton River Water Quality

Monthly laboratory water quality results are provided in Table 13 while field analysis results are provided in Table 14. Quarterly water quality results are presented in Table 15. Long-term trends of analysed parameters are shown in Figure 8.

Monitored pH, EC and turbidity in the Hamilton River during flow periods were found to be consistent with previous years and with conditions required to sustain healthy aquatic communities in the catchment area.

The river stopped flowing during the months of January to June 2025, therefore no samples could be collected for analysis.

### Table 13: Monthly HAR1 Water Quality

| Month | EC (µS/cm) | pH | Na (mg/L) | Cl (mg/L) | Al (mg/L) |
|---|---|---|---|---|---|
| 17 Jul 2024 | 592 | 6.81 | 88 | 191 | NM |
| 13 Aug 2024 | 411 | 7.09 | 61 | 103 | 0.01 |
| 15 Oct 2024 | 368 | 7.00 | 60 | 109 | NM |
| 12 Nov 2024 | 482 | 7.01 | 73 | 118 | <0.01 |
| 9 Dec 2024 | 551 | 7.04 | 93 | 122 | NM |

NM: Not measured

### Table 14: Monthly HAR1 Water Quality (Field)

| Month | EC (µS/cm) | pH | DO (ppm) | Turbidity (NTU) | Temperature (°C) |
|---|---|---|---|---|---|
| 17 Jul 2024 | 377 | 6.81 | 8.23 | 0.00 | 10.49 |
| 13 Aug 2024 | 251 | 7.09 | 7.90 | 0.40 | 12.00 |
| 15 Oct 2024 | 321 | 7.00 | 8.28 | 21.46 | 16.58 |
| 12 Nov 2024 | 446 | 7.01 | 7.72 | 0.00 | 19.08 |
| 9 Dec 2024 | 552 | 7.04 | 7.08 | 0.75 | 23.03 |

## Table 15: Quarterly HAR1 Water Quality

| Parameter | Unit | 13 Aug 2024 | 12 Nov 2024 |
|---|---|---|---|
| Total alkalinity | mg/L | 17 | 37 |
| Bicarbonate | mg/L | 21 | 40 |
| Carbonate | mg/L | <1 | <1 |
| Calcium | mg/L | 6 | 7 |
| Iron | mg/L | 0.06 | 0.11 |
| Magnesium | mg/L | 9 | 9 |
| Potassium | mg/L | 2 | 2 |
| Sulphate | mg/L | 14 | 16 |
| TDS (calculated) | mg/L | 267 | 313 |

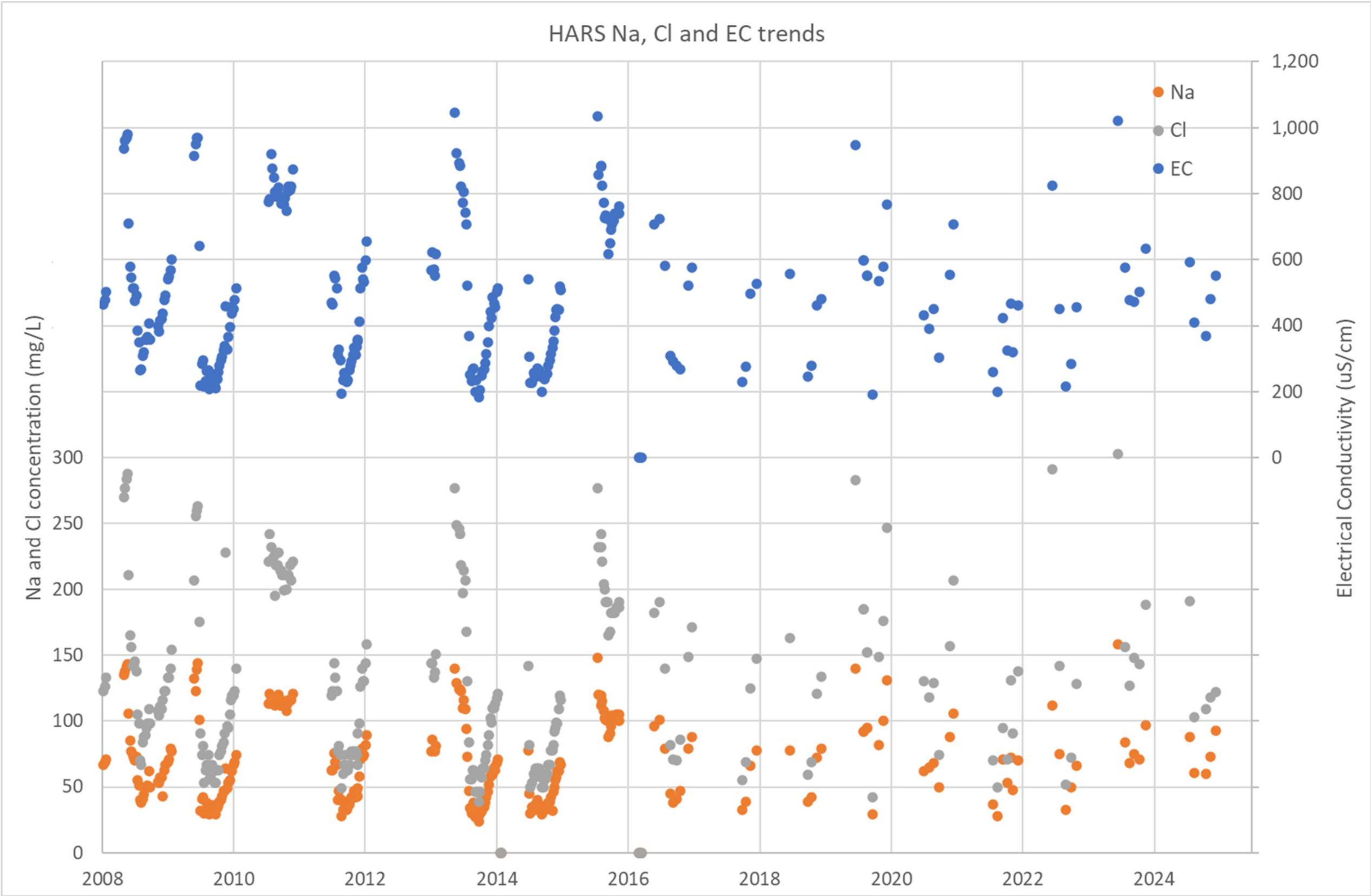


Figure 9: HAR1 Long-term water quality trends

# 6.0 GROUNDWATER MONITORING NETWORK

## 6.1 Baseline groundwater data

Baseline groundwater data was collected between 1980 and 1983, prior to the commencement of WAPL Refinery operations in 1984. To strengthen their understanding of baseline conditions, WAPL subsequently drilled additional monitoring bores across the site.

The monitoring record shows a high degree of natural variability, which provides a valuable reference for long-term trend analysis. When comparing baseline water quality data to the ANZECC Aquatic Ecosystems guideline trigger values, it is noted that some concentrations fall outside the guideline ranges. This highlights the importance of baseline data and the long-term trending of continuous water monitoring at the WAPL operations.

## 6.2 Groundwater monitoring program

The monitoring dataset comprises 303 sampling locations, including 260 groundwater monitoring bores. Over time, many of these bores have been destroyed due to ongoing development, leaving 107 active sampling locations, of which 92 are groundwater monitoring bores.

From this dataset, a subset targeted groundwater monitoring bores were selected to detect possible down-gradient groundwater contamination from the SPHD, NPHD, RCL, SEPs and the refinery complex. The targeted groundwater monitoring bores were selected considering their spatial distribution, representation of all hydrostratigraphic units and historical groundwater trends. The monitoring program also includes four up-gradient background groundwater monitoring bores and sampling locations from underflows that are used to identify potential contamination trends.

These targeted groundwater monitoring bores were initially selected based on a comprehensive review of the hydrogeological conditions at the site (GRM, 2019). Since then, groundwater conditions have been reassessed through annual reviews, and the network has been expanded as required.

The groundwater monitoring program comprises the following:

- 34 Targeted groundwater monitoring bores.
- 32 In-situ water quality sensors.
- Two wastewater underflow streams

Note that telemetry and conventional monitoring bores are shared.

The FY25 monitoring program incorporates 3 new monitoring bores (Table 16) described in more detail later. Two of these, M114sR and M117sR, were installed to replace two blocked monitoring bores, M114s and M117s, while one, RCL2s, is a new monitoring bore installed based on recommendations described in more detail later.

The background monitoring bore, R35c, were removed from the monitoring program as the bore was dry since installation in FY23.

Note that R26A is a monitoring bore installed during the FY23 period, replacing the blocked R25A monitoring bore, and was referred to as R25A in the F24 annual review.

For FY25, groundwater sampling was also carried out in an additional 10 groundwater monitoring bores (in addition to the targeted monitoring bores) as part of the ongoing assessment of groundwater conditions at the site. This is described in more detail later in this report.

Groundwater sampling was carried out using conventional groundwater sampling (purging) or low flow sampling techniques. As part of the field program, the groundwater sampler also measured the standing water level in the monitoring bores (prior to sampling) and collected field measurements of EC and pH of the groundwater.

Automated water quality sondes are installed in all groundwater monitoring bores except R26A, a background bore, and NVM22s. In FY24, the sonde in NVM22s became stuck and, although it was retrieved in June 2025, it was decided not to reinstall it due to the risk of recurrence.

New water quality sondes have been ordered for installation in the newly constructed bores (M114sR, M117sR, and RCL2s). At the time of preparing this report, the sondes had not yet been delivered. Recommendations for their installation, once delivered, are provided later in this report.

The automated sondes are programmed to measure water levels, EC and temperature at 6-hour intervals. Fourteen sondes form part of the Trigger Response Action Plan, described in more detail in Section 6.3.

The groundwater monitoring network is shown in Figure 10 and locations are summarised in Table 17. Sampling frequency and the list of analytes are detailed in Table 18.

## 6.3 Groundwater monitoring program expansion

Three additional monitoring bores were drilled and installed during the FY25 reporting period, following recommendations as part of an earlier hydrogeological assessment at the Refinery Catchment Lake (RCL) and Solar Evaporation Ponds (SEPs) (GRM, 2023). The three monitoring bores are:

- M114sR, replacing the blocked M114s monitoring bore
- M117sR, replacing the blocked M117s monitoring bore
- RCL2s, a new monitoring bore at the RCL.

Furthermore, the drilling contractor removed the water quality sonde stuck in NVM22s, thereby allowing the continued use of NVM22s for monitoring purposes.

Table 16 provides a summary of the new monitoring bores and a detailed description of the monitoring bores, including geological and hydrogeological logs, are provided by GRM (2025).

## Table 16: Summary of monitoring bore completion details

| ID | Date drilled | Easting (mE) | Northing (mN) | Ground elevation (m RL) | Steel collar (m) | Borehole depth (mbgl) | Casing diameter (mm) | Slotted section (mbgl) | Static water level (mbtoc) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| M114sR | 27/05/2025 | 412,867 | 6,322,382 | 290.49 | 1.08 | 11.5 | 100 | 5.0-11.0 | 9.18 (29/05/2025) | Airlift yield: 0.05 L/s at 11 mbgl, EC:1.2 mS/cm, pH: 8.8. |
| M117sR | 26/05/2025 | 413,166 | 6,321,456 | 294.41 | 1.03 | 11.5 | 100 | 4.9-10.9 | Dry | Dry, trace of water at 9.7 m |
| RCL2s | 27/05/2025 | 413,166 | 6,321,456 | 277.29 | 1.13 | 11.5 | 100 | 5.0-11.0 | 3.77 (29/05/2025) | Airlift yield: 0.05 L/s at 11 mbgl, EC:1.2 mS/cm, pH: 8.8. |

Notes:

- Construction: 100 mm Class 12 threaded uPVC blank casing and 100 mm Class 12 threaded uPVC slotted casing, 0.5mm aperture and 12/20 filter pack. Bentonite seal and grout to surface.
- Surface works: Concrete plinth and steel monument.
- Coordinate projection is MGA GDA94 Zone 52
- Steel collar height is from ground surface, not from concrete plinth

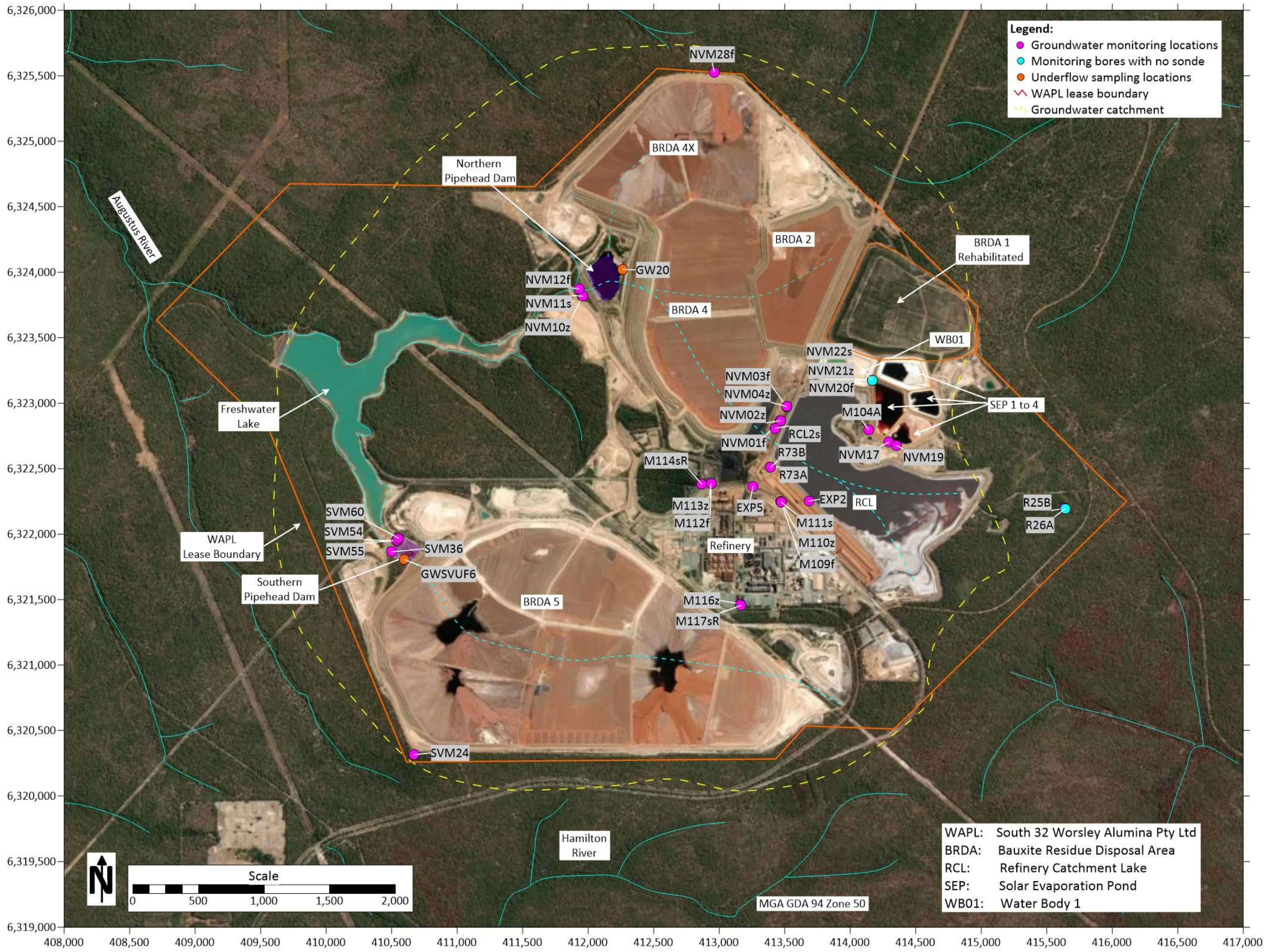


Figure 10: Groundwater monitoring network

## Table 17: Groundwater Monitoring Bores

| Name | Aquifer | Easting | Northing | Elevation | Slotted interval | In-situ sensors |
|---|---|---|---|---|---|---|
| **South Pipe Head Dam** | | | | | | |
| SVM36 | Fractured | 410,499 | 6,321,865 | 241.8 | 16.4 -23.4 | 05/08/2021<br>30/06/2025 |
| SVM60 | Fractured | 410,552 | 6,321,970 | 242.5 | 17.9 – 24.9 | 05/08/2021<br>30/06/2025 |
| SVM54 | Zersatz | 410,539 | 6,321,947 | 240.6 | 7.5 -14.5 | 01/07/2021<br>30/06/2025 |
| SVM55 | Shallow | 410,539 | 6,321,953 | 240.6 | 4.0 -5.8 | 06/08/2021<br>30/06/2025 |
| **North Pipe Head Dam** | | | | | | |
| NVM12f | Fractured | 411,930 | 6,323,873 | 243.4 | 44.0 – 50.0 | 01/07/2021<br>30/06/2025 |
| NVM11s | Shallow | 411,958 | 6,323,817 | 245.1 | 6.0 – 10.0- | 01/07/2021<br>30/06/2025 |
| NVM10z | Zersatz | 411,957 | 6,323,817 | 245.1 | 21.0 – 27.7 | 01/07/2021<br>30/06/2025 |
| **RCL and Refinery** | | | | | | |
| NVM01f | Fractured | 413,466 | 6,322,866 | 281.0 | 38.2-44.2 | 01/07/2021<br>30/06/2025 |
| NVM02z | Zersatz | 413,467 | 6,322,867 | 281.0 | 30.0-36.0 | 01/07/2021<br>30/06/2025 |
| M117sR* | Shallow | 413169 | 6321459 | 294.4 | 4.9-10.9 | 21/06/2025<br>30/06/2025 |
| M116z | Zersatz | 413,162 | 6,321,466 | 296.7 | 21.3-27.3 | 01/07/2021<br>30/06/2025 |
| M112f | Fractured | 412,939 | 6,322,387 | 286.8 | 33.4-45.4 | 01/07/2021<br>30/06/2025 |
| M113z | Zersatz | 412,938 | 6,322,387 | 286.7 | 19.9-31.9 | 01/07/2021<br>30/06/2025 |
| M114sR* | Shallow | 412,869 | 6,322,383 | 290.5 | 5.0-11.00 | 21/06/2025<br>30/06/2025 |
| M111s | Shallow | 413,472 | 6,322,244 | 289.2 | 4.0-13.0 | 03/11/2021<br>30/06/2025 |
| M110z | Zersatz | 413,471 | 6,322,246 | 289.2 | 20-23 | 01/11/2022<br>30/06/2025 |
| M109f | Fractured | 413,472 | 6,322,246 | 289.2 | 24.6-30.6 | 01/11/2022<br>30/06/2025 |
| EXP02 | ND | 413,686 | 6,322,253 | 286.5 | 26.3 - 32.3 | 01/11/2022<br>30/06/2025 |
| EXP05 | ND | 413,260 | 6,322,364 | 291.1 | 26.0 - 32.0 | 01/11/2022<br>30/06/2025 |
| R73A | ND | 413,393 | 6,322,509 | 286.6 | ND | 01/11/2022<br>30/06/2025 |
| R73B | ND | 413,393 | 6,322,509 | 286.7 | ND | 01/11/2022<br>30/06/2025 |
| NVM03f | Fractured | 413,515 | 6,322,972 | 279.9 | 59.0 - 62.0 | 01/11/2022<br>30/06/2025 |
| NVM04z | Zersatz | 413,516 | 6,322,974 | 279.9 | 32.1 - 38.1 | 01/11/2022<br>30/06/2025 |
| RCL2s* | Shallow | 413,427 | 6,322,808 | 277.3 | 5.0-11.0 | 21/06/2025<br>30/06/2025 |

* New

## Table 17: Groundwater Monitoring Bores (contd.)

| Name | Aquifer | Easting | Northing | Elevation | Slotted interval | In-situ sensors |
|---|---|---|---|---|---|---|
| **SEP monitoring bores** | | | | | | |
| NVM22s | Shallow | 414,168 | 6,323,173 | 297.5 | 9.0-21.0 | 01/07/2022<br>30/06/2024 |
| NVM21z | Zersatz | 414,169 | 6,323,174 | 297.6 | 33 - 39 | 01/11/2022<br>30/06/2025 |
| NVM20f | Fractured | 414,170 | 6,323,175 | 297.7 | 44.9 - 53.9 | 01/11/2022<br>30/06/2025 |
| M104A | ND | 414,141 | 6,322,797 | 291.4 | 6.0 - 33.0 | 01/11/2022<br>30/06/2025 |
| NVM17 | ND | 414,154 | 6,322,554 | 294.7 | 12.0 - 17.0 | 01/11/2022<br>30/06/2025 |
| NVM19 | ND | 414,213 | 6,322,530 | 294.8 | 12.0 - 17.0 | 01/11/2022<br>30/06/2025 |
| **Background monitoring bores** | | | | | | |
| R26A | Zersatz | 415,640 | 6,322,194 | 298.2 | 4.5-38.0 | None |
| R25B | Fractured | 415,634 | 6,322,197 | 298.3 | 38.0-48.0 | 01/07/2021<br>30/06/2022 |
| SVM24 | Fractured | 410,669 | 6,320,314 | 268.7 | 31.2-36.2 | 01/07/2021<br>30/06/2022 |
| NVM28f | Fractured | 412,961 | 6,325,529 | 307.5 | 38.0-40.5 | 01/07/2021<br>30/06/2025 |
| **Underflows** | | | | | | |
| GWSVU6 | | 410,596 | 6,321,806 | | | None |
| GW20 | | 412,262 | 6,324,023 | | | None |

## Table 18: Groundwater Monitoring Program

| Frequency | Analysis Required | Analysis type |
|---|---|---|
| Real-time (6-hour interval) | Water Level, EC, Temp °C | Monitoring bore datalogger |
| In response to trigger / alert | Water Level (WL), EC, Temp °C, pH and DO | Field |
| | pH, EC, Alkalinity, K, Na, Ca, Mg, Fe, Al, Cl, SO4, Sb, As, Ba, Be, B, Cd, Cr, Co, Cu, Pb, Mn, Mo, Ni, Se, Sn, Zn, and Hg (Calculated Results: TDS, NA/CL, HCO3, CO3, OH), | Laboratory |

## 6.4 Trigger Response and Action Plan

*Trigger and action values – Telemetered bores*

Water quality results are compared to site specific triggers derived from the baseline monitoring data shown in Table 19. Any adverse trends or exceedances of these triggers results in the initiation of an investigation to determine the validity, source, cause, and extent of any potential contamination event. The Worsley Water Management Plan contains the Trigger Response Action Plan that will be activated in the event of a reading exceeding the trigger level.

### Table 19: Baseline Levels for Telemetered Bores

| Monitoring bore | Electrical Conductivity (µS/cm) | Groundwater levels (m) |
|---|---|---|
| NVM01f | 818 | 12.2 |
| NVM02 | 640 | 15.0 |
| NVM11s | 942 | 1.7 |
| NVM10z | 672 | 1.8 |
| NVM12f | 424 | 0.9 |
| SVM54 | 3,338 | 3.4 |
| SVM55 | 2,230 | 2.7 |
| M112f | 562 | 3.2 |
| M113z | 450 | 3.1 |
| M114s | 1,992 | 3.1 |
| M116z | 536 | 11.7 |
| M111s | 3,220 | 4.6 |
| SVM36 | 631 | 3.6 |
| SVM60 | 560 | 4.0 |

*Trigger and action values – groundwater telemetry sensors*

For the FY23 hydrological review, GRM carried out a reassessment of the trigger levels for all monitoring bores equipped with telemetry sensors. The trigger level reassessment was carried out for the following:

- EC value exceedances for all monitoring bores equipped with telemetry sensors.
- Groundwater depth exceedances for monitoring bores at the North and South Pipe Head Dams (PHDs).

EC trigger values were set to identify elevated EC values which could be an early indication of groundwater contamination. The EC trigger values were determined considering the natural range of groundwater quality at each of the respective monitoring bores.

An upper-level EC value was determined for each of the monitoring bores, which represents the 75% percentile probability of non-exceedance. Trigger and action values were selected as follows:

- A trigger value set at 10% higher than the upper-level EC value. This value indicates that EC readings are likely outside the range of normal EC fluctuations, and which could be indicative of potential groundwater contamination.
- An action value is set at 20% higher than the upper-level EC value. If the hydrogeological assessment indicated groundwater contamination, WAPL should proceed with addressing this contamination in line with the WAPL water management plan.

Groundwater level exceedances have been redefined in terms of the following criteria:

- The North and South PHDs water levels should remain deeper than the groundwater levels as measured in the surrounding monitoring bores. This will ensure that any potential contaminated water from the PHDs will not seep into the downstream groundwater and FWL.
- Groundwater levels downstream of the RCL, refinery and SEPs should not increase within the vegetation root zone as this may affect vegetation health.

No trigger levels have been established for groundwater depth. However, water levels in the PHDs should be managed to remain lower than those in the FWL. This will maintain a negative hydraulic gradient, providing an additional barrier to flow into the surrounding groundwater. Recommendations for monitoring PHD water levels are presented later in this report.

## Table 20: Trigger and Action Levels for Telemetered Bores

| Monitoring bore | Electrical Conductivity (µS/cm) | | |
|---|---|---|---|
| | Upper level | Trigger | Action |
| NVM10z | 400 | 440 | 480 |
| NVM11s | 920 | 1,010 | 1,100 |
| NVM12f | 470 | 510 | 560 |
| M111s | 920 | 1,010 | 1,100 |
| M112f | 420 | 460 | 500 |
| M113z | 360 | 390 | 430 |
| M114s | 920 | 1,010 | 1,100 |
| M116z | 470 | 510 | 560 |
| NVM22s | 920 | 1,010 | 1,100 |
| NVM01f | 780 | 860 | 940 |
| NVM02z | 660 | 720 | 790 |
| SVM36 | 470 | 520 | 570 |
| SVM54 | 820 | 900 | 980 |
| SVM55 | 650 | 720 | 790 |
| SVM60 | 450 | 500 | 550 |

*Trigger and action values – groundwater laboratory quality samples*

Trigger and action values were also determined for the groundwater quality samples. The trigger levels for telemetered monitoring bores were determined for rapid assessment of potential groundwater contamination while the groundwater laboratory quality samples aim to identify long-term groundwater quality trends. As such, trigger levels (e.g. EC values are different to that of the telemetered bores.

A three-step verification method is used for identifying and detecting possible process liquor contamination in groundwater:

1. An increasing trend in groundwater EC levels, using the 2019 sampling record as a baseline dataset.
2. An increasing trend in the Alkalinity/TDS ratio.
3. An increasing trend of the Na/Cl concentration ratio.

Table 21 shows the adopted trigger and action values that forms part of the WAPL Water Management Strategy. The increase in EC values is used as a key indicator for trigger assessments.

The action values are set to a 20% increase in EC levels over a two-year period, confirming increasing trends and using the 2019 sampling record as the baseline value. In addition, Na/Cl and Alkalinity/TDS ratios should also show a continued increasing trend.

If trigger values are reached, WAPL is to investigate the reasons behind the increasing trend and assess the current water management practices at the relevant facility. Resampling and analysis might be required to confirm the water quality parameters.

If action values are reached, WAPL is to initiate a full groundwater sampling and analysis program for all groundwater monitoring bores around the facility of concern. WAPL should then initiate remediation measures, which could include the installation of groundwater abstraction bores or a change in the operating strategy (e.g., keeping PHDs at a lower water level).

## Table 21: Groundwater Laboratory Quality: Trigger Values

| Name | Trigger values | | Action values | |
|---|---|---|---|---|
| | EC value (µS/cm) | Na/Cl and Alkalinity/TDS ratios | EC value (µS/cm) | Na/Cl and Alkalinity/TDS ratios |
| SVM36 | 640 | Increasing trend | 770 | Increasing trend |
| SVM60 | 570 | | 690 | |
| SVM54 | 950 | | 1,140 | |
| SVM55 | 860 | | 1,030 | |
| NVM12f | 570 | | 690 | |
| NVM11s | 790 | | 950 | |
| NVM10z | 500 | | 600 | |
| NVM01f | 1,160 | | 1,400 | |
| NVM02z | 970 | | 1,160 | |
| M111s | 930 | | 1,120 | |
| M116z | 560 | | 670 | |
| M112f | 610 | | 730 | |
| M113z | 470 | | 560 | |
| M114s | TBD | | TBD | |

*Monitoring bore is blocked and should be removed from the monitoring program

## 6.5 FY25 groundwater monitoring program

During the FY25 period, groundwater samples were collected from all targeted monitoring bores except M117sR, which was dry, and NVM22s, where the water quality sonde was stuck. Samples were also collected from two underflow locations and an additional 10 monitoring sites.

The expanded sampling program was initiated in response to declining water quality trends at SPHD, and the southwest corner of BRDA5 with the aim of delineating the extent of potentially affected zones. Four additional monitoring bores were also sampled at NPHD, RCL, the refinery, and the SEPs area.

The targeted groundwater monitoring bores are listed in Table 17. A summary of the additional groundwater monitoring results is provided in Table 22, and the locations of all FY25 sampling sites are shown in Figure 11.

Table 22: Additional groundwater monitoring bores sampled for FY25

| Name | Aquifer | Easting | Northing | Elevation | Slotted interval | In-situ sensors |
|---|---|---|---|---|---|---|
| **BRDA5** | | | | | | |
| SVM30 | Zersatz | 410,564 | 6,320,462 | 270.7 | 14.8-20.0 | None |
| SVM33 | Fractured | 410,487 | 6,320,648 | 271.3 | 23.0-29.0 | None |
| **South Pipehead Dam** | | | | | | |
| SVM38 | Zersatz | 410,485 | 6,321,886 | 240.0 | 18.7-25.7 | None |
| SVM48 | Zersatz | 410,522 | 6,321,937 | 242.3 | 15.8-22.8 | None |
| SVM53 | Shallow | 410,550 | 6,321,931 | 240.2 | 3.0-4.6 | None |
| SVM62 | Shallow | 410,574 | 6,321,962 | 239.6 | 5.8-23.0 | None |
| **North Pipehead Dam** | | | | | | |
| NVM27s | Shallow | 412,122 | 6,324,330 | 257.1 | 7.0-10.0 | None |
| **RCL and refinery** | | | | | | |
| M107z | Zersatz | 413,786 | 6,321,482 | 294.1 | 10.2-19.2 | None |
| M108f | Fractured | 413,783 | 6,321,482 | 294.0 | 27.7-34.2 | None |
| **SEPs** | | | | | | |
| M105A | Shallow | 414,074 | 6,322,874 | 289.7 | 6.0-33.0 | None |

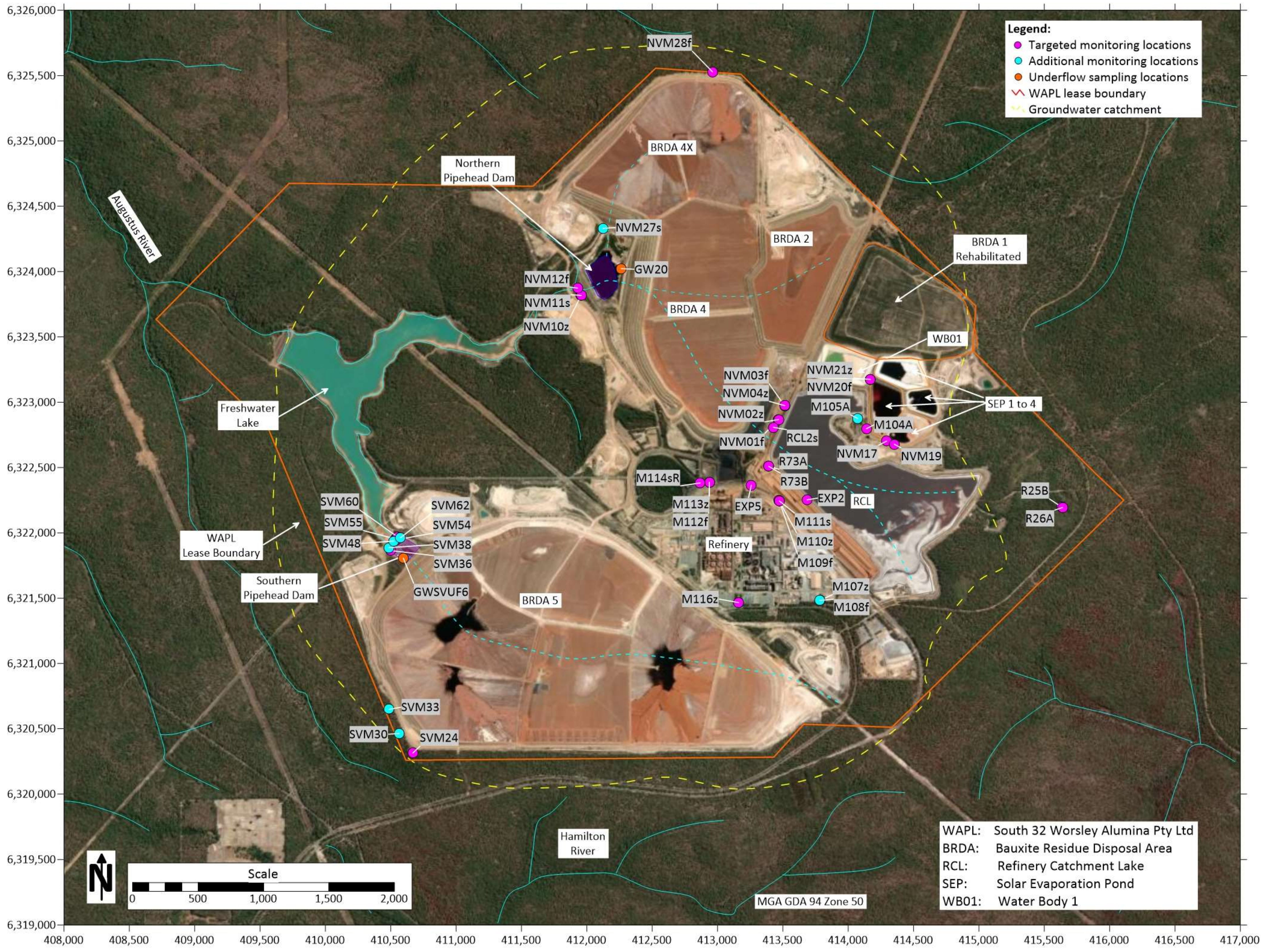


Figure 11: FY25 monitoring locations

## 6.6 Monitoring issues

The following is issues were noted during the FY25 monitoring program:

- All groundwater quality sondes are reaching the end of their operational life, and these are evident from the data losses explained in more detail below. Recommendations for their replacement are provided later in this report.
- M114s remained partially blocked, and WAPL could not obtain a groundwater sample from the monitoring bore. However, one groundwater sample was obtained from the replacement monitoring bore, M114sR.
- M117s also remained blocked, and no groundwater sample could be obtained for the monitoring bore. The replacement monitoring bore, M117sR, was dry at the time of sampling.
- R35C remained dry during the FY25 period, and the bore was removed from the monitoring program.
- The water quality sonde remained stuck in the NVM22s and the sonde was only removed towards the end of the FY25 period, hence no water quality samples were collected at this bore.
- Two water quality sondes, M117sR and RCL2s, were only installed towards the end of the reporting period and water quality results will be presented in the FY26 hydrology review.
- The EC data showed a gradual “drift”. The sensors were recalibrated every 4 months with EC values re-adjusted to the correct value. This recalibration caused small data “jumps” that is evident from the graphs.
- For the background monitoring bores, R25B and SVM24, showed unusual low EC values for part of the year. These were inspected and recalibrated during the reporting period. NVM28f had missing data between August and December 2024.
- For the NPHD, NVM12f had missing data between July and August 2024 while NVM11 s had missing data between November and December 2024.
- For the SPHD, SVM55 had missing data between August and October 2024 and then June 2025 onwards. SVM36 had missing date between March and May 2025.
- For the refinery, M114s ran dry at about October 2024, and no EC measurements were recorded. M114sR was installed to replace M114s but was also dry. NVM01f had missing data between December 2024 and March 2025. NVM03f had missing data between December 2024 and March 2025.
- For the RCL, R73A had missing data from July 2024 to November 2024. R73B had missing data between December 2024 and April 2025. M109f and M110z had missing data in July 2024.
- For the SEP, the water quality sonde was removed from NVVM22s to prevent a reoccurrence where the sonde got stuck. There are missing data from NVM17 between October and November 2024.

Despite these issues, the data is considered comprehensive enough to assess water quality trends and carry out an impact assessment.

# 7.0 GROUNDWATER MONITORING RESULTS

## 7.1 Telemetry Water Quality Results

Table 23 and Table 24 present the average monthly EC values at the equipped monitoring bores. Note that EC values are expressed as specific EC values corrected for temperature at 25°. Average water levels are shown in Table 25. The following is evident from these values.

- There were EC exceedances at both the NPHD and SPHD.
- At the NPHD, occasional exceedances were recorded at NVM10z and NVM12f.
- At the SPHD, exceedances were recorded at SVM60 for eight of the 12 months while occasional exceedances were also recorded at SVM54 and SVM55.
- There were EC exceedances at M111s for seven out of the 12 months with occasional exceedances at M112f. These are associated with aspects of the RCL.
- There were also exceedances at M114s, but the bore was dry since October 2024 and no further water quality measurements were made at the bore for the year.
- Even though there are no EC trigger levels set at various at monitoring bores, high EC values were observed at the southern part of the RCL at R73A and R73B.
- High EC values also occur at NVM21z and M104A at the SEPs. It is also noted that data could not be obtained from NVM22s, but this monitoring bore had high EC values in FY23.
- Water levels increased to within 4.0 m from the ground surface at M111s for the months January to May 2025.
- It is noted that trigger water levels have not yet been defined, and these are the subject to recommendations shown later in this report.

Figures 12 to 17 shows the EC trends for the dataloggers. The results are summarised below:

- For the background monitoring bores, very low, likely erroneous EC readings were recorded at R25B and at SVM24 for the months July 2024 to November 2024 and January to April 2025. EC values for the remaining background monitoring data (Figure 12) are within the expected EC range with no significant trend.
- At the NPHD (Figure 13), NVM11s showed an initial decrease in EC levels in August 2024 before increasing again in September 2024, after which it remained stable and then decreasing again in June 2025. This EC trend is probably seasonal and represent the influx of fresh rainfall recharge into the shallow hydrostratigraphic unit during the wet season.
- There are no other significant EC trends at the NPHD.
- At the SPHD (Figure 14), there is a decrease in EC values at SVM55 for the period July 2025, after which there were a gradual increase until March 2025 where there was an increasing trend again.
- SVM54 shows a decreasing trend in EC values for August and September 2024 followed by a gradual increase through the remaining reporting period.
- There are no other significant EC trends at the SPHD.
- For the northern RCL area and the refinery (Figure 15), no significant EC trend was observed, except at M112f, where EC values increased in August 2024 before gradually decreasing and stabilizing at levels similar to those recorded prior to August 2024.

- For the southern RCL area (Figure 16), the EC values at M111s shows significant seasonal variation with lower EC values recorded at the end of the wet season (August to November) followed by a gradual increase in EC values for the remainder of the FY25 period. There are no other significant trends.
- The SEP monitoring bores (Figure 17) shows increasing EC trends at NVM21z. NVM21z is slotted within the saprock zoned directly below the shallow hydrostratigraphic unit (NVM22s) which had very high EC values during FY23. Hence the increasing EC values represent a gradual movement of high EC groundwater into the saprock zone. M104A shows seasonal variability with increasing EC values at the end of the wet season (September to October) returning to lower levels for the remaining period. There are no significant EC trends in the other SEP monitoring bores.

Table 23: Average Monthly Groundwater Electrical Conductivity (µS/cm): PHDs and SEP

| Month | NPHD | | | SPHD | | | | SEP | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NVM10z | NVM11s | NVM12f | SVM36 | SVM54 | SVM55 | SVM60 | NVM20f | NVM21z | NVM22s | M104A | NVM17 | NVM19 |
| **Trigger value** | **440** | **1,010** | **510** | **520** | **900** | **720** | **500** | **ND** | **ND** | **1,010** | **ND** | **ND** | **ND** |
| July 2024 | ND | 580 | 438 | 478 | 939 | 438 | 425 | 254 | 2,003 | ND | 911 | 386 | 485 |
| Aug 2024 | 411 | 352 | 489 | 453 | 851 | ND | 426 | 254 | 2,003 | ND | 1,484 | 381 | 488 |
| Sep 2024 | 407 | 635 | 565 | 408 | 655 | 107 | 423 | 235 | 2,023 | ND | 1,323 | 383 | 496 |
| Oct 2024 | 400 | 788 | 458 | 468 | 580 | 497 | 560 | 233 | 2,025 | ND | 1,230 | 384 | 504 |
| Nov 2024 | 406 | 169 | 427 | 461 | 594 | 530 | 554 | 235 | 2,139 | ND | 1,231 | 463 | 498 |
| Dec 2024 | 404 | 421 | 431 | 472 | 594 | 557 | 540 | 234 | 2,412 | ND | 1,086 | 466 | 507 |
| Jan 2025 | 401 | 811 | 296 | 474 | 595 | 576 | 539 | 233 | 2,445 | ND | 895 | 476 | 505 |
| Feb 2025 | 401 | 803 | 273 | 414 | 600 | 594 | 539 | 233 | 2,420 | ND | 770 | 483 | 505 |
| Mar 2025 | 434 | 720 | 430 | 408 | 627 | 631 | 531 | 232 | 2,389 | ND | 686 | 429 | 495 |
| Apr 2025 | 448 | 707 | 430 | 467 | 644 | 843 | 527 | 231 | 2,396 | ND | 668 | 403 | 492 |
| May 2025 | 446 | 785 | 431 | 412 | 681 | 876 | 528 | 232 | 2,460 | ND | 677 | 406 | 497 |
| Jun 2025 | 440 | 648 | 432 | 430 | 426 | 576 | 439 | 243 | 2,569 | ND | 770 | 405 | 498 |

ND=Not determined

Table 24: Average Monthly Groundwater Electrical Conductivity (µS/cm): RCL

| Month | RCL and refinery | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | EXP02 | EXP05 | M109f | M110z | M111s | M112f | M113z | M114s | M116z | NVM01f | NVM02z | NVM03f | NVM04z | R73A | R73B |
| **Trigger value** | **ND** | **ND** | **ND** | **672** | **1,010** | **460** | **390** | **1,010** | **510** | **860** | **720** | **ND** | **ND** | **ND** | **ND** |
| July 2024 | 217 | 898 | ND | ND | 2,255 | 438 | 369 | 1,287 | 436 | 747 | 663 | 621 | 579 | ND | 1,860 |
| Aug 2024 | 217 | 899 | 315 | 411 | 1,908 | 489 | 368 | 1,281 | 442 | 747 | 666 | 622 | 579 | ND | 1,835 |
| Sep 2024 | 217 | 871 | 319 | 407 | 712 | 565 | 364 | 1,342 | 376 | 741 | 669 | 626 | 582 | ND | 1,750 |
| Oct 2024 | 218 | 859 | 322 | 400 | 712 | 458 | 355 | ND | 476 | 738 | 668 | 628 | 585 | ND | 1,748 |
| Nov 2024 | 219 | 863 | 326 | 406 | 818 | 427 | 362 | ND | 464 | 740 | 615 | 625 | 595 | 1,886 | 1,746 |
| Dec 2024 | 225 | 885 | 326 | 404 | 996 | 431 | 354 | ND | ND | ND | 370 | ND | 665 | 1,926 | ND |
| Jan 2025 | 224 | 885 | 320 | 401 | 1,251 | 296 | 349 | ND | ND | ND | 463 | ND | 666 | 1,928 | ND |
| Feb 2025 | 223 | 885 | 320 | 401 | 1,192 | 273 | 266 | ND | ND | ND | 483 | ND | 668 | 1,934 | ND |
| Mar 2025 | 217 | 868 | 328 | 434 | 1,441 | 430 | 348 | ND | 437 | ND | 499 | ND | 616 | 1,926 | ND |
| Apr 2025 | 214 | 857 | 332 | 448 | 717 | 430 | 270 | ND | 433 | 748 | 466 | 621 | 584 | 1,937 | 1,738 |
| May 2025 | 213 | 857 | 331 | 446 | 1,663 | 431 | 349 | ND | 432 | 749 | 540 | 621 | 582 | 1,916 | 1,745 |
| Jun 2025 | 214 | 859 | 337 | 440 | 1,734 | 432 | 352 | ND | 432 | 751 | 556 | 619 | 567 | 1,758 | 1,758 |

ND=Not determined

Table 25: Average Monthly Groundwater Levels (m below ground level)

| Month | NPHD | | | RCL and refinery | | | | | | | SPHD | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NVM10z | NVM11s | NVM12f | NVM01f | NVM02z | M111s | M112f | M113z | M114s | M116z | SVM36 | SVM54 | SVM55 | SVM60 |
| **Trigger value** | **ND** | **ND** | **ND** | **ND** | **ND** | **ND** | **ND** | **ND** | **ND** | **ND** | **ND** | **ND** | **ND** | **ND** |
| July 2024 | 2.7 | 2.3 | ND | ND | 6.8 | 5.7 | 9.4 | 8.9 | 9.1 | 14.3 | 5.9 | 4.7 | 4.9 | 5.5 |
| Aug 2024 | 2.2 | 1.7 | 1.1 | ND | 6.1 | 5.1 | 8.2 | 7.8 | 8.1 | 13.4 | 5.4 | 4.3 | 5.7 | 4.8 |
| Sep 2024 | 2.2 | 1.8 | 1.2 | ND | 5.3 | 4.8 | 7.7 | 7.5 | 7.5 | 16.9 | 5.4 | 4.0 | 2.9 | 5.0 |
| Oct 2024 | 2.5 | 2.2 | 1.5 | ND | 5.2 | 4.9 | 8.1 | 8.0 | 15.4 | 12.3 | 6.0 | 4.1 | ND | 5.2 |
| Nov 2024 | 2.9 | 8.0 | 2.0 | ND | 7.9 | 5.0 | 8.6 | 8.0 | 15.7 | 12.5 | 5.1 | 4.3 | 2.0 | 5.5 |
| Dec 2024 | 3.1 | 6.1 | 2.2 | ND | 10.0 | ND | 9.4 | 8.5 | 15.7 | 31.4 | 5.1 | 4.4 | 3.8 | 5.8 |
| Jan 2025 | 3.4 | 3.1 | 2.5 | ND | 5.4 | -0.2 | 19.9 | 8.7 | 15.7 | 35.4 | 5.1 | 5.0 | 4.0 | 6.0 |
| Feb 2025 | 3.8 | 3.5 | 3.0 | ND | 5.8 | 0.2 | 4.4 | 9.1 | 15.8 | 16.2 | 5.9 | 4.5 | 4.3 | 6.3 |
| Mar 2025 | 3.9 | 5.1 | 3.1 | ND | 6.3 | 0.4 | 4.6 | 9.2 | 15.7 | 16.5 | 5.9 | 4.8 | 4.4 | 6.5 |
| Apr 2025 | 4.1 | 5.3 | 3.3 | ND | 9.0 | 2.1 | 4.8 | 9.4 | 15.8 | 16.9 | 5.7 | 4.8 | 4.5 | 6.6 |
| May 2025 | 4.2 | 3.9 | 3.3 | ND | 6.3 | 2.6 | 5.1 | 9.7 | 15.8 | 17.2 | 6.8 | 4.9 | 4.8 | 6.7 |
| Jun 2025 | 3.7 | 3.4 | 2.7 | ND | 6.3 | 6.3 | 5.2 | 9.8 | 8.6 | 17.4 | 6.8 | 5.0 | ND | 8.9 |

ND: Not determined

Trigger values not determined but water levels within 4 m from ground surface highlighted

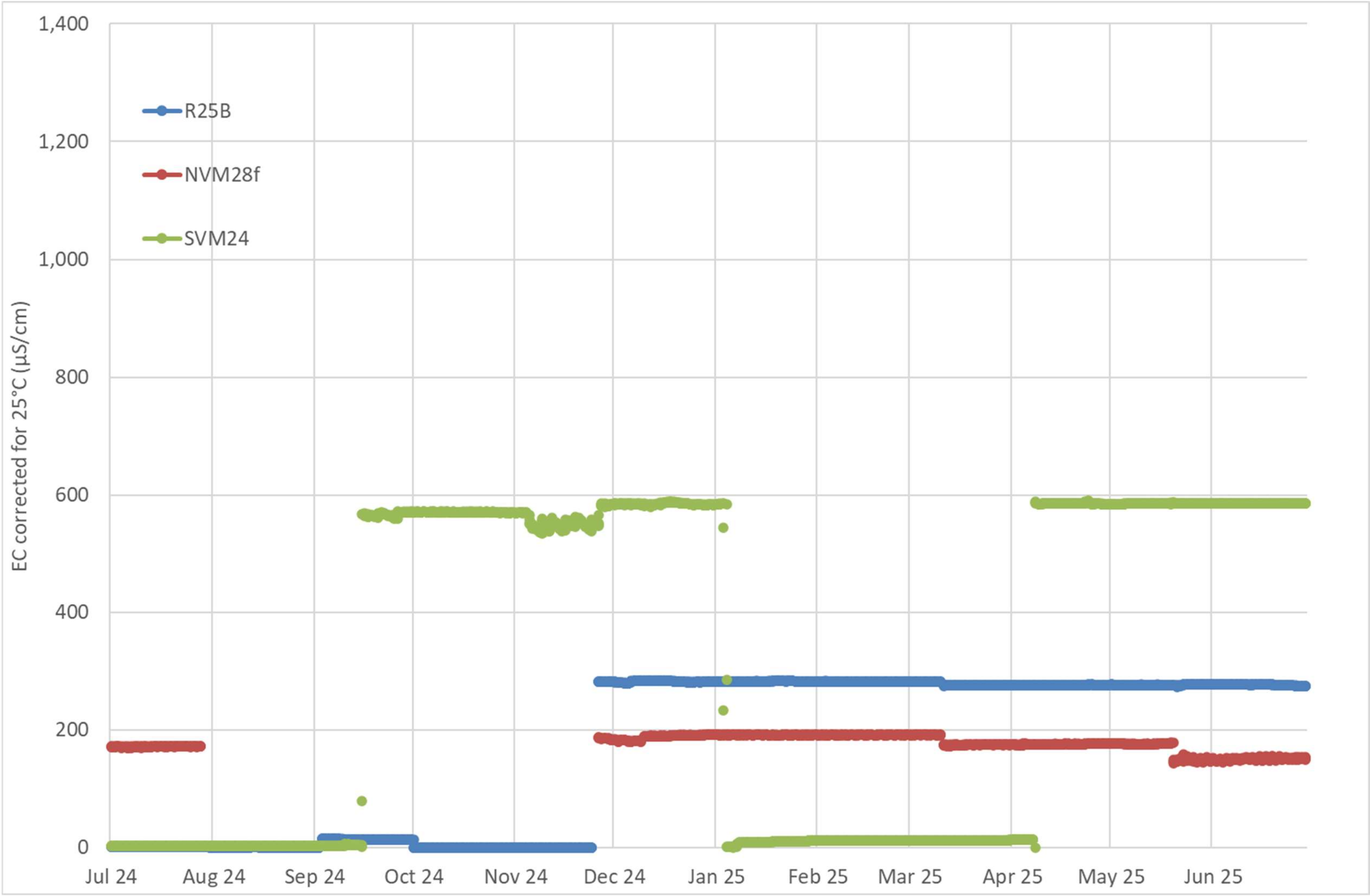


Figure 12: EC value trends: Background monitoring bores

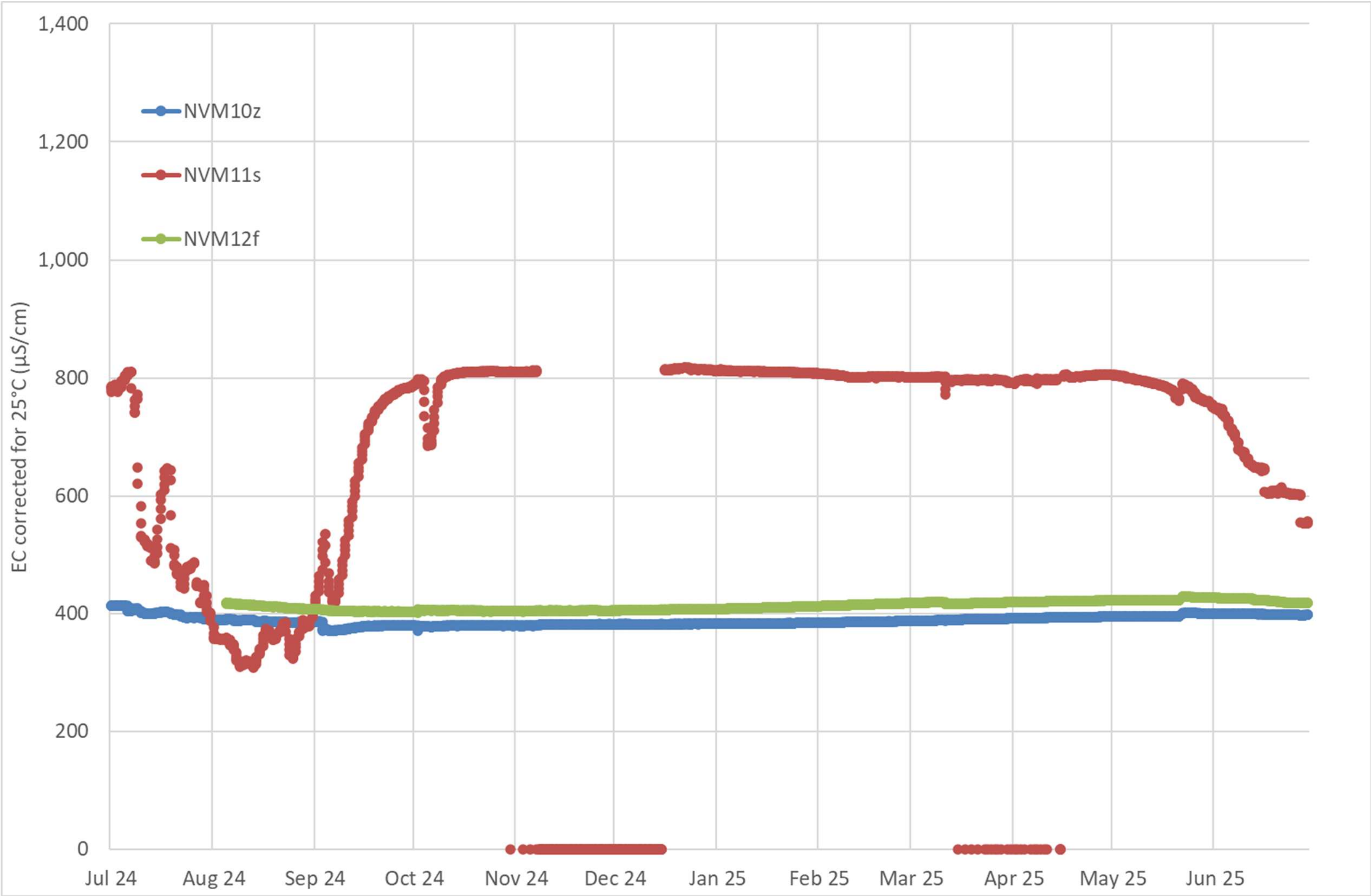


Figure 13: EC value trends: Monitoring bores downgradient of NPHD

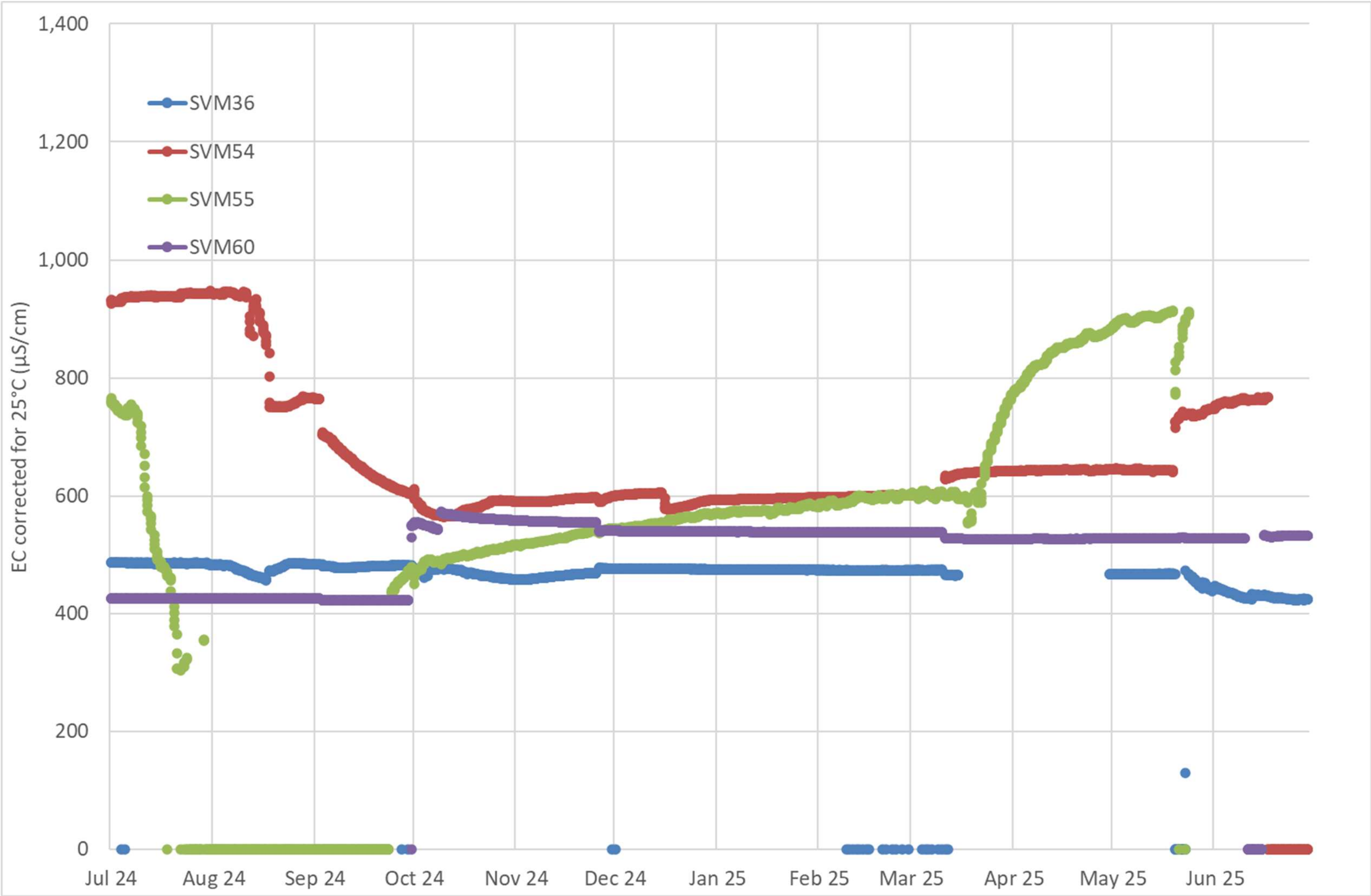


Figure 14: EC value trends: Monitoring bores downgradient of SPHD

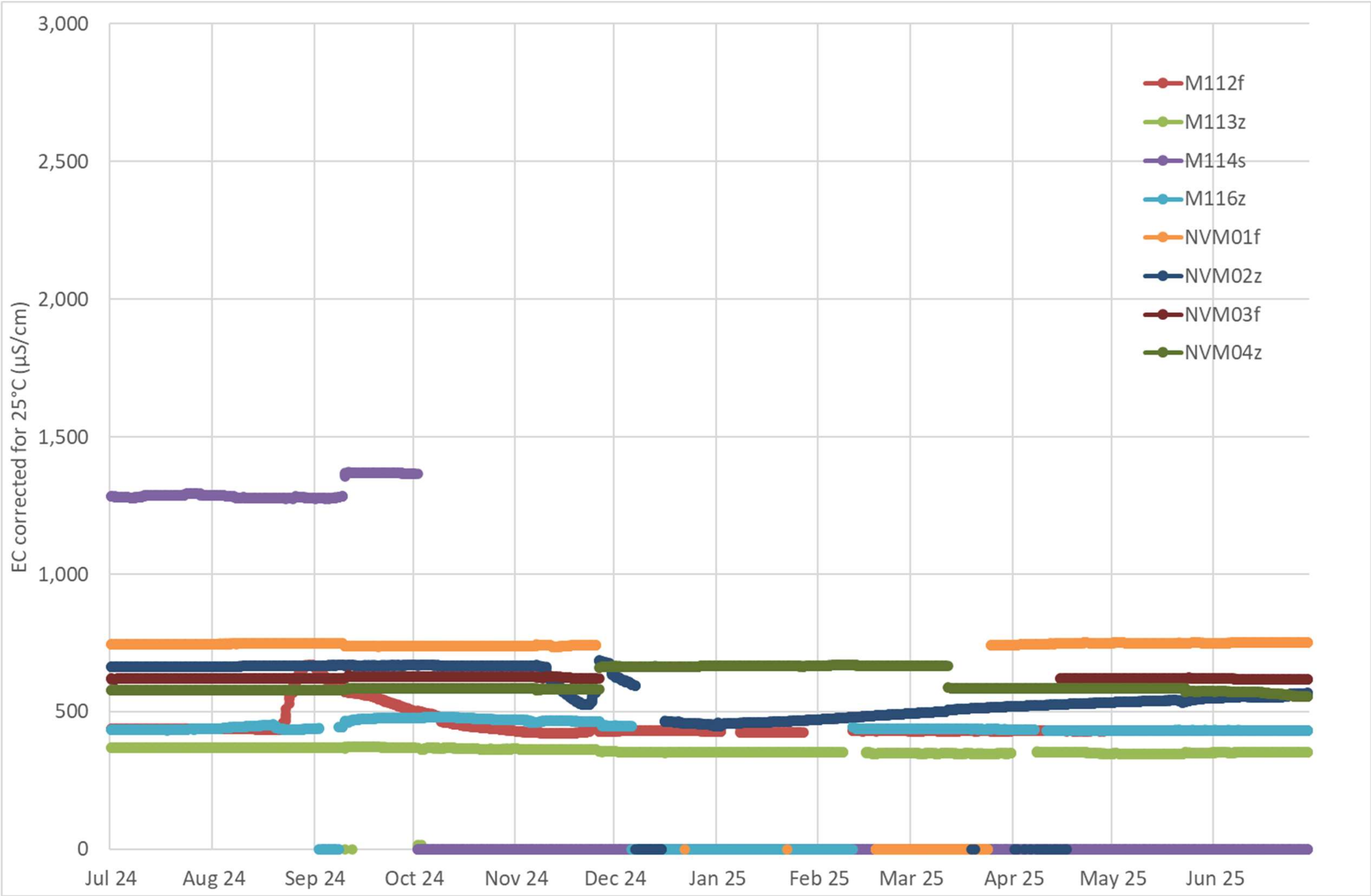


Figure 15: EC value trends: Monitoring bores downgradient of the north RCL and refinery.

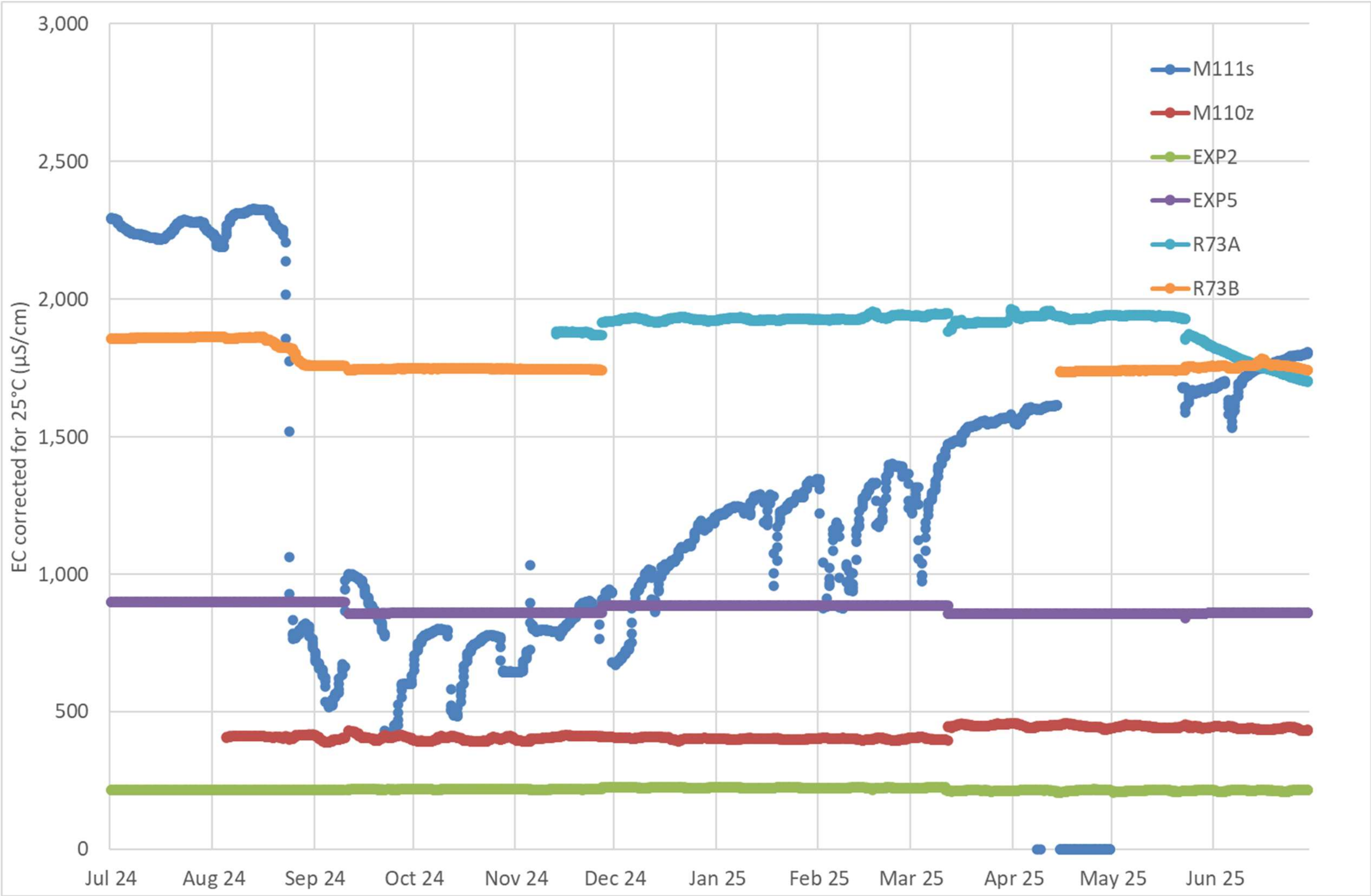


Figure 16: EC value trends: Monitoring bores downgradient of the south RCL

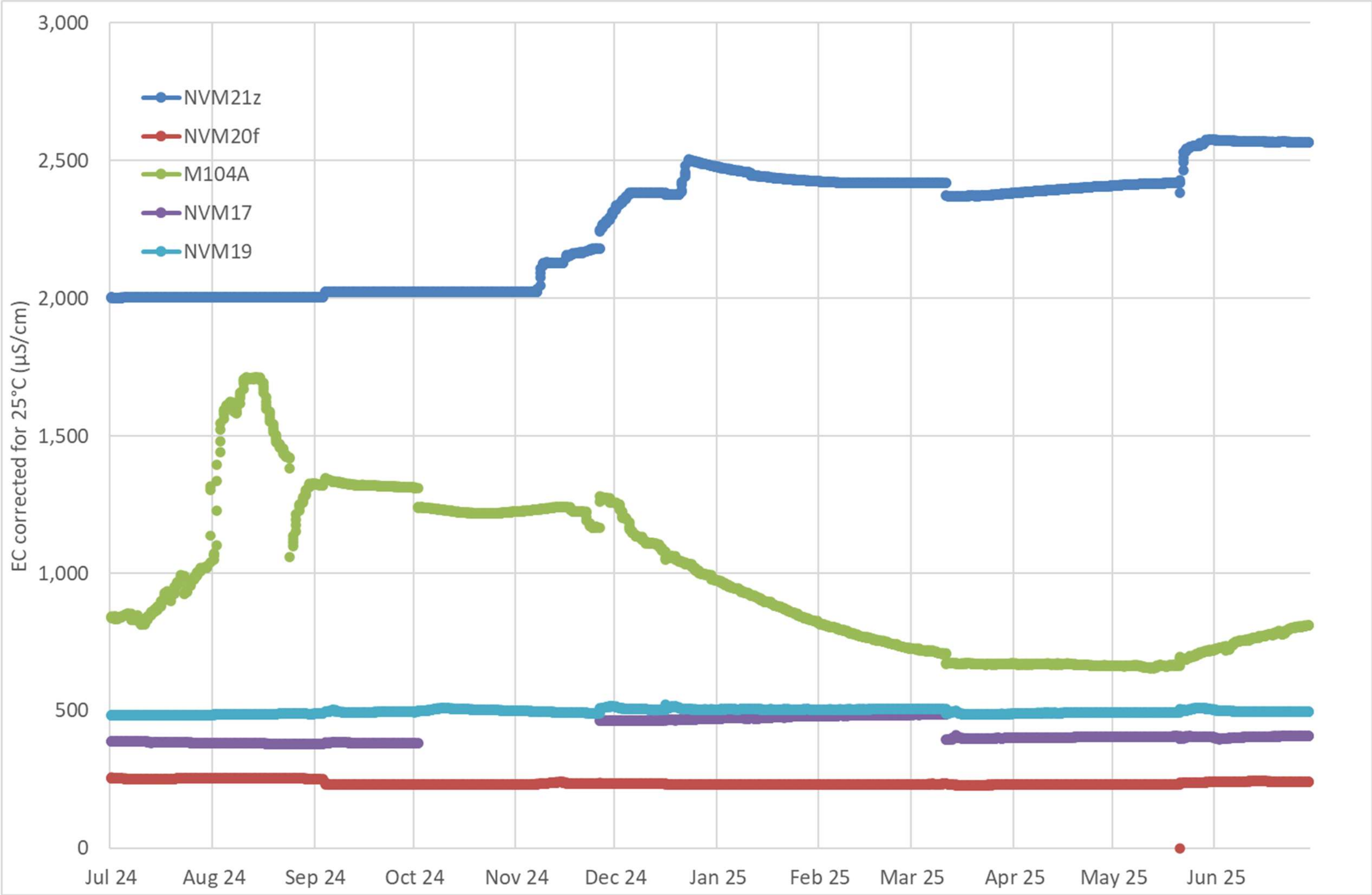


Figure 17: EC value trends: Monitoring bores downgradient of the SEPs

## 7.2 Groundwater Sampling Programme

The groundwater sampling program carried out during FY25 comprised field parameters and laboratory analysis. Two rounds on sampling were undertaken:

- The first round was carried out between September and November 2024.
- The second round was undertaken in May and June 2025.

### 7.2.1 Field Parameters Results

Field monitoring results are summarised in Table 26 to Table 29 for the respective sampling rounds. Results are compared with the water quality results of the wastewater facilities as described in Section 5.4, namely Table 16 and Table 18.

Electrical Conductivity

The September-November sampling round shows that, with some exceptions, EC values typically range between 137 and 892 µS/cm. By comparison, waste water EC values range between 17,000 and 62,000 µS/cm as described in Section 3.4.

Several samples recorded an EC value of more than 820 µS/cm namely:

- NVM21z, situated downgradient of the SEP facilities recorded EC values of 6,314 µS/cm. Note that no samples were undertaken at NVM22s due to an obstruction, which has since been removed. NVM22s also showed historical elevated EC values.
- M104 situated downgradient of the SEP facilities also recorded an EC values of 1,118 µS/cm.
- R73A and R73B, situated downgradient of the RCL recorded an EC value of 1,652 and 1,460 µS/cm respectively.

The May/June sampling round confirmed the high EC values at both the SEP and RCL facilities namely:

- NVM21z, situated downgradient of the SEP facilities, recorded elevated EC values of 7,675 µS/cm, but M104 had a lower an EC values of 624 µS/cm.
- M111s, R73A, R73B and the new monitoring bore, RCL2s, situated downgradient of the RCL, recorded elevated EC values ranging between 1,465 µS/cm at M111s to 2,795 µS/cm at RCL2s.
- The new refinery monitoring bore, M114sR, showed an elevated EC value of 1,740 µS/cm.

pH

The September-November monitoring round shows that, with some exceptions, the pH of the groundwater samples is neutral to slightly acidic ranging between 4.5 and 7.5. By comparison, the wastewater pH range between 10.5 to 13.1.

None of the groundwater samples had a pH of more than 7.5 which indicate that bauxite liquor (or wastewater containing bauxite liquor), was not detected in any of the monitoring bores. However, there are groundwater quality trends which may indicate mixing of small amounts of bauxite liquor in the groundwater at localised areas, described in more detail later in this report.

For the September-November monitoring round, six samples recorded pH of less than 4.5 namely:

- NVM19 and M104A, situated downgradient of the SEP with a pH of 4.1 and 3.9 respectively.
- EXP5, downgradient of the RCL with a pH of 4.3.
- M107z, at the refinery area with a pH of 4.0.
- NVM27s, upgradient of the NPHD with a pH of 4.2.
- R26A which is an upgradient background monitoring bore with a pH of 4.4.

The May/June monitoring round showed two monitoring bores having a pH of less than 4.5.

- M104A and NVM19, situated downgradient of the SEP with a pH of 4.1 and 3.9 respectively.

Explanations for these trends are provided in Section 8.

Table 26: Monitoring Results: Field Data: September to November 2024

| Bore ID | Date | Water Level (m) | Temperature (C°) | Dissolved Oxygen (%) | Electrical Conductivity (uS/cm) | pH |
|---|---|---|---|---|---|---|
| EXP2 | 05 Nov 2024 | 2.43 | 20.0 | 1.6 | 195 | 4.99 |
| EXP5 | 07 Nov 2024 | 8.77 | 20.4 | 50.3 | 708 | 4.26 |
| GW20 | 02 Oct 2024 | NA | 18.4 | 19.0 | 1,151 | 6.86 |
| GWSVUF6 | 30 Sep 2024 | NA | 18.1 | 56.0 | 652 | 5.62 |
| M104A | 02 Oct 2024 | 6.68 | 17.7 | 5.0 | 1,118 | 3.87 |
| M105A | 02 Oct 2024 | 4.34 | 14.9 | 38.0 | 195 | 4.98 |
| M107Z | 05 Nov 2024 | 5.54 | 17.7 | 98.2 | 110 | 4.03 |
| M108F | 05 Nov 2024 | 5.45 | 17.6 | 1.5 | 123 | 5.93 |
| M109F | 05 Nov 2024 | 5.31 | 20.1 | 1.8 | 262 | 5.09 |
| M110Z | 07 Nov 2024 | 5.44 | 22.1 | 21.7 | 431 | 5.35 |
| M111S | 05 Nov 2024 | 4.83 | 20.8 | 0.4 | 568 | 7.20 |
| M112F | 02 Oct 2024 | 8.87 | 17.6 | 10.0 | 419 | 6.55 |
| M113Z | 02 Oct 2024 | 7.40 | 15.9 | 2.0 | 353 | 4.97 |
| M114S | 02 Oct 2024 | 7.42 | NM | NM | NM | NM |
| M116Z | 05 Nov 2024 | 12.26 | 18.2 | 110.0 | 364 | 5.19 |
| NVM01F | 07 Nov 2024 | 5.57 | 22.1 | 14.0 | 694 | 6.36 |
| NVM02Z | 07 Nov 2024 | 5.08 | 20.8 | 17.8 | 546 | 5.02 |
| NVM03F | 07 Nov 2024 | 4.45 | 21.8 | 8.6 | 526 | 6.47 |
| NVM04Z | 07 Nov 2024 | 4.65 | 20.3 | 92.3 | 502 | 5.00 |
| NVM10Z | 02 Oct 2024 | 2.05 | 16.6 | 3.0 | 316 | 5.38 |
| NVM11S | 02 Oct 2024 | 2.09 | 18.0 | 3.0 | 534 | 4.55 |
| NVM12F | 02 Oct 2024 | 1.29 | 17.0 | 7.0 | 316 | 7.10 |
| NVM17 | 02 Oct 2024 | 9.67 | 16.8 | 7.0 | 318 | 5.58 |
| NVM19 | 01 Oct 2024 | 9.47 | 22.1 | 10.0 | 445 | 4.06 |
| NVM20F | 07 Nov 2024 | 12.88 | 18.6 | 18.0 | 217 | 4.58 |
| NVM21Z | 07 Nov 2024 | 12.67 | 18.8 | 15.5 | 6,314 | 4.81 |
| NVM22S | 07 Nov 2024 | 12.37 | NM | NM | NM | NM |
| NVM27S | 02 Oct 2024 | 4.34 | 15.1 | 4.0 | 179 | 4.19 |
| NVM28F | 01 Oct 2024 | 14.66 | 16.0 | 6.0 | 153 | 6.07 |
| R25B | 01 Oct 2024 | 9.55 | 16.4 | 5.0 | 245 | 6.00 |
| R26A | 01 Oct 2024 | 10.14 | 17.2 | 7.0 | 137 | 4.40 |
| R73A | 08 Nov 2024 | 6.02 | 21.4 | 12.6 | 1,652 | 6.08 |
| R73B | 08 Nov 2024 | 6.09 | 19.9 | 6.6 | 1,460 | 6.09 |
| SVM24 | 05 Nov 2024 | 10.09 | 17.2 | 6.2 | 468 | 6.97 |
| SVM30 | 05 Nov 2024 | 13.57 | 17.1 | 7.0 | 402 | 8.04 |
| SVM32 | 05 Nov 2024 | NM | NM | NM | NM | NM |
| SVM33 | 05 Nov 2024 | 12.37 | 17.3 | 21.9 | 216 | 6.43 |
| SVM36 | 30 Sep 2024 | 4.53 | 20.6 | 6.0 | 453 | 7.29 |
| SVM38 | 01 Oct 2024 | 3.09 | 21.8 | 11.0 | 599 | 6.94 |
| SVM48 | 01 Oct 2024 | 4.15 | 23.0 | 11.0 | 290 | 5.66 |
| SVM53 | 30 Sep 2024 | 2.96 | 21.9 | 23.0 | 256 | 6.31 |
| SVM54 | 01 Oct 2024 | 3.69 | 21.9 | 20.0 | 892 | 6.12 |
| SVM55 | 30 Sep 2024 | 3.25 | 23.4 | 22.0 | 461 | 6.31 |
| SVM60 | 30 Sep 2024 | 5.08 | 23.4 | 2.0 | 485 | 7.34 |
| SVM62 | 02 Oct 2024 | 5.45 | 17.9 | 26.0 | 670 | 6.97 |

NA: Not applicable, NM: Not measured

Table 27: Monitoring Results: Field Data: May and June 2025

| Bore ID | Date | Water Level (m) | Temperature (C°) | Dissolved Oxygen (%) | Electrical Conductivity (uS/cm) | pH |
|---|---|---|---|---|---|---|
| EXP2 | 23 May 2025 | 4.85 | 17.9 | 2.0 | 217 | 4.97 |
| EXP5 | 23 May 2025 | 9.58 | 17.4 | 1.0 | 756 | 4.70 |
| GW20 | 22 May 2025 | NA | 17.5 | 1.0 | 1,647 | 6.54 |
| GWSVUF6 | 20 May 2025 | NA | 18.0 | 51.0 | 1,249 | 6.40 |
| M104A | 21 May 2025 | 9.27 | 20.0 | 1.0 | 624 | 4.13 |
| M105A | 21 May 2025 | 10.93 | 20.1 | 1.0 | 410 | 5.07 |
| M107Z | 19 May 2025 | 10.05 | 17.3 | 9.0 | 144 | 4.09 |
| M108F | 19 May 2025 | 9.97 | 17.4 | 2.0 | 167 | 5.67 |
| M109F | 23 May 2025 | 7.18 | 19.7 | 1.3 | 328 | 4.84 |
| M110Z | 23 May 2025 | 7.11 | 18.8 | 1.0 | 307 | 4.89 |
| M111S | 23 May 2025 | 6.25 | 19.8 | 2.0 | 1,465 | 6.63 |
| M112F | 23 May 2025 | 10.25 | 17.9 | 7.0 | 451 | 5.93 |
| M113Z | 23 May 2025 | 9.81 | 17.2 | 1.0 | 450 | 4.98 |
| M114SR | 17 Jun 2025 | 8.53 | 18.6 | 2.6 | 1,740 | 6.83 |
| M116Z | 19 May 2025 | 14.46 | 17.5 | 7.0 | 430 | 4.89 |
| M117SR | 17 Jun 2025 | NM | NM | NM | NM | NM |
| NVM02Z | 21 May 2025 | 6.37 | 20.3 | 1.0 | 591 | 5.41 |
| NVM03F | 23 May 2025 | 7.81 | 19.1 | 2.0 | 585 | 6.63 |
| NVM04Z | 23 May 2025 | 5.77 | 18.5 | 2.0 | 559 | 5.40 |
| NVM10Z | 22 May 2025 | 3.92 | 18.3 | 6.0 | 346 | 5.23 |
| NVM11S | 22 May 2025 | 3.97 | 17.8 | 5.0 | 707 | 4.47 |
| NVM12F | 21 May 2025 | 6.68 | 20.4 | 2.0 | 757 | 6.38 |
| NVM12F | 22 May 2025 | 3.20 | 18.2 | 3.0 | 485 | 6.64 |
| NVM17 | 21 May 2025 | 11.15 | 16.8 | 3.0 | 347 | 4.63 |
| NVM19 | 21 May 2025 | 11.01 | 17.5 | 4.0 | 434 | 3.85 |
| NVM20F | 21 May 2025 | 13.24 | 18.6 | 1.0 | 330 | 5.12 |
| NVM21Z | 21 May 2025 | 13.02 | 20.2 | 1.0 | 7,675 | 5.09 |
| NVM27S | 22 May 2025 | 15.69 | 20.8 | 12.0 | 216 | 4.57 |
| NVM28F | 20 May 2025 | 15.61 | 17.0 | 1.0 | 152 | 5.77 |
| R25B | 21 May 2025 | 11.65 | 17.3 | 3.0 | 275 | 6.10 |
| R26A | 21 May 2025 | 12.93 | 17.1 | 2.0 | 138 | 4.51 |
| R73A | 23 May 2025 | 8.25 | 16.7 | 2.0 | 1,680 | 6.14 |
| R73B | 23 May 2025 | 8.05 | 17.7 | 2.0 | 1,654 | 6.14 |
| RCL2S | 17 Jun 2025 | 4.03 | 18.9 | 2.9 | 2,795 | 6.42 |
| SVM24 | 19 May 2025 | 12.87 | 16.9 | 2.0 | 557 | 6.36 |
| SVM30 | 19 May 2025 | 14.87 | 17.3 | 4.0 | 481 | 8.97 |
| SVM32 | 19 May 2025 | NM | NM | NM | NM | NM |
| SVM33 | 19 May 2025 | 13.26 | 16.8 | 3.0 | 248 | 6.01 |
| SVM36 | 20 May 2025 | 5.67 | 19.4 | 2.0 | 434 | 6.93 |
| SVM38 | 20 May 2025 | 4.14 | 19.9 | 2.0 | 538 | 6.93 |
| SVM48 | 20 May 2025 | 6.16 | 20.3 | 2.0 | 253 | 5.40 |
| SVM53 | 20 May 2025 | 4.40 | NM | NM | NM | NM |
| SVM54 | 20 May 2025 | 5.00 | 20.2 | 5.0 | 850 | 6.02 |
| SVM55 | 20 May 2025 | 4.86 | 20.9 | 2.0 | 655 | 6.02 |
| SVM60 | 20 May 2025 | 6.67 | 20.1 | 2.0 | 528 | 6.86 |
| SVM62 | 20 May 2025 | 5.84 | 20.9 | 2.0 | 678 | 6.49 |

NA: Not applicable, NM: Not measured

### 7.2.2 Laboratory Analysis

The laboratory results were used to assess the potential impacts on groundwater, which could potentially be caused by the seepage from the wastewater facilities or other release mechanisms into the groundwater. The focus is potential caustic liquor releases, which is characterised by high pH, high alkalinity concentrations and elevated Na/Cl ratios.

The laboratory results were used to compare water quality results to the Australian and New Zealand Guidelines for Fresh and Marine Water Quality by the Australian and New Zealand Environment and Conservation Council (ANZECC, 2000) for freshwater ecosystems. A 90% level of protection has been adopted for groundwater sampling points.

The laboratory results are presented in Appendix B.

Results were also compared with the trigger and action values as described in Section 4.2 and the results are summarised in Table 28. The increasing trend of EC values is used as the key indicator of potential contamination, but all three verification steps (increasing EC values, increasing Na/Cl ratios and increasing alkalinity/TDS ratios) is required to positively identify process liquor contamination.

*Background monitoring bores*

Background groundwater quality is fresh with TDS concentrations varying between 94 and 213 mg/L and neutral with pH ranging between 7.0 and 7.2. R26A is the exception with a naturally low pH of between 4.4 and 5.2. Alkalinity concentrations are low, generally less than 70 mg/L, except R26 with alkalinities less than 5 mg/L. Na/Cl ratios vary between 0.6 and 0.8.

R26A has natural copper and aluminium concentration exceedances when compared to the ANZECC guidelines with a copper concentration of up to 0.006 mg/L compared to an ANZECC guideline value of 0.0018 mg/L aluminium concentrations of up to 0.94 mg/L compared to an ANZECC guideline value of 0.08 mg/L. These exceedances are interpreted to be natural caused by the acidic conditions at the monitoring bore which mobilises copper and aluminium.

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Table 28: Water Quality Trend Analysis

| Bore ID | Trigger/ Action EC (µS/cm) | Sample Date | EC (µS/cm) | Total alkalinity (mg/L) | TDS (mg/L) | Alkalinity/ TDS | Sodium (mg/L) | Chloride (mg/L) | Sodium/ Chloride | Comment |
|---|---|---|---|---|---|---|---|---|---|---|
| **South Pipe Head Dam** | | | | | | | | | | |
| SVM36 | T: 640 | 30 Sep 2024 | 547 | 170 | 329 | 0.52 | 62 | 78 | 0.79 | Fluctuating Na/Cl ratio trend |
| | A: 770 | 20 May 2025 | 558 | 171 | 314 | 0.54 | 58 | 67 | 0.87 | |
| SVM54 | T: 950 | 01 Oct 2024 | 808 | 74 | 557 | 0.13 | 53 | 132 | 0.40 | Increasing EC & TDS trend, stabilising |
| | A: 1,140 | 20 May 2025 | 793 | 80 | 521 | 0.15 | 44 | 94 | 0.47 | |
| SVM55 | T: 860 | 30 Sep 2024 | 385 | 74 | 241 | 0.31 | 32 | 25 | 1.28 | Fluctuating Na/Cl, increasing EC trend, decreasing alkalinity/TDS |
| | A: 1,030 | 20 May 2025 | 613 | 71 | 400 | 0.18 | 32 | 51 | 0.62 | |
| SVM60 | T: 570 | 30 Sep 2024 | 555 | 161 | 341 | 0.29 | 62 | 62 | 1.00 | Fluctuating Na/Cl, increasing EC trend, decreasing alkalinity/TDS |
| | A: 690 | 20 May 2025 | 633 | 171 | 351 | 0.49 | 52 | 61 | 0.85 | |
| **North Pipe Head Dam** | | | | | | | | | | |
| NVM10z | T: 500 | 02 Oct 2024 | 419 | 30 | 258 | 0.08 | 63 | 131 | 0.48 | No significant trend |
| | A: 600 | 22 May 2025 | 426 | 31 | 257 | 0.09 | 56 | 103 | 0.54 | |
| NVM11s | T: 790 | 02 Oct 2024 | 1,000 | <1 | 444 | 0.00 | 140 | 311 | 0.45 | Fluctuating and increasing EC & TDS trend |
| | A: 950 | 22 May 2025 | 947 | <1 | 444 | 0.00 | 130 | 282 | 0.46 | |
| NVM12f | T: 570 | 02 Oct 2024 | 538 | 152 | 313 | 0.48 | 59 | 96 | 0.61 | Fluctuating and increasing EC & Na/Cl trend |
| | A: 690 | 23 May 2025 | 581 | 190 | 335 | 0.56 | 54 | 70 | 0.77 | |
| **RCL and Refinery** | | | | | | | | | | |
| EXP02 | T: ND | 05 Nov 2024 | 255 | 12 | 147 | 0.10 | 38 | 70 | 0.54 | No significant trend |
| | A: ND | 23 May 2025 | 256 | 13 | 150 | 0.09 | 36 | 65 | 0.55 | |
| EXP05 | T: ND | 07 Nov 2024 | 939 | 9 | 500 | 0.02 | 143 | 286 | 0.50 | No significant trend |
| | A: ND | 23 May 2025 | 960 | 8 | 497 | 0.02 | 138 | 312 | 0.44 | |
| M109f | T: ND | 05 Nov 2024 | 343 | 19 | 180 | 0.11 | 50 | 86 | 0.58 | Slight increasing EC, TDS and Na/Cl trend |
| | A: ND | 23 May 2025 | 380 | 21 | 191 | 0.11 | 63 | 79 | 0.80 | |
| M110z | T: ND | 05 Nov 2024 | 499 | 43 | 279 | 0.15 | 90 | 85 | 1.06 | Decreasing EC, TDS and Na/Cl ratio trend |
| | A: ND | 23 May 2025 | 359 | 24 | 172 | 0.14 | 51 | 87 | 0.59 | |
| M111s | T: ND | 05 Nov 2024 | 671 | 170 | 372 | 0.46 | 117 | 61 | 1.92 | Persistent high Na/Cl ratios, fluctuating, seasonal trends |
| | A: ND | 23 May 2025 | 1,690 | 508 | 934 | 0.54 | 369 | 55 | 6.71 | |
| M112f | T: 610 | 02 Oct 2024 | 543 | 111 | 309 | 0.36 | 49 | 77 | 0.64 | Variable alkalinity and Cl concentrations |
| | A: 730 | 23 May 2025 | 553 | 91 | 314 | 0.29 | 49 | 106 | 0.46 | |
| M113z | T: 470 | 02 Oct 2024 | 478 | 25 | 278 | 0.08 | 71 | 116 | 0.61 | Increasing Na/Cl trend |
| | A: 560 | 23 May 2025 | 565 | 34 | 291 | 0.09 | 88 | 125 | 0.70 | |
| M114sR | T: ND<br>A: ND | 17 Jun 2025 | 2,050 | 794 | 1,350 | 0.59 | 478 | 28 | 17.07 | Very high Na/Cl |
| M116z | T: 560 | 05 Nov 2024 | 502 | 13 | 284 | 0.05 | 63 | 144 | 0.44 | No significant trend |
| | A: 670 | 19 May 2025 | 513 | 14 | 287 | 0.05 | 60 | 145 | 0.41 | |
| NVM01f | T: 860 | 07 Nov 2024 | 892 | 184 | 524 | 0.35 | 90 | 172 | 0.52 | EC exceeding trigger value |
| | A: 940 | 21 May 2025 | 906 | 182 | 535 | 0.34 | 86 | 189 | 0.46 | |
| NVM02z | T: 720 | 07 Nov 2024 | 716 | 37 | 406 | 0.09 | 93 | 173 | 0.54 | EC exceeding trigger value |
| | A: 790 | 21 May 2025 | 726 | 47 | 396 | 0.12 | 91 | 194 | 0.47 | |
| NVM03f | T: ND | 07 Nov 2024 | 671 | 181 | 401 | 0.45 | 66 | 102 | 0.65 | Slight increasing Na/Cl trend |
| | A: ND | 23 May 2025 | 690 | 179 | 388 | 0.46 | 65 | 106 | 0.61 | |
| NVM04z | T: ND | 07 Nov 2024 | 668 | 34 | 394 | 0.09 | 91 | 181 | 0.50 | No significant trend |
| | A: ND | 23 May 2025 | 688 | 40 | 395 | 0.10 | 86 | 189 | 0.46 | |
| R73A | T: ND | 08 Nov 2024 | 2,090 | 263 | 1,390 | 0.19 | 432 | 98 | 4.41 | Persistent high Na/Cl ratios, decreasing trend |
| | A: ND | 23 May 2025 | 2,090 | 252 | 1,270 | 0.20 | 407 | 103 | 3.95 | |
| R73B | T: ND | 08 Nov 2024 | 1,930 | 238 | 1,260 | 0.19 | 380 | 85 | 4.47 | Persistent high Na/Cl ratios |
| | A: ND | 23 May 2025 | 2,030 | 235 | 1,250 | 0.19 | 390 | 83 | 4.70 | |
| **SEPs** | | | | | | | | | | |
| NVM22s | T: ND<br>A: ND | Inaccessible | | | | | | | | Historical persistent high EC and TDS |
| NVM21z | T: ND | 07 Nov 2024 | 9,060 | 37 | 8,150 | <0.01 | 756 | 1,190 | 0.64 | Persistent high EC and TDS |
| | A: ND | 21 May 2025 | 9,110 | 40 | 8,430 | <0.01 | 771 | 1,280 | 0.60 | |
| NVM20f | T: ND | 07 Nov 2024 | 293 | 8 | 236 | 0.03 | 44 | 82 | 0.54 | No significant trend. |
| | A: ND | 21 May 2025 | 419 | 21 | 237 | 0.12 | 49 | 90 | 0.54 | |
| M104A | T: ND | 02 Oct 2024 | 1,480 | < 1 | 768 | < 0.01 | 189 | 494 | 0.38 | Fluctuating EC and TDS |
| | A: ND | 21 May 2025 | 819 | < 1 | 438 | < 0.01 | 92 | 246 | 0.37 | |
| NVM17 | T: ND | 02 Oct 2024 | 877 | 2 | 458 | < 0.01 | 127 | 270 | 0.47 | Fluctuating EC and TDS |
| | A: ND | 21 May 2025 | 422 | < 1 | 224 | < 0.01 | 63 | 142 | 0.44 | |
| NVM19 | T: ND | 01 Oct 2024 | 549 | < 1 | 269 | < 0.01 | 71 | 82 | 0.39 | No significant trend |
| | A: ND | 21 May 2025 | 571 | < 1 | 264 | < 0.01 | 69 | 90 | 0.43 | |

*South Pipe Head Dam*

A single EC trigger exceedance was recorded at the SPHD monitoring bore SVM60. Groundwater quality trends identified during the FY24 review have continued into the FY25 reporting period. At bores SVM55 and SVM60, these trends include a fluctuating Na/Cl ratio and increasing EC and TDS concentrations. Na/Cl ratios of 1.28 and 1.00 were recorded at SVM55 and SVM60, respectively, in September 2024, decreasing to 0.62 and 0.85 by May 2025.

Despite these trends, groundwater quality at the SPHD remains broadly comparable to background groundwater. Reported TDS concentrations ranged between 175 mg/L and 557 mg/L, while pH values ranged from 5.4 to 7.3. Although lower pH values were reported in some monitoring bores during the FY24 review period, none were observed in FY25. It is noted, however, that monitoring during FY24 was more extensive. Several minor copper and zinc exceedances were recorded against ANZECC guideline values, and constituents remain consistent with background water quality.

The elevated Na/Cl ratios may indicate minor mixing with bauxite liquor (Section 8). However, the generally neutral pH and low TDS concentrations suggest that any liquor entering the groundwater was likely minimal. As outlined later in this report, several controls are in place at the SPHD to prevent downgradient groundwater contamination. One such control is the maintenance of high FWL water levels, which ensures a hydraulic gradient towards the SPHD. This control may have been less effective during the FY25 period due to the low water levels recorded at the FWL.

It is also noted that there has been a reversal in groundwater quality trends between the September-October and May/June monitoring rounds with Na/Cl decreasing from 1.28 to 0.62 at SVM55 and decreasing from 1.00 to 0.85 at SVM60. This may be indicative of a higher degree of intervention success at SPHD, reversing deleterious groundwater trends, though these improvements have not yet been observed with respect to EC trends.

*BRDA5 southern corner*

The southern corner of BRDA5 straddles a topographic high with a very small portion situated in the Hamilton surface water catchment. About 17.5 ha of the BRDA5 is situated within the Hamilton catchment, which is about 3.8% of the total BRDA5 footprint area.

The groundwater quality measured at the monitoring bores are similar to background water quality with TDS concentrations ranging from 197 to 422 mg/L while pH ranged from 7.0 to 8.1. There were no exceedances recorded against ANZECC guideline values.

It is noted that lower pH and some copper, aluminium and zinc exceedances were recorded in some monitoring bores for the FY24 period, which was more extensive compared to the FY25 monitoring period.

Despite the general good water quality at the monitoring bores, elevated Na/Cl ratios were detected at SVM30 and SVM33, varying between 1.1 and 1.3. The elevated Na/Cl ratios might be indicative of some mixing with bauxite liquor (Section 8), though the generally neutral pH and low TDS concentrations indicate that the amounts of liquor (if any) entering the groundwater were likely to be very minor.

*North Pipe Head Dam*

For the north PHD monitoring bores, EC trigger level exceedances were recorded at NVM11s and NVM12f. However, Na/Cl ratios for all monitoring bores were below 0.8, suggesting that the groundwater at NPHD might not be affected by bauxite liquor release.

Groundwater quality at the NPHD remains broadly comparable to background groundwater, except for lower pH values reported at NVM11s with pH of 3.5 and 3.8 recorded at the monitoring bore. This lower pH groundwater is interpreted to be natural and was also encountered at background monitoring bores (R26A). The natural low pH groundwater conditions are described in more detail in Section 8.

Reported TDS concentrations ranged between 120 mg/L and 444 mg/L, and apart from the low pH groundwater at NVM11s, while pH values ranged from 4.8 to 7.3. Minor aluminium, copper and zinc exceedances were recorded against ANZECC guideline values at NVM11s, which are interpreted to be caused by the natural low pH conditions that mobilise these metals in the groundwater.

Despite the EC trigger level exceedances at NVM11s and NVM12f, there is no conclusive evidence of bauxite liquor release from the NPHD. The increasing EC trends are likely natural caused by the lower groundwater conditions in the region, which were caused by the lower FWL water levels during the reporting period. This lower groundwater levels resulted in intense localized paleo-leaching in these areas which removed alkalinity from the soil profile, described in more detail in Section 8.

*RCL and refinery*

Sixteen groundwater monitoring bores were sampled during the FY25 reporting period, with the monitoring bores expanded to better delineate affected groundwater at the site. Three new monitoring bores were installed during the FY25 period namely M114sR, M117sR and RCL2s, but M117sR could not be sampled because it was dry.

Several groundwater monitoring bores show evidence of bauxite liquor influence, as indicated by comparatively elevated EC values exceeding 1,000 µS/cm and Na/Cl ratios above 1.00 in many bores. However, the extent of bauxite liquor release appears limited, as all monitoring bores recorded acidic to neutral pH values. If groundwater were substantially affected by bauxite liquor, pH values around 10 would be expected.

The affected groundwater monitoring bores are M111s, M114sR, R73A, R73B and RCL2s. EC values for these bores ranged from 671 µS/cm to 2,795 µS/cm and Na/Cl ratios varies between 1.92 to 17.07.

The remaining 11 monitoring bores appears not be significantly affected by the bauxite liquor influence, but some monitoring bores do show increasing trends in EC values. EC trigger values were exceeded at three monitoring bores namely M113z, NVM01f and NVM02z.

The TDS concentrations for the unaffected bores ranged between 74 mg/L and 314 mg/L and even the affected bores had a good water quality with TDS concentrations ranging between 372 mg/L and 2,000 mg/L. pH values ranged between 4.0 and 7.2 which clearly showed that bauxite liquor influence is limited.

Several minor aluminium, copper and zinc exceedances were recorded against ANZECC guideline values with single exceedances of lead and nickel also observed. It is noted that the copper and aluminium exceedances occur mainly at monitoring bores with natural lower pH values as opposed to bores with minor bauxite liquor influences.

*SEPs*

Six groundwater monitoring bores at the SEPs were sampled during FY25 period. One monitoring bore, NVM22s, was not accessible for water quality sampling as a groundwater sonde was stuck in the bore. The water quality sonde has since been removed allowing for continued monitoring to be presented in the FY26hydrological review.

One groundwater monitoring bore, NVM21z was affected by historical waste water releases from the SEPs with TDS concentrations of between 8,150 and 8,430 mg/L. It is noted that NVM22s also had historical poor water quality with elevated TDS, low pH and several metal exceedances. Groundwater at NVM21z deteriorated since the FY24 monitoring period, which implies a continued downstream movement of affected groundwater from the shallow aquifer to the saprock (Zersatz) zone.

The affected groundwater monitoring bores have been identified during the FY22 and FY23 hydrological reviews and a current work program is in place to address these issues, described in Section 9. Groundwater quality in this localised zone is characterised by elevated TDS concentrations (compared to background groundwater quality) ranging between 2,080 and 13,500 mg/L.

The nearby monitoring bore. M104A seems to have been affected to a limited extent as is evident by the higher EC values and higher TDS concentrations. Other monitoring bores seems to have been less affected, if at all, by the historical release as is evident by the TDS concentrations ranging from 236 mg/L to 458 mg/L. pH values for the unaffected bores ranged between 3.8 and 6.0. It is not clear whether pH at the unaffected bores were affected by the waste water release or whether it is due to natural groundwater conditions.

Several minor aluminium, copper and zinc exceedances were recorded against ANZECC guideline values. At NVM21z, substantial manganese concentrations (35 to 37 mg/L) and exceedances of nickel were also recorded.

# 8.0 ASSESSMENT OF IMPACTS

## 8.1 Augustus River turbidity

Turbidity levels within the FWL remained elevated throughout the FY25 period, complicating FWL releases as per license requirements and necessitating treatment before discharge into the Augustus River. However, the FWL turbidity concentrations decreased through the FY25 reporting period suggesting that management plans, aimed at limiting sediment release to the FWL, is taking effect.

There was one spike of elevated NTU measured at the ARGS during October 2024, which was likely caused by fouling. The sensor was subsequently removed, cleaned and recalibrated in late October 2024 and turbidity levels were lower in subsequent measurements.

The turbidity levels during the release period shows some variability, ranging between <5 and 40 NTU with occasional spikes of higher turbidity, but average turbidity levels remained below 20 NTU.

Our interpretation is that turbidity levels in the Augustus River remain generally low, with no significant environmental impacts observed. However, we recommend that treatment continue throughout the FY26 monitoring period of turbidity levels in the FWL remains elevated.

## 8.2 Augustus River water quality

The water quality of the Augustus River remained within the expected historical range, with no significant environmental impacts observed. The increase in EC values, sodium, and chloride concentrations observed during the FY24 reporting period has since decreased and then stabilised during the FY25 reporting period. Since these water quality parameters fall within the expected historical range, no additional work is recommended beyond ongoing monitoring to track these trends.

## 8.3 Groundwater quality results: Background and natural processes

The background groundwater quality is fresh, with TDS concentrations below 500 mg/L, and slightly acidic, with a pH range between 4.5 and 6.5. Alkalinity concentrations are low, generally less than 50 mg/L, and the Na/Cl ratios vary between 0.4 and 0.6.

This background groundwater quality is consistent with the expected range for laterite units, which are widespread in the region. These laterite units formed under tropical conditions with high rainfall and good drainage, leading to intense weathering and leaching of soils. This leaching removed most alkalinity constituents from the groundwater, while the acidity increased due to dissolved CO2 in rainwater, forming carbonic acid. This process explains the slightly acidic pH range of 4.5 to 6.5.

Elevated copper, and zinc concentrations, are interpreted as naturally occurring in the region, associated with the high copper and zinc content in the underlying hydrostratigraphic units, which dissolve in the slightly acidic groundwater.

Low-pH groundwater

As described in the FY24 review, new information provided insights into the causes of low-pH groundwater in the area.

Our current interpretation is that zones of low-pH groundwater were caused by natural processes due to intense localized paleo-leaching in these areas. This intense leaching almost completely removed all alkalinity, eliminating the buffering capacity from these units. The pH likely decreased because iron and aluminium hydrolysed, releasing further acidity into the groundwater. This low-pH groundwater then dissolved iron and aluminium, resulting in elevated metal concentrations.

The localised elevated aluminium concentrations associated with this low pH water are also considered to be caused by natural processes, with low pH dissolving naturally occurring aluminium in the underlying stratigraphic units, with the exception of local groundwater areas downgradient of the SEPs, which are described in more detail below.

## 8.4 Groundwater bauxite liquor impacts at the RCL

No bauxite liquor (characterized by a pH >12) was detected at any of the monitoring locations.

However, groundwater monitoring confirmed one localised affected zone at the RCL, first identified during the FY22 and FY23 hydrological reviews. Five monitoring bores (M111s, R73A, and R73B, M114sR, RCL2s.) show elevated TDS concentrations and high Na/Cl ratios, although the groundwater pH remains slightly acidic to neutral. Note that two of these bores (M114sR, RCL2s) were installed in the FY25 period to delineate the extent of the affected groundwater zone.

Our interpretation is that a very limited amount of RCL wastewater entered the groundwater at this localised zone. The wastewater, with its high pH, was neutralised by the naturally slightly acidic groundwater. The resultant mixture contained elevated sodium and sulphate, which increased the TDS concentration and EC values of the groundwater, while the pH remained buffered at slightly acidic levels. There are no elevated metal concentrations when compared to ANZECC guidelines, and it is possible that the groundwater mixture may have lowered the naturally elevated copper and zinc concentrations in the groundwater.

This zone was assessed in FY23 (GRM, 2023b), with findings indicating a low risk of impacts to the downgradient environment in the foreseeable future due to the numerous engineered barriers and the slow movement of groundwater. The work program addressing this zone is detailed in Section 9.2.

The FY25 monitoring review indicates no significant deterioration in groundwater quality for the affected zone, and there are no signs that the affected zone has expanded to other monitoring bores in the area. Therefore, the assessed risk to the downgradient environment remains low.

## 8.5 Groundwater bauxite liquor impacts at the SPHD, NPHD and southern corner of the BRDA5

The groundwater downgradient of the NPHD, SPHD, and the southern corner of BRDA5 shows water quality similar to the background groundwater quality. However, there are several early warning signs of potential, albeit very limited, bauxite liquor releases in these areas. Some monitoring bores show elevated Na/Cl concentrations, and one monitoring bore at NPHD shows elevated EC readings. Unlike the RCL zone, there are no elevated TDS concentrations at the SPHD and the southern corner of BRDA5. There is some monitoring bores at NPHD with elevated TDS concentrations but no corresponding elevated Na/Cl trend. Therefore, potential bauxite liquor impacts in these zones remain inconclusive despite the early warning signs.

As was the case for the FY24 period, FWL water levels were lower than normal and lower than the water levels at SPHD and NPHD. Additionally, several groundwater depression bores were out of order during the FY24 period. It is therefore likely that, during the FY24 period, a positive groundwater gradient developed between the PHDs and the FWL, which could have caused very limited groundwater movement toward the FWL. However, the downgradient grout curtain would have restricted this movement.

There are early signs that with the additional management systems in place at the SPHD has reversed the impacts of the groundwater movement, as is evident by the decreasing Na/Cl ratio trend between the two monitoring rounds during FY25. However, further monitoring is required to confirm this trend.

The impact on the downgradient environment is assessed to be very low, as the groundwater quality downgradient of the PHDs remains good, and the FWL serves as an additional barrier to groundwater movement.

The ongoing work program to lower the water levels within the PHDs to prevent future positive downgradient hydraulic gradients (Section 9.2). This will further mitigate potential downgradient impacts.

## 8.6 Groundwater impacts at the SEPs

Groundwater monitoring results confirmed one localised affected zone at the SEPs, first identified during the FY22 and FY23 hydrological reviews. One monitoring bores (NVM21z) show elevated TDS concentrations, low pH, and several metal exceedances compared to ANZECC guidelines. Another inaccessible monitoring bore, NVM22s, also had historical elevated TDS concentrations, low pH, and several metal exceedances. One other monitoring bore, M104A shows evidence of limited impacts as is evident by the higher TDS concentrations.

The water quality results for other monitoring bores remain inconclusive as these bores exhibit low pH but not elevated TDS concentrations. It is worth noting that naturally low pH groundwater occurs in the region.

Our interpretation remains that limited SEP wastewater entered the groundwater at a localised zone. The wastewater, presumably containing historical non-neutralised acids, had a low pH and elevated metal concentrations, particularly aluminium and iron. This release is confined to a small, localized area at NVM22s and is largely restricted to the shallow aquifer. However, the increasing EC trend at NVM21z suggests that the affected groundwater is migrating to deeper zones.

This zone was assessed in FY23 (GRM, 2023b), with findings indicating a low risk of impacts to the downgradient environment in the foreseeable future due to the numerous engineered barriers and the slow movement of groundwater. However, the observed downward migration of affected groundwater, evidenced by increasing TDS concentrations at NVM21z, suggests an elevated risk that contaminants could eventually enter the deeper fractured bedrock aquifer, where they may eventually bypass engineered barriers over time. Although the short-term risk of off-lease groundwater contamination remains low given the slow movement of groundwater, remediation of the affected zone should be assigned a higher priority.

# 9.0 CONCLUSIONS AND RECOMMENDATIONS

## 9.1 Conclusions

The WAPL operations complied with all the water license conditions for the FY25 period.

Environmental releases to the Augustus River were successfully carried out via the turbidity treatment plant at the base of the FWL dam wall. Both field turbidity measurements and sensor data during the release period indicate that turbidity levels were mostly within ANZECC discharge guideline values. WAPL is continuing with several work programs to more effectively control sediment release into the FWL, and turbidity levels in the FWL has decreased during the FY25 period. However, the turbidity treatment may still be required for the FY26 release period of turbidity levels in the FWL remains high.

Two natural groundwater background types occur at the site, as identified during the FY24 hydrology review and confirmed during this monitoring period:

- Slightly acidic groundwater associated with leached soils of the laterite zone, extending to the saprock and fractured bedrock zones.
- Naturally low pH groundwater associated with extensive paleo-leaching zones, where pH was further lowered due to iron and aluminium hydrolysis.

Naturally elevated copper and zinc concentrations, compared to ANZECC guidelines, are widespread in the region, while naturally elevated aluminium concentrations are associated with low pH groundwater.

No bauxite liquor (characterised by a pH >12) was detected in any of the monitoring locations.

However, the groundwater monitoring results confirmed two localised affected groundwater zones at the RCL and SEPs, first identified during the FY22 and FY23 hydrological reviews. At the RCL, five monitoring bores (M111s, R73A, R73B, M114sR and RCL2s) show elevated TDS concentrations and high Na/Cl ratios, indicative of potential bauxite liquor impacts, though groundwater pH remains slightly acidic to neutral. At the SEPs, one monitoring bores (NVM21z) show elevated TDS concentrations, low pH, and several metal exceedances compared to ANZECC guidelines, likely related to historical spent acid releases from the SEPs. Another inaccessible monitoring bore, NVM22s, also showed historical elevated TDS concentrations, low pH, and several metal exceedances.

These zones were assessed in FY23 (GRM, 2023b), with findings indicating a low risk of impacts to the downgradient environment in the foreseeable future due to the numerous engineered barriers and the slow movement of groundwater. The work program addressing these two zones is detailed in Section 9.2.

Additionally, several early warning signs of potential, albeit very limited, bauxite liquor releases were observed at the SPHD and the southern corner of BRDA5. At the SPHD, several monitoring bores show elevated Na/Cl ratios, while two monitoring bores at the southern corner of BRDA5 also show elevated Na/Cl ratios. Although no monitoring bores at NPHD show elevated Na/Cl ratios, telemetry EC readings at NVM11s are higher than background levels.

The monitoring data does not indicate that groundwater at SPHD, NPHD, and BRDA5 is affected, as TDS concentrations and pH readings are within the expected background range. However, these early warning signs allow for early intervention and increased groundwater monitoring efforts, detailed further in Sections 9.2 and 9.3.

## 9.2 FY25 recommendations

The following recommendations are made with respect to the monitoring programme:

- Installation of new water quality sondes in the newly constructed monitoring bores, M114sR. M117sR and RCl2s. once the water quality sondes are delivered.
- All groundwater water quality sondes are reaching the end of their life and should be systematically replaced over the forthcoming years.
- A monitoring system should be implemented to measure both FWL and PHD water levels, ensuring that PHD levels remain lower than FWL levels in accordance with the WMP.

No further recommendations are provided with respect to the monitoring programme, and the focus moves instead to the updated groundwater assessment, numerical modelling and conceptual treatment options at the RCL and SEPs.

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## Signatures

Groundwater Resource Management Pty Ltd

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# REFERENCES


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# APPENDIX A

## LICENSE TO TAKE WATER

# APPENDIX B

## LABORATORY RESULTS