Appendix A Raw Water Quality

A.1 Alkalinity and hardness

Raw water alkalinity and total hardness (TH) over time is shown in Figure A-1. Total hardness was calculated from the concentrations of calcium and magnesium.

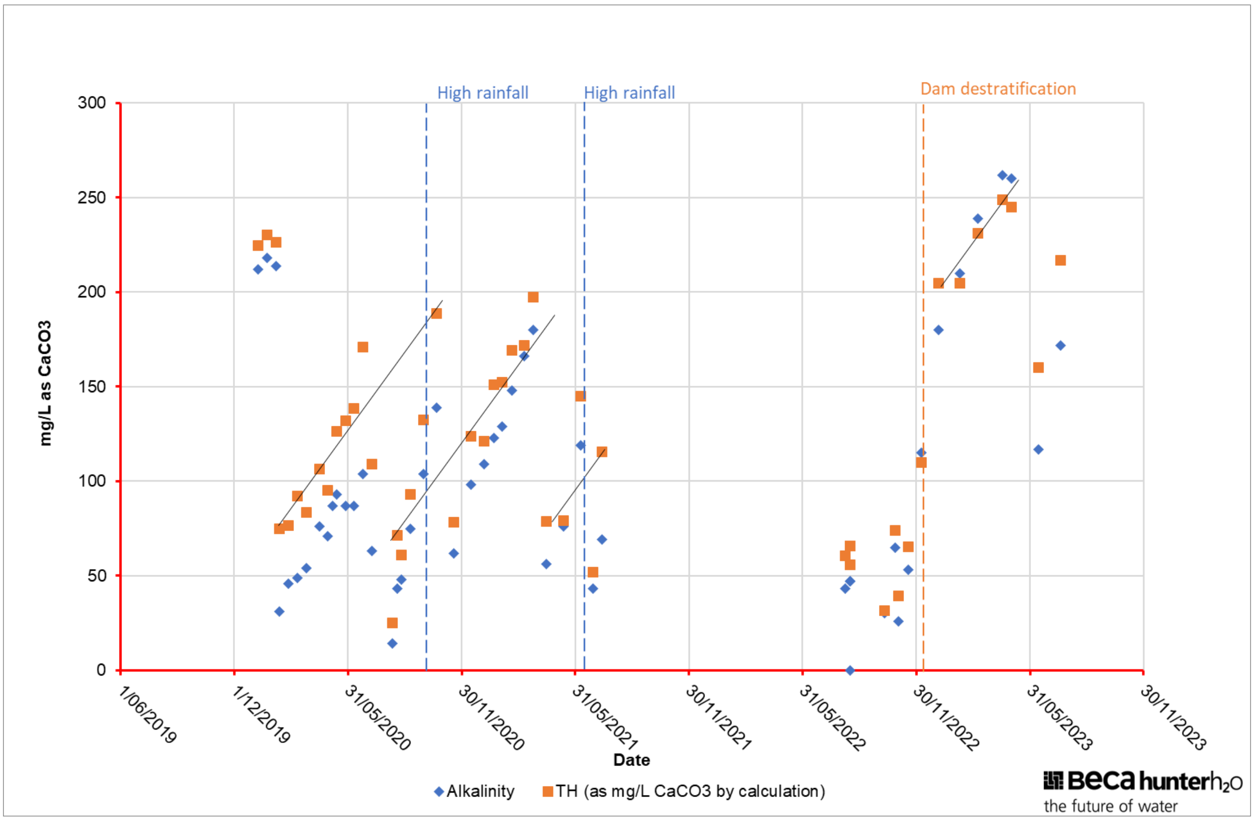

Figure A-1 Raw water alkalinity and total hardness

From Figure A-1, a pattern is observed where total hardness will start at around 75 mg/L and then increase over a period of no rainfall. A high rainfall event will then lower hardness down to around 75 mg/L as $CaCO_3$. There are two high rainfall events observed between January 2020 and July 2021 (marked as blue, vertical dotted lines). Each event involved around 30 – 60 mm of rainfall lasting for around 2-3 days each time (*Weather station 073050 Bowning, Bureau of Meteorology*).

It is therefore expected that the high total hardness recorded after commencement of dam destratification is due to there being no recorded high rainfall event of the same description from January 2023 to April 2023. Since the hardness concentration can increase to over 200 mg/L after several months without a significant rainfall event, it suggests, as was found in the 2020 Options Assessment undertaken by Hunter H2O, that a softening process is required at Yass WTP to achieve the ADWG aesthetic guidelines value for Total Hardness of 200 mg/L as $CaCO_3$.

A.1.1 Historic hardness

From 2005 to 2020, periods of low rainfall / low river flow have correlated with high total hardness over 200 mg/L as $CaCO_3$. Total hardness as high as 350 mg/L have been recorded in 2007 and 2013. The median river daily flow and treated water total hardness from 2005 to 2020 is shown in Figure A-2.

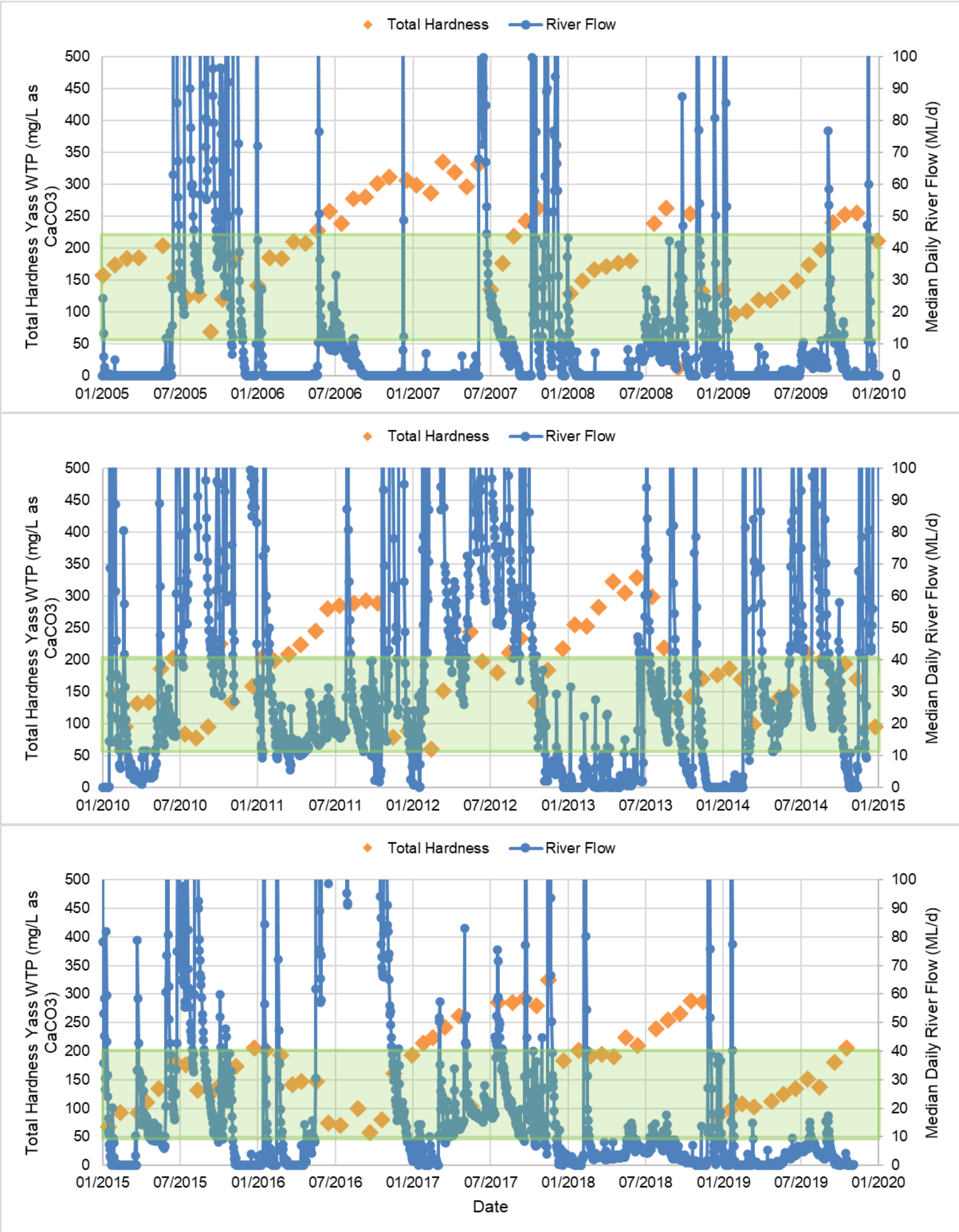

Figure A-2 River daily flow and treated water hardness

A.2 DOC, UVA and TOC

Dissolved organic carbon (DOC), ultraviolet absorbance (UVA) and total organic carbon (TOC) over time are shown in Figure A-3, Figure A-4 and Figure A-5 respectively.

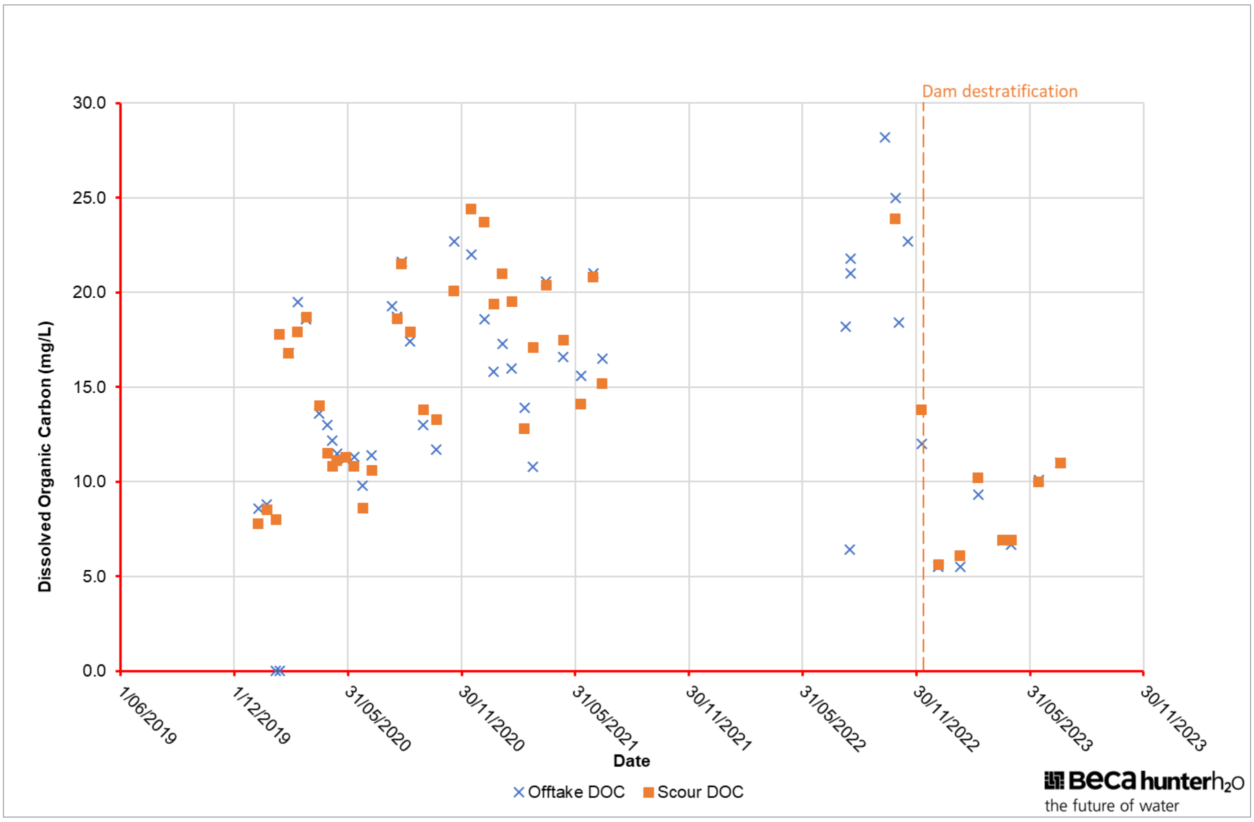

Figure A-3 Raw water dissolved organic carbon (DOC)

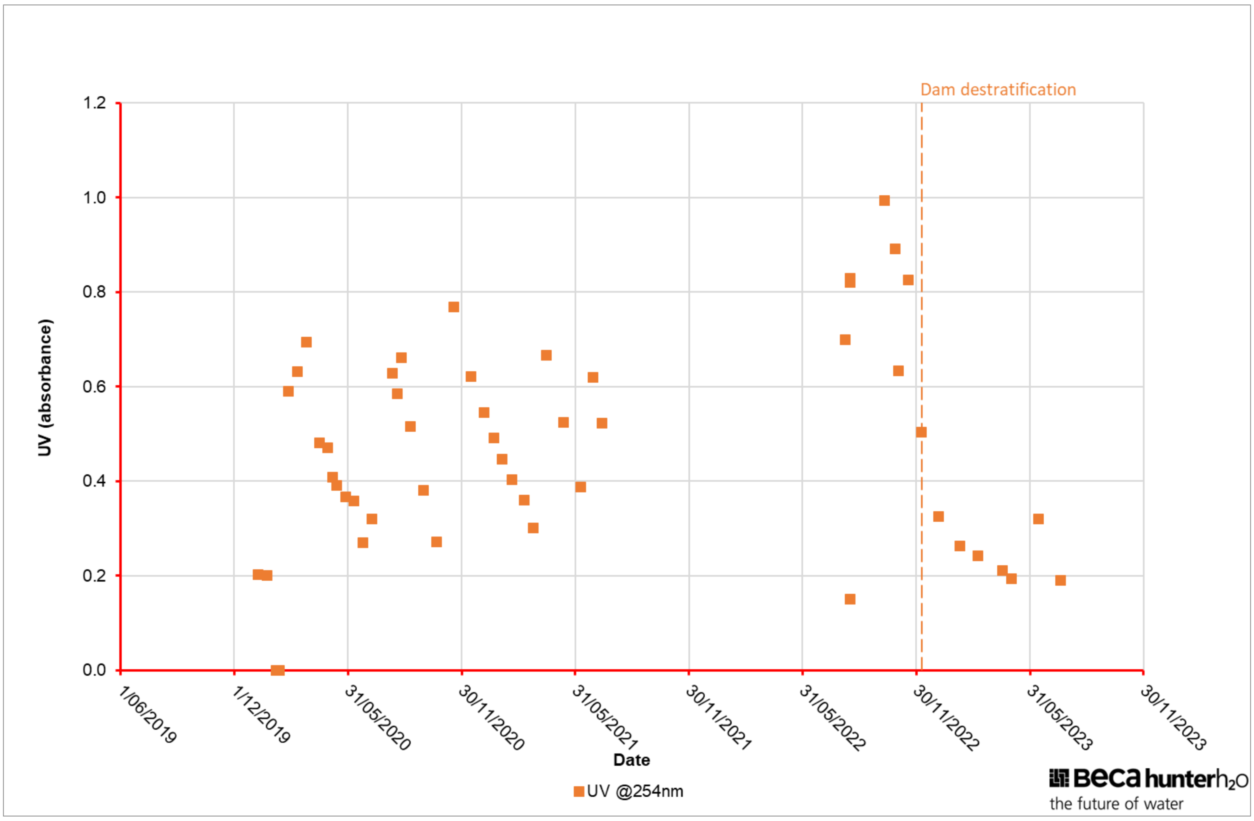

Figure A-4 Raw water UV absorbance (UVA)

Following operation of the newly installed bubble plume aeration system (marked as the vertical, orange dotted line in Figure A-3), DOC has decreased. Offtake DOC concentration decreased from around 23 mg/L to 5.5 mg/L after starting the bubble plume dam aeration system. The most recent data point from the 9th of March 2023 shows DOC beginning to increase again. This could be due to a change in the operation of the aeration system but further monitoring and analysis is required. Similar DOC concentrations from the scour valve and from the offtake are observed after starting dam aeration suggesting mixing and homogenisation of the dam water has been achieved.

Coinciding with the DOC results, the raw water UVA has shown to decrease following operation of the bubble plume dam aeration system. UVA decreased from 0.8-1.0 to 0.2-0.3 after dam destratification (marked as the vertical, orange dotted line in Figure A-4). The decrease in UVA is expected given observed lower DOC concentrations. Lower UVA and DOC generally means a lower burden on the plant's treatment process and less likely to require operation in enhanced coagulation mode.

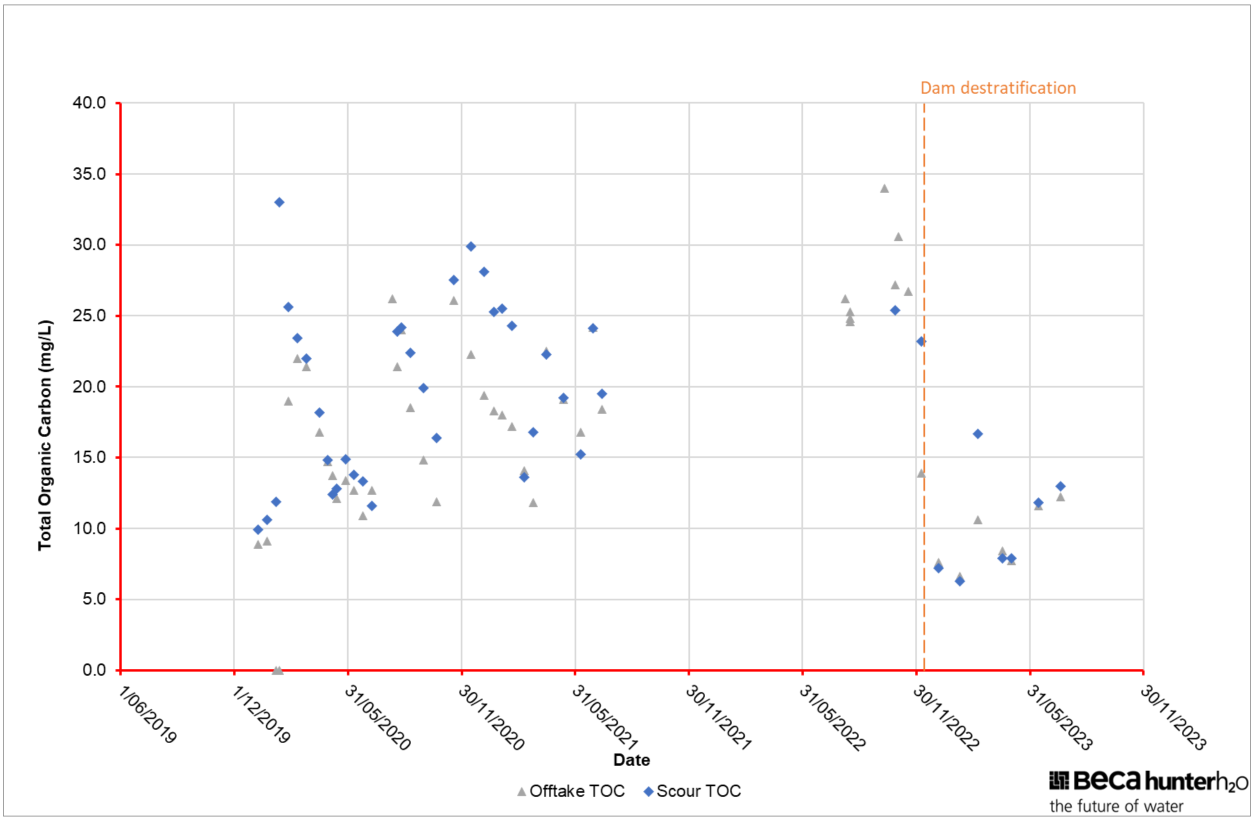

Figure A-5 Raw water total organic carbon (TOC)

From Figure A-5, TOC decreased following starting the bubble plume dam aeration system similarly to the observed DOC and UVA improvements. TOC at the scour valve level and the offtake level in the dam are the same immediately after start-up which suggests mixing and homogenisation of the dam water has been achieved. However, the latest data point from the 9th of March 2023 shows the TOC levels at the two depths have separated, a situation similar to the data before starting the bubble plume dam aeration system. As discussed in reference to DOC, this could be due to a change in the operation of the aeration system however it is unclear and further monitoring and analysis is needed to optimise bubble plume dam aeration system operating duration and frequency.

A.3 Iron and manganese

Manganese (soluble and total) concentration over time is shown in Figure A-6 and Figure A-7. Iron (soluble and total) concentration over time is shown in Figure A-8 and Figure A-9.

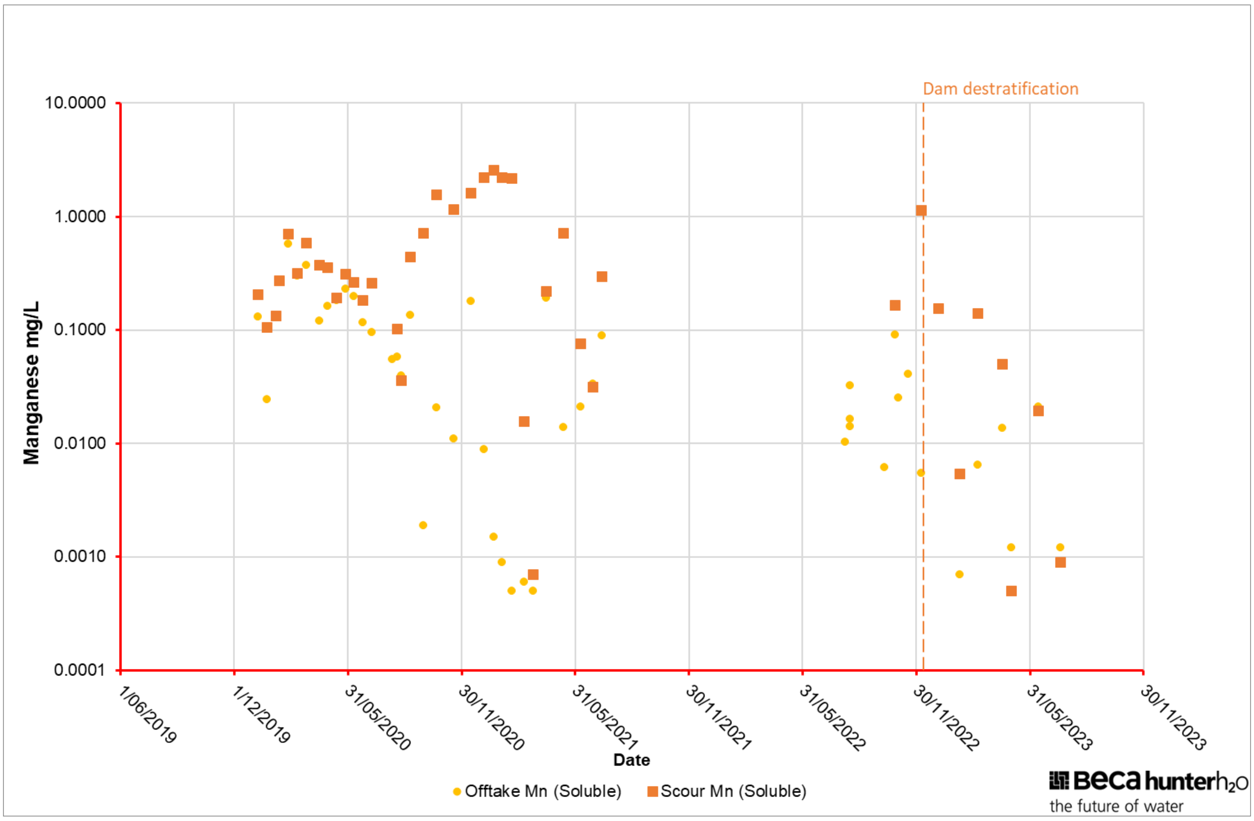

Figure A-6 Raw water soluble manganese – offtake conc. decreased, scour level conc. trend uncertain

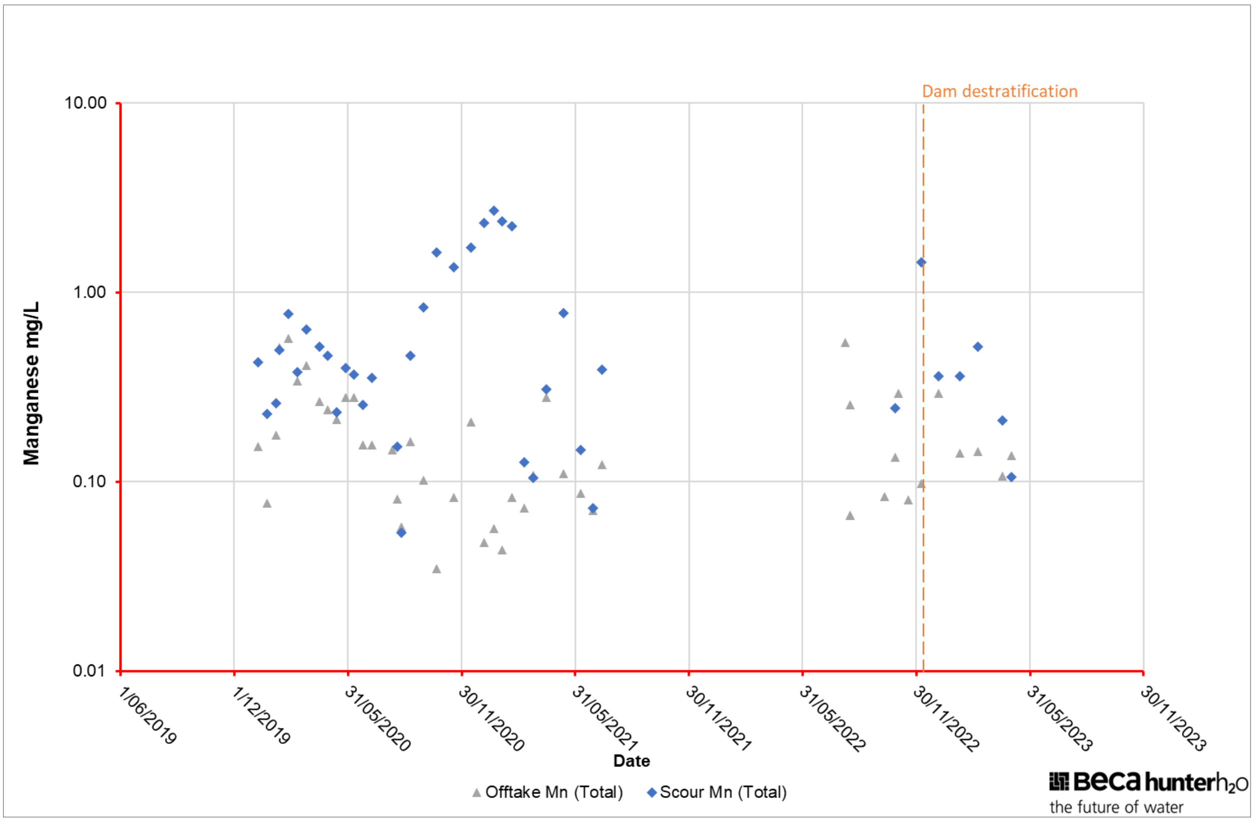

Figure A-7 Raw water total manganese – offtake conc. increasing, scour conc.

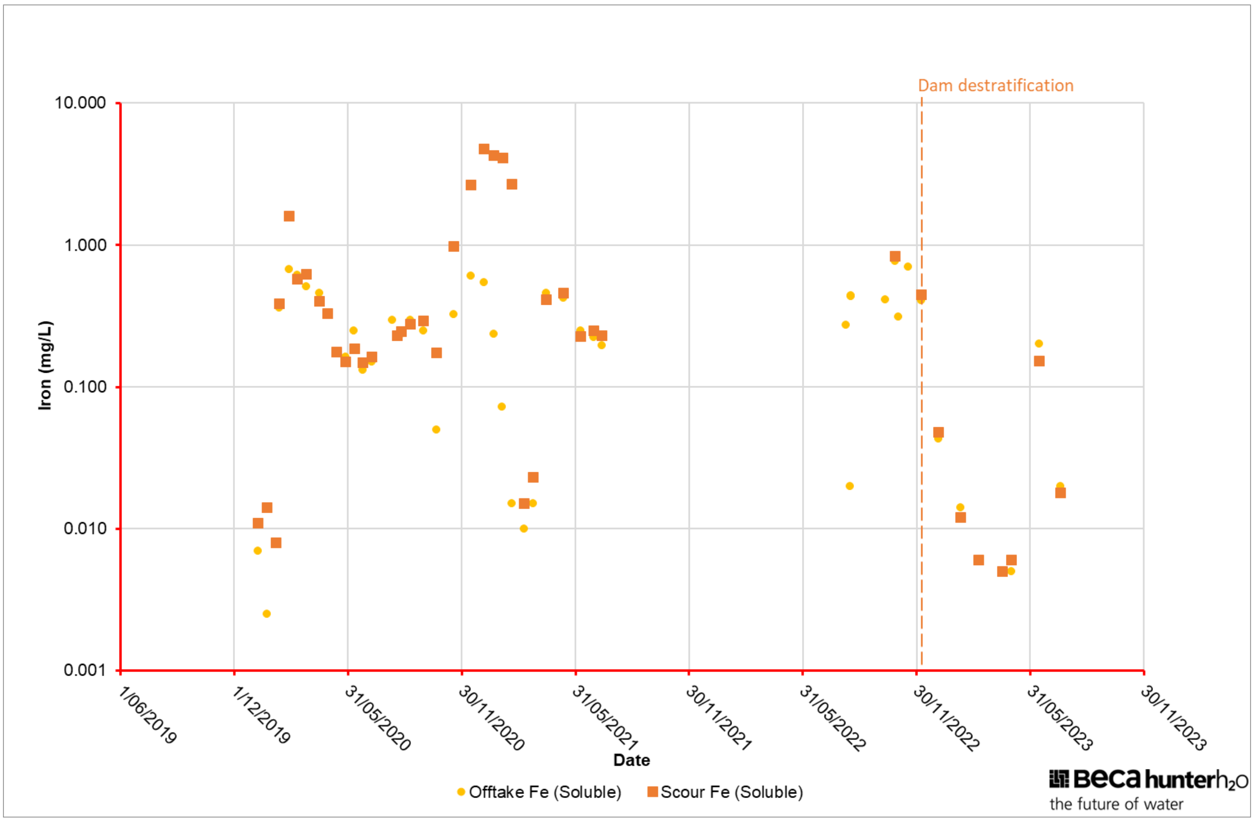

Figure A-8 Raw water soluble iron – offtake and scour conc. decreased

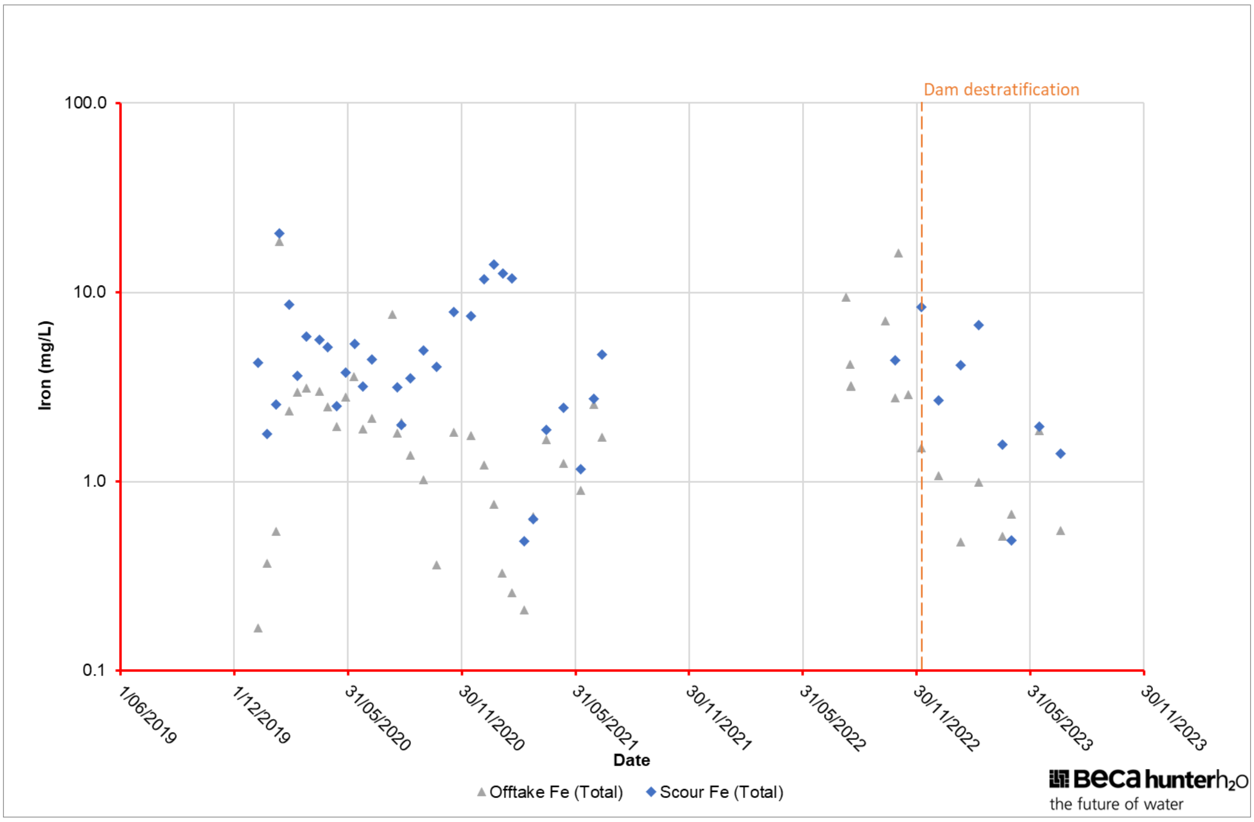

Figure A-9 Raw water total iron – offtake conc. decreasing, scour conc. decreasing

Iron is more readily oxidised than manganese and so the change in raw water quality is easier to observe in the soluble and total iron graphs (Figure A-8 and Figure A-9). However, the soluble and total manganese concentrations (Figure A-6 and Figure A-7) demonstrate similar trends.

Soluble iron concentrations decreased from around 0.5 mg/L to practically zero following operation of the bubble plume dam aeration system (marked as the vertical, orange dotted line in Figure A-8). The soluble iron concentrations at the scour valve and the offtake level are both near zero which can also suggest the dam water has a low reduction potential.

Soluble manganese concentration at the offtake level decreased from around 0.15 mg/L to 0.05 mg/L following operation of the bubble plume dam aeration system. At the scour level, a clear trend for soluble manganese is yet to appear.

It can also be seen from the one data point at the time of bubble plume dam aeration system start up, that initial start-up stirred up iron and manganese from the bottom of the dam as the concentrations from the scour valve spike at this time. Despite this situation at the bottom of the storage, the offtake level iron and manganese concentrations were unaffected and the concentrations at the scour valve level soon returned to normal.

The total iron and total manganese concentrations at the scour level increase linearly following bubble plume dam aeration system commencement. This potentially indicates that iron and manganese is being mobilised into the water column via shear and mixing induced by the bubble plume operation however oxidative conditions exist and the soluble fraction of iron and manganese is decreasing.

Although these are promising results, there are only 3 data points since the system's installation and further monitoring and analysis is required to see if the trend continues.

A.4 Onsite analysis of UVA and Sol Mn

Soluble manganese and UVA have also been analysed onsite by the Yass Valley Council (YVC) team. Analysis is from 23rd of January to 17th of April 2023. Sample concentrations were recorded at 5 different depths in the dam, with V1 (valve 1) being at the offtake level and SV (scour valve) being the lowest dam level. Soluble manganese variation with dam level is shown in Figure A-10. UVA variation with dam level is shown in Figure A-11.

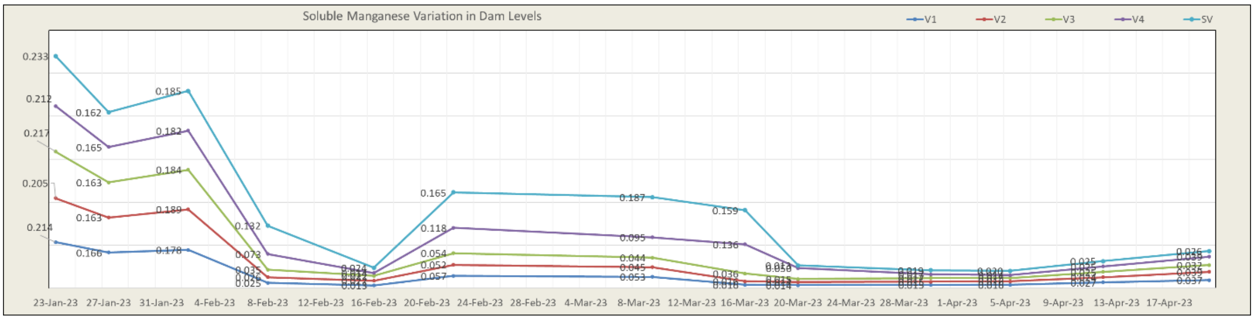

Figure A-10 Soluble manganese concentration at varying dam levels (onsite analysis)

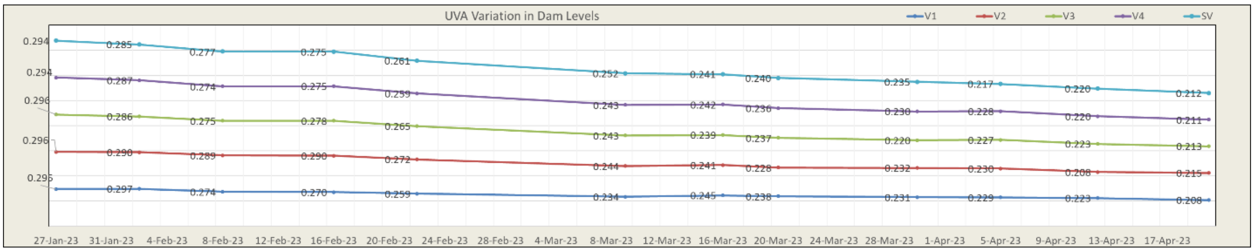

Figure A-11 UVA concentration at varying dam levels (onsite analysis)

The onsite analysis continues the early trend observed in the laboratory analysis in Sections A.2 and A.3.

Figure A-10 confirms that soluble manganese concentrations at the low levels of the dam, at SV, have been below 0.2 mg/L since operation of the bubble plume dam aeration system. At the offtake level (V1), concentrations have been around 0.05 mg/L or below.

Figure A-11 shows that UVA concentrations have been around 0.2 – 0.3 across all levels of the dam which coincides with Figure A-4. This confirms that there have been lower levels of organic matter since operation of the bubble plume dam aeration system.

A.5 Taste and odour

Taste and odour, represented by MIB and geosmin concentrations, over time is shown in Figure A-12.

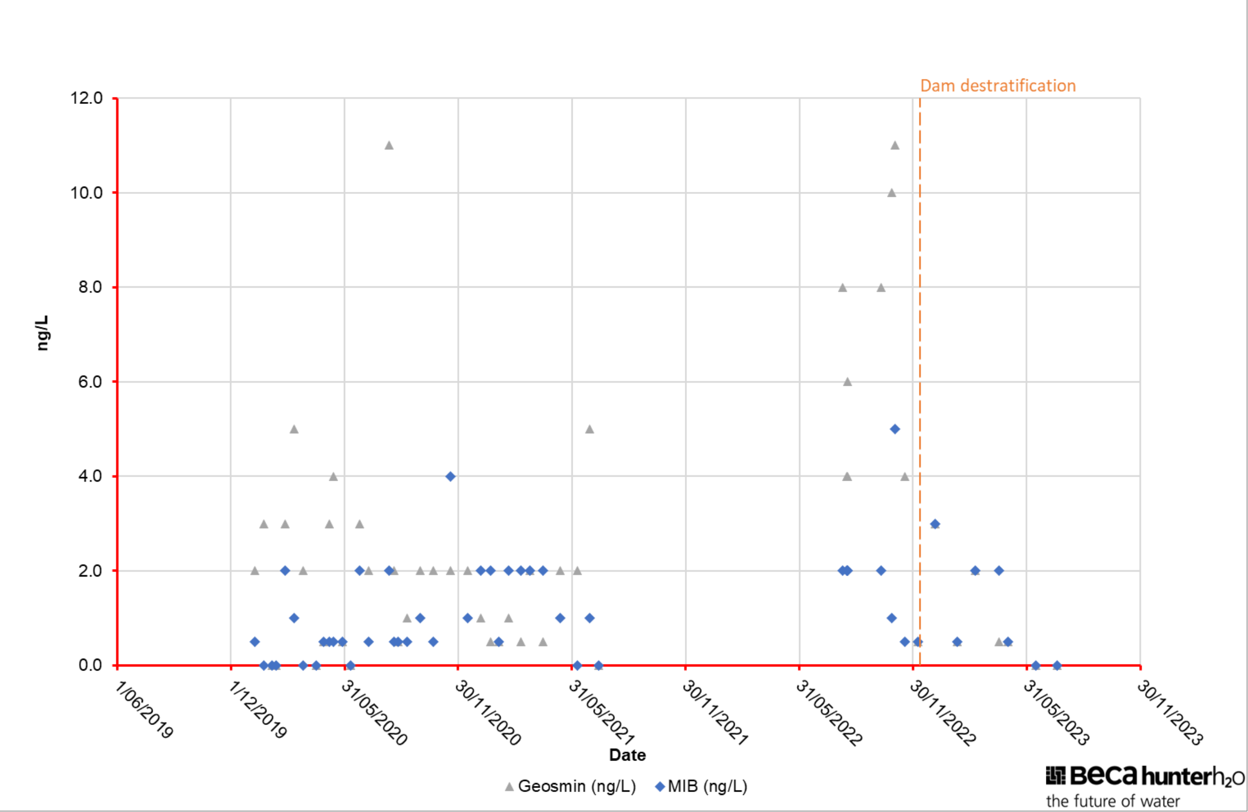

Figure A-12 Raw water MIB and geosmin (taste and odour)

River flow over time is shown in Figure A-13.

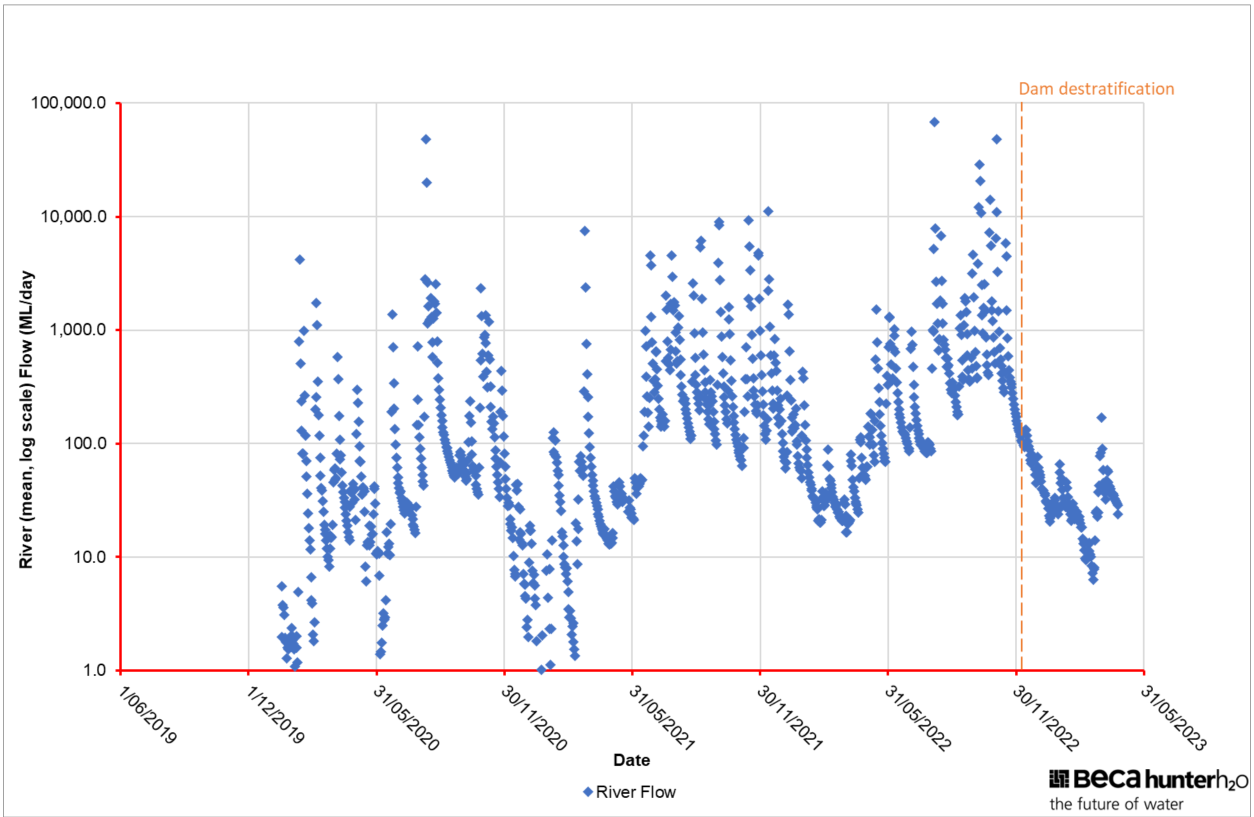

Figure A-13 River flow over time

Poor raw water quality was observed just before the bubble plume aeration system started operating with elevated MIB and geosmin concentrations, particularly geosmin. Following start-up (marked as the vertical, orange dotted line in Figure A-12), MIB and geosmin have decreased to concentrations similar to historical levels at around 1-3 ng/L. These concentrations are below the usually adopted thresholds and should not be noticeable to most consumers.

The peaks in Figure A-13 of high river flow correlate with a high rainfall event. These high flow events match up at the same time the geosmin spikes are observed in Figure A-12. It is believed that run-off from the Yass River catchment and overflowing of farm dams causes elevated taste and odour levels during a high rainfall event.

A.6 Microbial Pathogens

Pathogens are disease-causing microorganisms and can be separated into three main categories:

- Bacteria (e.g. *Escherichia coli (E. coli)*, total and faecal coliforms are commonly used to indicate the bacteria);
- Viruses (e.g. Poliovirus); and
- Protozoa (e.g. *Giardia* and *Cryptosporidium*).

Microbial Health Based Targets (HBTs) for water quality have been in the foreground of water treatment planning for some time. Microbial HBTs were added to the ADWG (NHMRC, 2016) in Version 3.8 amended in September 2022.

The potential implications for HBTs on planned water treatment plant designs at present are:

- That upgrades should be designed in such a way that future upgrades to achieve the HBTs are straight forward to implement, or
- Where practical, upgrades should be designed to achieve the level of treatment required to meet future HBTs.

Currently the level of treatment required to meet HBTs depends upon the individual catchment category. An assessment of the catchment has not been undertaken as part of this project, however NSW Health have undertaken a project across NSW and have suggested that Yass treated water is a Medium risk which suggests that the catchment is a Category 4 (highest category – highest level of treatment required) (Water Services Association of Australia, 2015).

The risk is likely a result of:

- Yass Dam collects water from an "Unprotected catchment" due to the presence of sheep and cattle in the inner catchment area
- Allowing recreational use of the dam further increases drinking water quality risk as it provides a pathway for transfer of human disease-causing pathogens into the drinking water.
- Potential for future community wastewater treatment plants with discharge to waters in the catchment of Yass Dam (e.g. Gundaroo)
- The presence of upstream communities and many onsite sewer management systems that if not managed well could impact on the river water quality.

Microbial testing for E. coli is typically used to support the catchment vulnerability assessment. The microbial indicator concentration category defines Category 4 catchment as returning at least a single result (from weekly testing over 2 years) of >2000 mpn/100mL and ≤ 20,000 mpn/100mL.

A.6.1 Summary of Microbial Pathogens

The Yass WTP draws from an unprotected catchment that contains numerous onsite effluent management systems in proximity to the river and domestic stock animals with direct access to the river. As such, microbial pathogens including chlorine tolerant protozoans are likely to be present in the raw water and it is assumed that were a sanitary survey and vulnerability assessment undertaken, the catchment would be ranked as a “Category 4”.

As a Category 4 source to achieve a target of an additional health burden, from potable water, of less $1x10^{-6}$ DALY’s (Disability Adjusted Life Years) would require the following log reductions across the WTP:

- 6.0 Log reduction in Bacteria
- 6.0 Log reduction in Viruses and
- 5.0 Log reduction in Protozoa

A DALY is essentially a measure of disease burden which takes into account the severity of the illness and the duration. It is calculated by:

DALY = Severity (of illness) x Duration

In plain English, a target of $1x10^{-6}$ DALY’s is that for a town population of 5000 people, the consumption of potable water will theoretically add around 1 extra bacterial gastroenteritis case per year.

As pathogens cannot be reliably and efficiently measured it must be assumed that they are present and a multi barrier process utilised that recognises the challenge and targets the log removals listed above.

Appendix B Review of WTP Capacity and Capability

B.1 2020 Assessment Report

Capacity and performance assessment were completed on the Yass WTP by Beca HunterH2O. The assessment looked at major sections of the plant in detail. These included:

- Design flow
- Raw water intake, pump station and rising main
- Pre-treatment (raw water chemical conditioning)
- Dissolved air flotation
- Filtration
- Post Dosing and Disinfection
- Clear Water Storage
- Sludge Lagoons
- Overflows and Stormwater
- Plant Services
- Plant Electrical and Control System
- Plant Amenities and Laboratories

Each capacity and performance assessment report follow the report structure below:

- Description
- Hydraulics
- Process capacity and performance
- Performance issues and areas for improvement
- Redundancy
- Information gaps (where relevant)

Details of the 2019/2020 assessment of the WTP are contained in Appendix C. A summary of key points is presented below:

- The current plant is 30 years old and many assets, systems and processes are at the end of their service life.
- YVC is planning for the upgrade of the raw water pump station (RWPS) to ensure that the pumps can deliver the design flow rate of 165 L/s described in the WTP design documentation. Our review has found that the available filter area, filter condition and acceptable filtration rates limit maximum filtration rate to approximately 135 L/s.
- The WTP electrical and control system is 30 years old and the technology and assets are at the end of their service life. The plant operates at a fixed flow rate and has a basic automatic operational mode. Changes to the process to deal with changing water quality or plant performance must be manually implemented by operators attending the plant. The main switchboard arrangement and location does not comply with current standards and there are many dilapidated switchgear and control gear assemblies for unit process distributed around the WTP. Upgrade of the electrical and control system, provision of a SCADA system and implementation of automatic, unattended operation of the plant at variable flows, is considered to be an essential element of the upgrade of the WTP.
- There is a single flocculation train comprising 3 stage tapered flocculation. The detention times and mixing regime is more suited to a conventional clarification process and modifications to produce a floc size consistent with clarification using dissolved air flotation should be implemented.
- There is a single DAF cell (Purac design) with single saturator operating at approximately 500-600 kPa and a recycle rate of 10%. Recycle is taken from the clarified water and can contain solids. The typical performance of the DAF is below the design standard of 3 NTU. This is due to a range of factors including raw water treatability, coagulant dosing and mixing, dispersion valve performance, and DAF

float stability and removal rate. Refurbishment of the DAF recycle, saturation and dispersion systems is recommended. Installation of walls around the DAF cell to limit wind effects on the float is also recommended.

- The WTP design parameters in regard to a design filtered water quality of 1 NTU is inconsistent with current standards for filtered water of <0.2 NTU. Filter refurbishment consisting of inspection and repair (where necessary) of the filter floor and filter nozzles, upgrade of the air scour system, filter media replacement, installation of supports for backwash troughs, renewal of actuated valves, and new instrumentation is required.
- All chemical systems are largely original with ageing components and numerous non-compliances with existing WHS Regulations and Australian Standards. Replacement of the coagulant system, polymer system, soda ash wet end, PAC system, and renewal of the chlorine system is required.
- Amenities and laboratory facilities are undersized and in poor condition. While the upper floor has under-utilised space, the core activities of the WTP are undertaken on the lower level making this the natural and preferred working area. A new amenities building should be provided that includes separate areas for control and administration, meals and meetings, shower/ toilet, and wet work/ sample analysis.

B.2 2023 EI&C Asset Rating

In April 2023, an assessment of electrical and mechanical assets at the WTP was undertaken to inform the business case in terms of required replacement and renewals, and to inform YVC and Constructors who may be engaged to undertake the WTP upgrade as to the suitability of assets for continued service.

Mechanical and electrical assets (i.e. pumps, valves, fans, compressors, switchboards, motors, actuators and instruments) were assigned an Asset Condition Rating Scale of 1-5 based on a visual inspection and discussion with operations personnel. Items were assessed based on factors such as age, corrosion, leakage, vibration, noise and maintainability.

Mechanical assets were found to be generally in good to fair condition given their age. Of note, was the limited accessibility to many assets within the main building which presents a safety risk for operation and maintenance activities. Hazards include narrow access and congested areas, low head clearances, and the clear water pumps located within a confined space.

- Approximately 15% of the rated mechanical assets have been assessed as having a rating of poor or very poor.
- Approximately 1% of the rated mechanical assets have been assessed as having a rating of very poor.

Electrical assets were found to be aging, with the site main switchboard (MSB) and satellite switchboards now 34 years in service. The frequency of failures is steady and repairs are increasingly difficult due to the obsolescence of installed equipment, lack of up to date schematics, lack of spare capacity in switchboards and cableways, and physical access to equipment.

- Approximately 47% of the rated electrical assets have been assessed as having a rating of poor or very poor.
- Approximately 32% of the rated electrical assets have been assessed as having a rating of very poor.

The results of the asset rating were used in developing the scope of works for Options 1 and 2. A summary of the rating assessment recommended actions is presented in Table B-1.

Table B-1: Summary of WTP asset rating (April 2023)

No.	Recommendation
1	Provide a WTP control system (PLC and SCADA) to replaced failing and failed relay based control system
2	Schedule replacement main switchboard and local control panels, including provision of a dedicated switchroom
3	Fit RCD protection to all Building Services circuits.
4	Provide more accurate electromagnetic flow meters that would report to a WTP control system and be monitored by SCADA.

5	Program the replacement of actuators and position indicator switches across the WTP with priority given to the actuated valves controlling filter operation and backwashing
6	Provide the following instruments: ▪ Alum storage level ▪ Chlorine drum weight sensors Fluoride concentration analyser
7	Consider the following additional water quality instrumentation: ▪ Dosed water ORP ▪ Clear Water pH ▪ Fluoride concentration *Note - representative samples for treated water chlorine and fluoride must be obtained from the CWRs as the clear water tank is too turbulent*
8	Install machine guarding compliant to AS4024.1 on the flocculator drives and the clear water pump shaft couplings.
9	Conduct annual drain and inspection of the DAF tank and scraper system.
10	Undertake 5 yearly replacements of the DAF tank scraper cable and skimmer wipers.
11	Renew the DAF saturator level control system including inlet and outlet control valves and level and pressure sensing.
12	Renew the DAF recycle pumps within the next 10 years.
13	Renew the air scour blower and add an acoustic enclosure and soft start control within the next 5 years.
14	Configure the two Clear Water Reservoirs to have separate inlet and outlet pipework to prevent short circuiting.
15	Renew the soda ash batching, and dosing equipment and associated pipework within the next 5 years.
16	Replace the soda ash silo dust extractor. (Council is actioning this as of June 2023)
17	Renew the polymer batching, and dosing equipment and associated pipework within the next 5 years.
18	Seal the alum storage bund to provide a liquid retaining function. Ensure bunding complies with AS3780
19	Remove and dispose of the existing fluoridation equipment and decontaminate the fluoride room. Future uses for the room should be considered.
20	Construct a new purpose built fluoridation facility conforming to the relevant Act, Regulation and Code of Practise.
21	Review the compliance of the chlorination room and chlorination system against AS2927:2019 and rectify all deficiencies.
22	Consider the removal of the redundant SCA6 to improve access to the air compressors and air dryer.
23	Replace the service water pipe network.

B.3 Stage 1 Upgrade Review

The Stage 1 Upgrade included:

- Raw water Pump Station upgrade including new switchboard, telemetry and control, connection point for back up diesel generator, installation of variable speed drives, WHS and compliance improvements, and minor building renewals.
- Bubble plume aeration system for Yass Dam including variable speed compressor in the raw water pump station, air supply line to the dam, and a 110 m air diffuser in the dam.
- WTP Urgent works provided a number of improvements including:
    - Changed dosing locations and sequence for potassium permanganate, pre-dose soda ash and PAC

- Changed dosing arrangement and location for alum and polymer
- Flow paced, automatic batching and flow paced dosing of potassium permanganate
- Flow paced dosing of alum
- Coagulation pH monitoring and alarming
- Individual filtered water turbidity monitoring and alarming
- Treated water chlorin monitoring and alarming
- New control and telemetry systems

An assessment of the improvements achieved by the Stage 1 Upgrade is included in the following sections.

B.3.1 Yass Dam Bubble Plume Aeration

The Yass Dam Bubble Plume Aeration System comprises a 55 kW oil free low pressure screw compressor supplying up to 180 L/s of air to the dam. Air is introduced at depth using a 110m long HDPE diffuser laid along the path of the original streambed. The system is operated intermittently (several times per day). The compressor is currently (winter) operating at 70% of its rated output and is achieving > 6mg/L of DO at the bottom of the storage as measured by weekly manual sampling.

Based on information to date, the dam bubble plume aeration system has reduced a number of previously identified raw water quality risks since it commenced operation on the 19th of December 2022. The notable improvements are in:

- Lower soluble iron and manganese
- Lower organic matter (DOC and UVA)
- Reduced taste and odour causing compound concentrations

However, there are only a limited number of samples taken since the aeration system was put into operation and so the confidence in these conclusions is low until further monitoring and analysis can provide indication of how well the raw water risks of elevated soluble manganese, elevated DOC and taste and odours have been mitigated by the aeration system.

Historically, the wet weather water quality is poor due to run off from farm dams in the catchment which contribute to high turbidity and taste and odour in the raw water. There has been no high rainfall event since the aeration system has been in operation and so it is too early to conclude the effectiveness of bubble plume aeration system to cope with pollutant loads during and after an extreme rainfall event.

In the first 7 months of operation of the dam aeration system, improvement has been observed in reducing concentrations of soluble iron and manganese, DOC and taste and odour (MIB and geosmin):

- Soluble iron – reduced significantly from an average of 0.5 mg/L to 0.02 mg/L in August 2023
- Soluble manganese – reduced 100 times from an average of 0.1 mg/L to 0.001 mg/L in August 2023
- DOC – reduced by half from an average of 22 mg/L to 11 mg/L in August 2023
- Taste and odour – reduced significantly from an average of 4 and 5 mg/L for MIB and geosmin to <1 mg/L for both in August 2023

B.3.2 Raw Water Pump Station Upgrade

The upgrade of the Raw Water Pump Station (RWPS) has allowed operators to remotely change the raw water flow, start and stop the pumps, and acknowledge alarms and reset faults.

The upgrade of the RWPS has allowed operation of the WTP at a reduced flow rate of approximately 120 L/s. This reduces the loading rates on the dissolved air flotation unit and the filters which has is beneficial in terms of filtered water quality.

While the minimum flow that the pumps can achieve is less than 100 L/s, operation at <110L/s results in the water level in the DAF tank to fall to a level such that the float removal system becomes inoperable. Therefore the minimum raw water flow for the WTP is approximately 115 L/s.

The new power and control system includes switchboard and VSD capacity for upgrading of the raw water pump capacity (if needed)

Compliance, WHS and building condition improvements have also been achieved.

B.3.3 WTP Performance Review

Filtered water turbidity data from 2020 – April 2023 for Yass WTP has been reviewed in the *Yass WTP Performance Review Technical Memo Revision 0*.

Filtered water turbidity measured immediately after each of the four filters and after the filtered water has been combined. Data is collected at 5 minute intervals while the WTP is running and stored in the new monitoring and control system installed as part of the Stage 1 upgrade. A summary of collected data is shown in Table B-2.

Table B-2 Filtered water turbidity after filter 1, filter 2, filter 3 and filter 4

Statistic	Filter 1 Turbidity (NTU)	Filter 2 Turbidity (NTU)	Filter 3 Turbidity (NTU)	Filter 4 Turbidity (NTU)	Combined Filter Turbidity (NTU)
25%ile	0.10	0.08	0.05	0.09	0.06
50%ile	0.33	0.26	0.08	0.21	0.08
75%ile	1.35	0.95	0.14	0.71	0.14

Filter 3 demonstrates better performance than the other filters with a median (50%ile) turbidity of 0.08 NTU compared to 0.21 – 0.33 NTU for the other 3 filters. Filter 1 appears to have the worst performance with a median filtered water turbidity of 0.33 NTU and a 75th percentile of 1.35 NTU. However, there were sample pump issues prior to February 2023 and it is likely that individual filter turbidity readings were affected which reduces the confidence in these results.

The combined filter turbidity is seen to be performing at a similar level to filter 3. This is unusual since the expected turbidity of the combined filtered water should be an average of the 4 filters which would be expected to be a median of 0.2 - 0.25 NTU, instead of the recorded 0.08 NTU.

To better help understand individual filter performance, individual filtered water turbidity is examined over a 24-hour period on a day that represents usual raw water conditions and also on a day with high turbidity raw water. The two days nominated are on the 05/12/2022 and on the 05/01/2023. The performance for each filter during these two days are shown in Figure B-1 and Figure B-2.

Filter water quality performance, shown on a two day basis, up until July 2023 are shown in Figure B-3 to Figure B-7. Comments on the observed improvements or changes include:

- Some improvement in filtered water turbidity has been observed following the Stage 1 upgrades with fewer spikes above 1 NTU. The additional filtered water monitoring after each individual filter has provided insight into the true filtration performance.
- Before the Stage 1 upgrades (December and January 2023), individual filter turbidites would average 0.3 NTU and often spike to 1 NTU over the course of a day. Recent data from the end of May 2023 indicates that individual filter performance has improved with an average of 0.1 – 0.2 NTU and no spikes above 0.3 NTU. When filter performance is examined over a 24 hour period, higher filtered water turbidity is seen during pump starts. Frequent pump starts and stops causing higher levels of turbidity remains an issue, however the high turbidity spikes are lower now at 0.3 NTU instead of > 1 NTU.
- Yass WTP's filtered water CCP target limit is <0.5 NTU but it is to be noted that the ADWG has a filtered water target of <0.2 NTU which should be considered as the target in the long term plan of the plant.
- The online pH sensor has proven useful in pH monitoring but the plant is unable to achieve a reliable coagulation pH due to the lack of automatic pH control.
- The treated water chlorine residual has fallen under 0.5 mg/L, which is Yass WTP CCP critical limit for low chlorine residual on numerous occasions. However, modification of the inlet/outlet arrangement would allow a more consistent free chlorine residual to be achieved.

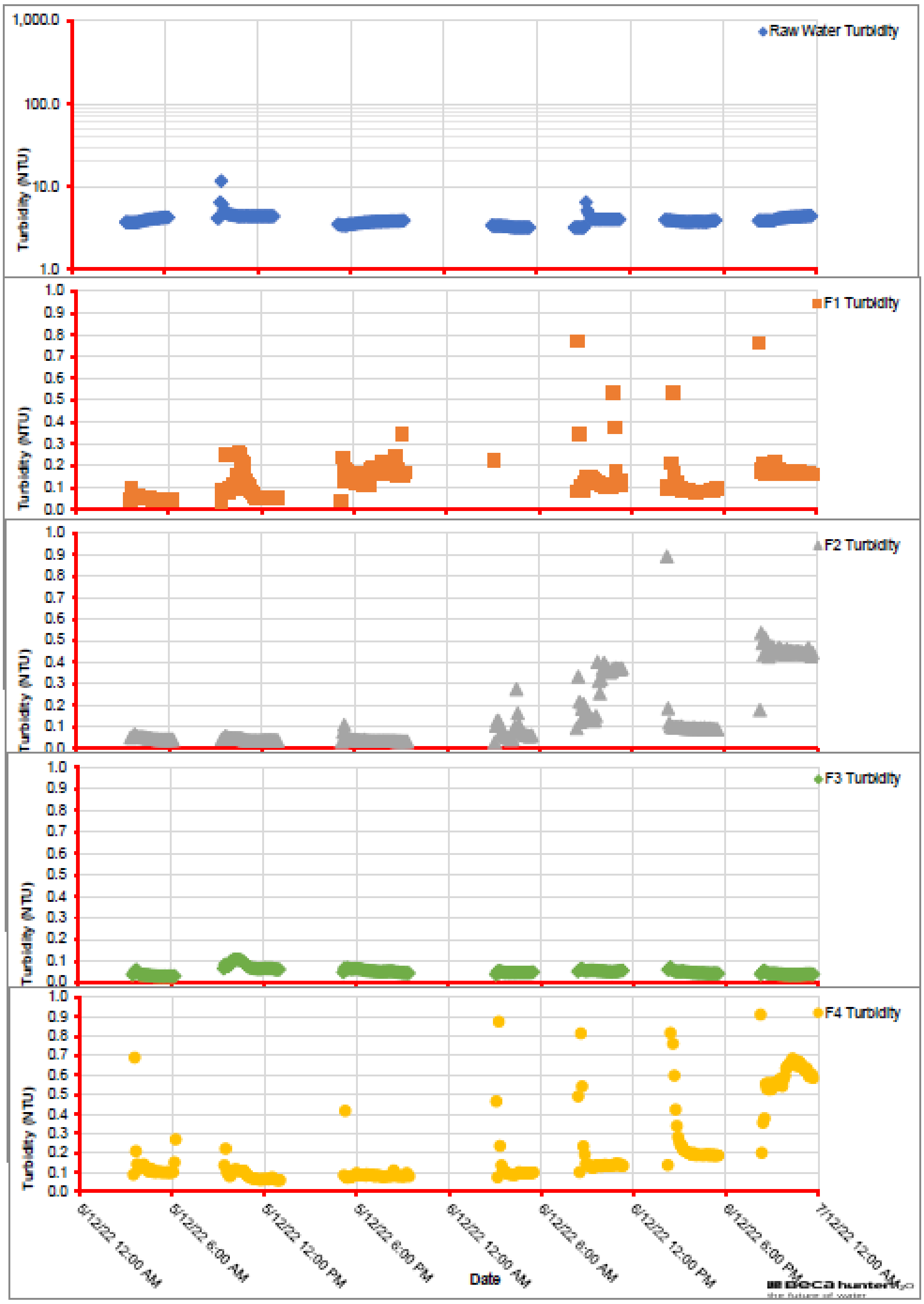

Figure B-1 Individual filter performance on 05/12/2022 (usual raw water conditions)

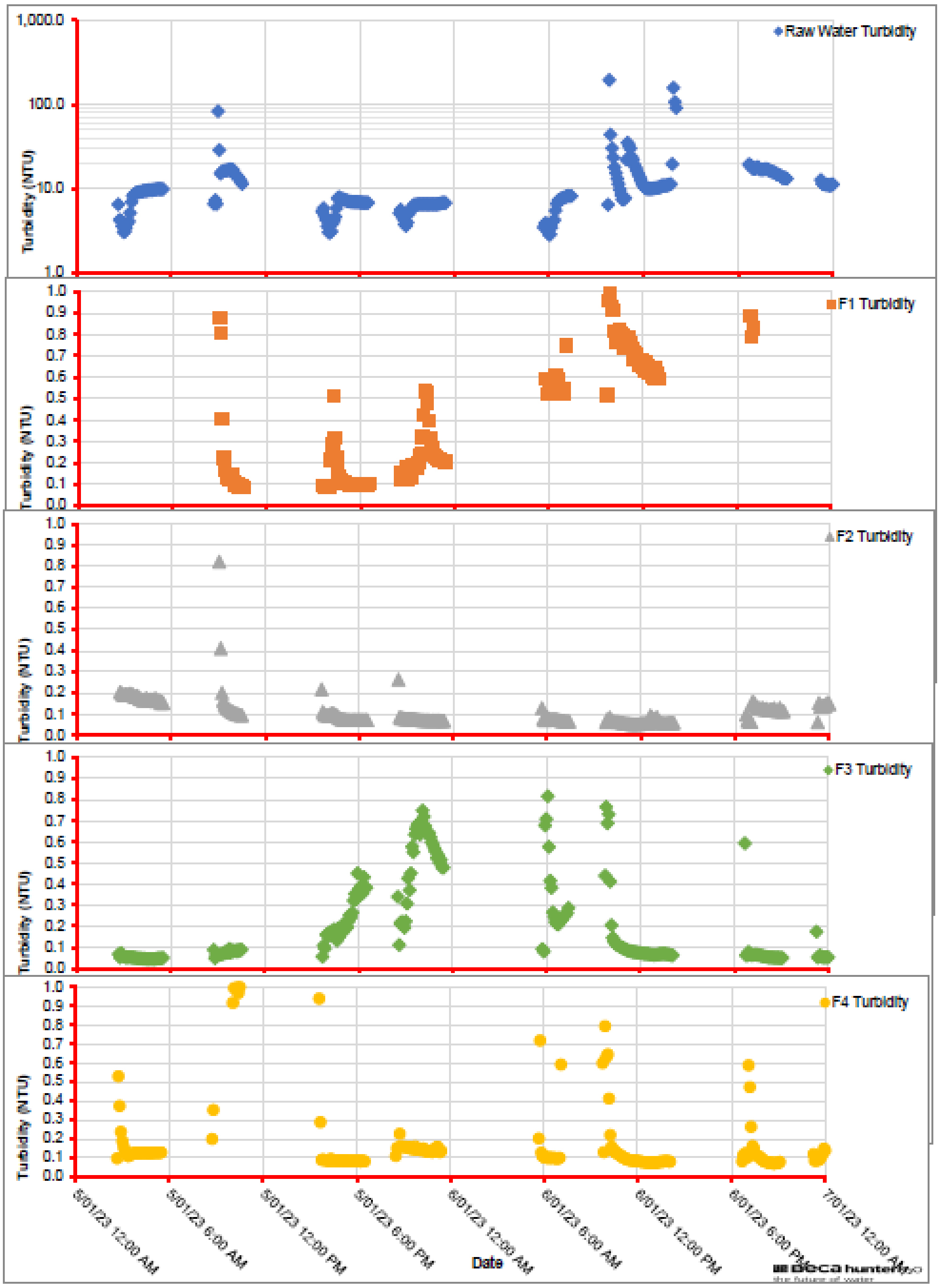

Figure B-2 Individual filter performance on 05/01/2023 (high turbidity raw water)

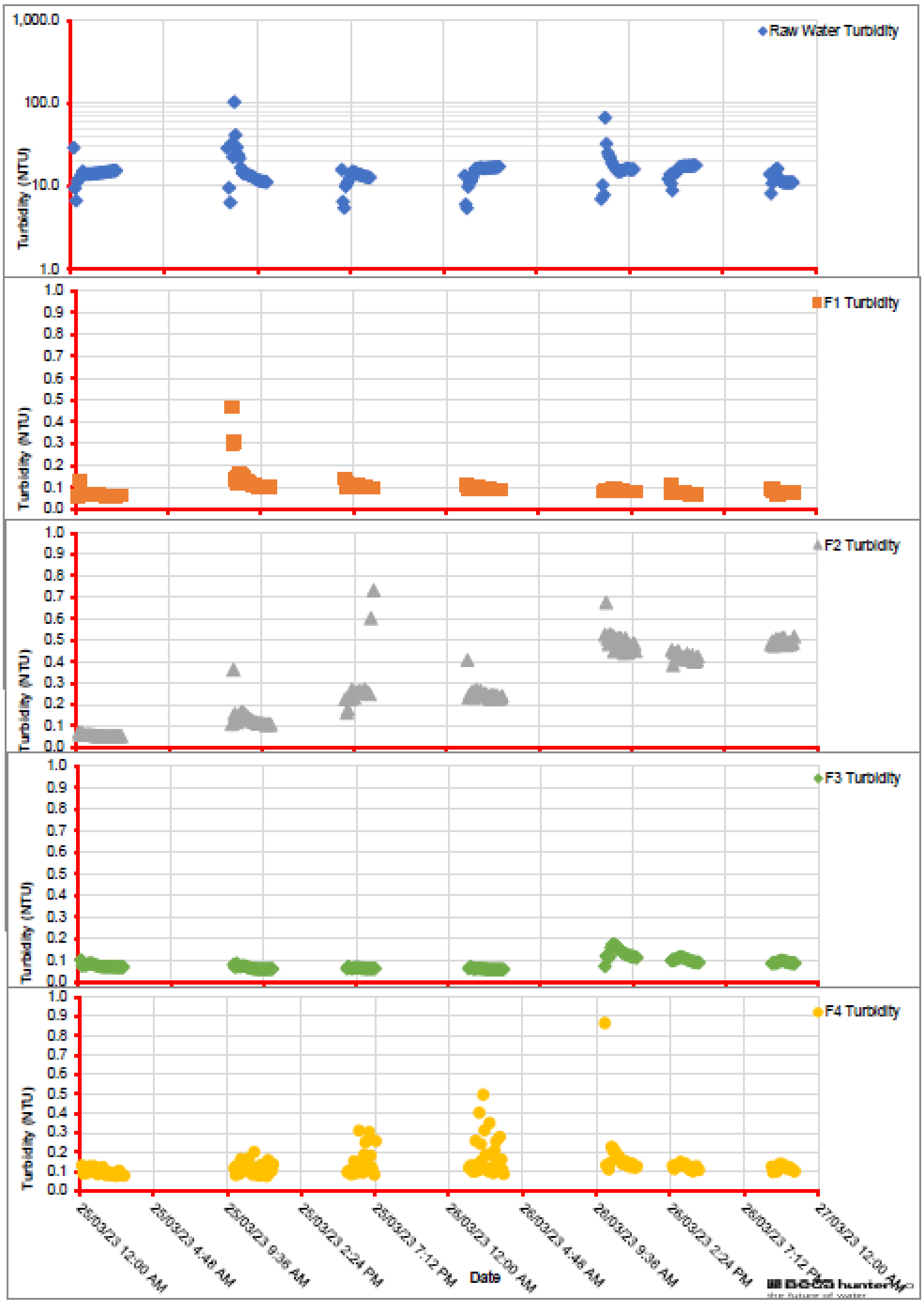

Figure B-3 Individual filter performance on 25/03/2023

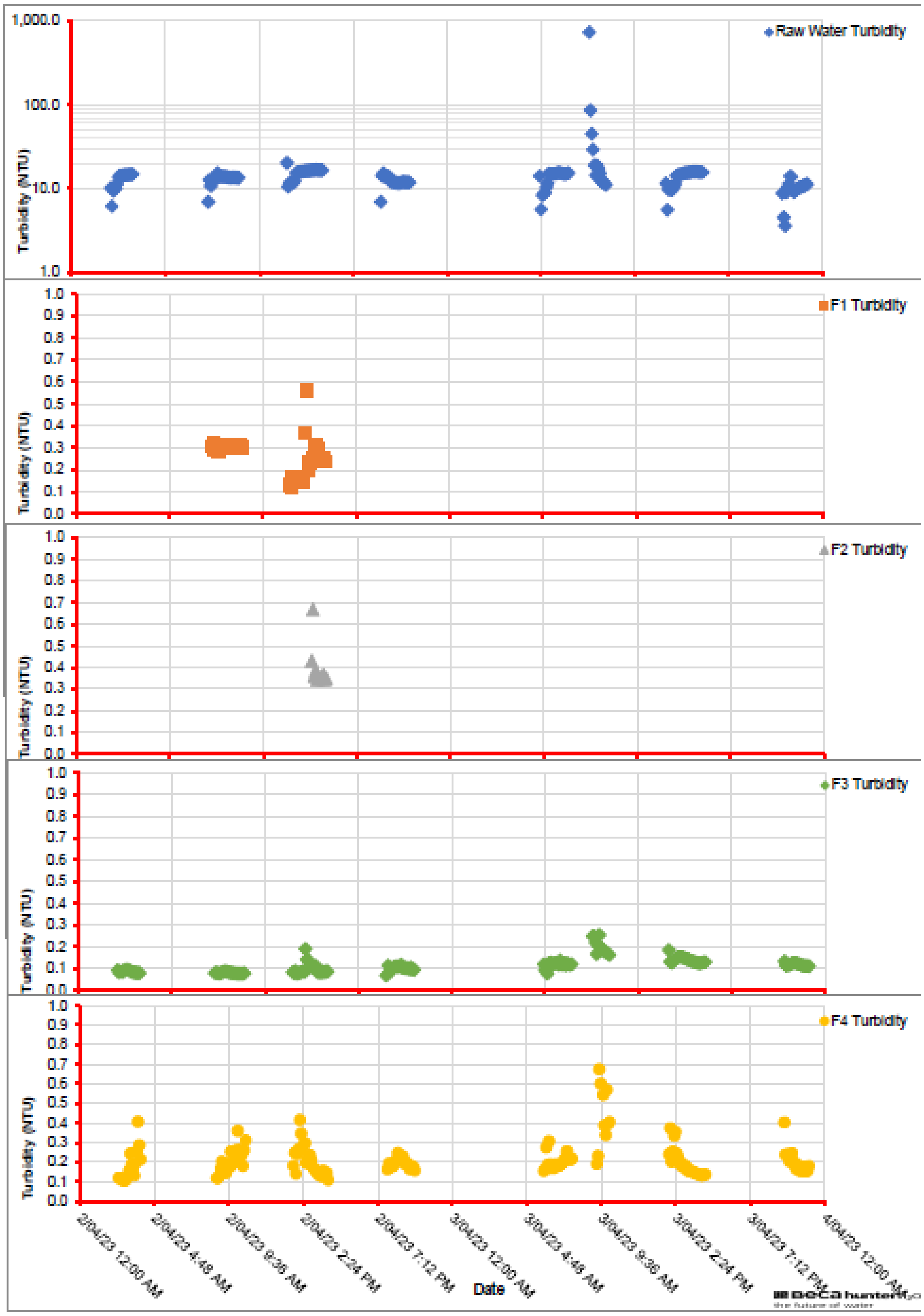

Figure B-4 Individual filter performance on 02/04/2023

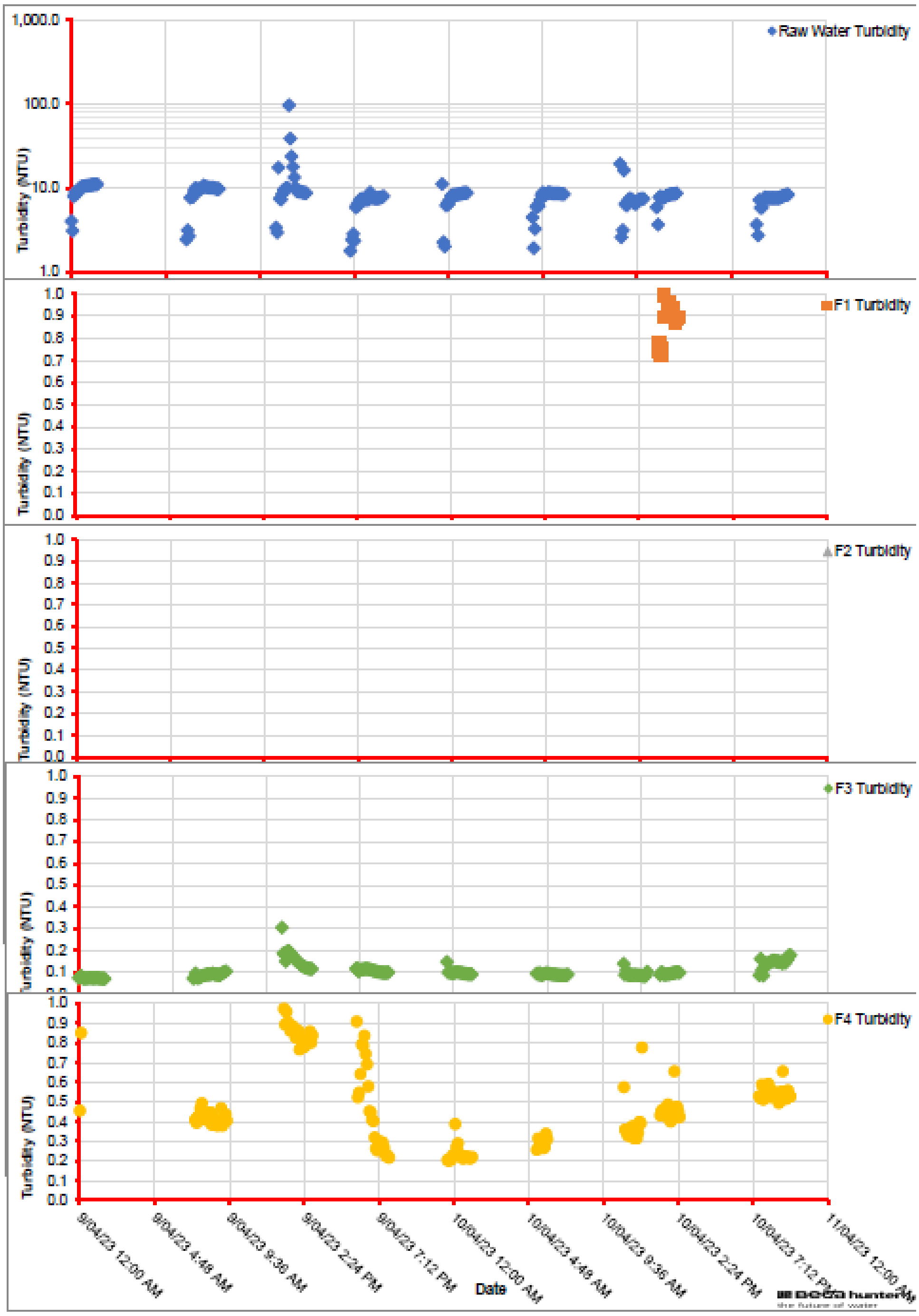

Figure B-5 Individual filter performance on 09/04/2023

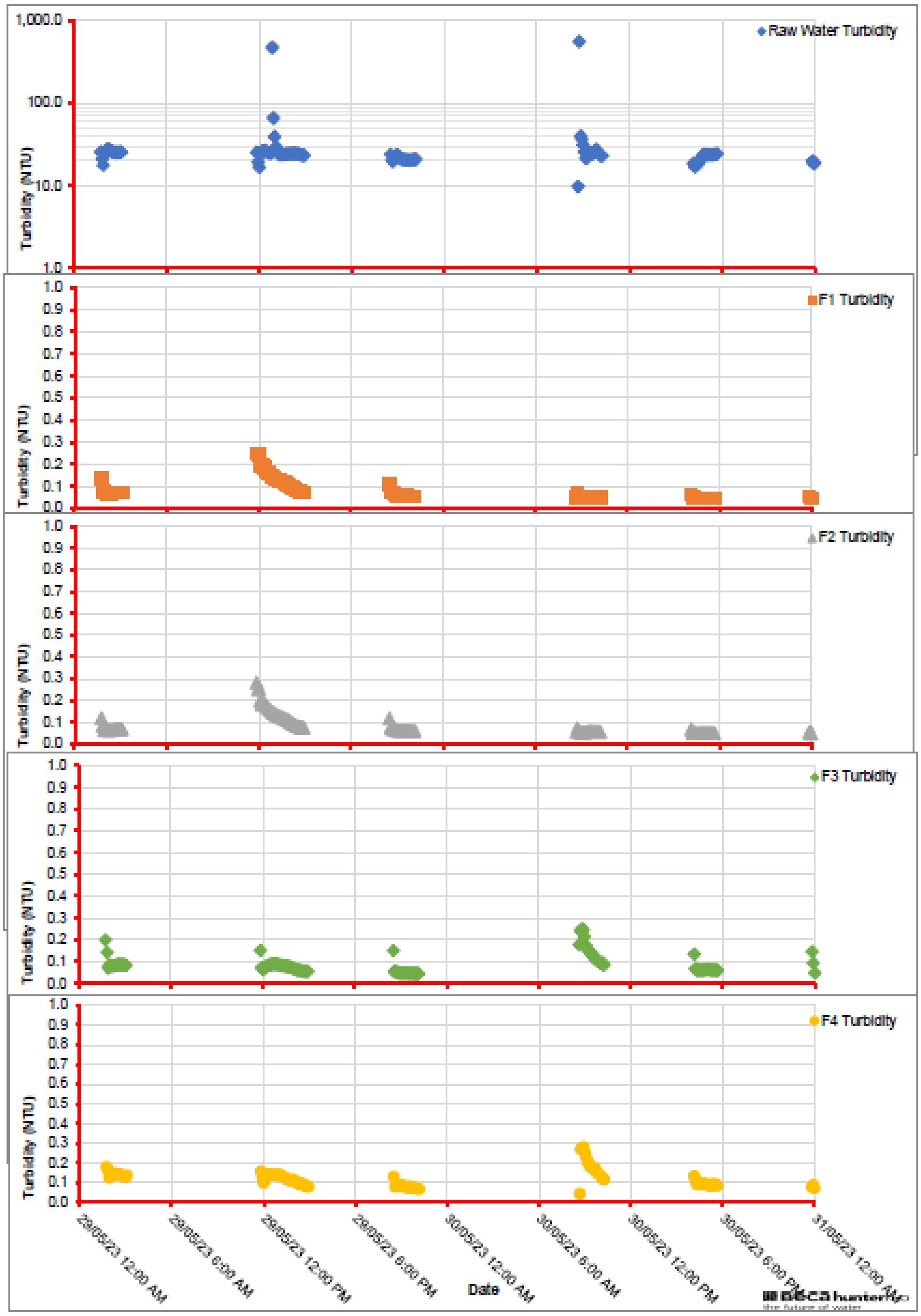

Figure B-6 Individual filter performance on 29/05/2023

Figure B-7 Individual filter performance on 25/07/2023