Liverpool Plains Shire Council

Drinking Water Management System

Annual Report 2021-2024

Liverpool Plains Shire Council

Date: January 2025

Version: 2.0

Document control

Version	Date	Status	Person
0.1	27/08/2024	For review (internal)	Authors: N. Lewis and P.de Souza (Atom Consulting) Reviewed by: P. Schnelle (Atom Consulting)
1.0	17/09/2024	For issue	Draft issued to Liverpool Plains Shire Council for additional data and comment
2.0	29/01/2025	For issue	Updated following feedback from Liverpool Plains Shire Council

Executive summary

This annual report documents Liverpool Plains Shire Council's (LPSC's) Drinking Water Management System (DWMS) implementation and drinking water performance from 1 July 2021 to 30 June 2024. The drinking water performance for the period is summarised below.

Critical control points

The CCP excursions in each system from July 2021 to June 2024 are in Table 1-1.

Table 1-1. CCP excursions per system

System	Date	CCP	Value	Details and corrective action
Quipolly	1 March 2024	CCP6-1 UVT	70	Issue with UVT sensor identified during process commissioning. Interim approach consulted with NSW Health: assume UVT of 70% as a conservative value for process control and undertake daily grab samples to confirm actual UVT higher than 70%
	2 March 2024	CCP6-1 UVT	70	
	3 March 2024	CCP6-1 UVT	70	
	4 March 2024	CCP6-1 UVT	70	
	5 March 2024	CCP6-1 UVT	70	
	6 March 2024	CCP6-1 UVT	70	
	7 March 2024	CCP6-1 UVT	70.39	
	8 March 2024	CCP6-1 UVT	79.07	
	9 March 2024	CCP6-1 UVT	77.46	
	10 March 2024	CCP6-1 UVT	70	
	11 March 2024	CCP6-1 UVT	70	
	12 March 2024	CCP6-1 UVT	70	
	13 March 2024	CCP6-1 UVT	70	
	14 March 2024	CCP6-1 UVT	70	
	15 March 2024	CCP6-1 UVT	70	
	16 March 2024	CCP6-1 UVT	70	
	17 March 2024	CCP6-1 UVT	70	
	18 March 2024	CCP6-1 UVT	70	
Werris Creek (filter 1)	2 September 2022	Turbidity	1.13 NTU	Blockage in Alum dosing system. Notified to NSW Health, dosing system repaired, clarifier operation restored, filters backwashed and filter to waste until within CCP's.
Werris Creek (filter 2)	2 September 2022	Turbidity	1.39 NTU	
Werris Creek (filter 3)	2 September 2022	Turbidity	1.1 NTU	

Water quality

Operational monitoring includes SCADA (online monitoring) and manual testing (grab sampling).

Verification data and operational data are regularly reviewed by LPSC. LPSC implements regular water quality meetings, including capturing of formal minutes from these meetings over the reporting period, 1 July 2021 to 30 June 2024.

The Critical Control Points (CCPs) for each system, the performance against the CCPs and a general water quality summary based on the supplied operational data is included in section 4 and section 5.

Continuous improvement plan

LPSC have a continuous improvement plan (Section 9). The delivery of the new Quipolly WTP during the reporting period is key improvement item for the Quirindi and Werris Creek supply systems.

DWMS reviews

The DWMS reviews undertaken within the reporting period are listed in Table 1-2.

Table 1-2. Summary of DWMS reviews

Review	Scope/ findings	Person(s)
2 June 2022	Review and update of the DWMS, following the risk assessment workshop.	Tasleem Hasan Principal Drinking water Viridis
5 July 2022	Review by LPSC	Luke Whitten Water Services Engineer LPSC

NSW Health engaged Atom Consulting to facilitate a water quality risk assessment for the Quipolly WTP and update LPSC's DWMS with the outcomes of the Quipolly risk assessment and CCP review. The risk assessment was held on 25 June 2024. Atom Consulting are updating the DWMS with the changes associated with the Quipolly WTP risk assessment (predominately focussing on ADWG elements 2, 4 and 12). The DWMS review was not finalised within the reporting period covered by this report.

Reservoir inspections

Operational reservoir inspections over the reporting period are summarised in Table 11-2.

Contents

Tables

Figures

1 Report purpose

This Annual Report documents Liverpool Plains Shire Council's (LPSC's) Drinking Water Management System (DWMS) implementation and drinking water quality performance from 1 July 2021 to 30 June 2024. It has been prepared to support the reporting (Element 10), evaluation (Element 11) and review and continual improvement (Element 12) requirements of the DWMS.

This report includes the following areas:

- Performance of critical control points
- Water quality review
- Levels of service (including consumer complaints)
- Water quality incidents
- Staff development and training
- Continuous improvement plan implementation
- Drinking Water Management System implementation
- Reservoir inspections

A review of system performance has been made against the Australian Drinking Water Guidelines (ADWG) 2011, levels of service and other regulatory requirements (Element 1).

2 Scheme summary

LPSC is responsible for seven water supply schemes as shown in Table 2-1. Note that from 1 March 2024, the Werris Creek scheme has been supplied by Quipolly WTP.

Table 2-1. LPSC drinking water supplies

Scheme	Raw water source	Treatment
Quirindi, including Willow Tree	Bores	Aeration Chlorination Note: can also be supplied by Quipolly WTP, but was not supplied by Quipolly WTP during the reporting period.
Werris Creek	Quipolly Dam	Currently supplied from Quipolly WTP. Prior to 1 March 2024: PAC Clarification Filtration Chlorination pH correction
Blackville	Bore	Chlorination
Caroona	Bore	Chlorination
Premer	Bore	Chlorination
Spring Ridge	Bore	Chlorination
Wallabadah	Bores	Chlorination
Quipolly	Quipolly Dam	PAC dosing and contact pH adjustment, coagulation and flocculation Inclined plate sedimentation Dissolved air flotation (DAF) Ozone dosing and contact BAC filtration Treated water pH adjustment UV disinfection Chlorine disinfection

A summary of the system upgrades is shown in Table 2-2.

Table 2-2. Summary of system upgrades

Checklist	Detail
Have there been any system upgrades within the reporting period?	Yes
Upgrade or system improvements details have been provided	Quipolly - Construction of new WTP near Quipolly Dam - Construction of 750 m of raw water pipeline - Construction of 20 km of treated water pipelines - New 0.4 ML concrete reservoir in Werris Creek - Installation of new intake manifold, raw water pump station and destratification in Quipolly Dam

3 DWMS document control

The DWMS reviews undertaken are listed in Table 3-1.

Table 3-1. DWMS updates

Date	Scope	Person(s)	Submitted to NSW Health and date submitted?
2 June 2022	Review and update of the DWMS, following the risk assessment workshop.	Tasleem Hasan Principal Drinking water Viridis	Submitted to HNELHD 19/7/2022
5 July 2022	Review by LPSC	Luke Whitten Water Services Engineer LPSC	

NSW Health engaged Atom Consulting to facilitate a water quality risk assessment for the Quipolly WTP and update LPSC's DWMS with the outcomes of the Quipolly risk assessment and CCP review. The risk assessment was held on 25 June 2024. Atom Consulting are updating the DWMS with the changes associated with the Quipolly WTP risk assessment (predominately elements 2, 4 and 12). The DWMS review was not finalised within the reporting period covered by this report.

4 Critical control points

The current CCPs are shown in Table 4-1. The water quality graphs are shown with the updated CCPs in Section 5 and Appendix A. CCPs for all systems were updated in April 2024, as Werris Creek is now supplied by Quipolly WTP. A summary of the previous Werris Creek CCPs is included in Table 4-2.

Table 4-1. Summary of critical control points

System	CCP	Monitoring Parameter	Units	Target criterion	Alert limit	Critical limit
Blackville, Caroona, Quirindi, Spring Ridge and Wallabadah	OS1	Free chlorine	mg/L	0.6-0.9	< 0.6 or > 0.9 (any one sample)	≤ 0.5 mg/L (any two immediate consecutive samples)
		Turbidity	NTU	< 0.8	≥ 0.8 (any one sample)	> 1.0 NTU (any two immediate consecutive samples)
Premer	P1	Free chlorine	mg/L	0.8-1.1	< 0.8 or > 1.1 (any one sample)	≤ 0.7 mg/L (any two immediate consecutive samples)
		Turbidity	NTU	< 0.8	≥ 0.8 (any one sample)	> 1.0 NTU (any two immediate consecutive samples)
All systems	OS2	Integrity of Reservoir		No detection	Detection of a breach of integrity	Source of contamination in the storage
Quipolly	CCP5	Turbidity	NTU	≤ 0.2 @ each filter	> 0.2 and ≤ 0.5 for > 15 min @ each filter	> 0.5 NTU for > 15 min @ each filter
	CCP6	UVT	%	> 90	< 90 & ≥ 80 for > 30 mins	< 80% for 30 mins
	CCP7	C.t	mg.min/L	> 30.0	C.t < 15 mg.min/L at any time	C.t < 15 mg.min/L for > 15 mins

***Source**: CCPs Ref Guide & Procedures*

Table 4-2. Summary of Werris Creek critical control points

System	CCP	Monitoring Parameter	Units	Target criterion	Alert limit	Critical limit
Werris Creek	WC1	Turbidity	NTU	< 0.2	≥ 0.2 NTU (any one sample)	> 0.5 NTU (any two consecutive samples)
	WC2	Free chlorine	mg/L	1.5-2.0	< 1.5 or > 2.0 mg/L (any one sample)	≤ 0.5 (any two immediate consecutive samples)
		pH	-	6.8-8.0	< 6.8 or > 8.0 (any one sample)	> 8.5 (any two immediate consecutive samples)

***Source**: CCPs Ref Guide & Procedures*

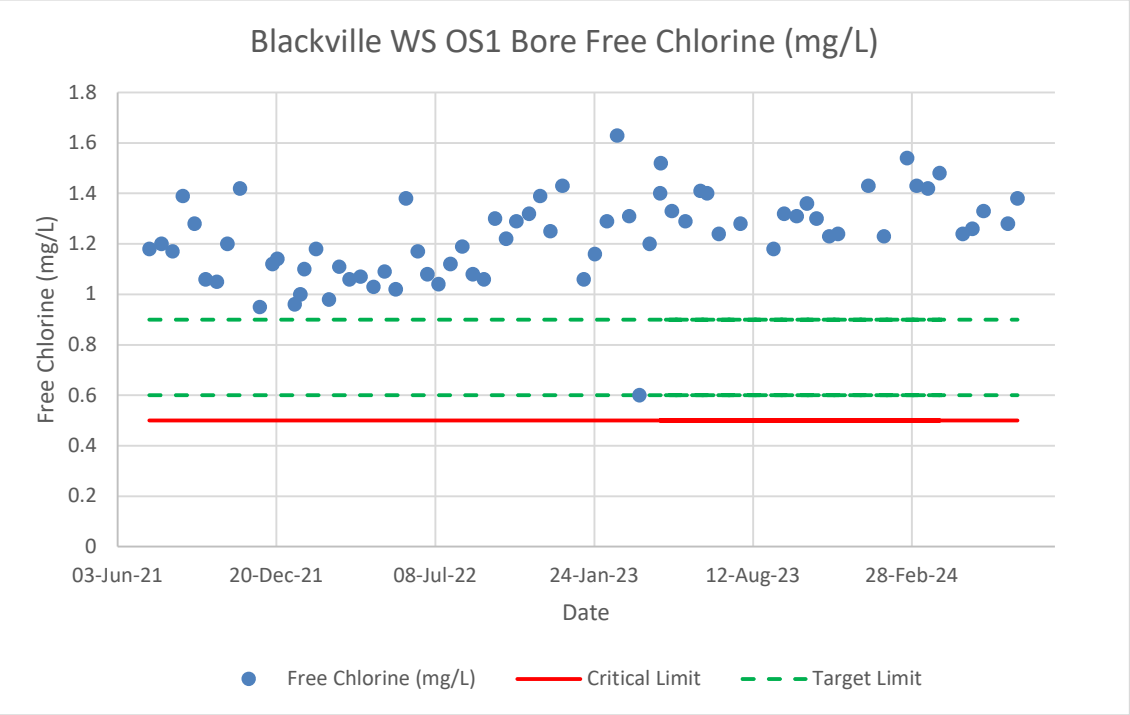
4.1 Critical control point performance

Note: There are data gaps for turbidity (Blackville, Caroona, Premer, Spring Ridge and Wallabadah). Although the bores were operational, resources were not available for data collection.

4.1.1 Blackville

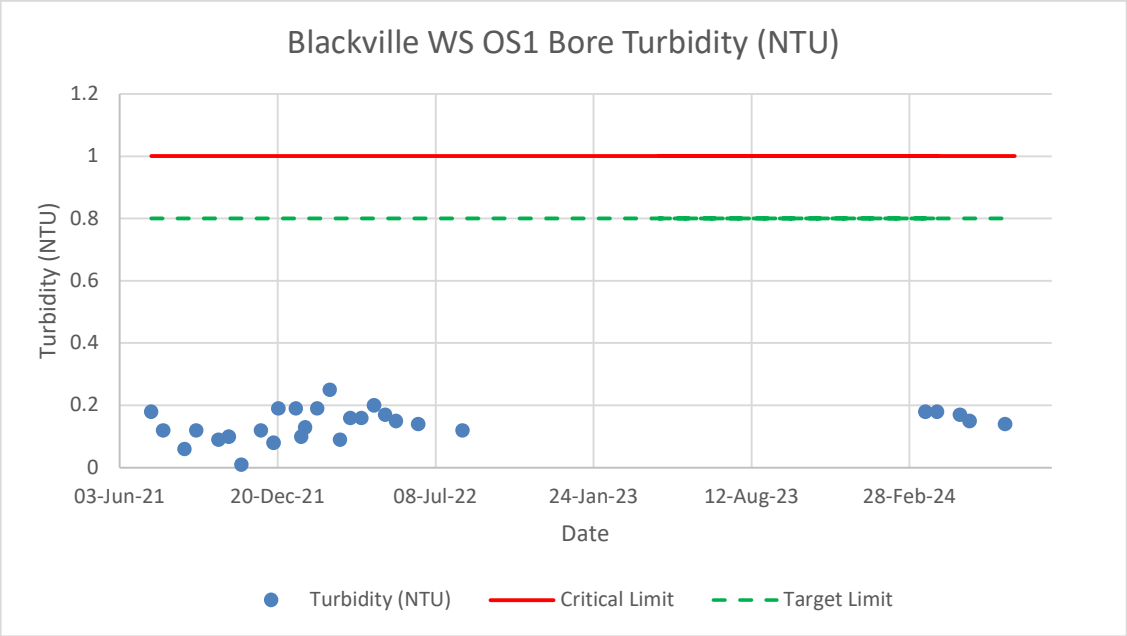
There were no critical control point excursions during the reporting period for Blackville WS. Critical control point performance is graphed in Figure 4-1 and Figure 4-2.

Figure 4-1. Blackville OS1 (1st July 2021 – 30th June 2024)



***Source**: Village Monitoring Data*

Figure 4-2. Blackville OS1 (1st July 2021 – 30th June 2024)



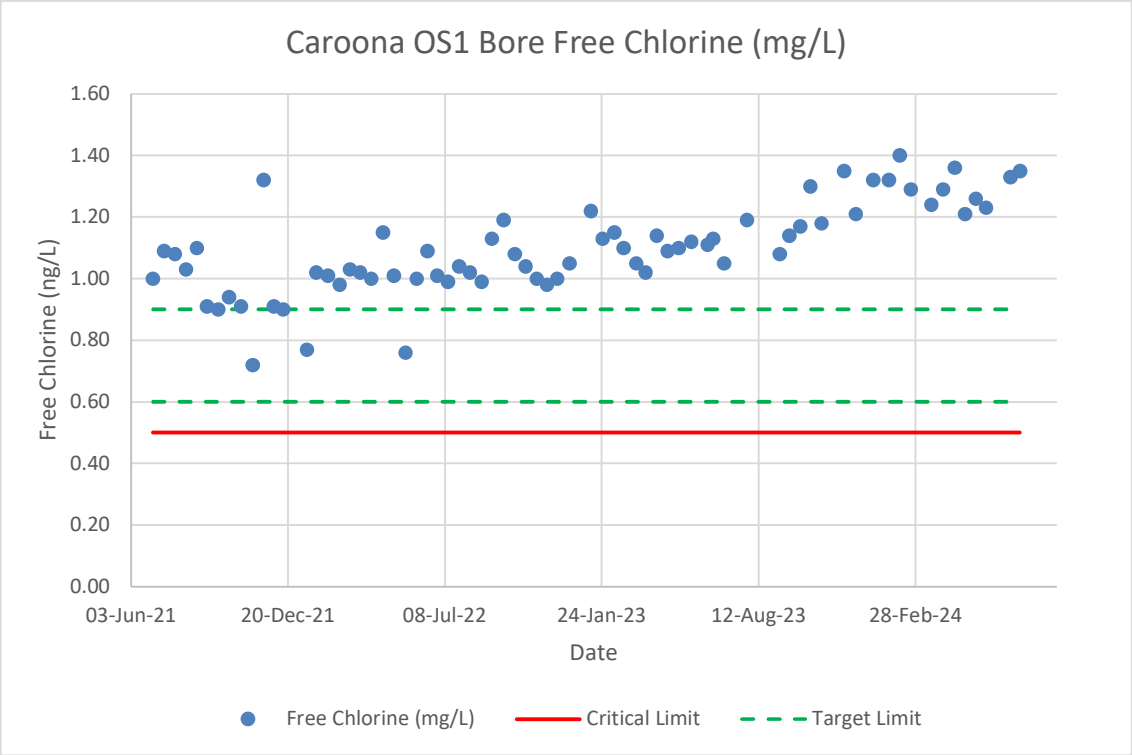
***Source**: Village Monitoring Data*

4.1.2 Caroona

There were no critical control point excursions during the reporting period for Caroona WS. Critical control point performance is graphed in Figure 4-3 and

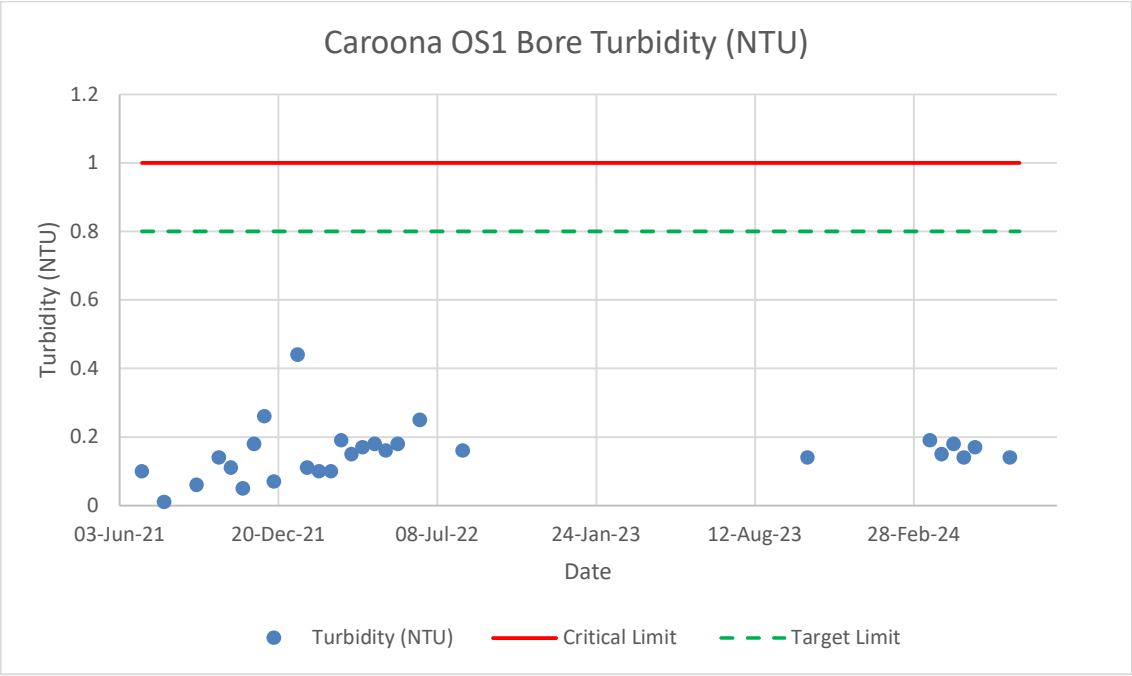
Figure 4-4.

Figure 4-3. Caroona OS1 (1st July 2021 – 30th June 2024)



***Source**: Village Monitoring Data*

Figure 4-4. Caroona OS1 (1st July 2021 – 30th June 2024)

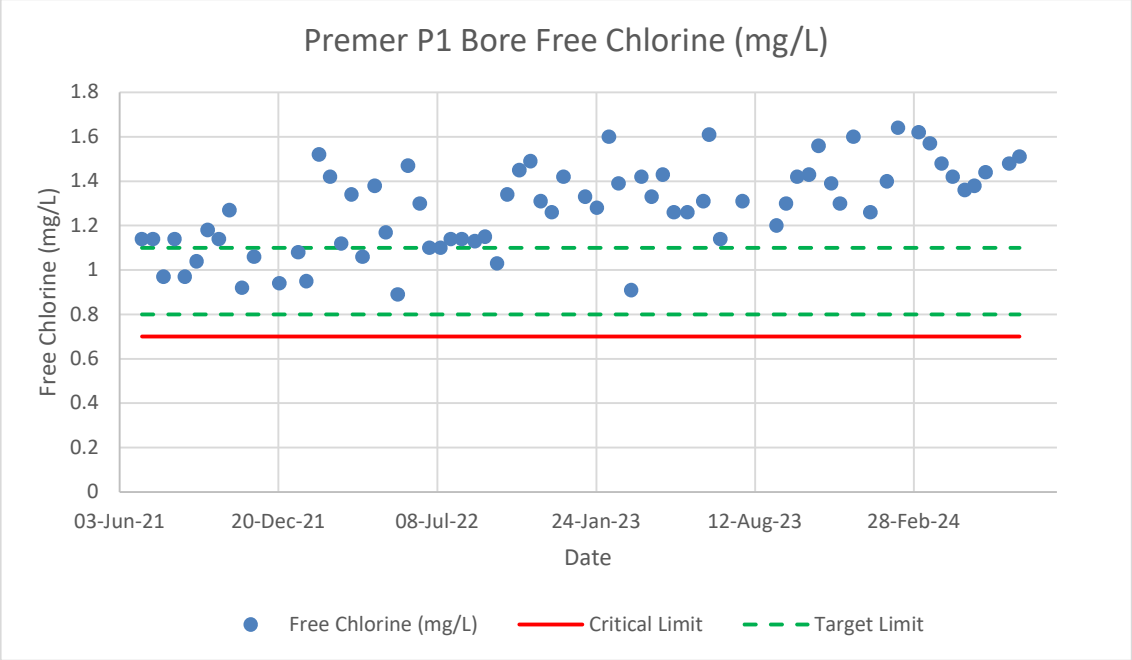


***Source**: Village Monitoring Data*

4.1.3 Premer

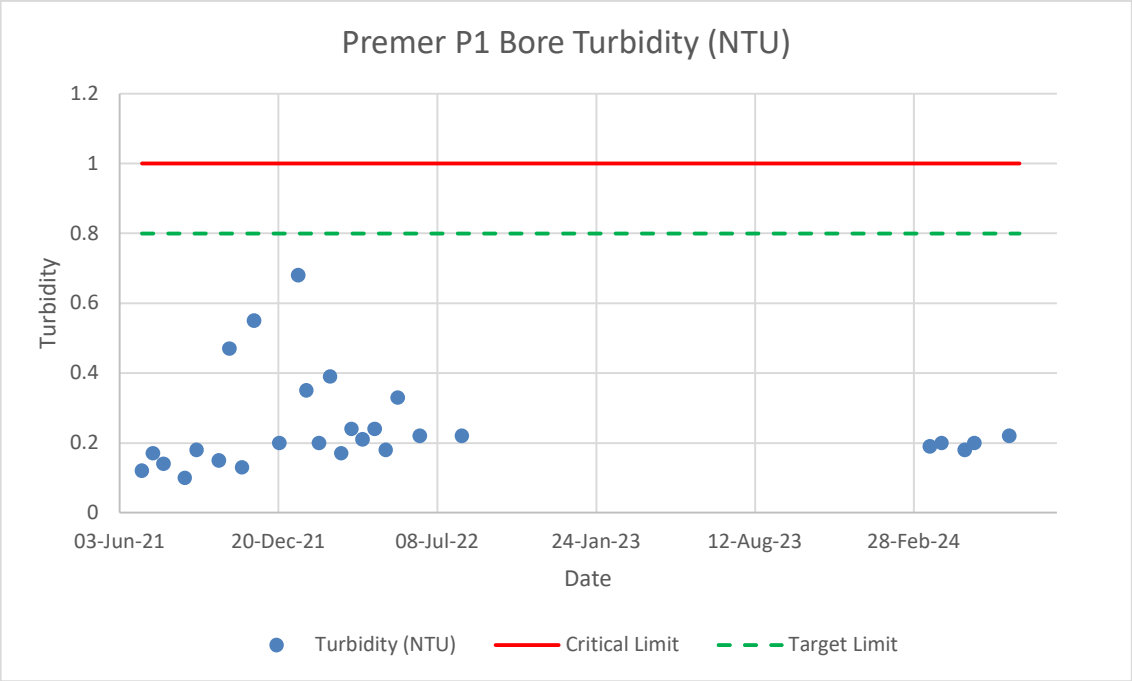
There were no critical control point excursions during the reporting period for Premer WS. Critical control point performance is graphed in Figure 4-5 and Figure 4-6.

Figure 4-5. Premer P1 (1st July 2021 – 30th June 2024)



***Source**: Village Monitoring Data*

Figure 4-6. Premer P1 (1st July 2021 – 30th June 2024)

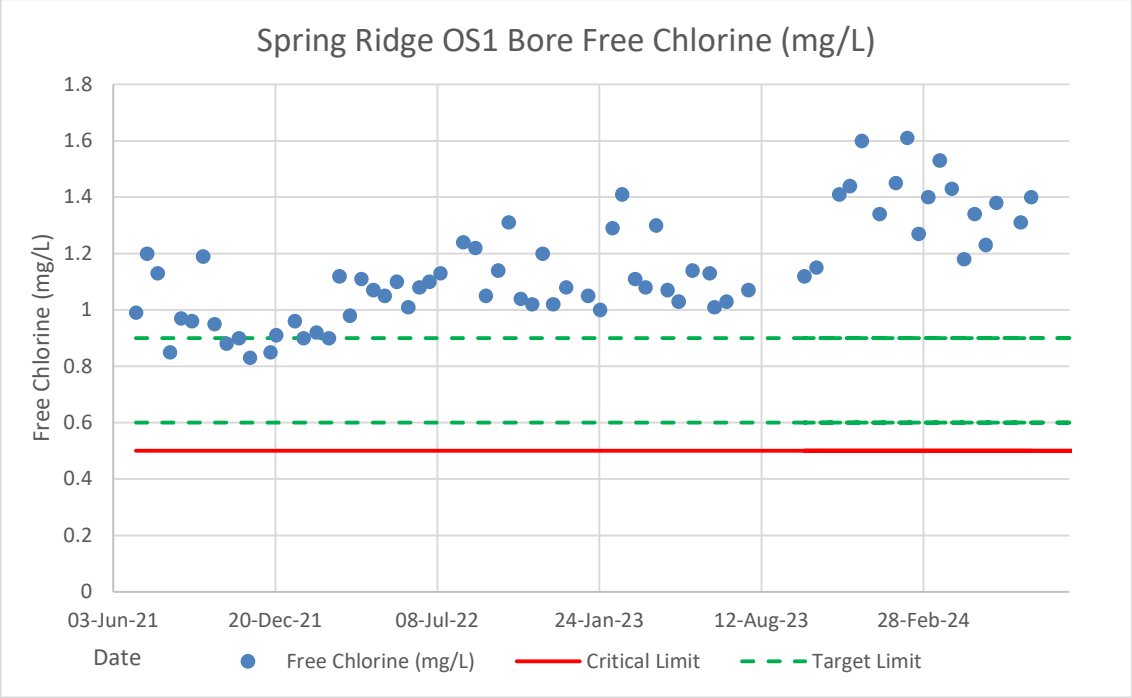


***Source**: Village Monitoring Data*

4.1.4 Spring Ridge

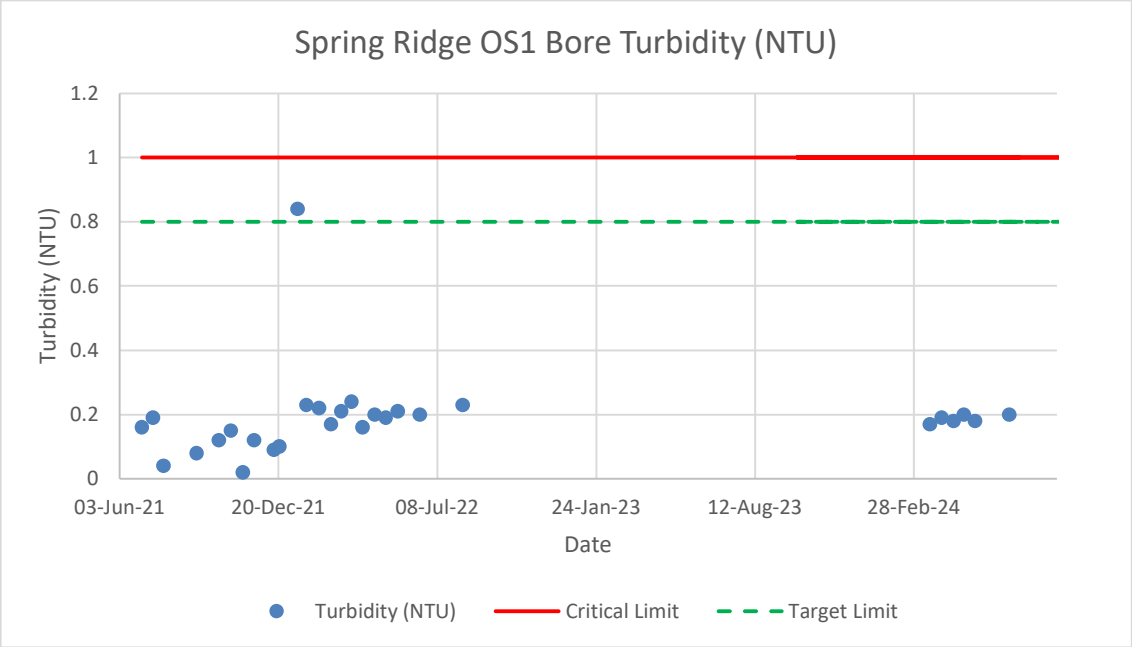
There were no critical control point excursions during the reporting period for Spring Ridge WS. Critical control point performance is graphed in Figure 4-7 and Figure 4-8.

Figure 4-7. Spring Ridge OS1 (1st July 2021 – 30th June 2024)



***Source**: Village Monitoring Data*

Figure 4-8. Spring Ridge OS1 (1st July 2021 – 30th June 2024)

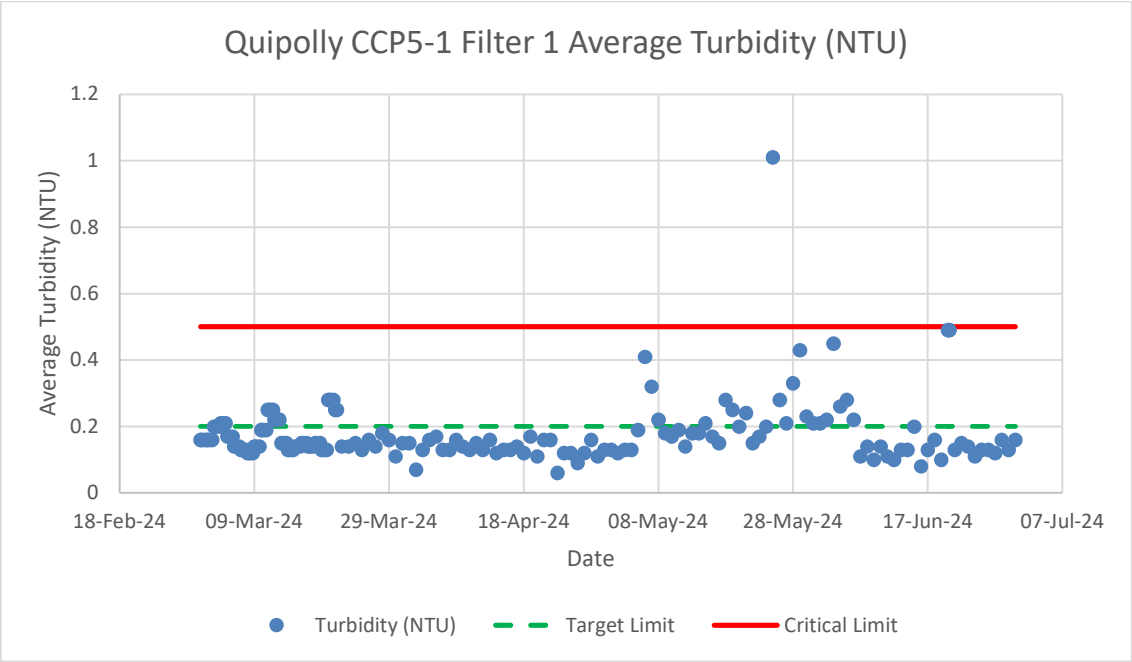


***Source**: Village Monitoring Data*

4.1.5 Quipolly

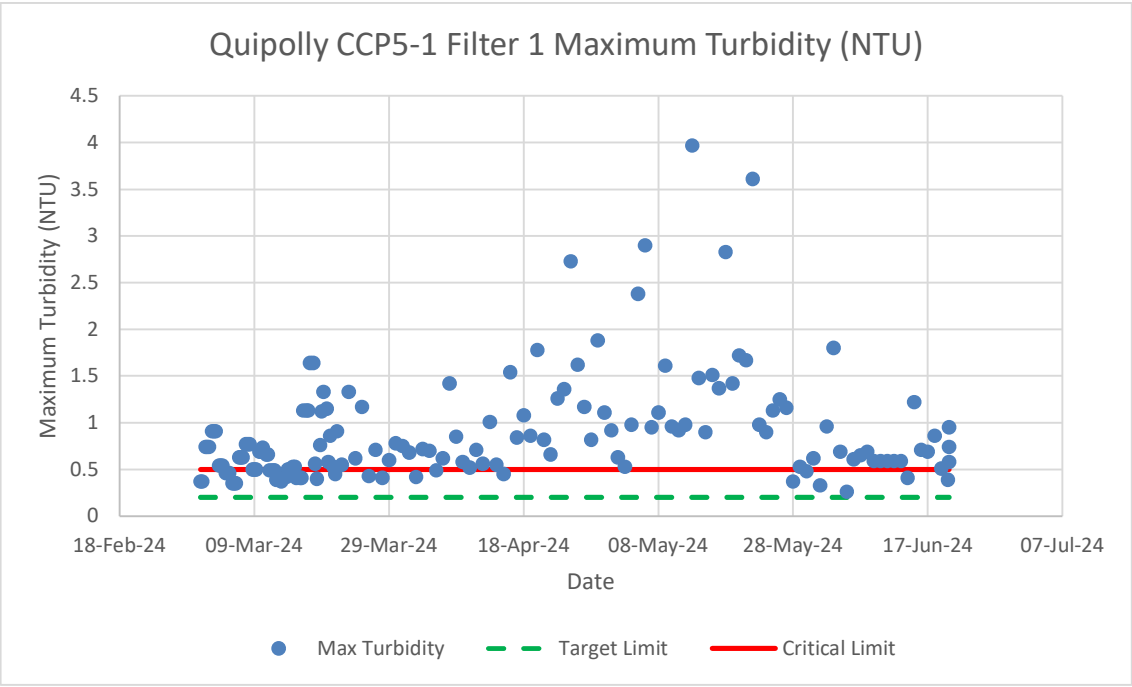
Data for Quipolly has been provided since 1st March 2024 when the WTP first started supplying. Data provided for the CCPs was given in a daily summary format that provided the daily average, minimum and maximum values for the CCPs. As the CCP's have time delays, we cannot conclude from the dataset whether there were any excursions from the critical limits.

Figure 4-9. Quipolly CCP5-1 (1st March 2024 – 30th June 2024)



Source: *Quipolly WTP data*

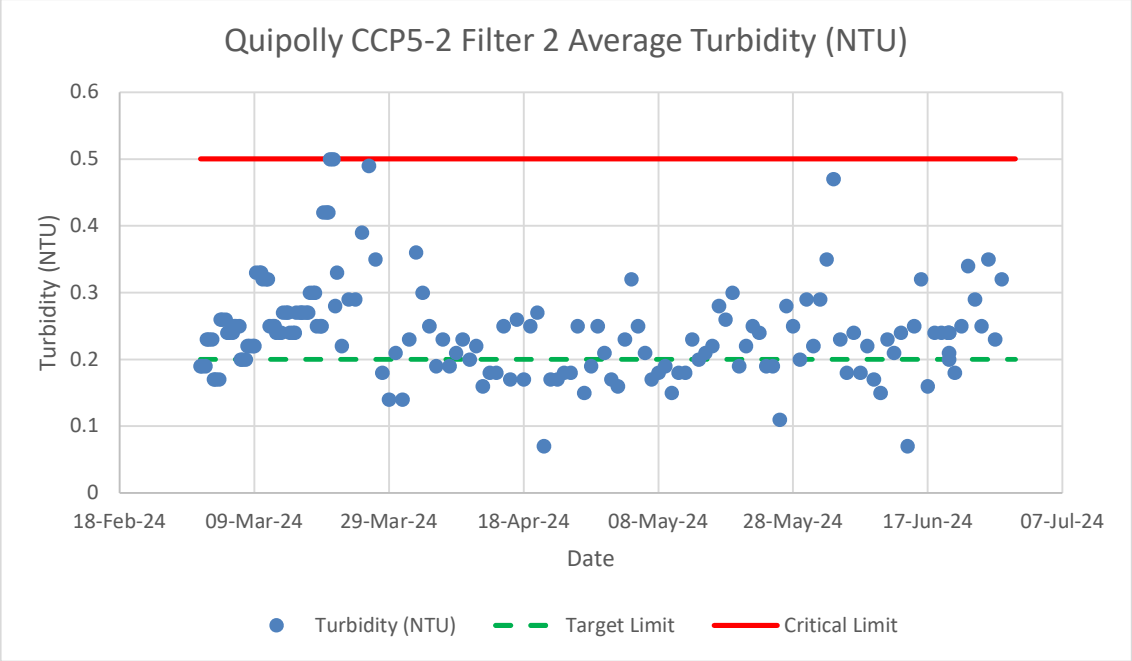
Figure 4-10. Quipolly CCP5-1 (1st March 2024 – 30th June 2024)



Source: *Quipolly WTP data*

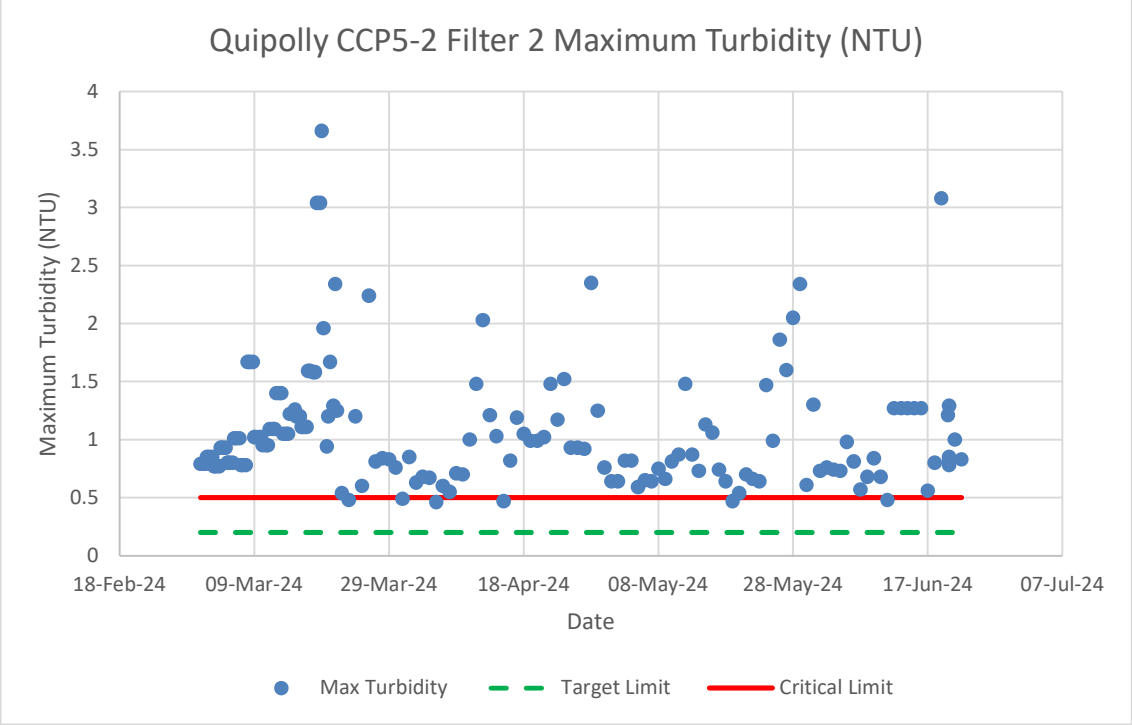
Note: *Maximums represent instantaneous recordings on instruments which are typically higher on plant startup and following backwash, but correct inside the time delay for the CCP triggers.*

Figure 4-11. Quipolly CCP5-2 (1st March 2024 – 30th June 2024)



Source: *Quipolly WTP data*

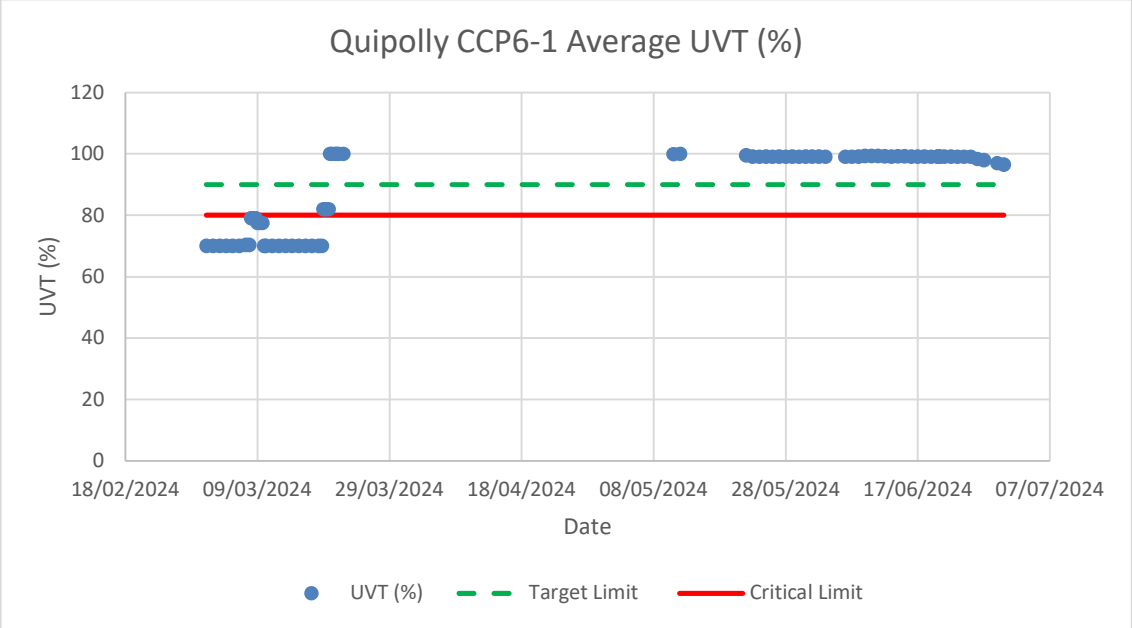
Figure 4-12. Quipolly CCP5-2 (1st March 2024 – 30th June 2024)



Source: *Quipolly WTP data*

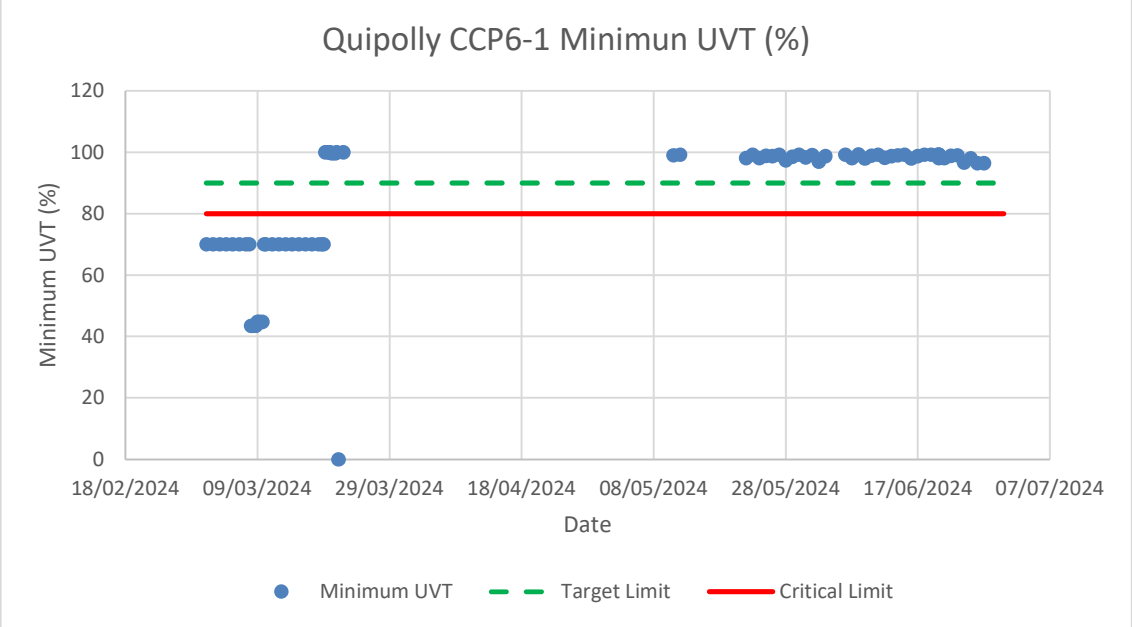
Note: *Maximums represent instantaneous recordings on instruments which are typically higher on plant startup and following backwash, but correct inside the time delay for the CCP triggers.*

Figure 4-13. Quipolly CCP6-1 (1st March 2024 – 30th June 2024)



Source: *Quipolly WTP data*

Figure 4-14. Quipolly CCP6-1 (1st March 2024 – 30th June 2024)

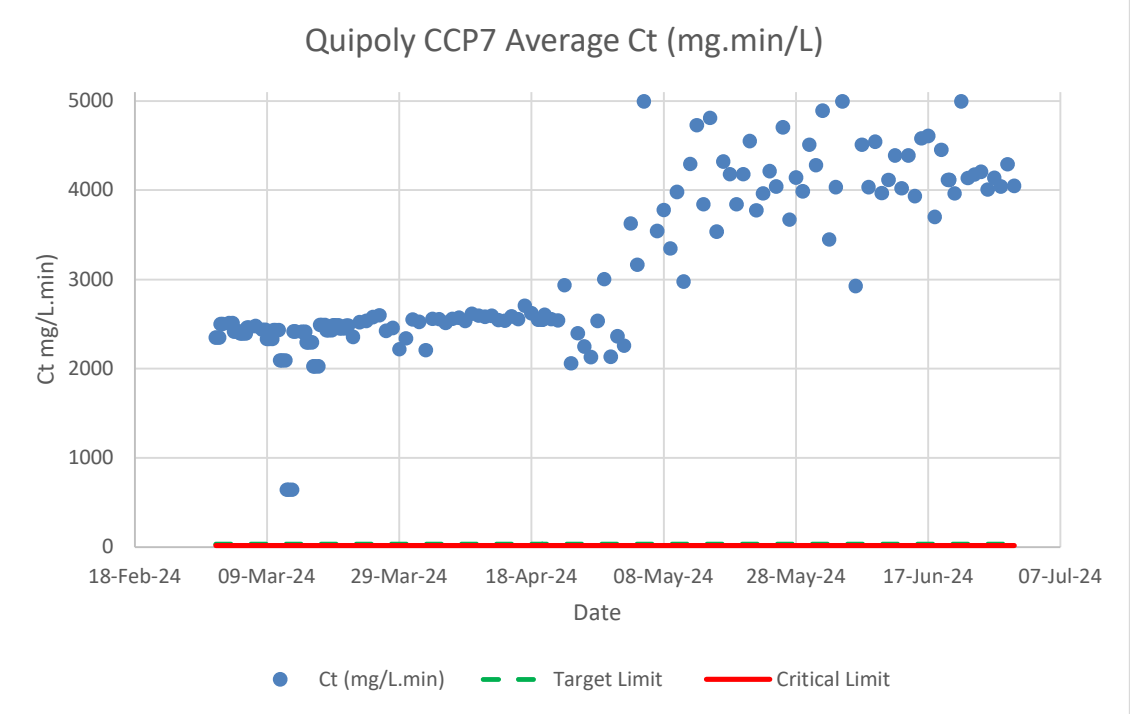


Source: *Quipolly WTP data*
Notes:

- *Where there are no data points, this indicates that the system hasn't deviated from the previous data point.*
- *Excursions are identified via alarm triggering which takes into account time delay.*

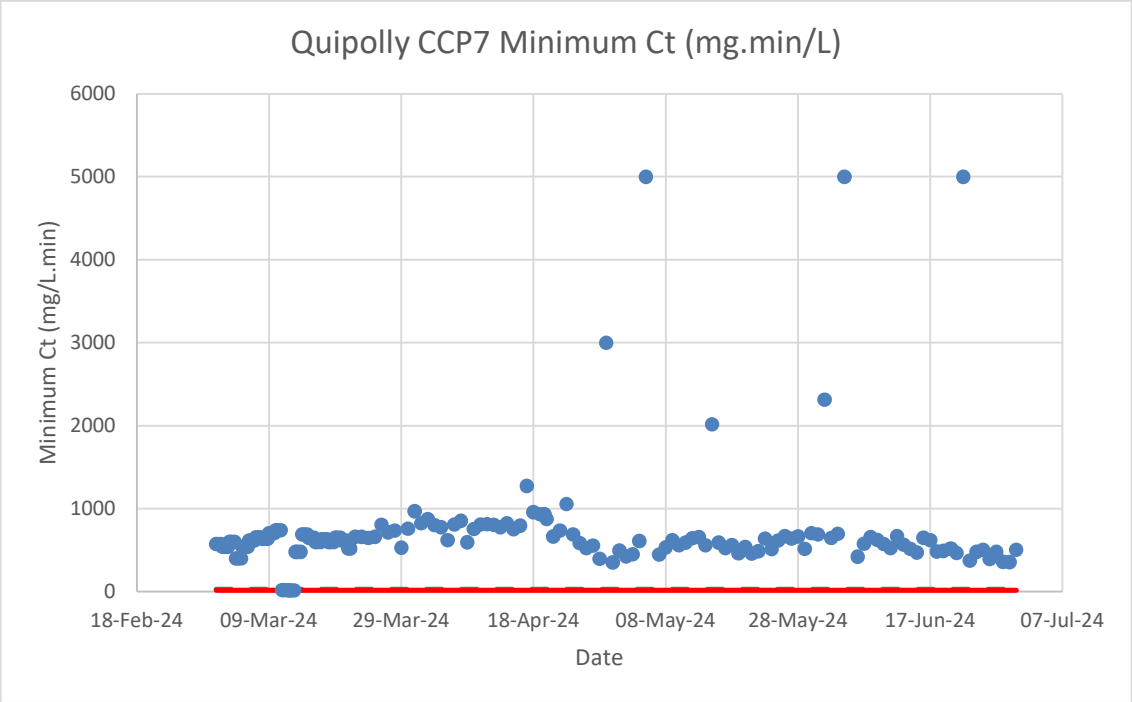
25 excursions were recorded for the UVT within the first 18 days of Quipolly WTP's operation (1 March 2024 – 18 March 2024). This related to an issue with the UVT sensor identified during process commissioning. An interim solution was consulted with NSW Health whereby a UVT of 70% was assumed as a conservative value for process control and daily grab samples were collected to confirm that the actual UVT was higher than 70%.

Figure 4-15. Quipolly CCP7 (1st March 2024 – 30th June 2024)



Source: *Quipolly WTP data*

Figure 4-16. Quipolly CCP7 (1st March 2024 – 30th June 2024)

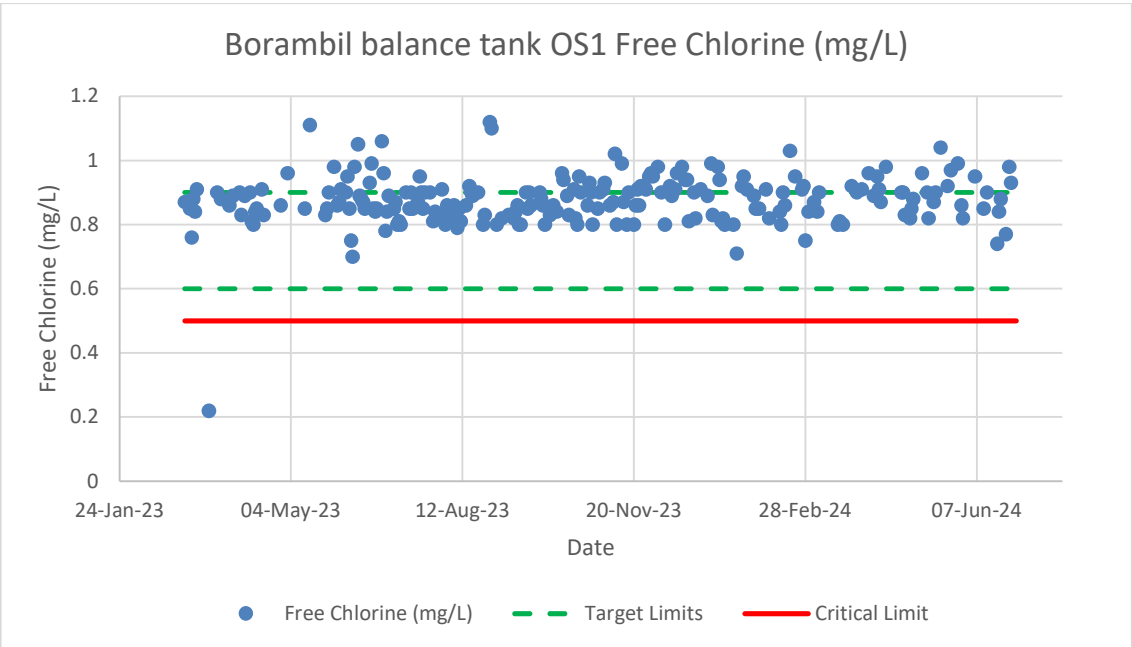


Source: *Quipolly WTP data*

4.1.6 Quirindi

The data set provided for Quirindi contained data from the period 3 March 2023 to 30 June 2024 and did not contain turbidity data. There were no known critical control point excursions during the reporting period at Quirindi. Critical control point performance is graphed Figure 4-17. ***Note:*** There is no turbidity data available.

Figure 4-17. Quirindi OS1 (3rd March 2023 – 30th June 2024)



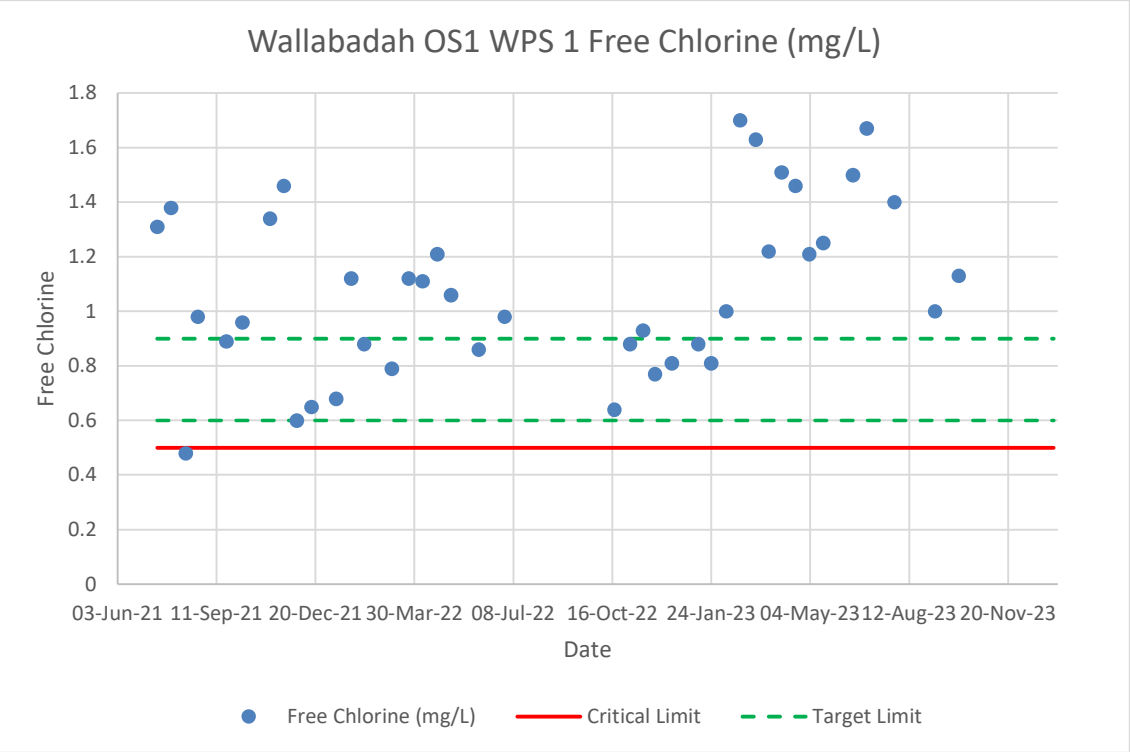
Source: *Borambil reservoir and pump station report*

The free chlorine in Quirindi OS1 lies predominantly above the target limit except for the value recorded on 17 March 2031, 0.22 mg/L. However, this is not considered a critical control point excursion as two consecutive samples below the limit 0.5 mg/L were not recorded.

4.1.7 Wallabadah

There were no known critical control point excursions during the reporting period at Wallabadah. Critical control point performance is graphed from Figure 4-18 to Figure 4-21.

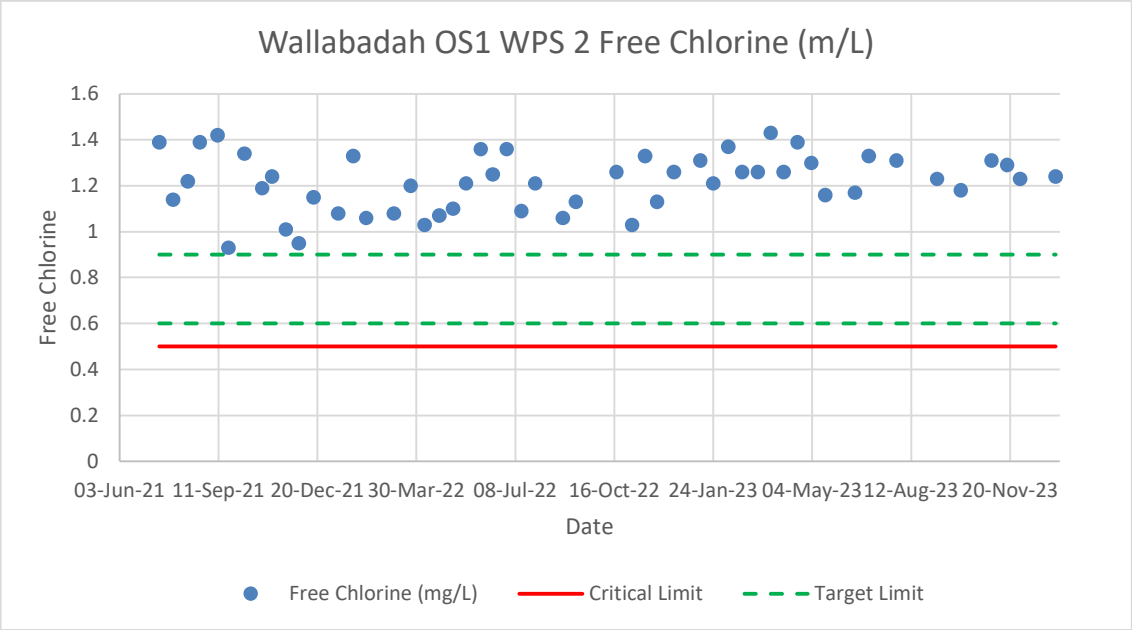
Figure 4-18. Wallabadah OS1 (1st July 2021 – 30th June 2024)



Source*: Village Monitoring Data*

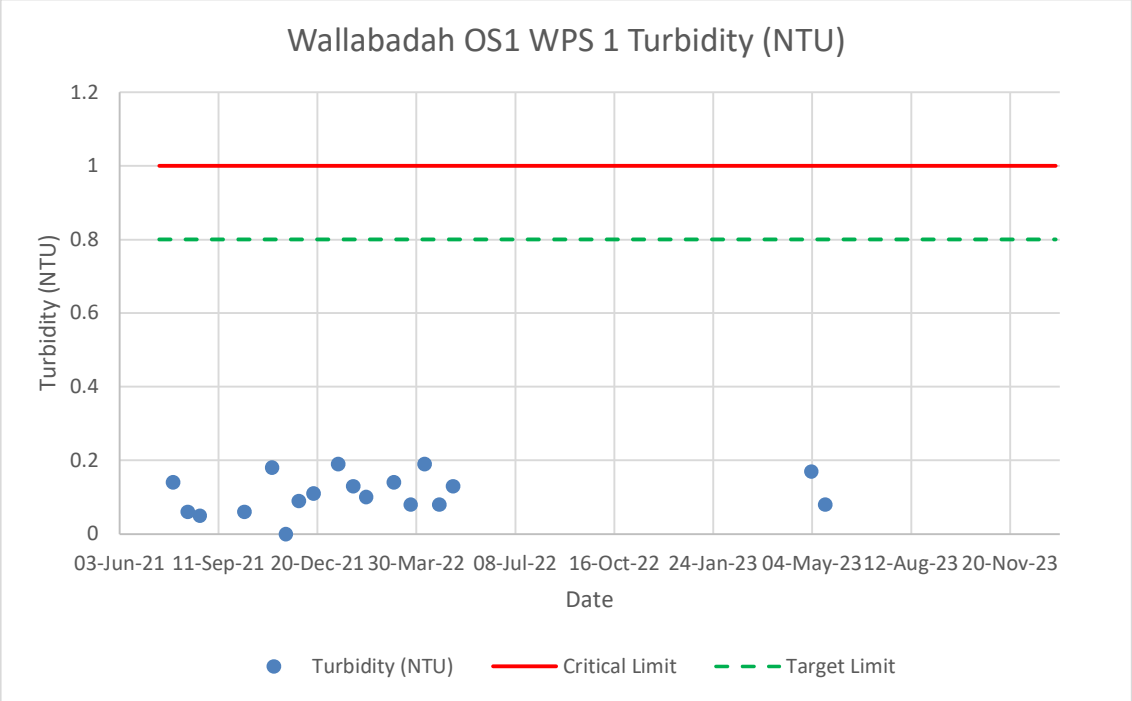
The free chlorine in WPS 1 lies predominantly above the target limit except for the value recorded on 11 August 2021, 0.48 mg/L. However, this is not considered a critical control point excursion as two consecutive samples below the limit 0.5 mg/L were not recorded.

Figure 4-19. Wallabadah OS1 (1st July 2021 – 30th June 2024)



***Source**: Village Monitoring Data*

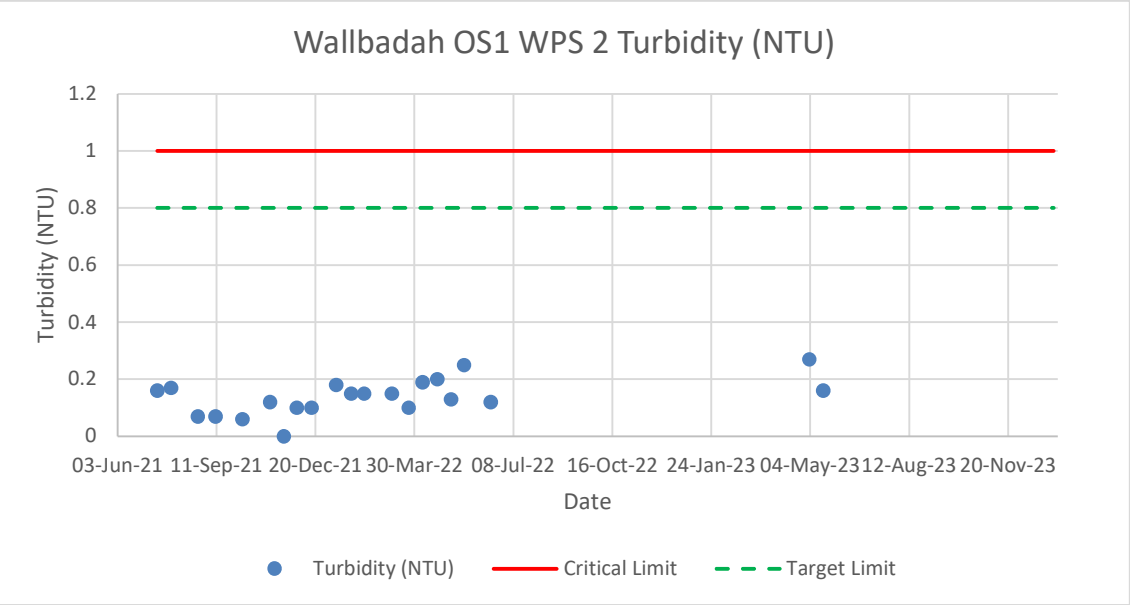
Figure 4-20. Wallabadah OS1 (1st July 2021 – 30th June 2024)



***Source**: Village Monitoring Data*

The WPS 1 turbidity data provided lies within the target limit at Wallabadah. Portions of the data between April 2022 to May 2023 and June 2023 to January 2024 are unavailable.

Figure 4-21. Wallabadah OS1 (1st July 2021 – 30th June 2024)



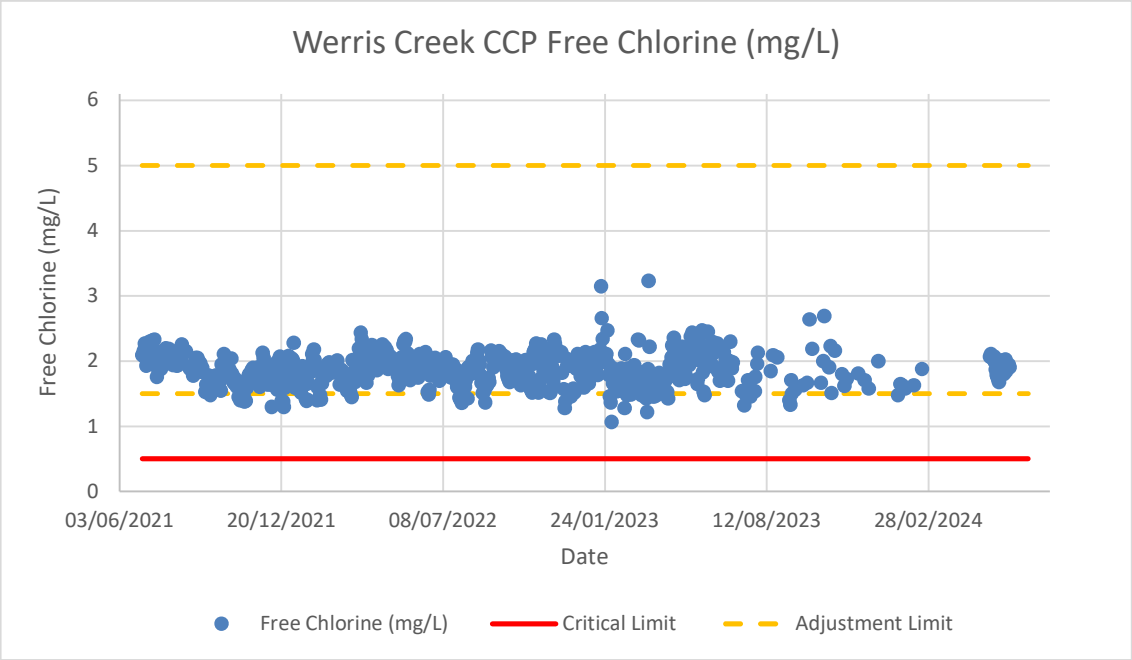
***Source**: Village Monitoring Data*

The WPS 2 turbidity data provided lies within the target limit at Wallabada. Portions of the data between April 2022 to May 2023 and June 2023 to January 2024 are unavailable.

4.1.8 Werris Creek

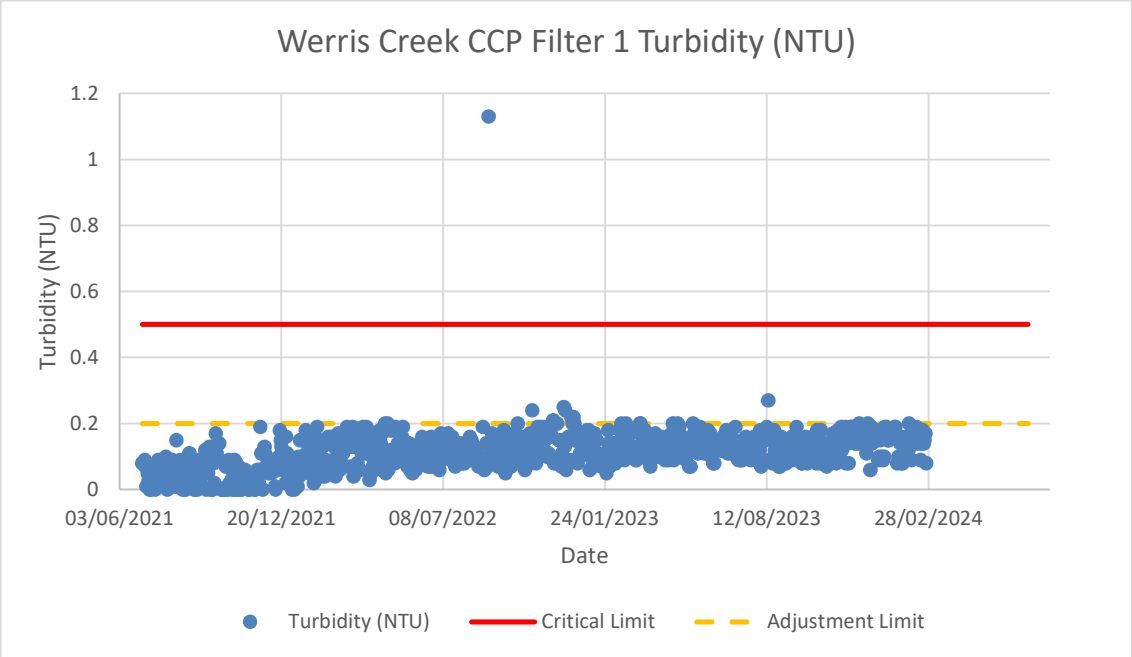
Note that the Werris Creek WS has been supplied by the new Quipolly WTP that started supplying 1 March 2024 and thus there are no data points for Werris Creek past this point. There were three critical control point excursions during the reporting period at Werris Creek. Three occurred on 2 September 2022 in filter 1 (1.13 NTU), filter 2 (1.39 NTU) and filter 3 (1.1 NTU).

Figure 4-22. Werris Creek critical control point (1st July 2021 – 29th February 2024)



Source: *Werris Creek WTP*

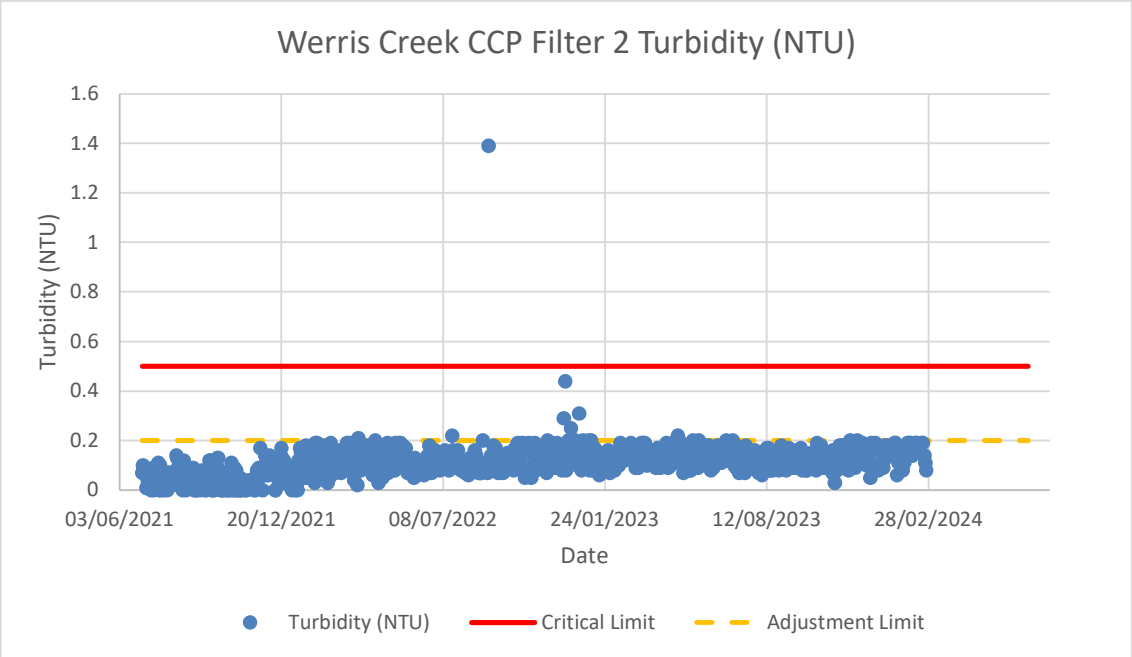
Figure 4-23. Werris Creek critical control point (1st July 2021 – 29th February 2024)



Source: *Werris Creek WTP*

Filter 1 turbidity lies predominantly within the adjustment limit below 0.2 NTU except for one critical control point excursion on 2 September 2022 at 1.13 NTU.

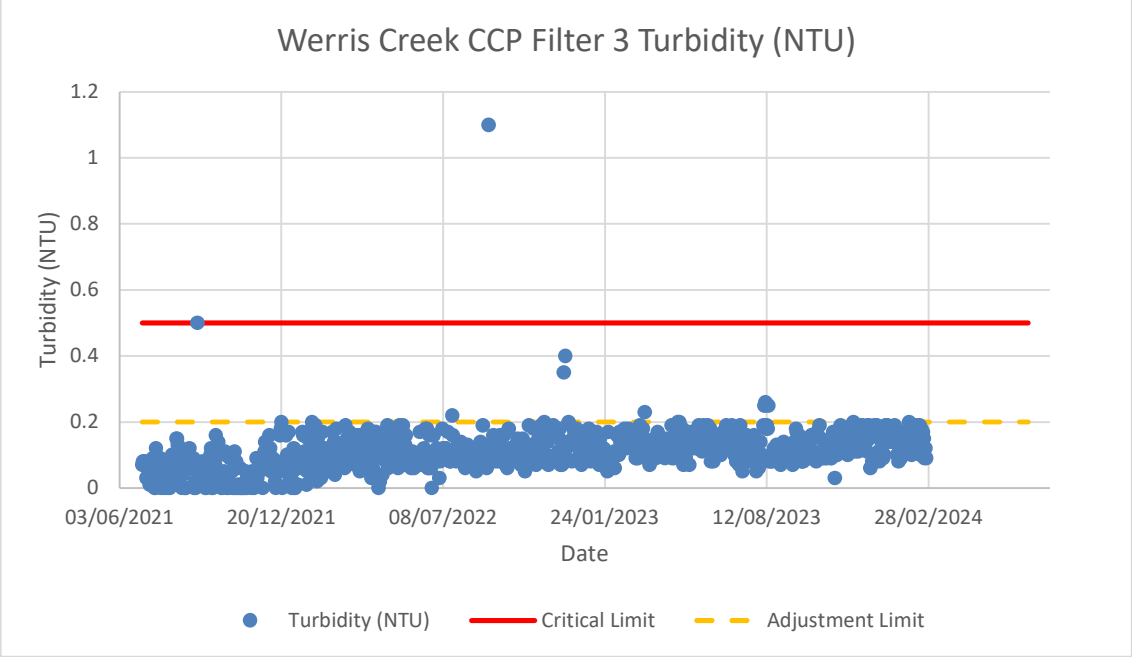
Figure 4-24. Werris Creek critical control point (1st July 2021 – 29th February 2024)



Source: *Werris Creek WTP*

Filter 2 turbidity lies predominantly within the adjustment limit below 0.2 NTU except for one critical control point excursion on 2 September 2022 at 1.39 NTU.

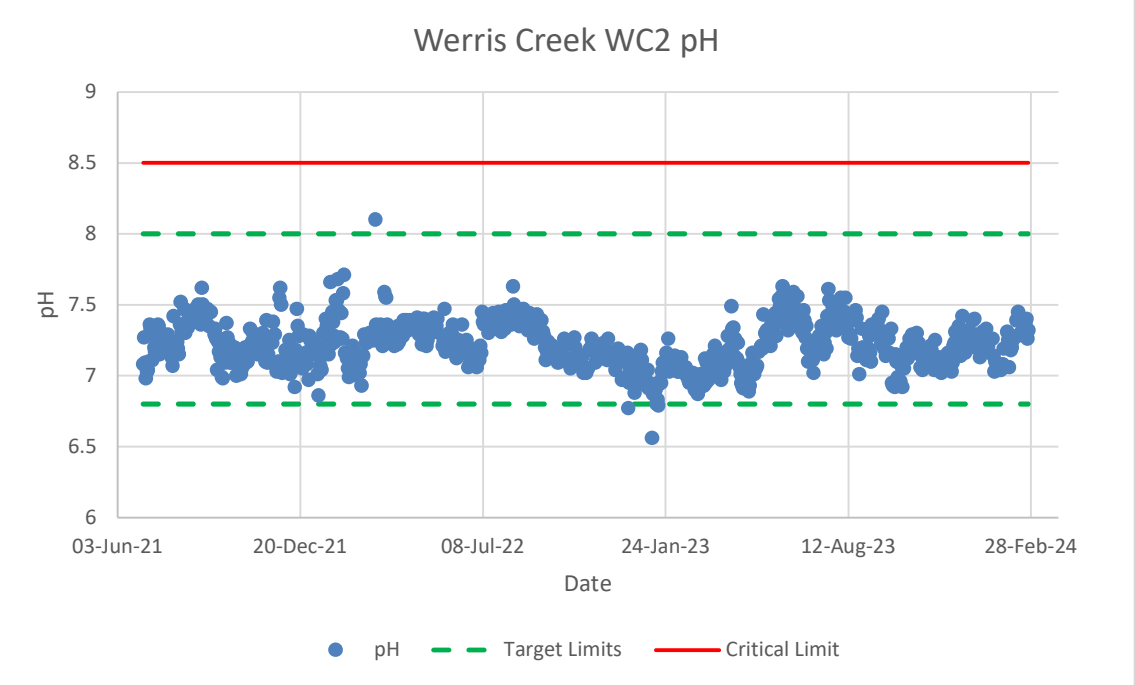
Figure 4-25. Werris Creek critical control point (1st July 2021 – 29th February 2024)



Source: *Werris Creek WTP*

Filter 3 turbidity lies predominantly within the adjustment limit below 0.2 NTU except for one critical control point excursion on 2 September 2022 at 1.1 NTU.

Figure 4-26. Werris Creek critical control point (1st July 2021 – 29th February 2024)



Source: *Werris Creek WTP*

Two points were excluded from the data set due to measurement errors for pH readings of 1.18 and 0.14 on 21 November 2021 and 22 April 2022 respectively. Disregarding these two errors, there were no excursions in pH at Werris Creek over the reporting period.

4.1.9 Willow Tree

The Willow Tree Water System consists of only a reticulation system as it receives its water source from Quirindi. For this reason, there are no water quality graphs at Willow Tree. Refer to Appendix A.1.8 for reticulation data.

4.2 Critical limit excursions

A summary of the critical limit excursions is included in Table 4-3.

Details of water quality incidents are provided in Section 7. In some cases, water quality incidents outlined in Section 7 were not observed in the data provided (e.g. for the Premer scheme).

Table 4-3. Critical limit excursions

System	Date	CCP	Value	Details and corrective action
Quipolly	1 March 2024	CCP6-1 UVT	70	Issue with UVT sensor identified during process commissioning. Interim approach
	2 March 2024	CCP6-1 UVT	70	
	3 March 2024	CCP6-1 UVT	70	
	4 March 2024	CCP6-1 UVT	70	
	5 March 2024	CCP6-1 UVT	70	

System	Date	CCP	Value	Details and corrective action
	6 March 2024	CCP6-1 UVT	70	consulted with NSW Health: assume UVT of 70% as a conservative value for process control and undertake daily grab samples to confirm actual UVT higher than 70%.
	7 March 2024	CCP6-1 UVT	70.39	
	8 March 2024	CCP6-1 UVT	79.07	
	9 March 2024	CCP6-1 UVT	77.46	
	10 March 2024	CCP6-1 UVT	70	
	11 March 2024	CCP6-1 UVT	70	
	12 March 2024	CCP6-1 UVT	70	
	13 March 2024	CCP6-1 UVT	70	
	14 March 2024	CCP6-1 UVT	70	
	15 March 2024	CCP6-1 UVT	70	
	16 March 2024	CCP6-1 UVT	70	
	17 March 2024	CCP6-1 UVT	70	
	18 March 2024	CCP6-1 UVT	70	
Werris Creek (filter 1)	2 September 2022	Turbidity	1.13 NTU	A boil water alert was not deemed necessary in discussion with NSW Health.
Werris Creek (filter 2)	2 September 2022	Turbidity	1.39 NTU	
Werris Creek (filter 3)	2 September 2022	Turbidity	1.1 NTU	

5 Water quality

This section includes a review of water quality data for the reporting period, July 2021 to June 2024, including data collected as part of the NSW Health drinking water monitoring system program. A more detailed summary of water quality data can be found in Appendix A.

5.1 Data collection

A summary of the operational monitoring undertaken at each of the water supplies is shown from Table 5-1 to Table 5-4. The operational monitoring plan provided noted a date of last review of 17 June 2022.

Table 5-1. Werris Creek operational monitoring (1st July 2021 – 30th February 2024)

Location	Frequency	Parameter	Corrective actions
Dam	3 x week	- Dam surveillance - Algae visual inspection	- Check PAC dose rate - Check biovolume from BGA management protocol table - Inform Water Supervisor of any issues
Dam tower	Weekly	- Algae biovolume - Total manganese - Soluble manganese - Turbidity - True colour - Temperature - pH - Dissolved oxygen	- To provide water storage data to correlate to treatment process changes
Dam surface	Weekly	- Temperature - pH - Dissolved oxygen	- To provide water storage data to correlate to treatment process changes
WTP raw water intake	Daily	- Turbidity - pH - Colour	- Undertake jar testing to optimise and adjust alum dose - Inform Water Supervisor of any issues
Ex-clarifier	Daily	- Turbidity	- Jar test
	Continuous	- Turbidity	- Adjust coag and floc aid dosing - Ensure clarifier rakes are working - Check clarifier has been de-sludge - Inspect and clean clarifiers
	Daily	- pH	- jar test - adjust alum dosing - consider need for pH correction
	In accordance with response plan	- Total manganese - Soluble manganese	- Ensure chlorine residual maintained through filters
Ex-filters (each filter)	Daily	- Turbidity	- As per the filtration CCP
	In accordance	- Total manganese - Soluble manganese	- Ensure chlorine residual maintained through filters

Location	Frequency	Parameter	Corrective actions
	with response plan		- As per CCP for ex-filter turbidity
WTP final water (clear pipe)	Daily	- Turbidity - pH - Total chlorine - Free chlorine	- As per the filtration CCP - As per the disinfection and bore integrity CCP - Reduce chlorine dose (but ensure CCP is not breached), check clarification process is working well. Undertake additional THM test
	In accordance with response plan	- Total manganese - Soluble manganese	- Ensure chlorine residual maintained through filters - As per CCP for ex-filter turbidity
Ex-Clear water tank (final water)	Daily	- Free chlorine - Total chlorine - Turbidity - pH - Colour - Taste and odour	- Reduce chlorine dose (but ensure CCP is not breached), check clarification process is working well. Undertake additional THM test - Investigate the treatment chain for faults - Ensure all CCPs are working well - Ensure equipment used is calibrate - As per the disinfection and bore integrity CCP - Check algal biovolume results - Adjust PAC dose as required - Inform Water Supervisor of any issues
Distribution network	Daily	- Free chlorine	- Ensure as per the disinfection and bore integrity CCP is working well - Adjust chlorine dose as required - Consider need for E. coli testing if 0.2mg/L
	Continuous	- Free chlorine	
	Daily	- Total chlorine - Turbidity - pH - Colour	- Reduce chlorine dose (but ensure CCP is not breached), check clarification process is working well - Undertake additional THM test - Investigate the treatment chain of results - Check for pipe breaks or back flows - Ensure all CCPs are working well

Location	Frequency	Parameter	Corrective actions
			- Ensure equipment used is calibrated
	Monthly	- THM	- Check chlorine levels aren't excessive - Identify options to reduce chlorine usage within treatment system
CWT and all reservoirs	Routine – weekly Periodic – quarterly to 6 monthly more detailed	- Reservoir integrity - Free chlorine	- As per the reservoir CCP - Ensure as per the disinfection and bore integrity CCP is working well - Adjust chlorine dose as required - Consider need for E. coli testing if 0.2mg/L

Source: *LPSC Monitoring Plan*

Table 5-2. Quipolly operational monitoring (1st March 2024 – 30th June 2024)

Location	Frequency	Parameter	Corrective actions
Quipolly Dam	3 x week	- Dam surveillance - Algae visual inspection	- Check PAC dose rate - Check biovolume from BGA management protocol table - Inform Water Supervisor of any issues
Dam tower	Weekly	- Algae biovolume - Total manganese - Soluble manganese - Turbidity - True colour - Temperature - pH - Dissolved oxygen	- To provide water storage data to correlate to treatment process changes
Dam surface	Weekly	- Temperature - pH - Dissolved oxygen	- To provide water storage data to correlate to treatment process changes
WTP raw water intake	Daily	- Turbidity - pH - Colour	- Undertake jar testing to optimise and adjust alum dose - Inform Water Supervisor of any issues
Ex-Clear water tank (final water)	Daily	- Free chlorine - Total chlorine - Turbidity - pH - Colour - Taste and odour	- Reduce chlorine dose (but ensure CCP is not breached), check clarification process is working well. Undertake additional THM test - Investigate the treatment chain for faults - Ensure all CCPs are working well - Ensure equipment used is calibrate - As per the disinfection and bore integrity CCP

Location	Frequency	Parameter	Corrective actions
			- Check algal biovolume results - Adjust PAC dose as required - Inform Water Supervisor of any issues
Distribution network	Daily	- Free chlorine	- Ensure as per the disinfection and bore integrity CCP is working well - Adjust chlorine dose as required - Consider need for E. coli testing if 0.2mg/L
	Continuous	- Free chlorine	
	Daily	- Total chlorine - Turbidity - pH - Colour	- Reduce chlorine dose (but ensure CCP is not breached), check clarification process is working well - Undertake additional THM test - Investigate the treatment chain of results - Check for pipe breaks or back flows - Ensure all CCPs are working well - Ensure equipment used is calibrated
	Monthly	- THM	- Check chlorine levels aren't excessive - Identify options to reduce chlorine usage within treatment system
CWT and all reservoirs (Werris Creek reservoir and North Quirindi reservoir)	Routine – weekly Periodic – quarterly to 6 monthly more detailed	- Reservoir integrity - Free chlorine	- As per the reservoir CCP - Ensure as per the disinfection and bore integrity CCP is working well - Adjust chlorine dose as required - Consider need for E. coli testing if 0.2mg/L

Source: *Updated from Werris Creek operational monitoring*

Table 5-3. Blackville, Caroona (including Walhallow), Spring Ridge, Premer, Wallabadah operational monitoring (1st July 2021 – 30th June 2024)

Location	Frequency	Parameter	Corrective actions
Bore (raw water)	Fortnightly	- Turbidity - pH	- As per the disinfection and bore integrity CCP - Inform Water Supervisor - Ensure integrity of bore - Check chlorine in retic - Increase chlorine dose as required
Bore site dosing point	Fortnightly	- Free chlorine	- Check dosing equipment and dosing lines

Location	Frequency	Parameter	Corrective actions
(after chlorination)			- Check chlorine stock - Adjust dose as necessary
Distribution network	Fortnightly	- Free chlorine - Turbidity - pH - Colour	- As per the disinfection and bore integrity CCP - Check for pipe breaks or back flows - Ensure CCP is working well - Ensure equipment used is calibrated
All reservoirs	Routine – Fortnightly Periodic – quarterly to 6-monthly more detailed	- Reservoir integrity - Free chlorine	- As per the reservoir CCP - Ensure as per the disinfection and bore integrity CCP is working well - Adjust chlorine dose as required - Consider need for E. coli testing if 0.2mg/L

Source: *LPSC Monitoring Plan*

Table 5-4. Quirindi (including Willow Tree) operational monitoring (1st July 2021 – 30th June 2024)

Location	Frequency	Parameter	Corrective actions
Bore (raw water)	Fortnight	- Turbidity - pH	- as per the disinfection and bore integrity CCP - inform Water supervisor - ensure integrity of bore - check chlorine in retic - increase chlorine dose as required
Bore site dosing point (after balance tank)	Weekly	- Free chlorine	- Check dosing equipment and dosing lines - Check chlorine stock - Adjust dose as necessary
Quirindi SPS 5 sampler	Online	- Free chlorine	- As per the disinfection and bore integrity CCP
North and south reservoirs Quirindi	Weekly	- Free chlorine - Reservoir integrity	- As per the disinfection and bore integrity CCP - As per the reservoir CCP
Distribution network	Weekly Continuous Weekly	- Free chlorine - Free chlorine - Turbidity - pH - Colour	- Ensure as per the disinfection and bore integrity CCP is working well - Adjust chlorine dose as required consider need for E. coli testing if < 0.2 mg/L - Check for pipe breaks or back flows - Ensure CCP is working well - Ensure equipment used is calibrated

Location	Frequency	Parameter	Corrective actions
East and high zone reservoirs Quirindi, all reservoirs Will Tree	Routine – weekly Quirindi Routine – fortnightly Willow Tree Periodic – quarterly to 6-monthly more detailed	- Reservoir integrity - Free chlorine	- As per the reservoir CCP - Ensure as per the disinfection and bore integrity CCP is working well - Adjust chlorine dose as required - Consider need for E. coli testing if 0.2mg/L

Source: *LPSC Monitoring Plan*

A summary of the verification monitoring undertaken at each of the water supplies is shown in Table 5-5. This verification monitoring plan was last reviewed on 17 June 2022.

Table 5-5. All supplies verification monitoring

Parameter	Total coliforms	E. coli	Free chlorine	Other[1]
Blackville	1 per fortnight	1 per fortnight	With micro sample	2 per year
Caroona (including Walhallow)	1 per fortnight	1 per fortnight	With micro sample	2 per year
Premer	1 per fortnight	1 per fortnight	With micro sample	2 per year
Quirindi Main zone	1 per fortnight	1 per fortnight	With micro sample	2 per year
High zone	-	-	Operational	-
Spring Ridge	1 per fortnight	1 per fortnight	With micro sample	2 per year
Wallabadah	1 per fortnight	1 per fortnight	With micro sample	2 per year
Werris Creek Low Zone	3 per month	3 per month	With micro sample	2 per year
High zone	1 per month	1 per month	With micro sample	2 per year
Willow Tree Main zone	1 per fortnight	1 per fortnight	With micro sample	2 per year
High zone	-	-	Operational	-

Source: *LPSC Monitoring Plan*

[1]Aluminium, antimony, arsenic, barium, boron, cadmium, calcium, chloride, chromium, copper, fluoride, iodine, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, nitrate, nitrite, pH, selenium, silver, sodium, sulphate, TDS, hardness, true colour, turbidity, zinc

5.2 Excursions from ADWG health and aesthetic data

Excursions of health and aesthetic values provided by the ADWG over the reporting period are noted in Table 5-6. There were no excursions at Werris Creek over the reporting period.

Table 5-6. Summary of water quality value excursions (1st July 2021 – 30th June 2024)

Location	Parameter	ADWG limit	Exceedance Count	Exceedance values	Exceedance Date	LPSC response
Blackville	Residual chlorine	< 0.2, > 5 mg/L (H)	2	0.16 0.06	27/02/2024 06/06/2024	Sampling officer

Location	Parameter	ADWG limit	Exceedance Count	Exceedance values	Exceedance Date	LPSC response
						undertaking routine verification program samples. Checked by water operator and found to be suitable chlorine, sampling procedure refreshed with sampling officer.
	Total hardness as CaCO3	> 200 mg/L (A)	5	393.6 416.7 437.7 446.8 441.7	09/12/2021 22/06/2022 22/12/2022 19/07/2023 22/11/2023	Aesthetic parameter natural to source water
Caroona	Residual chlorine	< 0.2, > 5 mg/L (H)	1	0.03	18/08/2021	Fault in dosing equipment. Notified to NSW Health and rectified
	pH	< 6.5, >8.5 (A)	1	8.86	05/01/2022	One off anomaly
	Total hardness as CaCO3	> 200 mg/L (A)	6	352.1 373.0 389.7 407.6 400.5 405.5	29/10/2021 09/12/2021 24/06/2022 22/12/2022 19/07/2023 24/11/2023	Aesthetic parameter natural to source water
Premer	Residual chlorine	< 0.2, > 5 mg/L (H)	3	0.11 0.11 0.18	13/02/2024 26/03/2024 12/03/2024	Sampling officer undertaking routine verification program samples. Checked by water operator and found to be suitable chlorine, sampling procedure refreshed with sampling officer.

Location	Parameter	ADWG limit	Exceedance Count	Exceedance values	Exceedance Date	LPSC response
	Total hardness as CaCO3	> 200 mg/L (A)	5	375.0 385.6 389.2 407.7 408.4	09/12/2021 24/06/2022 22/12/2023 26/07/2023 28/11/2023	Aesthetic parameter natural to source water
Quirindi	Total hardness as CaCO3	> 200 mg/L (A)	5	371.6 373.9 391.0 386.4 401.7	08/12/2021 24/06/2022 22/12/2022 25/10/2023 24/11/2023	Aesthetic parameter natural to source water
	Turbidity	> 5 NTU (A)	1	14.7	17/08/2022	One off anomaly
Spring Ridge	Chloride	> 250 mg/L (A)	4	611.0 652.0 647.0 739.0	09/12/2021 24/06/2022 22/12/2022 20/07/2023	Aesthetic parameter natural to source water
	Residual chlorine	< 0.2, > 5 mg/L (H)	2	0.1 0.05	10/04/2024 23/05/2024	Sampling officer undertaking routine verification program samples. Checked by water operator and found to be suitable chlorine, sampling procedure refreshed with sampling officer.
	Sodium	> 180 mg/L (A)	4	463.0 433.0 454.0 419.0	09/12/2021 24/06/2022 22/12/2022 20/07/2023	Aesthetic parameter natural to source water
	Total dissolved solids (TDS)	> 600 mg/L (A)	4	1387.0 1387.0 1230.0 1295.0	07/12/2021 21/06/2022 21/12/2022 18/07/2023	Aesthetic parameter natural to source water
	Total hardness as CaCO3	> 200 mg/L (A)	4	393.0 419.0 430.9 455.4	09/12/2021 24/06/2022 22/12/2022 20/07/2023	Aesthetic parameter natural to source water
Walhallow	pH	< 6.5, >8.5 (A)	1	5.36	13/09/2021	One off anomaly
	Total hardness as CaCO3	> 200 mg/L (A)	6	367.9 374.7 382.0 400.1	27/10/2021 08/12/2021 24/06/2022 22/12/2022	Aesthetic parameter natural to

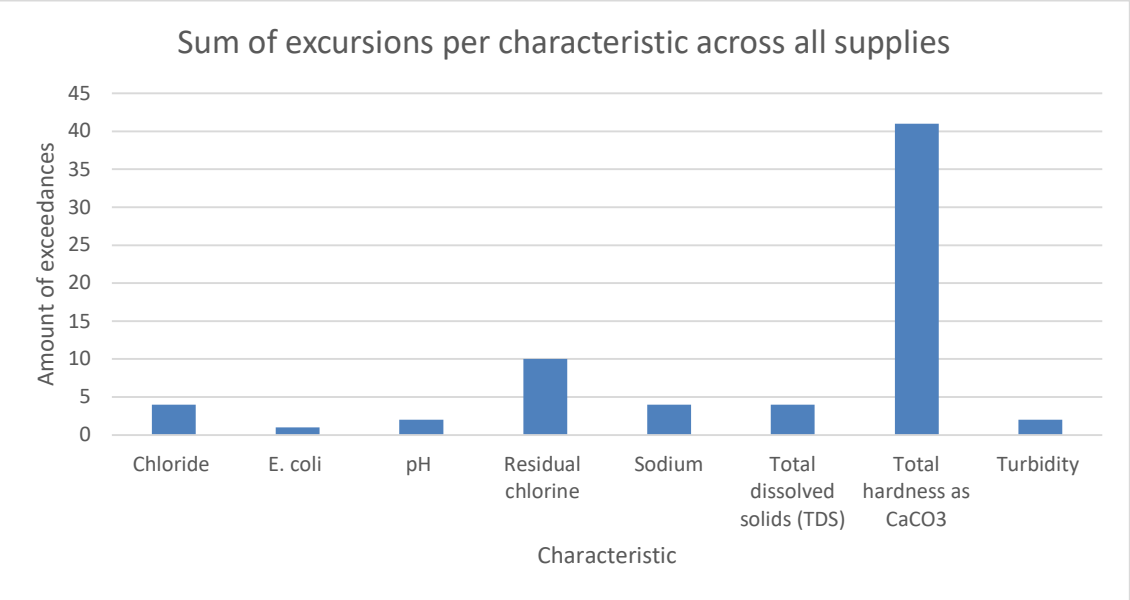
Location	Parameter	ADWG limit	Exceedance Count	Exceedance values	Exceedance Date	LPSC response
				403.7 439.5	20/07/2023 24/11/2023	source water
Wallabadah	E. coli	> 0 mpn/100mL (H)	1	2.0	01/02/2023	Response identified low chlorine dose, corrected and discussed with NSW Health BWA issued
	Residual chlorine	< 0.2, > 5 mg/L (H)	1	0.05	12/03/2024	Sampling officer undertaking routine verification program samples. Checked by water operator and found to be suitable chlorine, sampling procedure refreshed with sampling officer.
	Total hardness as CaCO3	> 200 mg/L (A)	5	430.8 431.2 451.9 439.4 494.2	09/12/2021 22/06/2022 22/12/2022 20/07/2023 22/11/2023	Aesthetic parameter natural to source water
	Turbidity	> 5 NTU (A)	1	15.0	16/09/2021	One off anomaly
Willow Tree	Residual chlorine	< 0.2, > 5 mg/L (H)	1	0.12	27/02/2024	Sampling officer undertaking routine verification program samples. Checked by water operator and found to be suitable chlorine, sampling procedure refreshed

Location	Parameter	ADWG limit	Exceedance Count	Exceedance values	Exceedance Date	LPSC response
						with sampling officer.
	Total hardness as CaCO3	> 200 mg/L (A)	5	366.5 372.9 403.5 377.2 432.9	09/12/2021 24/06/2022 22/12/2022 20/07/2023 24/11/2023	Aesthetic parameter natural to source water

5.3 Water quality discussion

There was one microbiological exceedance with ADWG health values in the reporting period that occurred at Wallabadah. This occurred on 31 January 2023 with a count of 2 mpn/100mL. The number of excursions for each parameter across all the systems was plotted in Figure 5-1. Total hardness as $CaCO_3$ had a sum of 41 excursions over the reporting period.

Figure 5-1. Sum of excursions per characteristic across all supplies (1st July 2021 – 30th June 2024)



During each water quality meeting, issues were discussed and recorded as summarised in Table 5-7. LPSC provided meeting records for 2022 and 2023.

Table 5-7. Summary of water quality meetings (5th May 2022 – 5th April 2023)

Date	Attendees	Agenda items
05/05/2022	Rod Batterham, Luke Whitten, Hank Shollenberger, Andrew Stevenson, Bryce James, Cameron Young, Mick McCreanor, Bill Stone, Nicky Kennewell and Jo Porter	- Leakage detection program - Meter reading - Plant sheets and fuel dockets - Timesheets - Plant assessor - Job cards - GIPA request - Sealing of repair patches - Cascade/Wang clamps - Risk assessments

Date	Attendees	Agenda items
		- Telemetry alarms - Quipolly water project cut-in - Operating performance ratio - OSMS and trade waste
02/06/2022	Rod Batterham, Luke Whitten, Hank Shollenberger, Bryce James, Cameron Young, Mick McCreanor, Bill Stone and Jo Porter	- Leakage detection program - Meter reading - Plant sheets and fuel dockets - Timesheets - Plant assessor - Job cards - Sealing of repair patches - Cascade/Wang clamps - Risk assessments - Telemetry alarms - OSMS - WASA – failure modes in pressurised pipeline systems - Performance appraisals - Email and phone protocols - Water outlook
27/07/2022	Rod Batterham, Luke Whitten, Hank Shollenberger, Andrew Stevenson, Bryce James, Cameron Young, Bill Stone and Jo Porter	- Water outlook - Water supply system checks
08/09/2022	Rod Batterham, Luke Whitten, Hank Shollenberger, Andrew Stevenson, Bryce James, Cameron Young, Bill Stone and Jo Porter	- DSEP meeting - Water Outlook - Standard minimum daily SCADA checks - RUOK day
19/10/2022	Rod Batterham, Luke Whitten, Hank Shollenberger, Andrew Stevenson, Bryce James, Cameron Young, Bill Stone and Jo Porter	- State cover self-assessment audit - Current projects - Water outlook – additions
02/03/2023	Rod Batterham, Luke Whitten, Hank Shollenberger, Andrew Stevenson, Bryce James, Cameron Young, Bill Stone and Jo Porter	-
05/04/2023	Rod Batterham, William Stone, Cameron Young, Hank Shollenberger, Andrew Stevenson, Luke Whitten, Bryce James, John Ringland and Jo Porter	-

Source: *Water Services' Meeting Minutes*

6 Consumer complaints

The consumer complaints received during the period are shown in Table 6-1. No data was provided for complaints filed in 2021. The majority of complaints occurred at Werris Creek over the reporting period.

Table 6-1. Water quality complaints

Date	Location	Details of complaint	Response
31/05/2022	Quirindi	Poor water quality – switched over from tank to mains.	Flushed at meter and cleaned.
06/01/2023	Werris Creek	Complaint regarding dirty water – found broken meter.	Replaced meter and flushed service until clean.
30/10/2023	Werris Creek	Meter blocked with rust from old gal.	Response not recorded or missing
08/02/2024	Werris Creek	Water is brown and unusable.	Response not recorded or missing
11/03/2024	Werris Creek	Muddy water. Valves not set the right way.	18/03/2024 – caller advised will be flushed following morning.
14/03/2024	Werris Creek	Strong colour from water as well as discolouration.	Response not recorded or missing
25/03/2024	Werris Creek	Fire hydrant needs to be flushed so that the water quality can improve.	Response not recorded or missing
03/04/2024	Werris Creek	Discoloured water complaint.	Response not recorded or missing
07/05/2024	Werris Creek	Customer complaint for bad tasting water.	Response not recorded or missing
30/05/2024	Quirindi	Plumbing issues due to quality of the water.	Response not recorded or missing
10/06/2024	Werris Creek	Dirty water complaint.	Response not recorded or missing
11/06/2024	Werris Creek	Water supply “very muddy” from all taps.	Response not recorded or missing
18/06/2024	Willow Tree	Poor water quality – water with bad taste and odour, build-up of calcium in pipes.	Response not recorded or missing

***Source**: LPSC weekly CRM report*

7 Water quality incidents

A summary of water quality incidents that occurred during the reporting period are outlined in Table 7-1. The number of water quality incidents is broken down by location in Figure 7-1 To date, there have been no incidents at Quipolly WTP.

Table 7-1. Summary of incident and emergencies, recommendations and preventive actions

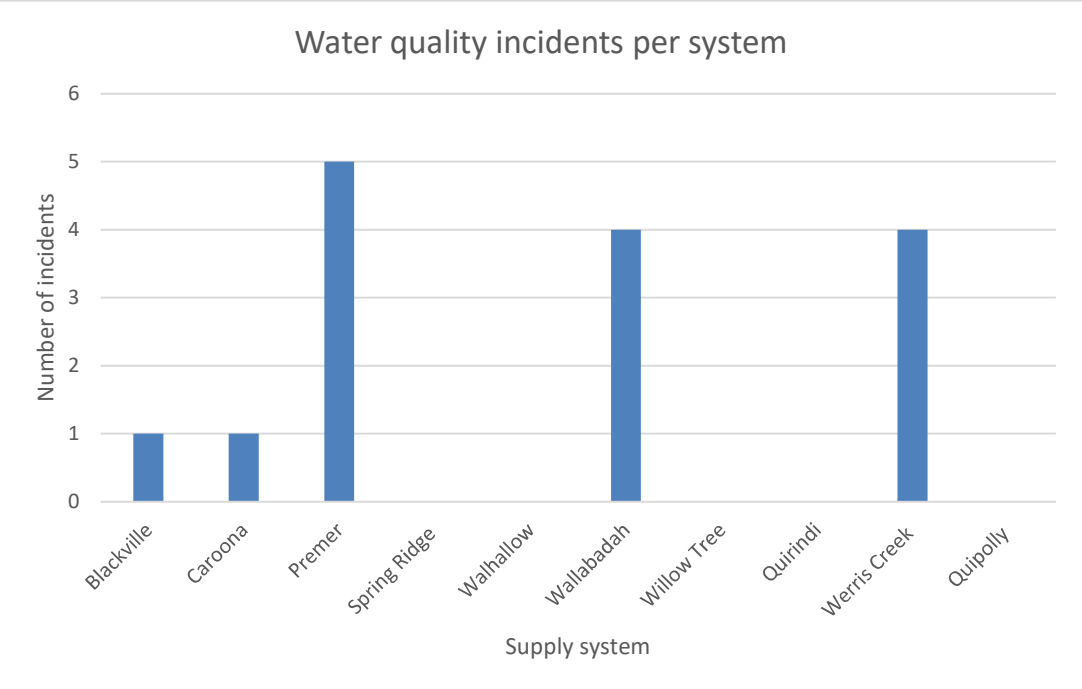
Date notified	Scheme	Details of incident/emergency	Investigation recommendations	Additional comments
17/08/2021	Caroona	Faulty non return valve at Cl2 dosing pump when bore was running. Sample was taken mid pump run and as system fills reservoir through reticulation excursions was recorded.	17/08/2021 sampled Storage Reservoir 0.68mg/L Free Cl2 and Dosed to 1mg/L. CCP sample point returned 0.65mg/L. WPS checked and faulty non return valve repaired. Dose rate returned to 0.98mg/L Free Cl2 at WPS. WPS run for 15mins. Dosing system to be confirmed as normal operation 18/08/2021.	
19/10/2021	Premer	CCP (sample tap) returned 0.02 mg/L Free CL2 & 0.14 NTU. Premer WPS site was checked, and no Sodium Hypochlorite was available within storage tank.	Onsite Storage tank had 20 L Hypo added WPS isolated @ 12:50pm. Reservoir was sampled @ 13:20pm and returned 0.28mg/L Free Cl2 & 0.14NTU. Reservoir was dosed to 1mg/L Total Cl2 @ 13:40pm. Extremities of distribution network were flushed to 0.60mg/L Free Cl2 (3 points - North End Bomera St, North & South End Elersile St) with NTU ranging from <0.50 - >1.10. WPS was returned to service with Bore Sample tap returning 1.27mg/L Free Cl2 & 0.47NTU. CCP (sample tap) was sampled @ 15:30pm and returned 0.98mg/L Free Cl2 & 0.12NTU	
26/10/2021	Blackville	CCP (sample tap) returned 0.37 mg/L Free CL2 & 0.05 NTU. Blackville WPS site was checked and leak discovered on the dosing line.	Leak repaired, reservoir dosed to 1mg/L Total CL2. Extremities of distribution network to be flushed until residual >0.5mg/L returned.	Follow up testing to occur 27/10/2021
04/11/2021	Premer	CCP (sample tap) returned 0.03 mg/L Free CL2 & 0.1 NTU. Premer WPS site was checked and no Sodium	Onsite Chlorine Storage tank refilled, dosing system primed and checked to be operating normally.	Follow up testing to occur 5/11/2021

Date notified	Scheme	Details of incident/emergency	Investigation recommendations	Additional comments
		Hypochlorite was available within storage tank. Investigation revealed excessively high water production rate used available chlorine, when CCP resolved will investigate for leakage in the system.	Actions to follow: confirm chlorine residual at the reservoir, dose to 1mg/L if required chlorinated water to be flushed through the system Follow up testing tomorrow to confirm corrective actions working.	
27/11/2021	Premer	Boil Water Alert. Bore failure associated with recent wet weather event.	Effective immediately water used for drinking or food preparation brought to a rolling boil to ensure it is safe.	
01/02/2022	Premer	Online Chlorclam device showed free cl2 started dipping low 31/01/2022. CCP sampled 01/02/2022 for Microbiology testing and returned 0.08mg/L Free Cl2, 0.42ntu. Samples still taken. Fitting on injection quill had split causing low rates of hypo dosed.	01/02/2022 Premer Reservoir sampled with return of 0.85mg/L Free Cl2, 0.60ntu. Premer CCP sampled at 0.08mg/L, 0.40ntu. Premer WPS - Fitting replaced and dosing returned to approx. 1.00mg/L free cl2. with main flushed via pumping to reservoir.	Follow up monitoring via online analyser to occur 2nd/3rd/4th February 2022.
05/08/2022	Premer	Boil Water Alert. Flooding in Coxs Creek resulted in Council unable to ensure Premer Water supply is safe.	Effective immediately water used for drinking or food preparation brought to a rolling boil to ensure it is safe.	
02/09/2022	Werris Creek	CCP breaches at Filter 1, 2, and 3. Turbidity ex-clarifier was in the order of 5NTU and the alum pump was blocked. The final water (clear tank) was tested with the following results: 1.74mg/L free chlorine, 0.14 NTU turbidity (over last 5 days: Free chlorine: 1.37-1.66mg/L, turbidity: 0.08-0.16 NTU)	The WTP was shut down, the clarifier lowered and alum manually broadcast and left to settle. The filters have been backwashed. The alum pump is being cleared. Once the alum pump is operating the plant will run with filter to waste until stable results within CCP's are achieved then the WTP will be returned to service.	
02/02/2023	Wallabadah	Detection of 2 mpn/100mL E.coli in routine monitoring program sample.	Planned to resample for E.coli using a repeat label. Check chlorine and turbidity at key system locations: distribution sample tap, reservoirs, bore and well.	
02/02/2023	Wallabadah	CCP breached: free chlorine at East Reservoir.	Dosed reservoirs commenced flushing low chlorine water from system repeat sample collected.	

Date notified	Scheme	Details of incident/emergency	Investigation recommendations	Additional comments
02/02/2023	Wallabadah	Boil Water Alert. A failure of the treatment system has resulted in Council being unable to ensure that the Wallabadah Water supply is safe to drink.	Effective immediately water used for drinking or food preparation brought to a rolling boil to ensure it is safe.	
26/02/2024	Wallabadah	CCP breached: free chlorine residual.	Reservoir dosed to 1.0mg/L and flushed through system. Cause traced to a leak (split) in dosing hose at the pump station which has been repaired. Left dosing at 1.29mg/L after repair Note that chlorine analyser offline for maintenance.	

***Source**: LPSC Incident reports*

Figure 7-1. Water quality incidents per system



8 Staff development and training

Table 8-1 lists staff training undertaken in the reporting period.

Table 8-1. Summary of staff training

Name	Training course	Provider	Year
Cameron Young	Tag & Test	Allens Training	December 2022
	Traffic Controller	Australian Training plus	December 2022
	Traffic Management Implementer	Australian Training plus	
William Stone	Safety Committee Training	Safety Australia Group	February 2023
Rodney Batterham	Safety Committee Training	Safety Australia Group	February 2023

Source: *Water staff training summary*

9 Continuous improvement plan

LPSC maintain a continuous improvement plan to track actions that drive water quality improvement. Continuous improvement plan actions that have been completed are listed in Table 9-1. A DWMS improvement plan was initially created in 2012 by AECOM.

As part of an improvement plan revision in 2022, pending actions from the 2012 improvement plan were consolidated with the 2022 risk workshop outcomes and transferred to the new improvement plan. Progress of current improvement items are shown in Table 9-2. ***Note:*** No review of the improvement plan has been undertaken in this period.

Table 9-1. History of DWMS improvement plans revisions

Actions	Completed	To start	Underway	N/A	Total actions
2012 Improvement plan	84	7 (moved to 2022 improvement plan)	3 (moved to 2022 improvement plan)	5 (moved to 2022 improvement plan) 11 (reoccurring – no end date)	110
2022-onwards	0	72	2	-	74

Table 9-2. Continuous improvement plan activities that have been progressed, completed or added during the period 2021-24

Supply	Action	Priority	Timeframe	Status	Who is responsible
All groundwater supplies	Seal any gaps (e.g. via electrical conduits and/or plates) at the borehead	High	01/12/23	To start	WSE
All groundwater supplies	Investigate multiple barrier for protozoa (e.g. filtration or UV disinfection).	High	01/12/24	To start	WSM
All groundwater supplies	Investigate online turbidity monitoring at the bores.	High	01/12/24	To start	WSM
All groundwater supplies	Undertake event-based turbidity monitoring (e.g. rain events) and develop a response plan.	High	01/06/23	To start	WSE/WSS
All groundwater supplies	Consider the link between hardness and use of alternative sources of drinking water.	Low	01/12/24	To start	WSE
All groundwater supplies	Consider bore shutdown on chlorine pump faults. [Pump faults should consider no flow, no dosing and continued dosing]	High	01/12/24	To start	WSM
All groundwater supplies	As a project, tested for DBPs in the groundwater supplies (tie/link to event-based turbidity monitoring project).	Medium	01/12/23	To start	WSE/WSS
All groundwater supplies	Investigate individual networks for identifying low chlorine areas and need for a flushing program - village supplies.	Medium	01/12/24	To start	WSS
All supplies	Consider public signage in the catchment to report pollution /	Medium	01/12/24	To start	WSM / WSE

Supply	Action	Priority	Timeframe	Status	Who is responsible
	other significant issue (start can be made at Quipolly Dam, signage development can be coordinated with other signs that will be developed for the new WTP).				
All supplies	Implement pesticides monitoring in partnership with HNELHD, every 2 years for surface water and every 5 years for groundwater. Implement radiological monitoring in partnership with HNELHD, every 5 years for surface water and every 2 years for groundwater.	Medium	01/06/23	To start	WSE / WSS
All supplies	Develop a schedule for parameters to be periodically monitored in water (e.g. pesticides every 2 years in surface water and radiology every 5 years for surface water, vice versa for groundwater).	Medium	01/12/23	To start	WSE
All supplies	Develop a protocol/procedure for notification of THMs exceedances to the PHU.	Medium	01/12/22	To start	WSE
All supplies	Consider review of high level chlorine as CCP critical upper limit to operational monitoring (with target/actions).	Medium	01/12/22	To start	WSE
	Document procedure for response to chloroclam alarms.	High	01/12/22	To start	WSE / WSS
	Review and consider implementation of chlorine gas as part of future upgrades.	Medium	01/12/24	To start	WSM / WSE
	Critically review the roof structure and access points/vents/overflows for reservoirs and clear water tanks, and implement a program to rectify defects.	High	01/12/23	To start	WSE / WSS
	Implement a works order process for following up on actions from the reservoir inspection undertaken weekly/fortnightly.	High	01/12/22	To start	WSS
	Consider increasing the frequency of detailed reservoir inspections (monthly or quarterly).	Medium	01/12/22	To start	WSE / WSS
	Consider implementing a drone inspection program.	Medium	01/06/23	To start	WSM/ WSE
	Consider documented internal integrity inspection as part of reservoir cleaning.	Medium	01/12/23	To start	WSE
	Consider a programmed cleaning schedule for all reservoirs (3-yearly).	High	01/06/23	To start	WSM / WSE

Supply	Action	Priority	Timeframe	Status	Who is responsible
	Document procedure for mains repairs, including flushing and testing following repairs (e.g. chlorine and turbidity).	Medium	01/12/23	To start	WSE / WSS
	Review SOP on new main installations.	Medium	01/12/23	To start	WSE / WSS
	Document all bypasses and valves, and establish a supervisory/administrative control on bypass activation, if needed.	Medium	01/12/23	To start	WSE / WSS
	Fully implement the backflow prevention program (including education program). Evaluate its effectiveness in 12 months.	High	01/12/23	To start	WSM / Trade Waste Officer
Blackville	Replace the bore.	High	01/12/24	To start	WSM
Premer	Replace the bore.	High	01/12/24	To start	WSM
Quirindi	Refurbish bores 7 and 8 (Quirindi).	High	01/12/24	To start	WSM
	Consider a hood on top of the aerator	High	01/12/24	To start	WSM/WSE
	Document the inspection and maintenance procedure for the aerator.	Medium	01/12/23	To start	WSS
	Review procedure for manual tablet dosing.	Medium	01/06/23	To start	WSE
	Remove / physically separate the connection between old system and new system (Quirindi). Develop a protocol for disconnecting potential cross connections.	Medium	01/12/24	To start	WSM/WSE
Spring Ridge	Construct new bore (approx. 2023) and refurbish existing bore (Spring Ridge).	High	01/12/23	To start	WSM
Wallabadah	As a project (for Wallabadah), consider raw water testing and investigating links to fractured zones and identify links to response actions.	Medium	01/06/23	To start	WSE/WSS
Werris Creek	Verify if properties in the dam catchment have been identified and prioritised for inspection.	High	01/06/24	To start	Trade waste officer / WSM
	Engage with Local Land Services (LLS) on farming practices that can have an impact on water quality in the catchment.	Low	01/12/24	To start	WSM
	Consider further investigation on water quality impacts from industry in the catchment (Equine Horses) in light of the new WTP.	Medium	01/12/24	To start	WSM / WSE
	Council to seek further advice from water Unit / other experts in relation to endocrine disrupters	Medium	01/12/23	To start	Water Services Engineer (WSE)

Supply	Action	Priority	Timeframe	Status	Who is responsible
	and drinking water quality related public health impact.				
	Document procedure on using boat, including basic service and maintenance.	Medium	01/12/24	To start	Water Services Supervisor (WSS)
	Review application of spill kit for spills in water.	Low	01/12/24	To start	WSE / WSS
	Review dam safety checklist to include some relevant water quality inspections.	Medium	01/06/24	To start	WSE
	Review jar testing SOP, including frequency of jar tests.	Medium	01/12/23	To start	WSS
	Install online raw water monitoring turbidity meter with new WTP, with alerts and shutdown (already planned).	High	01/12/24	To start	WSM
	Investigate destratification of the dam (already planned).	High	01/12/24	To start	WSM
	Werris Creek Review the algal response flow chart and plan for consistency and relevance.	Medium	01/12/23	To start	WSE
	Document the process on response to taste test at the WTP (e.g. CAR is raised, actions taken).	Medium	01/12/23	To start	WSS
	Develop an inspection sheet for clarifier.	Medium	01/12/23	To start	WSS
	Install telemetry/SCADA for clarified turbidity meter.	High	01/12/23	To start	WSM / WSE
	Maintain jar testing records (weekly and as required tests).	Medium	01/12/22	To start	WSS
	Undertake weekly testing of manganese to verify manganese management/control process.	Medium	01/12/22	To start	WSS / Operators
	Confirm/develop SOP for soda ash batching and drop test.	Medium	01/12/23	To start	WSS
	Develop a SOP on manual backwashing process	High	01/12/22	To start	WSS
	Investigate media depth and condition and need for any interim improvements.	High	01/06/24	To start	WSE / WSS
	Consider installation of online monitoring for individual filters, with alarms and auto shutdown, and automation of backwash process (with new WTP).	High	01/12/24	To start	WSM
	Consider installation of online chlorine analyser with alarms and auto shutdown.	High	01/12/23	To start	WSM
	Engineer out all raw water connections with the new plant/system.	Medium	01/12/24	To start	WSM
General	Review the proposed control measures identified within the LPSC Integrated Water Cycle	Low	01/12/24	To start	WSM

Supply	Action	Priority	Timeframe	Status	Who is responsible
	Management Strategy Concept Study and Integrated Water Cycle Management Plan, when reviewed and updated, to determine those that relate to water quality and should also be included in this Improvement Plan.				
	As per the outcomes of the drinking water quality risk assessment, identify whether EPA is monitoring private fuel supplies under POEO Act at the catchment across all 8 water supply systems.	Medium	01/06/23	To start	WSM
	As per the outcomes of the drinking water quality risk assessment, document the operator training and competency program across all water systems.	Medium	01/12/23	To start	HR
	Review documentation relevant to water supply systems to ensure review dates are specified (e.g. SOPs and checklists).	Medium	01/12/23	To start	WSM
	Develop a procedure that manages document control for all DWMS documentation (i.e. ensure the currency, accessibility and appropriate review of DWMS documents)	Medium	01/12/23	To start	WSM
	Develop internal audit procedures and schedules appropriate to functionality of LPSC and their water supply systems.	Low	01/12/24	Underway	WSM
	Implement the recommendations from the DWQ IERP Scenario Testing and Training exercise undertaken in June 2016, including revise the sampling procedure; develop a detailed reservoir inspection checklist for 6-monthly inspection; undertake monthly incident de-brief and discuss with FASS about receiving notifications via e-mail.	Medium	01/12/23	Underway	WSM
	Develop the procedures or address gaps from Table 5 in the DWMS related to key operational procedures.	Medium	01/12/24	To start	WSM
	Customer Service to better categorise water quality related Customer complaints.	Medium	01/12/23	To start	Customer service / WSM
	Review incident and emergency response plan (underway).	Medium	01/12/22	Underway	WSE

Supply	Action	Priority	Timeframe	Status	Who is responsible
	Populate water Outlook with appropriate documents and procedures.	Medium	01/12/23	To start	WSE
	Review data and trends and explore outliers (in general for all results/data).	High	01/06/23	To start	WSE/WSS
	Follow up chemical delivery in line with specification (batch certificates).	Medium	01/12/23	To start	WSS
	Investigate testing (titration) process of chlorine being delivered.	Medium	01/12/23	To start	WSS
	Consider need for a checklist to verify critical equipment (e.g. dosing pumps) are back online and working after a power failure event.	Low	01/12/24	To start	WSE/WSS
	Make the current processes of material (for contact with drinking water) procurement more robust.	Medium	01/06/24	To start	WSE
	Review calibration program (external) for chloroclam. Consider additional grab samples during the calibration exercise (when chloroclam is not in use).	High	01/12/22	To start	WSM/WSS
	Identify the SOPs/schedules/documents that are not part of the Quipolly project and utilise templates from the Quipolly project to inform writing of remaining/different ones.	Medium	01/12/24	To start	WSE/WSS

***Source**: LPSC DWMS improvement plan register*
***Note**: the following abbreviations used:*

- *WSM: Water services manager*
- *WSE: Water services engineer*
- *WSS: Water services supervisor*

10 Review of DWMS

Table 10-1. Summary of internal reviews

Date	Reviewer	Scope	Findings
5 July 2022	Luke Whitten Liverpool Plains Shire Council	Review by LPSC.	Finalising changes from the Viridis support project.

Table 10-2. Summary of external reviews

Date	Reviewer	Scope	Findings
2 June 2022	Tasleem Hasan Principal Drinking water Viridis	Review and update of the DWMS, following the risk assessment workshop.	Output of risk assessment process

NSW Health engaged Atom Consulting to facilitate a water quality risk assessment for the Quipolly WTP and update LPSC's DWMS with the outcomes of the Quipolly risk assessment and CCP review. The risk assessment was held on 25 June 2024. Atom Consulting are updating the DWMS with the changes associated with the Quipolly WTP risk assessment (predominately focussing on ADWG elements 2, 4 and 12). The DWMS review was not finalised within the reporting period covered by this report.

11 Reservoir inspections

A summary of the internal and external reservoir inspections completed in the period is included in Table 11-2 and Table 11-2.

External inspections were conducted by NSW DCCEEW water inspectors for the Quirindi Balance, Quirindi East, Quirindi North, Quirindi South, Werris Creek High Zone, Werris Creek Clear Water and Villages Water supplies. Table 11-2 summarises the findings and corrective actions of the external inspections.

Table 11-1. Summary of internal reservoir inspections (1st July 2021 – 30th June 2024)

Reservoirs inspected	Number of inspections	System checks
Blackville Caroona Premer Spring Ridge Wallabadah Willow Tree	Blackville – 71 Caroona – 70 Premer – 71 Spring Ridge – 71 Wallabadah – 52 Willow Tree – 56 Total = 391	Reservoir compound - Gate condition - Fence condition - Compound secure Reservoir electrical - Telemetry - RTU secure - Mast free of damage - Batteries (incl. terminals) Reservoir - Reservoir secure - Secure from vermin - Reservoir free of contaminants - No leaks, holes or gaps Secure from windborne contaminants
Werris Creek	550	WTP grounds and structures maintenance e.g. every third day routine weekly – reservoir integrity
Quirindi (2023 and 2024 only)	227	WTP grounds and structures maintenance

Table 11-2. Summary of external reservoir inspections (1 July 2021 – 30 June 2024)

Reservoirs inspected	Date	Next scheduled inspection	Findings and corrective actions
Werris Creek Water treatment plant	16/08/2022	2027	On-site testing and review of operational records indicated the CCP target for filtered water turbidity had been met. A sample reticulated town water indicated iron (0.39 mg/L) was above the ADWG aesthetic guideline value. Potential to cause staining and dirty water issues within the system.
Quirindi and Villages Water supplies	10/11/2022	2027	Treatment processes at each site found to be operating satisfactorily. CCP documentation available on site and CCP's adequately understood and monitored by operational staff.
Quirindi Balance Reservoir	06/12/2023	2028	
Quirindi East Reservoir	06/12/2023	2028	Some rust to access and egress components.
Quirindi North Reservoir	06/12/2023	2028	Outlet and overflow components heavily corroded.
Quirindi South Reservoir	06/12/2023	2028	Some rust to access and egress components. Internal walls and columns exhibit leaks.

Reservoirs inspected	Date	Next scheduled inspection	Findings and corrective actions
Werris Creek HZ Reservoir	05/12/2023	2028	
Werris Creek Clear Water	05/12/2023	2028	Some rust to access and egress components.

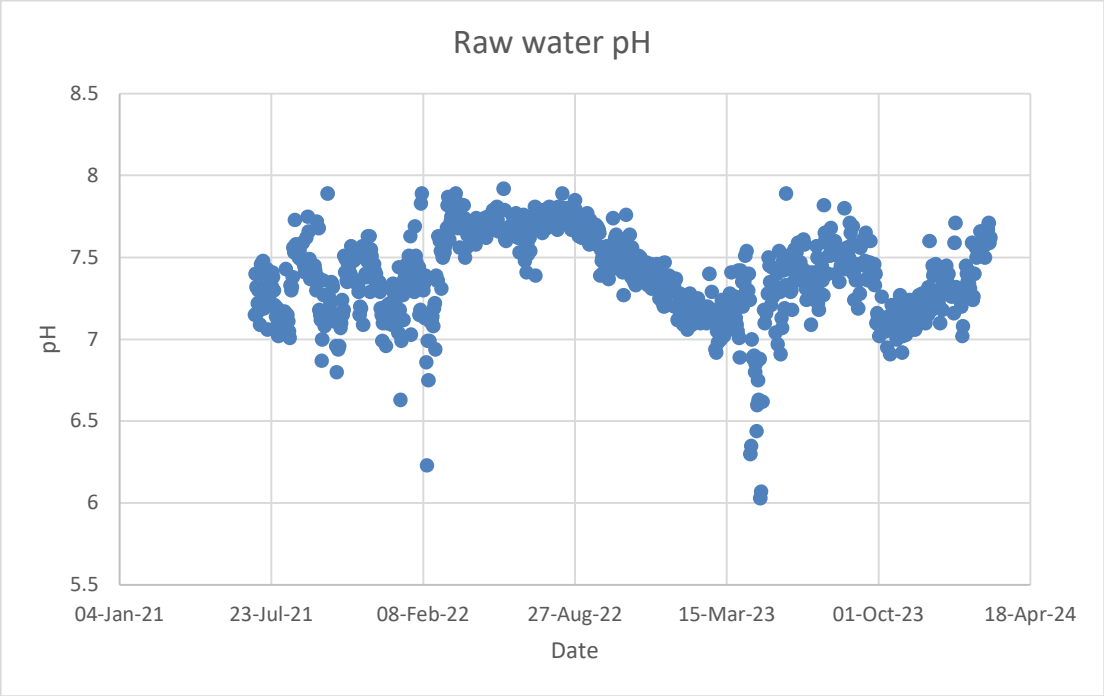
Appendix A Water quality data

A.1 Water quality graphs

A.1.1 Werris Creek

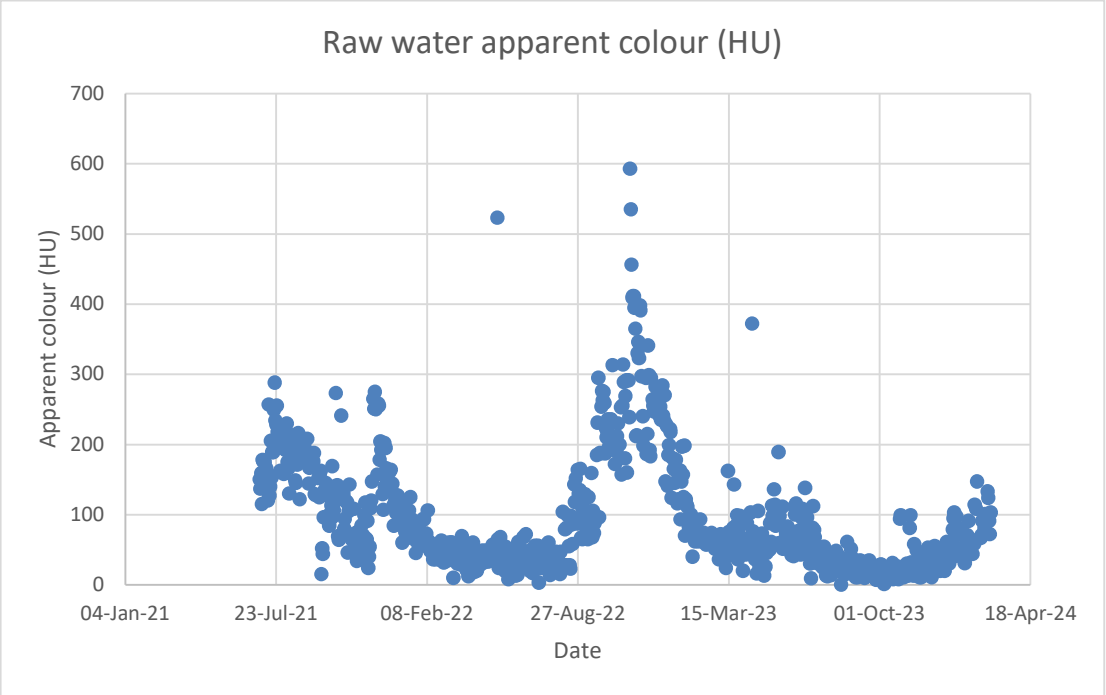
Figure A-1 to Figure 11-12 indicate the raw and treated water at Werris Creek in operation until 29 February 2024.

Figure A-1. Werris Creek raw water pH (1st July 2021 – 29th February 2024)



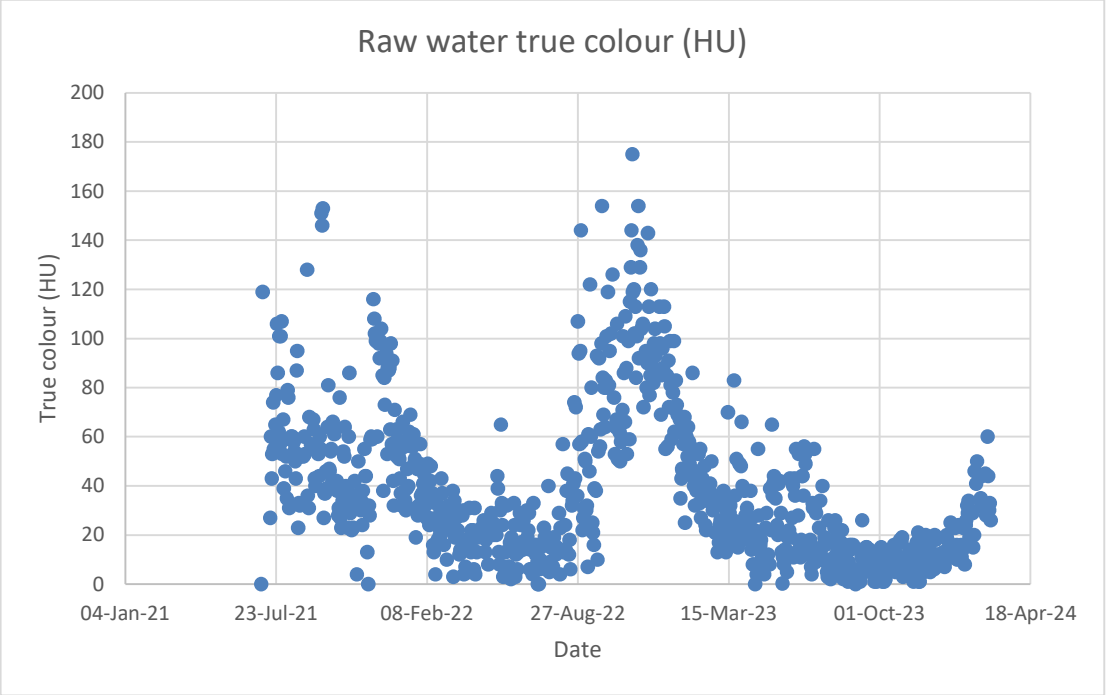
Source: *Werris Creek WTP*

Figure A-2. Werris Creek raw water apparent colour (1st July 2021 – 29th February 2024)



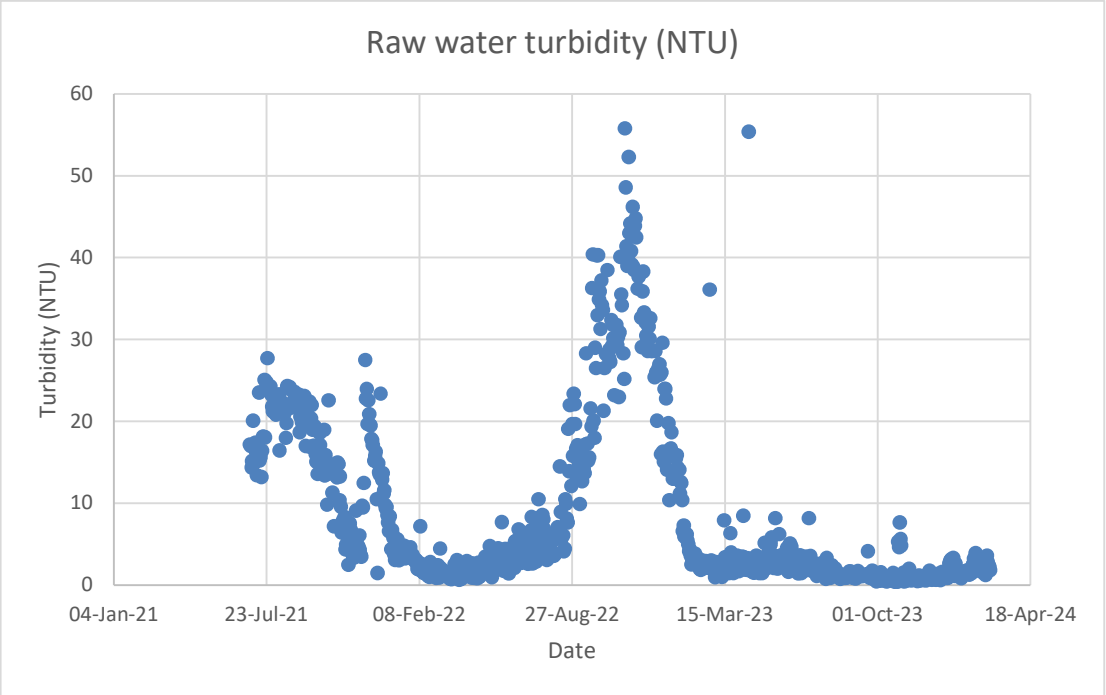
Source: *Werris Creek WTP*

Figure A-3. Werris Creek raw water true colour (1st July 2021 – 29th February 2024)



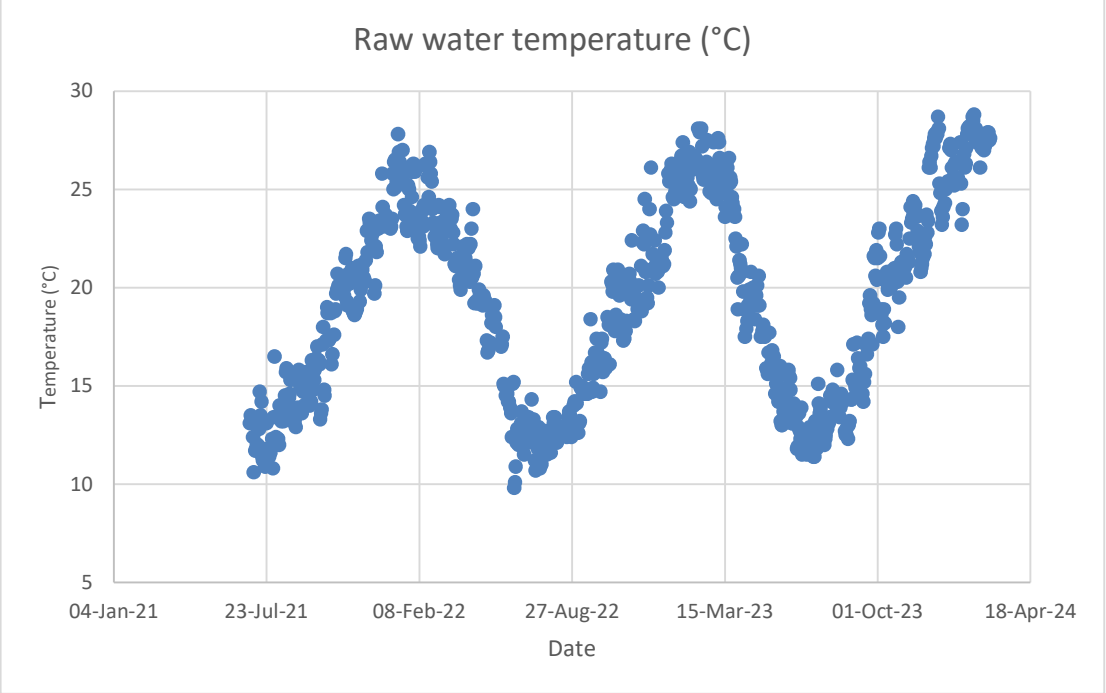
Source: *Werris Creek WTP*

Figure A-4. Werris Creek raw water turbidity (1st July 2021 – 29th February 2024)



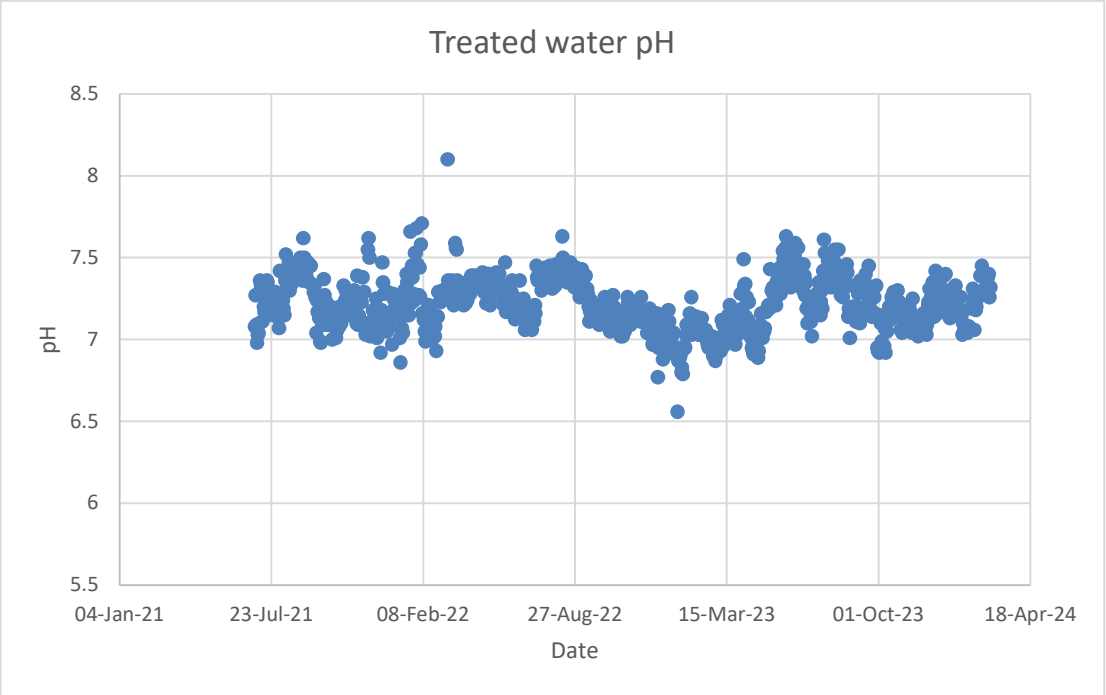
Source: *Werris Creek WTP*

Figure 11-5. Werris Creek raw water temperature (1st July 2021 – 29th February 2024)



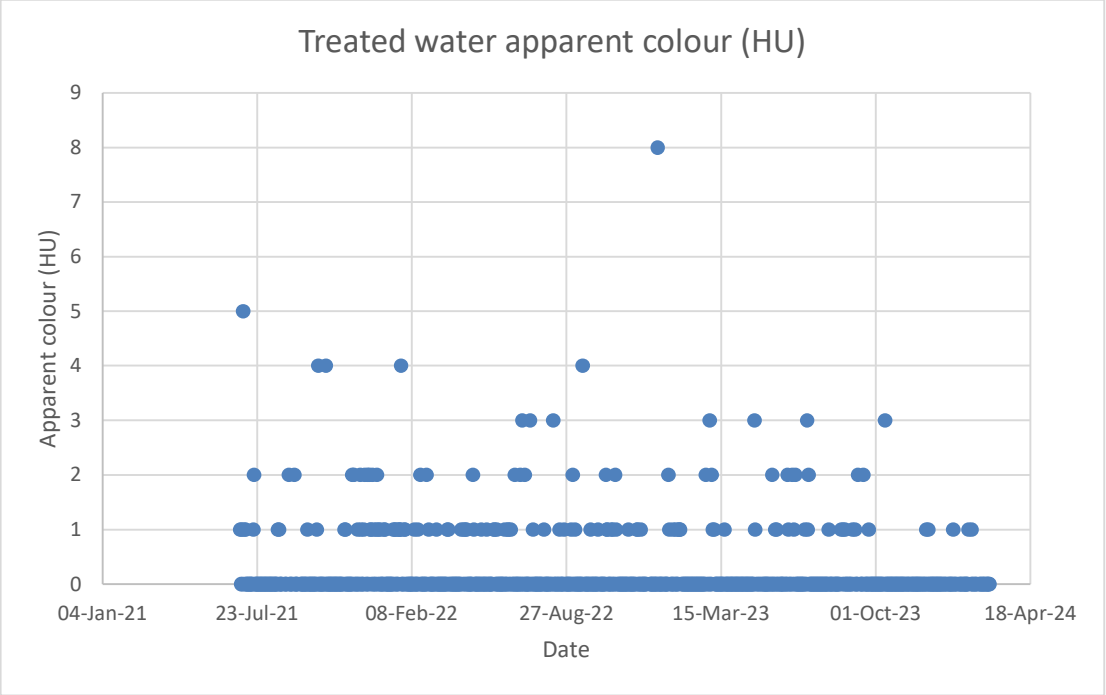
Source: *Werris Creek WTP*

Figure 11-6. Werris Creek treated water pH (1st July 2021 – 29th February 2024)



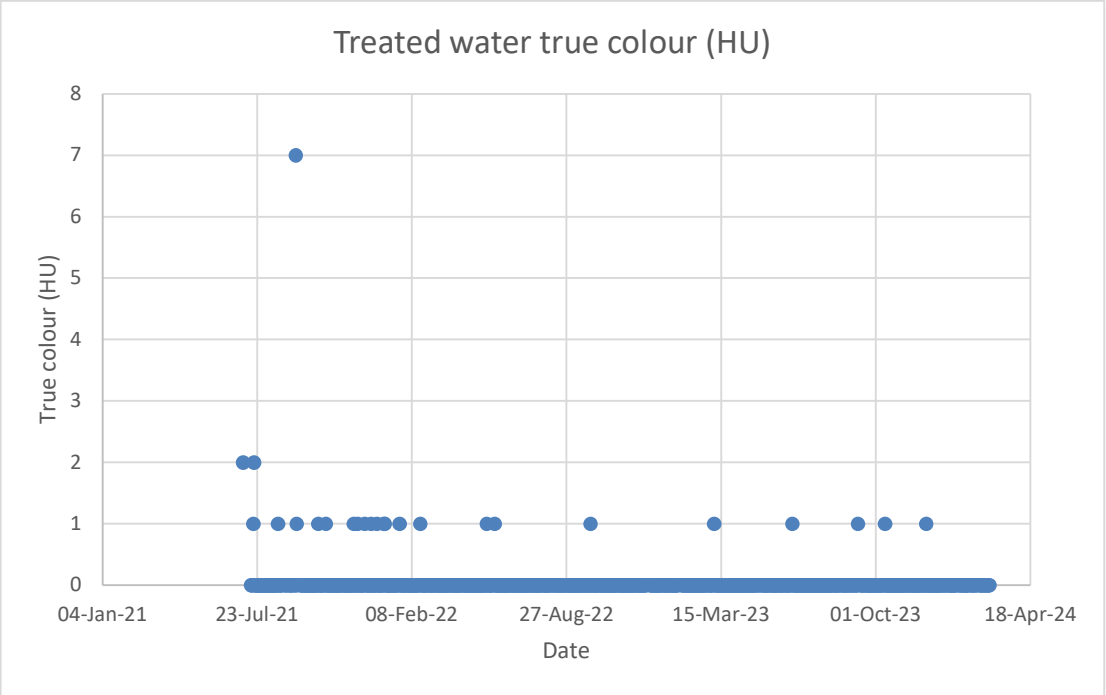
Source: *Werris Creek WTP*

Figure 11-7. Werris Creek treated water apparent colour (1st July 2021 – 29th February 2024)



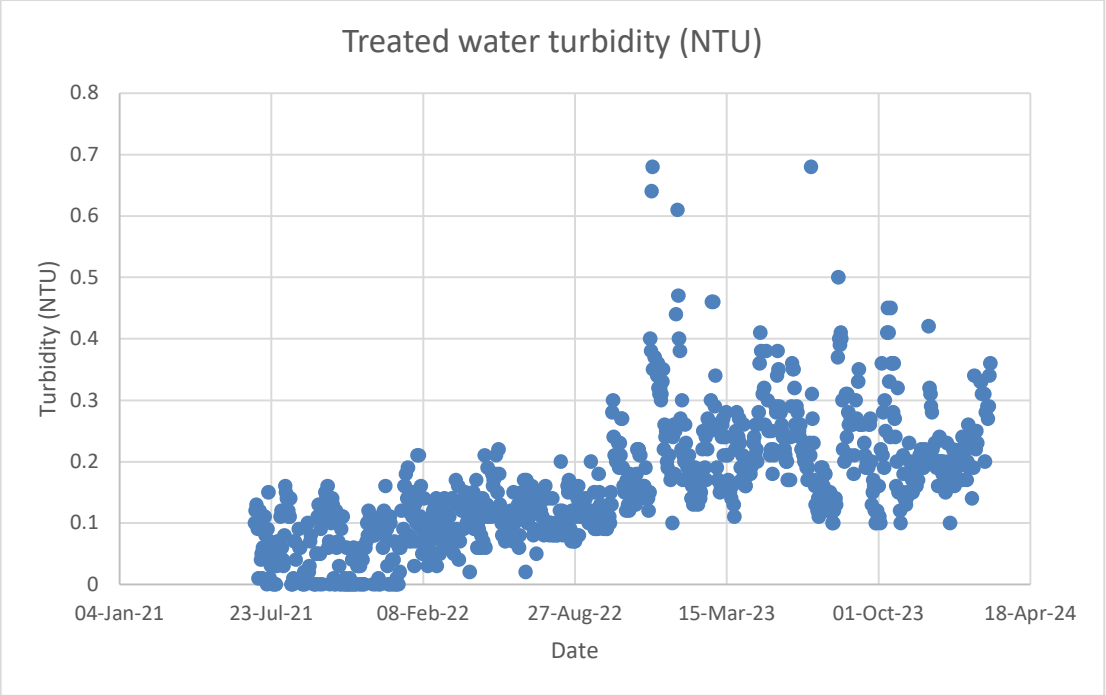
Source: *Werris Creek WTP*

Figure 11-8. Werris Creek treated water true colour (1st July 2021 – 29th February 2024)



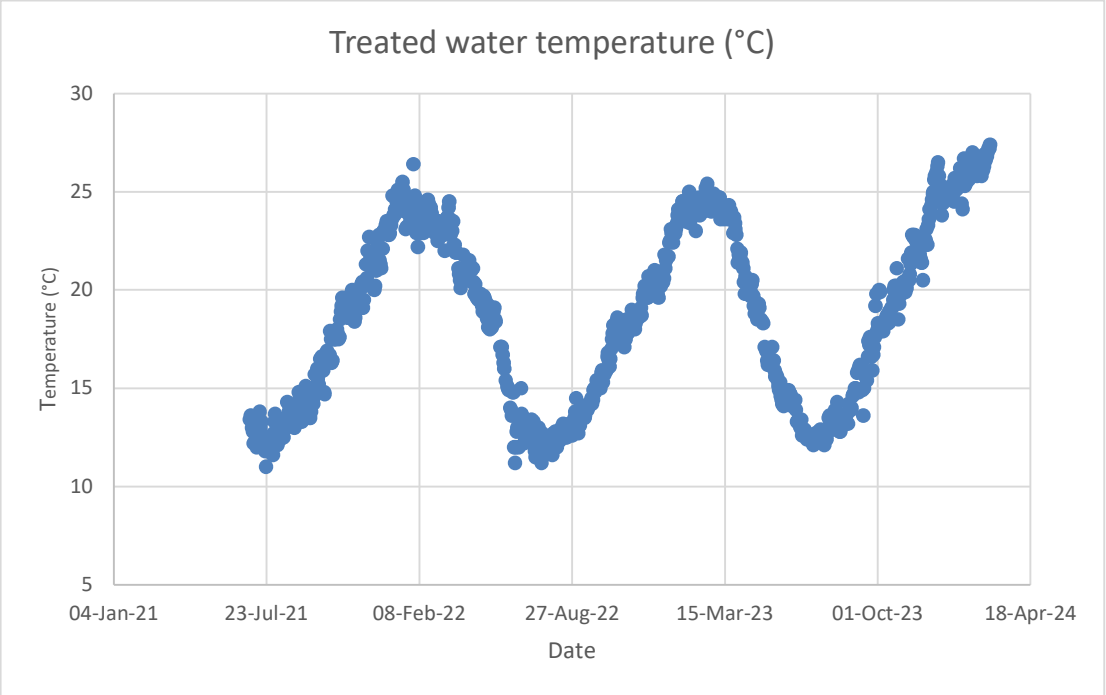
Source: *Werris Creek WTP*

Figure 11-9. Werris Creek treated water turbidity (1st July 2021 – 29th February 2024)



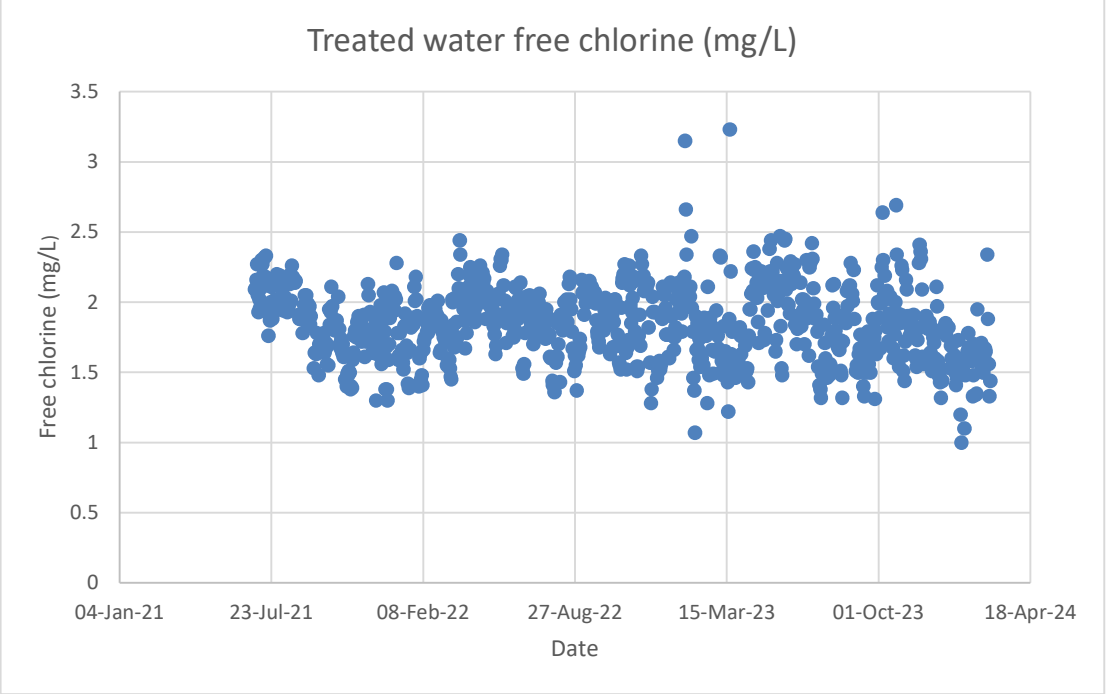
Source: *Werris Creek WTP*

Figure 11-10. Werris Creek treated water temperature (1st July 2021 – 29th February 2024)



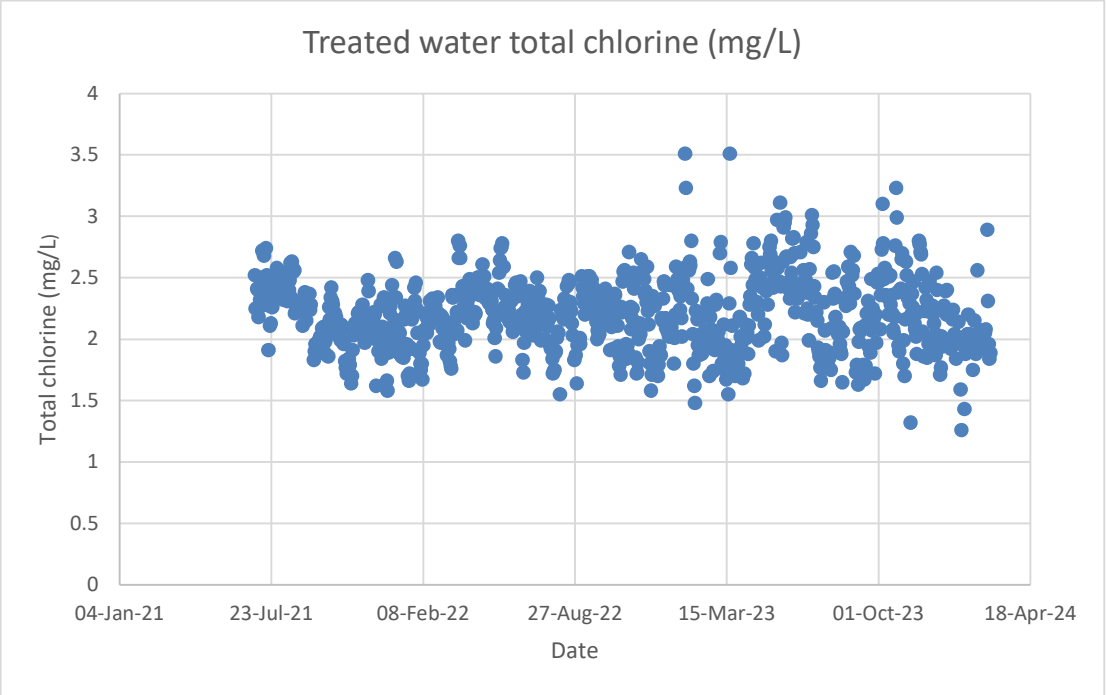
Source: *Werris Creek WTP*

Figure 11-11. Werris creek treated water free chlorine (1st July 2021 – 29th February 2024)



Source: *Werris Creek WTP*

Figure 11-12. Werris Creek treated water total chlorine (1st July 2021 – 29th February 2024)

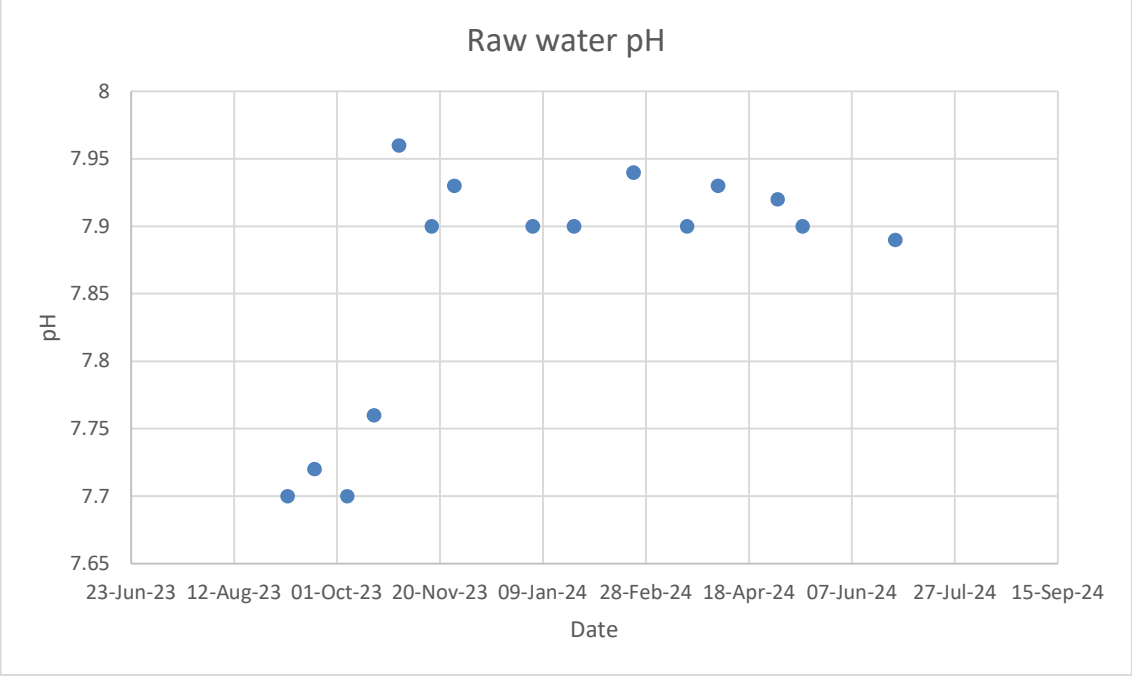


Source: *Werris Creek WTP*

A.1.2 Blackville

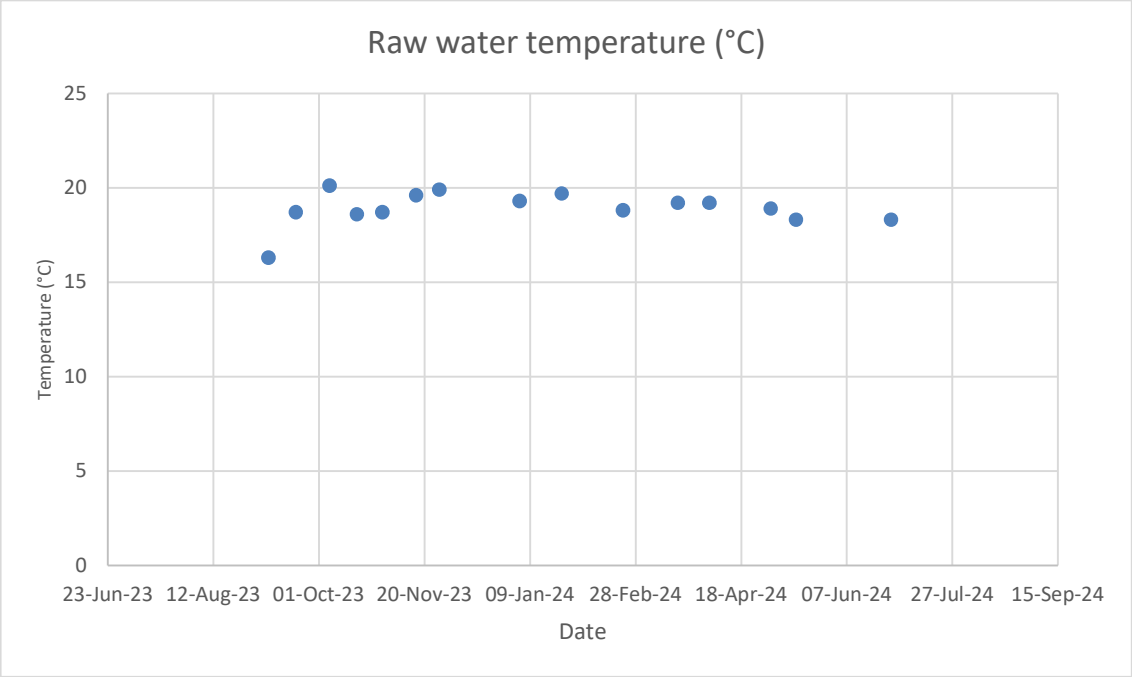
Figure 11-13 to Figure 11-16 indicate the raw and treated water at Blackville. Data was provided for the period 7 September 2023 to 30 June 2024. ***Note:*** Prior to this date, data was not being recorded.

Figure 11-13. Blackville raw water pH (7th September 2023 – 30th June 2024)



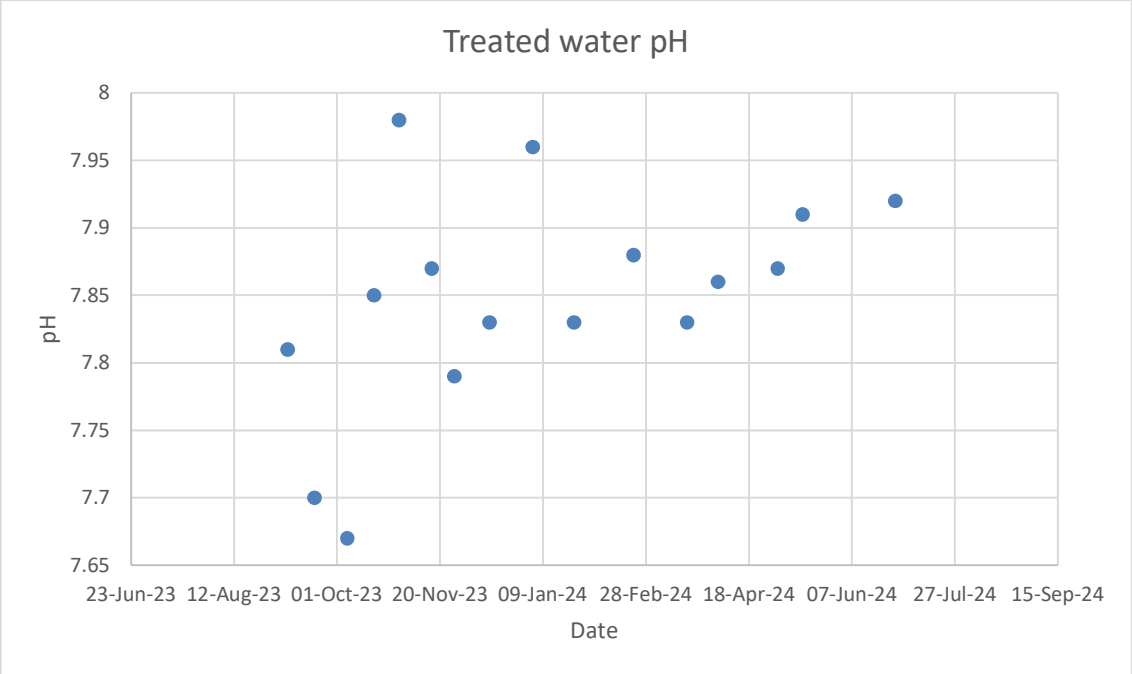
***Source**: Village Monitoring Data*

Figure 11-14. Blackville raw water temperature (7th September 2023 – 30th June 2024)



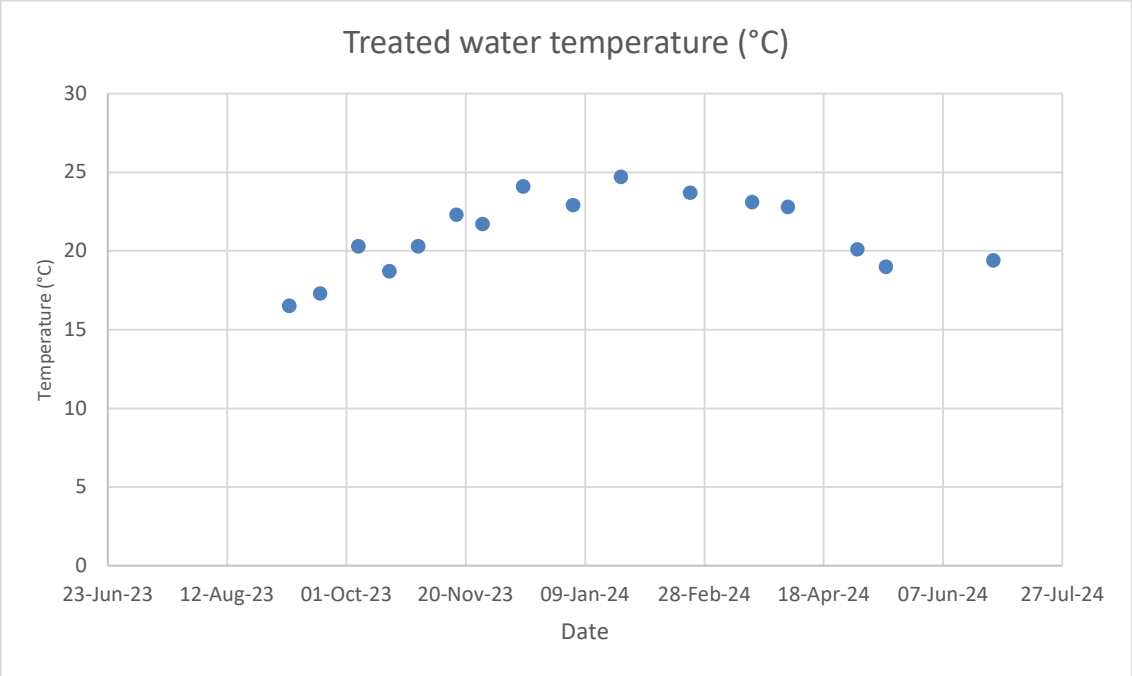
***Source**: Village Monitoring Data*

Figure 11-15. Blackville treated water pH (7th September 2023 – 30th June 2024)



***Source**: Village Monitoring Data*

Figure 11-16. Blackville treated water temperature (7th September 2023 – 30th June 2024)

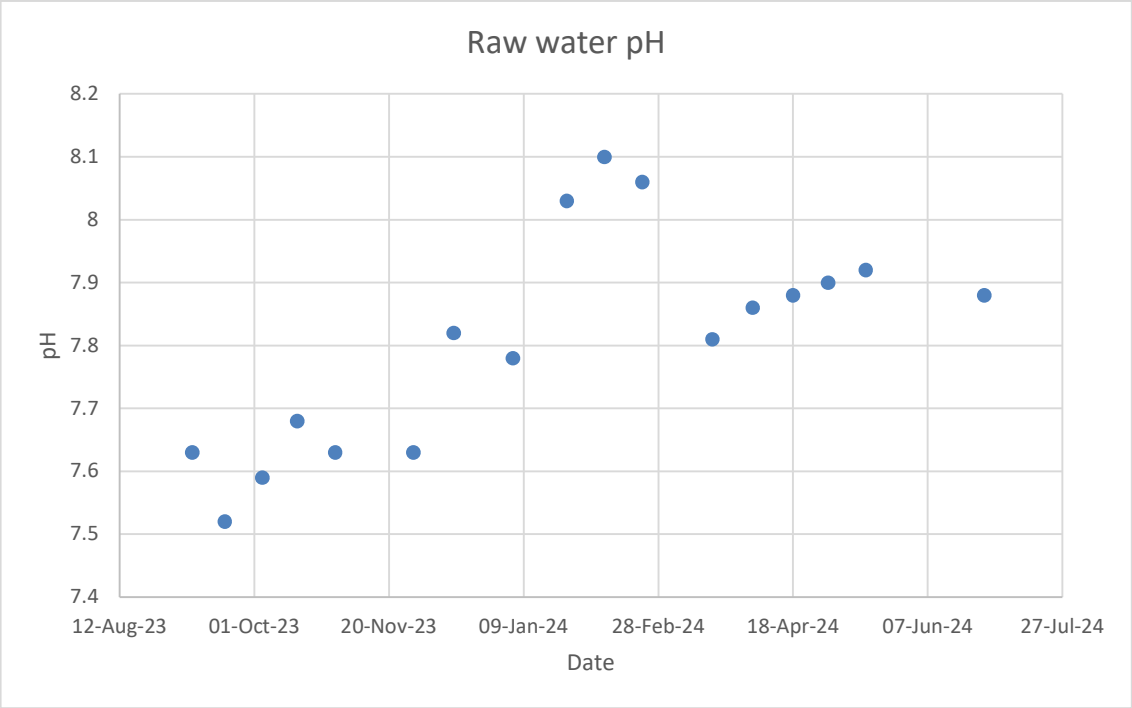


***Source**: Village Monitoring Data*

A.1.3 Caroona

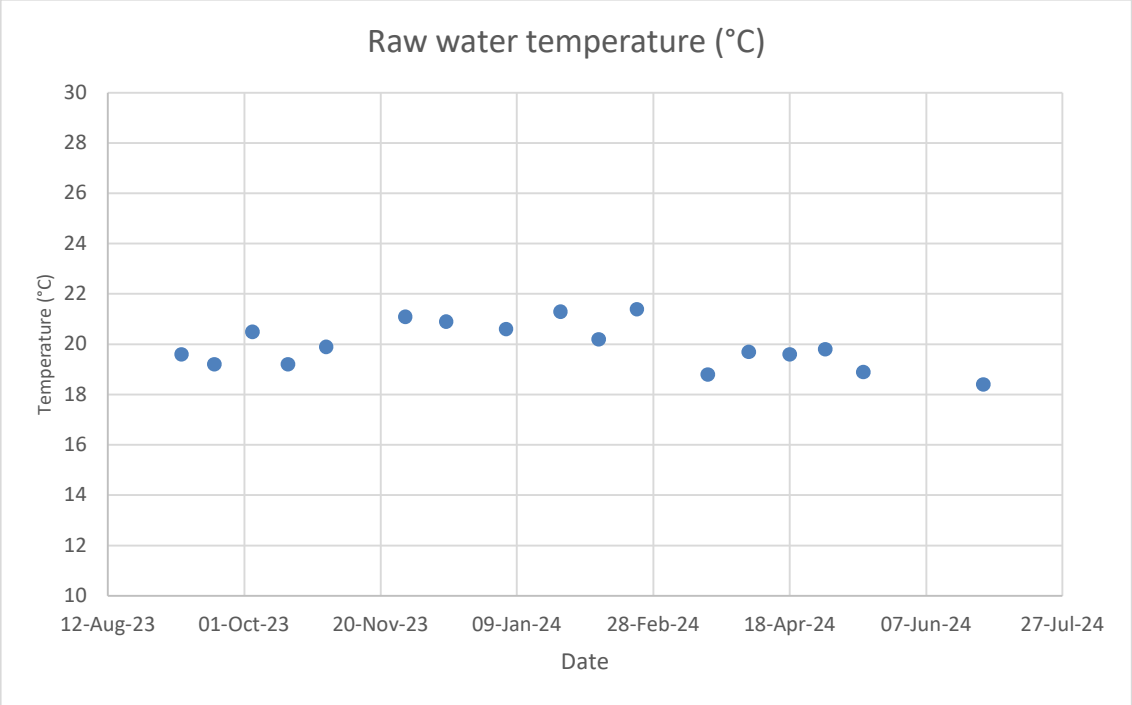
Figure 11-17 to Figure 11-20 indicate the raw and treated water at Caroona. Data was provided for the period 7 September 2023 to 30 June 202.

Figure 11-17. Caroona raw water pH (7th September 2023 – 30th June 2024)



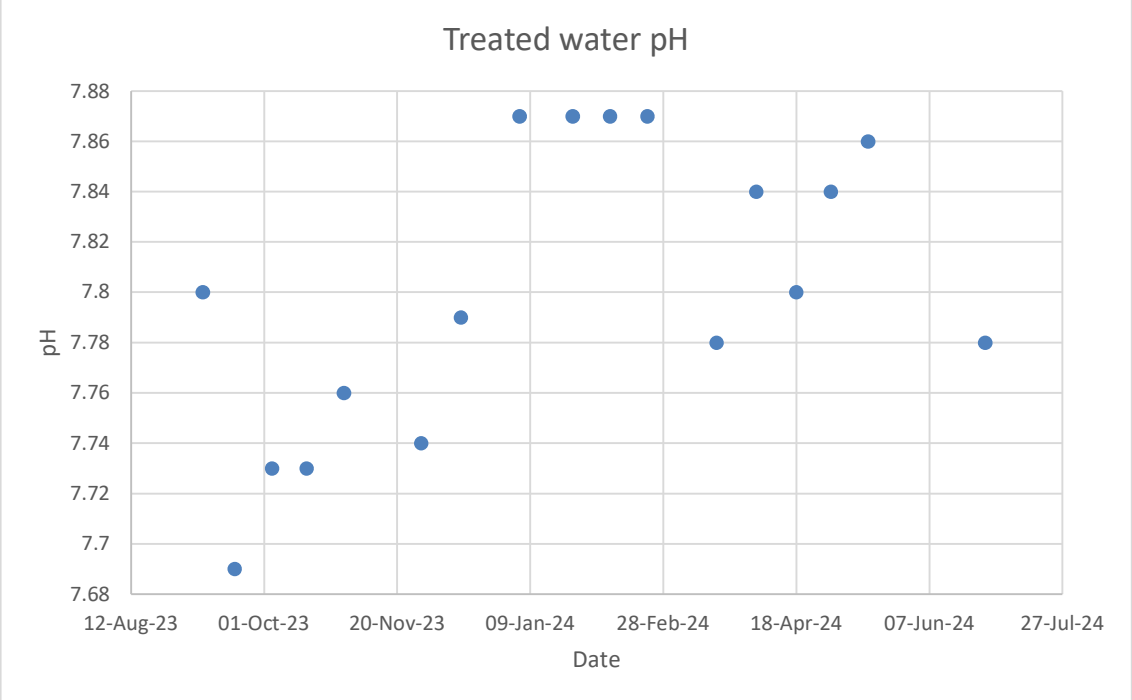
***Source**: Village Monitoring Data*

Figure 11-18. Caroona raw water temperature (7th September 2023 – 30th June 2024)



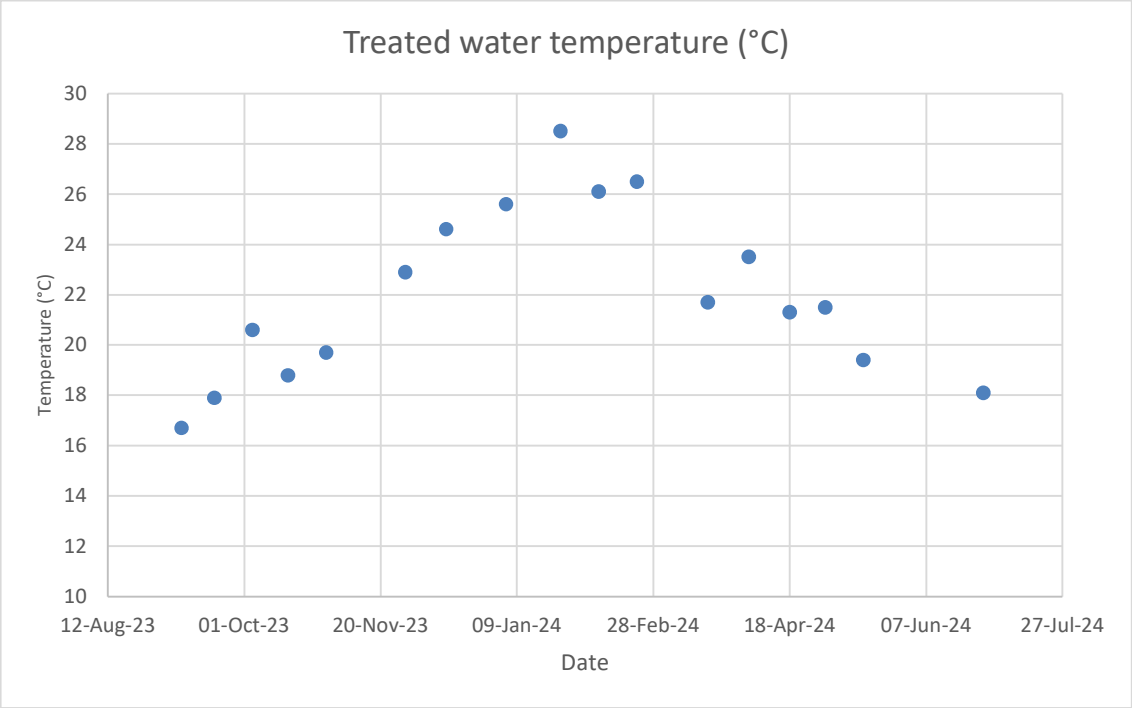
***Source**: Village Monitoring Data*

Figure 11-19. Caroona treated water pH (7th September 2023 – 30th June 2024)



***Source**: Village Monitoring Data*

Figure 11-20. Caroona treated water temperature (7th September 2023 – 30th June 2024)

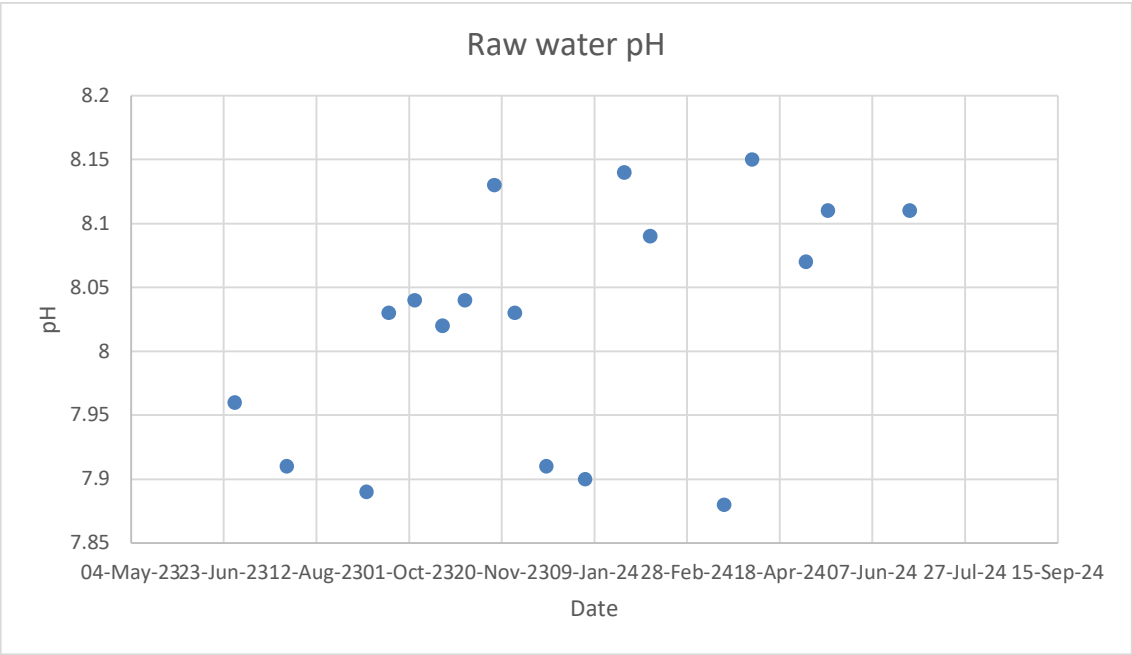


***Source**: Village Monitoring Data*

A.1.4 Premer

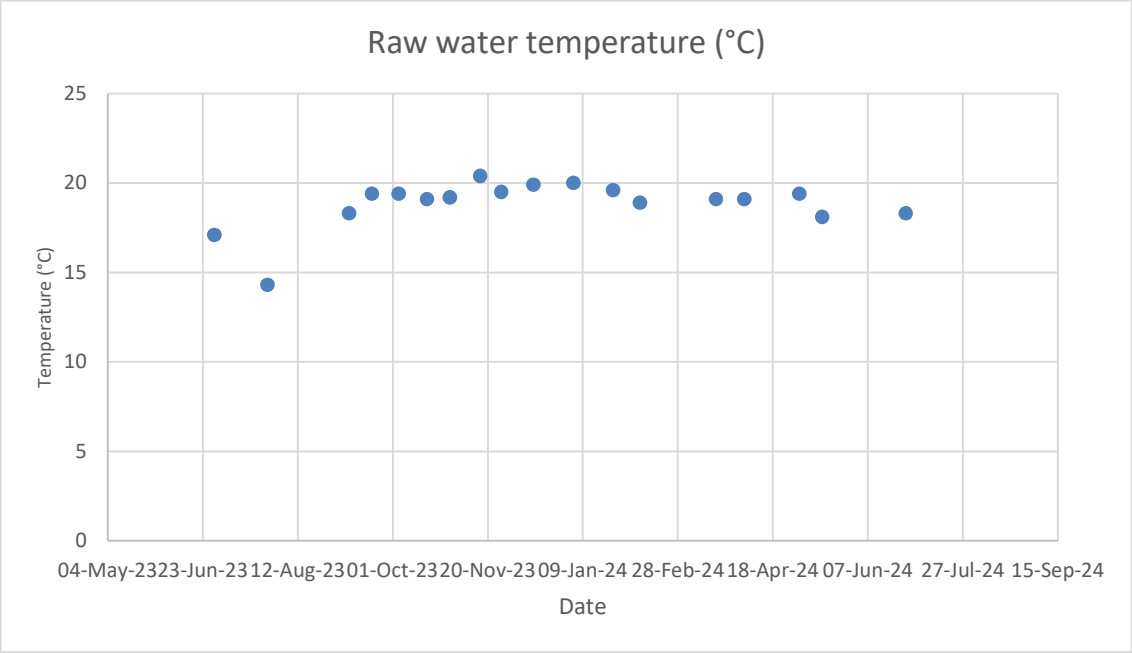
Figure 11-21 to Figure 11-24 indicate the raw and treated water at Premer. Data was provided for the period 29 June 2023 to 30 June 2024.

Figure 11-21. Premer raw water pH (29th June 2023 – 30th June 2024)



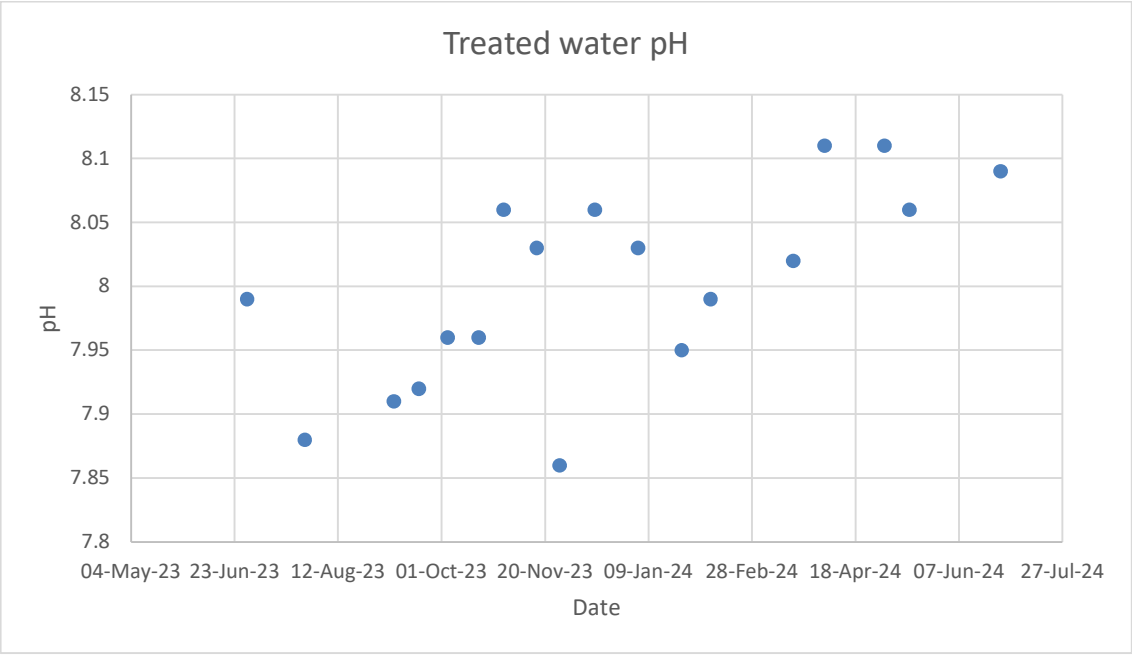
***Source**: Village Monitoring Data*

Figure 11-22. Premer raw water temperature (29th June 2023 – 30th June 2024)



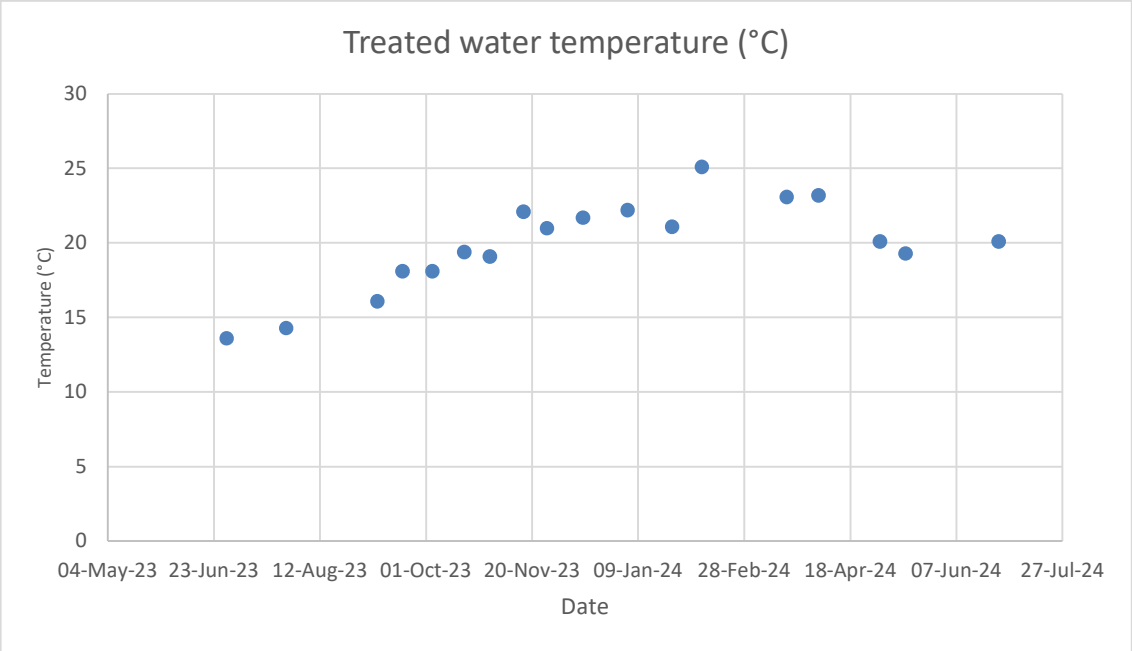
***Source**: Village Monitoring Data*

Figure 11-23. Premer treated water pH (29th June 2023 – 30th June 2024)



***Source**: Village Monitoring Data*

Figure 11-24. Premer treated water temperature (29th June 2023 – 30th June 2024)

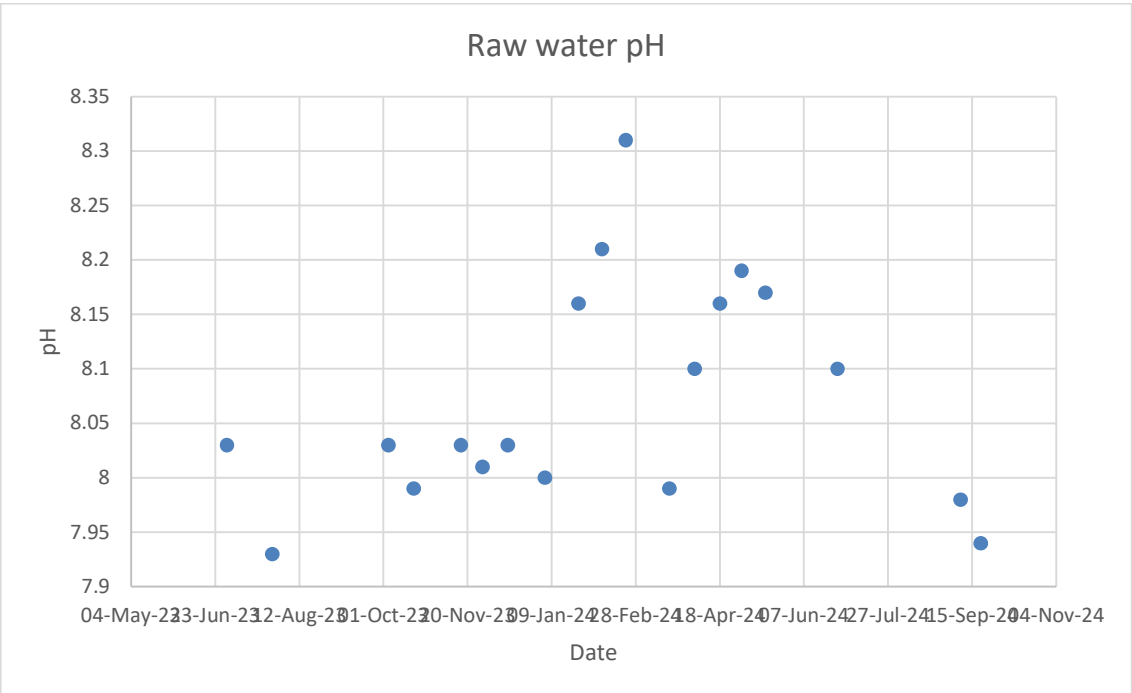


***Source**: Village Monitoring Data*

A.1.5 Spring Ridge

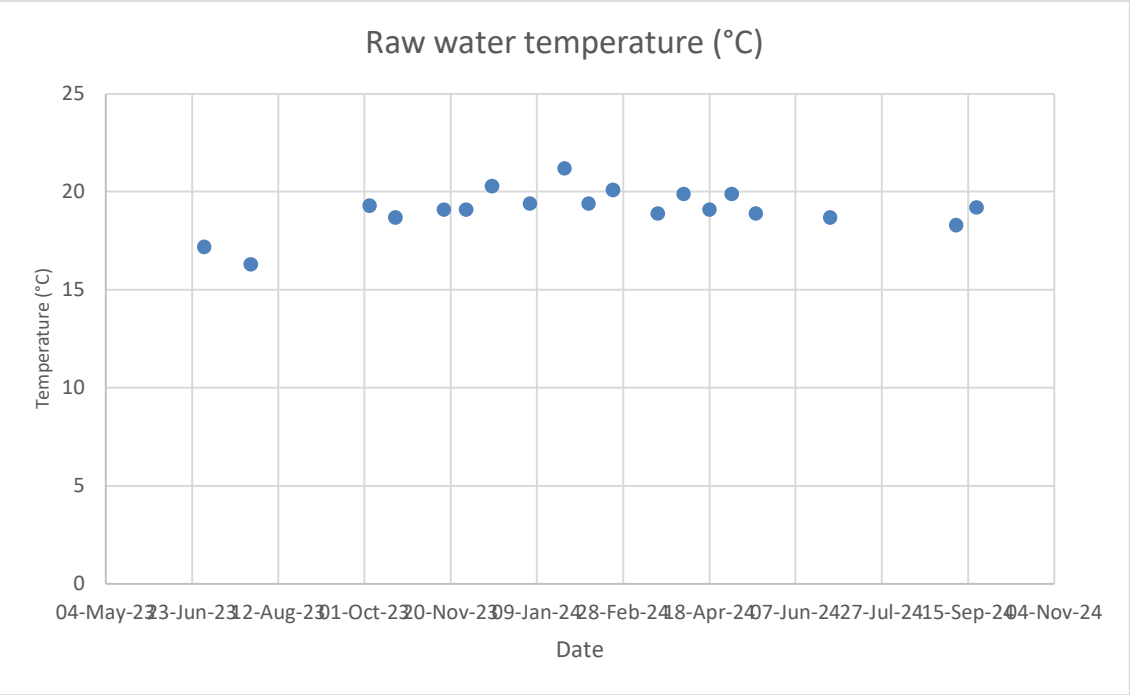
Figure 11-25 to Figure 11-28 indicate the raw and treated water at Spring Ridge. Data was provided for the period 30 June 2023 to 30 June 2024.

Figure 11-25. Spring Ridge raw water pH (30th June 2023 – 30th June 2024)



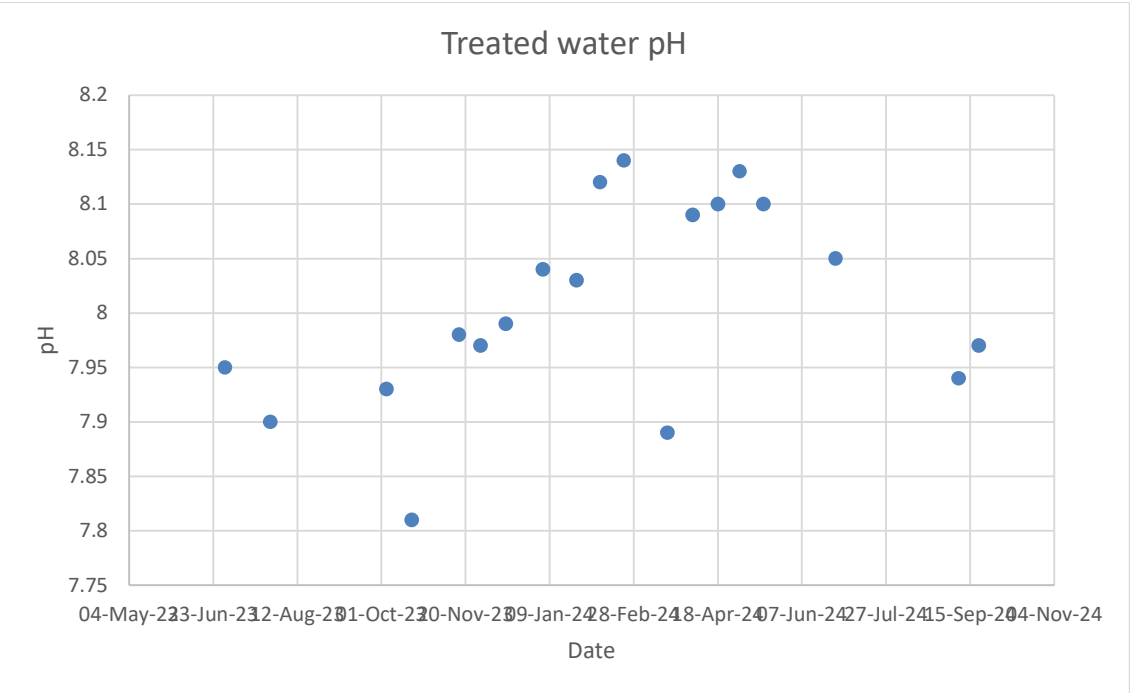
***Source**: Village Monitoring Data*

Figure 11-26. Spring Ridge raw water temperature (30th June 2023 – 30th June 2024)



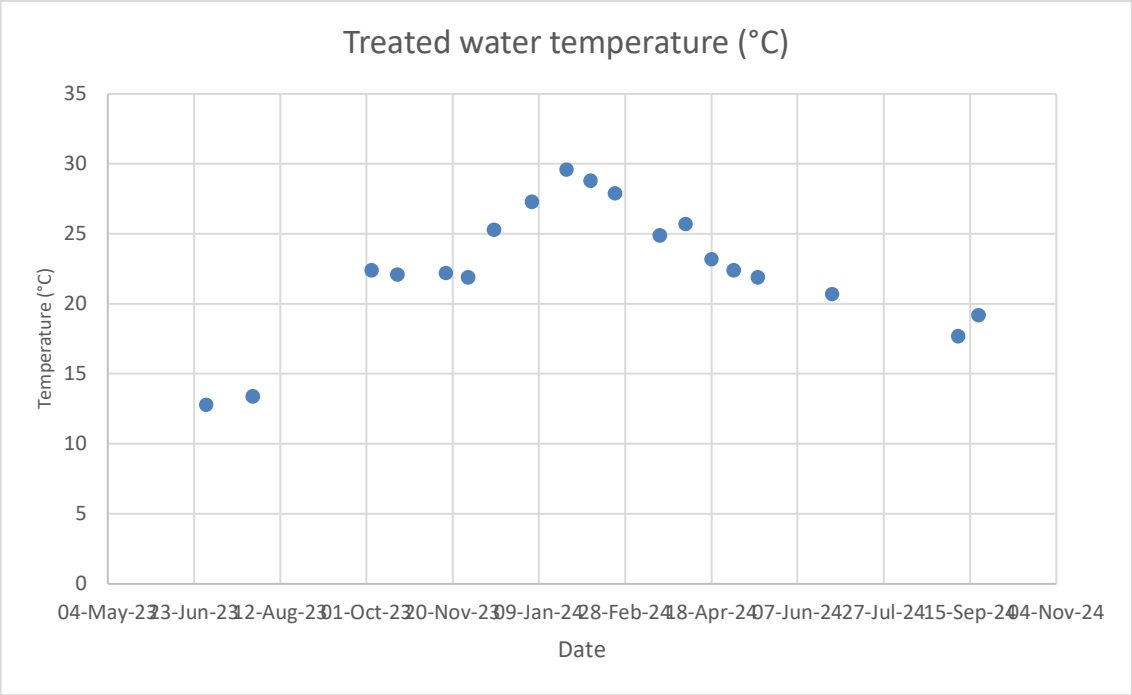
***Source**: Village Monitoring Data*

Figure 11-27. Spring Ridge treated water pH (30th June 2023 – 30th June 2024)



***Source**: Village Monitoring Data*

Figure 11-28. Spring Ridge treated water temperature (30th June 2023 – 30th June 2024)

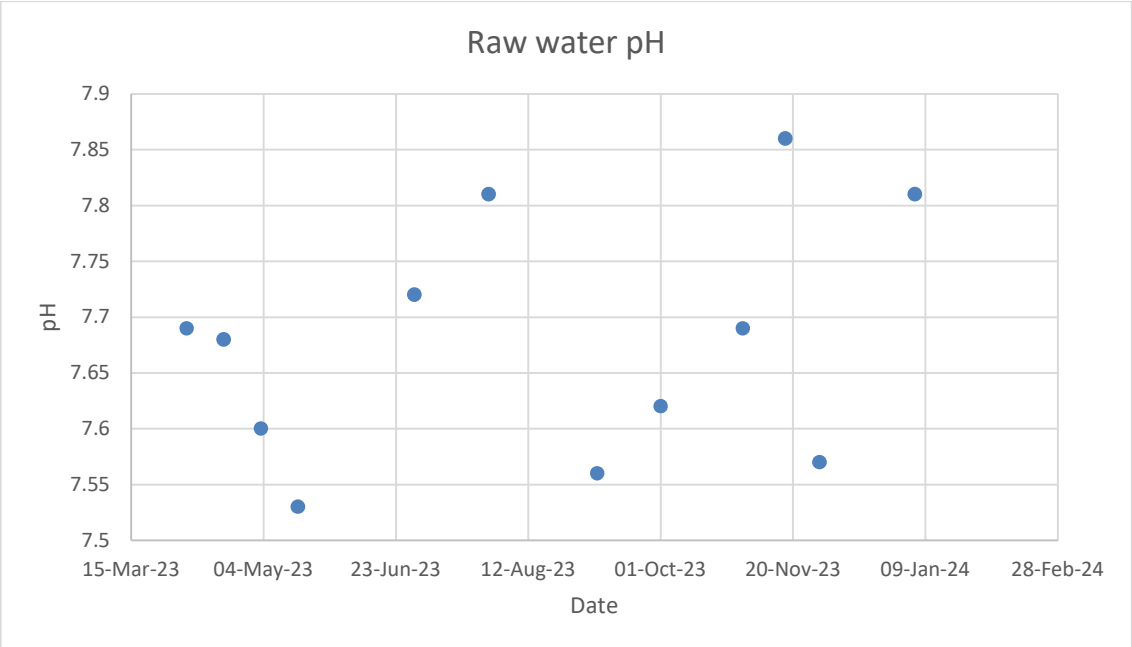


***Source**: Village Monitoring Data*

A.1.6 Wallabadah

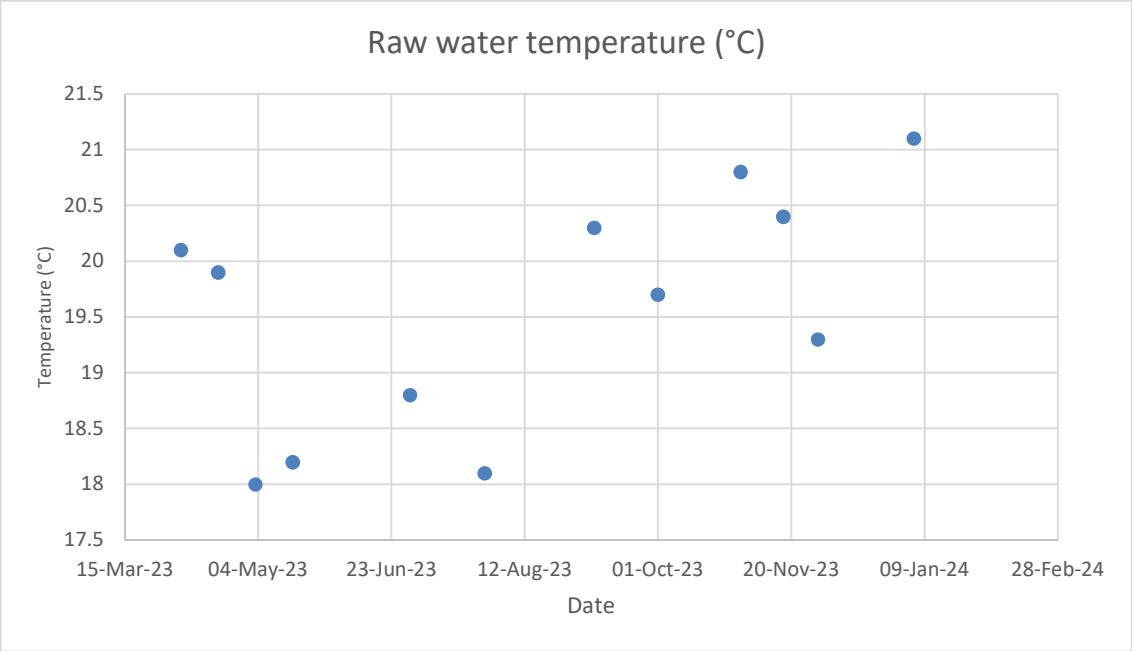
Figure 11-29 to Figure 11-32 indicate the raw and treated water at Wallabadah. Data was provided for the period 5 April 2023 to 5 January 2024.

Figure 11-29. Wallabadah raw water pH (5th April 2023 – 5th January 2024)



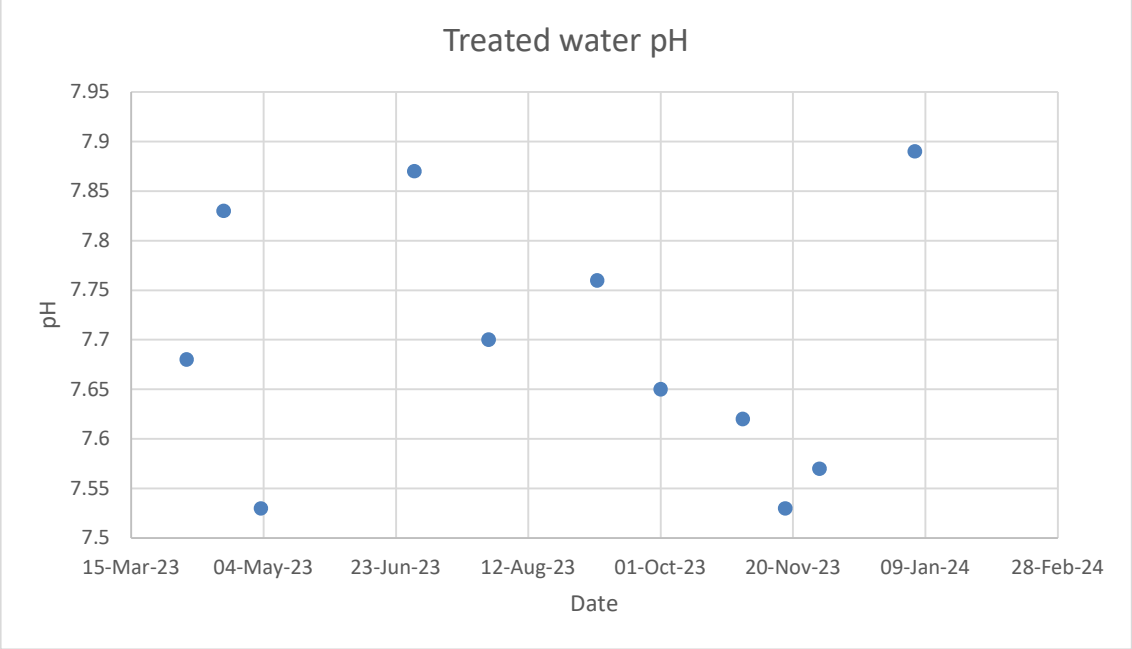
***Source**: Village Monitoring Data*

Figure 11-30. Wallabadah raw water temperature (5th April 2023 – 5th January 2024)



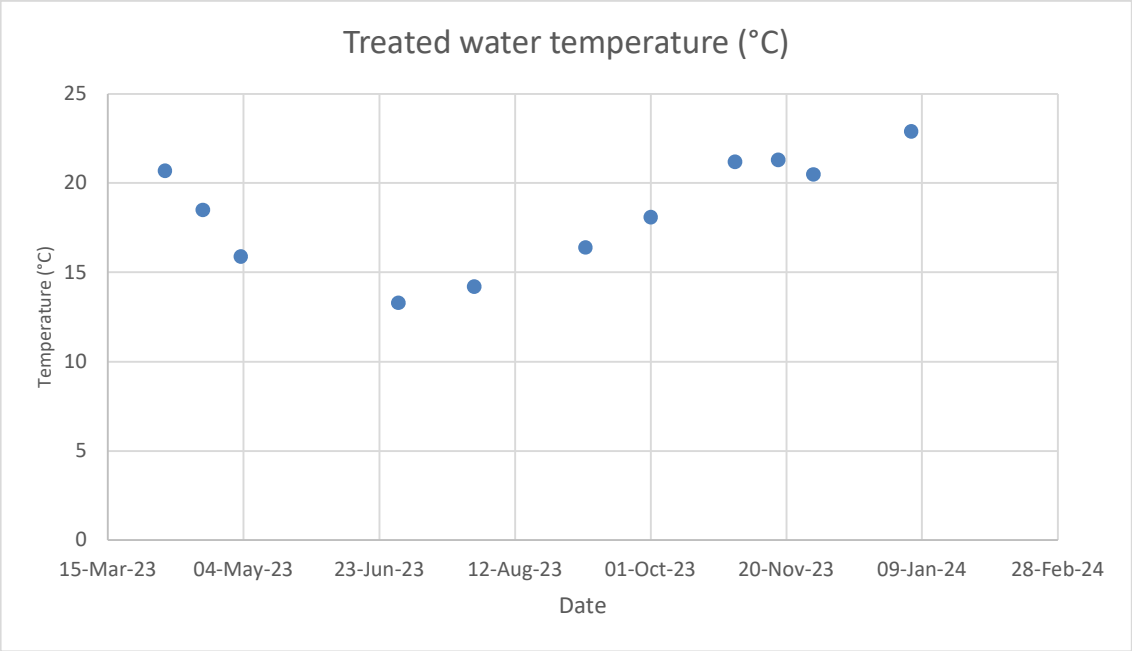
***Source**: Village Monitoring Data*

Figure 11-31. Wallabadah treated water pH (5th April 2023 – 5th January 2024)



***Source**: Village Monitoring Data*

Figure 11-32. Wallabadah treated water temperature (5th April 2023 – 5th January 2024)

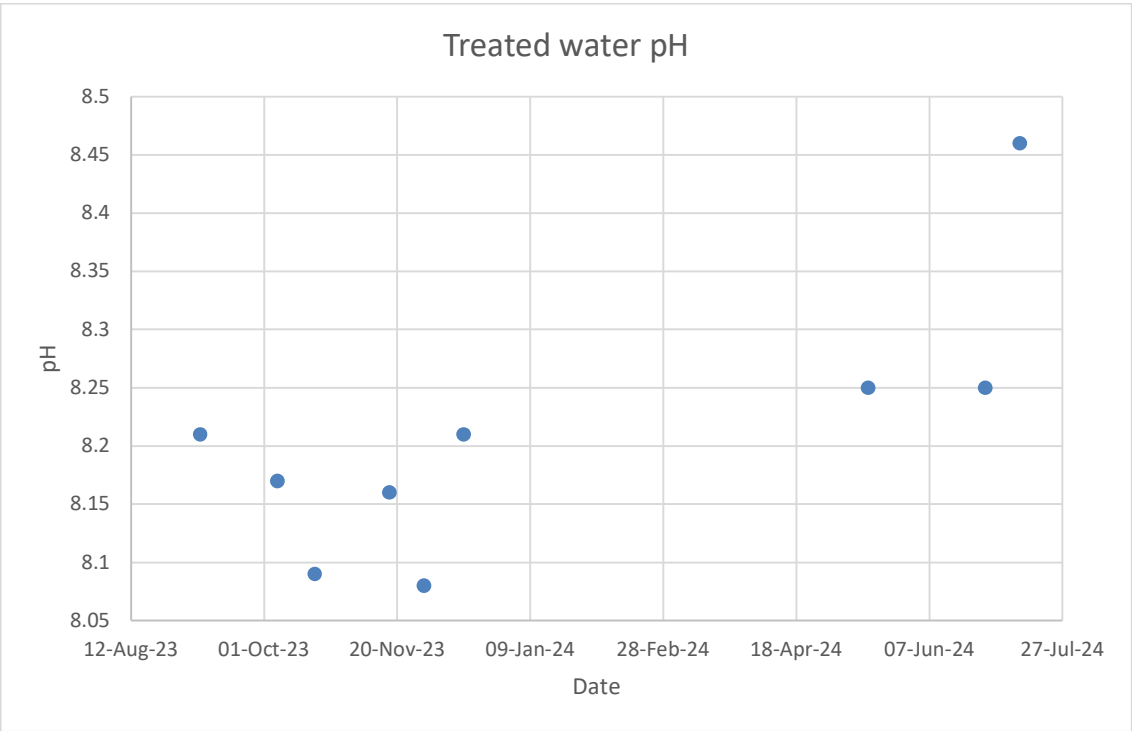


***Source**: Village Monitoring Data*

A.1.7 Willow Tree

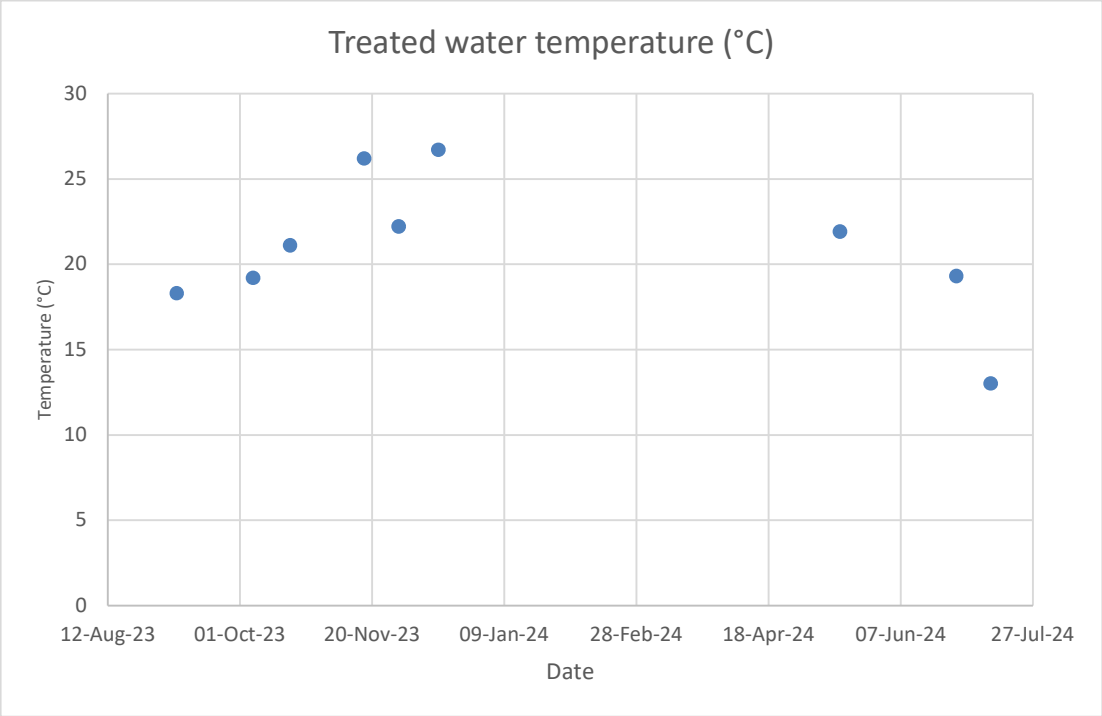
Figure 11-33 and Figure 11-34 indicate the treated water at Willow Tree. Data was provided for the period 7 September 2023 to 30 June 2024.

Figure 11-33. Willow Tree treated water pH (7th September 2023 – 30th June 2024)



***Source**: Village Monitoring Data*

Figure 11-34. Willow Tree treated water temperature (7th September 2023 – 30th June 2024)

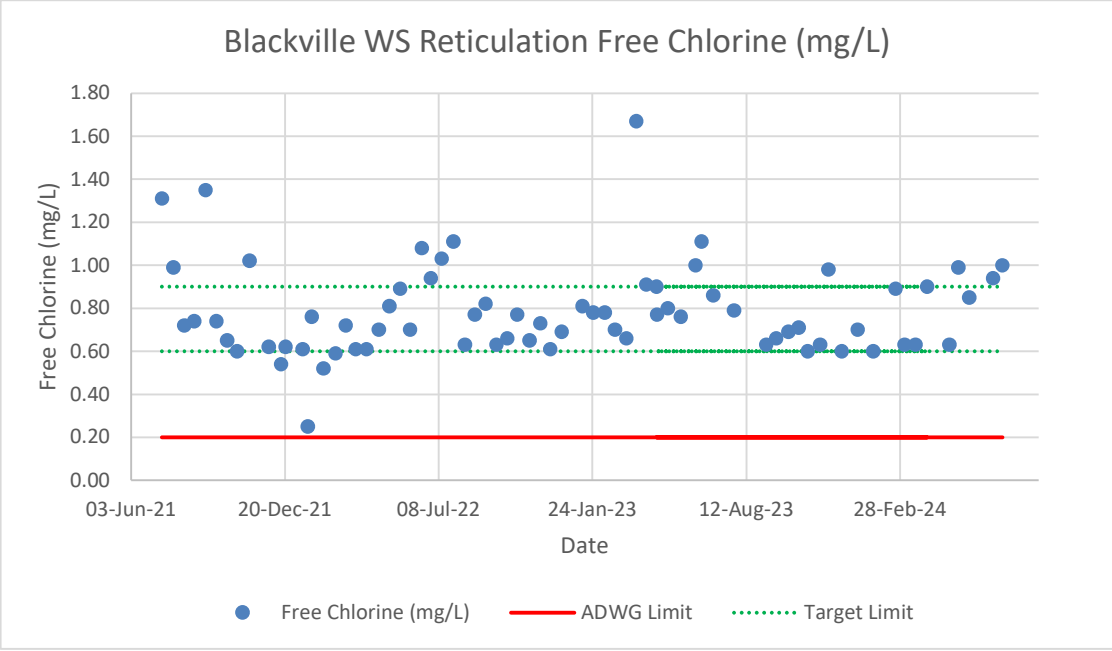


***Source**: Village Monitoring Data*

A.1.8 Reticulation

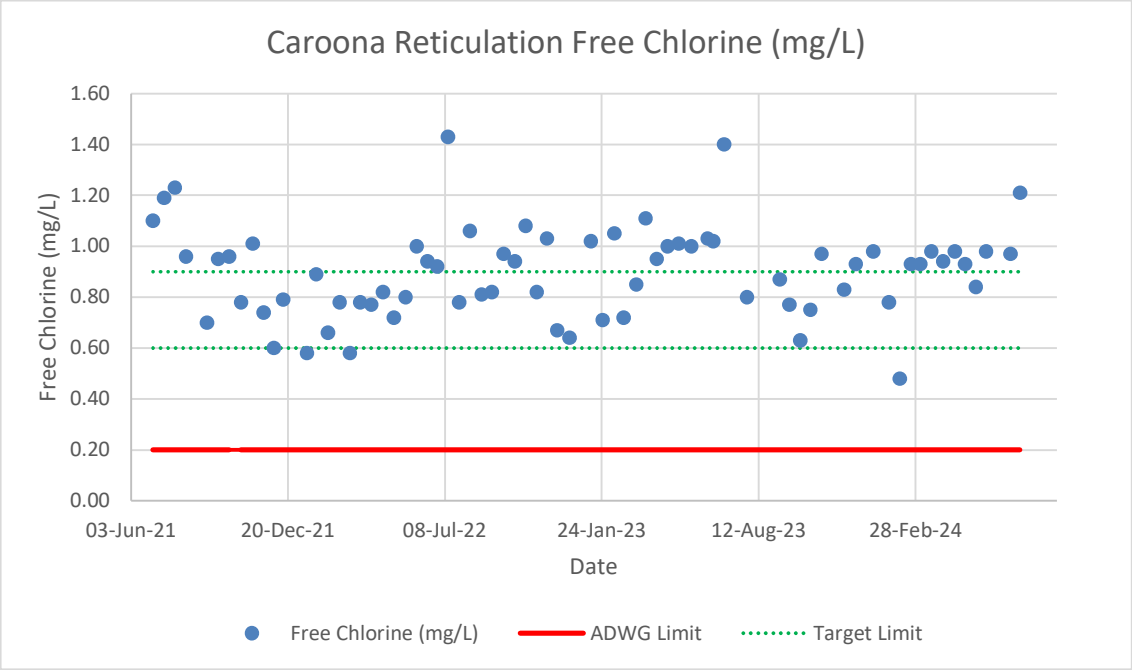
Note: Werris Creek and Quirindi reticulation data is captured on the NSW Health database. Quipolly doesn't have a reticulation system, and therefore no reticulation data is available.

Figure 11-35. Blackville reticulation free chlorine (1st July 2021 – 30th June 2024)



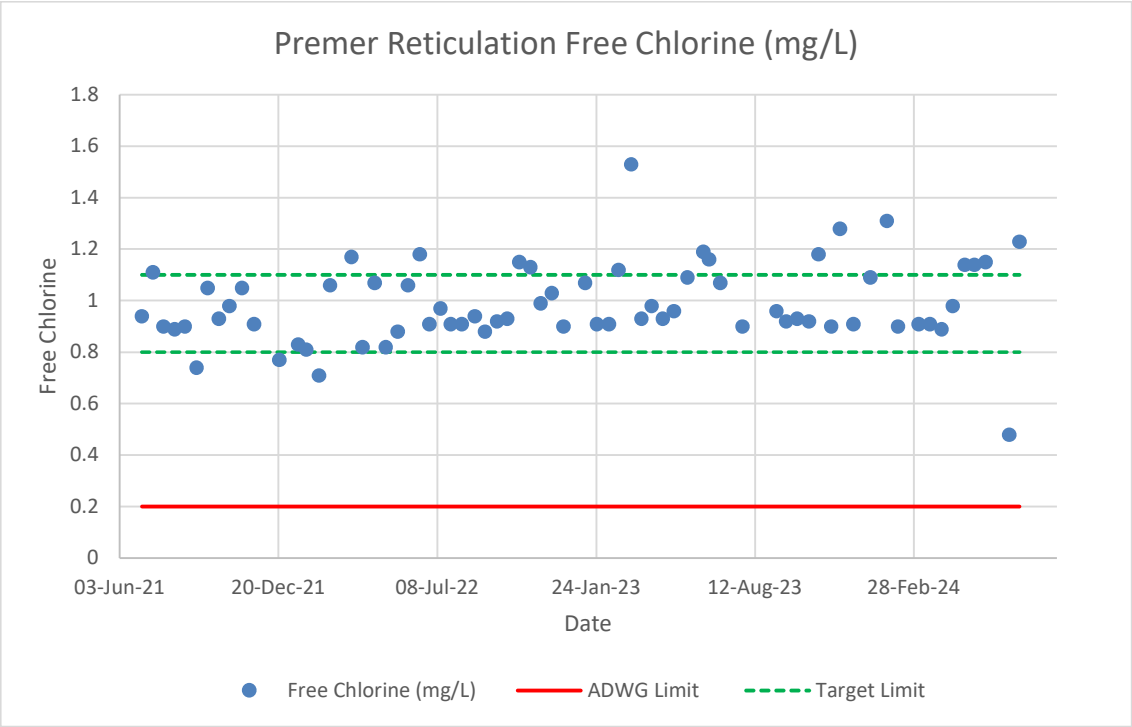
***Source**: Village Monitoring Data*

Figure 11-36. Caroona reticulation free chlorine (1st July 2021 – 30th June 2024)



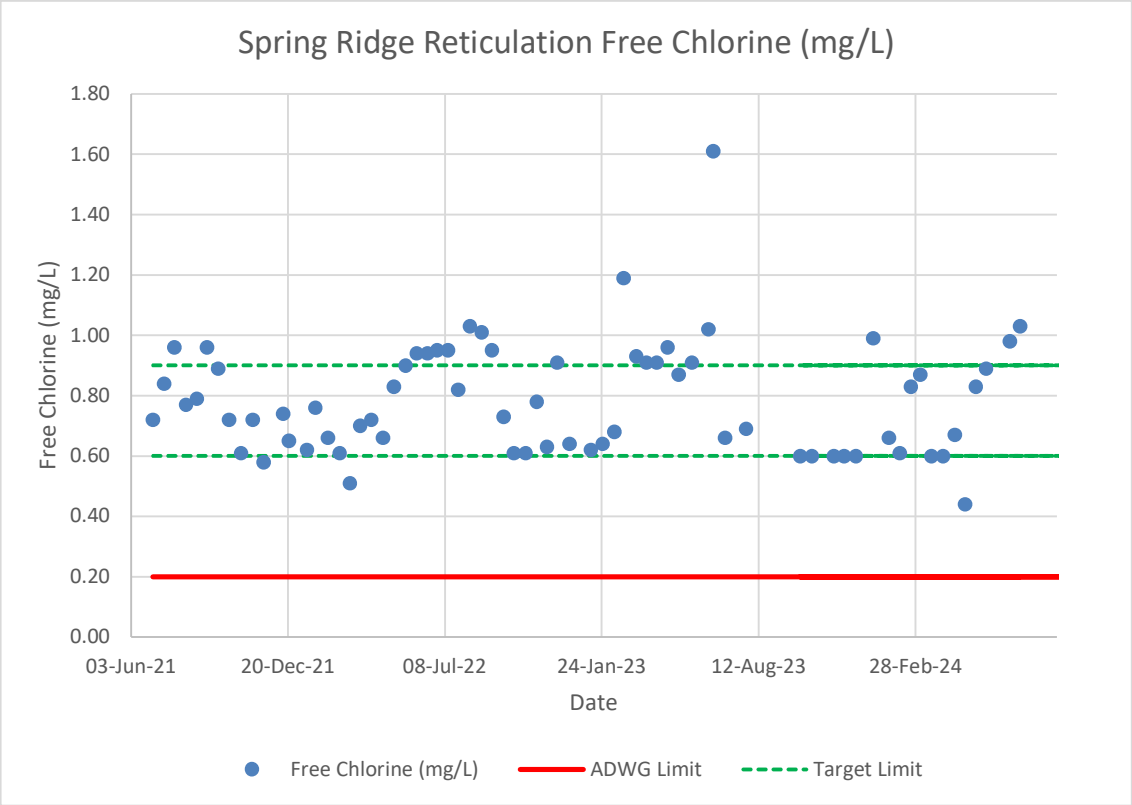
***Source**: Village Monitoring Data*

Figure 11-37. Premer reticulation free chlorine (1st July 2021 – 30th June 2024)



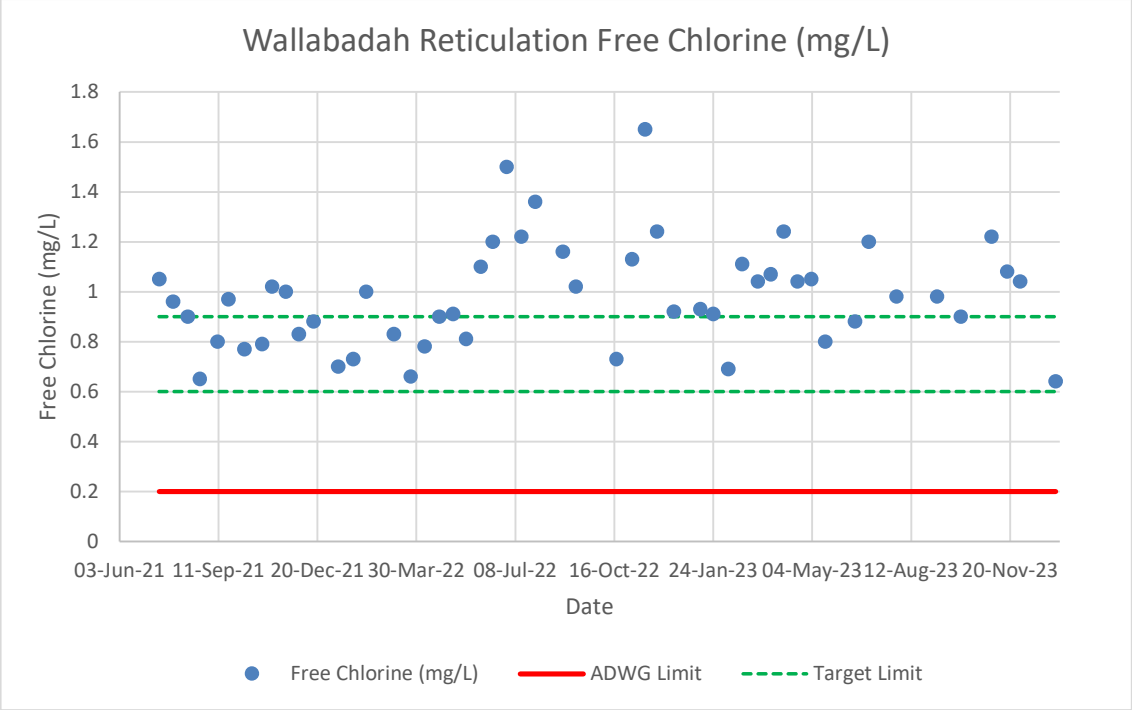
***Source**: Village Monitoring Data*

Figure 11-38. Spring Ridge reticulation free chlorine (1st July 2021 – 30th June 2024)



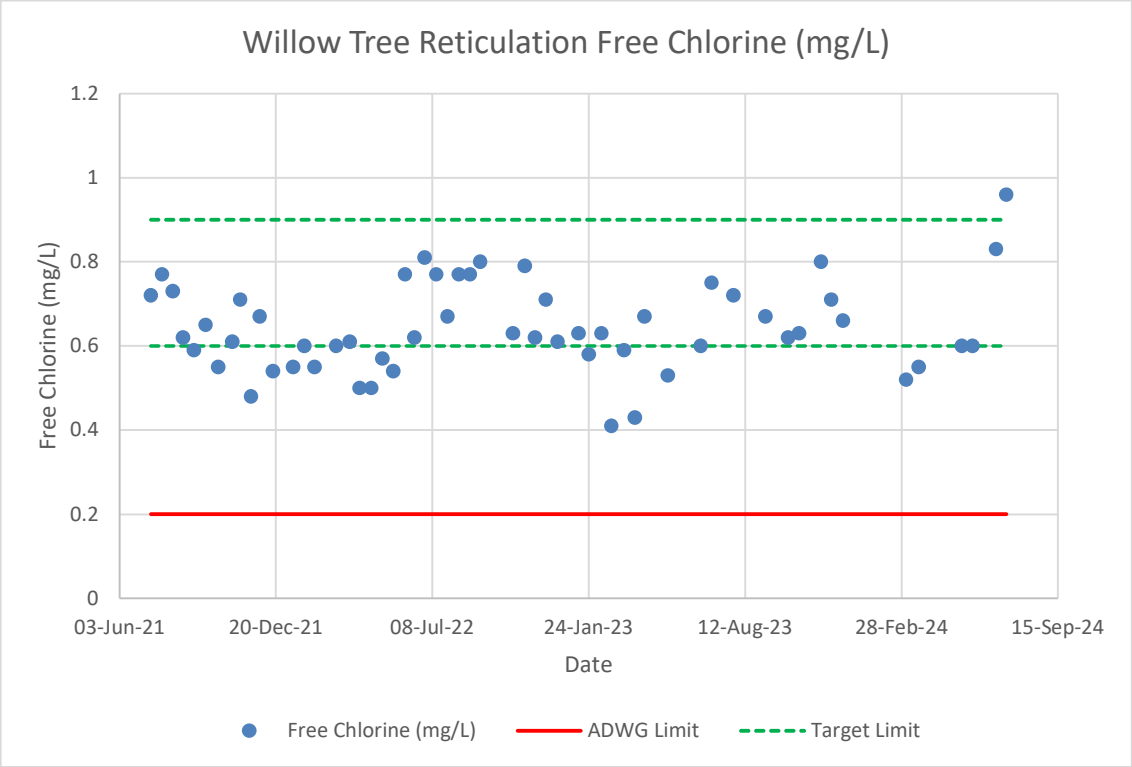
***Source**: Village Monitoring Data*

Figure 11-39. Wallabadah reticulation free chlorine (1st July 2021 – 30th June 2024)



***Source**: Village Monitoring Data*

Figure 11-40. Willow Tree reticulation free chlorine (1st July 2021 – 30th June 2024)



***Source**: Village Monitoring Data*

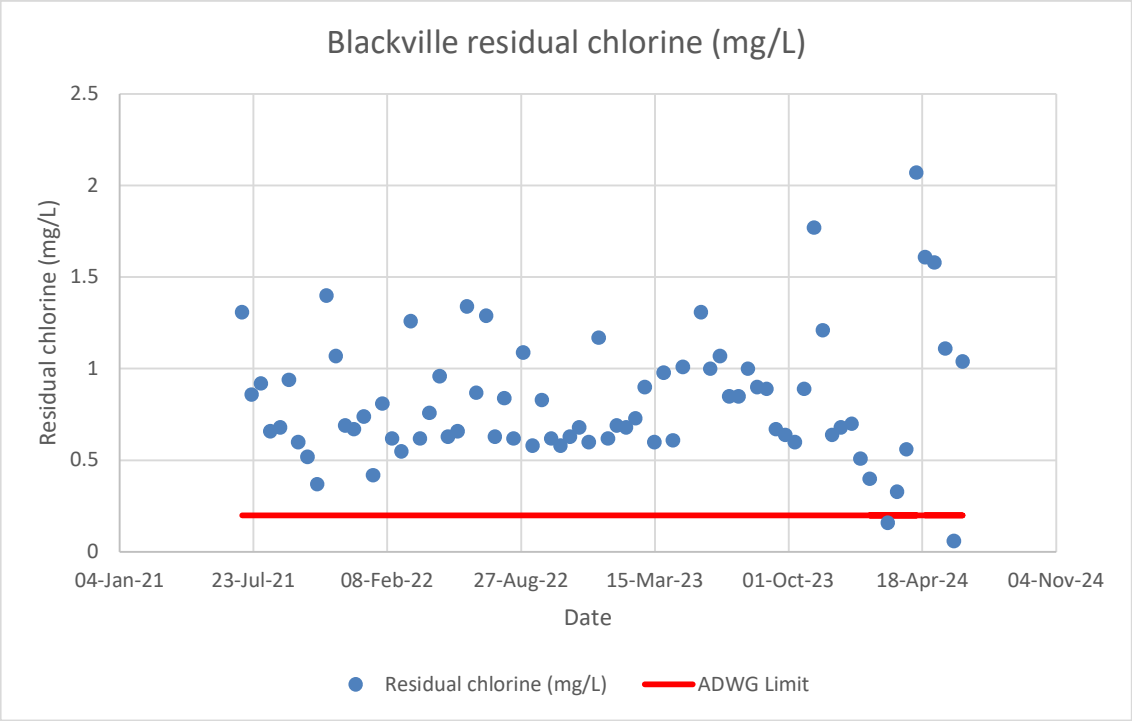
A.1.9 ADWG health exceedances

There was a total of 11 excursions from ADWG health values across the supply systems. Figure 11-41 to Figure 11-47 indicate the 10 residual chlorine excursions at the relevant systems. Additionally, there was one microbial excursion at Wallabadah on 1 February 2023 at a value of 2 mpn/100 mL.

No health excursions were recorded at Werris Creek or Walhallow.

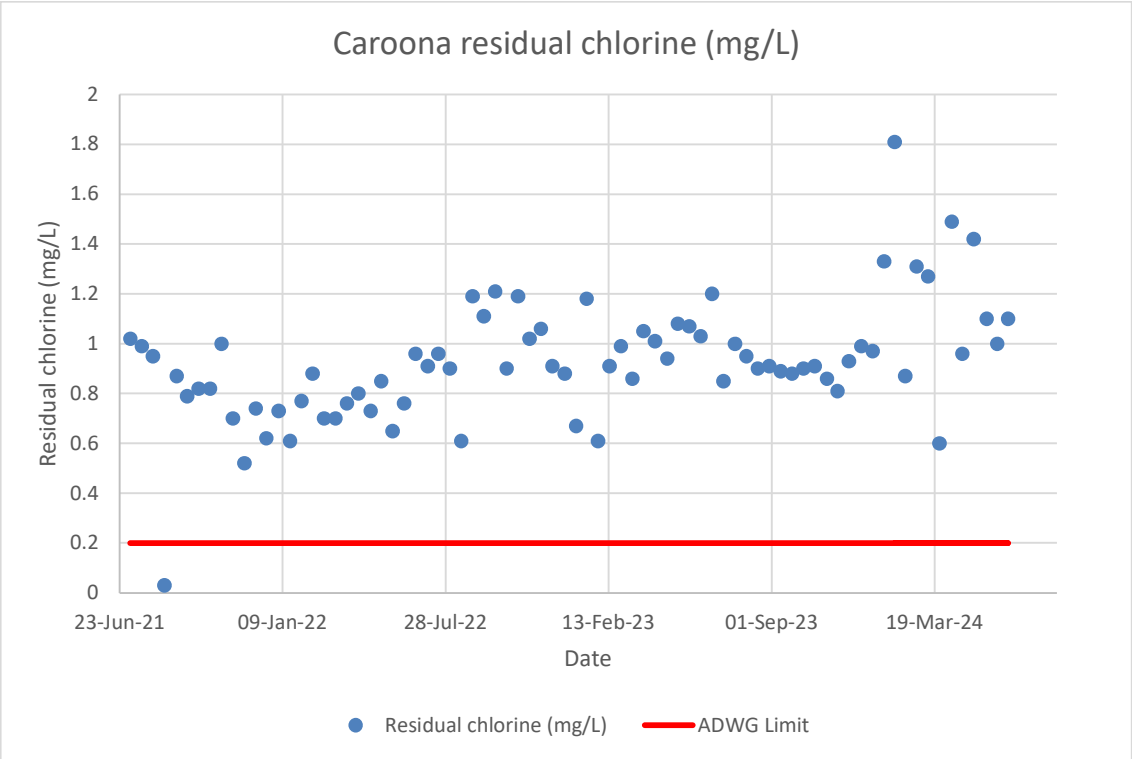
No data was provided for Quipolly WTP.

Figure 11-41. Blackville residual chlorine (1st July 2021 – 30th June 2024)



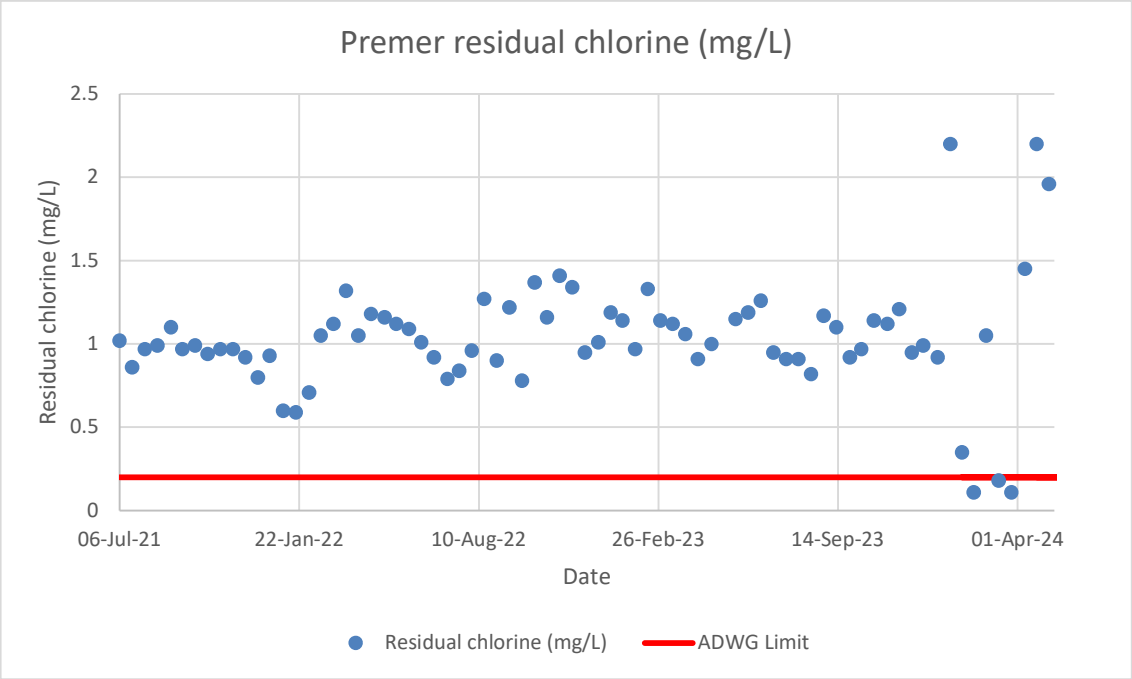
Source: *Verification data analysis*

Figure 11-42. Caroona residual chlorine (1st July 2021 – 30th June 2024)



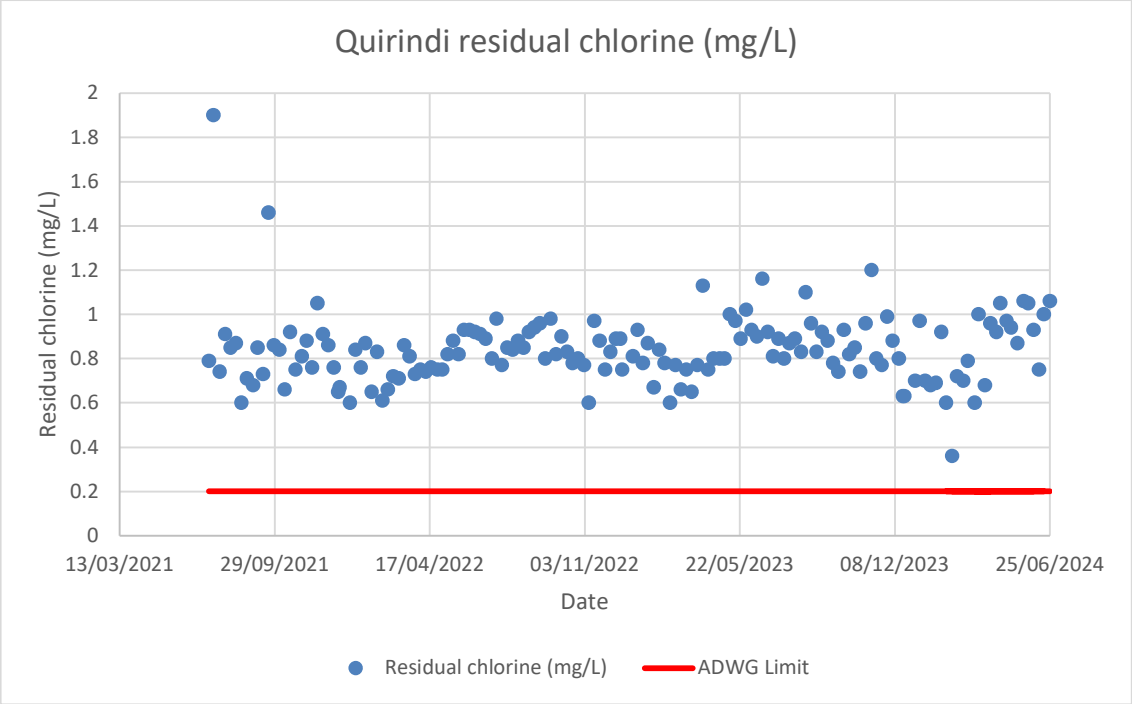
Source: *Verification data analysis*

Figure 11-43. Premer residual chlorine (1st July 2021 – 30th June 2024)



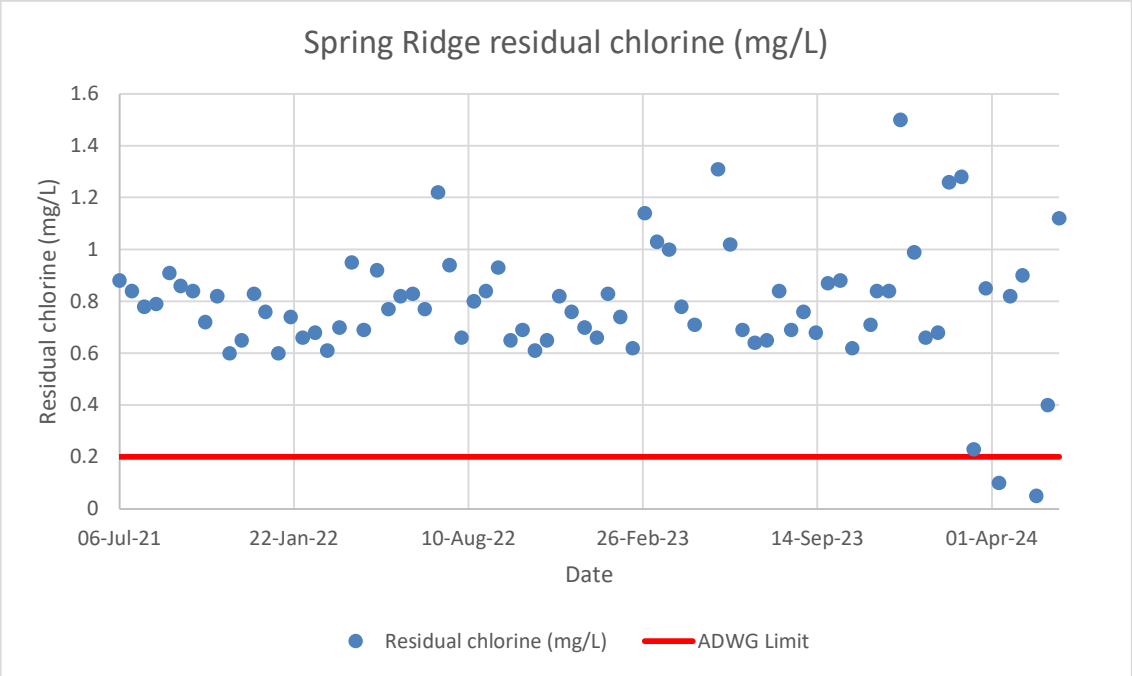
Source: *Verification data analysis*

Figure 11-44. Quirindi residual chlorine (1st July 2021 – 30th June 2024)



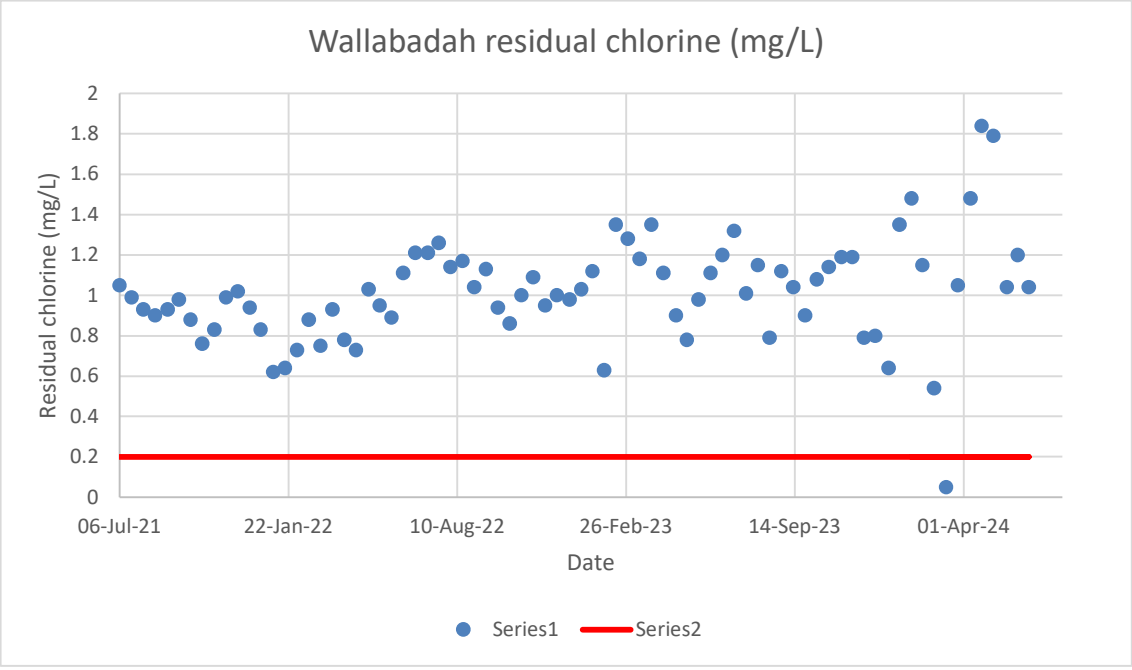
Source: *Verification data analysis*

Figure 11-45. Spring Ridge residual chlorine (1st July 2021 – 30th June 2024)



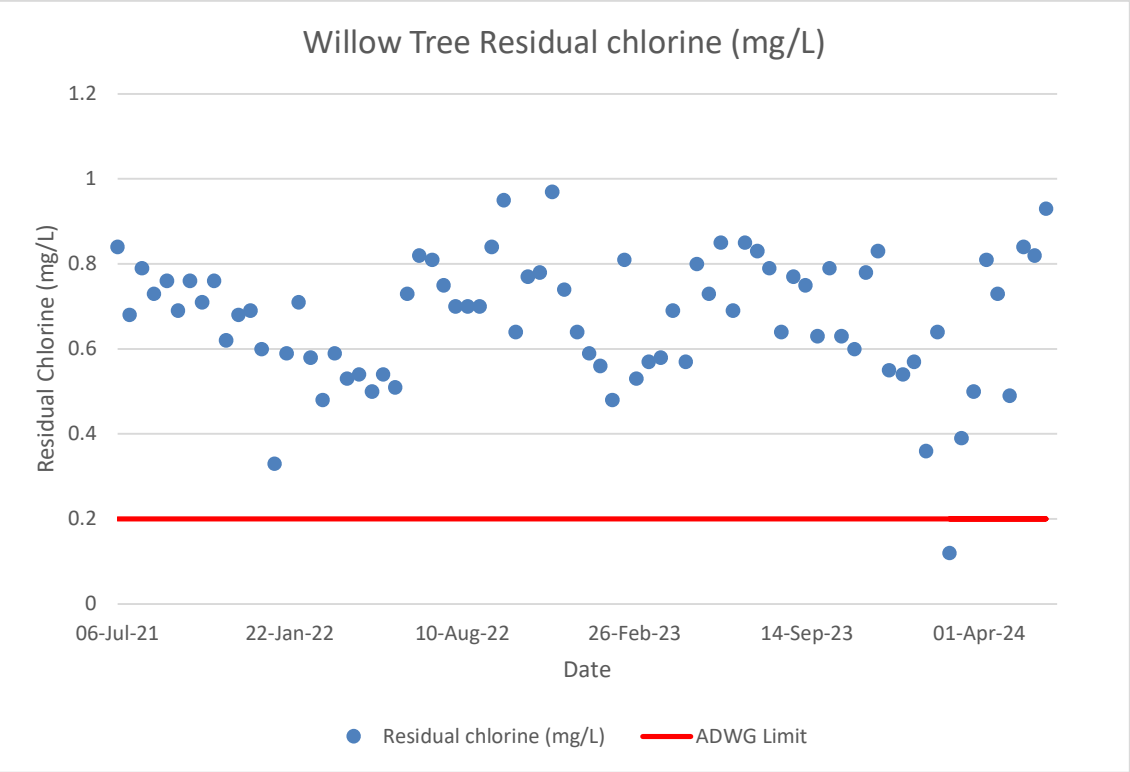
Source: *Verification data analysis*

Figure 11-46. Wallabadah residual chlorine (1st July 2021 – 30th June 2024)



Source: *Verification data analysis*

Figure 11-47. Willow Tree residual chlorine (1st July 2021 – 30th June 2024)



Source: *Verification data analysis*

A.2 Water quality data summary

Note: No data was provided for Quirindi raw water or Quirindi treated water. LPSC advised that treated water data available on NSW Health database, and that raw water records have been misplaced.

A.2.1 Raw Water

Note for the reporting period, Werris Creek is in operation from 1 July 2021 to 30 March 2024, until Quipolly overtakes from 1 March 2024.

Table A-1. Raw water data summary for all water supplies (1 July 2021 – 30 June 2024)

Location	Parameter	Minimum	Average	Maximum	Lower critical limit	Upper critical limit	No. samples
Werris Creek	pH	6.91	7.33	7.82			240
	Apparent colour (HU)	0.24	37.57	147		200	240
	True colour (HU)	0	14.13	60		100	240
	Turbidity (NTU)	0.43	1.51	8.19		100	240
	Temperature (°C)	11.4	20.34	28.8		25	240
Blackville	pH	7.7	7.86	7.96			15
	Turbidity (NTU)	0.14	0.16	0.18			5

	Temperature (°C)	16.3	18.9	20.1			15
Caroona	pH	7.52	7.81	8.1			17
	Turbidity (NTU)	0.14	0.15	0.44			27
	Temperature (°C)	18.4	19.95	21.4			17
Premer	pH	7.88	8.02	8.15			15
	Turbidity (NTU)	0.1	0.25	0.68			27
	Temperature (°C)	14.3	18.84	20.4			15
Spring Ridge	pH	7.93	8.07	8.31			17
	Turbidity (NTU)	0.02	0.19	0.84			28
	Temperature (°C)	16.3	19.11	21.2			17
Wallabadah	pH	7.53	7.68	7.86			12
	Turbidity (NTU)	0	0.14	0.27			21
	Temperature (°C)	18	19.56	21.1			12
Quipolly	pH	5.92	6.30	6.86	5.6	7	130
Quirindi	See Note						

A.2.2 Treated Water

Note for the reporting period, Werris Creek is in operation from 1 July 2021 to 30 March 2024, until Quipolly overtakes from 1 March 2024.

Table A-2. Treated water data summary for all water supplies (1 July 2021 – 30 June 2024)

Location	Parameter	Minimum	Average	Maximum	Lower critical limit	Upper critical limit	No. samples
Werris Creek	pH	6.92	7.22	7.61		8	240
	Apparent colour (HU)	0	0.12	3		5	240
	True colour (HU)	0	0.01	1		2	240
	Turbidity (NTU)	0.1	0.22	0.68		1	240
	Temperature (°C)	12.1	20.63	25.8		25	240
	Free chlorine (mg/L)	1	1.76	2.69	0.5		240
	Total chlorine (mg/L)	1	2.17	3.23		5	240
Blackville	pH	7.67	7.85	16.5			15
	Turbidity (NTU)	0.14	0.16	0.18			5
	Temperature (°C)	16.5	21.06	24.7			15
Caroona	pH	7.69	7.80	7.87			17
	Turbidity (NTU)	0.12	0.15	0.2			27

	Temperature (°C)	16.7	21.96	28.5			17
Premer	pH	7.86	7.99	8.11			15
	Turbidity (NTU)	0.18	0.21	0.22			27
	Temperature (°C)	13.6	19.87	25.1			15
Spring Ridge	pH	7.81	8.01	8.14			17
	Turbidity (NTU)	0.13	0.16	0.18			5
	Temperature (°C)	12.8	22.6	29.6			17
Wallabadah	pH	7.54	7.69	7.89			12
	Turbidity (NTU)	0.15	0.15	0.15			1
	Temperature (°C)	13.3	18.45	22.9			12
Willow Tree	pH	8.08	8.21	8.46			9
	Turbidity (NTU)	0.03	0.09	0.12			3
	Temperature (°C)	13	20.88	26.7			9
Quipolly	Turbidity (NTU)	0.17	0.38	0.75		0.5	163
	pH	0	0.16	0.6	0.05	0.4	156
	Free Chlorine (mg/L)	6.82	6.95	7.06	6.5	8.5	129
Quirindi	See Note						

A.2.3 Verification monitoring

The following data was extracted from the NSW Health Database over the period 1 July 2021 to 30 June 2024.

Any readings that were less than the limit of detection were taken as half the limit, (i.e. a value of '<1' became 0.5), except for microbiological readings less than the limit of detection, which were taken as zero, (i.e. a value of '<1' became zero).

ADWG aesthetic guideline excursions are highlighted green and ADWG health excursions or microbiological detections are highlighted orange.

Table A-3. Blackville verification monitoring summary

Parameter	Units	ADWG Limit	Count	Min	5th %ile	Mean	Median	95th %ile	Max	Excursion count	Exceedance %
E. coli	mpn/100 mL	> 0 (H)	76	0	0	0	0	0	0	0	0.00%
Total Coliforms	mpn/100 mL		76	0	0	0	0	0	0	0	0.00%
Aluminium	ug/L	> 200 (A)	5	5.00	5.00	5.00	5.00	5.00	5.00	0	0.00%
Antimony	ug/L	> 3 (H)	5	0.05	0.05	0.05	0.05	0.05	0.05	0	0.00%
Arsenic	ug/L	> 10 (H)	5	0.50	0.50	0.80	0.50	1.70	2.00	0	0.00%
Barium	ug/L	> 2000 (H)	5	0.2	0.5	2.1	2.3	3.1	3.1	0	0.00%
Boron	ug/L	> 4000 (H)	5	0.4	1.4	4.9	5.6	6.5	6.5	0	0.00%
Cadmium	ug/L	> 2 (H)	5	0.05	0.05	0.05	0.05	0.05	0.05	0	0.00%

Parameter	Units	ADWG Limit	Count	Min	5th %ile	Mean	Median	95th %ile	Max	Excursion count	Exceedance %
Calcium	mg/L		5	54.6	55.0	58.7	58.9	62.3	62.6	0	0.00%
Chloride	mg/L	> 250 (A)	5	23	25	36	34	47	47	0	0.00%
Fluoride	mg/L	> 1.5 (H)	5	0.14	0.14	0.15	0.16	0.17	0.17	0	0.00%
Iodine	mg/L		5	0.01	0.01	0.01	0.01	0.02	0.02	0	0.00%
Nitrate	mg/L	> 50 (H)	5	1.0	1.0	2.6	2.0	6.0	7.0	0	0.00%
Nitrite	mg/L	> 3 (H)	5	0.05	0.05	0.05	0.05	0.05	0.05	0	0.00%
Residual Chlorine	mg/L	< 0.2 > 5 (H)	76	0.06	0.39	0.83	0.72	1.45	2.07	2	2.63%
Selenium	ug/L	> 10 (H)	5	3.50	3.50	3.50	3.50	3.50	3.50	0	0.00%
Sodium	mg/L	> 180 (A)	5	45	46	49	50	51	51	0	0.00%
Sulfate	mg/L	> 250 (A)	5	4.0	4.0	4.2	4.0	4.8	5.0	0	0.00%
Total Chlorine	mg/L	< 0.2 > 5 (H)	76	0.05	0.40	0.96	0.87	1.67	2.20	2	2.63%
Colour - True	Hazen Units (HU)	> 15 (A)	5	0.50	0.50	0.60	0.50	0.90	1.00	0	0.00%
pH		< 6.5 > 8.5 (A)	82	6.9	7.4	7.7	7.8	8.0	8.3	0	0.00%
Temperature	C		77	12.7	13.1	18.8	19.0	24.3	26.1	0	0.00%
Total Dissolved Solids (TDS)	mg/L	> 600 (A)	5	403	405	419	415	441	447	0	0.00%
Total Hardness as CaCO3	mg/L	> 200 (A)	5	394	398	427	437	446	447	5	100.00%
Turbidity	NTU	> 5 (A)	81	0.01	0.04	0.15	0.13	0.22	1.20	0	0.00%
Chromium	ug/L	> 50 (A)	5	0.50	0.60	1.30	1.00	2.60	3.00	0	0.00%
Copper	ug/L	> 2000 (H) > 1000 (A)	5	0.5	1.2	5.5	6.0	8.8	9.0	0	0.00%
Iron	ug/L	> 300 (A)	5	5.0	5.0	5.0	5.0	5.0	5.0	0	0.00%
Lead	ug/L	> 10 (H)	5	0.10	0.10	0.20	0.20	0.30	0.30	0	0.00%
Magnesium	mg/L		5	62.5	63.4	68.1	69.2	71.4	71.6	0	0.00%
Manganese	ug/L	> 500 (H) > 100 (A)	5	0.15	0.15	0.15	0.15	0.15	0.15	0	0.00%
Mercury	ug/L	> 1 (H)	5	0.40	0.40	0.40	0.40	0.40	0.40	0	0.00%
Molybdenum	ug/L	> 50 (H)	5	0.05	0.14	0.41	0.50	0.50	0.50	0	0.00%
Nickel	ug/L	> 20 (H)	5	0.20	0.20	0.32	0.20	0.50	0.50	0	0.00%
Silver	ug/L	> 100 (H)	5	0.10	0.10	0.10	0.10	0.10	0.10	0	0.00%
Zinc	ug/L	> 3000 (A)	5	10.0	10.0	16.0	20.0	20.0	20.0	0	0.00%
Uranium	ug/L	> 20 (H)	5	0.05	0.18	0.61	0.70	0.80	0.80	0	0.00%

Source: *NSW Health database*

Table A-4. Caroona verification monitoring summary

Parameter	Units	ADWG Limit	Count	Min	5th %ile	Mean	Median	95th %ile	Max	Excursion count	Exceedance %
E. coli	mpn/100 mL	> 0 (H)	77	0	0	0	0	0	0	0	0%
Total Coliforms	mpn/100 mL		77	0	0	0.01	0	0	1	0	0%

Parameter	Units	ADWG Limit	Count	Min	5th %ile	Mean	Median	95th %ile	Max	Excursion count	Exceedance %
Aluminium	ug/L	> 200 (A)	6	5	5	5	5	5	5	0	0%
Antimony	ug/L	> 3 (H)	6	0.05	0.05	0.05	0.05	0.05	0.05	0	0%
Arsenic	ug/L	> 10 (H)	6	0.50	0.63	0.92	1.00	1.00	1.00	0	0%
Barium	ug/L	> 2000 (H)	6	30.3	30.3	31.1	30.9	32.4	32.5	0	0%
Boron	ug/L	> 4000 (H)	6	38.7	39.0	41.0	40.8	43.4	43.8	0	0%
Cadmium	ug/L	> 2 (H)	6	0.05	0.05	0.05	0.05	0.05	0.05	0	0%
Calcium	mg/L		6	76.6	77.1	81.6	81.7	85.7	85.7	0	0%
Chloride	mg/L	> 250 (A)	6	114	115	122	121	131	131	0	0%
Fluoride	mg/L	> 1.5 (H)	6	0.05	0.05	0.09	0.10	0.11	0.11	0	0%
Iodine	mg/L		6	0.01	0.01	0.01	0.01	0.02	0.02	0	0%
Nitrate	mg/L	> 50 (H)	6	3.00	3.00	3.33	3.00	4.00	4.00	0	0%
Nitrite	mg/L	> 3 (H)	6	0.05	0.05	0.05	0.05	0.05	0.05	0	0%
Residual Chlorine	mg/L	< 0.2 > 5 (H)	78	0.03	0.61	0.93	0.91	1.31	1.81	1	1%
Selenium	ug/L	> 10 (H)	6	3.5	3.5	3.5	3.5	3.5	3.5	0	0%
Sodium	mg/L	> 180 (A)	6	66.0	67.3	72.8	72.5	77.8	78.0	0	0%
Sulfate	mg/L	> 250 (A)	6	18.0	18.3	20.0	20.0	21.8	22.0	0	0%
Total Chlorine	mg/L	< 0.2 > 5 (H)	77	0.1	0.7	1.1	1.0	1.5	2.1	1	1%
Colour - True	Hazen Units (HU)	> 15 (A)	6	0.5	0.5	0.6	0.5	0.9	1.0	0	0%
pH		< 6.5 > 8.5 (A)	84	6.8	7.5	7.8	7.8	8.0	8.9	1	1%
Temperature	C		78	13.6	14.4	20.5	21.1	26.6	29.1	0	0%
Total Dissolved Solids (TDS)	mg/L	> 600 (A)	6	466	467	494	491	525	526	0	0%
Total Hardness as CaCO3	mg/L	> 200 (A)	6	352	357	388	395	407	408	6	100%
Turbidity	NTU	> 5 (A)	84	0.0	0.1	0.2	0.1	0.3	1.2	0	0%
Chromium	ug/L	> 50 (A)	6	0.5	0.6	1.1	1.0	1.8	2.0	0	0%
Copper	ug/L	> 2000 (H) > 1000 (A)	6	0.5	0.6	3.3	1.0	11.0	14.0	0	0%
Iron	ug/L	> 300 (A)	6	5	5	5	5	5	5	0	0%
Lead	ug/L	> 10 (H)	6	0.1	0.1	0.1	0.1	0.2	0.2	0	0%
Magnesium	mg/L		6	39.1	40.0	44.8	45.9	47.5	47.7	0	0%
Manganese	ug/L	> 500 (H) > 100 (A)	6	0.15	0.15	0.15	0.15	0.15	0.15	0	0%
Mercury	ug/L	> 1 (H)	6	0.4	0.4	0.4	0.4	0.4	0.4	0	0%
Molybdenum	ug/L	> 50 (H)	6	0.40	0.40	0.42	0.40	0.48	0.50	0	0%
Nickel	ug/L	> 20 (H)	6	1.20	1.20	1.42	1.35	1.85	2.00	0	0%
Silver	ug/L	> 100 (H)	6	0.1	0.1	0.1	0.1	0.1	0.1	0	0%
Zinc	ug/L	> 3000 (A)	6	10	12.5	20	20	27.5	30	0	0%
Uranium	ug/L	> 20 (H)	6	2.1	2.1	2.15	2.1	2.33	2.4	0	0%

Source: *NSW Health database*

Table A-5. Premer verification monitoring summary

Parameter	Units	ADWG Limit	Count	Min	5th %ile	Mean	Median	95th %ile	Max	Excursion count	Exceedance %
E. coli	mpn/100 mL	> 0 (H)	76	0	0	0	0	0	0	0	0%
Total Coliforms	mpn/100 mL		76	0	0	0.00	0	0	0	0	0%
Aluminium	ug/L	> 200 (A)	5	5	5	6	5	9	10	0	0%
Antimony	ug/L	> 3 (H)	5	0.05	0.05	0.05	0.05	0.05	0.05	0	0%
Arsenic	ug/L	> 10 (H)	5	0.50	0.50	0.80	1.00	1.00	1.00	0	0%
Barium	ug/L	> 2000 (H)	5	7.4	7.5	7.9	7.9	8.3	8.3	0	0%
Boron	ug/L	> 4000 (H)	5	15.6	15.7	16.7	16.6	17.8	18.0	0	0%
Cadmium	ug/L	> 2 (H)	5	0.05	0.05	0.05	0.05	0.05	0.05	0	0%
Calcium	mg/L		5	48.7	49.2	52.3	53.6	53.9	53.9	0	0%
Chloride	mg/L	> 250 (A)	5	99	99	103	102	107	108	0	0%
Fluoride	mg/L	> 1.5 (H)	5	0.10	0.10	0.11	0.12	0.12	0.12	0	0%
Iodine	mg/L		5	0.01	0.01	0.01	0.01	0.02	0.02	0	0%
Nitrate	mg/L	> 50 (H)	5	19.00	19.00	20.20	20.00	21.80	22.00	0	0%
Nitrite	mg/L	> 3 (H)	5	0.05	0.05	0.06	0.05	0.09	0.1	0	0%
Residual Chlorine	mg/L	< 0.2 > 5 (H)	77	0.11	0.32	1.02	1.00	1.42	2.20	3	4%
Selenium	ug/L	> 10 (H)	5	3.5	3.5	3.5	3.5	3.5	3.5	0	0%
Sodium	mg/L	> 180 (A)	5	49.0	50.2	54.0	55.0	55.8	56.0	0	0%
Sulfate	mg/L	> 250 (A)	5	2.0	2.2	2.8	3.0	3.0	3.0	0	0%
Total Chlorine	mg/L	< 0.2 > 5 (H)	77	0.1	0.3	1.2	1.1	1.6	2.2	4	5%
Colour - True	Hazen Units (HU)	> 15 (A)	5	0.5	0.5	0.6	0.5	0.9	1.0	0	0%
pH		< 6.5 > 8.5 (A)	82	7.3	7.8	7.9	7.9	8.2	8.3	0	0%
Temperature	C		77	13.4	14.2	18.9	18.8	23.5	25.2	0	0%
Total Dissolved Solids (TDS)	mg/L	> 600 (A)	5	407	408	430	417	460	463	0	0%
Total Hardness as CaCO3	mg/L	> 200 (A)	5	375	377	393	389	408	408	5	100%
Turbidity	NTU	> 5 (A)	82	0.0	0.1	0.2	0.2	0.3	1.0	0	0%
Chromium	ug/L	> 50 (A)	5	5.0	5.0	5.4	5.0	6.0	6.0	0	0%
Copper	ug/L	> 2000 (H) > 1000 (A)	5	0.5	0.8	2.3	2.0	3.8	4.0	0	0%
Iron	ug/L	> 300 (A)	5	5	5	6	5	9	10	0	0%

Parameter	Units	ADWG Limit	Count	Min	5th %ile	Mean	Median	95th %ile	Max	Excursion count	Exceedance %
Lead	ug/L	> 10 (H)	5	0.1	0.1	0.1	0.1	0.1	0.1	0	0%
Magnesium	mg/L		5	59.9	60.3	63.8	64.1	66.6	66.6	0	0%
Manganese	ug/L	> 500 (H) > 100 (A)	5	0.15	0.15	0.15	0.15	0.15	0.15	0	0%
Mercury	ug/L	> 1 (H)	5	0.4	0.4	0.4	0.4	0.4	0.4	0	0%
Molybdenum	ug/L	> 50 (H)	5	0.50	0.52	0.58	0.60	0.60	0.60	0	0%
Nickel	ug/L	> 20 (H)	5	0.20	0.20	0.20	0.20	0.20	0.20	0	0%
Silver	ug/L	> 100 (H)	5	0.1	0.1	0.1	0.1	0.1	0.1	0	0%
Zinc	ug/L	> 3000 (A)	5	10	10	12	10	18	20	0	0%
Uranium	ug/L	> 20 (H)	5	0.8	0.82	0.9	0.9	0.98	1	0	0%

Source: *NSW Health database*

Table A-6. Quirindi verification monitoring summary

Parameter	Units	ADWG Limit	Count	Min	5th %ile	Mean	Median	95th %ile	Max	Excursion count	Exceedance %
E. coli	mpn/100 mL	> 0 (H)	150	0	0	0	0	0	0	0	0%
Total Coliforms	mpn/100 mL		150	0	0	0.00	0	0	0	0	0%
Aluminium	ug/L	> 200 (A)	5	5	5	5	5	5	5	0	0%
Antimony	ug/L	> 3 (H)	5	0.05	0.05	0.05	0.05	0.05	0.05	0	0%
Arsenic	ug/L	> 10 (H)	5	0.50	0.60	0.90	1.00	1.00	1.00	0	0%
Barium	ug/L	> 2000 (H)	5	23.9	24.2	25.6	25.6	26.7	26.8	0	0%
Boron	ug/L	> 4000 (H)	5	18.5	18.5	19.5	19.1	21.2	21.5	0	0%
Cadmium	ug/L	> 2 (H)	5	0.05	0.05	0.05	0.05	0.05	0.05	0	0%
Calcium	mg/L		5	72.7	73.2	76.7	77.9	79.1	79.1	0	0%
Chloride	mg/L	> 250 (A)	5	112	112	115	113	120	120	0	0%
Fluoride	mg/L	> 1.5 (H)	5	0.10	0.10	0.11	0.11	0.12	0.12	0	0%
Iodine	mg/L		5	0.01	0.01	0.01	0.01	0.01	0.01	0	0%
Nitrate	mg/L	> 50 (H)	5	11.00	11.00	11.40	11.00	12.00	12.00	0	0%
Nitrite	mg/L	> 3 (H)	5	0.05	0.05	0.05	0.05	0.05	0.05	0	0%
Residual Chlorine	mg/L	< 0.2 > 5 (H)	156	0.36	0.63	0.84	0.83	1.05	1.90	0	0%
Selenium	ug/L	> 10 (H)	5	3.5	3.5	3.5	3.5	3.5	3.5	0	0%
Sodium	mg/L	> 180 (A)	5	54.0	54.0	56.2	57.0	58.0	58.0	0	0%
Sulfate	mg/L	> 250 (A)	5	41.0	41.4	43.6	44.0	45.6	46.0	0	0%
Total Chlorine	mg/L	< 0.2 > 5 (H)	156	0.3	0.7	0.9	0.9	1.2	2.2	0	0%

Parameter	Units	ADWG Limit	Count	Min	5th %ile	Mean	Median	95th %ile	Max	Excursion count	Exceedance %
Colour - True	Hazen Units (HU)	> 15 (A)	5	0.5	0.5	0.7	0.5	1.0	1.0	0	0%
pH		< 6.5 > 8.5 (A)	161	7.3	8.0	8.1	8.1	8.3	8.5	0	0%
Temperature	C		156	11.7	14.0	19.0	19.0	24.4	25.4	0	0%
Total Dissolved Solids (TDS)	mg/L	> 600 (A)	5	420	421	441	427	470	473	0	0%
Total Hardness as CaCO3	mg/L	> 200 (A)	5	372	372	385	386	400	402	5	100%
Turbidity	NTU	> 5 (A)	161	0.0	0.0	0.2	0.1	0.2	14.7	1	1%
Chromium	ug/L	> 50 (A)	5	0.5	0.5	0.8	1.0	1.0	1.0	0	0%
Copper	ug/L	> 2000 (H) > 1000 (A)	5	0.5	0.5	1.3	0.5	3.4	4.0	0	0%
Iron	ug/L	> 300 (A)	5	5	5	5	5	5	5	0	0%
Lead	ug/L	> 10 (H)	5	0.1	0.1	0.3	0.1	0.7	0.9	0	0%
Magnesium	mg/L		5	44.8	45.0	47.0	46.7	49.7	50.3	0	0%
Manganese	ug/L	> 500 (H) > 100 (A)	5	0.15	0.15	0.23	0.15	0.38	0.4	0	0%
Mercury	ug/L	> 1 (H)	5	0.4	0.4	0.4	0.4	0.4	0.4	0	0%
Molybdenum	ug/L	> 50 (H)	5	0.30	0.30	0.34	0.30	0.40	0.40	0	0%
Nickel	ug/L	> 20 (H)	5	0.40	0.40	0.44	0.40	0.50	0.50	0	0%
Silver	ug/L	> 100 (H)	5	0.1	0.1	0.1	0.1	0.1	0.1	0	0%
Zinc	ug/L	> 3000 (A)	5	20	20	20	20	20	20	0	0%
Uranium	ug/L	> 20 (H)	5	0.8	0.8	0.82	0.8	0.88	0.9	0	0%

Source: *NSW Health database*

Table A-7. Spring Ridge verification monitoring summary

Parameter	Units	ADWG Limit	Count	Min	5th %ile	Mean	Median	95th %ile	Max	Excursion count	Exceedance %
E. coli	mpn/100 mL	> 0 (H)	76	0	0	0	0	0	0	0	0%
Total Coliforms	mpn/100 mL		76	0	0	1.04	0	3.25	59	0	0%
Aluminium	ug/L	> 200 (A)	4	5	5	5	5	5	5	0	0%
Antimony	ug/L	> 3 (H)	4	0.05	0.05	0.05	0.05	0.05	0.05	0	0%
Arsenic	ug/L	> 10 (H)	4	1.00	1.00	2.00	1.50	3.70	4.00	0	0%
Barium	ug/L	> 2000 (H)	4	96.2	96.2	98.4	97.5	101.9	102.5	0	0%
Boron	ug/L	> 4000 (H)	4	92.0	92.1	96.5	96.1	101.5	101.9	0	0%
Cadmium	ug/L	> 2 (H)	4	0.05	0.05	0.05	0.05	0.05	0.05	0	0%
Calcium	mg/L		4	32.7	32.7	34.4	34.2	36.2	36.4	0	0%

Parameter	Units	ADWG Limit	Count	Min	5th %ile	Mean	Median	95th %ile	Max	Excursion count	Exceedance %
Chloride	mg/L	> 250 (A)	4	611	616	662	650	726	739	4	100%
Fluoride	mg/L	> 1.5 (H)	4	0.25	0.25	0.26	0.27	0.27	0.27	0	0%
Iodine	mg/L		4	0.07	0.07	0.09	0.09	0.10	0.10	0	0%
Nitrate	mg/L	> 50 (H)	4	12.0	12.2	13.8	13.5	15.7	16.0	0	0%
Nitrite	mg/L	> 3 (H)	4	0.05	0.05	0.05	0.05	0.05	0.05	0	0%
Residual Chlorine	mg/L	< 0.2 > 5 (H)	77	0.05	0.56	0.79	0.78	1.23	1.50	2	3%
Selenium	ug/L	> 10 (H)	4	3.5	3.5	3.5	3.5	3.5	3.5	0	0%
Sodium	mg/L	> 180 (A)	4	419	421	442	444	462	463	4	100%
Sulfate	mg/L	> 250 (A)	4	56.0	56.2	60.0	59.0	65.3	66.0	0	0%
Total Chlorine	mg/L	< 0.2 > 5 (H)	77	0.0	0.7	0.9	0.9	1.4	2.0	2	3%
Colour - True	Hazen Units (HU)	> 15 (A)	4	0.5	0.5	0.6	0.5	0.9	1.0	0	0%
pH		< 6.5 > 8.5 (A)	81	7.1	7.8	7.9	8.0	8.2	8.3	0	0%
Temperature	C		77	13.4	14.2	21.0	21.2	28.5	29.9	0	0%
Total Dissolved Solids (TDS)	mg/L	> 600 (A)	4	1230	1240	1350	1341	1472	1487	4	100%
Total Hardness as CaCO3	mg/L	> 200 (A)	4	393	397	425	425	452	455	4	100%
Turbidity	NTU	> 5 (A)	81	0.0	0.1	0.2	0.1	0.4	1.2	0	0%
Chromium	ug/L	> 50 (A)	4	5.0	5.2	6.3	6.5	7.0	7.0	0	0%
Copper	ug/L	> 2000 (H) > 1000 (A)	4	15.0	15.0	16.3	15.5	18.6	19.0	0	0%
Iron	ug/L	> 300 (A)	4	10	10	27.5	10	69.5	80	0	0%
Lead	ug/L	> 10 (H)	4	0.1	0.1	0.1	0.1	0.1	0.1	0	0%
Magnesium	mg/L		4	75.4	76.4	82.3	82.6	87.7	88.5	0	0%
Manganese	ug/L	> 500 (H) > 100 (A)	4	0.15	0.15	0.5375	0.15	1.4675	1.7	0	0%
Mercury	ug/L	> 1 (H)	4	0.4	0.4	0.4	0.4	0.4	0.4	0	0%
Molybdenum	ug/L	> 50 (H)	4	2.40	2.42	2.60	2.55	2.86	2.90	0	0%
Nickel	ug/L	> 20 (H)	4	0.20	0.20	0.20	0.20	0.20	0.20	0	0%
Silver	ug/L	> 100 (H)	4	0.1	0.1	0.1	0.1	0.1	0.1	0	0%
Zinc	ug/L	> 3000 (A)	4	10	10	12.5	10	18.5	20	0	0%
Uranium	ug/L	> 20 (H)	4	1.4	1.43	1.65	1.6	1.94	2	0	0%

Source: *NSW Health database*

Table A-8. Walhallow verification monitoring summary

Parameter	Units	ADWG Limit	Count	Min	5th %ile	Mean	Median	95th %ile	Max	Excursion count	Exceedance %
E. coli	mpn/100 mL	> 0 (H)	76	0	0	0	0	0	0	0	0.00%
Total Coliforms	mpn/100 mL		76	0	0	0	0	0	0	0	0.00%
Aluminium	ug/L	> 200 (A)	6	5.00	5.00	5.00	5.00	5.00	5.00	0	0.00%
Antimony	ug/L	> 3 (H)	6	0.05	0.05	0.05	0.05	0.05	0.05	0	0.00%
Arsenic	ug/L	> 10 (H)	6	0.50	0.63	1.08	1.00	1.75	2.00	0	0.00%

Parameter	Units	ADWG Limit	Count	Min	5th %ile	Mean	Median	95th %ile	Max	Excursion count	Exceedance %
Barium	ug/L	> 2000 (H)	6	29.6	29.8	30.9	30.9	31.8	31.9	0	0.00%
Boron	ug/L	> 4000 (H)	6	38.8	38.8	40.8	41.4	42.2	42.2	0	0.00%
Cadmium	ug/L	> 2 (H)	6	0.10	0.13	0.22	0.20	0.30	0.30	0	0.00%
Calcium	mg/L		6	78.4	78.6	83.4	83.4	89.7	91.3	0	0.00%
Chloride	mg/L	> 250 (A)	6	115	115	122	116	135	137	0	0.00%
Fluoride	mg/L	> 1.5 (H)	6	0.05	0.05	0.09	0.10	0.11	0.11	0	0.00%
Iodine	mg/L		6	0.01	0.01	0.01	0.01	0.02	0.02	0	0.00%
Nitrate	mg/L	> 50 (H)	6	3.0	3.0	3.5	3.5	4.0	4.0	0	0.00%
Nitrite	mg/L	> 3 (H)	6	0.05	0.05	0.05	0.05	0.05	0.05	0	0.00%
Residual Chlorine	mg/L	< 0.2 > 5 (H)	77	0.40	0.64	0.90	0.89	1.16	2.20	0	0.00%
Selenium	ug/L	> 10 (H)	6	3.50	3.50	3.50	3.50	3.50	3.50	0	0.00%
Sodium	mg/L	> 180 (A)	6	66	67	74	75	78	78	0	0.00%
Sulfate	mg/L	> 250 (A)	6	19.0	19.0	20.0	20.0	21.0	21.0	0	0.00%
Total Chlorine	mg/L	< 0.2 > 5 (H)	76	0.40	0.67	1.01	0.99	1.32	2.61	0	0.00%
Colour - True	Hazen Units (HU)	> 15 (A)	6	0.50	0.50	0.58	0.50	0.88	1.00	0	0.00%
pH		< 6.5 > 8.5 (A)	83	5.4	7.6	8.0	8.0	8.2	8.3	1	1.20%
Temperature	C		77	9.9	12.8	19.8	20.1	26.8	28.5	0	0.00%
Total Dissolved Solids (TDS)	mg/L	> 600 (A)	6	463	464	490	491	517	518	0	0.00%
Total Hardness as CaCO3	mg/L	> 200 (A)	6	368	370	395	391	431	440	6	100.00%
Turbidity	NTU	> 5 (A)	83	0.02	0.04	0.16	0.16	0.32	1.20	0	0.00%
Chromium	ug/L	> 50 (A)	6	0.50	0.63	1.08	1.00	1.75	2.00	0	0.00%
Copper	ug/L	> 2000 (H) > 1000 (A)	6	0.5	0.6	1.8	2.0	2.8	3.0	0	0.00%
Iron	ug/L	> 300 (A)	6	5.0	5.0	7.5	7.5	10.0	10.0	0	0.00%
Lead	ug/L	> 10 (H)	6	0.10	0.38	1.63	1.50	2.93	3.10	0	0.00%
Magnesium	mg/L		6	39.4	40.3	45.3	45.6	50.2	51.4	0	0.00%
Manganese	ug/L	> 500 (H) > 100 (A)	6	0.15	0.15	0.18	0.15	0.26	0.30	0	0.00%
Mercury	ug/L	> 1 (H)	6	0.40	0.40	0.40	0.40	0.40	0.40	0	0.00%
Molybdenum	ug/L	> 50 (H)	6	0.40	0.40	0.40	0.40	0.40	0.40	0	0.00%

Source: *NSW Health database*

Table A-9. Wallabadah verification monitoring summary

Parameter	Units	ADWG Limit	Count	Min	5th %ile	Mean	Median	95th %ile	Max	Excursion count	Exceedance %
E. coli	mpn/100 mL	> 0 (H)	78	0	0	0	0	0	2	1	1.28%
Total Coliforms	mpn/100 mL		78	0	0	5	0	0	200	0	0.00%
Aluminium	ug/L	> 200 (A)	5	5.00	5.00	5.00	5.00	5.00	5.00	0	0.00%
Antimony	ug/L	> 3 (H)	5	0.05	0.05	0.05	0.05	0.05	0.05	0	0.00%
Arsenic	ug/L	> 10 (H)	5	0.50	0.60	0.90	1.00	1.00	1.00	0	0.00%

Parameter	Units	ADWG Limit	Count	Min	5th %ile	Mean	Median	95th %ile	Max	Excursion count	Exceedance %
Barium	ug/L	> 2000 (H)	5	0.2	1.1	4.0	4.9	5.2	5.3	0	0.00%
Boron	ug/L	> 4000 (H)	5	0.4	36.0	156.7	180.7	217.1	220.5	0	0.00%
Cadmium	ug/L	> 2 (H)	5	0.05	0.05	0.05	0.05	0.05	0.05	0	0.00%
Calcium	mg/L		5	77.0	77.6	82.3	80.6	88.6	89.7	0	0.00%
Chloride	mg/L	> 250 (A)	5	57	58	66	60	76	76	0	0.00%
Fluoride	mg/L	> 1.5 (H)	5	0.23	0.23	0.25	0.25	0.27	0.27	0	0.00%
Iodine	mg/L		5	0.01	0.01	0.01	0.01	0.01	0.01	0	0.00%
Nitrate	mg/L	> 50 (H)	5	0.5	0.6	1.5	1.0	2.8	3.0	0	0.00%
Nitrite	mg/L	> 3 (H)	5	0.05	0.05	0.05	0.05	0.05	0.05	0	0.00%
Residual Chlorine	mg/L	< 0.2 > 5 (H)	79	0.05	0.63	1.01	1.01	1.36	1.84	1	1.27%
Selenium	ug/L	> 10 (H)	5	3.50	3.50	3.50	3.50	3.50	3.50	0	0.00%
Sodium	mg/L	> 180 (A)	5	83	83	88	87	93	94	0	0.00%
Sulfate	mg/L	> 250 (A)	5	99.0	100.2	107.8	107.0	114.0	114.0	0	0.00%
Total Chlorine	mg/L	< 0.2 > 5 (H)	79	0.05	0.70	1.13	1.14	1.50	2.20	1	1.27%
Colour - True	Hazen Units (HU)	> 15 (A)	5	0.50	0.50	0.60	0.50	0.90	1.00	0	0.00%
pH		< 6.5 > 8.5 (A)	84	7.0	7.4	7.7	7.7	7.9	8.2	0	0.00%
Temperature	C		79	12.2	12.9	18.4	19.1	23.1	24.1	0	0.00%
Total Dissolved Solids (TDS)	mg/L	> 600 (A)	5	495	496	521	504	557	559	0	0.00%
Total Hardness as CaCO3	mg/L	> 200 (A)	5	431	431	450	439	486	494	5	100.00%
Turbidity	NTU	> 5 (A)	84	0.01	0.02	0.34	0.16	0.32	15.00	1	1.19%
Chromium	ug/L	> 50 (A)	5	0.50	0.50	1.00	1.00	1.80	2.00	0	0.00%
Copper	ug/L	> 2000 (H) > 1000 (A)	5	0.5	2.6	11.1	11.0	17.4	18.0	0	0.00%
Iron	ug/L	> 300 (A)	5	5.0	5.0	5.0	5.0	5.0	5.0	0	0.00%
Lead	ug/L	> 10 (H)	5	0.10	0.16	0.48	0.50	0.76	0.80	0	0.00%
Magnesium	mg/L		5	56.2	56.5	59.2	58.0	64.2	65.6	0	0.00%
Manganese	ug/L	> 500 (H) > 100 (A)	5	0.15	0.15	0.27	0.15	0.48	0.50	0	0.00%
Mercury	ug/L	> 1 (H)	5	0.40	0.40	0.40	0.40	0.40	0.40	0	0.00%
Molybdenum	ug/L	> 50 (H)	5	0.05	0.32	1.23	1.50	1.66	1.70	0	0.00%

Parameter	Units	ADWG Limit	Count	Min	5th %ile	Mean	Median	95th %ile	Max	Excursion count	Exceedance %
Nickel	ug/L	> 20 (H)	5	0.20	0.20	0.30	0.20	0.48	0.50	0	0.00%
Silver	ug/L	> 100 (H)	5	0.10	0.10	0.10	0.10	0.10	0.10	0	0.00%
Zinc	ug/L	> 3000 (A)	5	60.0	62.0	86.0	100.0	100.0	100.0	0	0.00%
Uranium	ug/L	> 20 (H)	5	0.05	0.20	0.83	1.00	1.18	1.20	0	0.00%

Source: *NSW Health database*

Table A-10. Werris Creek verification monitoring summary

Parameter	Units	ADWG Limit	Count	Min	5th %ile	Mean	Median	95th %ile	Max	Excursion count	Exceedance %
E. coli	mpn/100 mL	> 0 (H)	151	0	0	0	0	0	0	0	0.00%
Total Coliforms	mpn/100 mL		151	0	0	1	0	0	200	0	0.00%
Aluminium	ug/L	> 200 (A)	5	10.0	14.0	52.0	40.0	102	110	0	0.00%
Antimony	ug/L	> 3 (H)	5	0.05	0.05	0.06	0.05	0.09	0.10	0	0.00%
Arsenic	ug/L	> 10 (H)	5	0.50	0.60	0.90	1.00	1.00	1.00	0	0.00%
Barium	ug/L	> 2000 (H)	5	9.2	9.6	15.0	17.2	19.1	19.4	0	0.00%
Boron	ug/L	> 4000 (H)	5	19.7	20.3	24.5	25.5	27.7	28.1	0	0.00%
Cadmium	ug/L	> 2 (H)	5	0.05	0.05	0.05	0.05	0.05	0.05	0	0.00%
Calcium	mg/L		5	21.7	21.7	25.3	26.8	28.7	29.1	0	0.00%
Chloride	mg/L	> 250 (A)	5	20	21	29	27	36	36	0	0.00%
Fluoride	mg/L	> 1.5 (H)	5	0.05	0.05	0.06	0.05	0.09	0.10	0	0.00%
Iodine	mg/L		5	0.02	0.02	0.03	0.02	0.05	0.05	0	0.00%
Nitrate	mg/L	> 50 (H)	5	0.5	0.5	0.6	0.5	0.9	1.0	0	0.00%
Nitrite	mg/L	> 3 (H)	5	0.05	0.05	0.05	0.05	0.05	0.05	0	0.00%
Residual Chlorine	mg/L	< 0.2 > 5 (H)	156	0.44	1.01	1.65	1.70	2.17	2.36	0	0.00%
Selenium	ug/L	> 10 (H)	5	3.50	3.50	3.50	3.50	3.50	3.50	0	0.00%
Sodium	mg/L	> 180 (A)	5	40	40	64	64	95	100	0	0.00%
Sulfate	mg/L	> 250 (A)	5	76.0	76.2	110	99.0	153	156	0	0.00%
Total Chlorine	mg/L	< 0.2 > 5 (H)	152							0	0.00%
Colour - True	Hazen Units (HU)	> 15 (A)	5	1.00	1.00	1.20	1.00	1.80	2.00	0	0.00%
pH		< 6.5 > 8.5 (A)	161	6.7	7.1	7.5	7.5	8.1	8.4	0	0.00%
Temperature	C		156	10.4	12.9	19.8	19.9	26.8	28.5	0	0.00%
Total Dissolved Solids (TDS)	mg/L	> 600 (A)	5	183	189	226	214	280	293	0	0.00%
Total Hardness as CaCO3	mg/L	> 200 (A)	5	91	91	109	117	127	129	0	0.00%
Turbidity	NTU	> 5 (A)	160	0.01	0.05	0.23	0.21	0.45	1.10	0	0.00%
Chromium	ug/L	> 50 (A)	5	0.50	0.50	0.60	0.50	0.90	1.00	0	0.00%
Copper	ug/L	> 2000 (H) > 1000 (A)	5	5.0	5.0	7.4	5.0	12.8	14.0	0	0.00%

Parameter	Units	ADWG Limit	Count	Min	5th %ile	Mean	Median	95th %ile	Max	Excursion count	Exceedance %
Iron	ug/L	> 300 (A)	5	5.0	6.0	23.0	10.0	60.0	70.0	0	0.00%
Lead	ug/L	> 10 (H)	5	0.10	0.10	0.10	0.10	0.10	0.10	0	0.00%
Magnesium	mg/L		5	9.0	9.0	11.2	12.0	13.4	13.6	0	0.00%
Manganese	ug/L	> 500 (H) > 100 (A)	5	0.70	0.70	1.60	0.80	3.68	4.20	0	0.00%
Mercury	ug/L	> 1 (H)	5	0.40	0.40	0.40	0.40	0.40	0.40	0	0.00%
Molybdenum	ug/L	> 50 (H)	5	0.20	0.24	0.44	0.50	0.58	0.60	0	0.00%
Nickel	ug/L	> 20 (H)	5	0.40	0.42	0.56	0.50	0.76	0.80	0	0.00%
Silver	ug/L	> 100 (H)	5	0.10	0.10	0.10	0.10	0.10	0.10	0	0.00%
Zinc	ug/L	> 3000 (A)	5	10.0	10.0	12.0	10.0	18.0	20.0	0	0.00%
Uranium	ug/L	> 20 (H)	5	0.05	0.05	0.07	0.05	0.10	0.10	0	0.00%

Source: *NSW Health database*

Table A-11. Willow Tree verification monitoring summary

Parameter	Units	ADWG Limit	Count	Min	5th %ile	Mean	Median	95th %ile	Max	Excursion count	Exceedance %
E. coli	mpn/100 mL	> 0 (H)	77	0	0	0	0	0	0	0	0.00%
Total Coliforms	mpn/100 mL		77	0	0	0	0	0	0	0	0.00%
Aluminium	ug/L	> 200 (A)	5	5.00	5.00	5.00	5.00	5.00	5.00	0	0.00%
Antimony	ug/L	> 3 (H)	5	0.05	0.05	0.05	0.05	0.05	0.05	0	0.00%
Arsenic	ug/L	> 10 (H)	5	1.00	1.00	1.20	1.00	1.80	2.00	0	0.00%
Barium	ug/L	> 2000 (H)	5	25.2	25.5	27.1	26.6	28.9	29.2	0	0.00%
Boron	ug/L	> 4000 (H)	5	19.0	19.1	20.8	21.3	22.8	23.1	0	0.00%
Cadmium	ug/L	> 2 (H)	5	0.05	0.05	0.05	0.05	0.05	0.05	0	0.00%
Calcium	mg/L		5	72.7	73.4	79.3	78.6	85.2	85.6	0	0.00%
Chloride	mg/L	> 250 (A)	5	113	113	118	115	124	124	0	0.00%
Fluoride	mg/L	> 1.5 (H)	5	0.05	0.06	0.10	0.11	0.12	0.12	0	0.00%
Iodine	mg/L		5	0.01	0.01	0.01	0.01	0.01	0.01	0	0.00%
Nitrate	mg/L	> 50 (H)	5	10.0	10.2	11.2	11.0	12.0	12.0	0	0.00%
Nitrite	mg/L	> 3 (H)	5	0.05	0.05	0.05	0.05	0.05	0.05	0	0.00%
Residual Chlorine	mg/L	< 0.2 > 5 (H)	78	0.12	0.47	0.67	0.69	0.85	0.97	1	1.28%
Selenium	ug/L	> 10 (H)	5	3.50	3.50	3.50	3.50	3.50	3.50	0	0.00%
Sodium	mg/L	> 180 (A)	5	52	52	56	57	60	60	0	0.00%
Sulfate	mg/L	> 250 (A)	5	40.0	40.4	44.2	45.0	47.6	48.0	0	0.00%
Total Chlorine	mg/L	< 0.2 > 5 (H)	78	0.21	0.46	0.75	0.79	0.96	1.10	0	0.00%
Colour - True	Hazen Units (HU)	> 15 (A)	5	0.50	0.50	0.60	0.50	0.90	1.00	0	0.00%
pH		< 6.5 > 8.5 (A)	83	7.8	8.1	8.2	8.2	8.4	8.4	0	0.00%
Temperature	C		78	10.9	12.4	19.5	19.5	26.4	28.1	0	0.00%
Total Dissolved	mg/L	> 600 (A)	5	423	424	445	434	472	474	0	0.00%

Parameter	Units	ADWG Limit	Count	Min	5th %ile	Mean	Median	95th %ile	Max	Excursion count	Exceedance %
Solids (TDS)											
Total Hardness as CaCO3	mg/L	> 200 (A)	5	367	368	391	377	427	433	5	100.00 %
Turbidity	NTU	> 5 (A)	81	0.01	0.02	0.15	0.12	0.30	1.10	0	0.00%
Chromium	ug/L	> 50 (A)	5	0.50	0.50	0.80	1.00	1.00	1.00	0	0.00%
Copper	ug/L	> 2000 (H) > 1000 (A)	5	6.0	6.2	8.0	8.0	10.4	11.0	0	0.00%
Iron	ug/L	> 300 (A)	5	5.0	5.0	5.0	5.0	5.0	5.0	0	0.00%
Lead	ug/L	> 10 (H)	5	0.10	0.14	0.32	0.30	0.48	0.50	0	0.00%
Magnesium	mg/L		5	42.9	43.1	46.8	46.5	52.1	53.2	0	0.00%
Manganese	ug/L	> 500 (H) > 100 (A)	5	0.15	0.15	0.15	0.15	0.15	0.15	0	0.00%
Mercury	ug/L	> 1 (H)	5	0.40	0.40	0.40	0.40	0.40	0.40	0	0.00%
Molybdenum	ug/L	> 50 (H)		0.30	0.30	0.36	0.40	0.40	0.40	0	0.00%
Nickel	ug/L	> 20 (H)	5	0.40	0.40	0.46	0.50	0.50	0.50	0	0.00%
Silver	ug/L	> 100 (H)	5	0.10	0.10	0.10	0.10	0.10	0.10	0	0.00%
Zinc	ug/L	> 3000 (A)	5	20.0	20.0	20.0	20.0	20.0	20.0	0	0.00%
Uranium	ug/L	> 20 (H)	5	0.80	0.82	0.90	0.90	0.98	1.00	0	0.00%

Source: *NSW Health database*