CHARTERS TOWERS
REGIONAL COUNCIL

DRINKING WATER QUALITY MANAGEMENT PLAN

NOVEMBER 2023

Charters Towers Regional Council
SPID 479

Drinking Water Quality Management Plan
November 2023

Revision History

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29 Nov 2023	3.1	Minor amendments	Jeff Ballard, NWM	Martin Drydale

Contents

Figures

Tables

Glossary of Terms

Abbreviation	Description
ADWG 2011	Australian Drinking Water Guidelines (2011). Published by the National Health and Medical Research Council of Australia, 2016 update.
Cfu/100mL	Colony forming units per 100 millilitres
CTRC	Charters Towers Regional Council
CTWTP	Charters Towers Water Treatment Plant
CTSTP	Charters Towers Sewerage Treatment Plant
DWQMP	Drinking Water Quality Management Plan
E. coli	Escherichia coli, a bacterium that is considered to indicate the presence of faecal contamination and therefore potential health risk
HACCP	Hazard Analysis Critical Control Points
mg/L	Milligrams per litre
NTU	Nephelometric Turbidity Units
MPN/100mL	Most probable number per 100 millilitres
RG	Ravenswood Gold
RMIP	Risk Management Improvement Plan
SCADA	Supervisory Control and Data Acquisition
WTP	Water Treatment Plant
WSP	Water Service Provider

1 INTRODUCTION

1.1 Registered Service Details

Charters Towers Regional Council (CTRC) is a registered Water Service Provider #479 under the Water Supply (Safety and Reliability) Act 2008. This Act requires that Council operate their drinking water schemes under an approved Drinking Water Quality Management Plan (DWQMP). In addition, Council also has regulatory requirements related to drinking water under the Public Health Act 2005. Subordinate regulations under both Acts also directly influence drinking water quality management.

1.2 Registered Drinking Water Schemes

CTRC is responsible for four registered drinking water schemes:

- Charters Towers
- Greenvale
- Pentland
- Ravenswood

These are shown in Figure 1-1 below.

Figure 1-1: Charters Towers Regional Council Drinking Water Schemes

The Charters Towers scheme covers most of the urban and semi-urban properties in Charters Towers, along with some industries. Some rural properties on the boundary of the urban area have been connected in the past using long, small diameter mains.

The Greenvale scheme was originally created when the town was supporting a mining operation. All properties in the town are connected. The connections are mainly urban housing with just a few commercial properties. The future population of Greenvale is very dependent on potential mining and defence activities proposed for the area and may vary significantly from the standard population projection.

The Pentland scheme was developed from the water supply system for Tancred's Cape River Meatworks, using a reliable bore field. The majority of properties in town are connected and there are some connections for rural properties along the treated water rising main.

The Ravenswood scheme was built to support a gold mining operation, with the town water system replacing the rainwater tanks that were previously used. The mine operates the system to supply water to the mine processes, the mining camp and the Ravenswood population. The future population of Ravenswood is dependent on the mining activity – cessation of mining would see a dramatic fall in population.

1.3 Populations Served

Scheme	Population[1]	Population Forecast[2]	Connections[3]		Consumption (ML/Annum)
			Residential	Non-Residential	
Charters Towers	7,979	8,396	3,756	357	2,853
Greenvale	232	239	142	17	76
Pentland	306	315	148	16	76
Ravenswood	255	263	121	20	42

Table 1-1: Populations served by CTRC water supply schemes

1.4 Application of this Plan

Table 1-2 identifies which sections of the plan are key for the different groups within CTRC. These groups make up the Operational and Management systems for the water supply schemes.

The Regulator has noted that the role of the Water Supply Provider (WSP) for the Ravenswood Scheme has been unclear due to the arrangement where Ravenswood Gold (RG) and CTRC jointly own the water supply system. This is being rectified by an agreement that will define CTRC clearly as the WSP. The agreement is yet to be signed.

Group	Section	Title	Relevance
Management	5.4	Risk Management Improvement Plan	Management and budgeting for the risk reduction items
Management	5.3	Management of incidents and emergencies	Understanding of how emergencies are to be managed
Management	5.1	Preventative Measures	Awareness of the activities that

[1] Charters Towers population is derived from the QGSO Regional Profile Projection for the statistical area whereas the townships are from the 2016 ABS Census data but have not been modified to reflect only the connected population.
[2] 2030 population forecast from the QGSO Regional Profile
[3] CTRC 2020 Annual Water Service Provider Performance Data

Group	Section	Title	Relevance
			the operators are required to carry out
Treatment Coordinator and Operators	5.4	Risk Management Improvement Plan	Follow-up and assistance in delivery of the improvements
Treatment Coordinator and Operators	5.3	Management of incidents and emergencies	Understanding how emergencies are to be managed
Treatment Coordinator and Operators	5.1	Preventative Measures	Awareness of tasks required to be performed to maintain the current risk level assessment
Treatment Coordinator and Operators	6	Operational and Verification Monitoring	List of tests and actions to be carried out
Treatment Coordinator and Operators	2	Details of Infrastructure providing the service	Improved knowledge of systems
Maintainers	5.1	Preventative Measures	Awareness of activities being performed
Maintainers	2	Details of Infrastructure providing the service	Improved knowledge of systems

Table 1-2 Application of this Plan within Charters Towers Regional Council

1.4.1 How this plan is used to manage water quality

The primary purpose of this plan is to present the water operations team with a consolidated list of measurable parameters and trigger points at which action is required to protect drinking water quality on a daily basis. The relevant sampling parameters for hazards of concern for each locality are listed in Table 1-3.

Parameter Type	Table
Charters Towers Raw Water	5-1
Charters Towers Reticulation	5-2
Greenvale Raw Water	5-3
Greenvale Reticulation	5-4
Pentland Raw Water	5-5
Pentland Reticulation	5-6
Ravenswood Raw Water	5-7
Ravenswood Reticulation	5-8

Table 1-3: Parameter Tables in this Document

2 DETAILS OF CATCHMENTS AND THE INFRASTRUCTURE PROVIDING THE SERVICE

2.1 Burdekin River Catchment

The Burdekin River has a catchment of 130,000 km^2 and services Greenvale, Charters Towers and Ravenswood. The River has complex geology but can be characterised as having volcanic, plutonic and metamorphic rock. The River can deliver annually up to 4,000,000 Tonnes of sediment into the Great Barrier Reef.[4]

During a rain event, the flow in the Burdekin River is significant. In the 2019 flood event, the flow in the river at Sellheim peaked at 1,574,668 ML/day (18 ML/s).

Upstream of Charters Towers Weir, the land is primarily used for agricultural and grazing purposes. There is some recreational use at the Charters Towers Weir (skiing) and Big Bend camping area. There is also regular recreational use at Sellheim, upstream of the Ravenswood intake.

A number of mining activities have occurred near the Burdekin upstream of Charters Towers over the years, which raises the possibility of contaminated runoff from old stockpiles.

Other than Greenvale which has a sewerage system that uses evaporation ponds, most properties in the northern reaches of the Burdekin would have septic tanks and there is little control over the maintenance and discharges from those systems.

Figure 2-1: Upper Burdekin Catchment

Water for Ravenswood is transferred into Suhrs Ck Dam, which has a 3.2 km^2 catchment comprising cattle grazing land. There is little control possible in the majority of the catchment as it is freehold land. Cattle have been observed grazing in the inner catchment, having broken through fences.

[4] Qld Dept of Science, Information, Technology and Innovation[4].

2.2 Glen Houghton Bore Field

The Glen Houghton bore field provides bore water for Pentland. It is a reliable aquifer system replenished by the Cape River when it flows. There are some cattle in the area but it is particularly used for agricultural purposes due to the reliable water source. The bores are not directly impacted by surface water flows. The bore field comprises four bores, of which only one is operational at present.

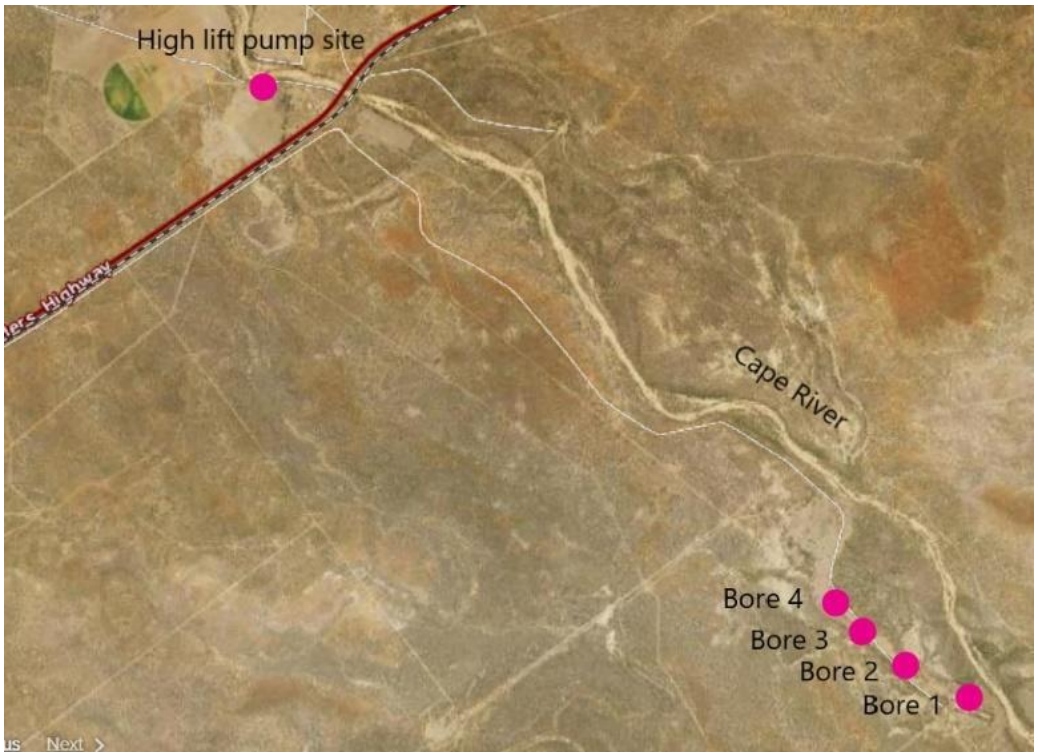


Figure 2-2: Glen Houghton Bore Field

3 DRINKING WATER SCHEMES

3.1 Charters Towers Drinking Water Scheme

3.1.1 Summary

Charters Towers has had a water supply scheme sourcing surface water from the Burdekin River since 1890. The original steam driven pump station used an infiltration tunnel under the river and pumped water to a concrete reservoir on Towers Hill. The reservoir is still in use today.

Drinking water for Charters Towers is provided via the Charters Towers Weir and pumped from the Phil Mathews pump station to the Charters Towers Water Treatment Plant (WTP). The WTP is a conventional plant utilising coagulation, flocculation, clarification, sedimentation, filtration, and disinfection. The treated water is delivered to two reservoirs, each having a common inlet/outlet. The connected population is approximately 8,520 persons.

3.1.2 Source Details

The Charters Towers scheme draws its water from the 5,227 ML Charters Towers Weir on the Burdekin River. CTRC owns an allocation of 7,500 ML per year. During times of drought, CTRC is obligated to release environmental flow through the weir, and this usually results in the introduction of water restrictions in Charters Towers.

The Charters Towers Weir has an intake structure that allows a range of water levels to be used, all of which have bar-screens to prevent the entry of large objects. The water then flows up an inclined grit settlement chamber to remove the heavier particles. The weir is shown in Figure 3-1.

Figure 3-1: Charters Towers Weir

3.1.3 Raw Water Supply System

The Weir Pump Station consists of qty 4 x 220 KW centrifugal pumps operating in a duty/duty/standby/reserve configuration on variable speed drives. Two pipelines transfer the raw water to the Water Treatment Plant (WTP). A 2.7 km long, 450 mm Asbestos Cement (A/C) main transitions to a 7 km long aboveground 375 mm mild steel pipeline which runs to the WTP. The second pipeline is a 9 km long 375 mm A/C main running direct to the WTP. The two mains meet at a booster pump station, located 3.3km before the WTP.

During the water supply upgrade project in 2020, the booster station was re- fitted with one x 90 KW booster pump on each pipeline. With the booster pumps running, the system can deliver 300L/s from the weir to the WTP.

A turbidity analyser at the weir provides an indication of raw water turbidity. Rainfall and river level information is available for upstream sites and these are used to predict increases in flow and turbidity.

Figure 3-2: Weir Pump Station

Figure 3-3: Trash Accumulation at Weir Intake after Flood Event

3.1.4 FEJ Butcher Water Treatment Plant

The original WTP was constructed in the 1970s with further additions in the 1990s. The treatment processes were reactivator/pressure filter and clarifier/gravity filter treatment trains.

In March 2020 under the Water Infrastructure Upgrade Project (WIUP) new treatment trains and dosing systems were commissioned. The old (Module 1) treatment train is still connected and able to be used as a standby system in case of failure of the new modules. The need for this spare capacity has reduced over time, and the existing Module 1 Reactivator Tank is now being refurbished and reconfigured to replace the existing Clear Water Tank, which is failing due to corrosion.

The overall plant capacity is 22 ML in 20 hours when the raw water is under 300 Nephelometric Turbidity Units (NTU).

3.1.5 Raw Water Bypass

The new plant draws water from both mains, which are interconnected within the old plant area. The 375 mm steel main continues through the plant with an actuated control valve, which allows water to bypass the treatment train to a pond from where it is pumped to the Pajingo Dam and used to supply raw water and backwash water to the Pajingo Gold Mine. All backwash water is utilised in this manner, with no backwash recycling into the WTP raw water.

3.1.6 Plant Inlet

The plant inlet pipework consists of two parallel above ground stainless steel 300 mm mains which include flowmeters, control valves, sample points and dosing points for sulphuric acid, Aluminium Chlorohydrate (ACH) and PolyDADMAC. The dosing for the ACH and PolyDADMAC is done via pumped injection to achieve a high level of mixing energy in the pipe. These pumped systems have flow detection to ensure the plant does not operate without chemical dosing. The online sampling for raw water consists of turbidity, pH, temperature and streaming current measurement. A recent improvement replaced the raw water used for chemical mixing with filtered water, to improve mixing pump capacity and life.

Figure 3-4: Plant inlet and dosing

Figure 3-5: Clarifiers and Lamella Plates

3.1.7 Clarifiers

There are 2 clarifiers consisting of twin floc chambers with floc mixers, followed by lamella plates in the main chamber. Cable driven sludge suckers are located on the floor of the clarifiers. Settled water turbidity is measured for each clarifier. The floc chambers include dose points for polyacrylamide to act as a settling aid.

3.1.8 Filters

Four gravity filters with coal, sand and garnet layers are configured with actuated inlet control and outlet filter level control. They have a backwash sequence incorporating air, low rate water and high rate water sequences and have a filter-to-waste functionality. The backwash system utilises water from the Treated Water Storage (TWS) tank and the outlet turbidity of each filter is measured on-line. The filters can be set to backwash on head using loss, turbidity or elapsed time as initialisation control.

3.1.9 Filtered Water Tank

The filter outlets are connected to an in-ground filtered water tank fitted with three submersible pumps in a duty/duty/standby configuration. These pumps lift the water into the TWS. The flow is measured just after the filtered water tank and the primary chlorine dose is injected using a static mixer. Prior to entering the TWS, the water is sampled for chlorine residual and pH. Low or high chlorine residual at this point will alarm or trip the plant.

Figure 3-6: WTP Gravity Filters

3.1.10 Treated Water Storage

This is an un-roofed 450 kL tank constructed in 1972. There is a shed over the top of the tank but it does not have a roof fixed to the walls. At the pump suction in this tank, a trim chlorine dose can be injected based on the treated water chlorine residual. At the time of writing this tank is about to be removed from the process, due to significant leakage around its base. An adjacent larger tank (Module 1) will be reconfigured to serve as the Treated Water Storage. The Module 1 storage will be covered and will also improve the pumping efficiency due to its higher top water level. The replacement tank is shown in Figure 3-8.

3.1.11 Treated Water Pump Station

The pump station consists of three 315 kW centrifugal pumps controlled by variable speed drives in a duty/duty/standby configuration. A treated water sampling system on the outlet of the pumps provides turbidity, free chlorine, and pH monitoring data. Failure of any of these parameters will stop the plant.

3.1.12 Chemical Systems

The sulphuric acid, ACH and polyDADMAC are stored in separate 15 kL storage tanks. Each dosing system has duty and standby dosing pumps for each clarifier train, with two dosing lines per system running down to the dose points. Carrier water and chemical flows are monitored to detect failure. The polyacrylamide is batched from powder and has duty and standby progressive cavity dosing pumps for each clarifier train. The chlorine system uses duty and standby 900 kg gas drums, duty and standby dosing for the primary and a single smaller dosing system for the trim.

3.1.13 Bypasses

The new WTP does not allow for the bypassing of treatment steps. There are still some bypasses built into the old plant but the primary risk, a single valve connection between the raw water and the TWS, was removed during the upgrade.

Figure 3-7: PolyDADMAC Dosing Panels

Figure 3-8: Module 1 Reactivator and Filter Tank.

Module 1 will be reconditioned to serve as the Treated Water Tank. The Filter Tank will be demolished.

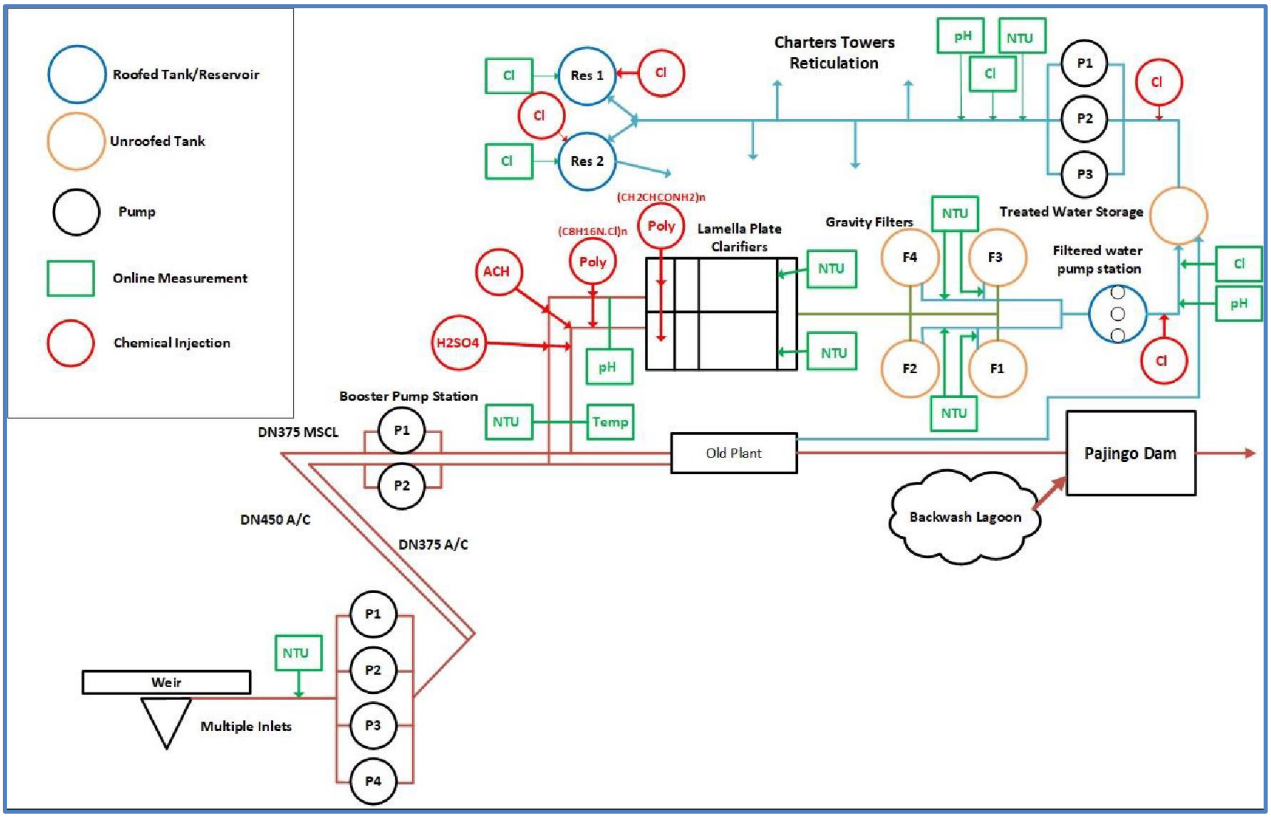


Figure 3-9: FEJ Butcher WTP Schematic

3.1.14 Rising Main

A 525 mm A/C rising main delivers treated water from the WTP to the reservoirs on Towers Hill. The rising main incorporates offtakes feeding reticulation along the way. Planning and design are in progress to duplicate this main with a storage and pump station near the Charters Towers jockey Club.

3.1.15 Reservoirs

A 9.8 ML in-ground concrete tank was constructed in the late 1800s, with the roof being added at some time after that. The concrete reservoir leaks from cracks and an attempt to increase the wall height in the 1970s resulted in leaks at the construction joint. The roof on this tank is not fully sealed although an effort was made in 2018 to seal up the ends of the roof sheeting to prevent vermin entering. This reservoir has passed the end of its life.

A 7.4 ML steel reservoir on a concrete base was constructed in the 1970s and had a new roof installed in 2017. This reservoir was refurbished with replacement floor seals in 2020. Both reservoirs operate on a single inlet/outlet. The steel reservoir has a floating mixer to prevent stagnant water and ensure adequate chlorination.

The existing configuration at the reservoirs provides for them to act only as pressure heads. This leads to potential stagnant water which is addressed by an internal circulation system and re-chlorination at the reservoirs. The total storage available is also limited by the poor connection between the existing and raised portions of the concreter reservoir wall, preventing the steel reservoir from being fully utilised.

The new rising main will be configured to flow through the steel reservoir to prevent stagnant water conditions.

3.1.16 Reservoir Re-chlorination

To address the potential for stagnant water to lose its disinfection capability, a re-chlorination system utilising calcium hypochlorite briquettes was installed in 2019. This system incorporates chlorine analysers and using a relatively low total dose, strives to maintain a set residual. The system operates

on a monitored system but at this stage is not connected to the CTRC Supervisory Control and Data Acquisition (SCADA) system. The operators perform a daily chlorine check at the reservoirs so any anomalies will be detected.

Figure 3-10: Re-chlorination system at Towers Hill Reservoirs

3.1.17 Reticulation

The reticulation system is extensive with a number of small size mains reaching out to the fringes of the town. A high percentage of the mains are composed of Asbestos Cement, and they are now at End of Life. The remainder of the pipes are polyvinyl chloride and polyethylene. Copper services feed to customer properties.

3.2 Greenvale Drinking Water Scheme

3.2.1 Summary

The town of Greenvale was constructed in the early 1970s as a support base for the Greenvale Nickel Mine. The water system was constructed by the mining company. It is estimated that up to 650 people were living in Greenvale at the time. When the mine closed in 1993 the population dropped, and the water supply system was handed over to Council.

Water is sourced from the Burdekin River from bed-sand spears. Four spears are currently installed, of which three are operational. The water is injected with chlorine for iron/manganese control before being pumped to storage where further chlorine injection is implemented for disinfection. The connected population is approximately 180 persons.

3.2.2 Source Details

Water supply for Greenvale is sourced from the Burdekin River approximately 9km north-east of town. The extraction system was installed as bed-sand spears in the form of shallow bores with stainless steel screens. Over time the river appears to have moved and most of the bores are covered by surface water. The quality of water pulled from the bores is heavily influenced by surface water conditions and there is considerable sand pumped up the main.

There have been several attempts to locate better bore sites away from the riverbed but to date, none have been found with sufficient flow available.

3.2.3 Raw Water System

The raw water is pumped up to a lift pump station on the upper bank of the river where two pumps in a duty/standby configuration pump the water via the 9 km 150 mm A/C pipeline to town.

On the outlet of the lift pumps near the river, the water was previously dosed with sodium hypochlorite from a single dosing pump. This is now turned off primarily to reduce Chlorate and other disinfection by product issues. This was intended to oxidise iron and manganese. The resultant change in pH and the level of chlorine was not monitored at this site.

The bores are located within the Burdekin River which is often subject to flooding. They are subject to surface water impact so when the turbidity in the river rises, so does the raw water turbidity. The lift pumps and switchboard are located on the bank above the flood level. The power to this location is a long line from Greenvale and is subject to disruption. There is no backup power located at the river pump station.

Figure 3-11: Greenvale bed-sand spear

Figure 3-12: Greenvale bores lift pump station

3.2.4 Greenvale Reservoir

At the reservoir site, the water first enters an activated carbon contact tank. This tank has lift pumps on the outlet, so water is pulled through the tank. The media has not been changed for many years. This tank is unlikely to be effective in removing taste and odour, but it does to a degree act as a strainer for the larger elements in the water. The turbidity is measured before and after this tank and there is usually a measurable difference. The water is then pumped, via the duty/standby pump sets, into the reservoir.

The reservoir capacity is 2.3 ML, sized to supply the original population as well as send water to the mine site. The size helps buffer the town supply against power and equipment failure in the systems. The reservoir is moderately well sealed however it is known to have a thick layer of sediment, including oxidised iron and manganese, on the floor. When the reservoir level has been dropped to a very low level the turbidity of the outgoing water is extreme.

The reservoir is fitted with a chlorine re-circulation system. A stream of outgoing water passes through an on-line chlorine analyser and is pumped back into the reservoir after the dose point to maintain a set residual in the tank. The analyser controls the recently installed chlorine gas system. Up to November 2023, the analyser a sodium hypochlorite dosing system was used but has been removed from service due to Chlorate and other disinfection by product issues. The outgoing turbidity is measured from the same water sample line.

The reservoir and chlorinator are located on a hill and therefore are not subject to flooding. There is no backup power at this location.

The total system capacity is approximately 1 ML/day.

Figure 3-13: Greenvale contact tank

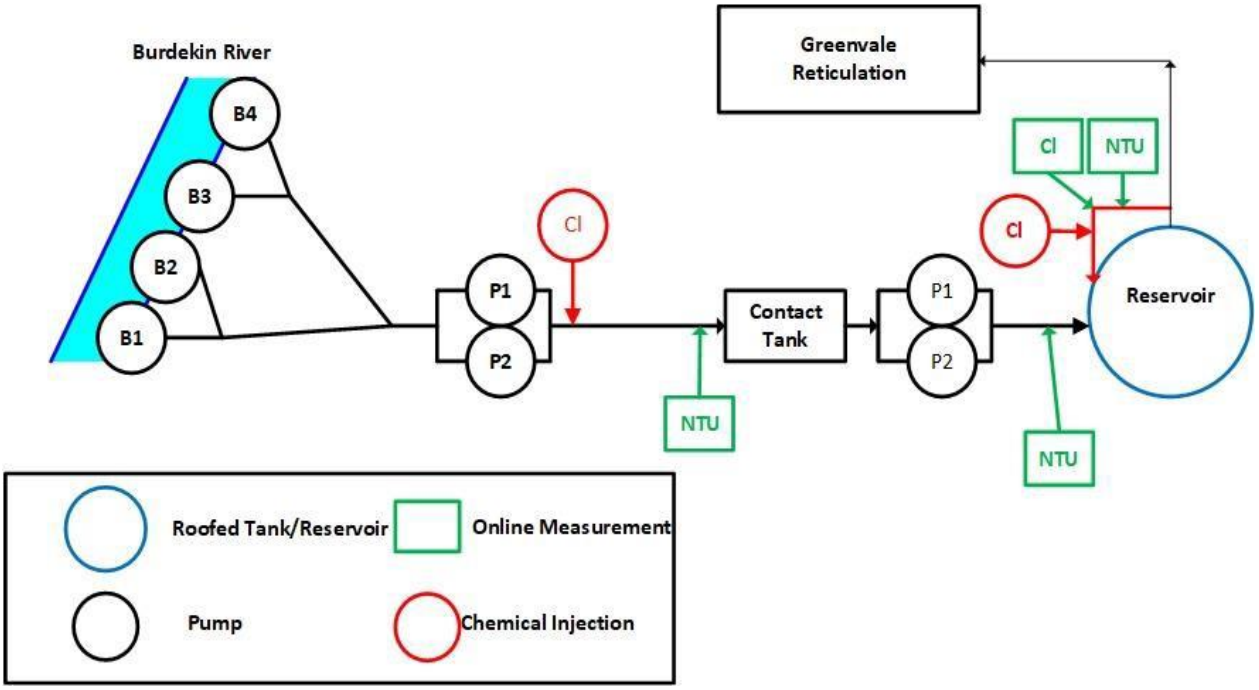


Figure 3-14: Greenvale water supply schematic

3.2.5 Greenvale Reticulation

The reticulation system consists of mostly 100mm and 150mm A/C mains and is relatively contained within the town area.

Below is a plan of the reticulation network that shows dead ends. This plan has formed the basis of a new flushing program for the township.

3.2.6 Greenvale Water Quality

The poor performance of the basic treatment system at Greenvale required Council in 2018 to declare a "Boil Water" notice for Greenvale. This Notice is still in effect and is likely to be lifted by December 2023.

As mentioned earlier, pre-treatment using Sodium Hypochlorite was used for Iron and Manganese removal and disinfection, followed by Sodium Hypochlorite at the reservoir. the pre-dosing system is now isolated from service and there is no other pre-dosing. At the reservoir site, the new chlorine gas system is now in place and the Sodium Hypochlorite system has been isolated. This overcomes the issue where Chlorates are formed from Sodium Hypochlorite degradation, particularly in hot conditions. While there is no concentration limit for Chlorate specified in the ADWG, Queensland Health has set an upper limit of 0.8 mg/L and requires Chlorate to be assessed as part of routine water quality monitoring. Council commenced analysis for Chlorate in November 2022.

In addition to the ongoing boil water notice, in December 2022, operator error of the manually controlled Sodium Hypochlorite dosing system caused elevated levels of Chlorine in the reticulation system. In addition, elevated levels of Chlorate were found in the system, and CTRC was directed by the Regulator and Qld Heath to declare the drinking water supply at Greenvale to be **non-potable**.

Council is currently supplying packaged drinking water to the community and is working with a consultant to design a replacement WTP. It is proposed that the replacement WTP will be incorporated into the upgraded water supply and sewerage systems to be installed to support the Australia-Singapore Military Training Initiative which will develop a training camp near Greenvale.

Until the new WTP is operational, an interim measure has been implemented by converting the disinfection system to gaseous chlorine as mentioned above. This has resolved the Chlorate issue, however, at certain times of the year, disinfection by products, and turbidity will still be a problem. Council aims to lift these restrictions when conditions allow, and the decision process will be based on turbidity and disinfection by product levels in conjunction with a flushing program. The flushing program is now in place. In summary, the following is a description of the main issues:

- Lack of Sufficient Barriers:
    - Raw water quality is very dynamic in colloidal content (NTUs ranging from 60 to > 3,000);
    - Final water requires a reduction to < 0.1 NTU.
- High Chlorates:
    - Gaseous Chlorine is preferred over the current Sodium Hypochlorite dosing to eliminate this issue – issue now closed;
    - A revision to the Chlorate Management Plan has been completed – issue now closed;
    - The not-for-human consumption notice will not reduce Chlorates – issue now closed;
    - Removing the sodium hypochlorite disinfectant is not considered an option even though a notice is in effect, as consumers may ignore this notice and may be exposed to microbiological risks – issue now closed.
- Chlorine Exceedances:
    - Several exceedances have occurred with one result being 11 mg/L due to operator error. The new chlorine gas system has addressed this risk – issue now closed.
- Chlorine Disinfection By-Products:
    - Trihalomethanes can be produced when chlorine reacts with organics in the water, particularly in high turbidity events. This is particularly an issue at the township due to having no clarification and filtration barrier.
- Reduction of Iron & Manganese:
    - Primary oxidation of iron and manganese is needed;
    - Removal by clarification and/or filtration is needed;
    - pH control is needed to avoid membrane fouling if this type of filter is chosen;

- Secondary trim chlorination at the reservoir to maintain potability on final water, of around 2.5 mg/L is currently required by council – issue now closed but will be reconfigured once a new WTP is built.

- Identifying and describing operational management issues and possible solutions – the current issues have been resolved, however some procedural matters may need ongoing management oversight;
- Identifying and describing a concept treatment process that will accommodate and achieve Health Based Targets for final water – this has been completed by Northern Water Management and transferred to a technical requirements schedule.

3.3 Pentland Drinking Water Scheme

3.3.1 Summary

The original Pentland water supply was sourced from a bore in Betts Ck. In 1981 the Shire Council constructed a pipeline from the Glen Houghton bore field, which is a groundwater recharge system, via the Cape River Meatworks, to a new reservoir 2 km North-West of Pentland and connected to the town reticulation system. The Cape River Meatworks is located nine km North-East of Pentland. It was established during World War 2 and ceased operation in 1989.

Two bores pump water to a small tank for settlement where water is disinfected with chlorine before reticulation to the township via a reservoir. The connected population is approximately 200 persons.

3.3.2 Raw Water System

There are four bores but only two are in use and these run in a duty/standby configuration. The isolation valves for the bores which are not in use have been tagged closed. The unused bores are not connected to power and therefore cannot be run without a significant upgrade. There is no foreseeable reason to utilise these bores as all four bores appear to be on the same aquifer.

Bores 3 and 4 have 200mm bore casings with 150mm bore pumps. Bore 3 is 20m deep and provides a flow of 11.2 L/s. Bore 4 is 21.3m deep and provides 17.2 L/s. The bore heads are raised above ground and protected from local runoff.

The bores pump through a 200 mm A/C main constructed in 1981 which runs to the High Lift Pump Station at the Meatworks site. The old Meatworks tanks are connected via a branch off this main, but the valve is isolated.

The bore field could be subject to minor flooding from the Cape River, however, the bore heads are raised and sealed. Flooding would affect the switchboard first, resulting in the pumps shutting down. There is no backup power at this site. Both active bores are on the same power line.

3.3.3 High Lift Pump Station

At the pump station, the raw water goes into two tanks. The details of these tanks are not recorded however they are approximately 100 kL each. These tanks have roofs however they are not well sealed. Both tanks have top entry and bottom withdrawal of water however one tank is taller than the other, so the outlet of the shorter tank has a non-return valve.

Two positive displacement lift pumps in a duty/standby configuration are installed. The total system capacity is approximately 0.73 ML/day.

The chlorine carrier water is drawn off on the discharge side of the pumps before the non-return valves. This water goes through a chlorine gas dosing system utilising duty/standby 70 kg chlorine cylinders. When the pumps operate, a flow is created in the dosing system which doses at the manually set rotameter rate. The carrier water is injected into the common pipe before the pumps so that it is well mixed. The carrier water line has an actuated valve linked to a pump-run signal so that the dosing cannot occur if the pumps are not running (i.e. on failure of a non-return valve) however there is a bypass around this valve.

Figure 3-15:Glen Houghton Bore No. 3

A chlorine analyser on the pump outlet will alarm or stop the pumps on low or high chlorine. The pump station is located near the Cape River and could be subject to minor flooding. With Ergon substations located on either side of the facility, power will be turned off before flooding could impact the water supply. There is no backup power at this location.

Figure 3-16: Tank at Pentland pump station

Figure 3-17: Pentland high lift pump station

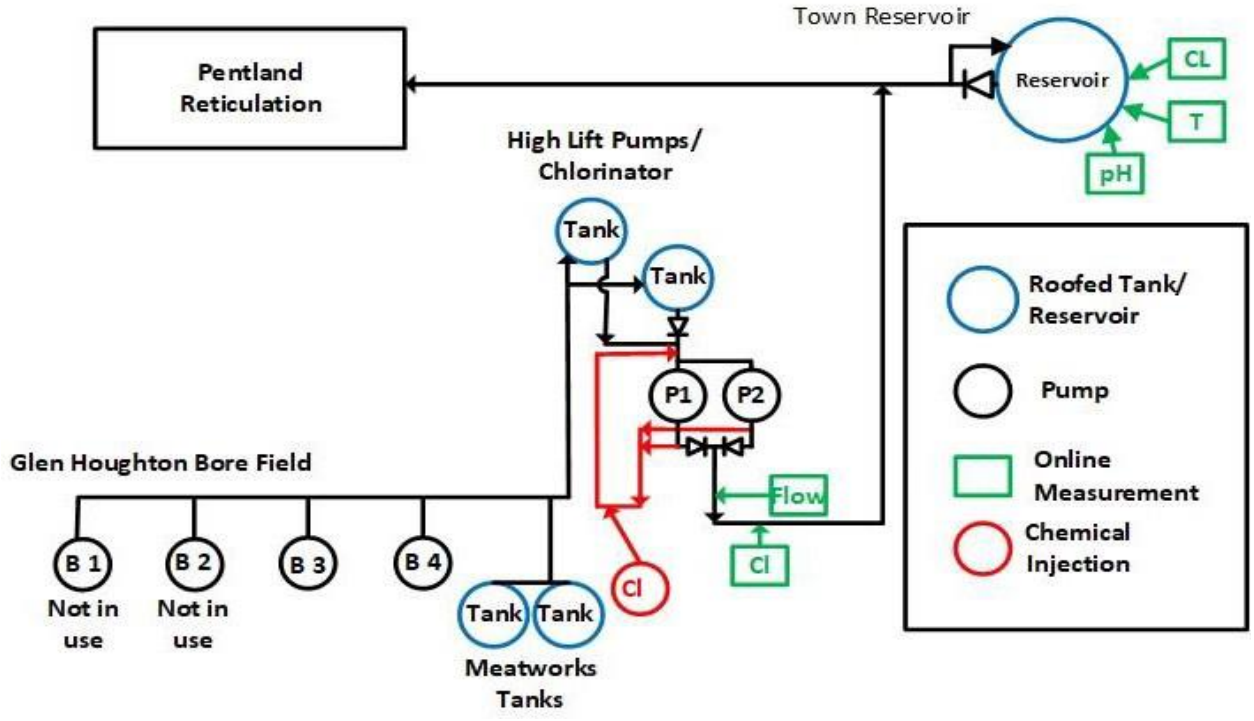


Figure 3-18: Pentland water supply schematic

3.3.4 Pentland Reservoir

The 150 mm A/C pipeline from the pump station reaches a tee where flow is provided to Pentland reticulation or up to the reservoir. The mains to the reservoir and town are 200 mm A/C.

The main to the reservoir is a single inlet/outlet however it splits with a non-return valve such that water enters over the top of the wall and exits from the bottom. There is a chlorine analyser on the reservoir monitoring free chlorine, pH, and temperature.

The 0.8 ML reservoir has a roof and for the most part is vermin proofed.

3.3.5 Pentland Reticulation

The reticulation system does not extend far beyond the town limits and consists mostly of old steel pipes and newer medium density polyethylene pipes. The main pipe providing water to the town is now near its end of life and is scheduled for replacement in the 2023-24 Financial Year.

The Tee junction arrangement at entry to Pentland is unsatisfactory as it can cause stagnant water in the reservoir when it is full, and the pumps are operating. There is also a direct residential service connection off the rising main after the Tee junction. It also causes water hammer effects on pump starts and stops. CTRC has provided funding in the 2023-24 budget to install a Pressure Regulating Valve on the town side of the Tee and reconfigure the connection to the private residence.

3.4 Ravenswood Drinking Water Scheme

3.4.1 Summary

Water is sourced from the Burdekin River by Ravenswood Gold (RG). The water is pumped to a turkey nest dam and then to Suhrs Ck Dam. Water is then pumped to the mining operations with a portion (less than 10%) diverted to a Water Treatment Plant which supplies potable water to the town and the mining operations. The connected population is approximately 200 in the township plus a variable population in the accommodation camp and the mining administration.

3.4.2 Ravenswood Raw Water System

Raw water for Ravenswood is sourced from the Burdekin River downstream of Sellheim. Both Ravenswood Gold (RG) and CTRC have extraction licences. Two river pumps are in service, and these pumps are pulled up the bank when the river is in flood. The water is pumped from the river into a turkey's nest dam, and utilising a floating intake for draw off, the water is then pumped to a balance tank from which it is pumped to Suhrs Ck Dam. If the floating intake pump fails, water can be pumped directly from the river into the balance tank. There are three pumps in a duty/duty/standby configuration at the river pump station.

There is no backup power at the river pump station or Suhrs Ck Dam. However, the pumping infrastructure from the river to Suhrs Ck Dam is not critical for daily operation as the raw water for the WTP is drawn from Suhr's Creek Dam. During parts of the year when the river flow is low, extraction is not permitted, and Suhr's Creek Dam is used to maintain supply. The water is pumped from the dam to the water treatment plant via a six pump pressure system which also pumps raw water to the Gold Mine and therefore has significantly more capacity than is required for feed water to the WTP. At the Gold Mine, the raw water flows via top entry into a holding tank, with an air break. The tank is fitted with a pressure sustaining valve on the raw water line which will act as a non-return valve.

The raw water infrastructure is owned in part by the mine and in part by Council. The treatment plant and the reticulation are owned by Council. The raw water system, the dam and the treatment plant are operated by the mine under contract. Council is currently negotiating an updated water supply agreement and asset transfer agreement with RG to ensure that all water supply assets involved in supplying potable water to Ravenswood will be owned by CTRC, to clearly define CTRC as the Water Service Provider for Ravenswood.

Figure 3-19: Suhr's Creek Dam

Figure 3-20: Suhrs Ck Dam Pump Station

3.4.3 Ravenswood Water Treatment Plant

The Ravenswood WTP has a nominal capacity of 1 ML/day however subject to raw water quality, it generally produces 0.5 ML/day, The water pumped from the dam is dosed with aluminium sulphate as the coagulant and non-ionic polyacrylamide as the coagulant aid. The polyacrylamide is batched from powder and dosed from a tank that has a stirrer. There is an option of dosing potassium permanganate upstream of the coagulant dose point for iron and manganese control. There is also an option of dosing hydrogen peroxide into the clarifier as an oxidant for iron and manganese and also as a disinfectant.

The dosed water enters a dual channel clarifier tank fitted with tube settlers and is then pumped to three pressure sand filters, and then into a treated water tank (the squat tank). Turbidity is normally measured online at the outlet of the clarifier but optionally can be measured on the outlet of each filter or the combined filtrate.

The water from the squat tank is pumped up to the header tank using duty/standby pumps. There is a recirculation flow from the header back down to the squat tank and this line has the sodium hypochlorite dosing point. The water is sampled for chlorine coming out of the squat tank and also in the recirculation line and the dose rate is determined by these readings.

A backup generator runs the lift pumps and the chlorine system which allows the volume of the squat tank to be utilised when power is cut. The WTP is not in a flood zone.

The Ravenswood raw water supply system and the WTP are operated by RG in a contractual relationship with CTRC. Those components of the raw water infrastructure owned by RG will be transferred to CTRC under the Assets Transfer Agreement and Water Supply Agreement and will likely be finalised by the end of 2023.

Figure 3-21: Ravenswood Water Treatment Plant - Inlet pipeline

3.4.4 Ravenswood Reticulation

The reticulation system is small and contained within the town limits. It consists of a mix of old and new pipes. A schematic for the Ravenswood water supply system is below.

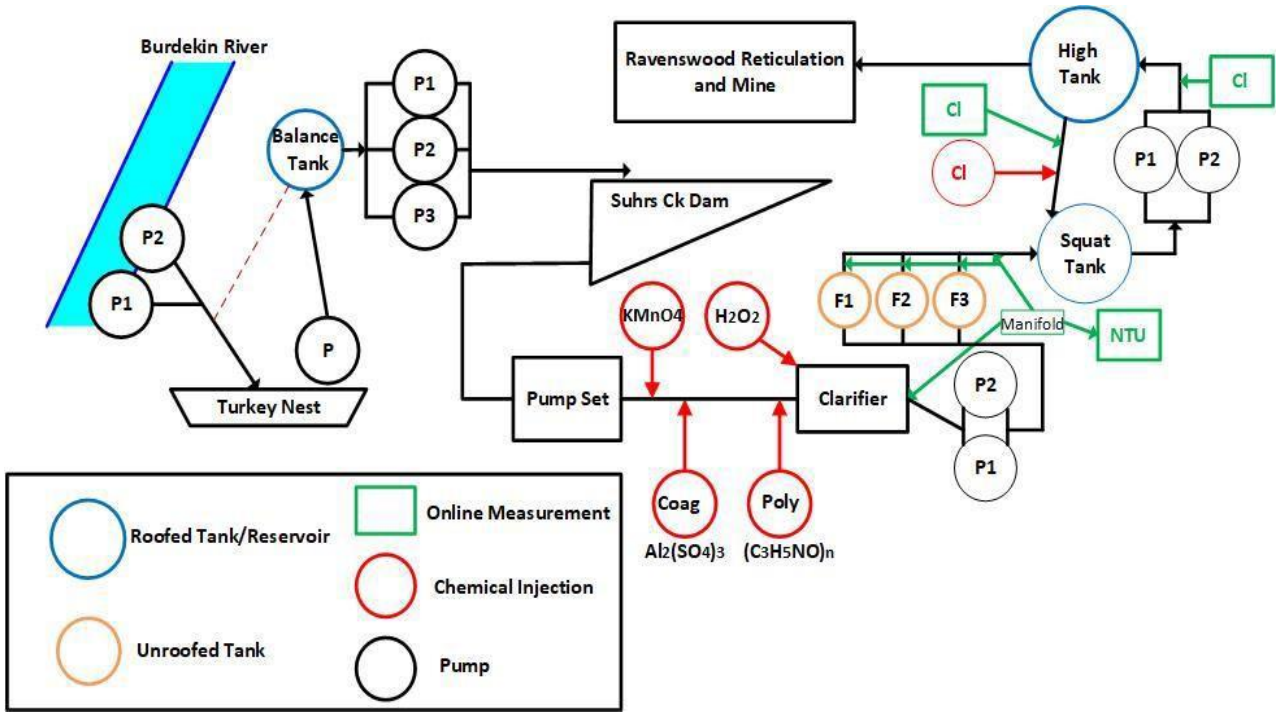


Figure 3-22: Ravenswood Water Supply Schematic

4 KEY STAKEHOLDERS FOR THE DRINKING WATER SCHEMES

The key stakeholders for the CTRC Drinking Water Schemes are listed in Table 4-1 below.

Organisation	Contact Details	Relevance	How they are engaged
Greenvale Progress Association		Represent Greenvale population on water quality issues	Via regular meetings with Council
Eventide (Qld Health)	4787 5555	Large residential aged care facility	Notices dropped in directly when a water issue may impact them
Dialysis Patients	There are currently no known home dialysis patients in the CTRC Drinking Water Scheme area.	Water quality and supply impacting treatment	Direct contacts to advise of any works that may affect the water supply
Water Treatment Services	4728 2920	Supplier of acid and flocculants and treatment assistance	As required
IXOM	1300 559 262	Chlorine gas supplier	As required
Townsville Laboratory Services	4727 8973	Principal water quality laboratory	Laboratory Services
Qld Health – Townsville Public Health Unit	4433 6900	Response to public health concerns related to drinking water	Public Health
DNRME – Drinking Water Regulator	1300 596 709	All regulatory issues regarding water quality including incident reporting	Regulator
Ravenswood Gold	4736 9100	Operator of Ravenswood Water System	Contracted service provider

Table 4-1: Key Stakeholders for the CTRC Water Supply Schemes

5 HAZARD IDENTIFICATION

5.1 Introduction

5.1.1 Methodology

A wide range of sample data has been collected over the period 2015 - 2020 and is summarised below. The assessment of this data will be utilised to identify the drinking water system hazards.

The water has been analysed against the Australian Drinking Water Guidelines (ADWG) health and aesthetic limits in order to determine what hazards would exist if they were not removed in treatment.

Each scheme has the raw water and treated water hazards identified. Raw water hazards carry through to become treated water hazards. If the hazard has never been detected in the treated water, then it will be subject to verification monitoring but is not necessarily treated as a hazard in the risk assessment.

The treatment processes can create hazards, in the form of chlorine, aluminium, acrylamide, and Trihalomethanes (THMs) along with changes in pH.

Cryptosporidium and Giardia have not been tested regularly but the assumption is that they can be present, particularly in the Burdekin River water.

5.1.2 Water Sampling

Water samples are collected by the water operators from Charters Towers. They have all been trained in collection techniques, and have received refresher training in 2021.

All testing is performed by the Townsville City Council laboratory in Townsville. Sample runs are timed to allow the samples to be couriered to Townsville such that they arrive within the required holding time.

5.2 Charters Towers Raw Water

The Charters Towers raw water results are shown in Appendix 1. In the results, exceedances are highlighted in yellow.

5.2.1 Charters Towers Raw Water Analysis

As expected for a river with a large catchment, rain events anywhere in the catchment can cause large rises in turbidity and E. coli, as shown in the graph. These results only reflect the monthly raw water samples. The WTP on-line recording of turbidity shows the excursions to be far more extensive. Only one sample has been taken for cryptosporidium and giardia with none found, however, the absence of a detection is not considered to be representative.

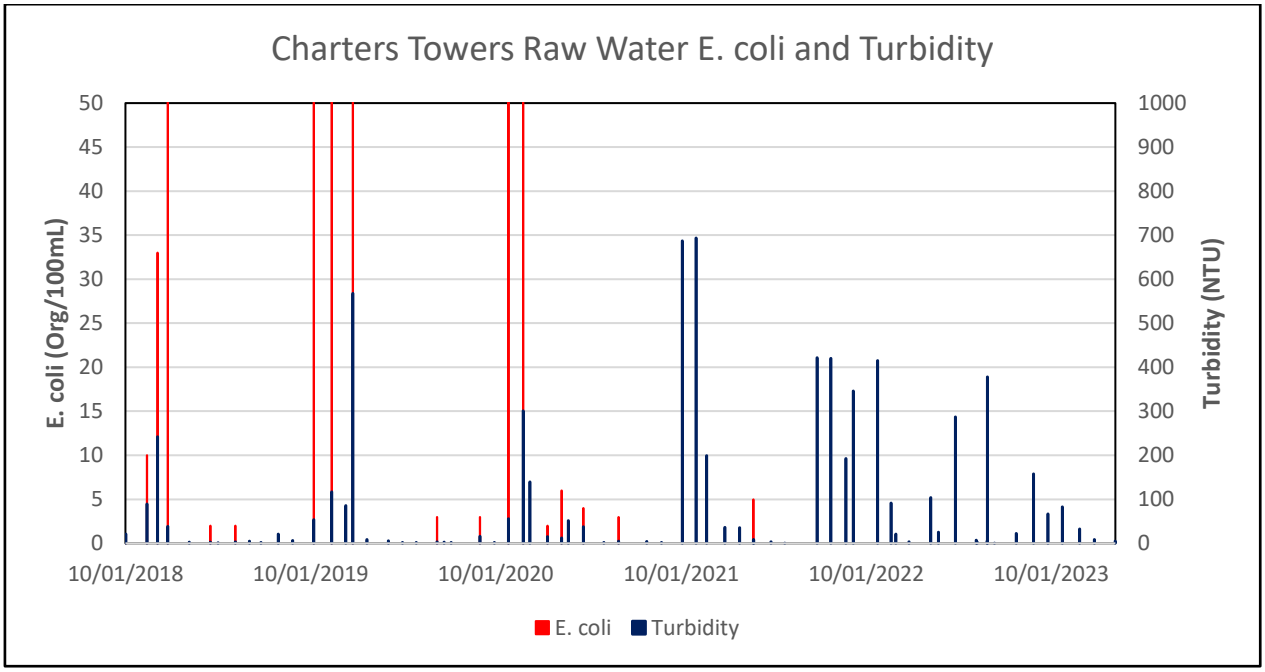


Figure 5-1: Charters Towers raw water E.coli and turbidity

The standard metals, aluminium, iron, and manganese are all in excess of ADWG limits in the raw water and while they need to be monitored, conventional treatment would be expected to remove these.

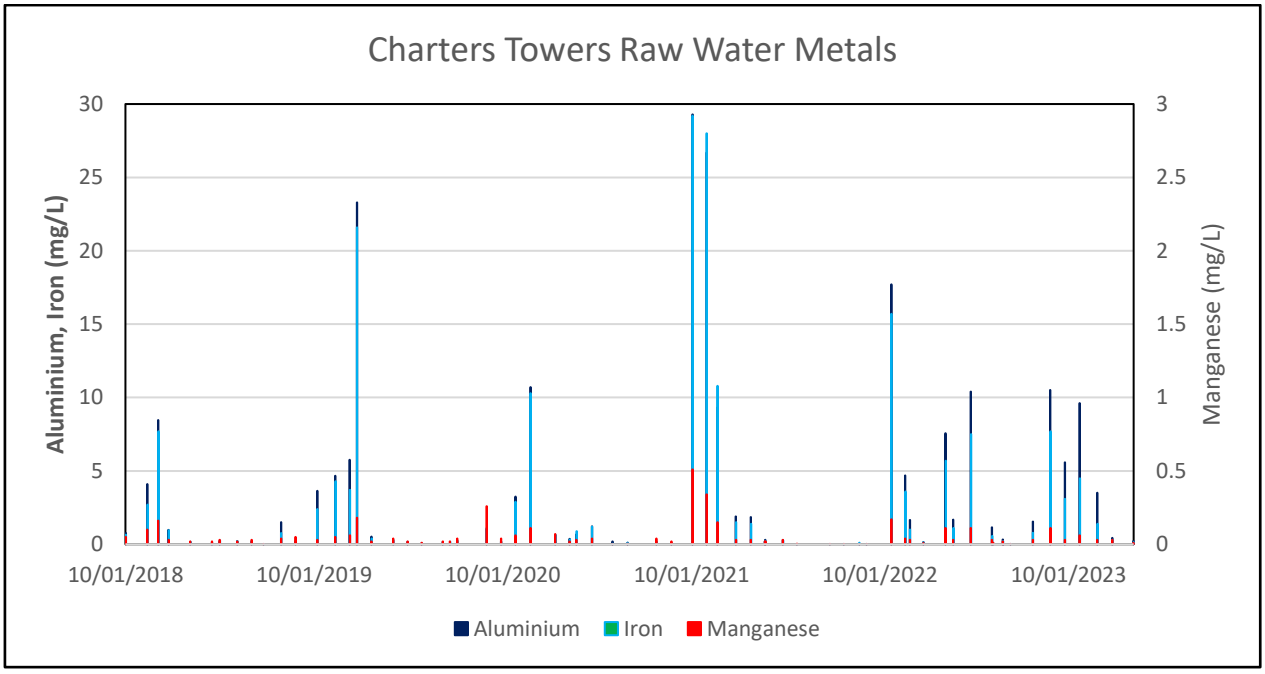


Figure 5-2: Charters Towers Raw Water - Metals Detected

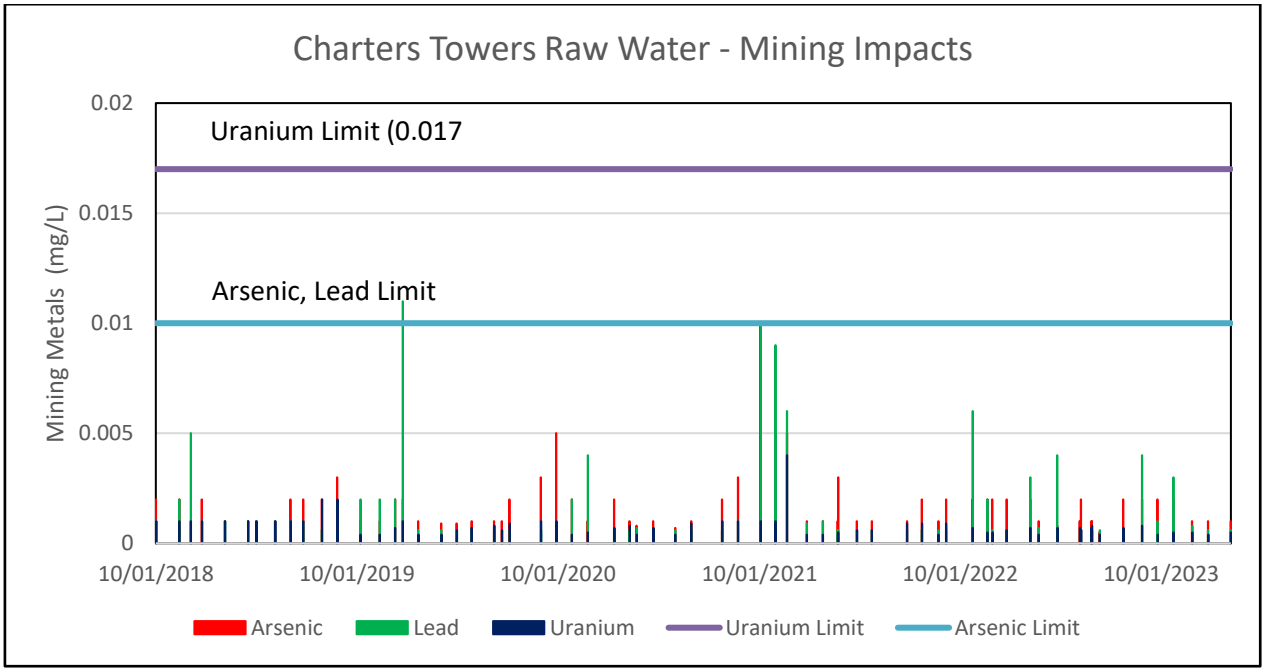


Figure 5-3: Potential Mining Impacts

With an array of mining activities upstream of Charters Towers, it would be expected that some by-products would be in the river. In particular, the abandoned Ben Lomond Mine near Townsville was feared to have been depositing lead, arsenic, and uranium into Keelbottom Ck, which flows into the Burdekin above Charters Towers. The results show that there are regular wet season increases in lead levels, but they are only marginally above the ADWG value and lead is generally removed in treatment. The measurement resolution for uranium and arsenic levels was increased in 2018. The 2019 monsoon low rain event does not appear to have had any appreciable impact on levels.

The Per- and Polyfluoroalkyl Substances (PFAS) testing conducted in 2018 did not reveal any concerns but needs to be monitored.

With significant agricultural activity up-stream there is potential for pesticides to be present however the pesticide sweep conducted in 2016 did not detect any issues. The large volume of water in the river, particularly during a rain event when pesticide residues may be washed into the river, serves to significantly reduce the concentration.

The hazards of concern in the Charters Towers raw water are listed in Table 5-1: Charters Towers Raw Water - Hazards of Concern

below.

Hazard	Frequency of detection above limits	Verification testing regime
E.coli	Often	Weekly, Monthly
pH	Often	Weekly, Monthly
Turbidity	Often	Daily, Monthly
Aluminium	Often	Monthly
Iron	Average 2 monthly	Monthly
Manganese	Rare	Monthly
Lead	Yearly	Minimum of Quarterly
Chromium	Rare	Minimum of Quarterly
Nickel	Rare	Minimum of Quarterly
Cryptosporidium, Giardia	Never (but likely to be present)	Testing not recommended – assume they are present
PFAS	Never	Annual
Pesticides	Never but could increase	Annual
Algal Products	Never	Annual or as required
Uranium	Never	Annual after the wet season
Arsenic	Never	Annual after wet season

Table 5-1: Charters Towers Raw Water - Hazards of Concern

5.3 Charters Towers Reticulation

The test results for the Charters Towers reticulation system are presented in Appendix 2. In the results, exceedances are highlighted in yellow.

5.3.1 Charters Towers Reticulation Analysis

The Charters Towers reticulation scheme has had some issues with Heterotrophic Plate Counts (HPC) regularly being detected. Improvements to the reservoir re-chlorination system and a refurbishment of the steel (No.2) Reservoir in September 2020 reduced the incidence of detections. This is shown in Figure 5-4 below. Three instances of E. coli detections (limited to 1 org/100mL) were detected in February 2022 in the reservoir and the reticulation system. Lines were flushed and Chlorine dosing and monitoring systems were checked. No recurrence of detections occurred.

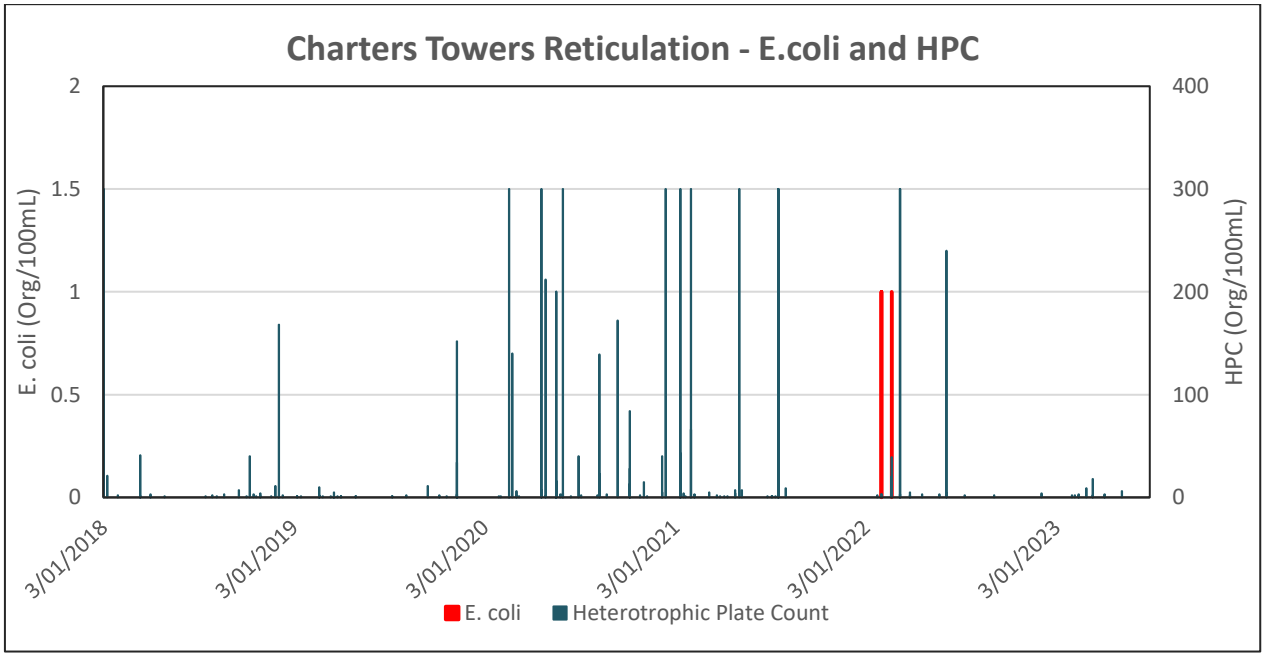


Figure 5-4: Charters Towers Reticulation E. coli and HPC counts.

There was a single high Iron reading in 2019 which may have been erroneous. Since that time the new WTP has been commissioned and it is anticipated that such occurrences will be rare.

There have been periodical high pH readings in the past, but this does not occur with the new WTP as there is acid pH correction available.

Higher than normal THM results were measured in January 2020. The raw and treated water conditions at the time were stable. This was however a few weeks after the reservoir re-chlorination system was turned on. This system not only was adding more chlorine but with extraction pumps in the concrete reservoir and a mixer installed in the steel reservoir, it is possible that settled organics were disturbed and formed trihalomethanes in contact with the chlorine. This requires ongoing monitoring.

Slightly elevated Methyl Isoborneol and Geosmin levels were detected in April 2019. With a significant flood event having occurred in February 2019 it is possible that some of these algal products were disturbed by inundation of normally dry areas.

The treatment processes have the potential to create hazards from chlorine, aluminium, pH, and acrylamide. Chlorates can be generated in the reservoir re-chlorination system.

Hazard	Frequency of detection above limits	Verification testing regime
E.coli	Rare	Weekly (Public Health Regulation)
pH	Rare	Weekly (altered during treatment)
Turbidity	Never (Aesthetic limit)	Weekly
Chlorine	Rare	Weekly (altered during treatment)
Aluminium	Never	Monthly (altered during treatment)
Iron	Rare	Monthly (from raw water hazards)
Manganese	Never	Monthly (from raw water hazards)
Lead	Never	Minimum Quarterly (from raw water hazards)
Chromium	Never	Minimum Quarterly (from raw water hazards)
Nickel	Never	Minimum Quarterly (from raw water hazards)
PFAS	Never	Annual
Pesticides	Never but could increase	Tested in raw water
Trihalomethanes	Never	Quarterly (created after treatment)
Algal Products	Never	Annual or as required
Acrylamide	Not Tested	Monthly (added during treatment)
Chlorates	Not tested	Monthly (created during treatment)
Naegleria Fowleri	Not tested	Risk in summer with low chlorine

Table 5-2:Charters Towers reticulation hazards of concern

5.4 Greenvale Raw Water

The raw water analysis for Greenvale is presented in Appendix 3. In the results, exceedances are highlighted in yellow.

5.4.1 Greenvale Raw Water Analysis

The raw water for Greenvale is drawn through bed-sand bores and is of similar quality to the surface water. The monthly verification samples do not show the worst results as typically the river intake cannot be accessed when there is a large rain event.

The E. coli results are relatively good however this is likely to be a false indication. The raw water sample is taken from a point in the vicinity of the chlorine injection and therefore the raw water E. coli results could appear to be far lower than they really are. As expected, the turbidity and E. coli increase over the wet season.

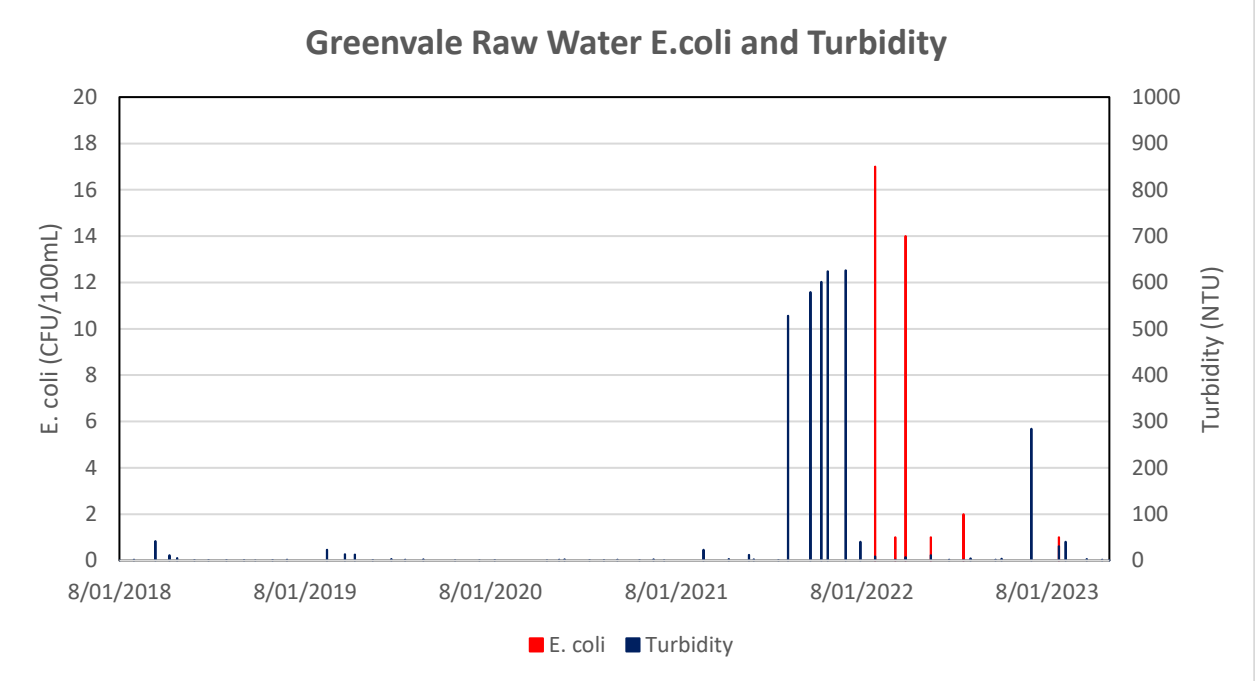


Figure 5-5: Greenvale raw water turbidity and E.coli

The metals iron, manganese and aluminium are a perennial problem in the raw water supply for Greenvale. The concentrations are almost always above the ADWG values.

Pesticide and PFAS sampling has not been identified as an issue but will require ongoing monitoring.

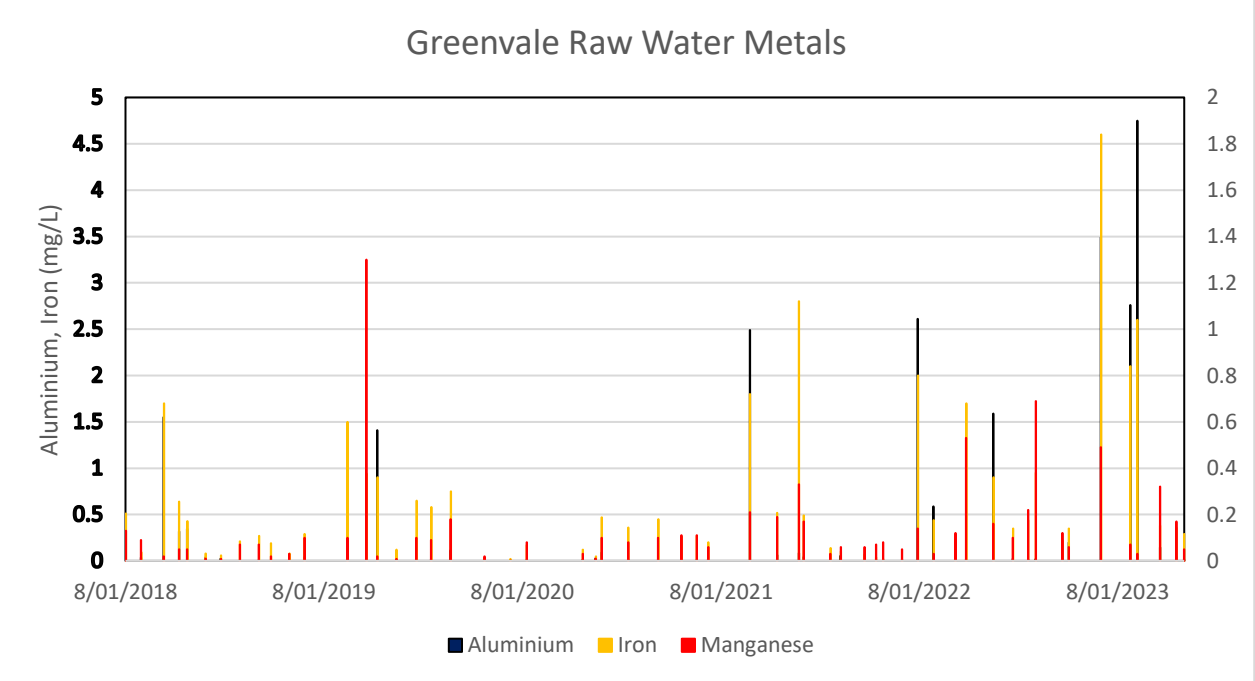


Figure 5-6: Greenvale Raw Water Metals

Hazard	Frequency of detection above limits	Verification testing regime
E.coli	Often	Monthly
pH	Rare	Monthly
Turbidity	Often	Monthly
Aluminium	Often	Monthly
Iron	Often	Monthly
Manganese	Periodically	Monthly
PFAS	Never	Annual
Pesticides	Never but could increase	Annual
Algal Products	Never	Annual or as required

Table 5-3: Greenvale raw water hazards of concern

5.5 Greenvale Reticulation

The Greenvale reticulation results are presented in Appendix 4. In the results, exceedances are highlighted in yellow.

5.5.1 Greenvale Reticulation Analysis

With poor raw water sourcing and no filtration, the turbidity and colour results for Greenvale show that not only do they breach ADWG guidelines, but the frequent incidence of turbidity above 1 NTU presents a risk of masking bacteria and protozoa from the chlorine. This situation will improve with the installation of a new water treatment facility to supply the Australia-Singapore Military Training Initiative.

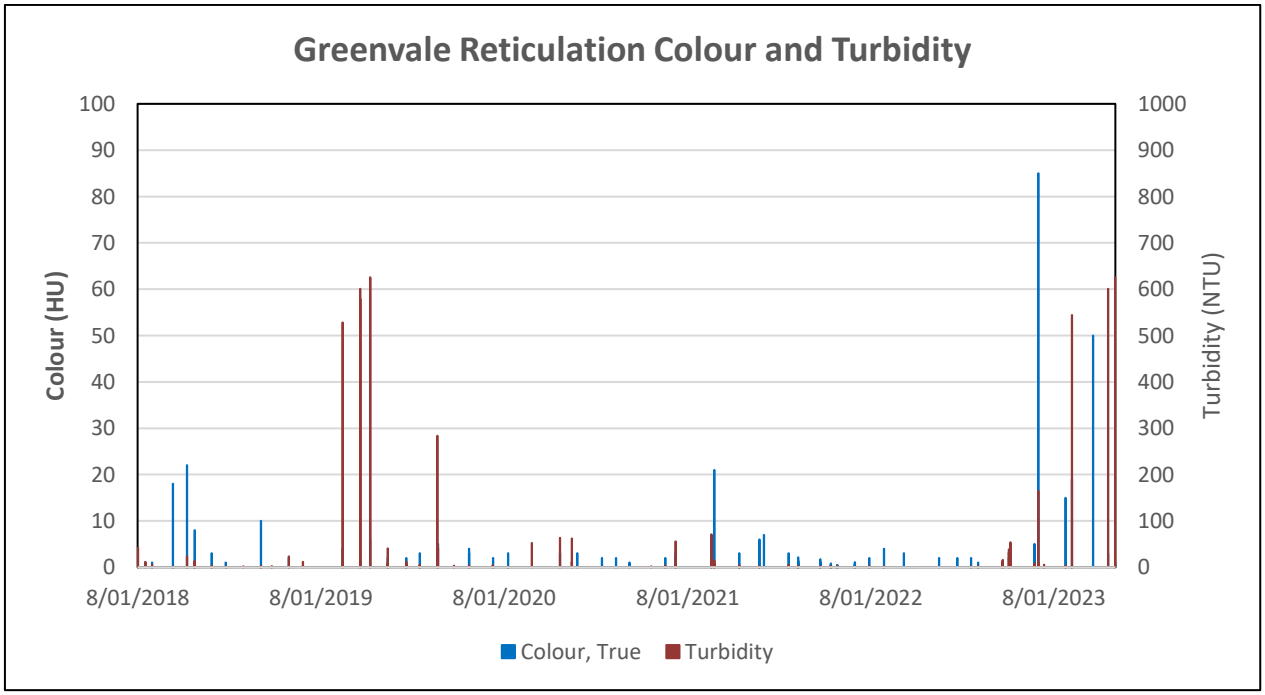


Figure 5-7: Greenvale Reticulation Colour and Turbidity

Greenvale reticulation often has HPCs but the relatively high level of chlorine prevents E. coli and faecal coliform detections.

The aesthetic limits for the metals aluminium, iron and manganese are often breached as the removal of these is primarily through settling. Any disturbance of the reservoir floor causes these levels to rise and exceed the aesthetic limits.

As would be expected with no filtration and high chlorine, the THM results are high albeit not over the ADWG limit. This needs to be monitored.

Sampling for Chlorate in the Greenvale water supply commenced in late 2020 and revealed routine Chlorate concentrations exceeding the limit of 0.8 mg/L proposed by Queensland Health. Subsequently, Greenvale water supply is now deemed Non-Potable and CTRC is supplying packaged drinking water to the community. This will continue until a replacement water supply and treatment system is established. The new system will provide much better treatment for the community.

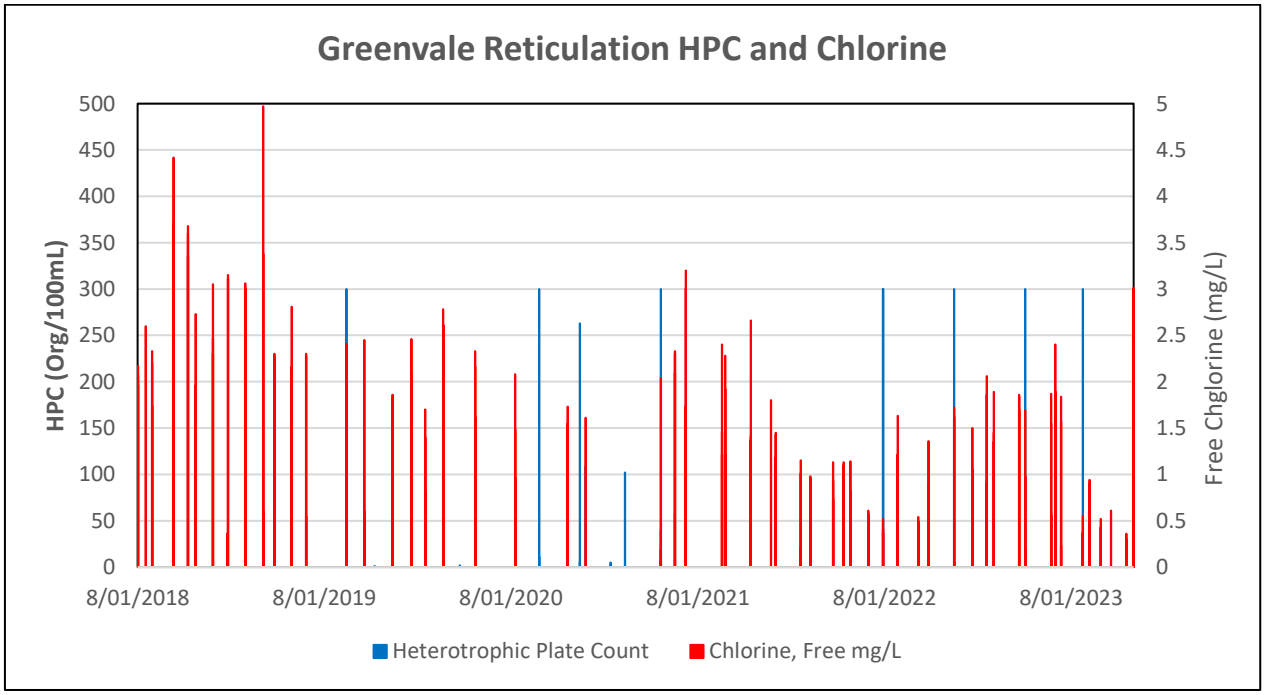


Figure 5-8: Greenvale Reticulation HPC and Chlorine

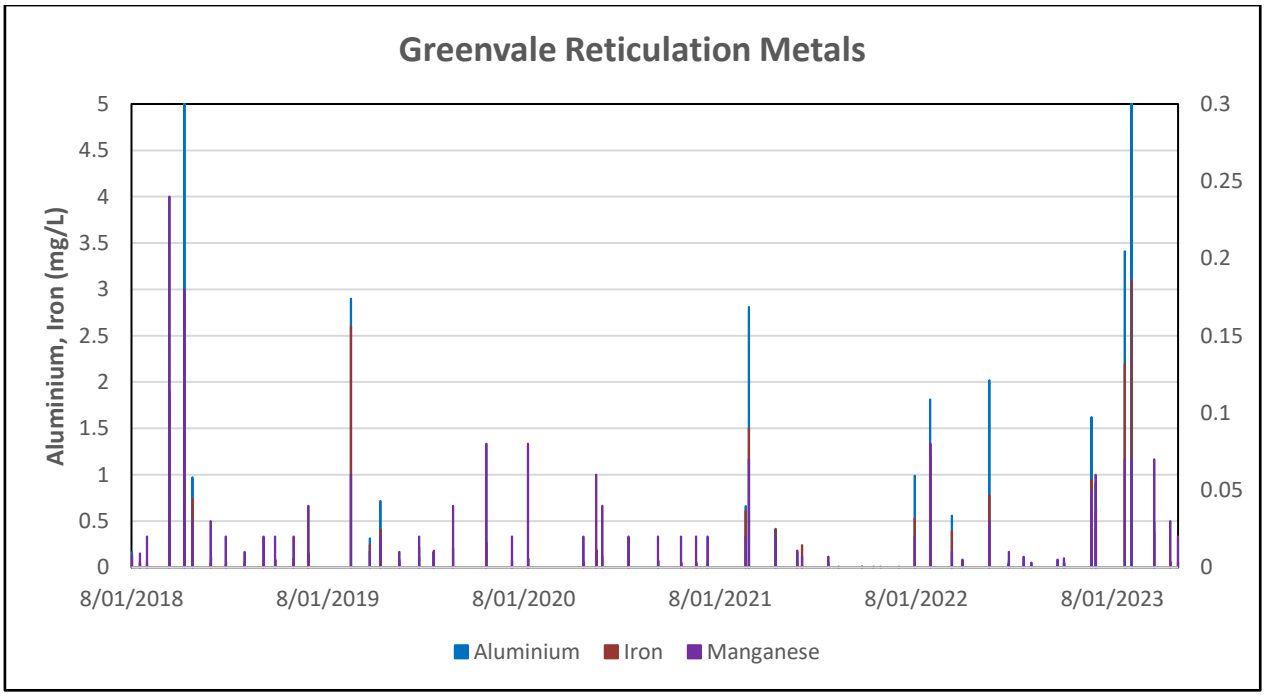


Figure 5-9: Greenvale reticulation metals

Hazard	Frequency of detection above limits	Verification testing regime
E.coli	Never	Monthly (Public Health Regulation)
pH	Rare	Monthly
Turbidity	Frequent (Aesthetic limit)	Monthly
Chlorine	Periodically	Monthly (altered during treatment)
Aluminium	Periodically	Monthly
Iron	Periodically	Monthly
Manganese	Periodically	Monthly
PFAS	Never	Annual
Pesticides	Never but could increase	Tested in raw water
Trihalomethanes	Often high but not over the limit	Quarterly (created after treatment)
Algal Products	Never	Annual or as required
Naegleria Fowleri	Not tested	Could develop in summer with low chlorine
Chlorates	Testing commenced Nov 2022	Monthly

Table 5-4: Greenvale reticulation hazards of concern

5.6 Pentland Raw Water

The Pentland raw water results are presented in Appendix 5. In the results, exceedances are highlighted in yellow.

5.6.1 Pentland Raw Water Analysis

Pentland Bores are well protected and are sourced from a reliable aquifer. The bacteriological profile is not however representative of that source. The raw water sample is taken at the bores. At this stage, the assumption is that there is biofilm in the lines of the sample taps.

At the high lift site, the raw water tanks are not well sealed so it is likely that contamination could be introduced prior to chlorination.

The turbidity and colour are not high but are probably also influenced by contamination from the tanks and the pipeline.

The metals and other contaminants often associated with bore water are not generally elevated. The PFAS testing was negative.

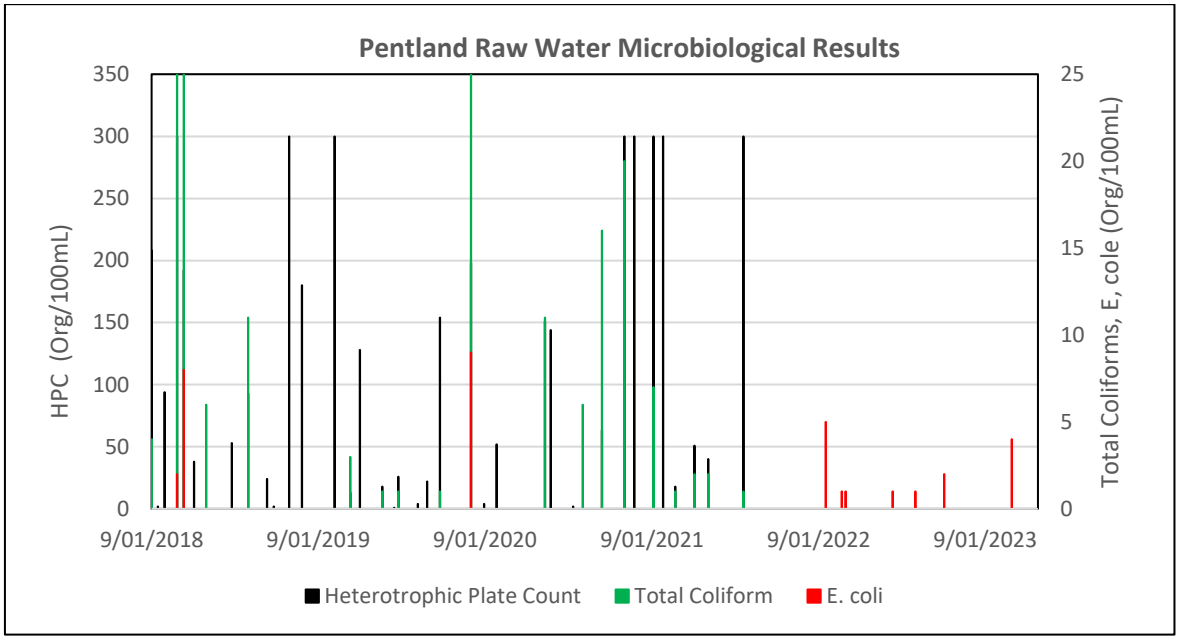


Figure 5-10:Pentland raw water microbes

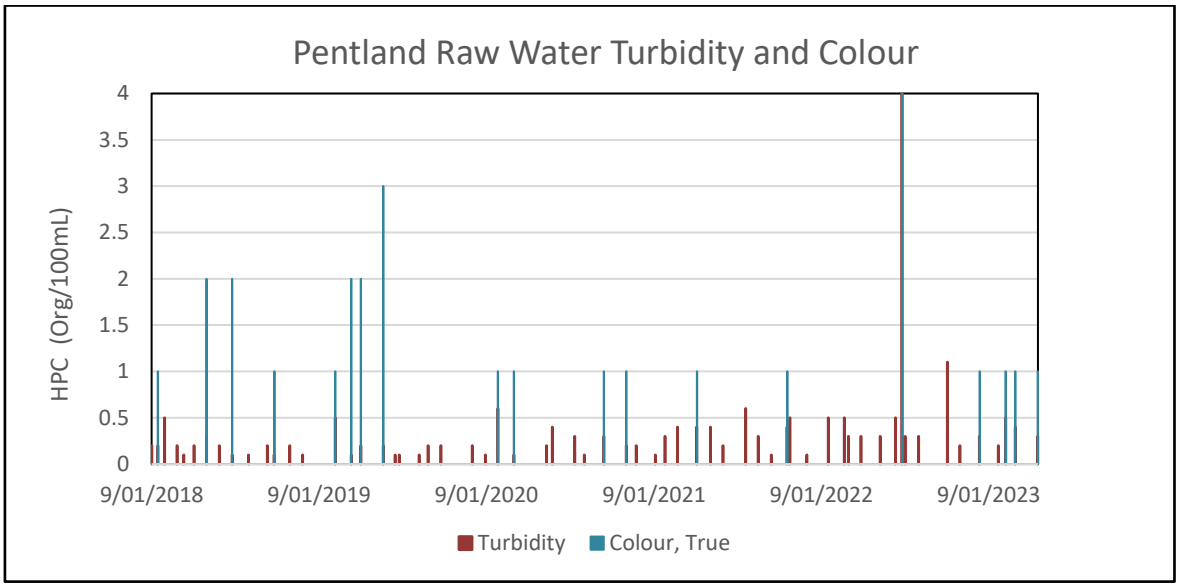


Figure 5-11:Pentland raw water turbidity and colour

Hazard	Frequency of detection above limits	Verification testing regime
E.coli	Periodically	Monthly
pH	Never	Monthly
Turbidity	Never	Monthly (monitor for changes)
Iron	Never	Monthly (monitor for changes)
Mercury	Rare	Quarterly
PFAS	Never	Annual (monitor for changes)
Pesticides	Never but could increase	Annual

Table 5-5: Pentland raw water hazards of concern

5.7 Pentland Reticulation

The Pentland reticulation results are presented in Appendix 6. In the results, exceedances are highlighted in yellow.

5.7.1 Pentland Reticulation Analysis

Despite the relatively poor condition of the raw water as it leaves the storage tanks, the Pentland reticulated water remains safe. The long chlorine contact time would be the principal driver of this result.

There are some HPC detections in Pentland. This is most likely due to long detention times. During rainy periods with the pumps off, water from the reservoir, which is lower in chlorine, can reach the slower moving parts of the reticulation system and allow the formation of microbiological elements.

There was a single high mercury reading in 2015 but all values before and after that have been below the limits. All other aspects of the Pentland treated water are under the ADWG values.

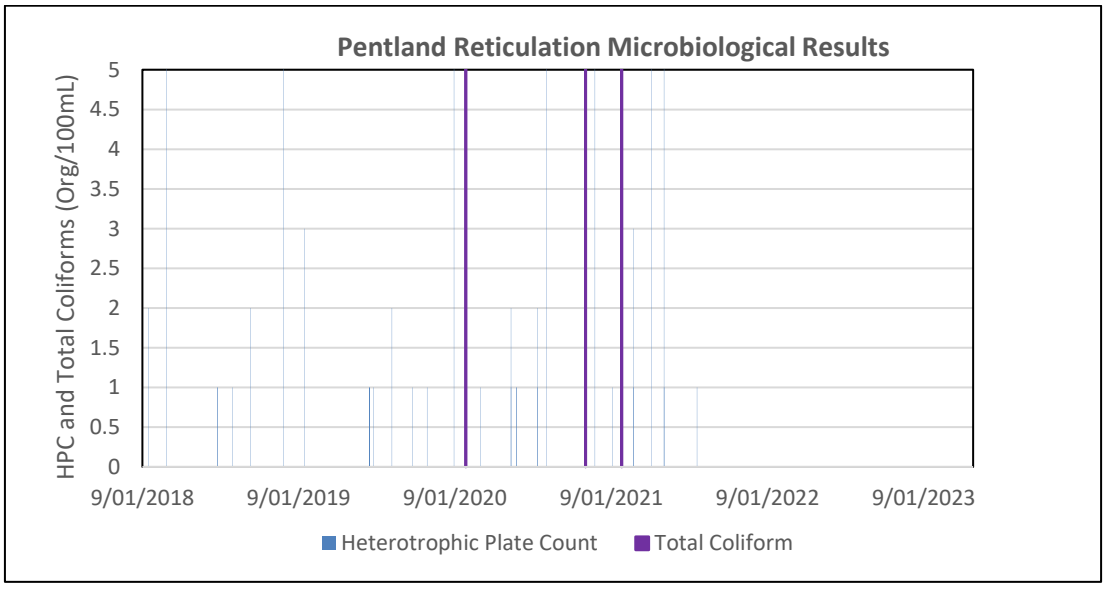


Figure 5-12: Pentland reticulation microbes

Hazard	Frequency of detection above limits	Verification testing regime
E.coli	Never	Monthly (Public Health Regulation)
pH	Never	Monthly
Turbidity	Never	Monthly
Chlorine	Periodically	Monthly (altered during treatment)
Iron	Never	Monthly (from raw water hazards)
Mercury	Rare	Quarterly
PFAS	Never	Annual
Pesticides	Never but could increase	Tested in raw water
Trihalomethanes	Never	Quarterly (created after treatment)
Naegleria Fowleri	Not tested	Could form in summer with low chlorine

Table 5-6: Pentland Reticulation Hazards of Concern

5.8 Ravenswood Raw Water

Data covering the period 2018-2023 is included in this assessment. The results are presented in Appendix 7. In the results, exceedances are highlighted in yellow.

5.8.1 Ravenswood Raw Water Analysis

The Ravenswood raw water is considerably contaminated with almost constant coliform and HPC detections. Some of this would come from the source water in the Burdekin as there is a degree of human activity upstream of this location. Cattle grazing in the vicinity of the Turkey Nest dam and Suhrs Ck Dam could also introduce contamination.

The raw water turbidity is moderately low due to the settling effect of the Turkey Nest and Suhrs Ck Dam, and the floating intake used on both the Turkey Nest and Suhrs Ck Dam.

There are moderate levels of metals in the raw water.

The mining by-product elements, lead, arsenic and uranium are all at very low levels. For the lead and uranium, this is quite likely a result of the settling effects of the dams

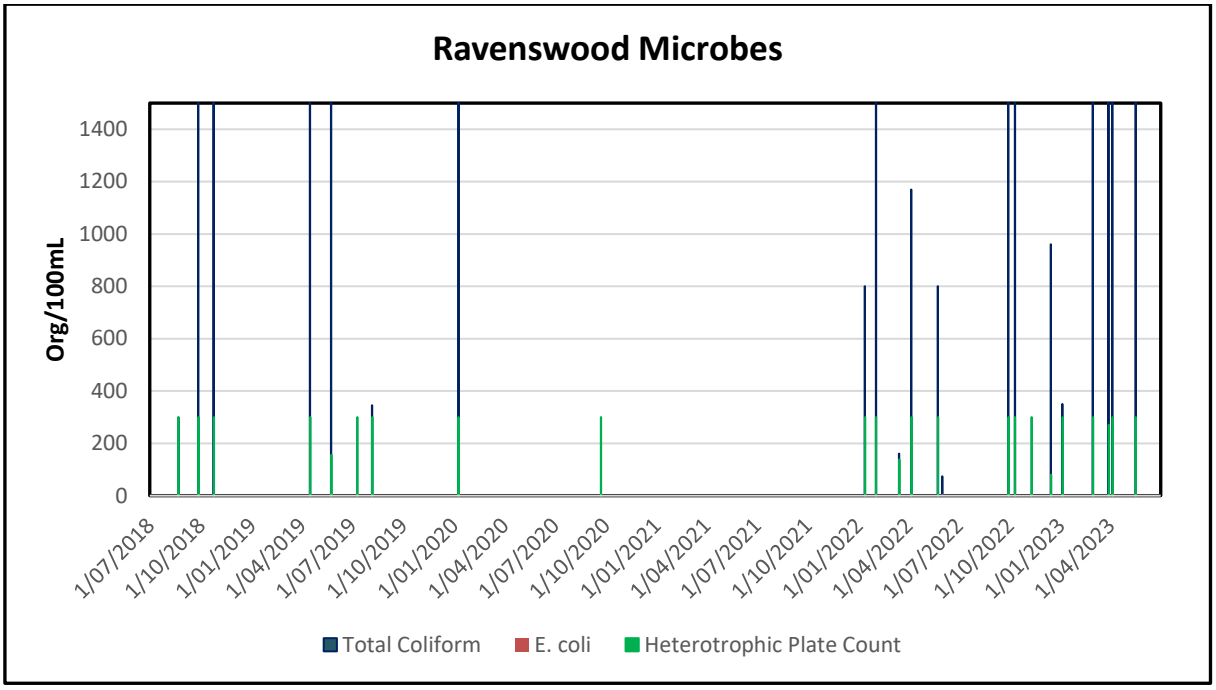


Figure 5-13: Ravenswood Raw Water Microbes

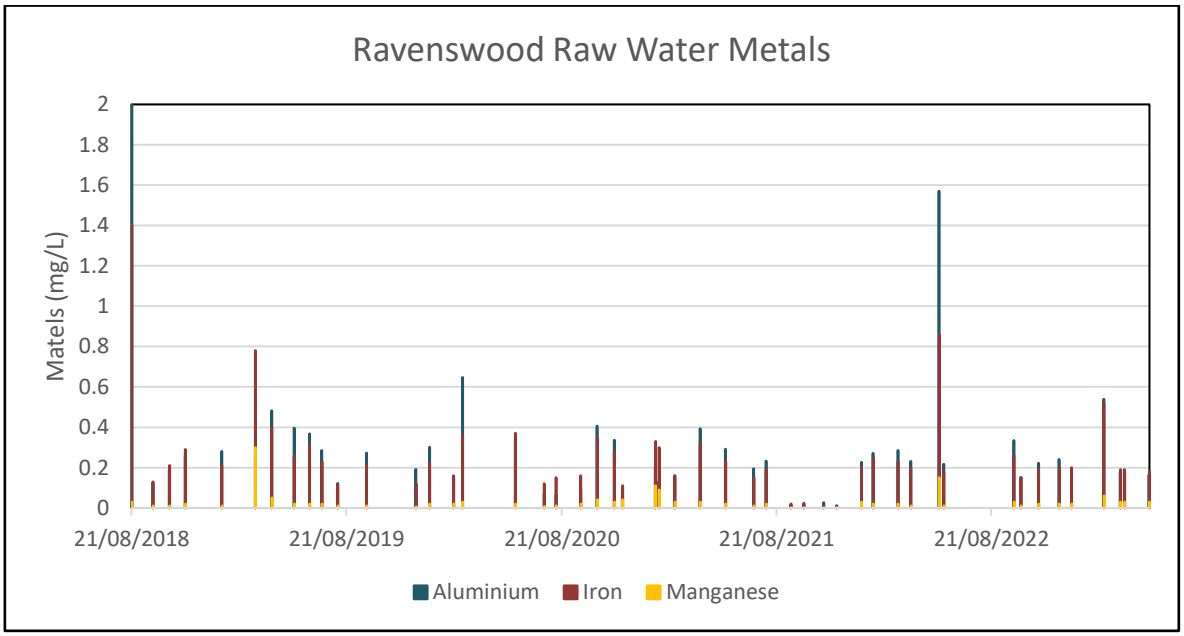


Figure 5-14: Ravenswood raw water metals

Hazard	Frequency of detection above limits	Verification testing regime
E.coli	Often	Monthly
pH	Often	Monthly
Turbidity	Often	Monthly
Aluminium	Often	Monthly
Iron	Often	Monthly
Manganese	Periodically	Monthly
PFAS	Never	Annual
Pesticides	Never but could increase	Annual
Algal Products	Never	Annual or as required

Table 5-7: Ravenswood Raw Water hazards of concern

5.9 Ravenswood Reticulation

The Ravenswood Treated Water results are presented in Appendix 8. In the results, exceedances are highlighted in yellow.

5.9.1 Ravenswood Reticulation Analysis

Despite having full treatment of clarification and filtration, the treated water quality in Ravenswood has been patchy with a number of drinking water incidents being recorded for cyanide, turbidity, and chlorine. There are detections of coliforms and HPCs on a regular basis, but it is not clear if that is from the treatment plant or slow moving water in the retic system.

The turbidity often exceeds 1 NTU in the reticulation system, presenting the risk of masking bacteria from the chlorine.

There are periodic breakthroughs of metals above the aesthetic limits.

THM levels are not above the ADWG however they are always present, indicating that there is a background level of organics in the water that is reacting with the chlorine.

Sodium hypochlorite is used for disinfection in a re-dose system, albeit there is a high rate of turnover of the header tank. There will be some chlorates in the water as a result of the hypo dosing and the rate of decay of the hypo in North Qld. The chlorate levels were not measured but will be included in sample analyses when a new Water Treatment Plant is commissioned at Ravenswood. The design of the new plant at a different location from the existing plant is almost complete at the time of writing. It is expected that it will be commissioned in mid-2024.

Council is negotiating an updated service agreement with Ravenswood Gold, to formalise reporting and water quality monitoring requirements. The agreement will be finalised when a suitable arrangement for ownership of the raw water infrastructure is signed off. This will ensure that Council is recognised as the sole Water Service Provider for Ravenswood township.

Filter management is key to ongoing quality water and has been included in the risk assessment.

Council oversight of the Ravenswood Gold WTP operations is a key issue, and an escalation process is planned and will include a flowchart. The primary basis will likely be operational site triggers such as online turbidity or chlorine, whereby the operator must notify CTRC. Where required, CTC will then notify the regulator. Recent turbidity logs for the WTP showed two days of high Turbidity (0.94 and 0.95 NTUs) leading up to and during a high turbidity event. These results were single grab samples on each day with no additional monitoring or verification sampling occurring. This is a critical issue as the system could have peaked at an unknown higher turbidity level without knowing. This is an RMIP action.

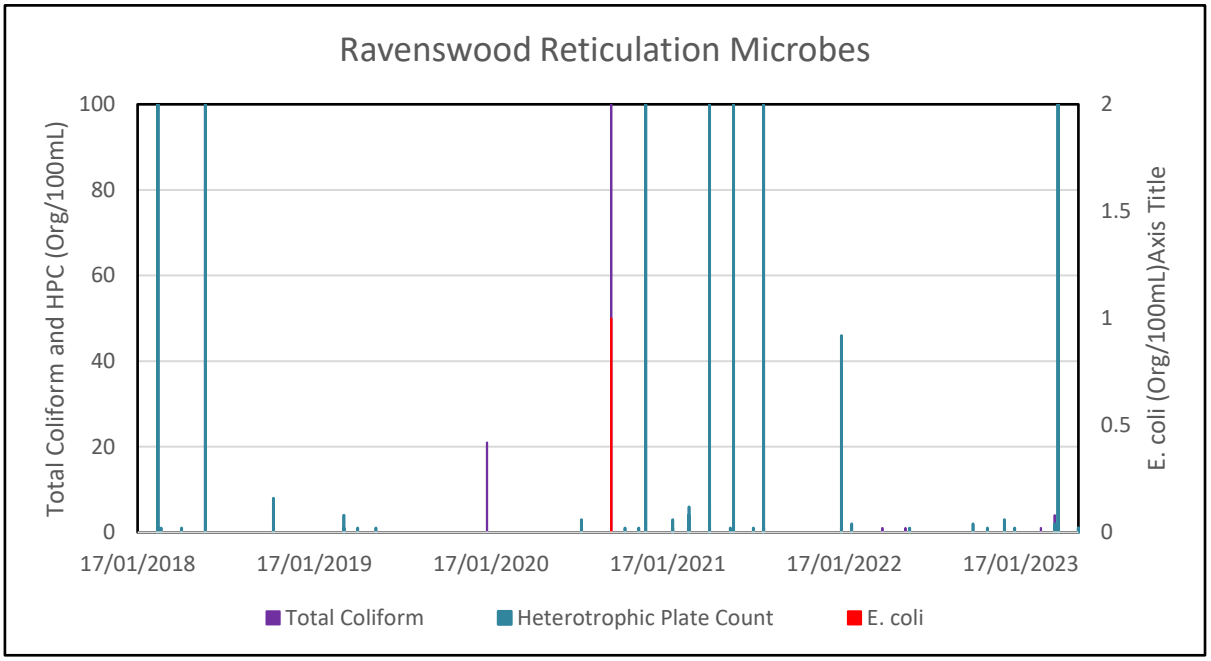


Figure 5-15: Ravenswood reticulation microbes

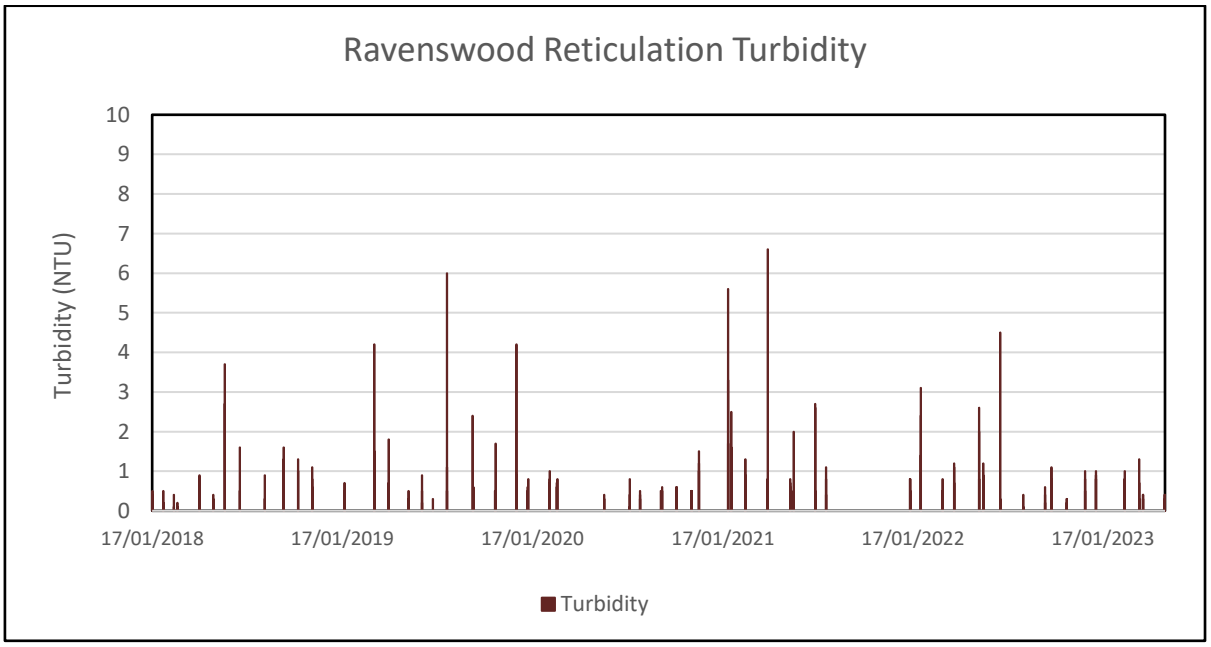


Figure 5-16: Ravenswood reticulation turbidity

Hazard	Frequency of detection above limits	Verification testing regime
E.coli	Rare	Monthly (Public Health Regulation)
pH	Rare	Monthly
Turbidity	Periodically (Aesthetic limit)	Monthly
Chlorine	Never	Monthly (altered during treatment)
Aluminium	Periodically	Monthly
Iron	Never	Monthly (from raw water hazards)
Manganese	Periodically	Monthly
PFAS	Never	Annual
Pesticides	Never but could increase	Tested in raw water
Trihalomethanes	Often high but not over the limit	Quarterly (created after treatment)
Acrylamide	Never	Monthly (added during treatment)
Algal Products	Never	Annual or as required
Chlorates	Periodically since Nov 2022	Monthly
Naegleria Fowleri	Not tested	Risk in summer with low chlorine

Table 5-8: Ravenswood reticulation hazards of concern

5.10 Customer Complaints

The majority of customer complaints received are localised problems, some of which occur on the owner's side. For the 2021/2022 financial year, there was one complaint for dirty water and one for taste and odour.

There are occasional complaints of dirty or milky water which occur after mains repairs. This has been addressed by educating the reticulation crews in maintaining water quality during repairs.

A flushing procedure will be in place before the end of 2023 for all 4 schemes.

Greenvale Progress Association has a longstanding complaint about the quality of the water in Greenvale. This is addressed in the risk assessment and improvement plan.

Currently there is no proper procedure to address customer complaints. This is addressed in RMIP.

6 RISK ASSESSMENT

6.1 Introduction

The risk assessment methodology for the CTRC Schemes has been based on Chapter 3 of the ADWG.

The hazards used are all derived from the physical and microbiological elements listed in the ADWG as suggested by the ADWG hazard process. The water quality analysis process has identified those hazards of concern for each scheme.

From the hazards and hazardous events, three outcomes are derived.

a) Ongoing actions (i.e. what should we do every day to maintain water quality),

b) Verification requirements (what should we measure to ensure that we have maintained water quality); and

c) Risk improvement items (what do we need to do to lower or remove a risk).

6.2 Hazard and Risk Assessment Team

Council has convened a Risk Assessment Team. The members of the team are listed in Table 6-1

Person	Role	Expertise and Experience
Peter Clark (Retired – replaced by Joe Galea)	Manager Water and Wastewater Reviewer of the DWQMP	Significant water industry experience in Brisbane Water, Toowoomba City Council, and water and sanitation projects in the Pacific Islands
Jake Stoll	SCADA Engineer/Treatment Co-ordinator Reviewer of the DWQMP	Many years of water industry experience particularly in control systems
Greg Smith	Technical Officer Water & Wastewater Reviewer of the DWQMP	Experienced water operator

Table 6-1: Hazard and risk assessment team

6.3 Hazards and their Consequences

The risk being assessed is that one of the hazards is present in drinking water. For that reason, the consequence used in the risk calculation is what would occur in the absence of preventative measures. The likelihood is then assessed on the ways that the preventative measures (if there are any) could fail to prevent that hazard from occurring.

This one-step calculation of risk results in numerous high or very high risks based on the consequence being the maximum consequence for that hazard. However, that is the reality of the water supply business – the ability to impact large populations very quickly.

The consequence levels for the primary hazards are listed in Table 6-2.

Hazard	Consequence	Notes
Chlorine	Moderate	Likely to be detected by users due to smell/taste. Excessive levels in drinking water are easily detected and consumers will not consume the water.
Cryptosporidium/Giardia	Major	While this has the potential to create severe ill health, the number of oocysts present in a reticulated water supply system is unlikely to be sufficient such that every household is impacted
E.coli	Catastrophic for Charters Towers. Major for other locations	Based on population impacted

Table 6-2: Primary hazard consequences

6.4 Risk Assessment Criteria

The criteria used for the risk assessment are as per the ADWG qualitative risk analysis matrix.

	Consequence	Insignificant	Minor	Moderate	Major	Catastrophic
Likelihood	Rating	**1**	**2**	**3**	**4**	**5**
Rare	**1**	Low	Low	Moderate	High	High
Unlikely	**2**	Low	Low	Moderate	High	Very High
Possible	**3**	Low	Moderate	High	Very High	Very High
Likely	**4**	Moderate	High	High	Very High	Very High
Almost Certain	**5**	Moderate	High	Very High	Very High	Very High

Table 6-3: Risk assessment ratings

6.5 Risk Assessment Worksheets

The risk assessment worksheets for each scheme are in Appendix 9 to 12.

6.6 Risk Action Plan

Based on the calculated level of risk, a number of actions can be identified. These are defined as follows:

a) Ongoing Actions – these are the actions that system operators should be carrying out to ensure that the preventative measure described will work – this links daily tasks to the observed risks.

b) Verification Requirement – these items provide the linkage between the risks and the verification plan.

c) Risk Improvement Item – these are the short or long term items that require addressing.

Level of Risk	Level of Acceptance	Priority of actions
Low	Acceptable	Monitor and implement continuous improvement
Moderate	Acceptable	Monitor and implement continuous improvement
High	Address if possible	Implement short term measures immediately. Long term items need to be budgeted for future years
Very High	Unacceptable	Implement short term measures immediately. Long Term items need to be planned in the current year.

Table 6-4: Risk Priority Actions

It must be noted that water supply to a population has inherent risk which is difficult to remove without significant expenditure. Some High-Risk items may not have an improvement item associated with them and some Very High risk items may not have interim measures.

6.7 Cyber Security Risk

The risk assessment includes the specific risks to water quality posed by cyber security threats. The overall risk to the systems that host and access the SCADA system was not able to be assessed by the DWQMP risk team. Honeypot testing suggests that the Charters Towers system is not subject to a high threat level, as the SCADA system is a separate entity from Council's internet systems, and with the exception of the Systems Control Engineer, operational staff are not well skilled in the use of digital technology.

6.8 Risk Assessment Framework Review

Council engages water quality management support from an external consultant. They advised that the risk assessment and accompanying HACCP assessments currently do not fully align with the QLD guidelines and the ADWG, and the procedural framework needs to match the risk assessment. This was also raised in the external audit. Council agrees with this assessment and intends to undertake a full DWQMP rewrite within two years. This has been added to the RMIP.

7 RISK MANAGEMENT PLAN

7.1 Management Oversight

7.1.1 Regular Meetings

Council plans to recommence regular and formalised DWQMP meetings that cover all areas of the DWQMP including all 12 elements of the ADWG.

7.2 Preventive Measures

The risk assessment has identified a number of activities that must be carried out regularly to ensure that the applied risk rating remains valid. These are summarised below by scheme.

Where the action is not currently carried out at the time of writing this plan, procedures will be developed to implement these within 12 months.

Scheme	Who	Actions	Frequency	Current
Charters Towers	Operators	SCADA Setpoint Checks	Daily	Yes
	Operators	Jar testing to optimise dose rates	Weekly or more often in changing conditions	Yes
	Operators	Check Chlorine dosing system operation	Daily	Yes
	Operators	Chlorine residual checks (WTP, reservoirs and hospital) Refer to the Hypo Management Plan	Daily	Yes
	Operators	Calibration of dosing pumps	Monthly	Yes
	Operators	Calibrate chlorine analysers	Weekly	Yes
	Operators	Control maintenance activities to ensure water quality is maintained	As required	Yes
	Maintenance Planner	Preventive maintenance for chlorine dosing and analysers	As required	No
	Operators	WTP, Weir and Reservoir security - lock gates, inspect sites for damage	Daily	Yes
	Operators	Respond to and investigate alarms	As required	Yes
	Operators	SCADA Security - logging out/locking unattended computers	As required	Yes
	Operators	SCADA Setpoint Checks, equipment enabled/simulated state, alarm review	Weekly	Yes
	Maintenance Planner	Reservoir Preventive Maintenance	As required	No
	Operators	Turbidity monitoring - raw,	Daily	Yes

Scheme	Who	Actions	Frequency	Current
		settled, filtered, treated		
	SCADA Engineer	SCADA Account management - disable accounts if not needed	As required	Yes
	Operators	Practice changeover to Module 1[5] to minimise water quality disturbance	Quarterly	Yes
	Operators	Monitor chlorine gas drum holdings, order more during risky periods	Weekly	Yes
	Operators	Monitor ACH, Sulphuric Acid, PolyDADMAC and Polyacrylamide levels, order well in advance of requirement	Weekly	Yes
	All Staff	Monitor and report on unsafe boating activity at the weir	As required	No
	Operators	Manual sample for pH	Daily	Yes
	Maintenance Planner	Flushing of mains to remove organic growth	Annual	No
	Maintenance Planner	Filter cleaning program (additional to 1809-MAN-ME-0003 Filters Operation and Maintenance Manual)	Annual	No
	Operators	Maintain calibration of test equipment and ensure reagents are appropriate and in date	As required	Yes
Greenvale	Town Officer	Site security checks on reservoir and river pumps	Weekly	Yes
	Town Officer	Site Checks - Chlorine dosing system, chlorine residual, chlorine stock, Refer to the Hypo Management Plan	Weekly	Yes
	Operators	SCADA Check - Plant operation, reservoir level, turbidity, chlorine residual	Weekly	No
	Operators	SCADA - Alarms enabled, setpoints checked	Weekly	No
	SCADA On Call Operator	Alarm response	As required	Yes
	Management	Declaration of boiled water on high turbidity[6]	As required	Yes
	Maintenance	Reservoir Preventive	Annual	No

[5] Module 1 is the components of the old WTP that can still be used if the new plant has to be decommissioned for any period of time.
[6] Greenvale water supply is currently declared Non-Potable. Boil Water Alert is no longer applicable.

Scheme	Who	Actions	Frequency	Current
	Planner	Maintenance		
	Maintenance Planner	Preventive Maintenance of Greenvale dosing system and analysers	As required	No
	Town Officer	Request flushing when Chlorine residuals are low	As required	Yes
Pentland	Operators	SCADA - Monitor plant operation, reservoir level, chlorine residual	Weekly	Yes
	Operators	SCADA - Alarms enabled, setpoints checked	Weekly	No
	SCADA On Call	Alarm Response	As required	Yes
	Town Officer	Site security checks on reservoir, pump station and bores	Weekly	Yes
	Town Officer	Site checks - Chlorine dosing system, chlorine residual, chlorine stock, Refer to the Hypo Management Plan	Weekly	Yes
	Operators	Calibration of analysers	Monthly	Yes
	Maintenance Planner	Maintenance of fences and bore heads	Annually	No
	Maintenance Planner	Tank and Reservoir Preventative Maintenance	As required	No
	Town Officer/ Operators	Initiate flushing when Chlorine residuals are low	As required	Yes
Ravenswood	Operators	Operation of the recirculation system when algal blooms are likely	As required	Yes
	Operators	Avoid holding too much sodium hypochlorite stock, Refer to the Hypo Management Plan	As required	Yes
	Operators	Chlorine residual checks,	Weekly	Yes
	Operators	Optimisation of the dosing, ensuring clarifier turbidity is kept low	As required	Yes
	Operators	Water chemistry check by external consultant (Water Treatment Services)	Monthly	Yes
	Operators	Chlorine and bacteriological tests of the plant and reticulation	Weekly	Yes
	Operators	Plant checks	Daily	Yes
	Operators	Respond to clarifier turbidity	As required	Yes

Scheme	Who	Actions	Frequency	Current
		alarm – jar test		
	Maintenance Planner	Plant preventative maintenance	Monthly	Yes
	Operators	Check plant operation, filter outlet turbidity, weekly bacteriological samples of plant and reticulation. Declare incident for elevated turbidity. Remove cattle from inner catchment.	Weekly	Yes
	Maintenance Planner	Filter cleaning program (additional to 1809-MAN-ME-0003 Filters Operation and Maintenance Manual - expandable to this WTP)	Annual	No
	Reticulation Crews	Flushing on demand, weekly chlorine, and bacteriological samples in reticulation	On demand	Yes
Common	Reticulation	Flushing Program and Procedure (replaces the above flushing actions.	Varies, Weekly	No
	Reticulation	Mains Bursts/Breaks and connections – flushing, swabbing, and testing using the Tecta B16 instrument for E. coli prior to entering into service, as per WSAA Appendix I.	As needed	No

Table 7-1:Preventive actions

7.3 Staffing

Charters Towers employs trained Operators for its water supply and wastewater management systems. Due to their remote locations, operations in Greenvale and Pentland are assisted by the town officers. Ravenswood raw water supply and water treatment plant are operated by Ravenswood Gold under an agreement with Council.

There is a risk of short staffing as the team is comprised of four Operators and a Technical Officer. Employees are entitled to five weeks of annual leave and 10 days of sick leave per annum. Consequently, the team can be reduced to three Operators and the Technical Officer for up to six months of the year. Their responsibilities include the operation of the Charters Towers water and sewage treatment plants and regular visits to the remote towns for sampling and monitoring. The Greenvale and Pentland systems are monitored by the Town Officers. The Greenvale Town Officer does not have operational accreditation.

Whilst routine verification sampling has not been missed, when an adverse result is found, there has been at least one instance where a re-sample was not undertaken. This was a critical failure in the management system and an investigation followed. The result was the implementation of a Corrective Action Reporting System, that has been in place for at least one year. Nevertheless an RMIP action has been made to manage staffing shortages.

Council's Administrative Directive on Learning and Development states: "Council will endeavour to maximise opportunities for employees to improve their levels of skills and knowledge in order to improve workplace productivity and staff satisfaction."

Trained operators are difficult to draw into the region, so Council has periodically selected existing staff to be trained as Operators undergo operator training.

CTRC has implemented an on duty/call phone for all plants:

- Water Plant – 0407 889 793;
- Wastewater Plant- 0419 303 687 (Alternate if the WTP cannot be contacted).

7.4 Training

Training requirements are ongoing.

Enviro-Check Australia has been engaged by CTRC to undertake training for all of its WTPs and will be held over 3 days, and will occur in 2024.

7.5 Operation and Maintenance Procedures

The Charters Towers WTP upgrade was fully documented with procedure manuals, and these are supplemented by the existing procedures.

Document	Title	Issued	Equipment/ Systems Covered
1809-MAN-ME-0001	Clarifiers Operation and Maintenance Manual	2020	Pre-treatment, instrumentation, Clarifiers, Lamella Plates, Sludge system, Floc mixers
1809-MAN-ME-0002	Chemical Dosing Operation and Maintenance Manual	2020	Coagulant, Acid and Coagulant Aid storage and dosing systems, Settling Aid batching and dosing, Chlorine storage and dosing
1809-MAN-ME-0003	Filters Operation and Maintenance Manual	2020	Filters, analysers, air blower
1809-MAN-ME-0004	Pump Station Operation and Maintenance Manual	2020	Pumps, surge vessels, treated water analysers
1809-MAN-ME-0005	Site Services Operation and Maintenance Manual	2020	WTP and Weir Compressed Air, WTP Service Water
1809-MAN-IN-0001	SCADA Manual	2020	WTP SCADA system
WTP RA	WTP Electrical Operation and Maintenance Manual	2020	WTP Electrical Systems
WTP PLC RA	WTP PLC Operation and Maintenance Manual	2020	WTP PLCs
WPS RA	WPS Electrical Operation and Maintenance Manual	2020	Weir Pump Station Electrical
WPS PLC RA	WPS PLC Operation and Maintenance Manual	2020	Weir Pump Station PLCs
BPS RA	BPS PLC Operation and Maintenance Manual	2020	Booster Pump Station Electrical

Document	Title	Issued	Equipment/ Systems Covered
BPS PLC RA	BPS PLC Operation and Maintenance Manual	2020	Booster Pump Station PLCs
WTP P01.0	WTP Orientation Procedure	2017	WTP Site and Safety brief
WTP P02.0	Chlorine Drum Change Procedure	2017	Chlorination
WTP P02.0	Regulatory Reporting Procedure	2017	Non-Compliance and Status reports to Regulator
WTP P04.0	Weir Readings & Inspection Procedure	2017	Weir level, equipment
WTP P05.0	Reservoir Readings & Inspection Procedure	2017	Reservoir Chlorine Residual, general condition
WTP P06.0	WTP Weekly Inspections Procedure	2017	General equipment and structures
WTP P07.0	WTP Monthly Inspection Procedure	2017	General equipment and structures
WTP P08.0	Rising Mains Inspection Procedure	2017	Raw water and rising mains
WTP P09.0	Weir Pump Station Flood Procedure & Weir	2017	Weir pump station
WTP P11.0	Water Alkalinity Bench Test Procedure	2017	Water chemistry
WTP P12.0	Water Alkalinity Test Procedure	2017	Water chemistry
WTP P13.0	Water Calcium & Magnesium Hardness Test	2017	Water chemistry
WTP P14.0	Water Colour Bench Test Procedure	2017	Water chemistry
WTP P15.0	Water pH Bench Test Procedure	2017	Water chemistry
WTP P16.0	Water pH Test Procedure	2017	Water chemistry
WTP P17.0	Jar Testing Procedure	2017	Water chemistry
WTP P18.0	Water Turbidity Test Procedure	2017	Water chemistry
WTP P19.0	Chlorine in Water Test Procedure	2017	Water chemistry
WTP P20.0	Collecting Water Samples for Micro Testing	2017	Raw water, process water and reticulation
WTP P21.0	Blue Green Algae Response Plan	2017	Water Bacteriology
WTP P41.0	Chlorine Shed Crane Procedure	2017	Chlorine drum crane
WTP P43.0	Chlorine Alarm Test Procedure	2017	Chlorine alarm
WTP P44.0	Chlorine Gas Emergency Procedure	2017	Safety with Chlorine

Document	Title	Issued	Equipment/ Systems Covered
WTP P45.0	Pump House Crane Procedure	2017	Pump house crane
WTP P52.0	Priming town Pumps Procedure	2017	Treated water pumps
WTP P54.0	Main Intake Works Services Procedure	2017	Weir intake works

Table 7-2: Operation and maintenance procedures

Greenvale, Pentland, and Ravenswood do not have documented Operations and Maintenance procedures at this point in time. The proposed new Water treatment Plant at Ravenswood will have operations and maintenance manuals.

7.6 Management of Incidents and Emergencies

7.6.1 Incident Management

The management actions for incidents and emergencies depend on the level of the incident.

Incident/ Emergency	Description of Level
Level 5	▪ Widespread outbreak of waterborne disease. ▪ Declared disaster that disrupts normal operation of supply – Cyclone, major flooding, loss of power. Supply has been turned off or is not available. ▪ Gross exceedance of ADWG guideline of a chemical parameter that poses a serious threat to consumers. ▪ Any cybersecurity activity that causes a Level 5 water quality incident.
Level 4	▪ High level of pathogens detected in reticulation/reservoir. E.g., E. coli greater than 5 CFU/100mL. ▪ Failure of infrastructure – severe or emergency level supply restrictions required to ensure continuity of supply. ▪ Any cybersecurity activity that causes a Level 4 water quality incident.
Level 3	▪ Mid-range detection of E. coli and other pathogens. E.g., E. Coli between 1-5 CFU/100mL. ▪ Failure of infrastructure – short term water restrictions may be required. ▪ Minor restrictions of ADWG guideline of a chemical parameter. ▪ Minor Flooding. ▪ Any cybersecurity activity that causes a Level 3 water quality incident.
Level 2	▪ Failure of infrastructure or source supply (possible water quality issue, e.g., Bore water has high turbidity). Still able to provide drinking water but there will be exceedances in ADWG aesthetic guideline. ▪ Any cybersecurity activity that causes a Level 2 water quality incident.
Level 1	▪ Exceedance of operational limit has occurred but is managed through operational and maintenance procedures. ▪ Any cybersecurity activity that causes a Level 1 water quality incident.

Table 7-3: Incident Management Levels

While exceedance of an ADWG health guideline (or parameters detected with no ADWG limit) has been listed as medium level / level 3, the Manager Water and Wastewater has to decide if the impact is likely to be severe enough to lift it to a high level i.e. E. coli in one of the reticulation samples is medium whereas E.coli in the reservoirs accompanied by reports of illness would be high level.

When an ADWG Health guideline value is exceeded (or parameters detected with no ADWG limit), the incident can be of 2 types:

a. A verification testing result has been received (incident has already occurred);
b. Operational monitoring has detected an exceedance (incident is occurring).

The Manager Water and Wastewater must decide the best plan to deal with the incident, but the table below identifies the normal range of responses.

An escalation process has been developed and is provided in Appendix 13.

Detailed actions are presented in Appendix 14 to assist with decision making.

To avoid any misunderstandings, a single point of contact has been established for operational results. All operators are to contact the CTWTP Duty Officer for any adverse results. The CTSTP Duty Officer is used as an alternate if the CTWTP Duty Officer cannot be contacted. For verification results, the laboratory will call the compliance officer. Both the compliance officer and the Manager Water and Wastewater will be emailed the test result, and also notify them of an expected exceedance prior to finalising the test report.

An important element of dealing with these incidents is that operational and management staff understand all schemes well enough to make sound decisions. Previous operational water quality incidents in CTRC have resulted from a lack of understanding of the treatment and reticulation systems.

7.6.2 Ravenswood Incidents

The WTP at Ravenswood is operated under contract by Ravenswood Gold (RG). The contract is not specific as to the water quality standards to be achieved or the emergency responses required. As the water supply system falls under the CTRC Drinking Water Quality Management Plan, RG is legally bound to operate the system in accordance with this plan. Any situation that is documented in this plan as requiring notification to management constitutes a requirement by Ravenswood Gold to communicate the situation to the CTRC Manager Water and Wastewater. Management of the incident is then carried out in accordance with this plan.

An updated agreement that assigns specific responsibilities to RG is being developed but has been delayed while stamp duty issues relating to the transfer of infrastructure are being resolved.

Ravenswood Gold are not responsible for liaison with the Drinking Water Regulator or with Qld Health.

7.6.3 Greenvale Incidents

The disinfection station at the Greenvale reservoir now has new gaseous chlorination and SCADA turbidity monitoring. Below is a screenshot of the SCADA system. The operator is likely to be trained by December 2023 in its use and control and is an RMIP action.

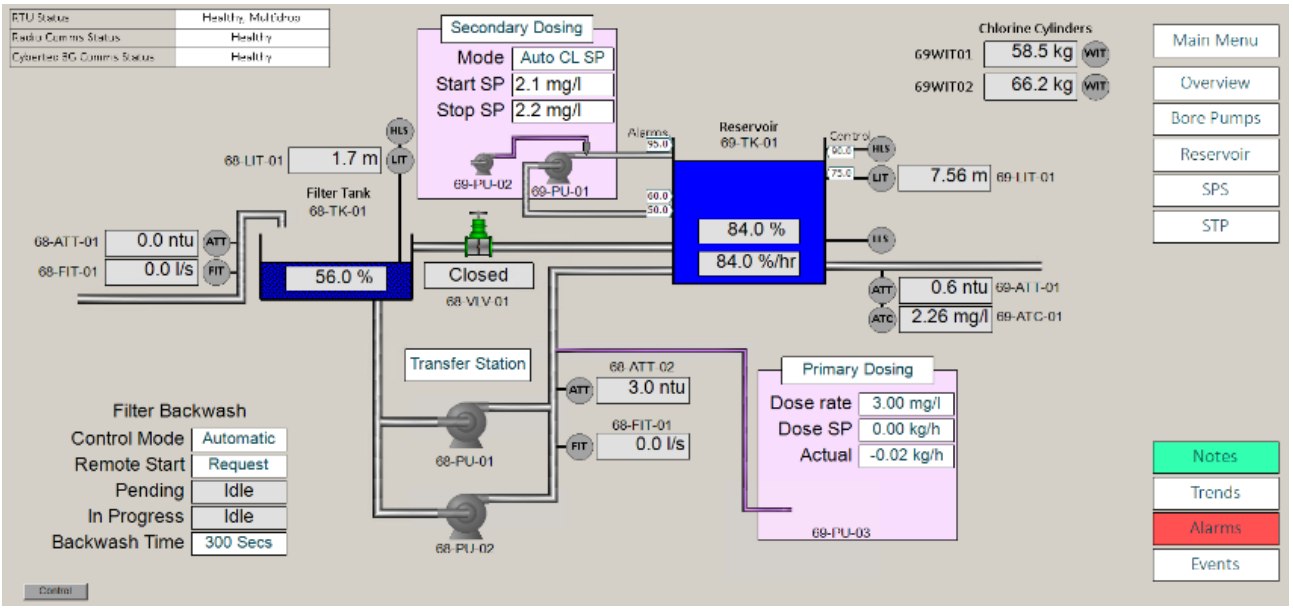


Figure 7-1: Greenvale SCADA system

7.6.4 Public Communication

The Charters Towers Disaster Management Plan has a Public Information and Warnings Sub Plan which is used to manage communication when the disaster plan has been activated. The Public Health Sub-Plan also has specific information relating to drinking water incidents.

In a medium level incident, the communication methods depend on the circumstance and location. Communication channels are limited in the townships. The following are possible methods of communication:

a. Council Facebook page – important items are forwarded rapidly by the public
b. Electronic Message Boards (particularly for townships)
c. Letter Drop
d. Verbal (particularly for townships and key facilities such as hospital and nursing homes)

7.6.5 Reporting to the Drinking Water Regulator

The following list itemises incidents which must be reported to the drinking water regulator.

a. Breach of an ADWG Health value or as specified in the DWQMP;
b. Detection of a parameter for which there is no ADWG guideline value;
c. Cybersecurity incident which has or is likely to impact drinking water quality;
d. Other event which has or is likely to impact drinking water quality; and
e. Table 5 Incidents which are reportable to the regulator.

The contact details and reporting requirements are as follows:

a. Phone: 1300 569 709 24hrs/7 days.
b. Notification of a drinking water event or detection of a parameter with no water quality criteria: Form WSR 507.
c. Notice of non-compliance with water quality criteria: Form WSR017.

If notification is required to the Public Health Unit, the Townsville contact is (07) 4433 6900.

7.7 Risk Management Improvement Plan

The following items are derived from the risk assessment tables and represent those items required to make an improvement in the current risk level. The responsibility to initiate/monitor these actions rests with the Manager Water and Wastewater.

Scheme	Risk	Action	Interim Action	Long Term Plan	Target Date
Charters Towers	Very High	Replace the concrete reservoir as it is in poor condition	Monitor roof condition, Seal off points of entry	Reservoir and rising main project is currently in design phase - this will result in decommissioning or reconstruction of the concrete reservoir	2025
Charters Towers	Very High	Create a larger roofed treated water storage at the WTP.	The Module 2 clarifier tank was made redundant in the WIUP works and is now being reconfigured to replace the existing treated water storage.	Transfer Clear Water storage to the Module 1 tank. Decommission and dispose of the existing Clear Water tank.	December 2023
Charters Towers	High	Conduct Health Based Targets assessment of the raw water and treatment to determine if UV treatment is warranted	Increase sampling of raw water for E.coli as an indicator for cryptosporidium to form baseline data for the study	Conduct a health based targets assessment of the raw water	2024
Charters Towers	High	Dedicated inlet and outlet mains at the reservoir to ensure adequate turnover	Utilise re-chlorination system to maintain residual in the reservoirs	To be installed as part of the rising main and reservoir replacement project	2025
Charters Towers	High	Periodic check of supplier chemical purity		Implement QA process by sending samples to the lab	2023 completed

Scheme	Risk	Action	Interim Action	Long Term Plan	Target Date
Greenvale	Very High	Ensure safe potable water is available to Greenvale	Packaged water has been supplied after the high Chlorine & Chlorates events of December 2022. This will continue until a gaseous Chlorine system is installed. Install a turbidity meter as part of being able to lift the non-potable notice.	Replace the Greenvale WTP. Preliminary design has been completed by consultants for Department of Defence in preparation for the Australia-Singapore Military Training Initiative (ASMTI).	December 2024
Greenvale	Very High	Full Health Based Target Assessment required to determine suitable level of treatment required for crypto/giardia		This will form part of the baseline for upgrades of the water system at Greenvale	2024
Greenvale	High	Reservoir roof improvement program to ensure it is sealed against vermin and runoff		Complete review of all reservoirs is to be conducted (currently resource constrained)	2024
Greenvale	High	Improve asset mapping capability to reduce the risk of cross connections		Corporate system is moving towards asset mapping.	2024
Greenvale	Very High	Screens need assessing while the river is low on the river side of the spheres & we need to review SCADA as to is capabilities in relation to remote access and warning system as part	Investigate the river screens and spears to determine their suitability for water quality and quantity.	Replace the spears as part of the ASMTI project.	2024

Scheme	Risk	Action	Interim Action	Long Term Plan	Target Date
		of being able to remove the alert for Boil Water notice.			
Greenvale	High	Training for the new SCADA system needs to occur.	Have the existing trained offers attend the site to change settings and correct errors.	Conduct training of the town operators.	2023
Pentland	Very High	Document the treatment process, identify failure modes, label equipment and pipework. Implement a maintenance authorisation system		Conduct complete review of infrastructure and procedures	2022
Pentland	Very High	Clean tanks at the pump station and replace/rectify damaged roofs		Pentland tank review program	2022
Pentland	High	Disconnect Meatworks tanks from the system		Reticulation task	2023
Pentland	High	Consider installation of Duty/Standby dosing systems		Conduct complete review of infrastructure and procedures	2024
Pentland	High	Insert a valve in the main immediately behind Bore 3		Raise job for reticulation crews to do this when next working in Pentland	2024

Scheme	Risk	Action	Interim Action	Long Term Plan	Target Date
Pentland	Moderate	Regular flushing program for Pentland Reticulation		Reticulation to establish flushing program for townships	2024
Pentland	Moderate	Install Pressure Regulating Valve after the Tee junction on the rising main to prevent water hammer in the reticulation		To be completed in the 2023-24 FY	2024
Ravenswood	Very High	Finalise updated water supply agreement	Resolve Stamp Duty issues to allow transfer of infrastructure to CTRC at minimum cost.	Remove ambiguity regarding which entity is the Water Service Provider. CTRC to assume full responsibility	2023
Ravenswood	Very High	Produce updated drawings of the water supply system.	RG is constructing a new (relocated) WTP. Obtain plans and technical documents for the new WTP.	Reticulation task to confirm main locations. Manager to obtain documents.	2023
Ravenswood	Very High	Consider possibility of moving to gas chlorination. Consider carrying out a Chlorates investigation to form a baseline		Ravenswood Gold is constructing a new water treatment plant as part of a mine expansion. Requirements for the new plant will address these deficiencies	2023
Ravenswood	High	Improvement in the management and oversight of the WTP processes	Management of the contract with Ravenswood Gold is being reviewed. The revised agreement will improve reporting and response systems.	Ravenswood Gold is constructing a new water treatment plant as part of a mine expansion. Requirements for the new plant will address these deficiencies	2023

Scheme	Risk	Action	Interim Action	Long Term Plan	Target Date
Ravenswood	Moderate	CTRC Plumbing inspector makes Ravenswood Gold a priority in his Backflow Prevention certification program		Backflow prevention on the mine site is certified and regularly maintained	End 2023
Ravenswood	Very High	Council oversight of the Ravenswood Gold WTP operations is a key issue, and an escalation process is planned and will include a flowchart. The primary basis will likely be operational site triggers such as online turbidity or chlorine, whereby the operator must notify CTRC. Where required, CTC we will then notify the regulator.	Daily check ins with Ravenswood Gold operators. Escalation process flowchart to be laminated in fixed to the WTP wall. Manual triggers run through with both CTRC and Ravenswood Go operators. Increase turbidity monitoring when reaching the H limit. Change the CCPs to target, alert, and critical limits in line with HACCP plans.	Online oversight. Formalised procedure to include all items.	2024
All Schemes	High	Training for maintenance staff in water quality when dealing with water main breaks		Provide training opportunities. Review current practices. Create a procedure to include equipment and machinery disinfection prior to use in water management situations where cross-contamination may be a risk. Ensure that there is a procedure for disinfection and flushing of mains after a repair has occurred.	2024

Scheme	Risk	Action	Interim Action	Long Term Plan	Target Date
All Schemes	High	Onsite training by an RTO on sampling and Townsville Water training for sample collection and storing	Experienced staff to show other staff what to do.	Undertake training.	2024
All Schemes	Very High	A corrective action reporting system is in place, however staffing to be able to address these issues remains a key issue	Ensure that management implement and monitor the corrective action reporting system. Water Quality Officer employed.	Employ an additional operator to relieve the work load of existing operators and to address shortages when staff are on leave.	2024
All Schemes	Very High	The risk assessment and accompanying HACCP assessments need to fully align with the QLD guidelines and the ADWG, and the procedural framework needs to match the risk assessment	The 2023 DWQMP update is to include procedural updated to manage the highest priority risks identified in this plan.	Undertake a significant DWQMP rewrite that centres around a major risk assessment and HACCP review to properly align with guidelines and known and unknown risks within each of the four schemes. Consider a major procedural framework review to be able to better manage issues.	2025
All Schemes	High	Council plans to recommence regular and formalised DWQMP meetings that cover all areas of the DWQMP including all 12 elements of the ADWG	Informal meetings are underway will existing and new staff.	Undertake monthly formalised DWQM meetings with all staff until issues are being managed effectively, then move to quarterly meetings. Create a procedure for SWIMLocal to ensure that data is entered which then helps flag exceedances that cannot be closed out until the management process is complete	2024

Scheme	Risk	Action	Interim Action	Long Term Plan	Target Date
All Schemes	Medium	SWIMLocal requires further development	Qld Water to assist with minor changes by the Water Quality Officer	Qld Water to undertaken significant changes with a brief provided by the Water Quality Officer	2024
All Schemes	Medium	Sampling: Both operational and verification sample locations properly mapped	Produce a preliminary set of maps to show the locations of operational and verification monitoring. Consider keeping or adding sampling locations located at system extremities, but balance with the water security management	Update the DWQMP and produce a flushing program for operational monitoring in the reticulation networks. Update the DWQMP to show verification monitoring locations and produce or update a verification monitoring procedure that includes sample location maps. Install proper sampling taps in line with industry trends to avoid false readings.	2024
All Schemes	Medium	There needs to be a proper procedure including a flow diagram to address customer complaints.	A corrective action process to be in place.	Add a flow diagram to the corrective action process.	2024
All Schemes	Medium	Incident Register with incident ID	Basic spreadsheet to be set up	Formalised spreadsheet and registered within ECM to ensure this held within a repository and checked out and in for each event.	2024
All Schemes	Medium	Reservoir security fencing is adequate.	Undertake interim repairs where possible Update procedures to ensure hatches and other access points are locked	Consider a capital program to replace fences where required.	2025

Scheme	Risk	Action	Interim Action	Long Term Plan	Target Date
All Schemes	Medium	CTRC aims to ensure that all monitoring equipment are properly maintained and calibrated.	Staff are instructed at the toolbox talks to: Undertake weekly monitoring of reagents, standards, and buffers and have an expiry date; Replacement orders at to be made ahead of the expiry date; Calibration records are to be kept in ECM; All instruments without calibration stickers ate to be checked for status and those that are not rectified.	A monitoring management procedure is written. An instrument register will be kept that includes a calibration status. Spare equipment is available to avoid having no instruments if they are sent away for maintenance. The preference is for a technician to come to town to do all equipment at the required intervals.	2024
All Schemes	Medium	CTRC aims to ensure that all SCADA monitoring equipment are dross-checked daily with hand-held monitoring equipment, fixed field instruments with displays, and verification records. This is effectively up to a four way check to ensure that the SCADA display is showing the correct information. Where fixed field instruments are replaced, the correct signal is delivered to SCADA.	Toolbox talk to discuss that this check is required, and the replacement activity can affect the SCADA display. Undertake regular meetings that include set point change needs; Add a prompt in a regular DWQMP meeting to check if a workshop is required for changes to management as a result of a plan update.	SCADA Instrumentation procedure written. Critical and target monitoring criteria are updated in SCADA once a new HACCP is completed. Create a procedure for updating SCADA alarms with time intervals; Create an access procedure for manager rights to be only allowed to change set-point values; Add a process to alert the administrator if someone leaves or changes roles;	2025

Table 7-4: Risk management improvement plan

7.8 Information Management

The following table records the storage location for the different elements of information relevant to this DWQMP.

Council operates a Technology One system incorporating Electronic Content Management (ECM) for record storage, One Council for purchasing and maintenance, and a legacy system Service Desk for customer call management.

Information	Format	Responsible Officer	Where Stored
Customer Complaints/Service Requests	Electronic	Customer Service/Water Admin Officer	Service Desk, ECM
Procedures	Electronic	Technical Officer Water and Wastewater	ECM / Fileserver
Lab Reports	Electronic	Technical Officer Water and Wastewater	SWIMLocal (requires further development), Fileserver
Daily Readings	Hard Copy / Electronic	Technical Officer Water and Wastewater	WTP Readings. Log Books, Fileserver Excel spreadsheets
Incident Reports	Electronic	Manager Water and Wastewater	ECM
Incident Register	Electronic	Manager Water and Wastewater	ECM
SCADA Settings/Backup	Electronic	Control Systems Engineer	External hard drives
Maintenance Information	Electronic	Electrical And Mechanical Team Leader/Technical Officer Water and Wastewater	Assets will progressively be loaded into the One Council system and maintenance scheduling and recording will be carried out within that system.
Drinking Water Quality Management Plan	Electronic	Manager Water and Wastewater	ECM/Fileserver
Drinking Water Quality Management Plan Annual Reports	Electronic	Technical Officer Water and Wastewater	ECM/Fileserver

Table 7-5: Information storage locations

8 OPERATIONAL AND VERIFICATION MONITORING

8.1 Operational Monitoring

8.1.1 Monitoring Responses

In the SCADA and Manual sampling tables, the High High (HH), High (H), Low (L) and Low Low (LL) limits are specified. The codes in the following table are used to clarify when the occurrence of a quality anomaly needs to be reported. These are shown in the table on the next page for common parameters.

Action	Symbol
Report to supervisor	S
Report to Manager Water & Wastewater	M
Report to Regulator and Qld Health (Incident)	R

Table 8-1: Reporting symbols

8.1.2 Monitoring Management

CTRC aims to ensure that all monitoring equipment are properly maintained and calibrated. The following will be undertaken:

- Reagents, standards, and buffers are all monitored weekly, and have an expiry date;
- Replacement orders for the above are made ahead of the expiry date;
- An instrument register will be kept that includes a calibration status;
- Calibration records will be kept in ECM;
- All instruments will have calibration stickers to indicate whether the instrument is reliable;
- Spare equipment is available to avoid having no instruments if they are sent away for maintenance. The preference is for a technician to come to town to do all equipment at the required intervals.

8.1.3 SCADA Monitoring

CTRC aims to ensure that all SCADA monitoring equipment are dross-checked daily with hand-held monitoring equipment, fixed field instruments with displays, and verification records. This is effectively up to a four way check to ensure that the SCADA display is showing the correct information.

Where fixed field instruments are replaced, the correct signal is delivered to SCADA.

8.1.4 Turbidity limits

The CTRC turbidity limit for treated water prior to reticulation is 1 NTU. The ADWG limit of 5 NTU is for aesthetic purposes only.

Treated water that exceeds 1 NTU carries the risk of microbiological contamination being masked from the chlorine and is therefore unsafe.

A single reticulation turbidity result in excess of 1 NTU does not pose the same hazard as the same result at the WTP as this often results from the re-suspension of settled solids in the pipeline. Flushing to remove the sediment will generally result in compliant turbidity results.

Water Type/ Location	SCADA Parameter	Units	HH	H	L	LL	Action on Breach	Reporting
Raw Water	Turbidity	NTU	4000	80			This value is for warning purposes and will always be set relative to the current conditions	S
Raw Water	Temperature	°C	45	40			HH: Scour water to Pajingo dam until cooler water is pulled through	S
Dosed Water	pH		8.8	8.5	6.7	6.6	Out of spec – stop plant, adjust sulphuric acid dosing	S
Settled Water	Turbidity	NTU	10	8			H/HH turbidity in clarified water: Stop plant, take manual sample, dump clarifier if necessary, jar test and adjust dose rates accordingly.	S
Filtered Water	Turbidity	NTU	0.5	0.4			Stop plant, take manual sample, perform jar testing, backwash filter	S
Filtered Water	Chlorine	mg/L	5	4.5	1	0.6	On any alarm – stop plant. Check chlorine setpoint, take manual sample, calibrate analyser, arrange maintenance of chlorine system if required	S
Filtered Water	pH			8.5	6.7		On any alarm – Stop plant. Check acid setpoint, take manual sample, calibrate analyser.	S
Treated Water	Chlorine	mg/L	4.5	4.0	1.5	1.0	Any alarm – stop plant. Take manual sample of treated water and treated water storage. Dump treated water storage if necessary. Calibrate analyser.	S
Treated Water	pH			8.3	6.7		On any alarm – Stop plant. Check acid setpoint, take manual sample, calibrate analyser.	

Water Type/ Location	SCADA Parameter	Units	HH	H	L	LL	Action on Breach	Reporting
Treated Water	Turbidity	NTU	0.9	0.5			H: investigate settled water and filtrate turbidity. Jar test, dump the treated water storage if necessary (unless backwash is required), HH: stop the plant, take manual samples, dump the treated water storage (unless backwash is required), jar test, restore plant only after source of turbidity has been identified and rectified	S

Table 8-2: Charters Towers SCADA sample points, limits, and actions

8.1.5 Charters Towers Water Quality Monitoring

Water Type/ Location	Parameter	Frequency	Units	HH	H	L	LL	Action on Breach	Reporting
WTP Raw Water	pH	Daily						Re-do jar testing if there has been a significant change in raw water quality	
WTP Raw Water	Alkalinity	Daily	mg/L					Re-do jar testing if there has been a significant change in raw water quality	
WTP Raw Water	Colour	Daily	HU					Re-do jar testing if there has been a significant change in raw water quality	
WTP Raw Water	Turbidity	Daily	NTU					Re-do jar testing if there has been a significant change in raw water quality	
WTP Settled Water	Turbidity	Daily	NTU	10	8			H/HH turbidity in clarified water: Stop plant, dump clarifier if necessary, jar test and adjust dose rates accordingly.	S
WTP Settled Water	Colour	Daily	HU	15	10			H/HH colour in settled water. Stop the plant, jar test and adjust dose rates	S
WTP Filtered Water	Turbidity	Daily	NTU	0.5	0.4			H: SCADA Monitoring 4 hourly HH: Stop plant, perform jar testing. If settled water is within specifications, then backwash filter	S
WTP Filtered Water	Colour	Daily	HU	10	5			H/HH colour in filtered water. Stop the plant, jar test and adjust dose rates	S

Water Type/ Location	Parameter	Frequency	Units	HH	H	L	LL	Action on Breach	Reporting
WTP Final Water	pH	Daily			8.0	7.0		On any exceedance – Stop plant. Check acid setpoint	
WTP Final Water	Colour	Daily	HU	10	5.0			H/HH colour in final water. Stop the plant, jar test and adjust dose rates.	S M
WTP Final Water	Turbidity	Daily	NTU	0.9	0.4			H: investigate settled water and filtrate turbidity. Jar test, dump the treated water storage if necessary (unless backwash is required). HH: stop the plant, dump the treated water storage (unless backwash is required), jar test. Restore plant only after source of turbidity has been identified and rectified	S S M
WTP Final Water	Chlorine	Daily	mg/L		4	1.5		H/L: Stop plant. Dump treated water storage if necessary. Calibrate analyser	S
Reservoir	Chlorine	Daily	mg/L	5.0	4	0.5	0.2	H: If plant is performing correctly, then turn off re-chlorination system L: check re-chlorination system HH or LL: Declare incident	S S S M R
Hospital	Chlorine	Daily	mg/L	4.0	3.0	0.5	0.2	Any limit – check reservoir and final water values L or LL: arrange for flushing in the area	S

Water Type/ Location	Parameter	Frequency	Units	HH	H	L	LL	Action on Breach	Reporting
Hospital	Turbidity	Daily	NTU	2.0	1.0			H or HH: If WTP output is within specification then arrange for flushing in the area	S

Table 8-3: Charters Towers manual sample points, limits, and actions

8.1.6 Greenvale Water Quality Monitoring

Water Type/ Location	SCADA Parameter	Units	HH	H	L	LL	Action on Breach	Reporting
Raw	Turbidity	NTU	50	30			H: Monitor reservoir ongoing turbidity/Reticulated water turbidity is <1.5 NTU. HH: Stop pumping	
Raw – leaving reservoir	Turbidity	NTU	1.5	1.0	0.7		Set to 10 and 5 for higher turbidity and with “boil water” in place L (target limit): perform 4 hourly monitoring H: (Alert limit): continue to perform 4 hourly monitoring, daily E. coli sampling using the TECTA Machine to validate the effectiveness of disinfection. If E. coli detected in the reticulation network, stop plant. HH: Stop plant, declare incident, isolate reservoir water, and let it clarify to below 1.0 NTU before bringing back on line or issue a boil	S

Water Type/ Location	SCADA Parameter	Units	HH	H	L	LL	Action on Breach	Reporting
							water notice. This is effectively batching and assuring the water for allowed usage, check reticulation system, and flush if turbidity is > 1.5.	
Reticulated	Turbidity	NTU	5	1.5			H: Check outlet turbidity in reservoir and review limits and actions. HH: If reservoir turbidity is under the limit and available, arrange for flushing, otherwise issue boil water notice.	S M R
Reticulated	Chlorine	mg/L	5	3.5	0.5	0.2	H: Arrange for manual chlorine sample to confirm reading, Turn down dose rate. HH: Declare incident, advise residents. Disable chlorine dosing and activate river pump to dilute reservoir. Scour reservoir if necessary. L: Check dosing, take manual sample, increase chlorine setpoint LL: Take manual sample, declare incident, implement Boil Water Notice	S S M R S S M R
Dosed	Dosing Pump Excess Runtime	Mins	300				HH: Arrange for manual water sample to confirm analyser reading	

Water Type/ Location	SCADA Parameter	Units	HH	H	L	LL	Action on Breach	Reporting
							Investigate dosing system (possible blockage or chlorine leak) Check reagent to ensure it has not run out. This would cause a Zero Chlorine reading	
Chlorine	Reservoir	Weekly	mg/L	4.0		1.0	Re-test, test dosed water at pump station, adjust dose rate	S

Table 8-4: Greenvale SCADA sample points, limits and actions

8.1.7 Pentland Water Quality Monitoring

Water Type/ Location	SCADA Parameter	Units	HH	H	L	LL	Action on Breach	Reporting
Dosed	Chlorine	mg/L	5.0	3.5	1.5	0.5	H: Stop pumps, take manual sample to confirm reading, turn down chlorine dose rate HH: Stop pumps. Declare incident, scour delivery main to remove high chlorine water. L: Take manual sample and turn up dose rate. LL: Stop Pumps. If Reservoir chlorine is also low then declare incident.	S S M R S S M R
Reservoir	Chlorine	mg/L	4.0	3.0	1.5	0.2	H: stop lift pumps, take manual sample to confirm reading, turn down chlorine dose rate L: Take Manual Sample and turn up dose rate LL: Declare incident. If pumped water free chlorine is high enough, scour reservoir then commence refilling. Scouring required in town.	S S S M R
Reservoir	pH		9	8	6.5	6	Any value outside of range – investigate cause	
Reservoir	Temp	°C	45	40			HH: scour some water from the reservoir then with the pumps running, scour in town to pull cooler water through	S M

Table 8-5: Pentland SCADA sample points, limits and actions

Water Type/ Location	SCADA Parameter	Frequency	Units	HH	H	L	LL	Action on Breach	Reporting
Chlorine	Pump Station	Weekly	mg/L	4.0			1.0	Check analyser reading, adjust dose rate	S
Chlorine	Reticulation	Weekly	mg/L	3.5			1.0	Retest, check reservoir and pump station, arrange for flushing	S

Table 8-6: Pentland manual sample points, limits and actions

8.1.8 Ravenswood Water Quality Monitoring

Water Type/ Location	SCADA Parameter	Units	HH	H	L	LL	Action on Breach	Reporting
Clarified Water	Turbidity	NTU	1.5	1			H: Jar test, adjust dose HH: Stop Plant and report to Supervisor, Manager CTRC and Regulator	S S M R
Treated Water	Chlorine	mg/L	5.0	4.0	1.0	0.2	H: Stop dosing system, take a manual sample, adjust setpoint, dilute the squat tank. HH: Stop dosing system, take a manual sample, declare an incident L: Take manual sample, adjust setpoint LL: Take manual sample, declare an incident	S S M R S S M R

Table 8-7: Ravenswood SCADA sample points, limits, and actions

Water Type/ Location	Parameter	Frequency	Units	HH	H	L	LL	Action on Breach	Reporting
Chlorine	Header tank	Weekly	mg/L	5.0	4.0	1.0	0.5	H: stop dosing system, adjust setpoint, run plant to dilute chlorine in header tank then restart dosing system. Monitor HH: stop dosing system, declare incident L: Check dosing system and adjust setpoint. Arrange for flushing once residual in the tank has risen LL: Declare an incident	S S M R S S M R
pH	Header tank	Weekly		8.5		6.5		Monitor	
Turbidity	Header tank	Weekly	NTU	1.5	1.0	0.7		L (target limit): perform 4 hourly monitoring (as per USEPA Guidance Manual for Compliance with the Surface Water Treatment Rules: Turbidity Provisions, June 2020). H: (Alert limit): continue to perform 4 hourly monitoring, daily E. coli sampling using the TECTA Machine to validate the effectiveness of disinfection. If E. coli detected in the reticulation network, stop plant. HH: Stop plant, declare incident, dump CWS water, if the town reservoir is available, check reticulation system, and flush if turbidity is > 1.5.	S M R

Water Type/ Location	Parameter	Frequency	Units	HH	H	L	LL	Action on Breach	Reporting
E.coli, Faecals, HPC	Header tank	Weekly	CFU/ 100mL	> 0				E.coli/Faecals: Declare incident HPC: review free chlorine across system, arrange for flushing	S M R S M
Chlorine	Assorted Reticulation locations	Weekly	mg/L	5.0	4.0	0.5	0.2	HH: stop dosing system, declare incident H: stop dosing system, adjust setpoint, run plant to dilute chlorine in header tank then restart dosing system. Flush reticulation to pull lower residual water through L: Check dosing system and adjust setpoint. Arrange for flushing once residual in the tank has risen	S M R S S
Turbidity	Assorted Reticulation locations	Weekly	NTU	5	1.5			HH: If header tank turbidity is under the turbidity limit and available, arrange for flushing	S M
E.coli, Faecals, HPC	Assorted Reticulation locations	Weekly	CFU/ 100 mL	>0				E.coli/Faecals: Declare incident HPC: review free chlorine across system, arrange for flushing	S M R S M

Table 8-8:Ravenswood manual sample points, limits, and actions

8.2 Verification Monitoring

8.2.1 E.coli

The following table lists the minimum E.coli testing requirements in accordance with the Public Health Regulation, Qld, 2018.

With the travel distance to the outlying towns and the cost of the courier service to Townsville taken into consideration, the table also shows the verification sampling regime which will then be applied to all other verification sampling.

Scheme	Population	Testing Requirement	Verification Test Sample Schedule
Charters Towers	7,873	1 per week plus 1 per month	Weekly
Greenvale	232	1 per month	Monthly
Pentland	306	1 per month	Monthly
Ravenswood	255	1 per month	Monthly

Table 8-9:E.coli sample requirements

8.2.2 Sample Suites

The range of tests to be carried out has been broken down into sets. Which individual tests within a set apply to a particular water type will be worked out with the testing laboratory.

Sample Suite	Test Elements
Basic Micro	E. coli[1] Total Coliforms1 Heterotrophic Plate Count
Basic Water Sample	Free Chlorine Total Chlorine pH Alkalinity Turbidity Colour
Chlorination By-products	Trihalomethanes
PFAS	PFAS Suite
Pesticides	Full range of pesticides with ADWG health or aesthetic values
Basic Metals	Iron Manganese Aluminium
Detailed Metals	Lead Copper Zinc Silver Nickel

Sample Suite	Test Elements
Algal Products	Geosmin Methyl Isoborneol Algal Count
Other Tests	Chromium Mercury
Amoeba	Naegleria Fowleri
Mining Byproducts	Uranium. Arsenic
Treatment Chemicals By-products	Acrylamide Chlorates
Treatment Chemical Quality	Sodium Hypochlorite Polyacrylamide PolyDADMAC ACH Sulphuric acid

[1]Council will test for these contaminants using the recently purchased TECTA B16 Automated Microbiology Detection System. 10% blind samples will be sent to the TCC Douglas Laboratory for NATA testing to monitor the results accuracy.

Table 8-10: Sample suites

8.2.3 Sample Schedule

The sample schedule has been determined based on the minimum requirement and the risk. The raw water monitoring for trend analysis is included in these tables for convenience as the samples are taken at the same time as the reticulation samples.

8.2.4 Excursion Management

Townsville Laboratory Services will call to advise of any treated water ADWG health guideline breaches to the Manager or the Treatment Supervisor, who will act in accordance with the incident procedures.

A confirmed turbidity result in excess of 1 NTU in treated water in a reservoir is to be regarded as a breach of a health guideline due to the microbiological risk.

A Chlorate level above 0.8 mg/L is a breach of the Qld Health set limit and must be reported as a breach.

All other results are reviewed when they arrive and are periodically trended.

Sample Suite\Water Type	CHT Raw	CHT Treated	GV Raw	GV Treated	PL Raw	PL Treated	RV Raw	RV Treated
Basic Micro	Monthly	Weekly, Monthly	Monthly	Monthly	Monthly	Monthly	Monthly	Monthly
Basic Water Sample	Monthly	Weekly, Monthly	Monthly	Monthly	Monthly	Monthly	Monthly	Monthly
Basic Metals	Monthly	Monthly	Monthly	Monthly	Monthly	Monthly	Monthly	Monthly
Chlorination By- products		Quarterly		Quarterly		Quarterly		Quarterly
PFAS	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual
Pesticides	Annual		Annual				Annual	
Detailed Metals	Monthly	Monthly	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly
Mining By-products	Annual						Annual	
Algal Products	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual
Other Tests	Quarterly	Quarterly	Annual	Annual	Quarterly	Quarterly	Annual	Annual
Amoeba		Annual (Summer)		Annual (Summer)		Annual (Summer)		Annual (Summer)
Treatment Chemicals – By-products		Monthly		Monthly (chlorates only)				Monthly
Treatment Chemicals - Quality	Biannual		Biannual					

Table 8-11: Verification Sampling Schedule

Sample\Location	Location 1	Location 2	Location 3
CHT Raw - Monthly, Annual	Weir Pump Station		
CHT Weekly	Reservoir	Hospital	
CHT Treated Monthly Micro and basic water, Quarterly	Picnic Creek Road	Wilson Court	Josh Road
CHT Treated Monthly, Annual	Reservoir		
GV Raw Monthly	River - before Chlorine	Reservoir - before Contact Tank	
GV Raw Annual	River - before Chlorine		
GV Treated Monthly Micro and basic water, Quarterly	Works Depot	Swimming Pool (Potable tap)	
GV Treated Monthly, Annual	Reservoir		
PL Raw	Bores		
PL Treated Monthly Micro and basic water, Quarterly	Works Depot	Town Hall	
PL Treated Monthly, Annual	Reservoir		
RV Raw	Suhrs Ck Dam		
RV Treated Monthly Micro and basic water, Quarterly	James St	Single Persons Quarters	
RV Treated Monthly, Annual	Reservoir		

Table 8-12: Verification sample locations

APPENDIX 1 – CHARTERS TOWERS RAW WATER RESULTS

Hazard	Units	No. Samples	Min	Max	Mean	Health Upper Limit	Aesthetic Upper Limit	Aesthetic Lower Limit
E. coli	org/100 mL	40	0	2,900	92	0		
pH		62	6.82	8.95	7.98		8.5	6.5
Turbidity	NTU	68	0.3	694	99		5	
Colour, True	HU	67	0	284	34		15	
Cryptosporidium[7]	org/100 mL	0	0	0	0	[0][4]		
Giardia	org/100 mL	0	0	0	0	[0]		
Aluminium	mg/L	67	0.01	29.3	0.09		0.2	
Iron	mg/L	67	0.85	29.2	2.85		0.3	
Manganese	mg/L	67	0.001	0.51	0.06	0.5	0.1	
Copper	mg/L	67	0.0	0.04	0.01	2	1	
Zinc	mg/L	67	0.0	0.069	0.03		3	
Antimony	mg/L	67	0.0	0.01	0.001	0.003		
Cadmium	mg/L	67	0.0001	0.004	0.0004	0.002		
Lead	mg/L	67	0.0001	0.003	0.002	0.01		
Silver	mg/L	67	0.0004	0.0009	0.0021	0.1		
Arsenic	mg/L	67	0.0005	0.01	0.002	0.01		
Barium	mg/L	67	0.01	0.17	0.055	2		
Boron	mg/L	67	0.004	0.068	0.022	4		
Chromium	mg/L	67	0.0	0.050	0.004	0.05		
Mercury	mg/L	67	0.0001	0.003	0.008	0.001		
Molybdenum	mg/L	67	0.000	0.008	0.001	0.05		
Selenium	mg/L	67	0.001	0.02	0.002	0.01		
Uranium	mg/L	67	0.00	0.004	0.001	0.017		
Ammonia as N	mg/L	68	0.001	0.12	0.022		0.5	
Chloride	mg/L	68	6.1	31.8	17.99		250	
Fluoride	mg/L	69	0.02	1.7	0.206	1.5		
Beryllium	mg/L	62	0.00	0.004	0.001	0.06		
Nickel	mg/L	67	0.001	0.04	0.003	0.02		
Trihalomethanes, Total	µg/L	1	5	5	5	250		
Sulphate	mg/L	69	0.5	27.2	4.16		250	

[7] The ADWG does not actually set a limit for Cryptosporidium or Giardia as there is no reliable method of detection, but if one was to be set it would be <1

Hazard	Units	No. Samples	Min	Max	Mean	Health Upper Limit	Aesthetic Upper Limit	Aesthetic Lower Limit
Total Dissolved Solids by EC	mg/L	47	7.8	372	160		600	
Methyl Isoborneol[8]	ng/L	5	2	3	2		[10]5	
Geosmin	ng/L	5	2	2	2		[10]	
Nitrite as N	mg/L	9	0.01	0.01	0.01	3		
Nitrate as N, Calc	mg/L	9	0.02	0.23	0.08	50		
Alkalinity	mg/L	67	4	284	114			
Sodium	mg/L	67	2	96.4	20.9		180	
Malathion	µg/L	1	0.02	0.02	0.02	70		
Methidathion	µg/L	1	0.1	0.1	0.1	6		
Omethoate	µg/L	1	0.01	0.01	0.01	1		
Parathion	µg/L	1	0.2	0.2	0.2	20		
Parathion-methyl	µg/L	1	0.5	0.5	0.5	0.7		
Pirimiphos-methyl	µg/L	1	0.01	0.01	0.01	90		
Profenofos	µg/L	1	0.01	0.01	0.01	0.3		
Pyrazophos	µg/L	1	0.1	0.1	0.1	20		
Sulprofos	µg/L	1	0.05	0.05	0.05	10		
DDT	µg/L	1	0.01	0.01	0.01	9		
Aldrin	µg/L	1	0.01	0.01	0.01	0.3		
Dieldrin	µg/L	1	0.01	0.01	0.01	0.3		
Endosulfan sulfate	µg/L	1	0.01	0.01	0.01	20		
Heptachlor	µg/L	1	0.005	0.005	0.005	0.3		
Heptachlor epoxide	µg/L	1	0.01	0.01	0.01	0.3		
Acephate	µg/L	1	0.5	0.5	0.5	8		
Chlorfenvinphos	µg/L	1	0.02	0.02	0.02	2		
Chlorpyrifos	µg/L	1	0.02	0.02	0.02	10		
Diazinon	µg/L	1	0.01	0.01	0.01	4		
Dichlorvos	µg/L	1	0.2	0.2	0.2	5		
Dimethoate	µg/L	1	0.02	0.02	0.02	7		
Disulfoton	µg/L	1	0.05	0.05	0.05	4		
Ethion	µg/L	1	0.02	0.02	0.02	4		
Ethoprophos	µg/L	1	0.01	0.01	0.01	1		
Fenamiphos	µg/L	1	0.01	0.01	0.01	0.5		
Fenitrothion	µg/L	1	2	2	2	7		

[8] MIB and Geosmin result in taste and odour issues – limit is an ADWG operational target rather than an aesthetic guideline value

Hazard	Units	No. Samples	Min	Max	Mean	Health Upper Limit	Aesthetic Upper Limit	Aesthetic Lower Limit
Fenthion	µg/L	1	0.05	0.05	0.05	7		
Perfluorooctanoic acid	µg/L	2	0.002	0.01	0.006	0.07		
Sum of PFHxS and PFOS	µg/L	2	0.002	0.01	0.006	0.56		

APPENDIX 2 – CHARTERS TOWERS RETICULATED WATER RESULTS

Hazard	Units	No. Samples	Min	Max	Mean	Health Upper Limit	Aesthetic Upper Limit	Aesthetic Lower Limit	Guideline/ Indicator
Total Coliform	Org/100 mL	660	0	101	0.45				0
E. coli	Org/100 mL	683	0	1	0.004	0			
Heterotrophic Plate Count	Org/100 mL	656	0	300	9.3				0
Thermotolerant Coliforms	Org/100 mL	673	0	67	0.32	0			
Chlorine, Free	mg/L	693	0.05	4.14	1.41				5
Chlorine, Total	mg/L	131	0.20	3.43	1.6	5			
pH		735	6.86	8.52	7.8		8.5	6.5	
Turbidity	NTU	62	0.1	1.8	0.32		5		0.2
Colour, True	HU	77	0	13.0	0.91		15		
Sodium	mg/L	67	7.6	42.0	20.99		180		
Aluminium	mg/L	34	0.01	0.31	0.02		0.2		0.1
Iron	mg/L	67	0.002	0.43	0.011		0.3		
Manganese	mg/L	67	0.0003	0.06	0.001	0.5	0.1		
Copper	mg/L	67	0.001	0.163	0.008	2	1		
Zinc	mg/L	67	0.001	0.035	0.004		3		
Antimony	mg/L	67	0.0005	0.001	0.0006	0.003			
Arsenic	mg/L	67	0.0005	0.004	0.0011	0.01			
Barium	mg/L	67	0.017	0.082	0.039	2			
Boron	mg/L	67	0.004	0.050	0.021	4			
Cadmium	mg/L	67	0.0001	0.0004	0.0004	0.002			
Chromium	mg/L	67	0.0003	0.005	0.0005	0.05			
Lead	mg/L	67	0.0006	0.0010	0.0007	0.01			
Mercury	mg/L	34	0.0001	0.0006	0.0003	0.001			
Molybdenum	mg/L	67	0.0004	0.0020	0.0008	0.05			
Selenium	mg/L	67	0.001	0.01	0.0011	0.01			
Silver	mg/L	67	0.0004	0.0080	0.0009	0.1			
Uranium	mg/L	67	0.0004	0.0010	0.0006	0.017			
Ammonia as N	mg/L	77	0.0010	0.84	0.0607		0.5		
Chloride	mg/L	67	12.6	35.4	22.5		250		
Fluoride	mg/L	67	0.02	4.90	0.365	1.5			

Hazard	Units	No. Samples	Min	Max	Mean	Health Upper Limit	Aesthetic Upper Limit	Aesthetic Lower Limit	Guideline/ Indicator
Beryllium	mg/L	2	0.001	0.001	0.001	0.06			
Nickel	mg/L	43	0.001	0.001	0.001	0.02			
Trihalomethanes, Total	µg/L	21	8	292	81	250			
Sulphate	mg/L	16	0.5	9.2	3.8		250		
Hardness	mg/L	13	52	225.4	111				200
Silica	mg/L	19	11.9	24	18.3				80
Total Dissolved Solids by EC	mg/L	13	105	368	230		600		
Methyl Isoborneol	ng/L	21	1	2	1.3				10
Geosmin	ng/L	21	1	7	1.7				10
Nitrite as N	mg/L	10	0.01	0.01	0.01	3			
Nitrate as N, Calc	mg/L	9	0.03	0.19	0.08	50			
Perfluorooctanoic acid	µg/L	2	0.002	0.01	0.006	0.07			
Sum of PFHxS and PFOS	µg/L	2	0.002	0.01	0.006	0.56			

APPENDIX 3 – GREENVALE RAW WATER RESULTS

Hazard	Units	No. Samples	Min	Max	Mean	Health Upper Limit	Aesthetic Upper Limit	Aesthetic Lower Limit	Guideline/ Indicator
E. coli	Org/100 mL	0				0			
pH		36	7.42	8.38	7.95		8.5	6.5	
Turbidity	NTU	41	0.2	626	77		5		0.2
Colour, True	HU	41	0	86	11.4		15		
Sodium	mg/L	40	11.4	49.0	30.44		180		
Aluminium	mg/L	40	0.01	2.49	0.22		0.2		0.1
Iron	mg/L	40	0.002	2.8	0.46		0.3		
Manganese	mg/L	40	0.002	1.3	0.11	0.5	0.1		
Copper	mg/L	40	0.002	0.009	0.01	2	1		
Zinc	mg/L	40	0.001	0.15	0.01		3		
Antimony	mg/L	40	0.0005	0.001	0.0006	0.003			
Arsenic	mg/L	40	0.001	0.003	0.0015	0.01			
Barium	mg/L	40	0.043	0.132	0.0721	2			
Boron	mg/L	40	0.004	0.05	0.024	4			
Cadmium	mg/L	40	0.0001	0.0011	0.0002	0.002			
Chromium	mg/L	40	0.0001	0.0004	0.0003	0.05			
Lead	mg/L	40	0.0006	0.005	0.0008	0.01			
Mercury	mg/L	39	0.0003	0.0006	0.0004	0.001			
Molybdenum	mg/L	40	0.0004	0.006	0.0009	0.05			
Selenium	mg/L	40	0.001	0.01	0.0012	0.01			
Silver	mg/L	40	0.0004	0.003	0.0011	0.1			
Uranium	mg/L	40	0.0004	0.001	0.0008	0.017			
Ammonia as N	mg/L	41	0.002	0.099	0.0244		0.5		
Chloride	mg/L	41	9.7	42.3	25.6		250		
Sum of PFHxS and PFOS	µg/L	2	0.002	0.01	0.006	0.56			
Nitrite as N		7	0.01	0.01	0.01	3			
Nitrate as N, Calc		6	0.01	0.03	0.025	50			
Sulfate	mg/L	13	0.5	6.8	3.3		250		
Silica	mg/L	16	30.6	51.8	36.1				80
Total Dissolved Solids by EC	mg/L	22	7	429	257		600		

APPENDIX 4 – GREENVALE RETICULATED WATER RESULTS

Hazard	Units	No. Samples	Min	Max	Mean	Health Upper Limit	Aesthetic Upper Limit	Aesthetic Lower Limit	Guideline/ Indicator
Total Coliform	Org/100 mL	140	0	2	0.03				0
E. coli	Org/100 mL	140	0	0	0	0			
Heterotrophic Plate Count	Org/100 mL	140	0	300	25.8				0
Thermotolerant Coliforms	Org/100 mL	140	0	0	0	0			
Chlorine, Free	mg/L	148	0.05	4.97	2.05				5
Chlorine, Total	mg/L	23	0.41	4.6	2.46	5			
pH		139	7.47	8.84	8.31		8.5	6.5	
Turbidity	NTU	89	0.3	71.2	6.31		5		0.2
Colour, True	HU	48	0	22	3.0		15		
Alkalinity	mg/L	46	81.7	372	242.6				
Sodium	mg/L	45	28.4	53.9	40.9		180		
Aluminium	mg/L	45	0.005	5.11	0.310		0.2		0.1
Iron	mg/L	45	0.03	2.9	0.31		0.3		
Manganese	mg/L	45	0.008	0.24	0.038	0.5	0.1		
Copper	mg/L	45	0.001	0.011	0.002	2	1		
Zinc	mg/L	45	0.001	0.009	0.005		3		
Antimony	mg/L	45	0.0005	0.001	0.0008	0.003			
Arsenic	mg/L	45	0.001	0.003	0.002	0.01			
Barium	mg/L	45	0.037	0.107	0.071	2			
Boron	mg/L	45	0.01	0.034	0.021	4			
Cadmium	mg/L	49	0.0001	0.0055	0.001	0.002			
Chromium	mg/L	45	0.0003	0.005	0.0009	0.05			
Lead	mg/L	45	0.0006	0.002	0.0009	0.01			
Mercury	mg/L	45	0.0003	0.0006	0.0005	0.001			
Molybdenum	mg/L	45	0.0004	0.002	0.0009	0.05			
Selenium	mg/L	45	0.001	0.001	0.001	0.01			
Silver	mg/L	45	0.0004	0.003	0.0020	0.1			
Uranium	mg/L	45	0.0004	0.001	0.0008	0.017			
Ammonia as N	mg/L	52	0.01	0.02	0.02		0.5		
Chloride	mg/L	47	26.7	56.1	38.1		250		
Fluoride	mg/L	47	0.02	0.29	0.05	1.5			
Nickel	mg/L	6	0.001	0.001	0.001	0.02			
Trihalomethanes, Total	µg/L	8	96	208	149	250			

Hazard	Units	No. Samples	Min	Max	Mean	Health Upper Limit	Aesthetic Upper Limit	Aesthetic Lower Limit	Guideline/ Indicator
Sulfate	mg/L	13	0.5	6.8	3.0		250		
Hardness	mg/L	9	171.8	258.9	208.1				200
Total Dissolved Solids by EC	mg/L	9	292	426	367		600		
Nitrite as N	mg/L	7	0.01	0.01	0.01	3			
Nitrate as N, Calc	mg/L	6	0.02	0.04	0.03	50			

APPENDIX 5 – PENTLAND RAW WATER RESULTS

Hazard	Units	No. Samples	Min	Max	Mean	Health Upper Limit	Aesthetic Upper Limit	Aesthetic Lower Limit	Guideline/ Indicator
Total Coliform	Org/100 mL	46	0	613	22				0
E. coli	Org/100 mL	55	0	9	1	0			
Heterotrophic Plate Count	Org/100 mL	45	0	300	112				0
Thermotolerant Coliforms	Org/100 mL	43	0	50	2	0			
pH		58	6.7	8.8	6.9		8.5	6.5	
Turbidity	NTU	63	0.1	5.4	0.36		5		0.2
Colour, True	HU	63	0	10	0.54		15		
Sodium	mg/L	62	16.3	26.8	22.6		180		
Aluminium	mg/L	62	0.01	0.26	0.01		0.2		0.1
Iron	mg/L	62	0.001	0.13	0.008		0.3		
Manganese	mg/L	62	0.000	0.01	0.001	0.5	0.1		
Copper	mg/L	62	0.001	0.004	0.002	2	1		
Zinc	mg/L	62	0.002	0.019	0.006		3		
Antimony	mg/L	62	0.0004	0.0010	0.0006	0.003			
Arsenic	mg/L	62	0.0004	0.002	0.0006	0.01			
Barium	mg/L	62	0.011	0.029	0.016	2			
Boron	mg/L	62	0.003	0.050	0.021	4			
Cadmium	mg/L	62	0.0001	0.0004	0.0003	0.002			
Chromium	mg/L	62	0.0002	0.0010	0.0005	0.05			
Lead	mg/L	62	0.0005	0.0010	0.0007	0.01			
Mercury	mg/L	31	0.0001	0.0009	0.0003	0.001			
Molybdenum	mg/L	62	0.0004	0.0020	0.0008	0.05			
Selenium	mg/L	62	0.0010	0.0100	0.0022	0.01			
Silver	mg/L	62	0.0003	0.0030	0.0009	0.1			
Uranium	mg/L	62	0.0004	0.0010	0.0006	0.017			
Ammonia as N	mg/L	64	0.004	0.2	0.025		0.5		
Chloride	mg/L	63	12.8	19.4	15.2		250		
Fluoride	mg/L	63	0.16	0.32	0.27	1.5			
Beryllium	mg/L	62	0.0003	0.0010	0.0005	0.06			
Nickel	mg/L	62	0.001	0.005	0.002	0.02			
Trihalomethanes, Total	µg/L	3	5	7	6	250			
Sulphate	mg/L	62	2.0	10.4	7.2		250		
Hardness	mg/L	41	61.7	96.5	80.6				200
Silica as SiO2	mg/L	62	11.4	87.9	54.6				80
Total Dissolved Solids by EC	mg/L	42	167	209	178		600		

APPENDIX 6 – PENTLAND RETICULATED WATER RESULTS

Hazard	Units	Count	Min	Max	Mean	Health Upper Limit	Aesthetic Upper Limit	Aesthetic Lower Limit	Guideline/ Indicator
Total Coliform	Org/100 mL	149	0	201	2.3				0
E. coli	Org/100 mL	148	0	0	0	0			
Heterotrophic Plate Count	Org/100 mL	148	0	300	16				0
Thermotolerant Coliforms	Org/100 mL	156	0	300	4	0			
Chlorine, Free	mg/L	153	0.11	9.6	1.71				5
pH		149	6.9	7.8	7.3		8.5	6.5	
Turbidity	NTU	63	0.1	1	0.2		5		0.2
Colour, True	HU	64	0	5	0.27		15		
Sodium	mg/L	61	15.3	27.1	22.7		180		
Aluminium	mg/L	61	0.005	0.344	0.014		0.2		0.1
Iron	mg/L	60	0.001	0.05	0.06		0.3		
Manganese	mg/L	61	0.0002	0.004	0.0005	0.5	0.1		
Copper	mg/L	61	0.001	0.009	0.004	2	1		
Zinc	mg/L	61	0.003	0.02	0.09		3		
Antimony	mg/L	61	0.0004	0.001	0.0006	0.003			
Arsenic	mg/L	61	0.0004	0.001	0.0006	0.01			
Barium	mg/L	61	0.013	0.028	0.02	2			
Boron	mg/L	61	0.004	0.05	0.02	4			
Cadmium	mg/L	61	0.0001	0.0004	0.0003	0.002			
Chromium	mg/L	61	0.0002	0.001	0.0006	0.05			
Lead	mg/L	61	0.0005	0.001	0.0006	0.01			
Mercury	mg/L	61	0.0001	0.0006	0.0003	0.001			
Molybdenum	mg/L	61	0.0004	0.002	0.0009	0.05			
Selenium	mg/L	61	0.001	0.01	0.002	0.01			
Silver	mg/L	61	0.0004	0.003	0.0021	0.1			
Uranium	mg/L	60	0.0003	0.003	0.0009	0.017			
Ammonia as N	mg/L	64	0.004	0.11	0.019		0.5		
Chloride	mg/L	64	14	24	17		250		
Fluoride	mg/L	59	0.054	0.32	0.27	1.5			
Beryllium	mg/L	3	0.0003	0.0004	0.0004	0.06			
Nickel	mg/L	39	0.0001	0.005	0.003	0.02			
Trihalomethanes, Total	µg/L	12	5	20	8	250			
Sulphate	mg/L	64	2.0	75	8.4		250		
Hardness	mg/L	41	65	100	84				200

Hazard	Units	Count	Min	Max	Mean	Health Upper Limit	Aesthetic Upper Limit	Aesthetic Lower Limit	Guideline/ Indicator
Silica	mg/L	57	9.3	127	56.2				80
Total Dissolved Solids by EC	mg/L	42	165	235	184		600		
Methyl Isoborneol	ng/L	3	1	5	2.7				10
Geosmin	ng/L	4	1	5	2.5				10
Nitrite as N	mg/L	17	0.0051	0.005	0.005	3			
Nitrate as N, Calc	mg/L	17	0.005	0.19	0.109	50			

APPENDIX 7 – RAVENSWOOD RAW WATER RESULTS

Hazard	Units	Count	Min	Max	Mean	Health Upper Limit	Aesthetic Upper Limit	Aesthetic Lower Limit	Guideline/ Indicator
Total Coliform	Org/100 mL	23	0	39,000	4,414				0
E. coli	Org/100 mL	18	0	60	11	0			
Heterotrophic Plate Count	Org/100 mL	24	0	300	264				0
Thermotolerant Coliforms	Org/100 mL	23	1	20,000	990	0			
pH		36	7	9	8.3		8.5	6.5	
Turbidity	NTU	36	7	9	8.3		5		0.2
Colour, True	HU	36	2	34	11.2		15		
Sodium	mg/L	35	18	35	26.4		180		
Aluminium	mg/L	35	0.06	2.51	0.35		0.2		0.1
Iron	mg/L	35	0.11	1.4	0.29		0.3		
Manganese	mg/L	35	0.006	0.3	0.031	0.5	0.1		
Copper	mg/L	35	0.001	0.017	0.002	2	1		
Zinc	mg/L	35	0.001	0.031	0.003		3		
Antimony	mg/L	35	0.0004	0.001	0.0005	0.003			
Arsenic	mg/L	35	0.002	0.005	0.003	0.01			
Barium	mg/L	35	0.02	0.247	0.063	2			
Boron	mg/L	35	0.005	0.046	0.031	4			
Cadmium	mg/L	35	0.0001	0.0004	0.0003	0.002			
Chromium	mg/L	35	0.0002	0.001	0.0004	0.05			
Lead	mg/L	35	0.0005	0.001	0.0006	0.01			
Mercury	mg/L	35	0.0002	0.0006	0.0003	0.001			
Molybdenum	mg/L	35	0.002	0.007	0.0033	0.05			
Selenium	mg/L	35	0.0005	0.001	0.0008	0.01			
Silver	mg/L	35	0.0003	0.003	0.0006	0.1			
Uranium	mg/L	35	0.0003	0.001	0.0006	0.017			
Ammonia as N	mg/L	34	0.01	0.06	0.023		0.5		
Chloride	mg/L	34	16.3	29.1	21.8		250		
Fluoride	mg/L	34	0.16	0.35	0.23	1.5			
Beryllium	mg/L	35	0.0003	0.001	0.0004	0.06			
Nickel	mg/L	35	0.0005	0.001	0.0008	0.02			
Trihalomethanes, Total	µg/L	1	5	5	5	250			
Sulfate	mg/L	34	0.62	6.6	3.2		250		
Hardness	mg/L	24	88	123	103				200
Total Dissolved Solids by EC	mg/L	25	186	236	208		600		

APPENDIX 8 – RAVENSWOOD RETICULATED WATER RESULTS

Hazard	Units	Count	Min	Max	Mean	Health Upper Limit	Aesthetic Upper Limit	Aesthetic Lower Limit	Guideline/ Indicator
Total Coliform	Org/100 mL	62	0	411	7				0
E. coli	Org/100 mL	38	0	1	0	0			
Heterotrophic Plate Count	Org/100 mL	38	0	300	15				0
Thermotolerant Coliforms	Org/100 mL	38	0	0	0	0			
Chlorine, Free	mg/L	38	0.5	3.6	1.5				5
Chlorine, Total	mg/L	1	1.4	1.4	1.38	5			
pH		38	6.9	8.9	7.4		8.5	6.5	
Turbidity	NTU	37	0.1	6	0.9		5		0.2
Colour, True	HU	1	0	2.0	0.7		15		
Sodium	mg/L	16	25	42	34		180		
Aluminium	mg/L	16	0.04	0.7	0.22		0.2		0.1
Iron	mg/L	16	0.01	0.19	0.05		0.3		
Manganese	mg/L	16	0.002	0.13	0.01	0.5	0.1		
Copper	mg/L	17	0.001	0.002	0.002	2	1		
Zinc	mg/L	16	0.003	0.035	0.010		3		
Antimony	mg/L	16	0.0005	0.0005	0.0005	0.003			
Arsenic	mg/L	16	0.001	0.002	0.001	0.01			
Barium	mg/L	31	0.031	0.116	0.053	2			
Boron	mg/L	16	0.026	0.045	0.036	4			
Cadmium	mg/L	16	0.0004	0.0004	0.0004	0.002			
Chromium	mg/L	16	0.0003	0.0003	0.0003	0.05			
Lead	mg/L	16	0.0006	0.0006	0.0006	0.01			
Mercury	mg/L	16	0.0003	0.0003	0.0003	0.001			
Molybdenum	mg/L	16	0.002	0.005	0.004	0.05			
Selenium	mg/L	16	0.001	0.001	0.001	0.01			
Silver	mg/L	16	0.0004	0.0004	0.0004	0.1			
Uranium	mg/L	16	0.0004	0.0004	0.0004	0.017			
Ammonia as N	mg/L	19	0.02	0.02	0.02		0.5		
Chloride	mg/L	15	25.3	39.6	31.4		250		
Fluoride	mg/L	15	0.02	0.21	0.11	1.5			
Nickel	mg/L	6	0.001	0.001	0.001	0.02			
Trihalomethanes, Total	ng/L	11	29	116	70	250			
Sulfate	mg/L	15	36	109	60		250		

Hazard	Units	Count	Min	Max	Mean	Health Upper Limit	Aesthetic Upper Limit	Aesthetic Lower Limit	Guideline/ Indicator
Hardness	mg/L	8	90	115	103				200
Total Dissolved Solids by EC	mg/L	9	234	293	259		600		
Nitrite as N	mg/L	6	0.01	0.01	0.01	3			
Nitrate as N, Calc	mg/L	6	0.01	0.03	0.02	50			

APPENDIX 9 – CHARTERS TOWERS RISK ASSESSMENT

Hazard	Current Preventive Measures	Hazardous Event	Consequence Description	Consequence Rating	Likelihood Description	Likelihood Rating	Risk Score	Risk Descriptor	Ongoing Actions	Verification Requirement	Risk Improvement Item
Algae/MIB/ Geosmin	Filtration, Chlorination	Exceed taste/odour threshold	Aesthetic risk or an algal toxin risk	3	Detected levels are generally low	2	2	Moderate	Monitor	Annual algae samples	
Aluminium	Clarification/ Filtration/Jar testing/ Sampling	High aluminium in the treated water	Post-floc in retic and aesthetic impact to consumers	2	Treatment will remove naturally occurring aluminium. Overdosing of ACH could lead to high aluminium in the treated water. May be picked up by increase in outgoing turbidity	3	2	Moderate	Jar testing to optimise dose rates. Daily SCADA setpoint checks	Aluminium levels in reticulation to be monitored monthly	
Amoeba - Naegleria Fowleri	Chlorine residual	Low chlorine with high heat allows development of this amoeba	Illness risk in pools which are not re- chlorinated	2	A variety of events which lead to low chlorine have higher level consequences so the risk of this situation developing is low	2	1	Low	Daily/weekly chlorine checks	Annual testing in summer	
Chlorates	Ongoing	Chlorates introduced at the reservoirs from the sodium hypochlorite dosing system	There is no ADWG limit for Chlorates however Qld Health has set a limit of 0.8 mg/l	4	Potential for generation of chlorates in the Calcium Hypochlorite dosing system at the reservoirs. This is a re-dosing system and the quantities are smal.l	1	3	Moderate	Minimise storage times and avoid hot conditions in storage	Monthly	
Chlorine	Two Chlorine analysers at the WTP, Re-dose system limited in capacity, daily sampling	Chlorine overdose due to operator/ maintainer error	High chlorine will generally be picked up by consumers through taste/odour. It would be detected and reported before rising to dangerous levels	3	Maintenance staff are not very familiar with this specialised equipment however a full set of process drawings and maintenance manuals are available. If detected, high chlorine will stop the plant.	2	2	Moderate	Daily chlorine checks. Calibration of analysers; control of on-site maintenance activities. Full investigation of all alarms.	Weekly chlorine samples	
Chlorine	Two Chlorine analysers at the WTP, Re-dose system limited in capacity, daily sampling	Failure of chorine analyser causes high chlorine in the reticulated water	High chlorine will generally be picked up by consumers through taste/odour. It would be detected and reported before rising to dangerous levels	3	Primary dose is based on a setpoint. Trim dose is based on the measurement of the residual so it is the trim dose system which would try to overdose. Trim dose system is of smaller capacity than the primary and therefore has limited capacity.	2	2	Moderate	Daily residual checks at WTP, reservoir and Hospital	Weekly chlorine sample	
Chlorine	Two Chlorine analysers at the WTP, Re-dose system limited in capacity, daily sampling	Overdose of primary chlorine lets high chlorine water into the reticulation system	High chlorine will generally be picked up by consumers through taste/odour. It would be detected and reported before rising to dangerous levels	3	Dosing systems are controlled via SCADA and are flow paced. It is unlikely that they will inherently overdose. Chlorine analyser on filtered water and on pump discharge will detect the overdose and stop the plant. As the dose point is before the treated water storage it is unlikely that high dosed water would make it to the pumps.	1	2	Moderate	Preventative maintenance and calibration of analysers. Weekly check of alarms and setpoints. Daily residual checks at WTP and reservoir	Weekly chlorine sample	
Chlorine	Two Chlorine analysers at the WTP, Re-dose system limited in capacity, daily sampling	Overdose of reservoir re-dose system causing high chlorine in reticulation	High chlorine will generally be picked up by consumers through taste/odour. It would be detected and reported before rising to dangerous levels	3	Re-dose system is of limited physical capacity such that even if it ran continuously it could not change the residual significantly in a 24 hour period and therefore the change in chlorine would be detected	1	2	Moderate	Daily checks and chlorine residuals	Weekly chlorine sample	
Chlorine	2 Chlorine analysers at the WTP, Re-dose system limited in capacity, daily sampling	Tampering with Chlorine dosing at WTP lets high chlorine water into the reticulation system	High chlorine will generally be picked up by consumers through taste/odour. It would be detected and reported before rising to dangerous levels	3	Site is fenced, dose rate is controlled by SCADA. Plant will stop if high chlorine is detected	1	2	Moderate	Locking gates, morning inspection of site, fully investigating alarms		

Hazard	Current Preventive Measures	Hazardous Event	Consequence Description	Consequence Rating	Likelihood Description	Likelihood Rating	Risk Score	Risk Descriptor	Ongoing Actions	Verification Requirement	Risk Improvement Item
Chlorine	Two Chlorine analysers at the WTP, Re-dose system limited in capacity, daily sampling	Tampering with control system	High chlorine will generally be picked up by consumers through taste/odour. It would be detected and reported before rising to dangerous levels	3	Hacker would have to get through CTRC security and log on to SCADA with an account with sufficient authority to make changes. If both chlorine analysers were put into simulate mode, then in theory the chlorine dose rate could be increased to the maximum possible dose - the effect of which is dependent on the flow rate at the time.	2	2	Moderate	Daily chlorine samples. Password management, logging out of unattended SCADA sessions. Weekly SCADA settings and alarm review		
Chromium	Clarification, filtration	Elevated total chromium levels in the raw water allow Chromium III to pass through to reticulation and oxidise to Chromium VI	Levels above ADWG in reticulation	4	Only one total chromium exceedance in the raw water monitoring data. Chromium III can be removed by conventional treatment.	1	3	High	Jar testing regularly and upon a change of raw water quality; daily turbidity checks; Verify SCADA setpoints and alarms weekly	Quarterly	
Cryptosporidium/ Giardia	Clarification/ Filtration/ Reservoir Roofs	Contamination at the reservoirs by mammals such as possums (crypto) or birds (giardia)	Public health risk	4	Steel reservoir Roof is in good condition. Concrete reservoir roof is in poor condition.	3	4	Very High	Reservoir preventative maintenance	Weekly E.coli (as a surrogate)	Replace the concrete reservoir as it is not in good condition
Cryptosporidium/ Giardia	Clarification/ Filtration/ Reservoir Roofs	Contamination by mammals such as possums (crypto) or birds (giardia) in the unroofed Treated Water Storage	Public health risk	4	Unroofed, no control over possums or birds	5	4	Very High		Weekly E.coli (as a surrogate)	Module 1 Storage is being reconfigured to replace the Clear Water Tank. To be completed in 2023 FY.
Cryptosporidium/ Giardia	Clarification/ Filtration	Increase in crypto/giardia due to recreation or cattle	Public health risk	4	Not able to fully assess this without conducting a Health Based Targets Assessment. Use turbidity as an indicator of filter effectiveness.	2	3	High	Jar testing regularly and upon a change of raw water quality; daily turbidity checks; Verify SCADA setpoints and alarms weekly	Weekly E.coli (as a surrogate)	Conduct Health Based Targets assessment of the raw water and treatment to determine if UV treatment is warranted
Cryptosporidium/ Giardia	Clarification/ Filtration	Turbidity breakthrough at WTP allows cysts to pass through	Public health risk	4	Control system will stop the plant if the turbidity exceeds the limits at any step. Dosing systems detect failure in the flow and stop the plant.	1	3	High	Jar testing regularly and upon a change of raw water quality; daily raw, settled, filtered and treated water turbidity checks; Verify SCADA setpoints and alarms weekly	Weekly E.coli (as a surrogate)	Conduct Health Based Targets assessment of the raw water and treatment to determine if UV treatment is warranted
E.coli/Coliforms	Clarification/ Filtration/ Chlorine at WTP/ Re-dose at Reservoir	Chlorine system failure at the WTP	Bacterial contamination	5	There are 4 chlorinators available and 2 chlorine drums on line. The chlorine analyser on the treated water will stop the plant if chlorine is low.	1	3	High	Preventative maintenance, weekly SCADA alarm and setpoint checks.	Weekly chlorine and E.coli tests.	
E.coli/Coliforms	Clarification/ Filtration/ Chlorine at WTP/Re-dose at Reservoir	Contamination at the reservoir	Bacterial contamination	5	Steel reservoir has a new roof. Concrete reservoir is a risk, Sites are fenced. Level of chlorine and the re-dose system provide a degree of protection	2	4	Very High	Preventative maintenance inspections on reservoirs	Weekly chlorine and E.coli tests.	Replace the concrete reservoir as it is not in good condition
E.coli/Coliforms	Clarification /Filtration/ Chlorine at WTP/Re-dose at Reservoir	Contamination at unroofed Treated Water Storage	Bacterial contamination	5	Open tank and birds etc are known to fly above it. Chlorine residual will provide a degree of protection.	3	4	Very High	Daily checks and chlorine residuals		Module 1 Storage is being reconfigured to replace the Clear Water Tank. To be completed in 2023 FY.

Hazard	Current Preventive Measures	Hazardous Event	Consequence Description	Consequence Rating	Likelihood Description	Likelihood Rating	Risk Score	Risk Descriptor	Ongoing Actions	Verification Requirement	Risk Improvement Item
E.coli/Coliforms	Clarification/ Filtration/ Chlorine at WTP/Re-dose at Reservoir	Control System failure at the WTP allows unfiltered/unchlorinated water to pass through	Bacterial contamination	5	System has been tested sufficiently to be sure that the plant will stop if abnormal conditions arise.	1	3	High	Alarm management, daily checks, instrument calibration		
E.coli/Coliforms	Clarification/ Filtration/ Chlorine at WTP/Re-dose at Reservoir	Control System Sabotage allows untreated/ unchlorinated water to pass through	Bacterial contamination	5	Hacker would have to get through CTRC security and log on to SCADA with an account with sufficient authority to make changes. Significant knowledge of the process systems would be required to allow untreated water to pass through - multiple analysers and dosing systems would have to be put into simulate mode.	1	3	High	Password management, logging out of unattended SCADA sessions, alarm management		
E.coli/Coliforms	Clarification/ Filtration/ Chlorine at WTP/Re-dose at Reservoir	Increase in E.coli due to recreation or contamination at the weir	Bacterial contamination	5	Filtration and chlorine will protect the system from this risk up to a limit	1	3	High	Monitor weir for pollution and carcasses	Weekly E.coli	
E.coli/Coliforms	Clarification/ Filtration/ Chlorine at WTP/Re-dose at Reservoir	Introduction of contamination during mains break	Bacterial contamination in a segment of the system	4	Residual chlorine reduces the risk however there has been little training for retic staff in water quality management during mains breaks so it is possible.	2	3	High			Water quality training for Reticulation staff
E.coli/Coliforms	Clarification/ Filtration/ Chlorine at WTP/Re-dose at Reservoir/ Flushing	Low chlorine due to long detention times in the reticulation system allows re-growth	Bacterial contamination at the ends of the reticulation system	4	Having a shared retic/trunk main makes chlorine management difficult. Reservoir is checked daily and retic is checked weekly. Flushing occurs when issues detected	2	3	High	Daily chlorine residuals at the reservoirs	Weekly residual checks	Dedicated inlet and outlet mains at the reservoir to ensure adequate turnover
E.coli/Coliforms	Clarification/ Filtration/ Chlorine at WTP/Re-dose at Reservoir	Old WTP process trains are brought on line, allowing dirty water to enter the system, carrying the risk of E.coli	Stale/high turbidity water will enter the TWS and will need to be dumped	3	Process has been trialled. Manual valves have to be opened for this to occur.	2	2	Moderate	Practice this changeover		Minor upgrades to ensure the old module can still run without compromising water quality
E.coli/Coliforms	Clarification/ Filtration/ Chlorine at WTP/Re-dose at Reservoir	Run out of Chlorine	Supply unchlorinated water under a boil water notice	4	920kg drums are also used a the STP. Could borrow a drum from Townsville if problem is only impacting Charters Towers (i.e. not a national shortage)	1	3	High	Monitor drum holdings. Order extra during risky periods		
E.coli/Coliforms	Clarification/ Filtration	Run out of flocculants	Plant will stop so release of contaminated water would have to be a controlled deliberate decision.	4	New tanks allow for extra chemical to be held and the levels are visible on SCADA and at the tank	1	3	High	Monitor chemical levels and re-order well in advance		
E.coli/Coliforms	Clarification/ Filtration/ Chlorine at WTP/Re-dose at Reservoir	Turbidity breakthrough at WTP which allows bacteria to be shielded from chlorine	Bacterial contamination	5	Control system will stop the plant if the turbidity exceeds the limits at any step. Dosing systems have flow detectors which will stop the plant if dosing stops.	1	3	High	Jar testing regularly and upon a change of raw water quality; daily turbidity checks; Verify SCADA setpoints and alarms weekly	Weekly turbidity and E.coli sampling	
Ethyl Benzene	Nil	Motor boat fuel spill in Weir water body	Petroleum by-products above ADWG guidelines	3	Small amount of fuel in a large body of water is unlikely to cause issues. Only a problem if the spill is immediately in front on the intake - 100m exclusion zone is in place	2	2	Moderate	Monitor activity at the weir and report unsafe actions		

Hazard	Current Preventive Measures	Hazardous Event	Consequence Description	Consequence Rating	Likelihood Description	Likelihood Rating	Risk Score	Risk Descriptor	Ongoing Actions	Verification Requirement	Risk Improvement Item
Iron/manganese	Clarification/ Filtration	High iron/manganese in the raw water leads to elevated levels in retic	Aesthetic impact on consumers	2	Treatment processes have demonstrated effectiveness to reduce the levels	1	1	Low	Jar testing regularly and upon a change of raw water quality; daily turbidity checks	Monthly raw water and reticulation samples	
Lead	Clarification/ Filtration	High lead in retic	Health risk	4	Very low likelihood of passthrough from WTP. More likely to be picked up from old brass fittings in household plumbing due to the age of the houses in Charters Towers	1	3	High	Jar testing regularly and upon a change of raw water quality; daily turbidity checks; Verify SCADA setpoints and alarms weekly	Monthly lead samples	
Nickel	Clarification/ Filtration	Increased concentration of nickel in the raw water passes through to treated water	Health Risk	3	Low likelihood of passthrough to reticulation	1	2	Moderate	Jar testing regularly and upon a change of raw water quality; daily turbidity checks; Verify SCADA setpoints and alarms weekly	Minimum quarterly	
Pesticides	Clarification/ Filtration	Increase in pesticides in the raw water due to farming activities	Pesticide levels above ADWG	3	Background levels are low. Most likely a spill would be required to have a significant impact on the levels - or high runoff rate during drought (reduced water body size)	1	2	Moderate		Annual pesticide sweep	
PFAS	Nil	Increase in PFAS in the raw water	PFAS levels above ADWG limits	4	Testing has found low levels but increases are possible with a large catchment	1	3	High	Ongoing monitoring	Annual PFAS sampling	
pH	Monitoring/ dosing	High pH due to low/no acid dose	pH above ADWG limit	2	pH analyser will detect the high pH and will alarm. Acid dose rate is manually set in SCADA to avoid running in auto dose rate based on a pH analyser. This means that the setpoint must be reviewed often to avoid this risk.	2	1	Low	Daily pH sample; weekly SCADA setpoint and alarm review	Weekly Reservoir sample	
pH	Monitoring	Low pH due to acid overdose	Low pH below ADWG limit	2	pH analyser will detect the low pH and will alarm. Dose rate is set and reviewed periodically	2	1	Low	Weekly check of SCADA settings and alarms; daily pH samples		
Polydiethyl dimethyl ammonium chloride/ Polyacrylamide	Dose rates/ clarification/ filtration	Overdose of polymers	Health risk	4	Low dose rates and quality controlled product should result in low likelihood of primary elements or contaminants being at a level of concern	2	3	High	Weekly check of SCADA settings. Daily check of dose rates. Jar testing.	Monthly Acrylamide sample	Periodic check of chemical purity through supplier
Trihalomethanes	Clarification/ Filtration	THMs above ADWG limits	Health risk	3	Generally will be low due to removal of organics at the WTP. Organics growing on slow moving pipelines create the risk, particularly if disturbed by high flows	2	2	Moderate	Mains flushing to remove organic growth	Monitor THMs quarterly	

APPENDIX 10 – GREENVALE RISK ASSESSMENT

Hazard	Current Preventative Measures	Hazardous Event	Consequence Description	Consequence Rating	Likelihood Description	Likelihood Rating	Risk Score	Risk Descriptor	Ongoing Actions	Verification Requirement	Risk Improvement Item
Algae, MIB, Geosmin	Minor removal in carbon tank	Increase in algae/MIB/Geosmin levels	Taste/odour issues or algal toxins	3	No sampling has been done to determine a likelihood however sampling downstream at Charters Towers has not revealed any appreciable levels.	2	2	Moderate		Annual raw water sample to provide a baseline	
Amoeba - Naegleria Fowleri	Chlorine residual	Low chlorine with high heat allows development of this amoeba	Illness risk in pools which are not re-chlorinated	2	There are a variety of events which could lead to low chlorine which have higher level consequences so the risk of this situation developing is low	2	1	Low	Daily/Weekly checks by Town Officer	Annual testing in summer	
Chlorates	Turnover of sodium hypochlorite stocks	Develop chlorate levels beyond WHO recommended level	There is no ADWG limit for Chlorates however Qld Health has set a limit of 0.8 mg/L.	4	Long Hypo supply and holding times, high temperature, no stock management procedures cause this to be likely (based on research performed by Townsville Water)	4	4	Very High	Turnover of hypo stock	Monthly	Replace Sodium Hypochlorite dosing systems with gaseous Chlorine systems. Design for upgraded treatment plant now in progress.
Chlorine	Chlorine analyser at Reservoir, chlorine samples in retic	Chlorine overdose at river pumps due to setting error	High chlorine will generally be picked up by consumers through taste/odour. It would be detected and reported before rising to dangerous levels	3	Dosing is on a setpoint and the dosing pump is of limited capacity. Reservoir system will stop dosing and an alarm will be raised on outgoing residual if it is too high.	2	2	Moderate	Weekly site checks, calibration of analysers; weekly check of SCADA alarms and setpoints	Monthly reservoir and reticulation free chlorine samples	To be addressed with upgraded WTP and supply system.
Chlorine	Chlorine analyser at Reservoir, chlorine samples in retic, SCADA security measures	Chlorine overdose due to control system sabotage	High chlorine will generally be picked up by consumers through taste/odour. It would be detected and reported before rising to dangerous levels	3	Hacker would need to get through CTRC security and log on to SCADA with Engineer rights in order to set the chlorine analyser to a simulated low value to force the dosing system to keep running. The run timer will however cause this to alarm, allowing the system to be shut down.	2	2	Moderate	Weekly site checks, calibration of analysers; weekly check of SCADA alarms and setpoints	Monthly reservoir and reticulation free chlorine samples	To be addressed with upgraded WTP and supply system.
Chlorine	Chlorine analyser at Reservoir, chlorine samples in retic, locked gates at reservoir	Chlorine overdose from the primary chlorinator due to tampering with chlorine dosing system	High chlorine will generally be picked up by consumers through taste/odour. It would be detected and reported before rising to dangerous levels	3	Fence around site and locked door on chlorination room. Analyser will detect high chlorine and will alarm	2	2	Moderate	Weekly site checks, calibration of analysers; weekly check of SCADA alarms and setpoints	Monthly reservoir and reticulation free chlorine samples	To be addressed with upgraded WTP and supply system.
Chlorine	Chlorine analyser at Reservoir, chlorine samples in retic	Chlorine overdose from the reservoir chlorinator due to control error	High chlorine will generally be picked up by consumers through taste/odour. It would be detected and reported before rising to dangerous levels	3	Dosing is based on the chlorine analysis of the recirculating line. If the analyser is artificially reading low then the system will continue to dose however there is a timer on the dosing pump which will alarm if it runs for an unreasonable duration	2	2	Moderate	Weekly site checks, calibration of analysers; weekly check of SCADA alarms and setpoints	Monthly reservoir and reticulation free chlorine samples	To be addressed with upgraded WTP and supply system.
Chlorine	Chlorine analyser at Reservoir, chlorine samples in retic	Chlorine overdose from the reservoir chlorinator due to operator/maintainer error	High chlorine will generally be picked up by consumers through taste/odour. It would be detected and reported before rising to dangerous levels	3	Pipework is not documented or labelled. There are no set maintenance procedures. The point where the chlorine dosing flow goes back into the reservoir is unknown. An overdose event due to this hazard event has occurred previously.	5	4	Very High	Daily/weekly site checks, calibration of analysers; weekly check of SCADA alarms and setpoints	Monthly reservoir and reticulation free chlorine samples	Document and label pipework. Document processes. Establish control over changes to infrastructure configuration

Hazard	Current Preventative Measures	Hazardous Event	Consequence Description	Consequence Rating	Likelihood Description	Likelihood Rating	Risk Score	Risk Descriptor	Ongoing Actions	Verification Requirement	Risk Improvement Item
Chlorine	Chlorine dosing at River, Chlorine dosing at reservoir	Loss of Chlorine analyser reagent leads to SCADA interpreting zero Chlorine and subsequent overdosing .	High chlorine will generally be picked up by consumers through taste/odour. It would be detected and reported before rising to dangerous levels	3	Has occurred when Town Operator took leave and replacement did not check reagent levels.	4	4	Very High	Weekly manual chlorine samples	Monthly chlorine, E.coli testing	Ensure Local Operators and replacement or relief staff are trained in monitoring and sampling. Ensure SCADA alarms are effective in determining event symptoms.
Cryptosporidium, Giardia	Nil	Increase in crypto/giardia in the water through upstream activities	Crypto/giardia risk in reticulated water - illness	4	Likely to occur during rain/turbidity events however there is no sampling data to confirm this	4	4	Very High	Declare boil water alert based on turbidity target	Monthly turbidity and E.coli testing as surrogates for crypto	Full Health Based Target Assessment required to determine suitable level of treatment required for crypto/giardia
Cryptosporidium, Giardia	Nil	Introduction of contamination by mammals (crypto) or birds (giardia) at Reservoir	Crypto/giardia risk in reticulated water - illness	4	Reservoir roof is in moderate condition so it is unlikely that this will occur, and will be refurbished under upgrade program.	2	3	High	Reservoir preventative maintenance	Monthly E.coli testing as surrogates for Crypto	Reservoir upgrade program to ensure it is sealed against vermin and runoff
E.coli, Coliforms	Chlorine dosing at River, Chlorine dosing at reservoir	Cross connection with sewerage	Increase in bacteria beyond the capacity of the chlorine - public health impact	4	No GIS however location of mains are generally known	2	3	High	Caution when cutting into mains	Sampling after works on mains	Improve asset mapping capability to reduce the risk of cross connections
E.coli, Coliforms	Chlorine dosing at River, Chlorine dosing at reservoir	Failure of Reservoir chlorine analyser leads to low chlorine and bacteria entering the reticulation system	Bacterial contamination	4	Single analyser in a remote location so failure is possible. If the analyser is unavailable, the dosing will stop and an alarm is raised. If the analyser reads a false high which will stop the dosing, a high chlorine alarm will be raised. If the analyser freezes on a value above the setpoint but below the high level (very unusual fault conditions), then the dosing system will not run	2	3	High	Weekly manual chlorine samples	Monthly chlorine, E.coli testing	Dual chlorine analysers would be beneficial due to the remote location
E.coli, Coliforms	Chlorine dosing at River, Chlorine dosing at reservoir	Failure of Reservoir chlorine dosing unit allows bacteria into the reticulation system	Bacterial contamination	4	Single dosing pump, single recirculation pump. Analyser will detect and alarm on the drop in chlorine on the outlet of the reservoir. Raw water pumps will then be turned off to reduce the dilution of chlorine in the reservoir until the dosing system is rectified.	2	3	High	Maintenance of dosing system; weekly checks of SCADA to ensure alarms are enabled	Monthly chlorine, E.coli testing	Long term plan for Greenvale water treatment will need to include redundancy of dosing systems
E.coli, Coliforms	Chlorine dosing at River, Chlorine dosing at reservoir	Failure of River chlorine dosing unit lowers the chlorine level and allows bacteria to pass through to the reticulation system.	Bacterial contamination	4	This is likely since there is a single dosing pump however the reservoir recirculating chlorination will dose for longer to make up the difference so there will be sufficient chlorine	1	3	High	Maintenance of dosing system; weekly checks of SCADA to ensure alarms are enabled		
E.coli, Coliforms	Chlorine dosing at River, Chlorine dosing at reservoir, bed sand spears	High turbidity entering the system masks bacteria from chlorine and allows bacteria into the reticulation system	Bacterial contamination	4	Constantly have high turbidity and little filtration so this is very likely to occur. Bedsand spears are influenced by surface water turbidity	5	4	Very High	Monitoring of turbidity levels leaving the reservoir. Boil water alert based on turbidity.	Monthly turbidity samples	Upgraded supply system to address improved water quality at the extraction point

Hazard	Current Preventative Measures	Hazardous Event	Consequence Description	Consequence Rating	Likelihood Description	Likelihood Rating	Risk Score	Risk Descriptor	Ongoing Actions	Verification Requirement	Risk Improvement Item
E.coli, Coliforms	Chlorine dosing at River, Chlorine dosing at reservoir	Increase in E.coli/coliforms in the raw water leading to bacteriological contamination	Bacterial contamination	4	Increases can occur due to pollution, animals, people, runoff from grazing land. Recirculating chlorine system monitors free chlorine residual and runs longer to achieve the setpoint dose so it is not likely that contamination will reach the reticulation system	2	3	High	Weekly confirmation that alarms are enabled; Weekly manual chlorine checks	Monthly E.coli, turbidity, HPCs, Coliforms	Upgraded supply system to address improved water quality at the extraction point
E.coli, Coliforms	Chlorine dosing at River, Chlorine dosing at reservoir	Introduction of contamination during mains break/installation	Bacterial contamination	4	Repairs are generally required to be done quickly due to travel time getting to Greenvale, and therefore time consuming precautions are likely to be minimal. There has also been little training in this area. Chlorine residual will lessen the probability of the risk.	3	4	Very High			Training for Retic staff in water quality management during pipeline repairs
E.coli, Coliforms	Chlorine dosing at River, Recirculating chlorine dosing at reservoir, flushing	Long detention time in retic - free chlorine too low allowing re-growth to occur	Bacterial contamination on the ends of the reticulation system	3	During the wet season water use drops significantly and therefore there are long detention times	3	3	High	Monitoring of residuals in retic to guide flushing requirements	Monthly E.coli, turbidity, HPCs, Coliforms	
E.coli, Coliforms	Chlorine dosing at River, Chlorine dosing at reservoir	Loss of power causes loss of chlorination	Bacterial contamination	4	Power outages are frequent and can be for long durations although Ergon installs a portable generator to run the town when this occurs. Whilst power is off pumps will not run so the chlorine in the reservoir is only subject to decay, not dilution.	2	3	High			Consider having a generator for chlorine dosing system to maintain the residual in the reservoir
E.coli, Coliforms	Chlorine dosing at River, Chlorine dosing at reservoir	Low chlorine due to control system error allows bacteria to pass through to retic	Bacterial contamination	4	Dosing system works in local loop so unlikely to be impacted by SCADA system. Chlorine analyser will alarm.	2	3	High	Weekly confirmation that alarms are enabled; Weekly manual chlorine checks		
E.coli, Coliforms	Chlorine dosing at River, Chlorine dosing at reservoir	Low chlorine due to control system sabotage allows bacteria to pass through to retic	Bacterial contamination	4	The chlorine dosing system control and the chlorine analyser alarm limits are accessible in SCADA. Knowledge of water systems and SCADA would be required to turn off the analyser alarms and turn off the dosing to achieve this. There will still be a minor residual from the river dosing which is not controlled on SCADA.	2	3	High	Weekly confirmation that alarms are enabled; Weekly manual chlorine checks		
E.coli, Coliforms	Chlorine dosing at River, Chlorine dosing at reservoir	Low chlorine due to tampering with chlorine dosing system allows bacteria to pass through to retic	Bacterial contamination	4	Fence around site and locked door on chlorination room. Analyser will detect low chlorine and will alarm.	2	3	High	Daily/Weekly checks by Town Officer		
E.coli, Coliforms	Chlorine dosing at River, Chlorine dosing at reservoir	Run out of chlorine/under strength chlorine	This would be a known event and the town would be put on "boil water"	3	Long supply lines, inconsistent staffing, little oversight from Charters Towers	3	3	High	Weekly chlorine stock check		Upgrade will change to chlorine gas so that longer lasting stock can be held without deterioration.

Hazard	Current Preventative Measures	Hazardous Event	Consequence Description	Consequence Rating	Likelihood Description	Likelihood Rating	Risk Score	Risk Descriptor	Ongoing Actions	Verification Requirement	Risk Improvement Item
E.coli, Coliforms	Chlorine dosing at River, Chlorine dosing at reservoir, roof on reservoir	Vermin contaminate reservoir	Bacterial contamination	4	Reservoir is in good condition but needs ongoing inspections to be sure of this. Chlorine residual will also lessen the probability of the risk	2	3	High	Reservoir inspection and maintenance program	Monthly bacteriological testing	Reservoir roof improvement program to ensure it is sealed against vermin and runoff
Iron, Manganese	Chlorine dosing to precipitate iron and manganese	Failure of chlorine dosing at the river	Aesthetic impact if iron and manganese pass through to retic	2	It has not been clearly established that the chlorine dosing is actually achieving the reduction in levels. More likely that sedimentation in the reservoir is causing the established drop in levels between the raw water and retic.	2	1	Low	Weekly checks of dosing system; preventative maintenance	Monthly iron/manganese/ aluminium samples	Perform analysis on pH, iron and manganese at the river pump station to determine if the dosing is effective
Iron, Manganese, Aluminium	Chlorine dosing at river and reservoir increases pH and drops out solids	High iron, manganese or aluminium in raw water pass through to reticulation	Aesthetic impact if these metals through to retic	2	Detention and dosing in reservoir drops out iron and manganese so there is reduced chance of this going through to retic	2	1	Low		Monthly iron/manganese/ aluminium samples	Investigation of full water treatment system
Pesticides	Small amount of removal in carbon tank	Increase in pesticide levels in the raw water	Pesticides beyond ADWG limits	3	Large rural catchment however the large flow in the river would dilute it	2	2	Moderate		Annual pesticide sample	
PFAS	Nil	Increase in PFAS in the raw water	PFAS levels above ADWG limits	3	Testing demonstrated low levels	1	2	Moderate		Annual PFAS sample	
Trihalomethanes	No barrier - created from high organics and chlorine dosing	Increase in organics or increase in chlorine increases THM level	THMs beyond ADWG limits	4	High chlorine dose and no filtration makes this likely during dirty water events	4	4	Very High		Quarterly THM samples in reticulation	Investigation of full water treatment system
Turbidity	Settling in reservoir	Turbidity of reticulated water increases	Aesthetic impact on customers	2	Occurs often	4	3	High	Periodic cleaning of the reservoir	Monthly turbidity	To be addressed in upgrade

APPENDIX 11 – PENTLAND RISK ASSESSMENT

Hazard	Current Preventative Measures	Hazardous Event	Consequence Description	Consequence Rating	Likelihood Description	Likelihood Rating	Risk Score	Risk Descriptor	Ongoing Actions	Verification Requirement	Risk Improvement Item
Chlorine	Chlorine analyser at dose point, town samples, manual chlorine adjustment	Chlorine overdose due to control system sabotage	High chlorine will generally be picked up by consumers through taste/odour. It would be detected and reported before rising to dangerous levels	3	Dosing setpoint is manual. From SCADA, the only way to start the dosing is to start the pumps which means the overdose would not occur	1	2	Moderate	Weekly site checks, calibration of analysers; weekly check of SCADA alarms and setpoints	Monthly sampling of free chlorine in reticulation system	
Chlorine	Chlorine analyser at dose point, town samples, manual chlorine adjustment	Chlorine overdose due to equipment failure (i.e. non return failure)	High chlorine will generally be picked up by consumers through taste/odour. It would be detected and reported before rising to dangerous levels	3	Configuration has not been checked to eliminate all possible failure modes. Failure of non-return causes a dosing flow even when the pumps are off. Solenoid valve fitted to prevent this has a bypass. Analyser will detect the high level and will shut down the system	4	3	High	Weekly site checks, calibration of analysers; weekly check of SCADA alarms and setpoints	Monthly free chlorine in reticulation system	Document treatment process, identify failure modes, label equipment and pipework. Implement a maintenance authorisation system.
Chlorine	Chlorine analyser at dose point, town samples, manual chlorine adjustment	Chlorine overdose due to operator or maintainer error	High chlorine will generally be picked up by consumers through taste/odour. It would be detected and reported before rising to dangerous levels	3	Not all staff are suitably aware of the water quality consequences of their decisions. They can override the analyser by placing the pumps in manual. This has occurred previously.	5	4	Very High	Weekly site checks, calibration of analysers; weekly check of SCADA alarms and setpoints	Monthly free chlorine in reticulation system	Document treatment process, identify failure modes, label equipment and pipework. Implement a maintenance authorisation system
Chlorine	Chlorine analyser at dose point, town samples, manual chlorine adjustment	Chlorine overdose due to tampering with chlorine dosing system	High chlorine will generally be picked up by consumers through taste/odour. It would be detected and reported before rising to dangerous levels	3	High chlorine will be detected by the analyser and pumps will stop. SCADA will alarm if analyser is not available.	2	2	Moderate	Weekly site checks, calibration of analysers; weekly check of SCADA alarms and setpoints	Monthly free chlorine in reticulation system	
Cryptosporidium, Giardia	Nil	Introduction of crypto/giardia by mammals (crypto) or birds (giardia) at the tanks or reservoir	Crypto/giardia risk in reticulated water - illness	4	Tanks are not well sealed which allows vermin to contaminate the water	4	4	Very High	Tank preventative maintenance		Clean tanks at the pump station and replace/rectify roofs
Cryptosporidium, Giardia	Raised bore heads, fences	Introduction of crypto/giardia in the bore heads through cattle grazing/washoff	Crypto/giardia risk in reticulated water - illness	4	Bore heads are elevated and sealed. E.coli has been detected in the raw water but the source of contamination has not been identified.	1	3	High	Weekly site checks. Maintenance of fences and bore heads.		
E.coli, Coliforms	Chlorine dosing at pump station, roof on reservoir	High turbidity masks bacteria from chlorine	Bacterial contamination	4	Bore water is very low turbidity. Some turbidity can be introduced at the tanks at the pump station.	2	3	High	Flush the raw water main	Turbidity testing in the treated water and the reticulation system	Clean out tanks and ensure they are sealed.
E.coli, Coliforms	Chlorine dosing at pump station	Introduction of contamination during mains break or mains installation	Bacterial contamination to a segment of the reticulation system	3	Repairs are generally done quickly due to travel time getting to Pentland, and therefore precautions are probably minimal. There has also been little training in this area	4	3	High		E.coli testing in the reticulation system	Training for maintenance staff in water quality when dealing with water main breaks

Hazard	Current Preventative Measures	Hazardous Event	Consequence Description	Consequence Rating	Likelihood Description	Likelihood Rating	Risk Score	Risk Descriptor	Ongoing Actions	Verification Requirement	Risk Improvement Item
E.coli, Coliforms	Chlorine dosing at pump station	Introduction of E.coli/coliforms at the bore heads	Bacterial contamination	4	Bore heads are elevated and sealed. E.coli has been detected in the raw water. Chlorine dosing will reduce the likelihood of contaminated water reaching customers.	2	3	High		Monthly E.coli and chlorine testing	
E.coli, Coliforms	Chlorine dosing at pump station, roof on reservoir	Vermin contaminate the Reservoir	Bacterial contamination	4	Reservoir has a roof but the condition of it is deteriorating. Chlorine will reduce the likelihood of contaminated water reaching customers.	2	3	High	Reservoir PM	Monthly E.coli and chlorine testing	
E.coli, Coliforms	Chlorine dosing at pump station	Vermin/contamination at the High Lift tanks	Bacterial contamination	4	Tanks have roofs but they are not well sealed and are believed to be introducing E.coli/coliforms into the system already. Chlorine dosing will reduce the risk of contaminated water reaching customers.	3	4	Very High	Tank PM	E.coli testing in the raw water at the high lift pump station	Clean tanks at the pump station and replace/rectify roofs
E.coli, Coliforms	Chlorine dosing at pump station	Vermin/contamination at the Meatworks tanks	Bacterial contamination	4	Uncontrolled access however valves have been verified as being closed. Chlorine dosing will reduce the likelihood of contaminated water reaching customers.	2	3	High		E.coli testing in the raw water at the high lift pump station	Meatworks tanks have been disconnected from the system
E.coli, Coliforms	Chlorine dosing at pump station	Failure of chlorine analyser allowing low chlorine to go undetected and therefore allow bacteria to enter the reticulation system	Bacterial contamination	4	If analyser goes low or high then an alarm will be raised. If analyser locks on current value and dosing fails (low probability) then high lift pumps would keep on running and contamination could occur.	2	3	High	Weekly site checks, calibration of analysers; weekly check of SCADA alarms and setpoints	Monthly E.coli and chlorine testing	
E.coli, Coliforms	Chlorine dosing at pump station	Failure of the chlorine dosing system allows bacteria into the treated water	Bacterial contamination	4	Single dosing system however the low chlorine will generate an alarm at the high lift site and will stop the pumps.	1	3	High	Weekly site checks, calibration of analysers; weekly check of SCADA alarms and setpoints		Consider installation of Duty/Standby dosing systems
E.coli, Coliforms	Chlorine dosing at pump station, roof on reservoir	Long detention times in delivery main/reservoir/retic causing re-growth	Bacterial contamination in outer reaches of the reticulation system	3	Chlorine residual in reservoir is monitored and if it is getting low then flushing would be commenced	2	2	Moderate	Weekly site checks, calibration of analysers; weekly check of SCADA alarms and setpoints	Monthly chlorine residual tests	
E.coli, Coliforms	Chlorine dosing at pump station	Low chlorine due to control system error resulting in bacteria entering the reticulation system	Bacterial contamination	4	Chlorine dosing is activated by a flow in the dosing line caused by the pump running. The control system cannot influence this.	1	3	High	Weekly site checks, calibration of analysers; weekly check of SCADA alarms and setpoints		
E.coli, Coliforms	Chlorine dosing at pump station	Low chlorine due to control system sabotage	Bacterial contamination	4	Whilst the chlorine analyser could be simulated at a value which would not trigger an alarm, the chlorine dosing cannot be impacted through SCADA so there would have to be a simultaneous failure of the chlorine dosing system	1	3	High	Weekly site checks, calibration of analysers; weekly check of SCADA alarms and setpoints		
E.coli, Coliforms, Naegleria	Chlorine dosing at pump station	Low chlorine due to tampering with the dosing system resulting in bacteria entering the reticulation system	Bacterial contamination	4	Remote site, locked gate and locked door. Analyser will detect high chlorine and stop the pumps.	2	3	High	Weekly site checks, calibration of analysers; weekly		

Hazard	Current Preventative Measures	Hazardous Event	Consequence Description	Consequence Rating	Likelihood Description	Likelihood Rating	Risk Score	Risk Descriptor	Ongoing Actions	Verification Requirement	Risk Improvement Item
					If the chlorine at the reservoir is rising, it will alarm.				check of SCADA alarms and setpoints		
E.coli, Coliforms	Chlorine dosing at pump station	Running out of chlorine allows bacteria to enter the reticulation system	Bacterial contamination	4	Dual chlorine bottles with auto changeover but at a remote site. Analyser will detect the low chlorine. This would be a known event and if untreated water was to be released then it would be under a boil water notice.	2	3	High	Weekly site checks, calibration of analysers; weekly check of SCADA alarms and setpoints		Formal system to manage chlorine stocks for Pentland
Iron	Nil	Increased iron levels passed through to reticulation or oxidised iron in the mains is flushed into town	Aesthetic risk	2	Levels of iron in the raw water have never exceeded the ADWG limit. There is a possibility that oxidised iron has built up in the 9km main to town	2	1	Low	Flushing to clear out sediment		
Mercury	Nil	Increased Mercury levels in the raw water	Health Risk	3	Mercury was only detected on one occasion in the sample set so it is considered to be a low likelihood that there is mercury contamination of the bore	1	2	Moderate		Quarterly monitoring	
Pesticides	Sealed bore heads	Increase in pesticide levels in the raw water due to agriculture	Pesticides above ADWG limits	4	Sealed bore heads would make it unlikely that pesticide laden water could enter the bores	1	3	High	Weekly site checks, calibration of analysers; weekly check of SCADA alarms and setpoints		
PFAS	Nil	Increase in PFAS in the raw water	PFAS above the ADWG limit	4	Sampling determined that there are very low levels	2	3	High		Annual PFAS testing to identify long term changes	
Trihalomethanes	No barrier - created from high organics and chlorine dosing	Increase in organics or increase in chlorine increases THM level	THMs above ADWG limits	3	There is low organic content in the bores but organic growth in the reticulation system could result in THM formation	2	2	Moderate	Flushing to clear out biofilms	Quarterly testing for THMs	Regular flushing program for Pentland Reticulation
E.coli / turbidity / trihalomethanes / colour / iron / manganese	N/A	Water in the 200mm main connecting bores 1 and 2 is pushed into the raw water main	Dirty water could have a range of impacts on the treated water	4	The electrical supply to the bores is disconnected. The main rises away from the bores so any break in the main will drain back and will not pull the dirty water forward.	1	3	High			Insert a valve in the main immediately behind Bore 3

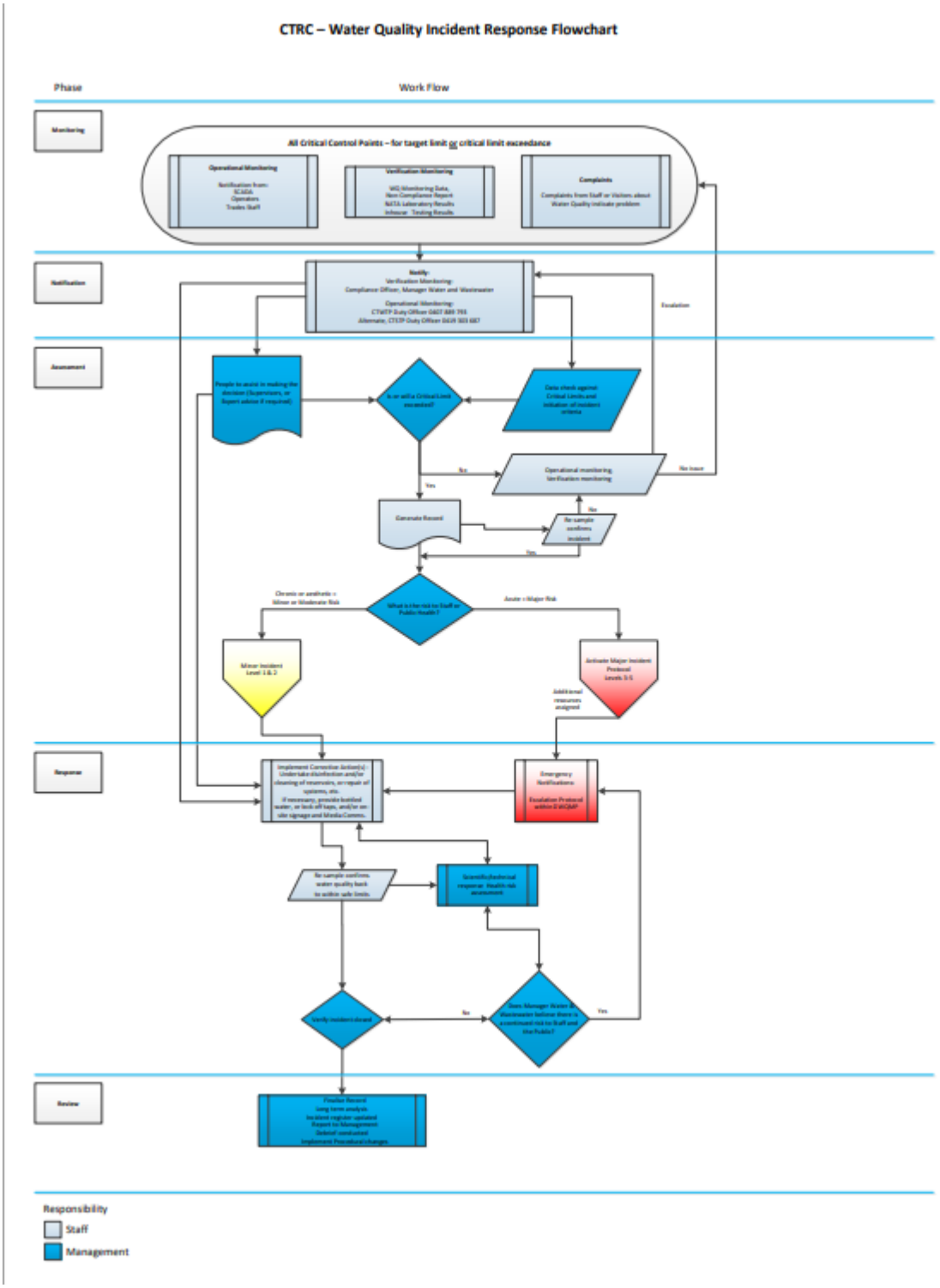
APPENDIX 12 – RAVENSWOOD RISK ASSESSMENT

Hazard	Current Preventative Measures	Hazardous Event	Consequence Description	Consequence Rating	Likelihood Description	Likelihood Rating	Risk Score	Risk Descriptor	Ongoing Actions	Verification Requirement	Risk Improvement Item
Acrylamide	Jar testing	Overdose of polyacrylamide results in increased acrylamide monomer levels in reticulation	Health risk	3	Polyacrylamide has set limits on the level of monomers present as an impurity, therefore this is an unlikely event	1	2	Moderate		Check acrylamide levels monthly	Periodic check of chemical purity through supplier
Algae	Destratification	Algae bloom in Suhrs Ck Dam	Algal toxins	3	No recorded data but there have been algal blooms in the past	3	3	High	Operation of the recirculation system in the dam when algal blooms are likely	Annual algal samples	
Aluminium	Filtration	Aluminium levels above ADWG aesthetic limit	Aesthetic hazard and may also cause post-floc turbidity	2	Aluminium levels are moderately high in the raw water but this should be removed by treatment. Reticulation levels are at times higher than raw so this may be from overdosing coagulant. Levels above the limit happen frequently.	4	3	High	Jar testing periodically and on change of water quality Monthly water chemistry check by external consultant	Monthly aluminium sample	Improvement in the management and oversight of the WTP processes
Amoeba - Naegleria Fowleri	Chlorine residual	Low chlorine with high heat allows development of this amoeba	Illness risk in pools which are not re-chlorinated	2	aa variety of events which could lead to low chlorine have higher level consequences so the risk of this situation developing is low	2	1	Low		Monthly chlorine samples, annual amoeba test (in summer)	
Chlorates	Turnover of hypo stock	Chlorates generated by decomposition of hypo	There is no ADWG limit for Chlorates but Qld Health has set a limit of 0.8 mg/l	4	High temperature, long holding times and long supply lines make generation of chlorates likely. The header tank however turns over fairly quickly so there is not a significant amount of re-dose occurring. As this is fully treated water the chlorine demand will not be high.	3	4	Very High	Avoid holding too much stock	Monthly	Review stock management, holding times, consider moving to gas chlorination. Complete a Chlorates investigation to form a baseline
Chlorine	Chlorine Analyser, Weekly checks	Chlorine overdose due to analyser failure	High chlorine will generally be picked up by consumers through taste/odour. It would be detected and reported before rising to dangerous levels	3	If analyser faults to a high or low level an alarm will be generated. If it faults to a level below the setpoint then the chlorine system will keep on dosing	3	3	High	Weekly chlorine checks	Monthly Chlorine samples	Consider addition of a second chlorine analyser
Chlorine	Chlorine Analyser, Weekly checks	Chlorine overdose due to control error	High chlorine will generally be picked up by consumers through taste/odour. It would be detected and reported before rising to dangerous levels	3	Recirculating dosing system based on the residuals into and out of the squat tank. Analyser will detect high chlorine and will alarm	3	3	High	Weekly chlorine checks		
Chlorine	Chlorine Analyser, Weekly checks	Chlorine overdose due to control system sabotage	High chlorine will generally be picked up by consumers through taste/odour. It would be detected and reported before rising to dangerous levels	3	High level multifactor authentication and geolocation conditional access on the servers makes it very unlikely that access could be gained to the SCADA server.	1	2	Moderate	Daily plant checks Weekly chlorine checks		

Hazard	Current Preventative Measures	Hazardous Event	Consequence Description	Consequence Rating	Likelihood Description	Likelihood Rating	Risk Score	Risk Descriptor	Ongoing Actions	Verification Requirement	Risk Improvement Item
Chlorine	Chlorine Analyser, Weekly checks	Chlorine overdose due to operator/maintainer error	High chlorine will generally be picked up by consumers through taste/odour. It would be detected and reported before rising to dangerous levels	3	Possible if the chlorine analyser is calibrated incorrectly	2	2	Moderate	Weekly chlorine checks	Monthly chlorine test	Consider addition of a second chlorine analyser
Chlorine	Chlorine Analyser, Weekly checks	Chlorine overdose due to tampering with the dosing system	High chlorine will generally be picked up by consumers through taste/odour. It would be detected and reported before rising to dangerous levels	3	Site is fenced. Analyser will alarm and will stop the dosing system if chlorine level is too high	2	2	Moderate	Daily plant checks Weekly chlorine checks	Monthly chlorine test	
Cryptosporidium, Giardia	Filtration	Increase in crypto/giardia in the water through upstream activities	Crypto/giardia risk in reticulated water - illness	4	Full treatment process should remove most oocysts but there are catchment risks which could increase the load	2	3	High	Optimisation of the dosing, ensuring clarifier turbidity is kept low	Monthly turbidity and E.coli testing as surrogates for crypto and giardia	
Cryptosporidium, Giardia	Filtration	Turbidity breakthrough in the plant allows oocysts to pass through	Crypto/giardia risk in reticulated water - illness	4	Turbidity spikes do occur at the WTP so there is a reasonable risk of this occurring.	3	4	Very High	Respond to clarifier turbidity alarm Weekly turbidity and chlorine checks Declare Incident if turbidity breakthrough occurs	Monthly turbidity and E.coli testing as surrogates for crypto and giardia	To be addressed in the replacement WTP to be constructed in different location
Cryptosporidium, Giardia	Roofs on tanks	Introduction of contamination by mammals (Possums) at high or low level tanks	Crypto/giardia risk in reticulated water - illness	4	Tanks are reasonably well sealed	1	3	High	Preventative maintenance program Weekly testing	Monthly E.coli (as an indicator)	
E.coli, Coliforms	Filtration, chlorine	Control System failure at the WTP allows unfiltered/unchlorinated water to pass through	Bacterial contamination	4	Plant will generate alarms on turbidity and low chlorine	1	3	High	Control system checks Daily plant checks		
E.coli, Coliforms	Filtration, chlorine	Control System Sabotage allows untreated/unchlorinated water to pass through	Bacterial contamination	4	High level multifactor authentication and geolocation conditional access on the servers makes it very unlikely that access could be gained to the SCADA server	1	3	High	Weekly chlorine and bacto tests of the plant and retic		
E.coli, Coliforms	Filtration, chlorine	Failure of chlorine dosing unit allows bacteria into the reticulation system	Bacterial contamination	4	Chlorine analyser will detect the low level and will alarm	1	3	High	Weekly chlorine tests Daily plant checks	Monthly chlorine test	
E.coli, Coliforms	Filtration, chlorine	Failure of chlorine analyser leads to low chlorine	Bacterial contamination	4	Failure of analyser will generate an alarm	1	3	High	Plant checks, preventative maintenance	Monthly E.coli testing	
E.coli, Coliforms	Filtration, chlorine	Increase in E.coli/coliforms in the raw water (Recreation in the Burdekin, cattle)	Bacterial contamination	4	Settling, Filtration and Chlorine will lower the risk but there have been turbidity and coliforms in the treated water previously	2	3	High	Check plant operation, filter outlet turbidities, weekly bacto samples of plant and retic. Remove cattle from inner catchment.	Monthly E.coli testing	

Hazard	Current Preventative Measures	Hazardous Event	Consequence Description	Consequence Rating	Likelihood Description	Likelihood Rating	Risk Score	Risk Descriptor	Ongoing Actions	Verification Requirement	Risk Improvement Item
E.coli, Coliforms	Chlorine	Introduction of contamination during mains break/installation	Bacterial contamination	4	Chlorine will provide a level of protection but it is likely that appropriate precautions are not being exercised	2	3	High			Training for maintenance staff in water quality when dealing with water main breaks
E.coli, Coliforms	Filtration, chlorine	Low chlorine due to long detention times in the reticulation system	Bacterial contamination	4	There will be long detention times during rain events but weekly testing will identify this	1	3	High	Flushing occurs on demand, weekly chlorine and bacto samples in retic	Monthly retic samples	
E.coli, Coliforms	Filtration, chlorine	Retic cross connection with sewerage	Bacterial contamination	4	Sewerage belongs to the mine but the mains pass through town and CTRC staff are not familiar with their location	4	4	Very High		Monthly E.coli testing	Produce updated drawings of the water and sewerage systems
E.coli, Coliforms	Filtration, chlorine	Run out of Chlorine	Bacterial contamination	4	Stock of chlorine is monitored and is readily available from Townsville	1	3	High	Monitor hypo stock		
E.coli, Coliforms	Filtration, chlorine	Run out of flocculants	Bacterial contamination	4	Stocks are monitored	1	3	High	Monitor chemical stocks		
E.coli, Coliforms	Filtration, chlorine	Turbidity breakthrough in filters allows bacteria to be shielded from chlorine	Bacterial contamination	4	No continuous filter turbidity analysis, no treated water turbidity analysis so therefore this is likely	3	4	Very High	Weekly chlorine and bacto tests of the plant and retic Declare Incident if turbidity breakthrough occurs	Monthly E.coli testing	Consider plant upgrade to address shortfalls
E.coli, Coliforms	Chlorine, roofs	Vermin contaminate reservoir	Bacterial contamination	4	Tanks are reasonably well sealed. Chlorine will provide a level of protection	2	3	High	Weekly chlorine and bacto tests of the plant and retic	Monthly E.coli testing	
Manganese	Filtration	High Manganese in the raw water	Aesthetic Hazard (Manganese levels in retic have never passed the health guideline value)	2	Occurs periodically	3	2	Moderate	Utilise permanganate dosing or peroxide dosing when levels increase	Monthly testing	
Pesticides	Filtration	Increase in pesticide use	Levels above ADWG	3	Runoff is unlikely to generate dangerous levels of pesticides due to the large water volumes.	1	2	Moderate		Annual pesticide sweep	
PFAS	None	Increase in PFAS levels	Levels above ADWG	3	Testing to date has demonstrated low levels	1	2	Moderate		Annual testing	
Trihalomethanes	Clarification, filtration	Increase in organics or chlorine in the treated water	Levels above the ADWG	3	There are moderate levels but they have never approached the ADWG limit	2	2	Moderate	Jar testing to optimise removal of organics	Quarterly testing	
Turbidity	Clarification, filtration	Change in raw water causes treatment plant to allow high turbidity water to pass through	Aesthetic hazard	1	Clarifier turbidity analyser should detect this There are however periodic spikes in turbidity in retic	3	1	Low	Jar testing to optimise removal of turbidity, weekly testing	Monthly sample	
Assorted mine chemicals	Break tank and potable water pumps	Potable water on the mine site is contaminated and flows back to the town water supply	Assorted hazards	3	Mine site potable water enters a tank and is then pumped around the mine site so minimal risk of backflow of contaminated water	1	2	Moderate			CTRC Plumbing inspector makes Ravenswood Gold a priority in his Backflow Prevention certification program

APPENDIX 13 – ESCALATION PROCESS



APPENDIX 14 – EMERGENCY ACTION PLAN

Management of Incidents and Emergences				Emergency Contact Details and Protocols		
Level	**Incident or Emergency**	**Summary of actions to be taken**	**Position responsible**	**Business Unit/ Organisation**	**Contact Person(s)**	**Communication protocols**
5	**Cyclone, that has an expected path within a 200km radius of the shire**	▪ Communicate with the Bureau of Meteorology of the intensity and expected impact time. ▪ Alert public to fill water bottles, etc in case of the need to turn off water reticulation. ▪ Ensure all reservoirs are at capacity prior to the event. ▪ If destructive path of cyclone is within range of the shire and above category 2 proceed with turning off the water supply. ▪ Ensure communication with the public on expected time the water reticulation will be turned on. ▪ Check for breakages from fallen trees. ▪ If ok, turn on water supply and monitor for any significant losses in storage.	▪ Manager Water & Wastewater ▪ WTP Operator	▪ Water & Wastewater / CTRC ▪ Bureau of Meteorology (for updates on event) ▪ Local Disaster Management Group	▪ Manager Water & Wastewater Joe Galea 0417 750 809 ▪ Director of Infrastructure Services, Brett Parsons 0476 408 471 ▪ Bureau of Meteorology, Townsville Field Meteorological Offices, (07) 4779 5999 ▪ CTRC CEO, Martin Drydale 0436 420 540	▪ Refer to Local Disaster Management Plan
5	**Major Flooding**	▪ Communicate with the Bureau of Meteorology for expected rainfall that could influence the catchment. ▪ Monitor river heights. ▪ Ensure each treatment plant has adequate supply and organise for staff to monitor plant if possible.	▪ Manager Water & Wastewater ▪ WTP Operator	▪ Water & Wastewater / CTRC ▪ Bureau of Meteorology (for updates on event) ▪ Local Disaster Management Group	▪ Manager Water & Wastewater Joe Galea 0417 750 809 ▪ Director of Infrastructure Services, Brett Parsons 0476 408 471 ▪ Bureau of Meteorology, Townsville Field Meteorological Offices, (07) 4779 5999	▪ Refer to Local Disaster Management Plan
5	**Loss of power for extended period of time (usually associated with Cyclones, severe weather, etc)**	▪ Communicate with Ergon Energy to determine extent of damage and expected time for infrastructure to be fixed. ▪ Use backup generators.	▪ Manager Water & Wastewater ▪ WTP Operator	▪ Water & Wastewater / CTRC ▪ Ergon Energy	▪ Manager Water & Wastewater Joe Galea 0417 750 809 ▪ Director of Infrastructure Services, Brett Parsons 0476 408 471 ▪ CTRC CEO, Martin Drydale 0436 420 540 ▪ Ergon Energy 13 10 46	▪ Refer to Local Disaster Management Plan
5	**Major Earthquake**	▪ A major earthquake can be associated with a Tsunami, so communication with the Bureau will need to take place to be made aware of the impending tsunami that is likely to occur.	Manager Water & Wastewater, CTWTP Duty Officer	Water & Wastewater / CTRC	▪ TWTP Duty Officer, 0407 889 793 ▪ CTSTP Duty Officer, 0419 303 687 ▪ Manager Water & Wastewater Joe Galea 0417 750 809	▪ Refer to Local Disaster Management Plan ▪

Management of Incidents and Emergences				Emergency Contact Details and Protocols		
Level	**Incident or Emergency**	**Summary of actions to be taken**	**Position responsible**	**Business Unit/ Organisation**	**Contact Person(s)**	**Communication protocols**
		▪ Buildings will need to be checked for any structural damage and all pumps, electrical equipment, etc will need to be checked for any faults.		Local Disaster Management Group Bureau of Meteorology (for updates on event)	▪ Director of Infrastructure Services, Brett Parsons 0476 408 471 ▪ CTRC CEO, Martin Drydale 0436 420 540 ▪ Bureau of Meteorology, Townsville Field Meteorological Offices, (07) 4779 5999 (07) 4779 5999	
5	**Fire, possibly associated with bush fire but more than likely caused by equipment malfunction, etc**	▪ Contact the Queensland Fire Department immediately to cease fire and assess any damage that it may have cause. ▪ Check building for any structural damage and ensure it is safe to entre. ▪ Assess equipment that has been damaged and if it can be replaced in order to keep the plant operational. ▪ If damage is extensive and to the entire plant, alternative options will need to be made.	Manager Water & Wastewater, CTWTP Duty Officer	Water & Wastewater / CTRC	▪ TWTP Duty Officer, 0407 889 793 ▪ CTSTP Duty Officer, 0419 303 687 ▪ Manager Water & Wastewater Joe Galea 0417 750 809 ▪ Director of Infrastructure Services, Brett Parsons 0476 408 471 ▪ CTRC CEO, Martin Drydale 0436 420 540	▪ Refer to Local Disaster Management Plan ▪ In the event of equipment malfunction, isolate the equipment and use appropriate fire extinguisher to put out the fire. Contact Queensland Fire Services as soon as possible. ▪ ▪
5	**Cybersecurity Breach**	▪ Same as Level 3 cybersecurity actions, plus Level 5 Disaster actions. ▪	▪ Manager Water & Wastewater, ▪ CTWTP Duty Officer	▪ Water & Wastewater / CTRC	▪ TWTP Duty Officer, 0407 889 793 ▪ CTSTP Duty Officer, 0419 303 687 ▪ Manager Water & Wastewater Joe Galea 0417 750 809 ▪ Director of Infrastructure Services, Brett Parsons 0476 408 471 ▪ CTRC CEO, Martin Drydale 0436 420 540	▪ Refer to Local Disaster Management Plan
4	**Detection of E. Coli greater than 5 CFU/100mL in reticulation**	▪ Boil Water Alert as per Queensland Health Guidelines	▪ Manger Water & Wastewater ▪ Manager Environmental Health Services ▪ CTWTP Duty Officer	▪ Water & Wastewater / CTRC	▪ Manager Water & Wastewater Joe Galea 0417 750 809 ▪ Director of Infrastructure Services, Brett Parsons 0476 408 471	▪ Boil Water Alert as per Queensland Health Guidelines ▪ Report exceedance to Regulator ▪
4	**Cybersecurity Breach**	▪ Same as Level 3 cybersecurity actions, plus Level 4 Disaster actions.	▪ Manger Water & Wastewater ▪ Manager Environmental Health Services	▪ Water & Wastewater / CTRC	▪ Manager Water & Wastewater Joe Galea 0417 750 809 ▪ Director of Infrastructure Services, Brett Parsons 0476 408 471	▪ Refer to Local Disaster Management Plan

Management of Incidents and Emergences				Emergency Contact Details and Protocols		
Level	**Incident or Emergency**	**Summary of actions to be taken**	**Position responsible**	**Business Unit/ Organisation**	**Contact Person(s)**	**Communication protocols**
			▪ CTWTP Duty Officer			
3	**Detection of 1-5 CFU/100mL E. Coli in reticulation**	▪ Boil Water Alert as per Queensland Health Guidelines	▪ Compliance Officer, ▪ Reticulation Officer, ▪ CTWTP Duty Officer	▪ Water & Wastewater / CTRC	▪ TWTP Duty Officer, 0407 889 793 ▪ CTSTP Duty Officer, 0419 303 687 ▪ Manager Water & Wastewater Joe Galea 0417 750 809 ▪ Director of Infrastructure Services, Brett Parsons 0476 408 471	▪ Boil Water Alert as per Queensland Health Guidelines ▪ Report exceedance to Regulator ▪ Flushing the impacted area, turnover of reservoir volume, hand dosing a reservoir, check for contamination sources ▪ Repeat verification test until consecutive clear results are obtained
3	**PFAS in reticulation**	▪ Turn off water supply. ▪ Restrict water usage. ▪ Flush reticulation lines. ▪ Switch raw water sources, if not possible, switch to treated water sources from another scheme.	Compliance Officer, Reticulation Officer, CTWTP Duty Officer	Water & Wastewater / CTRC	▪ TWTP Duty Officer, 0407 889 793 ▪ CTSTP Duty Officer, 0419 303 687 ▪ Manager Water & Wastewater Joe Galea 0417 750 809	▪ Report exceedance to Regulator ▪
3	**Minor Flooding**	▪ Parts of town could become isolated.	Reticulation Officer, CTWTP Duty Officer, Manager Water & Wastewater, Labourer	Water & Wastewater / CTRC	▪ TWTP Duty Officer, 0407 889 793 ▪ CTSTP Duty Officer, 0419 303 687 ▪ Manager Water & Wastewater Joe Galea 0417 750 809 ▪ Director of Infrastructure Services, Brett Parsons 0476 408 471	▪ Refer to Local Disaster Management Plan
3	**Cybersecurity Breach**	▪ Level 3 Disaster actions. ▪ Level 2 cybersecurity actions, plus: ▪ Detailed investigation attack source and entry point. ▪ Full network review. ▪ Review master control and actions.	Manager Water & Sewerage, CTWTP Duty Officer	Water & Wastewater / CTRC	▪ Manager Water & Wastewater Joe Galea 0417 750 809 ▪ Director of Infrastructure Services, Brett Parsons 0476 408 471	▪ Refer to Local Disaster Management Plan
2	**Water Main/ Service Break**	▪ Identify broken main and isolate area. ▪ Repair main. ▪ Turn water on and flush hydrant.	Reticulation Officer, Labourer	Water & Wastewater / CTRC	▪ TWTP Duty Officer, 0407 889 793 ▪ CTSTP Duty Officer, 0419 303 687 ▪ Manager Water & Wastewater Joe Galea 0417 750 809	▪ Reticulation Officer to contact CTWTP Duty Officer. ▪ CTWTP Duty Officer to contact Manager Water & Wastewater as soon as possible. ▪ Works requested issued by public or if identified by council staff,

Management of Incidents and Emergences				Emergency Contact Details and Protocols		
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						Manager Water and Wastewater notified. ▪ If after hours on call person notified. ▪ Labours sent to job site. ▪ When complete Manager Water and Wastewater notified.
2	**High levels of Turbidity in source water**	▪ Follow standard treatment process. ▪ For scheme 1, if turbidity has increased in the source water, use alternative sources.	WTP Operator	Water & Wastewater / CTRC	▪ TWTP Duty Officer, 0407 889 793 ▪ CTSTP Duty Officer, 0419 303 687 ▪ Manager Water & Wastewater Joe Galea 0417 750 809	▪ WTP Operator, to contact CTWTP Duty Officer. ▪ CTWTP Duty Officer to contact Manager Water & Wastewater as soon as possible. ▪ If exceeds ADWG, report to Regulator. ▪ Dump tanks/reservoirs then flush if cause is temporary, boil water notice if cause is ongoing ▪ Monitor operational results, conduct verification testing prior to declaring incident is over
2	**Cybersecurity Breach**	▪ Level 1 cybersecurity actions, plus: ▪ Contact Police if relevant ▪ Contact Australian Cyber Security Centre for all external activity 1300 292 371 ▪ Contact insurer ▪ Investigate and address attack source and entry point	▪ CTWTP Duty Officer	▪ Water & Wastewater / CTRC	▪ Manager Water & Wastewater Joe Galea 0417 750 809	▪ CTWTP Duty Officer to contact Manager Water & Wastewater as soon as possible. ▪ Report to Regulator.
1	**Exceedance in drinking water parameter in source water (incl. PFAS and Chlorine)**	▪ Follow standard treatment process. ▪ Monitor to ensure effective treatment. ▪ E.g. Operational chlorine exceedance into reticulation.	Ops Monitoring: Reticulation Officer, WTP Operator, Verification Monitoring: Compliance Officer	Water Department	▪ TWTP Duty Officer, 0407 889 793 ▪ CTSTP Duty Officer, 0419 303 687 ▪ Manager Water & Wastewater Joe Galea 0417 750 809	▪ Reticulation Officer, WTP Operator, to contact CTWTP Duty Officer. ▪ CTWTP Duty Officer to contact Manager Water & Wastewater as soon as possible. ▪ Compliance Officer to contact Manager Water & Wastewater as soon as possible. ▪ Report exceedance to Regulator if required. ▪ Dump tanks/reservoirs then flush if cause is temporary, boil water notice if cause is ongoing

Management of Incidents and Emergences				Emergency Contact Details and Protocols		
Level	**Incident or Emergency**	**Summary of actions to be taken**	**Position responsible**	**Business Unit/ Organisation**	**Contact Person(s)**	**Communication protocols**
						▪ Monitor operational results, conduct verification testing prior to declaring incident is over
	Low chlorine in reticulation	▪ Follow standard treatment process. ▪ Monitor to ensure effective treatment.	Reticulation Officer, WTP Operator,	Water Department	▪ TWTP Duty Officer, 0407 889 793 ▪ CTSTP Duty Officer, 0419 303 687 ▪ Manager Water & Wastewater Joe Galea 0417 750 809	▪ Reticulation Officer, WTP Operator, to contact CTWTP Duty Officer. ▪ CTWTP Duty Officer to contact Manager Water & Wastewater as soon as possible. ▪ Flush impacted area to turn over the reservoir volume ▪ Operational testing of chlorine level
1	**Cybersecurity Breach**	▪ Rectify water quality incident ▪ Contact Police if relevant ▪ Contact Australian Cyber Security Centre for all external activity 1300 292 371 ▪ For internal unintentional cybersecurity breach: o Check master controls and actions o Determine lack of cyber security control o Rectify control to prevent further incidents	CTWTP Duty Officer	Water Department	▪ Manager Water & Wastewater Joe Galea 0417 750 809	▪ CTWTP Duty Officer to contact Manager Water & Wastewater as soon as possible. ▪ Report to Regulator.