Recycled Water Quality Management Plan

Aquacell Pty Ltd

Alspec Industrial Business Park Blackwater Treatment Plant
Luddenham Rd, Orchard Hills

December 2024, Revision 3

Revision	Date	By	Checked	Document Status	Amendments
1	14/06/2024	AE/WJ	WTJ	Initial Issue	
2	30/07/2024	JJ	WTJ	For Review	Minor amendments throughout
3	4/12/2024	JJ	WTJ	For Review	Minor amendments in line with council RFI.

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1. Introduction

1.1 Purpose of the RWQMP

This Recycled Water Management Plan (RWQMP) has been prepared by Aquacell Pty Ltd in relation to the operation of the Blackwater Water Treatment Plant (BWTP) that will be located at the Alspec Industrial Business Park (AIBP) on Luddenham Road, Orchard Hills.

It states the microbial quality objectives for the scheme and describes how implementation of the management plan will ensure those objectives are achieved and maintained. The document contains:

- Responsibilities of the recycled water supplier;
- Description of the recycled water process, including composition of the source and end use applications for which the treated water is fit-for-purpose;
- Detailed validation of the treatment processes; and
- A detailed process control and monitoring program to ensure the treated water meets the required quality for end use.

1.2 Description of the scheme

1.2.1 Site Description

The Alspec Industrial Business Park will be located at 221-227 and 289-317 Luddenham Road, Orchard Hills. The proposed location of the BWTP is shown in Figure 1 below.

The blackwater to be used for recycle will be sourced from onsite toilets, showers, basins and drains (other than stormwater drains).

Recycled water will be supplied to the site for:

- Cooling tower make-up water
- Toilet flushing
- Irrigation

Additional demand beyond the available recycled water will be met using potable water.

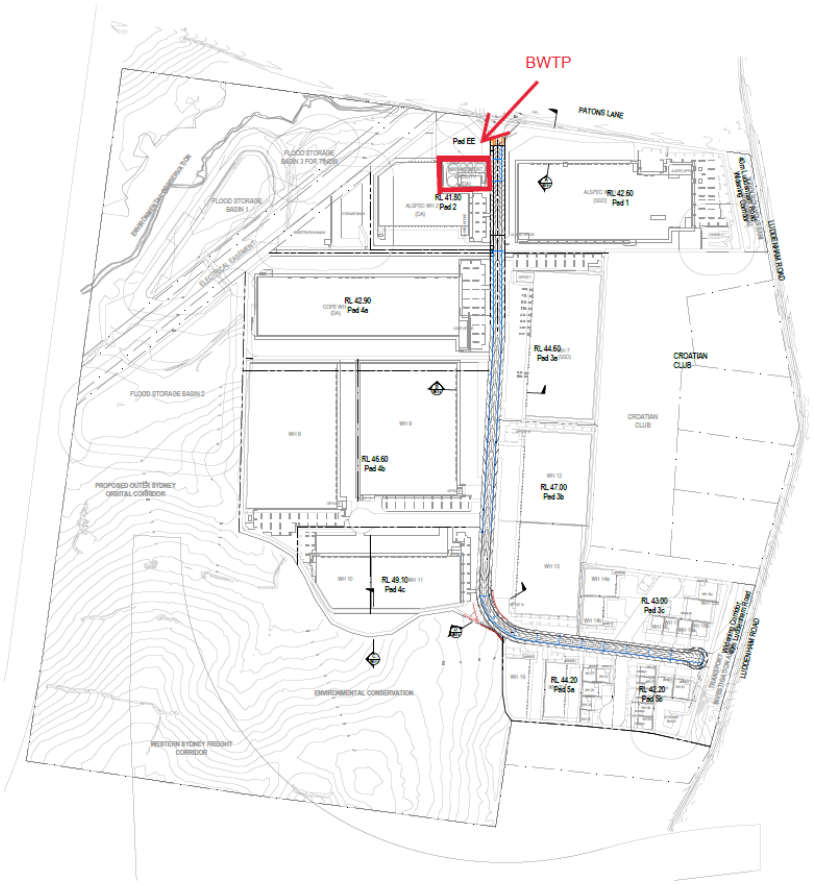


Figure 1: Proposed location of Blackwater Treatment Plant

1.2.2 System Process Design

A flow diagram of the plant showing the key unit operations is provided in Appendix 1, and a general arrangement drawing showing the physical layout of equipment is provided in Appendix 2.

Blackwater from the site is directed to a wet well adjacent to the treatment plant. Effluent from the wet well is pumped to a prescreen and the directed to 1000 kL buffer tank. The BWTP draws water from the buffer tank based on treated water demand, storing the final treated water in a 1000 kL treated water storage tank.

Referring to the flow diagram located in Appendix 1, the system consists of the following units:

- Wet Well
- Prescreen
- Buffer tank for collection of blackwater
- Two identical process trains with the following process units:
  - Annoxic Tank
  - Aerobic Tank

- Membrane bioreactor treatment system (MBR)
- Filtrate tank
- Ozonation
- Biological activated carbon filter (BAC)
- Ultraviolet light disinfection (UV)
- Chlorine disinfection

- Off-spec water holding tank
- Treated water storage tank
- Treated water chlorination
- Waste activated sludge (WAS) holding tank
- Screw press
- Vents connected to an odour scrubber for odour control
- Overflows and drains to wet well
- Chemical dosing systems

1.3 Management commitment

The scheme manager of the on-site recycling scheme at the AIBP is yet to be determined. They will be committed to ensuring the system is maintained and operated in compliance with relevant guidelines, regulations and standards at all times.

The scheme manager will engage Aquacell Pty Ltd (Aquacell), as the contracted provider of maintenance and operation services for the blackwater treatment plant. Both Aquacell and the scheme manager will provide the same commitment to maintain and operate the system in compliance with relevant guidelines, regulations, and standards at all times.

Under the agreement, the scheme manager will have maintenance personnel on site to undertake all daily, weekly and emergency response tasks associated with the running of the plant. Aquacell will provide initial training and ongoing technical support. Aquacell will be responsible for the majority of the technical and operational activities including on-site servicing, calibrations, regulatory reporting and remote operation as will be detailed in the service contract.

It should be noted that recycled water is treated to a high quality and suitable for human contact. As such, the water is suitable for the purpose of irrigating in the landscaped areas on each of the warehouse lots. Some of council's recommended setbacks have been varied as a result of this. Further information can be found within Whitehead & Associates' Land Capability Assessment.

A copy of the Aquacell Recycled Water Policy is provided in Appendix 3.

Comprehensive site management systems for the facility form part of this management plan. These describe the processes and procedures that will be in place to ensure the responsible use and management of recycled water.

1.4 Roles and responsibilities

The scheme manager will be responsible for both the recycled network for the collection and supply of blackwater to the BWTP, and the BWTP itself, which produces recycled water for the scheme. The scheme manager (or designated sub-contractor) will be responsible for the treated water storage and the delivery systems in which the recycled blackwater will be used.

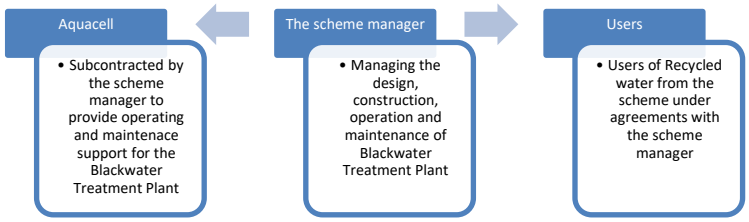
Aquacell provides operation and maintenance support for the BWTP.

In general terms, the scheme manager is responsible for:

- the production and supply of recycled water that is fit for purpose, ensuring that water quality complies with regulated standards and supply agreements up to designated transfer points defined in the RWQMP and supply agreements
- implementation of communication and reporting protocols if water quality does not meet required standards
- operation and maintenance of infrastructure for the production and supply of recycled water up to designated transfer points
- compliance with relevant regulatory requirements for recycled water
- using recycled water only in the manner and for the purposes for which it has been supplied, in accordance with supply agreements
- operation and maintenance of recycled water infrastructure after the designated transfer point
- implementation of control measures and compliance with usage restrictions defined in supply agreements.

The responsibilities and relationships between key roles are outlined in the figure below.

Figure 2. Greywater Treatment Plant Responsibilities and Relationships



1.5 Scheme Owner

The owner of the development where the BWTP will be installed is to be confirmed.

Business Entity: TBA

Address: TBA

Phone (Business): TBA

Email: TBA

1.6 Responsible entity and scheme manager

The scheme manager is to be confirmed.

Business Entity: TBA

ABN: TBA

Address: TBA

Phone (Business): TBA

Email: TBA

1.7 Scheme operator and recycled water supplier

The scheme operator and supplier of recycled water is Aquacell Pty Ltd (Aquacell).

Business Entity:	Aquacell Pty Ltd.
ABN:	79 072 487 015
Address:	Suite 6.02, 6A Glen Street, Milsons Point NSW 2061
Phone (Business):	(02) 4721 0545
Email:	info@aquacell.com.au

1.8 Users

The users of the recycled water are the staff, tenants and visitors at the AIBP.

2. Water quality objectives

2.1 Microbial

The proposed recycled water quality objectives have been derived based on the application of the principles described in the Australian Guidelines for Water Recycling: Managing Health and Environmental Risks Phase 1 (AGWR) (NRMMC, 2006).

2.1.1 Assumptions

In order to arrive at pathogen log reduction values for the treatment process, assessments must be made of the potential risk of ingestion and frequency of these events for the different exposure routes present in the reuse scheme. The following outlines the assessments made in order to calculate the required treated water quality and hence the associated Log Removal Value (LRV) for the treatment process.

The possible exposure to treated water at this site are:

- Ingestion from cross connections between the drinking and recycled water systems
- Aerosol ingestion from toilets
- Ingestion from cooling towers
- Ingestion of water used for irrigation

2.1.2 Ingestion from cross connections between the drinking and recycled water systems.

Guidance on typical exposure rates and ingestion volumes for cross connection of dual reticulation systems are provided in Table 3.3 of the AGWR. These figures have been adopted for the purposes of calculating performance targets.

There are a number of steps that have been taken to ensure that the risk of cross-connection is low. These include:

- The dual reticulation system will be installed according to AS/NZ 3500 and NSW Health Guidelines for recycled water, including lilac pipe and/or markings.
- Testable reduced pressure zone devices will be provided at all interconnection points between the treated water and the potable water supply.
- Signage to warn of the use of recycled water will be installed.

- The dual pipe system will undergo a full cross connection audit prior to commercial operation. If any cross connections are detected, these will be repaired prior to commercial operation. Cross-connection audits will be carried out at a frequency to be determined by Scheme Owner, in consultation with Aquacell and other stakeholders under the pending recycled water scheme approval to operate under Section 68 of the Local Government Act (1993). The detailed plan for carrying out cross-connection tests will be documented in the maintenance plan.
- Any maintenance or modification to the reticulation system will occur under strict supervision of the responsible entity and Scheme Manager and in accordance with the site management processes.
- All maintenance workers and plumbing contractors will be fully inducted to the site and made aware of the dual reticulation system and the consequences of cross connections.

2.1.3 Aerosol ingestion from toilets

Table 3.3 of the AGWR provide a guidance on typical exposure rates and ingestion volumes for toilet flushing. These figures have been used for calculating performance targets.

2.1.4 Ingestion from cooling towers

The exposure for those operating the cooling towers (occupational) is considered to be higher than those for the general public. Both of these risks have been considered in the analysis provided in section 2.1.6.

Occupational exposure is mitigated by various means:

- Access to cooling towers restricted to authorised staff only
- The normal practises for maintenance and servicing cooling towers to minimise risk to legionella are applied (e.g., as detailed in the NSW Health document *Legionella control in cooling water systems* (August 2018).
- New construction with modern, low drift design.

2.1.5 Ingestion of water used for irrigation

The proposed irrigation includes drip and spray irrigation for landscaped areas. Table 3.3 of the AGWR provide a guidance on typical ingestion volumes for garden irrigation which have been used for calculating performance targets.

2.1.6 Performance target calculations

The project specific ingestion risks have been considered in order to determine the pathogen removal targets (using sewage as source) required to meet the minimum tolerable health risk of 10^{-6} DALY as recommended by the AGWR. The exposure risks considered, along with associated assumptions, are summarised in

Table 1.

Table 1: Exposure risks for determining health based LRV targets based on AGWR

Use	Ingestion (L)	Frequency (/person/year)	Prop. of population affected (%)	Weighted total (L/yr)	Assumptions
Toilet flushing	0.00001	1100	100	0.011	Tenants and visitors - 3 uses per day
X-connect	1	365	0.1	0.365	1L/day per person; Assume 1 in 1000
Cooling towers – general public	0.00001	728	100	0.00728	2 exposures per visit (coming and going); 7 visits per week for each week of the year
Cooling towers – occupational	0.0001	728	100	0.0728	2 staff per visit each day, one visit per day, 7 days per week
Irrigation – Municipal + Dual Reticulation	0.001	52	100	0.052	Assumes most people use these areas sparingly and not during irrigation. Assume 1/week.
		Total		**0.503**	

Based on the dose equivalent to a DALY of 10^{-6} for each organism (DALYd), the LRV required can be calculated as described in Appendix 2 of the AGWR and shown below as:

LRV = log (raw water concentration x exposure (L) x N / DALYd)

Where "exposure (L) x N" is the weighted total calculated in

Table 1.

Using the AGWR recommended blackwater microbial concentrations (from AGWR Table A2.1) and the DALYd data for Cryptosporidium, Rotavirus, and Campylobacter (from AGWR Box A2.2), the minimum required and target LRV's (rounded up to the nearest 0.5-log) are determined and presented in Table 2. These values are consistent with the recommended log reduction targets for blackwater as shown in Table 3.8 of the AGWS (for dual reticulation, toilet flushing, washing machine and garden use).

Table 2: Minimum and target LRV's for protozoa, bacteria, and viruses (Blackwater Source)

	Representative family	Concentration in source (organisms/L)	Weighted total (L/yr)	DALYd for DALY of 10^6 (organisms/yr)	LRV required	LRV target
Rotavirus	Viruses	8000	0.503	2.5×10^{-3}	6.2	6.5
Cryptosporidium	Protozoa	2000	0.503	1.6×10^{-2}	4.8	5
Campylobacter	Bacteria	7000	0.503	3.8×10^{-2}	5.0	5

Treatment plant performance objectives are summarised in Table 3. The validation basis for these credits is discussed in section 5.3.

Table 3: Treatment plant performance objectives for blackwater

	MBR[1]	UV	Chlorination	Total LRV Achieved	Target LRV
Virus	1.5	1	4	6.5	6.5
Protozoa	2	4	0	6	5
Bacteria	4	4	4	12	5

1. *Based on WaterVal Tier 1 default for MBR (See section 5.1)*

2.2 Chemical

No major industry is conducted on site as it is mostly warehousing and offices, so this risk is considered low. However, there is some aluminium processing (extrusion), along with milling, product painting and washing in one of the warehouse facilities (Alspec 1). The wastewater from this these processes will be managed as trade waste to ensure that it does not contain adverse qualities of oil and grease or solvents.

3. System assessment

A Hazard Analysis and Critical Control Point (HACCP) analysis of the AIBP BWTP will be conducted and included in Appendix 4. The methodology used will be in accordance with the AGWR and Aquacell's documented risk procedures.

4. Compliance with Australian Guidelines for Water Recycling

The table below lists the 12 elements of the framework for managing recycled water quality and use (as per the AGWR) and shows how the scheme will meet the various elements.

Table 4: AQWR framework elements

Framework element	Activity	Reference Document
Element 1: Commitment to responsible use and management of recycled water quality		
Components: Responsible use of recycled water	The building manager will engage a suitable contractor to operate and maintain the treatment process and provide support. The blackwater recycle facility is part of a range of features by the council to achieve	

	sustainability . There is a commitment to ensure correct design installation and management. There is a Penrith City Council, Section 68 approval pending to install and operate the system.	Section 68 approval pending (Appendix 5)
Regulatory and formal requirements	There is a Penrith City Council, Section 68 approval pending to install and operate the system. **Note:** It is Aquacell's understanding that a WICA license will not be required for this scheme, as the system will not be providing sewerage services to 30 or more small retail customer premises, and having a design capacity of less than 750kL/day.	Section 68 approval pending (Appendix 5)
Engaging stakeholders	Stakeholder engagement is pending and will include the development of an information package to create awareness of the various stakeholders' obligations to achieve high water efficiency. This will include marketing material, contractual obligations and site induction information.	
Recycled water policy	The implementation of a recycled water policy is recommended.	Aquacell Recycled Water Policy exists (IMS Document EM010)
Element 2: Assessment of the recycled water system		
Components: Identify intended uses and source of recycled water	Uses are for toilet flushing, cooling tower makeup and irrigation. The water source is blackwater from the precinct.	This RWQMP
Recycled water system	The plant receives blackwater from the building. Water is subject to treatment through a membrane bioreactor, ozone, carbon filter, ultraviolet (UV) disinfection and chlorine disinfection. The treated water is piped to a dedicated storage tank and distributed for use.	Operations and Maintenance Manual pending (Appendix 11)
Assessment of water quality data	Raw wastewater is characterised based on typical values for this application, in addition to adopting the values for pathogen content outlined in the AGWS. Treated water quality from the wastewater treatment plant will be tested in accordance with a specified testing regime.	This RWQMPP section 0 and AGWR
Hazard identification and risk assessment	A Hazard Analysis and Critical Control Point (HACCP) analysis of the AIBP scheme will be conducted. The methodology used will be in accordance with the AGWR and Aquacell's documented risk procedures.	Aquacell HACCP pending (Appendix 4)
Element 3: Preventative measures for recycled water management		
Components: Preventative measures and multiple barriers	**Human health** Preventative measures to manage risks to human health include: Membrane filtration, UV disinfection and chlorine disinfection; Pipework (purple and/or with text) and signage at site of use indicating that recycled water is being used; Educational material to tenants and site managers about avoidance of inappropriate disposal of wastes; Signage at site to alert plumbers to recycled water system and co-ordination of plumbers through site management; Backflow prevention and cross-connection control; **Environmental performance** Preventative measures to manage risks to the environment include: Education programme for tenants and site managers promoting use of environmentally friendly detergents in the toilets and hand basins and avoidance of disposal of chemicals;	This RWQMP AS/NZS 3500:2003 Community page on Aquacell website Employer and contractor induction procedures and records Community page on Aquacell website

	A list of detergents considered appropriate for use in the building made available to cleaning staff and updated annually;	
Critical control points	Multiple critical control points will be confirmed through the HACCP analysis. These are detailed further in section 5.3.	Aquacell HACCP pending (Appendix 4) This RWQMP section 5.3
Element 4: Operational procedures and process control		
Components: Operational procedures	Operational procedures will be identified for all processes and activities associated with the system, including operation of treatment processes and auditing procedures for cross-connections. Documented procedures must be available to operations personnel and for inspection at any time. Operators are proficient and are able to recognize the significance of changes in the recycled water treatment plant and water quality. They are able to respond appropriately according to established procedures.	Operations and Maintenance Manual pending (Appendix 11) Aquacell Work instructions
Operational monitoring	A number of online monitoring instruments are used to ensure that we always meet the requirements of the Critical Control Points (CCP).	This RWQMP Section 5.3 and 0
Corrective action	Corrective actions include the following: Noncompliance with the CCP's results in the system being stopped or treated water diverted to the Off-spec water holding tank. If cross-connections detected, flow to property stopped until repairs completed. Site switches to potable water backup until cross connection is eliminated.	This RWQMP Section 5.3
Equipment capability and maintenance	Treatment plant and disinfection systems of standard and reliable design. Maintained by qualified supplier.	A service agreement will exist between the scheme manager and Aquacell for the maintenance and service of the recycled water treatment plant.
Materials and Chemicals	All plumbing and drainage work is conducted in a manner conforming to AS/NZS standard 3500. All chemical used in the plant are obtained from credible suppliers.	MSDS are supplied for each chemical. Purchasing is in accordance with Aquacell Purchasing and Inventory Procedure (IMS Document PI030)
Element 5: Verification of recycled water quality		
Components: Recycled water quality monitoring (specifically designed for individual systems, taking into account source of water, end uses and receiving environments)	**Human health** Monitoring of defined parameters is undertaken. Building occupant/customer satisfaction, monitored by the operator; complaints are investigated particularly when clusters of complaints are received.	This RWQMP Section 5.3 and 0 Aquacell "Complaints Handling and Dispute Resolution Policy" (IMS Document CS030) Aquacell website "Community" page
Application and discharge site monitoring	**Environmental performance** Out of specification water will be recirculated to the start of the treatment process.. Screenings and dewatered biosolids will be disposed of in landfill.	
Documentation and reliability	The sampling plan (location, parameters and frequency) will be determined and agreed to by the relevant authorities.	

	The sampling and testing will be performed by an independent, NATA accredited laboratory.	Laboratory NATA certification Chains of Custody Records of results.
Satisfaction of users of recycled water	In this application, comments regarding end user satisfaction are likely to be directed to the site management. Any complaints will be handled as described in the Human Health section of Element 5 above.	Aquacell "Complaints Handling and Dispute Resolution Policy" (IMS Document CS030)
Short-term evaluation of results	The customer is supplied with a monthly report regarding the performance of the plant. The Aquacell recycled water engineer and service technician are in regular verbal and e-mail correspondence with the building management. Results are provided to the regulator (Penrith City Council).	Monthly Service Report to the scheme manager regarding plant operation and performance indicators derived from onsite activities, data trending and analysis and water quality results.
Corrective responses	Corrective action depends on the incident. Most corrective actions occur automatically through appropriate PLC logic. As a minimum, it involves investigation of plant performance records to confirm normal operation, and additional testing to confirm the result and identify the source of any issue which arises. If target criteria for environmental parameters are exceeded, preventative measures need to be reassessed and corrective action taken to ensure environmental performance is improved.	Corrective actions are addressed in section 6.2 this RWQMP
Element 6: Management of incidents and emergencies		
Components: Communication	Noncompliance with approval conditions to be reported immediately to Penrith City Council. Noncompliance with approval conditions that that affect public health to also be reported immediately to Sydney Local Health District Public Health Unit (NSW Health) In the case of an incident or emergency that requires a media response, only the CEO is authorized to make any public comment.	Notification procedures as described in section 11.3 of this report. Reporting as required to relevant authorities.
Incident and emergency response protocols	Employees are trained in emergency response and incident protocols. Training records are kept. In the event where the water treatment plant is unable to supply treated water, potable water backup is available.	Aquacell "Incident and Emergency Management Procedure" (IMS Document IE010) Training records
Element 7: Operator, contractor and end user awareness and training		
Components: Operator, contractor and end user awareness and involvement	Operator of treatment plant to be sufficiently skilled to run the plant and investigate any faults; End users are made aware of the restrictions on the use of recycled water and any practice that could threaten human health. Contractors inducted to site are told of the presence of dual pipe systems and the precautions required.	Technician induction on commencement of employment, operating manuals, supervision from experienced engineers. End user awareness via signage, inductions and tenancy agreements. Induction records for the coming on site to work.
Operator, contractor and end user training	Operator to be aware of approval conditions and instructed on occupational health and safety requirements	

	Aquacell has an induction program for new employees and written procedures for all areas of responsibility. Training needs for individual employees are identified and adequate resources made available during the induction phase. Annual performance reviews identify additional training requirements and set performance targets. Training records are kept. Any contractors used on site are accredited, qualified and have the appropriate level of training. A site induction includes familiarization with Aquacell's Safe Work Method Statements (SWMS's), which are site specific. Aquacell maintains a partnership with several contractors to ensure continuity of knowledge and technical expertise.	Induction program Annual reviews Contractor induction records. Aquacell document "Hourly Rate Contractor Requirements" Aquacell terms of purchase to contractors and suppliers. Aquacell SWMS's
Element 8: Community involvement and awareness		
Components: Community consultation	The existence of water recycling will be a feature of advertising and promotion for the development.	
Communication and education	The site management will have an information package regarding recycled water use and hazards which it will make available to all new tenants or upon request.	Information supplied from the site managers for the tenants Undesirable chemical discharges to the recycled water system are listed on Aquacell' s website community page
Element 9: Validation research and development		
Components: Validation of processes	Ongoing investigations into recycled water quality and treatment plant performance to refine assessments. This may enable less conservative critical control points to be adopted or treatment requirements reduced.	Validation according to section 5 of this RWQMP
Design of equipment	The design of the plant is based on well-documented and validated technologies.	This RWQMP Section 5
Investigative studies and research monitoring	As the depth of operational knowledge regarding this and similar water treatment technologies increases, so the understanding of the weaknesses increases. This results in better opportunity to be proactive regarding operational control and maintenance of the plant, thereby improving operating costs and sustainability of the scheme.	This RWQMP will be reviewed in 12 monthly intervals as part of the process of continual improvement.
Element 10: Documentation and reporting		
Components: Management of documentation and records	Design of treatment plant and reticulation system documented; Operating procedures documented; All results to be recorded and stored; Aquacell has developed an in-house Integrated Management System (IMS) that is based on the ISO 9000 system. Included in this RWQMP and the Operations and Maintenance Manual is information pertaining to preventative measures employed, target and critical limits, critical control points, operating and corrective action procedures. These documents, along with the incident and emergency response plans, training programs and reporting protocols ensure that the plant is operating within set limits at all times. The document control system, ensures that only the most current version of any document is available for use. All documents are reviewed on an annual basis.	RWQMP Operations and Maintenance Manual pending (Appendix 11) Incident and Emergency Management Procedure, (IMS document IE010), Performance reviews, Risk Management Procedure (IMS document RM030)

Reporting	Internal reporting consists of verbal communication between the Aquacell engineer and the site service technician and written reports from the technician to the engineer. The owners of this treatment plant receive a monthly report detailing all operational and performance parameters and the maintenance performed during that month. Reports will also be prepared and submitted to the appropriate regulatory authority as required. Non-compliance breaches are reported immediately	Monthly reporting to the building managers regarding the plant performance. Reports as required by regulators
Element 11: Evaluation and audit		
Components: Long-term evaluation of results	Report as required by appropriate regulatory authority on compliance with approval conditions, including test results audited by regulator. This report will be reviewed by senior management prior to distribution and a copy sent to the regulatory authority and the owners of the treated water plant.	Aquacell will generate a report as required by regulators
Audit of recycled water quality management	Internal audits typically occur on an annual basis or as required by regulator and include a review of the management system, operational procedures and monitoring programs. An Independent audit in compliance with a Penrith City Council approved third party auditor occurs at a frequency yet to be determined.	Aquacell will conduct internal audits as required by regulators. Compliance audits by an independent auditor will be conducted. Results of the audit will be forwarded to the Penrith City Council. The frequency of these audits will be determined by the Penrith City Council.
Element 12: Review and continual improvement		
Components: Review by senior managers	Performance of treatment plant, customer complaints/satisfaction	A senior review of this plant will be conducted as required in combination with the compliance reporting
Recycled water quality management improvement plan	An improvement plan, based upon the results of the internal and external audits and monthly reports which addresses the performance of the plant and end user expectations is prepared as part of the annual review.	In combination with the compliance reporting, an improvement plan will be developed for this treatment plant, based on the monthly reports and any audits performed.

5. Validation of treatment processes

The validation program for the Alspec Industrial Business Park BWTP is outlined within this section of the RWQMP. The validation program has been designed to evaluate the BWTP's ability to achieve the water quality objectives outlined in section 5 of this RWQMP, which acts as a feasibility study of the BWTP design.

5.1 Membrane Bioreactor Validation

The Membrane Bioreactor (MBR) system is used to achieve a 1.5-log virus, 2-log protozoa and 4-log bacteria removal, as specified in Table 3.

The validation for the membrane bioreactor is based on the WaterVal™ Validation Protocol for Membrane Bioreactors (WaterSecure, 2017) (MBR Protocol). Default credits for the MBR can be claimed if the system operates under the WaterVal Tier 1 operating envelope. The table below shows that the AIBP's BWTP MBR system is designed to operate within this envelope.

Table 5: Operating Envelope for Tier 1 Log Reduction Credits for MBR

Parameter	WaterVal Protocol Tier 1 Operating Envelope		Design conditions	Tier-1 condition met
	Minimum	Maximum		
Bioreactor pH	6	8	6 – 8	✓
Bioreactor dissolved oxygen (mg/L)	1	7	1-2	✓
Bioreactor Temperature (°C)	16	30	16	✓
Solids Retention Time (d)	11	-	20	✓
Hydraulic detention time (h)	6	-	32	✓
Mixed liquor suspended solids (g/L)	3	-	7.5	✓
Transmembrane pressure (kPa)	3	-	3-20	✓
Flux (LMH)	-	30	12.2	✓
Turbidity (NTU)	-	0.2	≤ 0.2 Measured continuously online	✓

The default Tier 1 credits proposed by WaterVal and the claimed credits for this project are shown in Table 6 below.

Table 6: Tier 1 Default LRVs and Claimed LRVs

Pathogen type	Tier 1 Default LRV	Claimed LRV
Viruses	1.5	1.5
Protozoa	2	2
Bacteria	4	4

To ensure the MBR filtrate turbidity continuously meets the Tier 1 condition, it will be monitored and controlled via the critical control points as discussed in section 6.2.1.

5.2 UV Validation

Based on the analysis in section 0 and summarised in Table 3, the UV system is required to achieve a minimum pathogen reduction of 4-log for both protozoa and bacteria, and 1-log for viruses.

The selected UV model, a Hallett 1000P, is validated in accordance with the requirements of the US EPA Ultraviolet Disinfection guidance manual for the final long term 2 enhanced surface water treatment rule (UVDGM) (US EPA, 2006).

Table 1.4 of the UVDGM provides the UV dose requirements for pathogens, and is reproduced below in Table 7.

Table 7: Reproduction of the UVDGM UV dose requirements

Target pathogens	Log inactivation							
	0.5	**1.0**	**1.5**	**2.0**	**2.5**	**3.0**	**3.5**	**4.0**
Cryptosporidium	1.6	2.5	3.9	5.8	8.5	12	15	22
Giardia	1.5	2.1	3.0	5.2	7.7	11	15	22
Virus	39	58	79	100	121	143	163	186

A validated dose of 58 mJ/cm2 is required for 1-log virus inactivation, and 22 mJ/cm2 for 4-log protozoa. Bacteria are more UV sensitive than protozoa and will therefore be reduced by an amount at least equal to protozoa (e.g., E. coli up to 10 mJ/cm2 for 4-log inactivation (AwwaRF, 2004)).

The UV reactor must be validated in accordance with the UVDGM at the required operating conditions for the AIBP BWTP.

Aquacell confirms that the UV system was validated in accordance with the UVDGM, and will achieve the required validated dose for virus and protozoa under the conditions shown in Table 8.

Table 8: UV system operating parameters

Operating Parameter	Operating Conditions
Operating Mode	Calculated dose monitoring
Validated UV Dose	≥ 59 mJ/cm^2 (virus); ≥ 22 mJ/cm^2 (protozoa)
Flowrate	Design: 157 L/min (peak per train)
UVT	≥ 82% (validated min. 34.3%) at 254 nm

An analysis of the proposed UV system and validation of the ability to provide the required dose follows.

5.2.1 UV dose equation

The method of operation chosen for this project to ensure the required UV dose is the calculated dose monitoring approach.

The manufacturer of the UV system has had a validation study carried out by a third party in order to establish the UV performance in accordance with the requirements of the UVDGM. This document is confidential to the UV supplier and has been provided to Aquacell under a non-disclosure agreement for the purpose of validating the suitability of the UV and the required operating parameters.

The design assumptions and associated operating UV reactor design output is summarised in Table 10 below:

Table 9: UV system design assumptions

Parameter	Value	Comment
UVT (%)	82	UV Transmissivity (measured online)
UVA	0.086	UV absorbance (calculated from UVT)
S/S_0	0.85	Combined sleeve and lamp fouling factor (ratio of actual intensity to the intensity with new lamps and sleeves)
Reflection Aging Factors	0.95	Condition of UV light reflectors (a feature of the reactor design)
Flowrate (L/min)	157	Design flowrate per train
Validated UV Dose - Virus (mJ/cm^2)	59	Per US EPA UVDGM
Validated UV Dose - Protozoa (mJ/cm^2)	54	Per US EPA UVDGM

The data from Table 9 shows the UV will generate a validated UV dose of 59 mJ/cm2 for viruses under the conditions shown This is greater than 58 mJ/cm2 and therefore the UV reactor is capable of achieving a 1-log virus reduction (per USEPA).

Similarly, Table 9 shows a validated dose 54 mJ/cm2 is obtained for protozoa under the design conditions. This is greater than 22 mJ/cm2 and therefore the UV reactor is capable of achieving at least a 4-log reduction in protozoa (per USEPA).

5.2.2 UV validation envelope

The UV validation study indicates a validation envelope extending to a UVT of 34.3% and a minimum flow of 23.5 L/min (1.408 m^3/h), and up to a maximum flow of 386.9 L/min (23.05 m^3/h) and a UVT of 98.9%.

The design peak flowrate of 157 L/min (7.1 m3/h) is within the validated flow range.

UVT and validated UV dose are continuously measured and calculated by the UV controller. This in combination with the UV unit status and lamp age is read to the PLC which monitors the UV operational status.

5.3 Free Chlorine System Validation

The chlorine disinfection system is used to achieve a 4-log virus and bacteria inactivation, as specified in Table 3.

Critical C-T

Table 10 is an extract from the Guidance Manual for Compliance with Filtration and Disinfection Requirements for Public Water Systems using Surface Water Sources (USEPA 1991). This is considered an appropriate guideline for C-T values as the ultrafiltered water is essentially particle free, and therefore has no significant shielding by particles to limit chlorine contact. At a temperature of 15 degC and pH range of 6 – 9, the C-T requirement for 4.0-log virus inactivation is 4 mg.min/L.

Bacteria are more sensitive to chlorine and so a 4.0-log virus inactivation will also achieve 4.0-log bacteria inactivation.

Table 10: Copied from USEPA 1991 Table E-7 - CT values for Inactivation of viruses by free chlorine

Temperature (°C)	Log inactivation – virus					
	2.0		3.0		4.0	
	6-9 pH	10 pH	6-9 pH	10 pH	6-9 pH	10 pH
0.5	6	45	9	66	12	90
5	4	30	6	44	8	60
10	33	22	4	33	6	45
15	2	15	3	22	4	30
20	1	11	2	16	3	22
25	1	7	1	11	2	15

5.3.1 Chlorine contact tank design

The Theoretical Detention Time (TDT) required is given as follows:

TDT = V/Q

Where:

TDT = Theoretical Detention Time (min)

V = minimum volume of chlorinate contact system (L)

Q = flow rate (L/min)

Actual detention time (T) is determined by correcting for the impact of potential bypass by the use of a baffling factor (BF):

T = TDT x BF

Where:

T = time that water is contact with chlorine (min)

BF = baffling factor (usually between 0.1 – 1.0)

The design for the contact tank uses a long length of pipe to achieve the chlorine contact time. It is generally considered that a L/D of > 40 approximates plug flow (e.g., *Guidelines for validating treatment processes for pathogen removal (DH, 2013), section 8.1.3*), and that under these conditions contact time (T) is equal to theoretical contact time (TDT). That is, the baffling factor (BF) equals one under these conditions.

The design uses a total pipe length (L) of 30 m at a diameter (d) of 193.67 mm which gives L/d = 155, which is greater than the minimum of 40. The calculated volume for the contact pipe is determined as follows:

Volume (V) *= π * (193.67/1000)^2 /4 * 30*

= 0.884 m^3 = 884 L

5.3.2 Chlorine residual calculation

The C-T is defined as:

*C-T (mg·min/L) = C (mg/L) * T (min)*

*= C (mg/L) * TDT*BF*

*= C (mg/L) *V (L)/Q (L/min)*BF*

Rearranging gives the concentration C (mg/L) to achieve the required C-T as a function of flowrate (L/min):

*C (mg/L) = C-T (mg·min/L) * Q (L/min) / V (L) / BF*

As BF =1 for plug flow, V= 884 L, Q = 157 L/min (Design flow per train) and the minimum C-T is 4 mg·min/L, this equation becomes:

*C (mg/L) = C-T (mg·min/L) * Q (L/min) / V (L) / BF*

*C (mg/L) = 4 * 157 (L/min) / 884 / 1*

C (mg/L) = 0.71 mg/L

This is the minimum chlorine residual needed to achieve the required C-T at the peak flow rate.

The C-T will be calculated continuously based on the formula given above:

*C-T = C (mg/L) *V (L)/Q (L/min)*BF*

C-T = C (mg/L) / Q (L/min) * 884

6. Operational monitoring and process control

A Hazard Analysis and Critical Control Point (HACCP) analysis of the Alspec Industrial Business Park BWTP will be conducted after the risk management workshop and will be included in Appendix 4. The methodology used will be in accordance with the AGWR and Aquacell's documented risk procedures.

6.1 Operational control

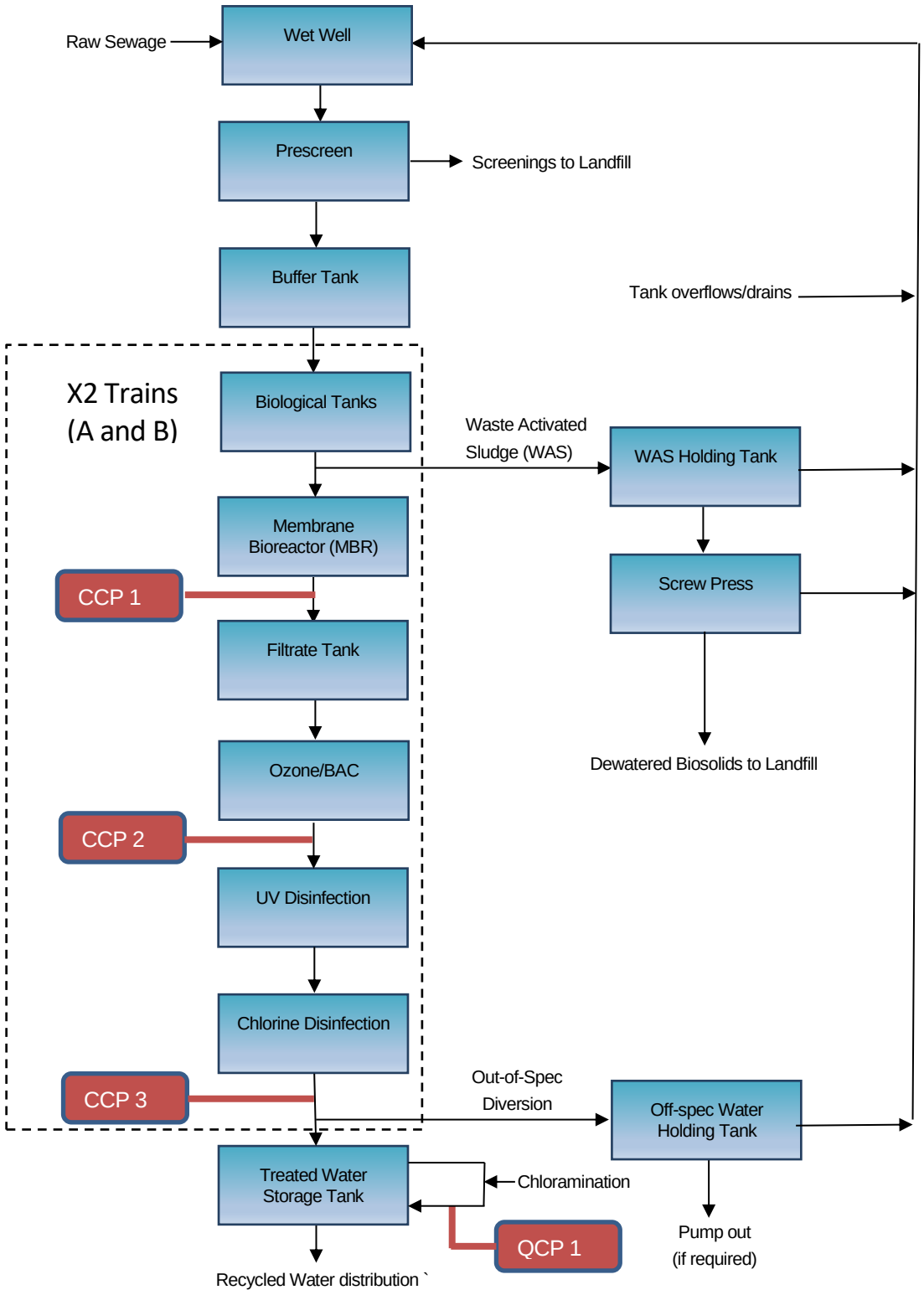
A flow diagram summarising the Quality Control Points (QCP) and Critical Control Points (CCP) is shown in Figure 3. If water quality parameters for either train A or B are exceeded at the CCPs, treated water from that train will either be recirculated (MBR CCPs) or diverted to the off-spec water holding tank. If the CCP limits continue to be exceeded for an extended period of time, the corresponding train will be shut down.

Two identical trains with the same process units and QCP's and CCP's will be installed (each producing 150 kL/day). Detailed monitoring and corrective actions for the QCP's and CCP's are described in the following sections.

6.1.1 Critical control points

If water quality parameters for either train A or train B are exceeded at the CCP's, treated water from that train will either be recirculated (MBR CCP's) or diverted to the Off-spec water holding tank. If the CCP limits continue to be exceeded for an extended period of time, the corresponding train will shutdown.

Figure 3: Recycled water process flow and critical control points



6.1.2 Process Description

Pre-screen:

The prescreen removes non-degradable solids such as fibers, or rags that can block or damage downstream processes and equipment. It also removes some of the degradable waste which help to lower the organic load to the biological treatment process.

Buffer Tank:

A 1 ML buffer tank is provided to capture peak flows from the site. This maximizes the amount of water than can be recovered and enables the plant to operate at an efficient and steady flow. A submersible mixer is employed in these tanks to keep solids suspended and to prevent anaerobic conditions occurring.

Bioreactor:

The biological system consists of both anoxic and aerobic stages.

The Anoxic Tank converts nitrate generated by the treatment process to nitrogen gas in order to reduce the nitrogen content of the treated water. Continuous mixing in the anoxic tank ensures that mixed liquor remains homogenous.

The Aerobic Tank carries out further biological treatment of the wastewater to reduce the organic content and convert ammonia nitrogen to nitrate and nitrite. Blowers aerate these tanks to ensure the required air for oxygen transfer is provided.

Mixed liquor suspended solids (MLSS) concentration is monitored continuously and waste activated sludge (WAS) is periodically discharged to maintain the required MLSS level.

Screw Press:

The screw press receives sludge from the WAS tank and separates the solid and liquid phases. The liquid is sent back to the start of the process train and the dewatered biosolids are collected for transportation to landfill.

Ultrafiltration membranes:

The combination of ultrafiltration and bioreactor is referred to as a membrane bioreactor (MBR). The biomass suspension from the bioreactor is recirculated past hollow fibre membranes, housed in the MBR tank, and returned to the bioreactor. A portion of the recirculated flow is withdrawn through the membranes as filtrate and collected in the filtrate tank for downstream disinfection.

The membranes are polymeric hollow fibres with a nominal pore size of 0.04 µm. The membranes effectively remove essentially all suspended solids and the bulk of any pathogens, including virus, bacteria and protozoa.

Ozone/BAC:

Filtered water then dosed with ozone and passed through an ozone contact pipe followed by Biological Activated Carbon (BAC) filters. This combination is used to remove colour from the feed water. The BAC employs periodic backwashing to control bacteria levels present in the filter and to ensure the filter bed is well distributed.

Ultraviolet light Disinfection (UV):

The UV system consists of two UV units in parallel. It provides the required dose to ensure the required inactivation of virus, bacteria and protozoa.

Chlorine Disinfection:

Following the UV, the water is dosed with sodium hypochlorite before entering a pipe contactor to provide the necessary chlorine contact time for disinfection. The free chlorine residual and pH of the recycled water are monitored at the end of the chlorine contact pipework.

Treated Water Storage Tank and Distribution:

The treated water is stored in a 1ML Treated Water Storage Tank (TWST) which allows the system to account for peak flows. Water in the TWST is recirculated and dosed with chlorine to maintain a free chlorine residual for storage and distribution.

Off-Spec Storage Tank:

Any treated water that cannot be used for distribution will be diverted to the Off-Spec Storage Tank. This water will then be recirculated back through the treatment process.

6.2 Monitoring and corrective actions

6.2.1 MBR System

Table 11: MBR critical control point

CCP 1	**MBR**		
	Turbidity	**Sample Flow Switch**	**Instrument Status**
Critical limits/alert limits			
Alert	≥ 0.15 NTU		
Critical	> 0.2 NTU	No Flow	Instrument Critical Fault
Monitoring procedures			
What	Turbidity	Flow Switch	Transmitter
How	AIT-MBR-01 (HACH TU5300sc)	FS-MBR-01	AIT-MBR-01 (HACH TU5300sc)
When	Continuous, during MOS FILTRATION		
Where	MBR filtrate line		
Who	Aquacell/Automatic		
Corrective actions			
What	MOS recirculation mode entered, returning filtrate to the MBR tank.		MOS goes to standby
How	Open recirculation valve (AV-302) and close filtrate to filtrate tank valve (AV-301)		Filtration stopped
When	If critical limit is exceeded for > 120 s	No flow for > 120 s	Immediate
Where	PLC		
Who	Automatic		

Turbidity:

If during MOS filtration, the turbidity exceeds the alert level for 120 seconds a warning alarm is generated to warn the operator. If the turbidity exceeds the critical level for more than 120 seconds, an alarm is triggered and the filtrate flow is diverted from the filtrate tank and recirculated back to the MBR tank. During recirculation, if the turbidity drops below the critical level for at least 120 seconds, filtrate is sent to disinfection. However, if after 3 filtration cycles, the filtrate turbidity has not fallen below the critical limit for at least 120 seconds, the MOS (Membrane Operating System) will go to standby and a standby alarm will be generated.

Production resumes when the operator resets the turbidity alarm after the cause has been identified and addressed.

Flow switch:

There is a flow switch in turbidity meter sample line to ensure sample flow is present during MOS filtration. If sample flow is lost, the turbidity readings are unreliable. If during MOS filtration, the flow switch turns off for more than 60 seconds an alarm is triggered to warn the operator. If the flow switch is off more than 120 seconds, an alarm is generated and the filtrate flow is diverted from the filtrate tank and recirculated back to the MBR tank. During recirculation, if the sample flow switch turns on for at least 120 seconds, treated water is redirected to storage. However, if after 3 filtration cycles, the sample flow switch has not turned on for at least 120 seconds, the MOS (Membrane Operating System) will go to standby and a standby alarm will be generated.

Production resumes when the operator resets the alarm after the cause has been identified and addressed.

Instrument Status:

If a critical turbidity instrument fault occurs during MOS filtration or recirculation, the MOS (Membrane Operating System) will immediately go to standby and a standby alarm will be generated.

Production resumes when the operator resets the alarm after the cause has been identified and addressed.

Maintenance:

Turbidity tested by handheld turbidity meter monthly, and recalibrated as required.

6.2.2 UV system

Table 12: UV disinfection critical control point

CCP 2	UV disinfection				
	Validated UV Dose – Virus	**UVT**	**Lamp age**	**UV status**	**Water flow**
Critical limits/alert limits					
Alert	< 60 mJ/cm^2	< 45%	> 10,000 hours		
Critical	< 58 mJ/cm^2	< 35%	> 12,000 hours	UV Fault	> 385 L/min
Monitoring procedures					
What	UV Dose	UVT Monitor	Hour monitor	Lamp monitor	Flowmeter
How	UV Controller (Hallett 1000P)	UV Controller (Hallett 1000P)	PLC recorded and UV controller (Hallett 1000P)	UV Controller (Hallett 1000P)	FIT-UV-01 (Burkert SE35)
When	Continuous, online				
Where	UV Unit	UV Unit	UV Unit and PLC	UV Unit Output	PLC
Who	Aquacell/Automatic				
Corrective actions					
What	Flow diverted to Off-spec Water Holding Tank		Disinfection System goes to shutdown		Flow diverted to Off-spec Water Holding Tank
How	Close AV-601 and open AV-602		Flow stopped		Close AV-601 and open AV-602
When	If critical limit is exceeded for > 120 s		Immediate	Immediate	If critical limit is exceeded for > 120 s
Where	PLC				
Who	Automatic				

Validated UV Dose – Virus:

The validated UV dose for virus is calculated by the UV controller using the flow rate, measured UVI and measured UVT. The dose is output from the controller to the PLC for monitoring.

If the UV dose drops below the alert level for more than 120 seconds an alarm is triggered to warn the operator that the UV system is approaching the low UV dose limit. The operator can then check the unit operation and rectify before the UV dose reaches the critical level. If the UV dose drops below the critical level for 120 seconds, an alarm is generated and the treated water is diverted to the Off-spec Water Holding Tank. If during diversion to the Off-spec Water Holding Tank, the UV dose increases back above the critical level for 120 seconds, the treated water will be redirected to the Treated Water Storage Tank. However, if after 2 hours the UV dose does not return above the critical limit for a minimum of 120 seconds, the disinfection system will go to shutdown and a shutdown alarm will be generated.

Production can resume when the operator resets the alarm after the cause has been identified and addressed.

UVT:

The UVT is continuously monitored to ensure it remains in the validated range. If the UVT drops below the alert level for more than 120 seconds an alarm is triggered to warn the operator that the UVT is approaching the low limit. If the UVT

drops below the critical level for 120 seconds, an alarm is generated and the treated water is diverted to the Off-spec Water Holding Tank. If during diversion to the Off-spec Water Holding Tank, the UVT increases back above the critical level for 120 seconds, the treated water will be redirected to the Treated Water Storage Tank. However, if after 2 hours the UVT does not return above the critical limit for a minimum of 120 seconds, the disinfection system will go to shutdown and a shutdown alarm will be generated.

Production can resume when the operator resets the alarm after the cause has been identified and addressed.

If the UVT exceeds the maximum validated UVT (98.7%) then the calculated UV dose will use the maximum validated UVT to determine the applied UV dose.

Lamp age:

Lamp age is monitored continuously by the UV control module. If the lamp hour alert level is reached, a warning alarm is generated to warn the operator. If the critical hours are exceeded, the disinfection system will immediately go to shutdown and a shutdown alarm will be generated.

Production can resume when the operator resets the alarm after the UV lamps have been replaced.

UV Status:

The UV Status is monitored continuously by the PLC and UV control module. If a critical UV fault occurs, the disinfection system will immediately go to shutdown and a shutdown alarm will be generated.

Production can resume when the operator resets the alarm after the cause of the fault has been rectified.

Water flow:

The flowrate is measured at the outlet if the UV units. If the flowrate increases above the critical level (maximum validated flow for the UV) for 120 seconds, an alarm is triggered and the treated water is diverted to the Off-spec Water Holding Tank. If during diversion to the Off-spec Water Holding Tank, the flowrate drops back below the critical level for 120 seconds, the treated water will be redirected to the Treated Water Storage Tank. However, if after 2 hours the flowrate does not return below the critical limit for a minimum of 120 seconds, the disinfection system will go to shutdown and a shutdown alarm will be generated.

Production can resume when the operator resets the alarm after the cause has been identified and addressed.

If the flowrate drops below the minimum validated flowrate (23.5 L/min) then the calculated UV dose will use the minimum validated flowrate to determine the applied UV dose.

Maintenance:

UVT is tested by handheld UVT meter monthly, and recalibrated as required.

6.2.3 Chlorine Disinfection

Table 13: Chlorine disinfection critical control point

CCP 3	Chlorine disinfection					
	Free Chlorine Residual (C)	**pH**	**Flow Switch**	**Temperature**	**Instrument Status**	**Chlorine Contact Time (C-T)**
	Critical limits/alert limits					
Alert	C < 0.6 mg/L or C > 4.5 mg/L	pH > 8.5 or pH < 6.5	No Flow	< 16 deg C		C-T < 4.2 mg.min/L
Critical	C < 0.5 mg/L or C > 5.0 mg/L	pH > 9.0 or pH < 6.0	No Flow	< 15 deg C	Instrument Fault	C-T < 4 mg.min/L
	Monitoring procedures					
What	Free chlorine residual	pH	Flow switch	Temperature	Transmitter	PLC
How	AE-OCT-03 (E&H CCS58D)	AE-CCT-02 (E&H CPS11D-7AA21)	FS-CCT-01 (E&H CYA27)	AE-CCT-01 (E&H CCS58D)	AIT-CCT-01 (E&H Liquiline CM442)	Calculated in PLC
When	Continuous, online					
Where	End of chlorine contact pipe (CCT)		UV-Chlorination Skid	End of chlorine contact pipe (CCT)	UV-Chlorination Skid	End of chlorine contact pipe (CCT)
Who	Aquacell/Automatic					
	Corrective actions					
What	Flow diverted to Off-spec Water Holding Tank				Disinfection System goes to shutdown	Flow diverted to Off-spec Water Holding Tank
How	Close AV-601 and open AV-602				Flow stopped	Close AV-601 and open AV-602
When	If critical limit is exceeded for > 120 s				Immediate	If critical limit is exceeded for > 120 s
Where	PLC					
Who	Automatic					

Free chlorine residual:

The free chlorine residual at the end of the chlorine contact pipe is continuously monitored. If the free chlorine concentration goes outside the alert range for more than 120 seconds an alarm is triggered to warn the operator. The operator can then check the unit operation and rectify before the it reaches the critical level. If the free chlorine concentration goes outside the critical range for 120 seconds, an alarm is triggered and the treated water is diverted to the Off-spec Water Holding Tank. If during diversion to the Off-spec Water Holding Tank, the free chlorine concentration goes back within the critical range for 120 seconds, the treated water will be redirected to the Treated Water Storage

Tank. However, if after 2 hours the free chlorine concentration does not return within the critical range for a minimum of 120 seconds, the disinfection system will go to shutdown and a shutdown alarm will be generated.

Production can resume when the operator resets the alarm after the cause has been identified and addressed.

pH:

The pH measurement at the end of the chlorine contact pipe is continuously monitored. If the pH goes outside the alert range for more than 120 seconds an alarm is triggered to warn the operator. The operator can then check the unit operation and rectify before the it reaches the critical level. If the pH goes outside the critical range for 120 seconds, an alarm is triggered and the treated water is diverted to the Off-spec Water Holding Tank. If during diversion to the Off-spec Water Holding Tank, the pH goes back within the critical range for 120 seconds, the treated water will be redirected to the Treated Water Storage Tank. However, if after 2 hours the pH does not return within the critical range for a minimum of 120 seconds, the disinfection system will go to shutdown and a shutdown alarm will be generated.

Production can resume when the operator resets the alarm after the cause has been identified and addressed.

Flow switch:

There is a flow switch in the temperature and free chlorine sample line to ensure sample flow is present. If sample flow is lost the readings are unreliable.

If the flow switch turns off for more than 60 seconds an alarm is triggered to warn the operator. If the flow switch is off more than 120 seconds, an alarm is generated and the treated water is diverted to the Off-spec Water Holding Tank. During diversion to the Off-spec Water Holding Tank, if the flow switch turns back on for 120 seconds, the treated water will be redirected to the Treated Water Storage Tank. However, if after 2 hours the flow switch has not turned on for a minimum of 120 seconds, the disinfection system will go to shutdown and a shutdown alarm will be generated.

Production resumes when the operator resets the alarm after the cause has been identified and addressed.

Water temperature:

The chlorine contact system has been designed based on chlorine contact time (C-T) values for a minimum temperature of 15 deg C.

If the temperature drops below the alert level for more than 120 seconds an alarm is triggered to warn the operator. If the temperature drops below the critical level for 120 seconds, an alarm is triggered and the treated water is diverted to the Off-spec Water Holding Tank. If during diversion to the Off-spec Water Holding Tank, the temperature increases back above the critical level for 120 seconds, the treated water will be redirected to the Treated Water Storage Tank. However, if after 2 hours the temperature does not return above the critical limit for a minimum of 120 seconds, the disinfection system will go to shutdown and a shutdown alarm will be generated.

Production can resume when the operator resets the alarm after the cause has been identified and addressed.

Instrument Status:

If there is a CCT instrument critical fault, the disinfection system will immediately go to shutdown and a shutdown alarm will be generated.

Production resumes when the operator resets the alarm after the cause has been identified and addressed.

Chlorine Contact Time:

The chlorine contact time (C-T) is calculated in the PLC using the free chlorine concentration and the flowrate. If the chlorine contact time (C-T) decreases below the critical level for 120 seconds, an alarm is triggered and the treated water is diverted to the Off-spec Water Holding Tank. If during diversion to the Off-spec Water Holding Tank, the C-T increases back above the critical level for 120 seconds, the treated water will be redirected to the Treated Water Storage Tank.

However, if after 2 hours the C-T does not return above the critical limit for a minimum of 120 seconds, the disinfection system will go to shutdown and a shutdown alarm will be generated.

Production can resume when the operator resets the alarm after the cause has been identified and addressed.

Maintenance:

The pH probe is checked against buffer solutions monthly and recalibrated if required.

The free chlorine probe is checked against a DPD photometric free chlorine test monthly and recalibrated as required.

Temperature tested by handheld temperature probe monthly, and recalibrated as required.

6.2.4 Treated Water Storage Chlorination System

Table 14: Treated Water Storage Chlorination quality control point

QCP 1	Total Chlorine Residual (TC)	pH	Sample Flow Switch	Instrument Status
Alert	TC < 0.6 mg/L or TC > 4.5 mg/L	pH > 9 or pH < 6.5	No Flow	
Critical	TC < 0.5 mg/L or TC > 5.0 mg/L		No Flow	Instrument Fault
Monitoring procedures				
What	Total chlorine residual	pH	Flow Switch	Transmitter
How	AE-STO-01 (E&H CCS120D)	AE-STO-02 (E&H CPS11E)	FS-STO-01 (E&H CCA250)	AIT-STO-01 (E&H Liquiline CM444)
When	Continuous, when Treated Water Storage Tank recirculation pump is running			
Where	Treated Water Storage Tank recirculation			
Who	Aquacell/Automatic			
Corrective actions				
What	Treated water diverted to Off-spec Water Holding Tank	Warning only	Treated water diverted to Off-spec Water Holding Tank	Disinfection System goes to shutdown
How	Close AV-601 and open AV-602	Warning only	Close AV-601 and open AV-602	Flow stopped
When	If critical limit is exceeded for > 120 s	If alert limit exceeded for > 120 s	If critical limit is exceeded for > 120 s	Immediate
Where	PLC/HMI			
Who	Automatic			

Total chlorine residual:

When the Treated Water Storage Tank recirculation pump is running, the total chlorine level is continuously monitored to ensure that there is a residual in the treated water distribution system. If the total chlorine level is outside of the alert limits for more than 120 seconds an alarm is triggered to warn the operator. If the total chlorine level is outside of the critical limits for more than 120 seconds, an alarm in generated and the treated water is diverted to the Off-spec Water

Holding Tank. If during diversion to the Off-spec Water Holding Tank, the total chlorine goes back within the critical limits for 120 seconds, the treated water will be redirected to the Treated Water Storage Tank. However, if after 2 hours the total chlorine does not return to being within the critical limits for a minimum of 120 seconds, the disinfection system will go to shutdown and a shutdown alarm will be generated.

Production resumes when the operator resets the alarm after the cause has been identified and addressed.

Treated water pH:

The pH in the treated water tank is continuously monitored to ensure it is with the range. If the pH is not within the limits for 120 seconds a warning alarm is generated.

Flow switch:

There is a flow switch in the pH and total chlorine sample line to ensure sample flow is present when the Treated Water Storage Tank recirculation pump is running. If sample flow is lost, the pH and total chlorine readings are unreliable. If the flow switch turns off for more than 60 seconds an alarm is triggered to warn the operator. If the flow switch is off more than 120 seconds, an alarm in generated and the treated water is diverted to the Off-spec Water Holding Tank. During diversion to the Off-spec Water Holding Tank, if the flow switch turns back on for 120 seconds, the treated water will be redirected to the Treated Water Storage Tank. However, if after 2 hours the flow switch has not turned on for a minimum of 120 seconds, the disinfection system will go to shutdown and a shutdown alarm will be generated.

Production resumes when the operator resets the alarm after the cause has been identified and addressed.

Instrument Status:

If a treated water storage tank instrument fault occurs when the Treated Water Storage Tank recirculation pump is running, the disinfection system will immediately go to shutdown and a shutdown alarm will be generated.

Production resumes when the operator resets the alarm after the cause has been identified and addressed.

Maintenance:

The pH probe is checked against buffer solutions monthly and recalibrated if required.

The total chlorine probe is checked against a DPD photometric total chlorine test monthly and recalibrated as required.

6.3 Standard operating procedures

An operations and maintenance manual will be supplied with the system to explain detailed operation. This includes a description of the CCP's and QCP's and required operator actions.

A summary of the CCP's is provided in Table 15 along with the control response and operator actions. Further details are provided in the operating and maintenance manual.

During shutdown, wastewater is collected in the buffer tank which has been sized to hold a three-day supply of blackwater. If during shutdown the buffer tank reaches full capacity, it will be pumped out.

Table 15: CCP Summary of control system response and operator actions

CCP	Control System Response	Operator Actions
CCP 1 – MBR	The MBR filtrate turbidity, instrument status and flow switch status are continuously monitored. The MBR will go into recirculation mode if the turbidity conditions are not met.	The system will automatically reset when CCP parameters are in spec. However, if this does not occur, the MBR will go into standby and operator intervention will be required. The operator should contact Aquacell for a detailed investigation. The most likely causes are membrane system leaks (seals or membrane integrity), faulty turbidity readings (due to air bubbles), or biogrowth shedding from pipework.
CCP 2 – UV Disinfection	The validated UV dose is continuously calculated and monitored along with UVT, lamp age and UV status. The plant diverts water to the Off-spec water holding tank after the CCT if the UV conditions are not all met.	The system will automatically reset when CCP parameters are in spec. However, if this does not occur, the disinfection system will shutdown and operator intervention will be required. The relevant parameters that affect UV dose are individually monitored and alarmed to guide the operator response. If further troubleshooting is required, contact Aquacell.
CCP 3 - Chlorination	The free chlorine concentration is continuously monitored along with the pH, temperature, flowrate, instrument status and flow switch status. The plant diverts water to the Off-spec water holding tank after the CCT if the chlorine disinfection conditions are not all met.	The system will automatically reset when CCP parameters are in spec. However, if this does not occur, the disinfection system will shutdown and operator intervention will be required. The most likely issues will be around chlorine dose or chlorine demand. If no obvious faults are present, contact Aquacell.

7. Verification and Ongoing monitoring

To provide evidence that the overall system can deliver water of the specified quality, the verification monitoring plan detailed in Table 17 will be used. This will provide a total of 12 samples over 6 weeks.

Influent and treated water samples will be take as defined below using Aquacell's sampling procedure (Appendix 6). Sample analysis is undertaken at a NATA accredited laboratory.

Table 16: Treated water verification monitoring program

Parameter	Units	Sampling Frequency (per week)	Duration of monitoring program (weeks)	Compliance Value
Influent				
E.coli	cfu/100ml	2	6	NA
FrNA Coliphage	pfu/100mL	2	6	NA
Clostridium perfringens	cfu/100mL	2	6	NA
Biochemical oxygen demand (BOD)	mg/L	2	6	NA
Total suspended solids (TSS)	mg/L	2	6	NA
pH		2	6	NA
Treated Water				
E.coli	cfu/100ml	2	6	< 1
FrNA Coliphage	pfu/100mL	2	6	< 1
Clostridium perfringens	cfu/100mL	2	6	<1
Crypto-sporidium oocysts	oocysts/L	1 sample during monitoring period	6	<1
Biochemical oxygen demand (BOD)	mg/L	2	6	< 10
Total suspended solids (TSS)	mg/L	2	6	< 10
Turbidity (MBR filtrate) (NTU)	NTU	Continuous online	6	≤ 0.2
Validated UV Dose (virus)	mJ/cm2	Continuous online	6	≥ 58
Chlorine Contact Time (C-T)	mg.min/L	Continuous online	6	C-T ≥ 4
pH (CCT)		Continuous online	6	pH ≤ 9.0 and pH ≥ 6.0
Total Chlorine (Treated Water Storage)	mg/L	Continuous online	6	TC ≥ 0.5 and TC ≤ 5.0

To provide evidence that the overall system can deliver water of the specified quality on an on-going basis, the following on-going monitoring plan is proposed (Table 17).

Table 17: Treated water ongoing monitoring program

Parameter	Units	Monitoring frequency	Compliance Value
Treated Water			
E.coli	cfu/100ml	Monthly	< 1
Turbidity (MBR filtrate) (NTU)	NTU	Continuous online	≤ 0.2
Validated UV Dose (virus)	mJ/cm2	Continuous online	≥ 58
Chlorine Contact Time (C-T)	mg.min/L	Continuous online	C-T ≥ 4
pH (CCT)		Continuous online	pH ≤ 9.0 and pH ≥ 6.0
Total Chlorine (Treated Water Storage)	mg/L	Continuous online	TC ≥ 0.5 and TC ≤ 5.0

8. Prerequisite programs

For the effective operation of this RWQMP, prerequisite programs that outline detailed procedures and protocols will be provided.

Operations and Maintenance Procedures:

An operations and maintenance manual in accordance with the AGWR will apply to the scheme and will be attached in Appendix 11. Included in the manual are the Standard Operating Procedures, Maintenance Procedures, Calibration Procedures and Chemical Safety Procedures.

Calibration of Monitoring Instruments:

The calibration of all on-line monitoring instruments will be conducted in accordance with the manufactures' recommendations. The calibration of each instrument is logged and maintained on a standard maintenance record.

Chemical Quality Assurance:

All chemicals required for cleaning, maintenance and water treatment will be supplied by an ISO9001 accredited supplier.

Organisational Quality Management:

Aquacell has developed an in-house management system, IMS (Integrated Management System), which is regularly audited. This system documents Aquacell's regulatory, risk and organisational procedures and protocols.

Inspections:

The plant is under continuous remote supervision by Aquacell as the contracted operator. Data logging of key parameters is a part of this supervision. Weekly inspections are conducted and a checklist is completed by the scheme manager according to the service agreement between the scheme manager and Aquacell. The responsibilities will be clearly

delineated in the service agreement. Also, in accordance with the service agreement, monthly maintenance including instrument calibration checks are carried out by Aquacell and records maintained. Quarterly servicing is also carried out by Aquacell and records maintained.

Aquacell will provide the necessary training for the scheme manager's staff to perform the work required. Records of this training will be kept by Aquacell.

9. Incidents and emergencies

Aquacell maintains a community contact and FAQ section of its website with procedures relating to the management of emergencies. This will be updated to include the Alspec Industrial Business Park BWTP.

In addition, a meeting attended between Aquacell, the scheme manager and its relevant contractors will be held to review emergency procedures that are specific to the recycled water scheme and the precinct.

Table 18 describes emergency response incidents and procedures.

Table 18: Incidents and emergencies

Hazards and events that may lead to emergencies	Immediate Response		Corrective Action		Authorities	
	What	Who	What	Who	What	Who
Non-conformance of water with critical limits	If detected by online instrument, plant automatically shuts off supply	Aquacell	Aquacell diagnose and rectify.	Aquacell	Has non-compliant water been delivered? If yes, Aquacell notify the scheme manager. The scheme manager to notify NSW Health.	The scheme manager
Response to exceedances of water quality targets	If there are any occurrences of positive results for the ongoing water quality monitoring as described in Table 17, supply of recycled water should be stopped, and the cause investigated. Aquacell to notify the scheme manager. The scheme manager to immediately notify NSW Health.	Aquacell/ The scheme manager	Aquacell to investigate cause and rectify. Re-test and achieve compliance before resuming delivery of recycled water.	Aquacell	Aquacell to notify the scheme manager. The scheme manager notify NSW Health.	The scheme manager
Accidents that increase level of contamination in source water	Feed water continuously monitored for pH.	Aquacell	Pause production investigate cause. Production resumed once pH returned to specification (may need manual adjustment)	Aquacell	NA	NA
Equipment breakdown and mechanical failure	Critical equipment alarmed for malfunction. Alarm received by operator. Operator to log in and inspect operation of plant. Disable plant if required.	Aquacell	Repair	Aquacell	NA	NA

Cross-connections	If a cross connection is detected, immediately stop use of treated water, and switch to potable water backup.	The scheme manager	Conduct audit to identify location of cross-connection. Rectify. Preventative measures include signage, labelling, colour-coding, information brochures for plumbers and public. Do not reinstate delivery of treated water until cross connect audit has been completed.	The scheme manager	Should a cross-connection be identified, notify the scheme manager and Aquacell. The scheme manager in turn notify NSW Health.	The scheme manager
Prolonged power outages	Plant shuts down in a safe state on power failure. Notify Aquacell so that restart procedures and checks can be made and the plant monitored during start-up. Potable water backup will provide water needs automatically.	The scheme manager	Remote operator log-in. Restart operation on return of power.	Aquacell	NA	NA
Leakage, spillage, or runoff of recycled water or greywater on site.	For minor contained spills, notify the scheme manager for repair. If treatment plant is responsible contact Aquacell.	The scheme manager	The scheme manager or site management to respond. Aquacell to action if treatment plant is responsible. Incident report to be prepared and corrective actions implemented.	Aquacell/ The scheme manager	If major spill that contaminates or potentially contaminates the environment also contact the Penrith City Council.	The scheme manager

10. Employee awareness and training

The scheme manager and Aquacell are responsible for ensuring their respective employees and contractors are familiar with the operation of the scheme and aware of the potential consequences of system failures, and of how their decisions can affect the safety of the scheme.

Aquacell will provide an experienced water recycling engineer to monitor the plant. Any contractors used on site must be accredited, qualified and have the appropriate level of training.

A site induction will be required for anyone doing work related to this scheme. This will be carried out and recorded by the scheme manager for work on the dual pipe system, and by Aquacell for work on the treatment plant. For plant work this includes familiarization with Aquacell's Safe Work Method Statements (SWMS's) which are site specific. Aquacell maintains a partnership with several contractors to ensure continuity of knowledge and technical expertise.

Aquacell has an induction program for new employees and written procedures for all areas of responsibility.

Training needs for Aquacell employees are identified and adequate resources made available during the induction phase. Annual performance reviews identify additional training requirements and set performance targets. Training records are kept.

11. Documentation and reporting

11.1 Documentation

The following records and documents will be maintained by Aquacell as the water recycling plant operator.

- Verification and on-going monitoring results
- CCP monitoring results and analysis
- Plant operation data
- Laboratory testing results and analysis
- Breaches of critical limits and corrective actions taken
- Incidents and emergencies and corrective actions taken
- Inspection and maintenance activities relevant to water quality

CCP results and operation data will be collected by an online data acquisition system and kept as an electronic copy by Aquacell.

Verification results will be collected by Aquacell from a NATA accredited testing laboratory and stored electronically by Aquacell.

A record of any maintenance to the treatment plant will be kept. Any equipment adjusted, repaired, replaced or calibrated will be recorded. Monthly maintenance checks and calibrations are recorded on a monthly maintenance checklist (See Operations and Maintenance Manual (Appendix 11), and stored according to Aquacell's document management procedures.

11.2 Reporting

Aquacell will provide a monthly report to the scheme manager in relation to the operation and maintenance of the water recycling plant.

Separate reports, as required by the relevant authorities will also be prepared. These reports will be signed by the designated Aquacell person and includes:

- a summary of the review and improvement processes, and whether the RWQMP has been complied with,
- a summary of priority areas for improvement and actions to address any non-compliances with the RWQMP,
- an analysis of the monitoring data collected for the management of environmental risks,
- an analysis of the monitoring data collected under the RWQMP,
- a summary of incidents and emergencies, including corrective actions,
- a listing or register of supplied recycling schemes, including quality, quantity and type of use, and
- a summary of audit outcomes.

The reports will also be signed by a person authorised as a representative of the organisation/s receiving the report.

11.3 Notifications

Aquacell, as the operator of the recycled water plant, must immediately notify the scheme manager of any incidents that occur with the treatment process or plant that could affect health. This includes:

- Incidents where recycled water has been supplied that does not comply with the three CCP conditions described in Section 5.3,
- Any other incident or emergency that could directly or indirectly impact on the health of the end users.

Notification should include details of corrective and future preventive action.

Contact details for various key entities in the project are listed in the table below. These will be updated from time to time as appropriate.

Table 19: Contact details

Entity	Contact	Details
Sydney Local Health District Public Health Unit (NSW Health)	Public Health officer	Phone: 02 9515 9420 Phone (after hours): 02 9515 6111 (to speak with the Public Health Officer on call for environmental health) Email: SLHD-PHUEHO@health.nsw.gov.au
Penrith City Council	TBA	TBA
Scheme Manager	TBA	TBA
Aquacell	Colin Fisher, Managing Director	Address: Suite 602, 6A Glen Street, Milsons Point, NSW 2061. Phone: 02 4721 0545 Mobile: 0409 393 389 Email: colinf@aquacell.com.au

12. Review and improvement

The plant operation and RWQMP will be reviewed annually and updated as needed. This is an internal review process with appropriate operating staff. The review and improvement process will include:

- Critical analysis of current improvement procedures
- Identify all known deficiencies that require improvement
- Make comparisons with targets and current practices
- Identification of new and continuous improvement opportunities
- Document success of improvements made
- Overall verification of current improvement practices

Any changes to CCP limits must be endorsed by NSW Health or approved by Penrith City Council before being implemented.

13. Commissioning the RWQMP

All operational monitoring, critical alarms and corrective actions within the RWQMP will be tested and verified as part of commissioning. A verification report and cross connection audit will conducted and submitted to Penrith City Council for review and approval before any treated water is delivered for use in the precinct.

14. Plumbing

The Building plumbing and drainage system has been designed in accordance with the Water Supply Code of Australia and in accordance with AS/NZS 3500.1 & AS/NZS3500.2.

15. Appendices

Appendix 1 – Process Flow Diagram

Appendix 2 – General Arrangement

Appendix 3 – Aquacell Recycled Water Policy

Appendix 4 – HACCP Analysis - pending

Appendix 5 – Penrith City Council Approval to install – pending

Appendix 6 - Aquacell Sampling Procedure

Appendix 7 – Not used

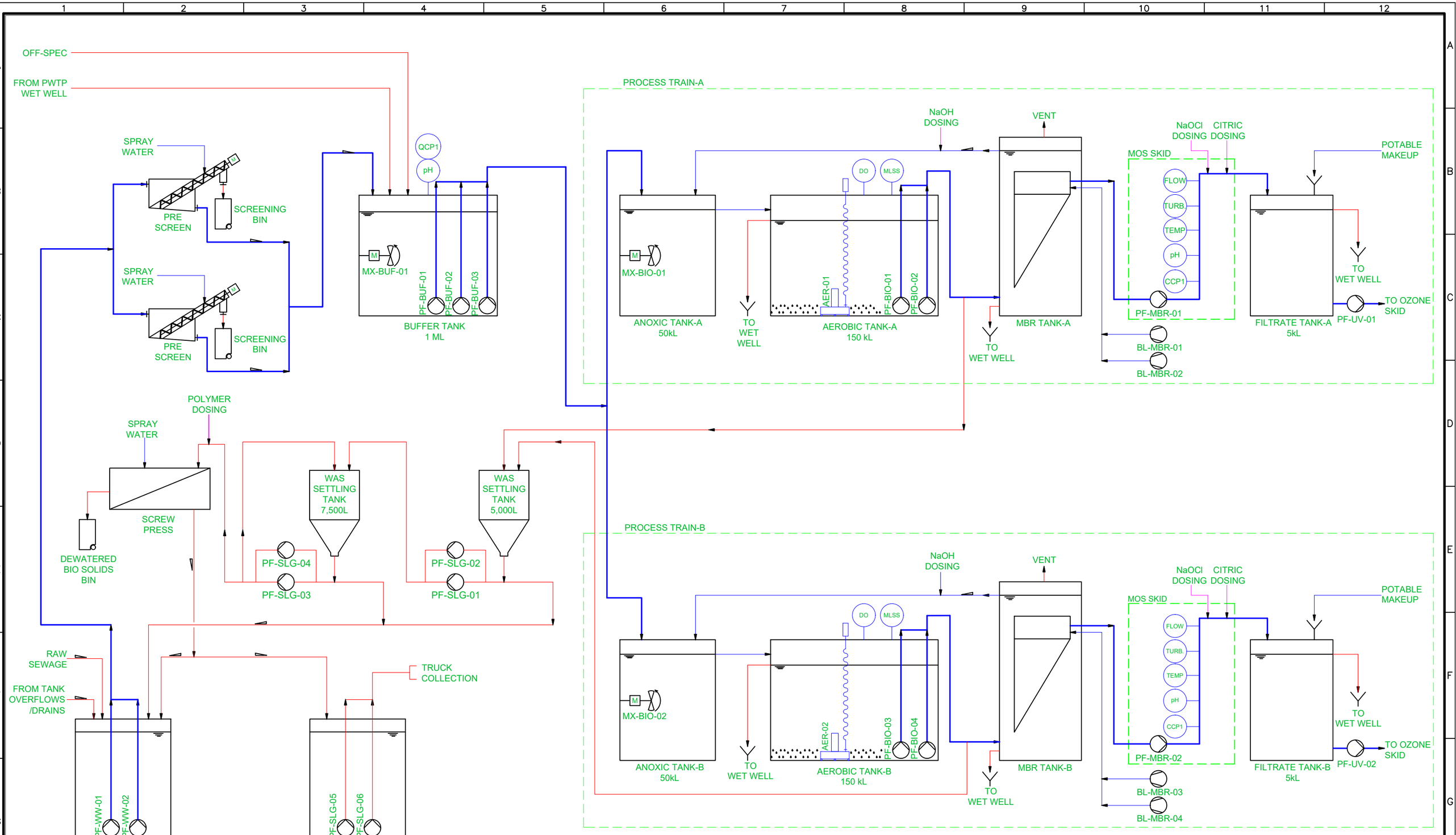
Appendix 8 – Not used

Appendix 9 – Plumbing Audit (cross connection Audit) - pending

Appendix 10 – Verification Report - pending

Appendix 11 – Operation and Maintenance Manual - pending

Appendix 1 – Process Flow Diagram



REVISION TABLE

REV	DATE	DESCRIPTION	DRAWN	CHECKED	APPROVED	REV	DATE	DESCRIPTION	DRAWN	CHECKED	APPROVED
A	15-Sep-2023	INTIAL ISSUE	S.B	E.B	J.J						
B	14-Jun-2024	UPDATED	S.B	W.J	W.J						

GENERAL TOLERANCES U.N.O
LINEAR : ± 0.5 mm
ANGULAR : ± 0.05 deg
ALL DIMENSIONS IN mm U.N.O

aquacell water recycling
Suite 602, 6A Glen St Milsons Point
NSW 2061 Australia
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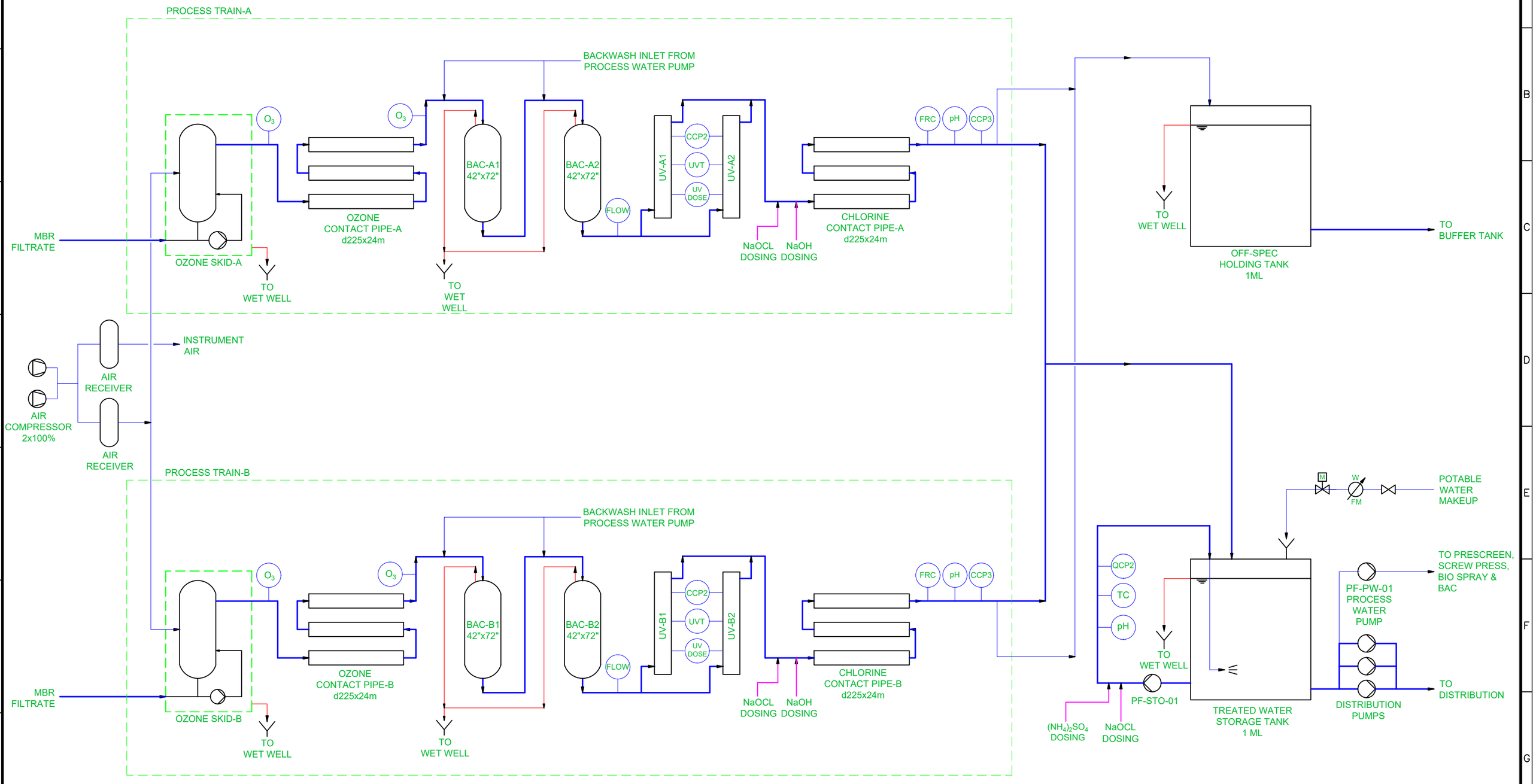
Email: info@aquacell.com.au

DRAWN	S.B	DATE	15-Sep-2023
CHECKED	A.E	DATE	15-Sep-2023
APPROVED	J.J	DATE	15-Sep-2023

TITLE: PROCESS FLOW DIAGRAM
BLACKWATER TREATMENT PLANT

JOB No	DRAWING No	PROJECT
A0144	A0144-002	LUDDENHAM RD ORCHARD HILLS

DRAWING STANDARD AS1100 | DO NOT SCALE | Rev: B | SHEET No:01 OFF 02 | A1



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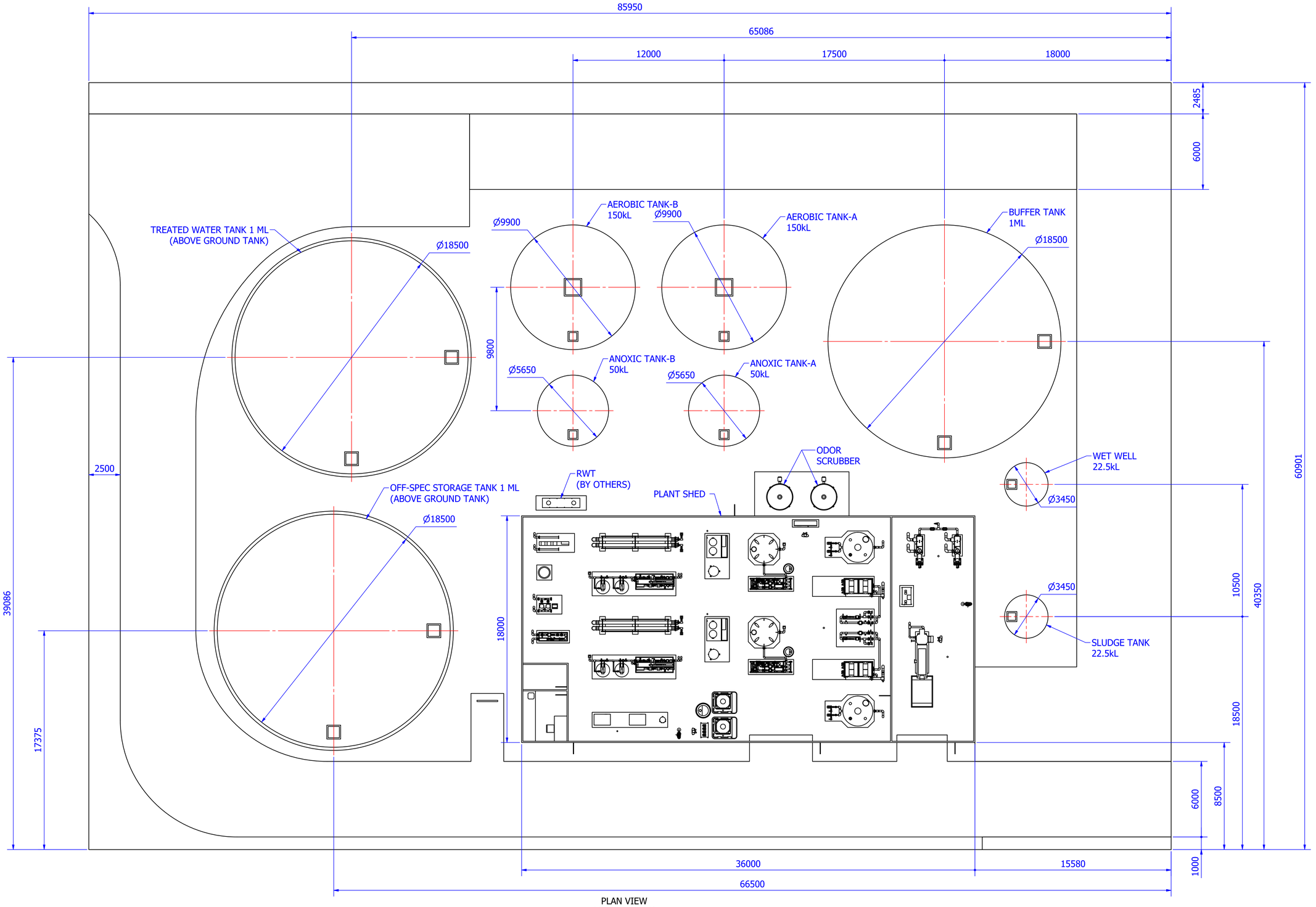
JOB No: A0144
DRAWING No: A0144-002
PROJECT: LUDDENHAM RD ORCHARD HILLS

DRAWING STANDARD AS1100 | DO NOT SCALE | Rev: B | SHEET No:02 OFF 02 | A1

Appendix 2 – General Arrangement



PLAN VIEW
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REV	DATE	DESCRIPTION	DRAWN	CHECKED
B	14-Jun-2024	UPDATED	S.BIABANI	W.JOHNSON
A	15-Sep-2023	INITIAL ISSUE	S.BIABANI	A.EISSENHAMMER

REVISION HISTORY

GENERAL TOLERANCES U.N.O
WHOLE : ± 1.0 mm
DECIMAL : ± 0.5 mm
ANGULAR : ± 0.5 deg
ALL DIMENSIONS IN mm U.N.O

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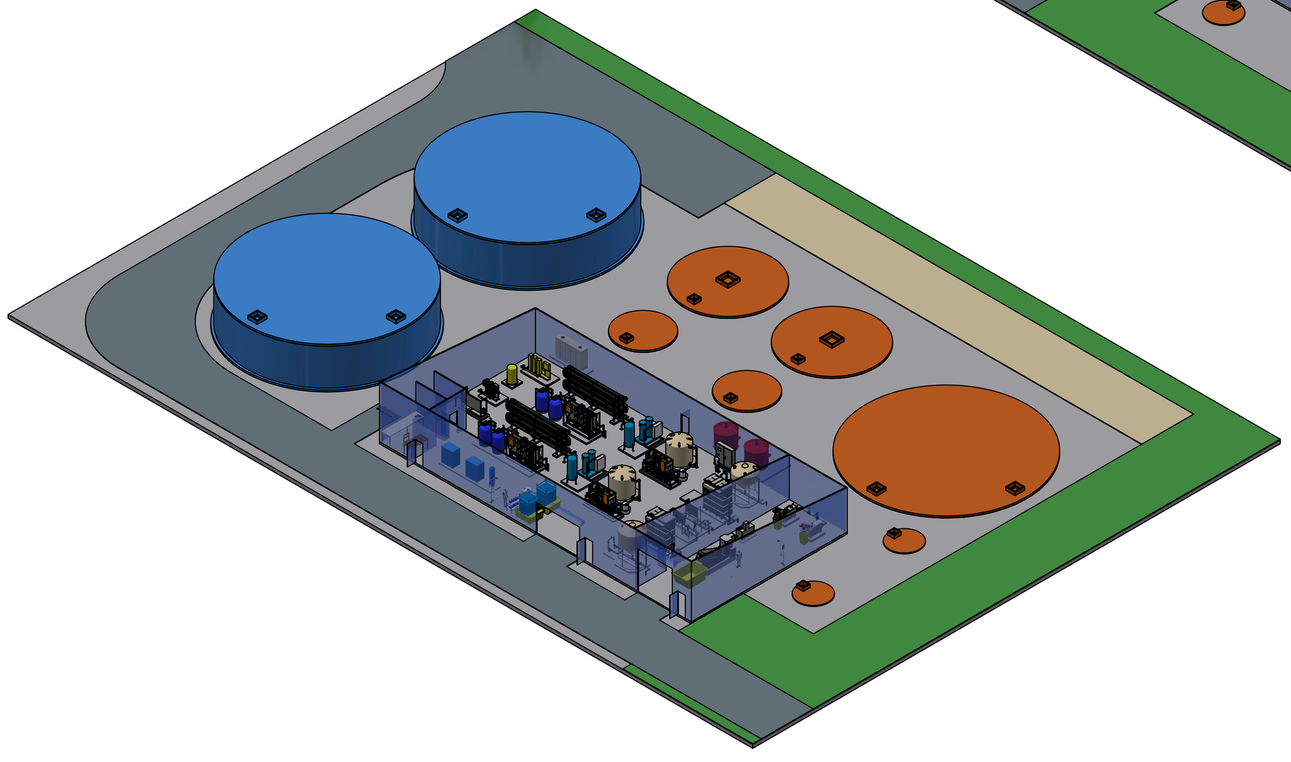
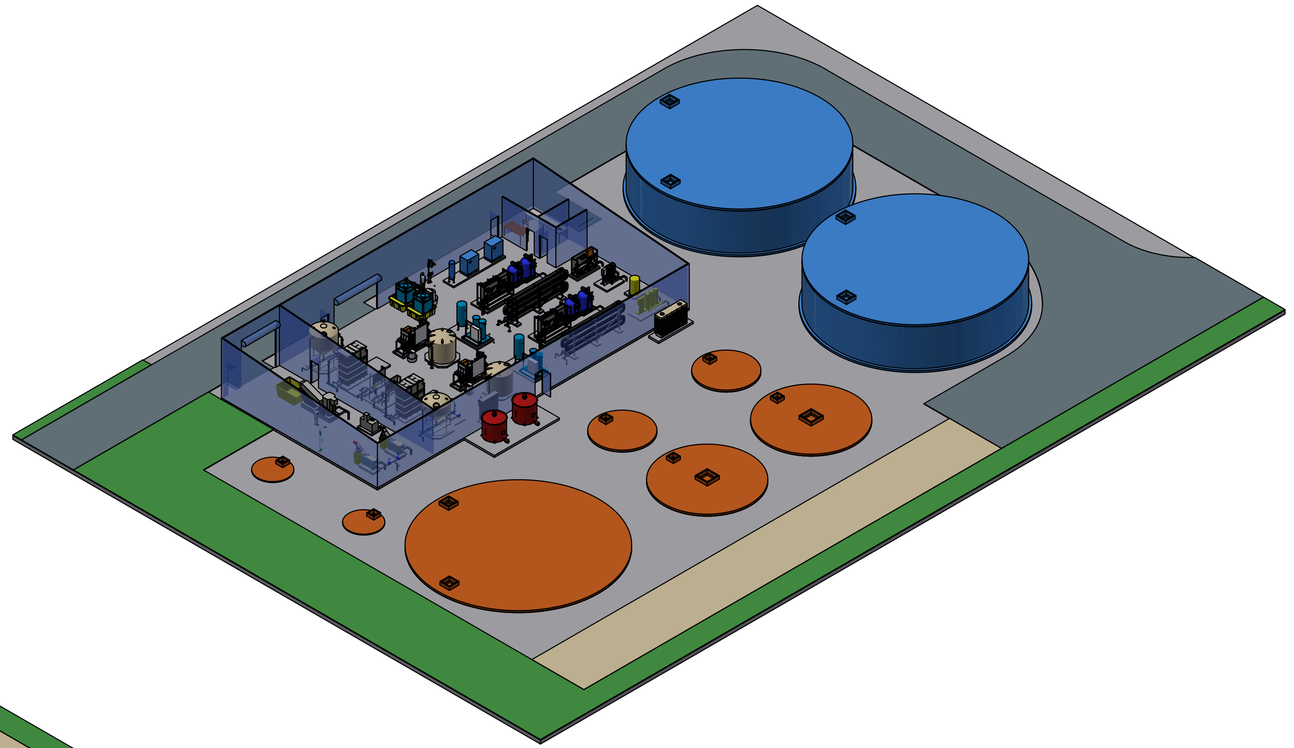
DRAWN	S.BIABANI	DATE	15/09/2023	TITLE: LAYOUT
CHECKED	A.EISENHAMMER	DATE	15/09/2023	BLACKWATER TREATMENT PLANT
APPROVED	J.JENNINGS	DATE	15/09/2023	
JOB No: A0144	DRAWING No: A0144-302-B			PROJECT: LUDDENHAM RD ORCHARD HILLS
DRAWING STANDARD : AS1100		DO NOT SCALE	Rev: B	SHEET No: 1 OFF 7 — A1





ISO VIEWS
SCALE (1 : 250)

REV	DATE	DESCRIPTION	DRAWN	CHECKED
B	14-Jun-2024	UPDATED	S.BIABANI	W.JOHNSON
A	15-Sep-2023	INITIAL ISSUE	S.BIABANI	A.EISSENHAMMER

REVISION HISTORY

GENERAL TOLERANCES U.N.O
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DECIMAL : ± 0.5 mm
ANGULAR : ± 0.5 deg
ALL DIMENSIONS IN mm U.N.O

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DRAWN	S.BIABANI	DATE	15/09/2023	TITLE: LAYOUT BLACKWATER TREATMENT PLANT
CHECKED	A.EISENHAMMER	DATE	15/09/2023	
APPROVED	J.JENNINGS	DATE	15/09/2023	
JOB No: A0144	DRAWING No: A0144-302-B			PROJECT: LUDDENHAM RD ORCHARD HILLS
DRAWING STANDARD : AS1100		DO NOT SCALE	Rev: B	SHEET No: 3 OFF 7 — A1

Appendix 3 – Aquacell Recycled Water Policy

Aquacell Recycled Water Policy

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Contents

Document Creation and Review

Revision No	Author	Reviewed By	Approved By	Date
Draft (EM 010-01)	P. Coulton	C. Fisher	C. Fisher	22 July 2011
EM010-2		Annabelle Caspersz		5 December 2011

Document Control

Revision No	Status	Issued To		Date
		Name	Organisation	

Recycled Water Policy

Aquacell supports and promotes the responsible use of recycled water and the application of a management approach that consistently meets the *Australian Guidelines for Water Recycling*, as well as recycled water user and regulatory requirements.

To achieve this we will:

- ensure that the protection of public and environmental health is recognised as being of paramount importance.
- maintain communication and partnerships with all relevant agencies involved in management of water resources, including waters that can be recycled
- engage appropriate scientific expertise in developing recycled water schemes
- recognise the importance of community participation in decision making processes and the need to ensure the community expectations are met
- manage recycled water quality at all points along the delivery chain from source to the recycled water user
- use a risk based approach in which potential threats to water quality are identified and controlled
- integrate the needs and expectations of our users of recycled water, communities and other stakeholders, regulators and employees into planning processes
- establish regular monitoring of control measures and recycled water quality and establish effective reporting mechanisms to provide relevant and timely information and promote confidence in the recycled water supply and its management
- develop appropriate contingency planning and incident response capability
- participate in appropriate research and development activities to ensure continuous improvement and continued understanding of recycled water issues and performance
- contribute to the development of industry regulations and guidelines and other standards relevant to public health and the water cycle
- continually improve our practices by assessing performance against corporate commitments and stakeholder expectations

Aquacell will implement and maintain recycled water management systems consistent with the *Australian Guidelines for Water Recycling* to effectively manage the risks to public and environmental health.

All managers and employees involved in the supply of recycled water are responsible for understanding, implementing, and continuously improving the recycled water management system. Membership and participation in professional associations dealing with management and use of recycled water is encouraged.

Colin Fisher

Managing Director 22nd July 2011

Appendix 4 – HACCP Analysis - Draft

HACCP Checklist

Project Name:	A0144 Luddenham Rd Orchard Hills
Completed by:	Justin Taylor
Date of Assessment:	11-Jun-24
Revision:	Draft
Approved By and Date:	Draft only

To be approved by the Technical Manager

HACCP Workshop Attendees			Revision 1 Attendees	Revision 2 Attendees

DESIGN /			Before Mitigation			After Mitigation													CONSTRUCTION STAGE HACCP			COMMISSIONING / HANDOVER STAGE HACCP			
Step	**Potential Hazard**	**Preventative Measure**	**Likelihood**	**Consequence**	**Resid. Risk**	**Likelihood**	**Consequence**	**Resid. Risk**	**Uncertainty**	**Decision Tree**				**CCP/QCP**	**Critical Levels**		**Monitoring**	**Corrective Action**		**Records**	**Action Checked**	**By**	**Date**	**Action Checked**	**By**	**Date**	**Closed Out**
Process unit	*Physical, chemical, biological, other*		*1 to 5*	*1 to 5*	*Likelihood + Consequence*	*1 to 5*	*1 to 5*	*Likelihood + Consequence*		*Y + N*					*Target*	*Action*	*How*	*What*	*How*	*Where*						
1. Source water (sewage influent, collection lines, pump stations)	Biological Hazard: Contact with raw sewage	Plant designed so that contact with sewage in normal operation is not required. Plant room locked so people cannot readily enter. Covers on tanks and locks where appropriate. Trained operators to servicing plant.	3	3	6	1	2	3	± 1	Y	N	N		No												
	Health Hazard: Source water is different to design specification and treatment plant cannot treat correctly.	Plant design conservative with some ability to remove short periods of our of specification sewage. Continuous online monitoring does not allow out of specification water to be delivered. Trade waste cannot be connected directly to the sewer. pH measurement in buffer tank may detect poor feed. Buffer tank will dilte short volumes of out of specification feed.	3	3	6	1	2	3	± 1	Y	N	N		No												
	Biological Hazard: Blockage upsteam of plant causes overflow	Upstream plumbing (by others) designed to comply with AS3500. Upsstream plumbing to have I/O points and gullies to facilitate contolled overflows and easy cleanout.	3	3	6	1	2	3	± 1	Y	N	N		No												
2. Inlet Works - Prescreen and Buffer Tank	Physical Hazard: Screen mesh blocks and causes the screen to overflow	Level transducer on screen detects prolonged high level and alarms. Screen overflows to buffer tank so there are no uncontained spills.	4	1	5	1	1	2	± 1	Y	N	N		No												
	Physical Hazard: Screen mesh fails and allows oversize material into system.	Routine weekly and monthly maintenance inspections. Heavy particles will settle in buffer tank and not make it into the rest of the treatment plant	2	3	5	1	1	2	± 1	Y	N	N		No												
	Health Hazard: Screenings need to be remove from site	Ensure appropriately experienced and licensed contractors are used for maintenance of system's. Contractors use adequate PPE to mitigate against ingestion, skin contact and inhalation. Remediate spills immediately and exclude public from the spill point until rectified.	5	3	8	1	3	4	± 1	Y	N	N		No												
	Health Hazard: Prescreen needs to be cleaned manually	Automatic sprays on pre-screen keep it clean reducing manual cleaning to once per month. Cleaning by trained operator wearing appropriate PPE.	5	3	8	1	3	4	± 1	Y	N	N		No												
	Physical Hazard: Screenings are typically heavy and need to be disposed of periodically by the operator	Appropriate screening bin selected with the ability to use manual handling aids where required. Change screenings bags frequently so the mass of each changeout is lower	5	3	8	1	3	4	± 1	Y	N	N		No												
	Environment Hazard: Odour	Screen and buffer tank are sealed and vented through the odour scrubber. Screenings are contained in an endless bag which contains odour. The endless bag can be changed without creating an odour path.	4	1	5	1	1	2	± 1	Y	N	N		No												
3. Biological Treatment Process (Anoxic tank and Aerobic bioreactor)	Chemical hazard: Presence of chemicals in the wastewater that disrupt the proper biological treatment.	pH monitoring of the influent may detect chemicals early. Each tennant is required to treat their trade waste separately before discharge from their premises.	3	2	5	1	2	3	± 1	Y	N	N		No												
	Biological hazards: Biology tank foams over due to an event which upsets the biomass	Tanks are sealed and foam will be contained within the biology tank.	3	3	6	3	1	4	± 1	Y	N	N		No												
	Biological Hazard: Potential aerosols from aeration of bioreactor leading to exposure of workers in the plant room or contamination of surfaces.	All aerated tanks are airtight and vented through an odour scrubber.	3	2	5	1	2	3	± 1	Y	N	N		No												
	Environment Hazard: Odour	Biologiy tank is aerated and less likely to cause odour than buffer tank. All tanks are sealed and vented externally through an odour scrubber.	4	1	5	1	2	4	± 1	Y	N	N		No												

Step	Potential Hazard	Preventative Measure	Likelihood	Consequence	Resid. Risk	Likelihood	Consequence	Resid. Risk	Uncertainty	Decision Tree				CCP/QCP	Critical Levels		Monitoring	Corrective Action		Records	Action Checked	By	Date	Action Checked	By	Date	Closed Out
Process unit	*Physical, chemical, biological, other*		*1 to 5*	*1 to 5*	*Likelihood + Consequence*	*1 to 5*	*1 to 5*	*Likelihood + Consequence*		*Y + N*					*Target*	*Action*	*How*	*What*	*How*	*Where*							
	Physical Hazard: Confined space.	Tanks designed so that maintenance an calibration can be undertaken without the requirement to enter the tanks. Trained personnel only to enter confined space after completing appropriate confined space entry procedure.	2	3	5	1	2	3	± 1	Y	N	N		No													
	Physical Hazard: Aerated liquid reduces ability to float in tank if person falls in	All lids and hatches secured by bolts or locks to prevent accidently falling in. Plant room only accessible to authorised personnel.	3	5	7	1	5	6	± 1	Y	N	N		No													
4. UF Membrane Filtration (membrane tank, skid and filtrate tank)	Health Hazard: Membrane integrity is compromised leading to reduced disinfection	Turbidity constantly monitored to detmine membrane integrity.	4	4	8	1	4	5	± 1	Y	Y			CCP1	Alert level t > 0.15 NTU Critical Level t > 0.2 NTU	Operator alarm is alert level triggered. If critical level is exceeded, the MOS system recirculates for a period to see if the turbidity reduces. If turbidity does not come back within range, the MOS system generates an alarm and goes into standby state.	Continous online monitoring of turbidity during filtration and reciculation by PLC and actuated valve when required.	MOS goes into standby if turbidity does not reduce during recirculation. Production resumed once cause is determined and contents in tank are within specification.	Identify cause remotely if possible. Otherwise attend site and investigate using hand held instruments and other tools as appropriate.	Service Records. Online datalogging.						
	Health Hazard: Turbidity measurement does not reflect the current state of the water because there is no flow through the instrument	Flow switch installed in the instrument loop upstream of the trubidity meter	4	4	8	1	4	5	± 1	Y	Y			CCP1	No Flow	If no flow is detected, the MOS system recirculates for a period to see if the flow returns. If flow does not retuen, the MOS system generates an alarm and goes into standby state.	Continous online monitoring of turbidity during filtration and reciculation by PLC and actuated valve when required.	MOS goes into standby if flow does not return during recirculation. Production resumed once cause is determined and contents in tank are within specification.	Identify cause remotely if possible. Otherwise attend site and investigate using hand held instruments and other tools as appropriate.	Service Records. Online datalogging.						
	Health Hazard: Turbidity instrument faults	The turbidity instrument has a built in fault relay which is wired to the PLC	4	4	8	1	4	5	± 1	Y	Y			CCP1	Instrument fault	If fault is detected, the MOS system immediately goes into standby state the MOS system generates an alarm.	Continous online monitoring of turbidity fault relay during filtration.	MOS goes into standby if fault does rectify during recirculation. Production resumed once cause is determined and contents in tank are within specification.	Identify cause remotely if possible. Otherwise attend site and investigate using hand held instruments and other tools as appropriate.	Service Records. Online datalogging.						
	Chemical Hazard: CIP requires operators to use chemicals	CIP process is automated. Chemicals are dosed into the system automatically reducing which almost eliminates the requirement for the operator to handle chemicals. Chemicals can be neutralised within the system in a similar manner before they are sent back to the head of the works. Chemicals are common in water treatement plants and can readily be handled with appropriate PPE.	3	3	6	1	3	4	± 1	Y	Y	N		No													
	Physical Hazard: Membrane installation requires manual handling	Membranes have a life expectency of >5 years so the activity is rare. The plant room has been designed to leave space to make installation and replacement safe. Two people are used to replace or install membranes.	3	3	6	1	3	4	± 1	Y	Y	N		No													
5. Ozone System	Chemical and Health Hazard: Ozone exposure and inhalation of ozone if leakage occurred	Ozone generator equipped with failure / leak detection system that automatcally shuts down oxone production of gas is detected. Plant room designed with ventilation system, so a small leak will not casue an issue before the detection system acts to shut down generation	1	3	4	1	2	3	± 1	Y	N	Y	Y	No													
	Health Hazare: Noise exposure from compressors high duty	If practical, enclose compressor in acoustic hood, PPE to be worn by operators if compressors are not enclosed.	3	3	6	1	3	4	± 1	Y	N	Y	Y	No													
6. Biological Activated Carbon (BAC) Filter	Physical Hazard: Presence of carbon fines during loading of the carbon vessel.	Operator training and use of dust mask.	3	1	4	1	1	2	± 1	Y	N	N		No													
	Physical Hazard: Loading bags of carbon into GAC	Use vacuum or "slurpee" to remove used carbon. Assign two people to the task if necessary. Use a funnel to make filling the vessel easier.	3	3	6	1	3	4	± 1	Y	N	N		No													
7. UV disinfection	Health Hazard: Excessive suspended solids material interfering with the efficiency of the UV disinfection system	UV is downstream of UF process. See UF membrane filtration section for control measures to ensure membrane integrity etc.	4	4	8	1	4	5	± 1	Y	Y	N		No													
	Health Hazard: Low UV dose leading to poor UV disinfection	UV dose contranly monitored by UV unit using flow rate, measured UVI and measured UVT. UV unit outputs dose to the PLC so it can be monitored and acted upon	4	4	8	1	4	5	± 1	Y	Y			CCP2	Alert level dose < 60mJ/cm2 Critical Level dose < 58mJ/cm2	Operator alarm is alert level triggered. Plant diverts to off spec if critical level triggered.	Continous online monitoring and diversion by PLC and actuated valve when required.	Plant automatically diverts to off-spec tank. Production resumed once cause is determined and contents in tank are within specification.	Identify cause remotely if possible. Otherwise attend site and investigate using hand held instruments and other tools as appropriate.	Service Records. Online datalogging.						
	Health Hazard: UVT is too low meaning the unit is operating ourside its validated range.	UV has inbuild UVT instrument which is used withing the device, but also ourput to the PLC.	4	4	8	1	4	5	± 2	Y	Y			CCP2	Alert level UVT < 45% Critical Level UVT < 35%	Operator alarm is alert level triggered. Plant diverts to off spec if critical level triggered.	Continous online monitoring and diversion by PLC and actuated valve when required.	Plant automatically diverts to off-spec tank. Production resumed once cause is determined and contents in tank are within specification.	Identify cause remotely if possible. Otherwise attend site and investigate using hand held instruments and other tools as appropriate.	Service Records. Online datalogging.						

Step	Potential Hazard	Preventative Measure	Likelihood	Consequence	Resid. Risk	Likelihood	Consequence	Resid. Risk	Uncertainty	Decision Tree				CCP/QCP	Critical Levels		Monitoring	Corrective Action		Records	Action Checked	By	Date	Action Checked	By	Date	Closed Out
Process unit	*Physical, chemical, biological, other*		*1 to 5*	*1 to 5*	*Likelihood + Consequence*	*1 to 5*	*1 to 5*	*Likelihood + Consequence*		*Y + N*					*Target*	*Action*	*How*	*What*	*How*	*Where*							
	Health Hazard: UV disinfection not effective due to excessive lamp age,	UV unit monitors lamp age based on actual run time. Other indicators such as UV dose offer a secondary way to monitor poor lamp performance.	4	4	8	1	4	5	± 1	Y	Y			CCP2	Alert level hours > 10,000 Critical Level hours > 12,000	Operator alarm is alert level triggered. Disinfection system goes into shutdown	Continous online monitoring and diversion by PLC and actuated valve when required.	Disinfection system geos into shutdown. Production resumed once cause is determined and contents in tank are within specification.	Identify cause remotely if possible. Otherwise attend site and investigate using hand held instruments and other tools as appropriate.	Service Records. Online datalogging.						
	Health Hazard: UV unit malfunctions or faults	UV has inbuilt monitoring that identifies warnings and faults. These outputs are monitored by the PLC so the status of the UV unit is knonwn at all times	4	4	8	1	4	5	± 1	Y	Y			CCP2	Instrument Fault	Operator alarm is alert level triggered. Disinfection system goes into shutdown	Continous online monitoring and diversion by PLC and actuated valve when required.	Disinfection system geos into shutdown. Production resumed once cause is determined and contents in tank are within specification.	Identify cause remotely if possible. Otherwise attend site and investigate using hand held instruments and other tools as appropriate.	Service Records. Online datalogging.						
	Health Hazard: Flow rate through UV unit takes the unti outside validated range, or doesn't provide sufficient UV dose	Flowmeter immediately downstream of the UV monitors flow.	4	4	8	1	4	5	± 1	Y	Y			CCP2	Critical Level flow > 385 L/min	Operator alarm is alert level triggered. Disinfection system goes into shutdown	Continous online monitoring and diversion by PLC and actuated valve when required.	Disinfection system geos into shutdown. Production resumed once cause is determined and contents in tank are within specification.	Identify cause remotely if possible. Otherwise attend site and investigate using hand held instruments and other tools as appropriate.	Service Records. Online datalogging.						
	Physical Hazard: UV lamps are harmful to humans if viewed directly	UV unit is completely sealed so that no light is visible during operation. UV is designed so that the power cable must be removed to access the lamps. This prevents accidentally accessing the lamps while that are lit.	4	4	8	1	4	5	± 1	Y	Y	N		No												
	Environmental Hazard: UV lamps are harmful if not disposed correctly	Dispose of used UV lanmps at an appropriate disposal site.	2	2	4	1	1	1	± 1	Y	Y	N		No												
8. Chlorine disinfection (chlorine, dosing pump)	Health Hazard: Insufficient chlorine or chlorine is too high and may cause harm.	System designed to meet minimum Ct in relevant legislation Contact tank designed so that minimum Ct is always achieved Free residual chlorine monitoring	3	2	5	1	2	3	± 1	Y	Y			CCP3	Alert Level pH < 6.5 pH >8.5 Critical Level pH < 6.0 or FRC > 9.0	Operator alarm is alert level triggered. Plant diverts to off spec if critical level triggered.	Continous online monitoring and diversion by PLC and actuated valve when required.	Plant automatically diverts to off-spec tank. Production resumed once cause is determined and contents in tank are within specification.	Identify cause remotely if possible. Otherwise attend site and investigate using hand held instruments and other tools as appropriate.	Service Records. Online datalogging.						
	Biological Hazard: Treated Water outside of target pH range	On-line treated water pH monitoring. pH correction installed as part of the plant.	1	3	4	1	2	3	± 1	Y	Y			CCP3	Alert Level pH < 6.5 pH >8.5 Critical Level pH < 6.0 or FRC > 9.0	Operator alarm is alert level triggered. Plant diverts to off spec if critical level triggered.	Continous online monitoring and diversion by PLC and actuated valve when required.	Plant automatically diverts to off-spec tank. Production resumed once cause is determined and contents in tank are within specification.	Identify cause remotely if possible. Otherwise attend site and investigate using hand held instruments and other tools as appropriate.	Service Records. Online datalogging.						
	Health Hazard: Equipment failure in the chlorine loop means current reported reading of pH or chlorine is not accurate	Monitor the flow through the instrumentation loop to ensure it is continuous. Monitor the instrument status	3	2	5	1	2	3	± 1	Y	N	Y	Y	CCP3	Flow through recirc loop must be continuous. Instrument must always be healthy.	Plant diverts to off spec if critical level triggered.	PLC monitors flow switch mounted in instrument cell and fault signal from the field instrument	Plant automatically diverts to off-spec tank. Production resumed once cause is determined and contents in tank are within specification.	Identify cause remotely if possible. Otherwise attend site and investigate using hand held instruments and other tools as appropriate.	Service Records. Online datalogging.						
	Health Hazard: Insufficient disinfection because due to variations in temperature.	On-line temperature monitoring, calculate CT for ambient temperature around storage tanks.	3	2	5	1	2	3	± 1	Y	Y			CCP3	Alert level t < 16 deg C Critical Level t < 15 deg C	Operator alarm is alert level triggered. Plant diverts to off spec if critical level triggered.	Continuous online Tepmerature probe.	Plant automatically diverts to off-spec tank. Production resumed once cause is determined and contents in tank are within specification.	Identify cause remotely if possible. Otherwise attend site and investigate using hand held instruments and other tools as appropriate.	Service Records. Online datalogging.						
	Health Hazard: Required Ct is not met because flows are too high, chlorine is too low	Chlorine contact is in a pipe of fixed volume which fixes one variable in the calculation. Flowmeter upstream of the contact tank and chlorine levels allow Ct to be calculated constantly in the PLC	3	2	5	1	2	3	± 1	Y	Y			CCP3	Alert level Ct < 4.2 mg.min/L Critical Level Ct < 4.0 mg.min/L	Operator alarm is alert level triggered. Plant diverts to off spec if critical level triggered.	Continuous online calculation from flowmeter and chlorine probe.	Plant automatically diverts to off-spec tank. Production resumed once cause is determined and contents in tank are within specification.	Identify cause remotely if possible. Otherwise attend site and investigate using hand held instruments and other tools as appropriate.	Service Records. Online datalogging.						
9. Distribution System and Storage Tanks (lines, end use, Off-spec tank)	Health Hazard: Improper use of recycled water.	Education program for occupants. Lilac coloured pipes and fittings. Signage indicating recycled water usage. No taps accessible to the public.	3	2	5	1	2	3	± 1	Y	Y	N		No												
	Health Hazard: Long period until use and all residual chlorine consumed	Chlorine is monitored in the treated water recirculation loop. Plant diverts to off spec tank if chlorine out of range.	3	2	5	1	2	3	± 1	Y	N	Y	Y	QCP1	Alert Level FRC < 0.6mg/L or FRC > 4.6mg/L Critical Level FRC < 0.5mg/L or FRC > 5.0mg/L	Operator alarm is alert level triggered. Plant diverts to off spec if critical level triggered.	Continous online monitoring and diversion by PLC and actuated valve when required.	Plant automatically diverts to off-spec tank. Production resumed once cause is determined and contents in tank are within specification.	Identify cause remotely if possible. Otherwise attend site and investigate using hand held instruments and other tools as appropriate.	Service Records. Online datalogging.						
	Health Hazard: pH drifts out of specification	pHis monitored in the treated water recirculation loop. Plant diverts to off spec tank if chlorine out of range.	1	3	4	1	2	3	± 1	Y	N	Y	Y	QCP1	Alert Level pH < 6.5 pH >8.5 Critical Level pH < 6.0 or FRC > 9.0	Operator alarm is alert level triggered. Plant diverts to off spec if critical level triggered.	Continous online monitoring and diversion by PLC and actuated valve when required.	Plant automatically diverts to off-spec tank. Production resumed once cause is determined and contents in tank are within specification.	Identify cause remotely if possible. Otherwise attend site and investigate using hand held instruments and other tools as appropriate.	Service Records. Online datalogging.						
	Health Hazard: Equipment failure in the chlorine loop means current reported reading of pH or chlorine is not accurate	Monitor the flow through the loop to ensure it is continuous. Monitor the instrument status	3	2	5	1	2	3	± 1	Y	N	Y	Y	QCP1	Flow through recirc loop must be continuous. Instrument must always be healthy.	Plant diverts to off spec if critical level triggered.	PLC monitors flow switch mounted in instrument cell and fault signal from the field instrument	Plant automatically diverts to off-spec tank. Production resumed once cause is determined and contents in tank are within specification.	Identify cause remotely if possible. Otherwise attend site and investigate using hand held instruments and other tools as appropriate.	Service Records. Online datalogging.						
	Biological Hazard: Delivery pipes and fittings leaking or burst leading to uncontained spill	Plumbing installed according to AS/NZS 3500:200. Any leaks reported to Bulding management according to tennant information brochure.	2	3	5	2	3	5	± 1	Y	N	N		No												
10. Sludge Handling including WAS Tank	Biological Hazard: Handling of sludge	System is fully automatic and does not require the operator to come into direct contact with sludge. Disposal bins will be designed so they can be handled with appropriate manual handling device.	2	3	5	1	2	3	± 1	Y	N	N		No												
	Environmental Hazard: Odour	Waste activate sludge does not typically have a strong odour. Dewatering system is vented through the odour scrubber.	2	2	4	1	2	3	± 1	Y	N	N		No												

Step	Potential Hazard	Preventative Measure	Likelihood	Consequence	Resid. Risk	Likelihood	Consequence	Resid. Risk	Uncertainty	Decision Tree				CCP/QCP	Critical Levels		Monitoring	Corrective Action		Records	Action Checked	By	Date	Action Checked	By	Date	Closed Out
Process unit	*Physical, chemical, biological, other*		*1 to 5*	*1 to 5*	*Likelihood + Consequence*	*1 to 5*	*1 to 5*	*Likelihood + Consequence*		*Y + N*					*Target*	*Action*	*How*	*What*	*How*	*Where*							
	Chemical Hazard: Chemical handling	Chemicals stored and bunded appropriately to prevent spills. PPE as per SDS to be used by operators.	3	3	6	1	3	4	± 1	Y	N	N		No													
11. Potable Backup Supply	Health Hazard: Contamination from cross connections	Coloured pipe to differentiate recycled water network. Education of plumbers through site inductions. Cross connection audit by installation plumbers.	3	5	8	1	5	6	± 1	Y	N	N		No													
	Biological Hazard: Reverse flow	RPZ installed on potable topup supply Airgap between fill point and highest water level in treated water storage tank.	3	4	7	1	4	5	± 1	Y	N	N		No													
12.General	Environmental Hazard: Noise polution disrupting users and residents.	Select equipment to be below 80dB(A) where possible; Louder equipment to be installed in plant room; Use of acoustic hoods to attenuate noise if required eg compressors; Maintain all levels below those specified in DA	2	2	4	1	1	2	± 1	Y	N	N		No													
	Environmental Hazard: Odour	All sanitary waste venting from the upstream collection systems are in accordance with AS3500.2 plumbing code requirements to ensure odour is properly handled and vented. The treatment plant prescreen, process and storage tanks are located inside a mechanically ventilated room, so any odours that do occur are unlikely to be a problem for those using the facility. The prescreen, buffer tanks, sludge tank which are the potential odour sources, are all sealed and vented through an odour scrubber. The bioreactor uses aerobic conditions which do not generate odour, however as a precaution, these are also vented The plant room is mechanically ventilated.	3	2	5	1	1	2	± 1	Y	N	N		No													
	Environmental Hazard: Runoff off recycled water from irrigation could come into contact with people	Landscape irrigation has controlled irrigation to prevent excessive watering. Land capabilitiy study undertaken at design to determine soils irrigation capacity.	1	2	3	1	2	3	± 1	Y	N	N		No													
	Environmental Hazard: Recycled water from irrigation that could introduce contamination into the environment	No industrial waste is sent to the plant which mitigates disolved contaminants passing through the plant. Instrumentation such as pH man indicate the presence of contaminants	1	2	3	1	2	3	± 1	Y	N	N		No													
	Environmental Hazard: Overflows or spills exposing people to partially treated sewage or chemicals.	Tank sizes are designed to buffer inflows and outflows from the plant. All tanks have appropriately sized overflows directed back to the wet well. Facilities to pump out system in the event of breakdown causes high tank levels. All checmical tanks bunded with bunds compliant with Australian Standards.	3	3	6	1	2	3	± 1	Y	N	N		No													
	Biological Hazard: Operators exposed to sewage	Plant is designed so the operator has minimal contact with Operators must be experienced with sewage treatment plants prior to servicing the plant. Plant operators are vaccinated.	3	3	6	1	2	3	± 1	Y	N	N		No													
	Biological Hazard: Sudden power outages leading to the plant stopping in a state that could lead to uncontrolled discharges	Equipment designed to be fail safe where possible on power down. Plant could be configured to run off a generator if required. In the event of a wide spread outage, the premises feeding the plant are unlikely to be operational which means no feed. Wet well has some capacity for short outages.	1	2	3	1	2	3	± 1	Y	N	N		No													
	Environmental Hazard: Prolonged power outage so that the plant sits idle and plant goes septic	Aside from the possibility of some odour,, this is not foreseen to have any health effects	1	1	1	1	1	1	± 1	Y	N	N		No													
	Biological Hazard: Extreme weather (flooding) causing sewage to mix with stormwater runoff	Site not near known water sources that flood. New development would have condsidered forseeable rain events and designed drainage for them.	1	4	5	1	4	5	± 1	Y	N	N		No													
	Biological Hazard: Earthquake causing damage to tanks or equipment that results in uncontained spill	Site not kown to be prone to siesmic activity	1	4	5	1	4	5	± 1	Y	N	Y		No													
	Environmental Hazard: Fire causing toxic fumes, eg, plastic tanksor pipework burning.	No flammable goods or chemicals are used in the process which reduces the risk of fire starting. System is in an industrial state that will have appropriate fire services and hydrants should a fire break out.	1	4	5	1	4	5	± 1	Y	N	N		No													
	Physical Hazard: Servicing heavy equipment	Heavy submersible pumps installed on rails with the provision to remove them using mechanical aids	3	3	6	1	3	4	± 1	Y	N	N		No													

Step	Potential Hazard	Preventative Measure	Likelihood	Consequence	Resid. Risk	Likelihood	Consequence	Resid. Risk	Uncertainty	Decision Tree				CCP/QCP	Critical Levels		Monitoring	Corrective Action		Records	Action Checked	By	Date	Action Checked	By	Date	Closed Out
Process unit	*Physical, chemical, biological, other*		*1 to 5*	*1 to 5*	*Likelihood + Consequence*	*1 to 5*	*1 to 5*	*Likelihood + Consequence*		*Y + N*					*Target*	*Action*	*How*	*What*	*How*	*Where*							
	Physical Hazard: Plant has multiple confined spaces	Confined spaces identified. Only trained and authorised personnel to enter spaces after completing appropriate confined space entry procedures. Plant has been designed so that maintenance can be conducted without the requirement to enter tanks.	3	5	8	1	5	6	± 1	Y	N	N		No													

Appendix 5 – Penrith City Council Approval to install – pending

Appendix 6 – Aquacell Sampling Procedure

Sampling Work Instructions

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Revision	Date	Author	Amendments
2	11/05/21	Tass Meli	Full update to include new sample preparation requirements and better specify sample point disinfection process

MR160-2
Revision 2, 11 May 2021
Sampling Work Instructions

Process Step	Onsite Sampling
Objectives	The following procedure will be followed when sampling process or recycled waters from Aquacell wastewater treatment facilities that will undergo analytical quality testing including microbiological tests (typically E.coli or Faecal Coliforms). • To collect samples for physical, chemical or microbiological analysis by an external laboratory • Ensure proper sampling techniques are followed
Management Strategy	Aquacell greywater/blackwater treatment and water recycling plants are verified for effective performance on commissioning as required by the local regulator (eg: NSW Health) and/or to validate design performance. Ongoing monitoring via regular sampling is generally required in order to comply with regulations and ensure no health risks are present in recycled water reuse applications The ongoing operational performance of the system is monitored to ensure efficient operation and to protect human health and the environment. When out of specification results occur, they are addressed via the corrective action specified under the appropriate site management plan.
Health and Safety requirements	Biological hazards may be present in process waters. Use gloves safety glasses and protective clothing when sampling. Safely store the alcohol & lighter used for sample point disinfection. Make sure that you have conducted the site hazard assessment before commencing.

Process Step	Onsite Sampling
Actions – off-site preparation	Prior to the commencement of sampling; 1. Obtain sufficient sealed and unused sample bottles as provided by the testing laboratory (eg; Envirolab, ALS). Note: Microbiological sampling bottles are usually 250mL. They are supplied prestrerilised and will contain a tiny amount of Sodium Thiosulphate solution as a preservative so it is normal for moisture to be present in the sample bottle and it must be unopened until sampling. Other sample bottles vary in size (up to 1000mL) and material according to the requirements of the analysis but will be plastic in almost all applications. Larger 15L or 20L carboys may be required for Cryptosporidium of Giardia testing in infrequent test 2. Place the sample bottles in a suitable clean cool storage or esky. Carry additional sample bottles in case resampling or extra samples become necessary. 3. Place frozen freezer blocks in the esky or obtain ice or other cooling medium for the esky once samples are taken - in order to keep samples cool during transport to the laboratory. Larger or carboy sample containers are to be kept out of the sun 4. Prepare a standard chain of custody (COC) form for each sampling site. These are printed from files stored on the Aquacell server at *S:\Aquacell Service\01 Admin\Sampling results - consolidated (use S folder for ongoing monitoring)\COC* 5. Ensure you have alcohol (spray or disinfectant wipes) for cleaning the sample point 6. Ensure you have gloves, safety glasses and any other required site PPE

Actions – On-site sampling	Sampling should be done at the end of site service visits to minimise the holding time prior to sample delivery. 7. Locate the correct sampling point(s). Greywater/blackwater influent sample will be collected from the appropriate sample points. For treated water, the sample point will be a dedicated valve and open line on the recirculation loop. (Note: If no sampling point is available, treated water may be sampled directly from the filtrate discharge to the filtrate pit (eg: Kurrajong) If no direct sampling point is available and a secondary sample container is to be used to dip in tanks or other sampling method, ensure it is clean and disinfected prior to use. If applicable sample collection devices will be rinsed with ethanol then water then dried (sample container for effluent and sample bailer or peristaltic pump for influent). 8. Check that the sample point is visually clean. If not, dismantle and clean the sample point and reassemble before sampling. 9. Complete the sample bottle label including the date and time. The sample description should state the site name. 10. Wear disposable gloves and safety glasses when sampling. 11. If any micro samples are to be taken, these should be taken first. Sample via the installed sample point after disinfecting as follows; - Fully open the sample tap and allow water to flow for 10-20 seconds. This purges the sample line with fresh sample - Close the sample tap - Spray or soak the sample pipe with alcohol. Ensure the open pipe tip is well covered with alcohol. If the sample pipe is metal flame off the alcohol by quickly striking a lighter near the alcohol-soaked sample pipe. Otherwise allow alcohol to evaporate. 12. Open the sample tap and set to flow at a flowrate suitable for sample collection. Flow should be fast enough to ensure quick sample bottle filling in 3-5 seconds but not too fast such that sample splashes out of the sample bottle. 13. Hold the unopened sample bottle close to the sample flow and carefully and quickly open the lid. Keep hold of the lid without touching the inside surface. Keep the lid face down while sampling. 14. Quickly place the sample bottle under the sample stream and fill to approximately 10-20mm from the top rim. Do not rinse out or overfill the sample bottle as this will reduce or remove the preservative in the bottle. 15. Quickly place the lid back on the bottle and tighten securely ensuring the lid is not cross-threaded. 16. If you suspect sampling has not been carried out correctly, discard the sample and retake the sample in a new unused sample bottle.

Process Step	Onsite Sampling
	17. If other sample bottles are required to be filled for non-microbiological testing (such as BOD, TSS, TN, TP) these should now be taken. Micro samples should be taken first. 18. Place all sample bottles into the esky with ice bricks or ice as planned to keep samples cool. 19. Promptly deliver samples to the laboratory on the day of sampling. The chain of custody form(s) will be kept with the sample esky and final notes completed when samples are delivered to laboratory receival point staff.
Corrective action	Depending on the analysis, test results will be available in 2-8days following sampling. BOD or micro tests such as E.coli and Coliforms will generally require 5 – 8 days before sample results are available. If treated water test results do not comply with site critical specifications once received, immediately divert the treated water supply and take other response actions and notifications as required in the site management plan. Arrange for resampling and analysis as soon as possible. Investigate the cause of out of specification samples and implement remedial action as required.
Equipment	PPE; gloves, safety glasses, alcohol solution, lighter Sample bottles as specified by the laboratory. (Note that laboratories will generally accept each other's micro sample bottles if necessary.)
Reporting	Laboratories will provide sample results by email. Details of results of analytical testing must be maintained. Save sample certificates of analysis (COA) in the site service "Monitoring" folder when received. Record routine site service results in the results file stored on the Aquacell server at *S:\Aquacell Service\01 Admin\Sampling results - consolidated (use S folder for ongoing monitoring)* .

Appendix 7 – Not used

Appendix 8 – Not used

Appendix 9 – Plumbing Audit (cross connection Audit) - pending

Appendix 10 – Verification Report - pending

Appendix 11 – Operation and Maintenance Manual - pending