5.2. DRINKING WATER QUALITY MANAGEMENT PLAN (DWQMP)

REPORT AUTHOR(S)	Peter White, Water and Wastewater Coordinator
GENERAL MANAGER	Michael Kriedemann, Acting General Manager Operations
DEPARTMENT	Water and Wastewater

RECOMMENDATION

That Council:

1. **Endorses the Drinking Water Quality Management Plan 2018 (DWQMP);**
2. **Notes the Department of Natural Resources, Mines and Energy approval of the Drinking Water Quality Management Plan 2018 dated 11 May 2018.**

EXECUTIVE SUMMARY

The Drinking Water Quality Management Plan (DWQMP) for Douglas Shire Council (Douglas) is a public health based risk management plan that meets the requirements of the Australian Drinking Water Guidelines 2011 (ADWG) and the *Water Supply (Safety and Reliability) Act 2008* (WS Act). The DWQMP describes the Mossman/Port Douglas, Whyanbeel and Daintree drinking water schemes operated by Douglas from catchment to tap.

Water staff, including the Coordinator Water & Wastewater and the General Manager Operations, participated in a risk assessment workshop in July 2017 to update the previous risk assessment framework from 2015. Through the risk assessment process, the Water and Wastewater Branch has identified a number of risks to the Shire's drinking water schemes that require improvements over time. These are detailed in the risk assessment table, and in the risk management improvement plan. The Water and Wastewater Branch intends to use the risk management improvement program to inform capital and operational budgets in coming financial years.

The updated document will provide user friendly regulatory guidance to water operational staff members on a daily basis. The draft DWQMP was submitted to the Department of Natural Resources, Mines and Energy (DNRME) on 5 February 2018 and was approved with conditions on 11 May 2018. The result is a new user friendly health based risk management plan that demonstrates how public health risks are managed. In addition, the plan also describes how Douglas meets the requirements of the environmental authority for the Mossman Water Treatment Plant under the Environmental Protection Act (1994) and Water Licences under the Water Act 2000.

DWQMP has been amended to include:

- Registered service details;
- Details of infrastructure for providing the service;
- Identify hazards and hazardous events;
- Information gathering – water quality and catchment characteristics;
- Assessment of risks;
- Risk management measures;
- Operation and maintenance procedures;

- Management of incidents and emergencies;
- Risk management improvement program;
- Service wide support – information management; and
- Operational and verification monitoring.

The next report, review and audit of the DWQMP must be undertaken at specified intervals. Reports are to be provided to the Department of Natural Resources, Energy and Mines at the following times:

- The DWQMP 2017 / 2018 annual report is due by 18 December 2018;
- Review of the DWQMP is due by 31 March 2020; and
- Regular audit of the DWQMP is due by 30 June 2021.

PROPOSAL

That Council:

1. Endorses the Drinking Water Quality Management Plan 2018 (DWQMP);
2. Notes the Department of Natural Resources, Mines and Energy approval of the Drinking Water Quality Management Plan 2018 dated 11 May 2018.

FINANCIAL/RESOURCE IMPLICATIONS

Implementation of the new DWQMP can be achieved using existing financial and human resources. Council needs to ensure that current operational budget allocations are continued into the future so that levels of service and compliance against the DWQMP are achieved.

RISK MANAGEMENT IMPLICATIONS

Council, as a registered water service provider, has a statutory obligation to ensure it is able to provide water services to customers. Council's reputation would suffer if it is unable to maintain service levels at prescribed standards. The DWQMP provides information on strategies and procedures on how to ensure safe drinking water for the community at all times, minimise occupational health and safety risks and risks to Council infrastructure.

SUSTAINABILITY IMPLICATIONS

Economic: It is essential to adequately maintain water infrastructure in order to provide satisfactory services in support of economic development in the Shire.

Environmental: Failing to provide adequate and compliant water services can lead to environmental harm and breaching of licence conditions. Water treatment staff are aware of their roles and responsibilities to manage operations in an environmentally sensitive way, including protection of the World Heritage areas and discharges can impact on the Great Barrier Reef.

Social: The community expects fully operational and compliant water services. Through the development and compliance of the DWQMP, Council will deliver this service.

CORPORATE/OPERATIONAL PLAN, POLICY REFERENCE

This report has been prepared in accordance with the following:

Corporate Plan 2014-2019 Initiatives:

Theme 2 - Building a Sustainable Economic Base
2.1.1 - Develop management plans for all Council assets and adequately resource their implementation.

Theme 5 - Governance
5.1.2 - Implement a robust enterprise risk management culture to identify and manage potential risks.

Operational Plan 2017-2018 Actions:

3.2.1 - Deliver actions as required from the DWQMP audit from 2016/2017

3.2.2 - Complete a review of the Drinking Water Quality Management Plan

COUNCIL'S ROLE

Council can play a number of different roles in certain circumstances and it is important to be clear about which role is appropriate for a specific purpose or circumstance. The implementation of actions will be a collective effort and Council's involvement will vary from information only through to full responsibility for delivery.

The following areas outline where Council has a clear responsibility to act:

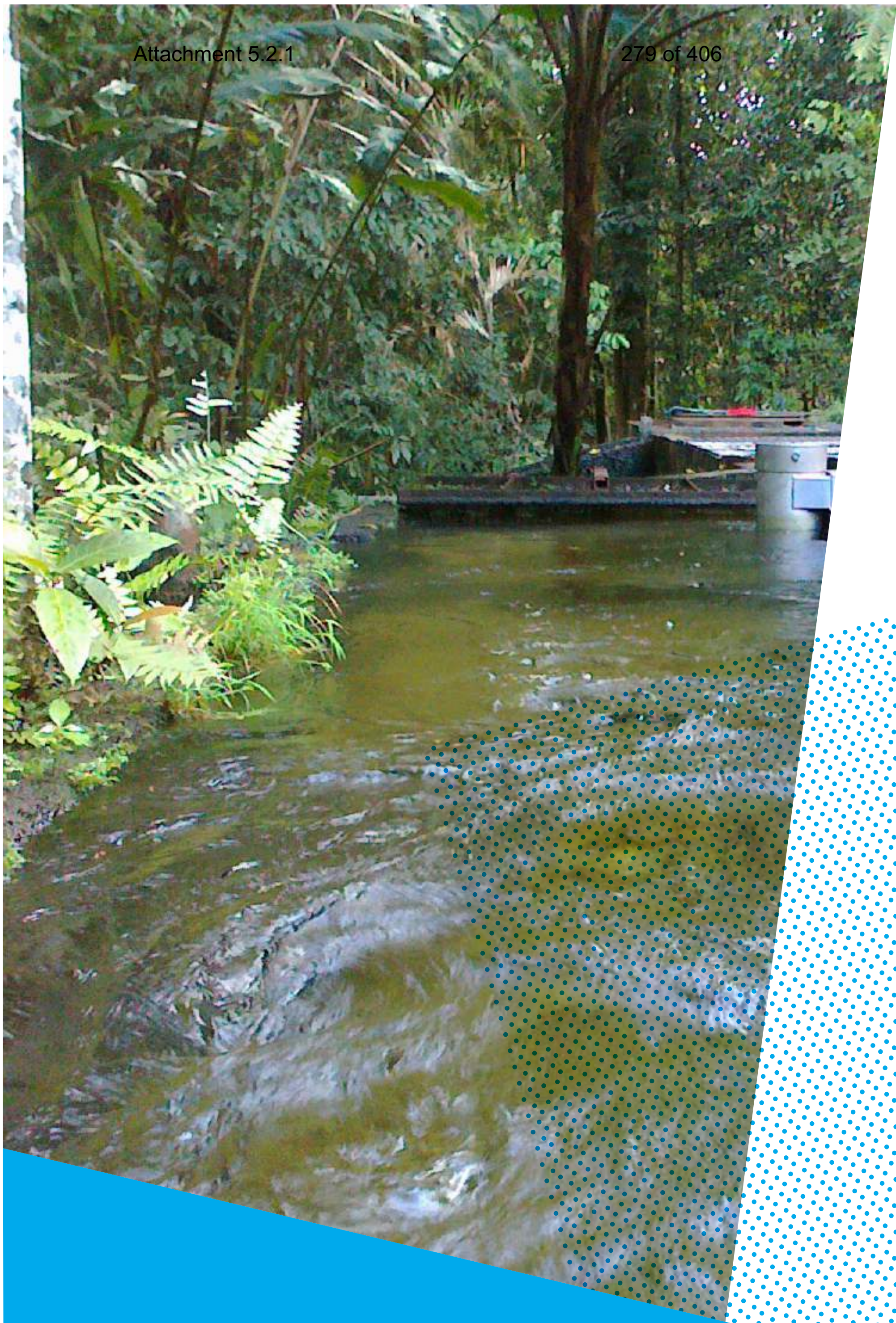
Asset-Owner	Meeting the responsibilities associated with owning or being the custodian of assets such as infrastructure.
Information Provider	Bringing people together to develop solutions to problems.
Regulator	Meeting the responsibilities associated with regulating activities through legislation or local law.

CONSULTATION

Internal:	Extensive internal consultation occurred during the formation of the new DWQMP. All water operational and management staff were actively involved in the internal audit, risk identification process and development of procedures.
External:	The review of the DWQMP was completed using external resources. In finalising the document, Council consulted with various state government agencies.

ATTACHMENTS

1. Douglas Shire Council Drinking Water Quality Management Plan Amendment Feb 2018 **[5.2.1]**



BLIGH TANNER

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Drinking Water Quality Management Plan

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BLIGH TANNER

+ DOCUMENT

'Drinking Water Quality Management Plan

+ JOB NUMBER

'2017.0720

+ PROJECT MANAGER

Michael Lawrence

+ CLIENT

Douglas Shire Council

+ CLIENT CONTACT

Nicholas Wellwood

VERSION	AUTHOR	REVIEWED	APPROVED	DATE
1	Michael Lawrence	Wouter van der Merwe		August 2015
1.1	Michael Lawrence	Wouter van der Merwe	Paul Hoye	October 2015
2	Michael Lawrence	Peter White		October 2017
2.1	Michael Lawrence	Peter White	Nicholas Wellwood	January 2018

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EXECUTIVE SUMMARY

The Drinking Water Quality Management Plan (DWQMP) for Douglas Shire Council is a public health based risk management plan that meets the requirements of the Australian Drinking Water Guidelines 2016 (ADWG) and the *Water Supply (Safety and Reliability) Act 2008*.

The DWQMP describes the Mossman Port Douglas, Whyanbeel and Daintree drinking water schemes operated by Council from catchment to tap.

Council has undertaken a system assessment and a public health risk assessment. Through the risk assessment process, Council has identified a number of risks to our drinking water schemes that require improvements over time. These are detailed in the risk assessment table, and in the risk management improvement plan.

Council intends to use the risk management improvement program to inform capital and operational budgets in coming financial years.

Critical items that have been identified that require attention include:

- Line remainder of Rex Creek race, and change Johnston Screens to increase self cleaning
- Craiglie Reservoir Roof Replacement
- Meter replacements to prevent backflow
- Replace Whyanbeel/Mossman interconnection
- Commission Daintree Bore
- Formalise professional development for water operations
- Securely lock out bypass to prevent accidental use

GLOSSARY

ADWG	Australian Drinking Water Guidelines
CCP	Critical Control Point
CEB	Chemically enhanced backwash
CIP	Clean in place
DBPs	Disinfection by-products (including trihalomethanes)
DWQMP	Drinking Water Quality Management Plan
OCP	Operational Control Point
PDT	Pressure Decay Test
PH Act	*Public Health Act 2005*
PHU	Public Health Unit – Queensland Health
PRV	Pressure Relief Valve
QH	Queensland Health
THM	Trihalomethanes – a subset of possible disinfection by-products
UF	Ultrafiltration
UV	Ultraviolet
WS Act	*Water Supply (Safety and Reliability) Act 2008*
WPR	Water Planning and Regulation, Department of Natural Resources Mines and Energy

Introduction

Douglas Shire Council provides drinking water to customers in three drinking water schemes. The Douglas Shire Drinking Water Quality Management Plan (DWQMP) is a risk based management plan that ensures that council can provide all of our customers in each of these schemes with safe drinking water.

The DWQMP is based on the principles of the Australian Drinking Water Guidelines 6 (NHMRC V3.3 2016), and meets the regulatory requirements of the *Water Supply (Safety and Reliability) Act 2008 (WS Act).*

Purpose of DWQMP

The Douglas Shire Council Drinking Water Quality Management Plan (DWQMP) is a public health based risk management plan that demonstrates how public health risks to our services are managed. In addition, we describe how we meet the requirements of our environmental authority for the Mossman Water Treatment Plant under the *Environmental Protection Act (1994)* and our Water Licenses under the *Water Act 2000.*

Registered service details

Douglas Shire Council is a registered water service provider, SPID 558, providing drinking water services to ~16250 customers. We supply water to 4 separate schemes of which 3 are potable drinking water services covered in this DWQMP. All 3 schemes are similar in their operation. All potable schemes source water from highly protected catchments, utilising a combination of ultrafiltration and chlorination, with the ability to use supplemental UV disinfection.

Table 1 — Drinking water schemes, populations and demand

Scheme Name/ Communities Served	Intake	Current**			Projected in 10 years		
		Population served	Total Connected Properties	Demand ML/annum	Population served	Total Connected Properties	Demand ML/day
Daintree	Martin Creek (Daintree Bores)	89	56	12.1	103	70	0.07
Mossman and Port Douglas	Rex Creek	15114	6744	3708.3	16036	7000	15.4
Whyanbeel	Little Falls Creek	1487	713	361.8	1526	800	2.1
Dagmar Heights*	Dagmar Bore	20	10	1.4	125	25	0.015
TOTAL		16544	7787	4033.5			17.985

* non-potable supply. Not discussed further.

** Data as reported in KPI reports 2016/2017

Element 1: Commitment to drinking water quality

Policy

Council is committed to consistently providing our customers within the drinking water schemes with a safe and reliable drinking water supply.

Figure 1 — Drinking Water Policy

Regulatory and formal requirements

DOUGLAS SHIRE COUNCIL

DRINKING WATER QUALITY GENERAL POLICY

Intent To establish a policy for the implementation and maintenance of a Drinking Water Quality Management System that is consistent with the Australian Drinking Water Guidelines.

Scope This policy applies to all Water and Waste activities associated with the supply of drinking water to the community.

PROVISIONS
The Drinking Water Quality Management System will utilise a risk-based "catchment to tap" approach to identify and manage potential risks associated with drinking water quality.

To achieve this, in partnership with stakeholders and relevant agencies, Water and Waste will:

- Consider the needs and expectations of our customers, stakeholders, regulators and employees and integrate appropriate solutions into our planning to provide and maintain safe water supplies.
- Undertake regular monitoring of drinking water quality and maintain effective reporting mechanisms to provide relevant and timely information and promote confidence in the management of the water supply systems.
- Have in place appropriate contingency plans and incident response capabilities to respond to and manage water quality incidents.
- Audit and review our practices against industry standards and stakeholder expectations to continually improve our performance.
- Provide training to all relevant employees to ensure that they are aware of this policy and are involved in the implementation of our Drinking Water Quality Management System.
- Openly communicate this policy to the community to encourage public awareness.

This policy assigns responsibility for drinking water quality management to all Water and Waste employees and acknowledges that corporate responsibility lies with the Water and Waste Management and ultimately the Douglas Shire Council, Chief Executive Officer.

♦♦♦♦♦♦

This policy is to remain in force until otherwise determined by Council.

Manager Responsible for Review: **Manager Water & Wastewater**

ORIGINALLY ADOPTED: 16/06/2015
CURRENT ADOPTION:
DUE FOR REVISION: 16/06/2019
REVOKED/SUPERSEDED:

1 #425995

The following table lists the regulatory requirements that Douglas Shire Council is required to meet with regard to the management of drinking water.

Table 2 — Regulatory register

Requirement	Council obligations and how they relate to the DWQMP
Water Supply (Safety and Reliability) Act 2008 Water Supply (Safety and Reliability) Regulation 2011	Council registered as a service provider. Service provider given powers to do certain things (e.g. disconnect customers, restrictions). Required to have an approved DWQMP and comply with the DWQMP. Required to report and respond to drinking water incidents. Plumbers are required to install water meters. Regulation currently has no impact.
Public Health Act 2005 Public Health Regulation 2005	Sets minimum sampling frequencies for E. coli as a provider. Council must not provide unsafe water.
Water Act 2000	Council is licensed to extract raw water. ▪ Rex Creek – Licence #408436 ▪ Little Falls Creek – Licence #500313 ▪ Daintree – Licence #408446
Environment Protection Act 1994	Water treatment is considered an environmentally relevant activity when treating >10ML/day. General obligation not to cause environmental harm. ▪ EA Permit number EPPR01790513. DSC Ref #729266 ▪ Whyanbeel Development application and ERA. DSC Ref #729267 ▪ Daintree Development application. DSC Ref #729268
Disaster Management Act 2003	Council is required to have a disaster management plan. This plan links to the Emergency Plan in this document.
Work Health and Safety Act 2011	Council must ensure safe work practices, including in the provision of drinking water.
Plumbing and Drainage Act (2002) Plumbing and Drainage Regulation (2003) Standard Plumbing and Drainage Regulation (2003)	Council must ensure that water infrastructure work is at a particular standard. Requires plumbers to install water meters (transitional arrangements for 18 months from July 2015).
Qld Plumbing and Wastewater Code (QPW code)	The code defines how drinking water infrastructure can be constructed.
Plumbing Code of Australia	Provides additional information to QPW code
Australian Standards	Numerous standards for plumbing, chemical handling etc.

The catchment is managed under the *Wet Tropics World Heritage Protection and Management Act 1993* but this is not Councils responsibility.

Customer and stakeholder engagement

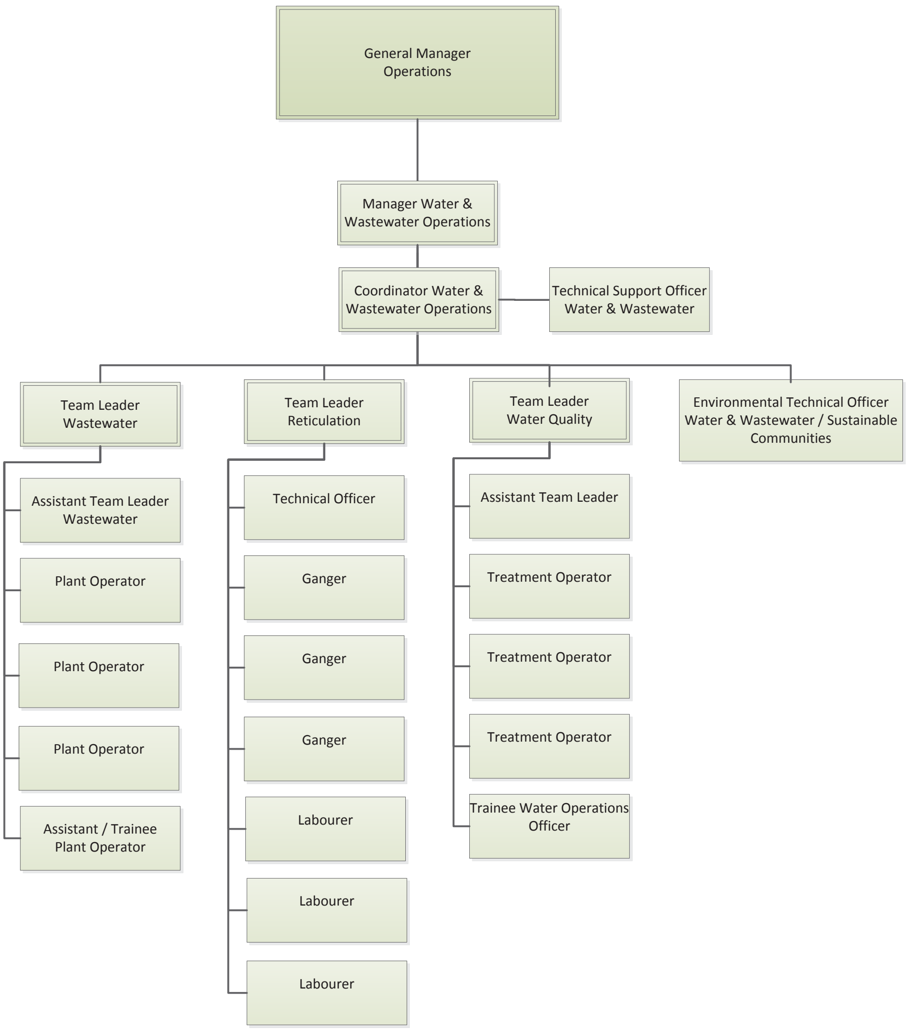
Douglas Shire Council has established customer service standards against which we are able to measure our performance. The most current version of these standards is available on our website at http://douglas.qld.gov.au/

In addition, when there are issues of community concern, Council undertakes community meetings to ensure that relevant information is made available.

Key stakeholders

Drinking water is managed in Douglas Shire Council by the Manager of Water and Wastewater, under the General Manager Operations. The following chart identifies the key internal stakeholders from within the water and wastewater group. This chart is updated by Council as required, and will be updated in the DWQMP either if there is a significant change in the structure, or following the biannual review of the DWQMP.

Figure 2 — Corporate Structure



External stakeholders are identified in the table below. These stakeholders have some influence on the management and operation of the water services.

Table 3 — External Stakeholders

Regulatory Stakeholder	Contact Details	Role
Water Planning and Regulation (Regulator)	1300 596 709	Regulation of drinking water, and incident reporting.
Tropical Public Health Services Cairns (Queensland Health)	4226 5555	Public health advice, assistance managing incidents.
Dept of Natural Resources and Mines	13 QGOV (13 74 68)	Water quality and flow monitoring
Dept of Environment and Science	13 QGOV (13 74 68)	Water treatment is ERA. Discharge licences etc.
Wet Tropics Management Authority	07 4241 0500	Catchment manager
Ozcare	07 4087 2805	High Risk Customers
Blue Care	07 4098 1126	High Risk Customers
Stella Maris Home for the Aged	07 4098 5946	High Risk Customers
Douglas Shire Aged Persons Home Inc.	07 4098 8233	High Risk Customers
Meals on Wheels	07 4098 1105	High Risk Customers
Mossman Multi-Purpose Health Service (Hospital)	07 4084 1200	High Risk Customers
Apumupima (Health Clinic)	07 4037 7100	High Risk Customers
Mossman State High School	07 4084 1333	Vulnerable Population Customers
Mossman State School	07 4099 9333	Vulnerable Population Customers
St Augustine's Primary School	07 4098 1631	Vulnerable Population Customers
Bubu Bamanga Ngadimunku	07 4098 1305	Vulnerable Population Customers
Petit Early Learning Journey (Port Douglas)	07 4237 8802	Vulnerable Population Customers
Port Douglas State School	07 4084 3222	Vulnerable Population Customers
Port Douglas Kindergarten	07 4098 5811	Vulnerable Population Customers
Wonga Beach State School	07 4099 9777	Vulnerable Population Customers
Wonga Beach Pre School	07 4099 9713	Vulnerable Population Customers
Miallo State School	07 4098 8130	Vulnerable Population Customers
Daintree State School	07 4098 6135	Vulnerable Population Customers
Goobidi Bamanga OSHC	07 4098 3244	Vulnerable Population Customers
Goobidi Bamanga CACs Ltd	07 4098 1283	Vulnerable Population Customers
Port Kidz Childcare Centre	07 4099 3392	Vulnerable Population Customers
Port Explorers	07 4099 3392	Vulnerable Population Customers
Petit Early Learning Journey	07 4237 8802	Vulnerable Population Customers
The Cubby House	07 4099 4292	Vulnerable Population Customers
Village Kids Children's Centre Cooya Beach	07 4098 3444	Vulnerable Population Customers
Cooya Kidz Kindergarten & Early Childhood	07 4098 3444	Vulnerable Population Customers
Goodstart Early Learning Mossman	07 4098 2044	Vulnerable Population Customers
Tropical North Family Day Care	07 4098 1831	Vulnerable Population Customers
C & K Community Kindergarten	07 4098 1880	Vulnerable Population Customers
Sheraton Mirage Resort	07 4099 5888	Large Population Resort
QT Resort	07 4099 8900	Large Population Resort
Rendezvous Reef Resort	07 4087 2790	Large Population Resort
Port Douglas Outrigger Holiday Apartments	07 4099 5662	Large Population Resort

Regulatory Stakeholder	Contact Details	Role
Mandalay Luxury Beachfront Apartments	07 4099 0100	Large Population Resort
Coconut Grove Apartments Port Douglas	07 4099 0600	Large Population Resort
Ramada Resort Port Douglas	07 4030 4333	Large Population Resort
Peppers Beach Club Port Douglas	07 4087 1000	Large Population Resort
Pullman Port Douglas Sea Temple Resort & Spa	07 4084 3500	Large Population Resort
Tourism Port Douglas / Daintree	07 4099 4588	Maintain contacts
Orica (Ixom)	Gerhard Florida 0478401092	Chlorine Gas
Elite chemicals	Glenn 07 4035 5699	Sodium hypochlorite, Citric acid, caustic soda.
Koch	Mark Forbes 0288334600	Membrane Supplier
KSB	Grant Butler 0429006895	Pumps
ABB	Nilesh Patel 07 3713 9007	Online Instruments
SGS	4035 5111	Verification sampling
Siemens	Len Walder 07 3332 8326	Online Instruments
Bligh Tanner	Michael Lawrence 07 3251 8509	Water Engineering, Risk Management, DWQMP preparation, Incident investigation, Review and Audits.

We liaise with these stakeholders as necessary, for example, we may contact these customers individually in the event of implementing "boil water" or "do not drink" alerts.

Customer complaints

Douglas Shire Council takes customer complaints seriously as they can provide advance warning of issues within the water network that may not yet be apparent, and may alert us to environmental issues.

All customer complaints received by council are recorded and investigated, with the officer assigned and the results of the investigation included in the record. These records are reviewed on a monthly basis by the Coordinator Water and Wastewater. Customer complaints are reported to the Regulator annually as required under the Key Performance Indicator reporting.

Element 2: Assessment of the water supply system

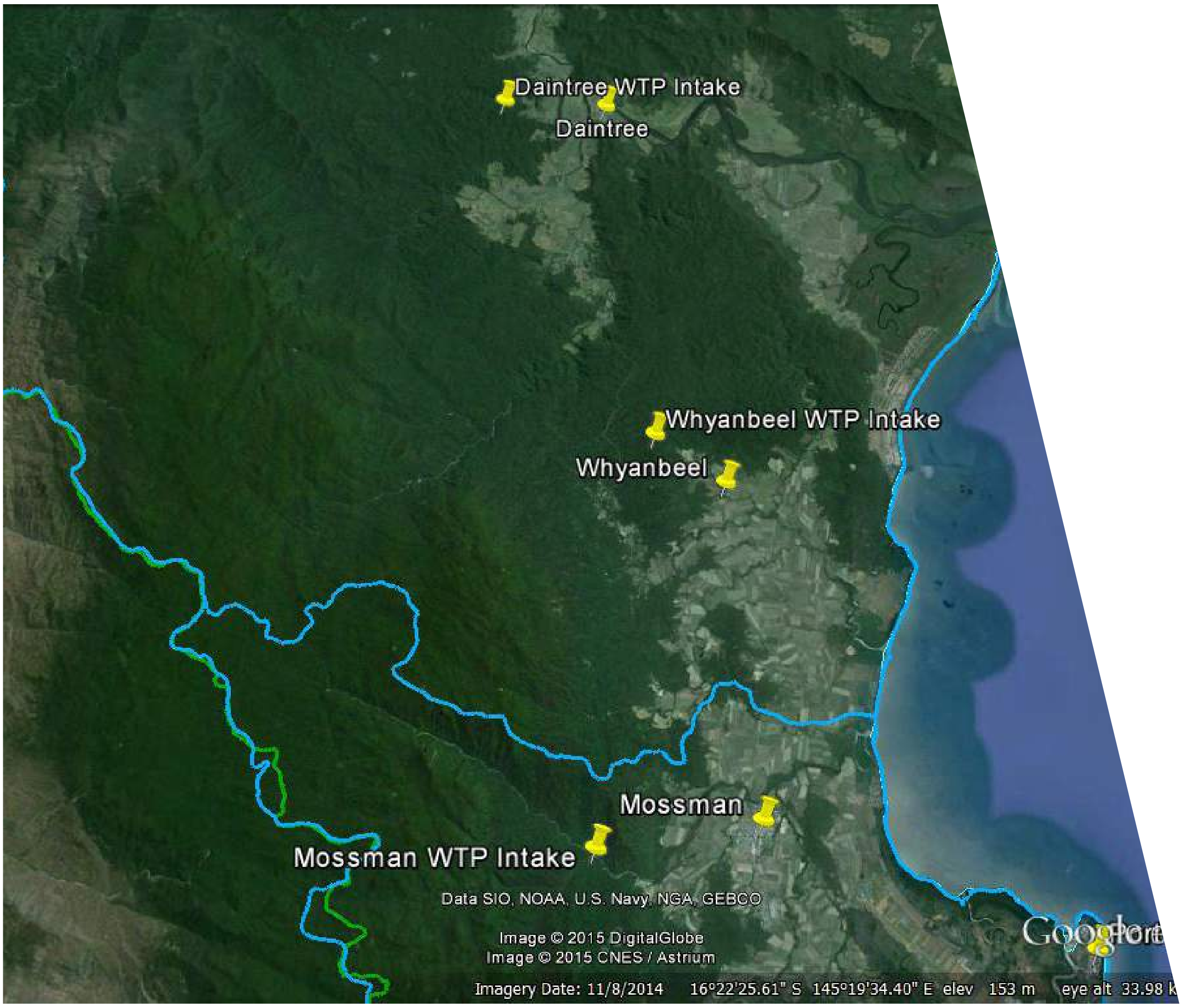
Catchment characterisation

Raw water for all the Douglas Shire Council schemes is sourced from remote intakes in rugged weathered granitic terrain, located in the Wet Tropics World Heritage Rainforest. The catchments have specific Wet tropics legislation that defines what can be done within the catchment. As a result, there is very limited potential for any human activity within the catchment area for any of the intakes, and the catchments can therefore be considered to be highly protected, and at lower risk of containing human pathogens than typical water sources.

There is a prevalence of native and feral wildlife in these catchments, so microbiological hazards are the most significant for our services. During the wet season, there are regular "high turbidity" events (> 50 NTU) but these are normally short lived. There is minimal to no risk of pesticides, heavy metals or other hazards in these catchments.

The locations of the water treatment plant intakes are indicated on the image below, demonstrating the protected nature of these catchments. In this image, the blue lines indicate the catchment boundaries, and the green line is the shire boundary.

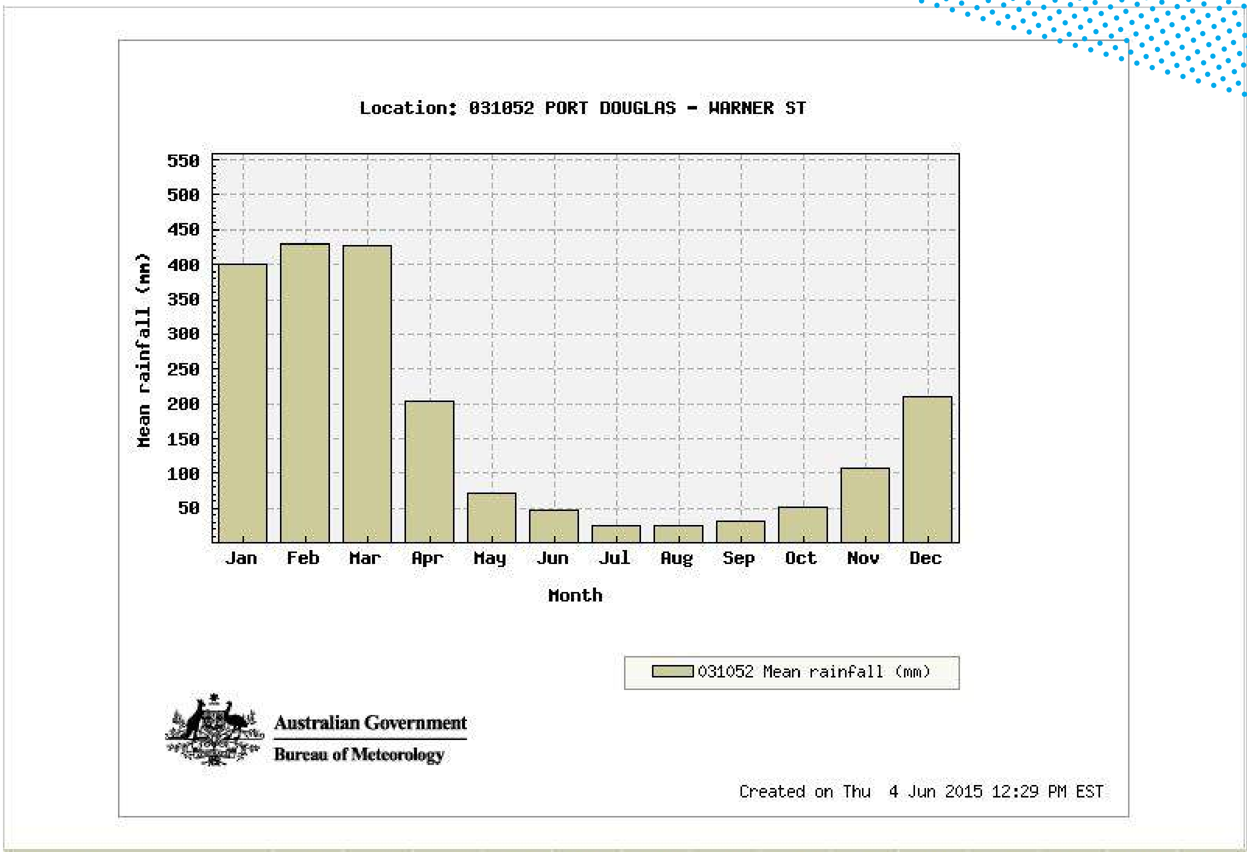
Figure 3 — Catchment and intakes for the 3 Douglas Shire Council Schemes



Rainfall

Rainfall in the wet tropics is concentrated from -November to May. The below rainfall averages are for Port Douglas, which has the longest record, but data from Daintree, Whyanbeel and Mossman indicates a very similar pattern.

Figure 4 — Rainfall Data Port Douglas



Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years
Mean rainfall (mm) for years 1884 to 2015	400.9	429.5	426.3	203.1	72.4	47.4	25.6	24.0	31.8	51.7	107.1	210.2	2031.5	125

As the Whyanbeel and Daintree schemes are small with relatively low water volumes extracted, there have been no occasions when raw water was unavailable. As such these schemes are considered 100% reliable.

The Mossman/ Port Douglas Scheme has a much higher demand, and there have been occasions in October/November when water supply from Rex Creek becomes less reliable. Whilst we have not run out of water, Douglas Shire Council must also meet its *Water Act 2000* obligations, and is obliged to maintain an environmental flow in Rex Creek as per the conditions of the water license (license number408436 expiry 30/6/2111). Water restrictions are regularly imposed during September, October and November. Douglas Shire Council has a project to replace the interconnection between the Mossman and Whyanbeel Schemes to improve supply resilience.

The water quality coming from these catchments is very good. However, due to the nature of rainfall in these catchments which can be very intense, turbidity can increase from the normal values of <1 NTU to over 50 NTU, but these events are usually short lived. At times, the raw water pH can drop below 6.5, and has been observed to be as low as 6.2. This has no impact on water treatment, and improves our disinfection process. There are no other water quality issues that have been identified.

Historically, these schemes were raw water, and then were operated as UF/UV schemes. There are sometimes customer complaints related to chlorine. We investigate these complaints, but as the WTP target dose rate is typically -1- 1.5 mg/L, we do not normally need to take any further action.

Treatment overview

Mossman, Whyanbeel and Daintree Water Treatment Plants treat water from Rex Creek, Little Falls Creek and Intake Creek respectively. All treatment plants have the following process steps

- Johnson Screen
- 200 micron pre-filter
- Ultrafiltration (caustic soda and sodium hypochlorite and citric acid used in cleaning)
- Chlorination (using 1 or more of sodium hypochlorite, calcium hypochlorite and/or gas chlorination)
- UV disinfection (optional)
- The Whyanbeel WTP has recently added a sodium carbonate pH adjustment step as the chlorine gas resulted in lower pHs. Similar dosing may be required in the future at the Mossman WTP.

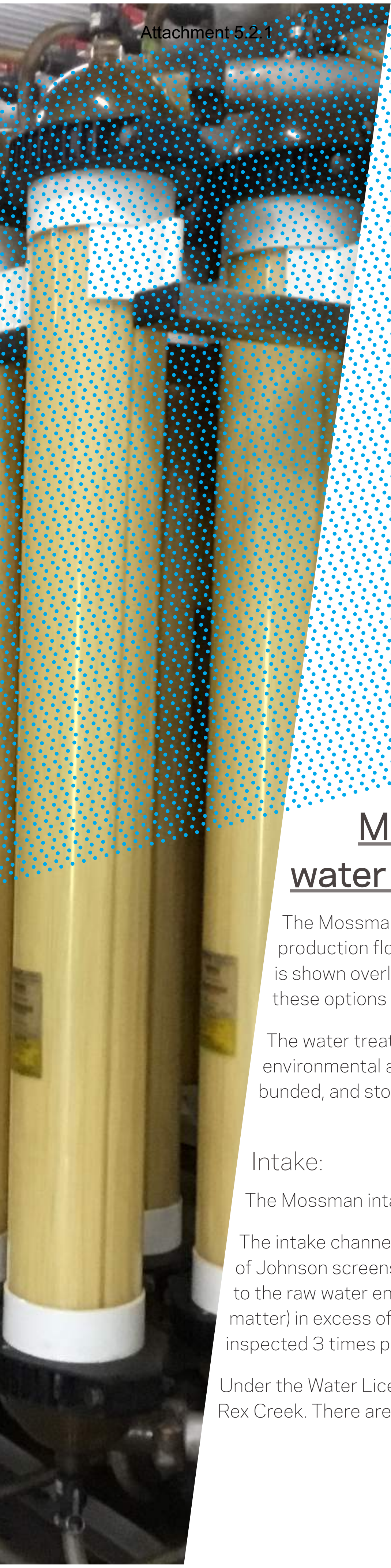
Reticulation overview

The reticulation networks for each of the three water supply schemes are ageing, have limited storage capacity and some long reticulation distances to rural areas. The length of the network and ageing infrastructure increases pH and results in reduced disinfection residual levels (or pH levels where only the hypochlorite ion is present, making disinfection less effective against ingress). Water quality testing of major storages and the reticulation network are conducted weekly to ensure efficient functioning of the network.

All available data regarding asset age, type, make is available from the Asset Management System Asset Life Cycle Software and is accessible to all staff using MapInfo ARCGIS Interface corporate mapping software.

Network maintenance is tracked and fed into the Asset Management documentation for these assets.

There are relatively high proportions of asbestos concrete mains, which are slowly being phased out of the system where possible through general maintenance, emergency works or if works are conducted and the main is identified as in need of repair. A camera, where possible, is passed up the main to look further at the condition. The actual age of many of the cast iron pipes is unknown as they have all been assigned a generic date of installation when the asset system was first started.



Mossman – Port Douglas drinking water scheme

The Mossman water treatment plant is a 30 ML/d design treatment plant, with a daily production flow range from 2160 to 30000 kL/d. The schematic, including bypasses is shown overleaf. .Opening bypass valves requires manual intervention, and none of these options are used in normal operation.

The water treatment plant is designed with the relevant development approval and environmental authorities in mind, such as ensuring that chemicals are appropriately bunded, and stormwater cannot be contaminated by activities on site.

Intake:

The Mossman intake is located on Rex Creek.

The intake channel has been built into the rock bed, and it diverts raw water flow to a series of Johnson screens. The Johnson screens offer initial coarse filtering of the raw water prior to the raw water entering the raw water pipeline and remove solids (generally sand and leaf matter) in excess of 1mm in diameter. The screens are designed to be self-cleaning but are inspected 3 times per week, 52 weeks per year and cleaned as required.

Under the Water License for Rex Creek, DSC has a nominal entitlement of 4800 ML from Rex Creek. There are maximum extraction limits based on flow. These limits are listed in the raw water operational procedure and additionally programmed into SCADA.

Screened water gravity feeds (6 km) to the WTP through 2 raw water mains. The available head is sufficient to provide water pressure feed to operate the ultrafiltration membranes.

Turbidity is measured immediately prior to the Johnson Screens and a second turbidity meter is located on the raw water main at Marrs Creek prior to entry to the WTP. A third meter is located at the WTP. Any of the three turbidity meters can be selected for duty to control shutdown of the WTP in the event of high turbidity.

The operational limits for raw water turbidity are listed in the table below. The water treatment plant can operate at higher turbidities (for example in extended periods of high demand) if absolutely necessary, but this comes at the expense of membrane life, and increases the frequency of cleaning. As such the limits below may change as required.

It is possible to bypass the Mossman WTP and provide raw water directly to the community. This was the original configuration of this scheme, but it is not intended to be used into the future.

At times the raw water from Rex Creek has a low pH that falls below 6.5. The backwash water quality in these scenarios is also below 6.5. However, as the backwash discharge pH is identical to the raw water pH, it is not considered that there can be any environmental impact.

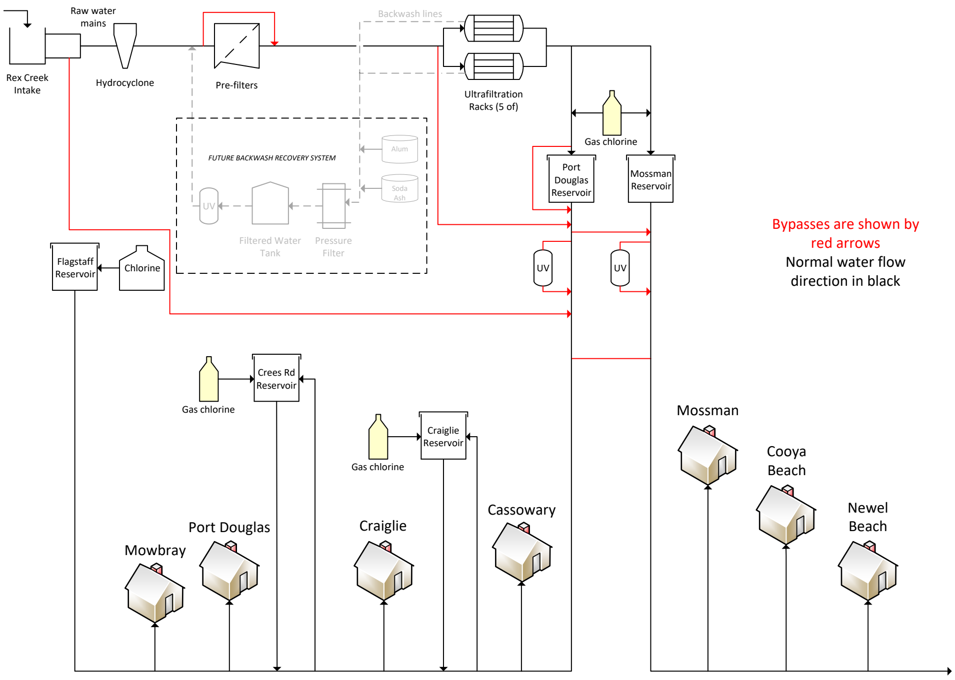
Hydrocyclone and Prefiltration

Raw water is passed through a hydrocyclone (to remove sand) and filtered to 200 microns through 4 pre-filters. The pre-filters provide a duty/ standby operation and are designed to provide raw water flow to meet 100% of the treatment plant design capacity.

The pre-filters are cleaned by automated backwashing using raw water (typically every 60 minutes depending on raw water turbidity). As no chemicals are used, backwash water is discharged directly to the water course. The pre-filters are removed and inspected to assess serviceability once every 12 months.

It is possible to bypass the pre-filters at Mossman.

Figure 5 — Catchment to tap Schematic



Ultrafiltration

The Mossman treatment plant uses 5 racks of 52 Koch polysulfone ultrafiltration membranes per rack. The membranes have a nominal size cut-off of 100000 Daltons.

The Ultra Filtration process is fully automated and includes its own main control panel which operates UF inlet/outlet valves, recirculation pumps, backwash supply pumps, a Chemical Enhanced Backwash (CEB), and Clean In Place (CIP) system including chemical dosing equipment. Critical process equipment is installed with a duty/ standby capacity to minimise disruptions to the water treatment process.

Operation and monitoring of the Ultra filtration treatment plants is via a PLC/SCADA system with a Citec user interface for process operation, monitoring and alarming functions.

The cleaning of the cartridges is via an automated backwashing sequence that utilises water only backwashing (typical frequency of 60 minutes) and chemically enhanced backwashing (CEB's) with a minimum ratio of one CEB to twelve backwashes in total. The frequency of backwashing and the ratio of CEB's to water only backwashes may be varied and is determined by the operator by observing trending values of the Trans-Membrane Pressure (TMP's) in relation to production flow set points and raw water inflow turbidity.

Figure 6 — Rex Creek Intake - race is lined with Stainless Steel

Currently, CEBs are programmed automatically in SCADA to occur 1 in every 12 backwash cycles. This changes operationally to maintain membrane performance.

Chemically Enhanced Backwashing utilises a Caustic/ Chlorine cleaning solution which is introduced to the membrane cartridges at a pre-determined concentration, typically pH 10 and concentration of chlorine at 60 mg/L. The cartridges are allowed to soak in this solution for 400 seconds. Effectiveness of the backwashing sequence is continually monitored and all associated parameters are recorded for reporting and operational planning purposes. CEB backwash water is directed to the sewer. Following backwashes, the membranes are rinsed prior to coming back into service.

A clean in place (CIP) utilises a heated cleaning solution of either citric acid pH 4 solution caustic (max pH 12) or a combined caustic/chlorine solution (pH 12, 200 mg/L). These are used to remove both organic and inorganic fouling. A CIP is typically undertaken on each rack once per month.

At the completion of a CIP the UF rack is backwashed, rinsed and tested to ensure all traces of chemicals are removed prior to placing the UF rack back into service. Testing is performed on the UF rack by means of sampling the retentate and permeate header water and conducting in house lab testing for pH and free chlorine levels. Test limit results for free chlorine < 0.1 mg/L and a pH result equivalent to the raw water pH value (typically 6.5 to 7.5) must be achieved prior to placing the UF rack back into service. Additional rinse cycles can be performed to ensure test results are within defined limits.

Environmental discharge

Discharges to the environment from the Mossman Water Treatment Plant are in accordance with our integrated environmental authority. Prefilter and UF water only backwashes are discharged directly to the creek. Chemically enhanced backwash water and clean in place waters are contaminated with chlorine (and in some cases the pH is outside of the acceptable range) and are discharged to sewer.

Membrane integrity – direct testing

Membrane integrity is evaluated every 24 hours (of elapsed production time) by undertaking an automated pressure decay test (PDT). The pressure decay test measures whether there are any breaches of the membrane greater than 3 microns in size. Membrane integrity is considered as a critical control point for managing the protozoa risk, and the CCP procedure, relevant to all schemes, is presented in a later section. If the UF rack fails the integrity check it is immediately and automatically taken off line for inspection and repair.

Trending data and outcomes of the integrity check cycle are monitored to pre-determine UF cartridge maintenance/repair intervals allowing UF racks to be removed from service and repaired to avoid unexpected shutdowns on account of integrity check failure.

Nonetheless, there is sufficient production capacity of treated water that under normal demand 2 racks can remain offline until repaired.

Membrane integrity – indirect testing.

The permeate turbidity is monitored using individual filter rack permeate turbidity meters capable of 0.001 NTU resolution.

Where the permeate turbidity exceeds 0.15 NTU on any rack, the affected UF rack is taken offline and undergoes a PDT to determine if there is a breach of the membranes, as per the relevant CCP procedure.

The ultrafiltration racks can be bypassed – but this would not be used except in emergency situations. Permeate is directed to the clear water reservoirs.

Figure 7 — Ultrafiltration Rack at Mossman/Port Douglas WTP

Chlorination

All disinfection points are operated as per the Chlorination (Primary and Re-dosing) CCP procedure. Disinfection is achieved through gas chlorination using 2 by 920 kg chlorine gas drums as duty standby, with automated change over operation. The system uses a vacuum chlorine gas draw off injector disinfection system to chlorinate the Mossman 1.8 ML and Port Douglas 5 ML reservoirs. Current operation uses a recirculation system on each of the treated water reservoirs with a set point control mode of operation.

The target for chlorine is as stated in the CCP with actions and critical limits as described below. The two critical limits ensure effective disinfection (low side) and prevent exceedances of the chemical health guideline value (high side). It is possible to bypass chlorination. This is not used under normal operation.

(Ultraviolet disinfection)

The original WTP design was for UF and UV only. UV disinfection is achieved by the use of Hanovia totally encapsulated in pipe-line UV systems. The UV systems have been designed to meet treatment plant maximum flow design capacity and achieve a minimum dose rate of 12 mJ/cm^2. This dose rate is sufficient for 3.5 log reduction of protozoa, and ~4 log reduction for most bacteria. However, the dose rate is not sufficient to provide any additional barrier for viruses.

The UV units are not currently operational but physically remain. There is an intent to consider renewal of the UV units in the 2018/19 financial year.

Backwash Recovery Project

Currently, approximately 10% of the raw water extracted is lost as backwash, and during 2017/18 a backwash recovery system will be installed. Current planning includes coagulation/sedimentation, pH adjustment and filtration followed by UV. The recovered water will be added to the raw water stream - however, it is not believed that this will change the risk profile, The risk assessment will be updated after the backwash recovery plant has been commissioned. The preliminary design is shown in the schematic, but this could change prior to construction.

Reticulation

Water is reticulated under gravity to Mossman and Port Douglas water scheme. Network maps showing sampling locations are on pages 54 and 55.

The reticulation network has the following materials and age ranges.

Table 4 — Mossman/Port Douglas Reticulation

Scheme	Total Length	% of total	Length (km)	Material	Age Range
Mossman - Port Douglas	214.5 km	51.74	111	AC	1960-1997
		22.94	49.2	PVC	1940-2010
		12.62	27.1	DICL	1940-2009
		9.15	19.6	HDPE	1960-2008
		1.83	3.93	CI	1960
		1.58	3.39	DI	1960
		0.02	0.04	GI	unknown
		0.02	0.04	MSCL	unknown

The pipe material code is as follows;

> AC: Asbestos Cement, CI: Cast Iron, DICL: Ductile Iron Cement Lined, GI: Galvanised Iron, MSCL: Mild Steel Concrete lined, Poly: Polyethylene, PVC: Polyvinylchloride

There are 2 reservoirs located at the Mossman water plant, the Port Douglas and Mossman reservoirs. There are two Cooya reservoirs, but these are currently not in use. It is intended to commission these reservoirs in the future. There are 2 reservoirs that service Port Douglas, including the Craiglie Reservoir (Hope St) and the Flagstaff Reservoir.

The Craiglie and Flagstaff Reservoir are utilised to provide additional storage capacity for the Port Douglas scheme. Either reservoir can be gravity fed from the Mossman WTP, but Flagstaff can additionally be fed from the Craiglie Reservoir pump station. Outflow from the Craiglie reservoir is by the way of two pumps in a duty standby arrangement.

All reservoirs are roofed and have vermin proofing, but the roof at Craiglie is in poor condition. The roof is budgeted for replacement but this has been delayed until after the new 20 ML Crees Rd reservoir has been constructed, as this sequence ensures continuity of supply. Other operational reservoirs are in reasonable to good condition, but the vermin proofing on all reservoirs will nonetheless be sequentially and comprehensively assessed and ensured. In the case of Cassowary and Mowbray, these reservoirs are offline and the condition is poor. They will not be brought online until they are rehabilitated.

There are no areas of low pressure within the scheme, but the distribution network to Newell and Cooya Beach represents a relatively long detention time. Cassowary and Mowbray also have long detention times.

There is an additional reservoir at Mowbray that is currently offline, but can be used in times of high demand or for cyclone preparedness. There is also a roofed reservoir at Cassowary. This is not used in normal situations, but may be considered as cyclone preparation (for example, with manual chlorination), but is otherwise not expected to be used.

Table 5 — Reservoir Details - Mossman/Port Douglas Scheme

Scheme	Reservoir	Capacity (ML)	Material	Roofed	Vermin Proof	(Re) chlorination	Alarms
Mossman - Port Douglas	Mossman Clearwater	1.8	Concrete	Y	Y	Y	Chlorine high and low level. Reservoir level
	Port Douglas Clearwater	5	Concrete	Y	Y	Y	Chlorine high and low level. Reservoir level
	Cooya Beach	2	Concrete	Y	Y	N	
	Cassowary	0.1	Zinc Anneal	Y	Offline	N	
	Craiglie	10.1	Concrete	Y	Y	Y	Chlorine high and low level. Reservoir level, Pressure alarms for pumps, flow rate.
	Flagstaff Two Reservoir	2.2	Concrete	Y	Y	Y	Chlorine high and low level. Reservoir level, Pressure alarms for pumps, flow rate.
	Mowbray	0.125	Concrete	Y	Offline	N	Reservoir level
	Crees Road (in construction)	20ML	Concrete	Y	Y	Y	Chlorine high and low, Reservoir Level.

Redosing

The Craiglie, Rocky Point and Flagstaff Reservoirs are rechlorinated within the limits defined in the CCP procedure. The Craiglie redosing stations uses two 70 kg chlorine gas cylinders in duty standby configuration with automated change over between cylinders. The system operates using a set point based vacuum chlorine gas draw off injector disinfection system. The Crees Road Reservoir will redose with chlorine gas (two 920 kg cylinders) , also with the same CCP setpoints. The Rocky Point and Flagstaff reservoirs have calcium hypochlorite eroders that also operate using the same CCP set points.

Whyanbeel drinking water scheme

The Whyanbeel water treatment plant is a 4.7 ML/d design treatment plant, with a daily flow range from 1728 to 4924.8 kL/d. As the WTP is <5 ML/day it is not considered an environmentally relevant activity.

Intake

The Whyanbeel intake is located on Little Falls Creek.

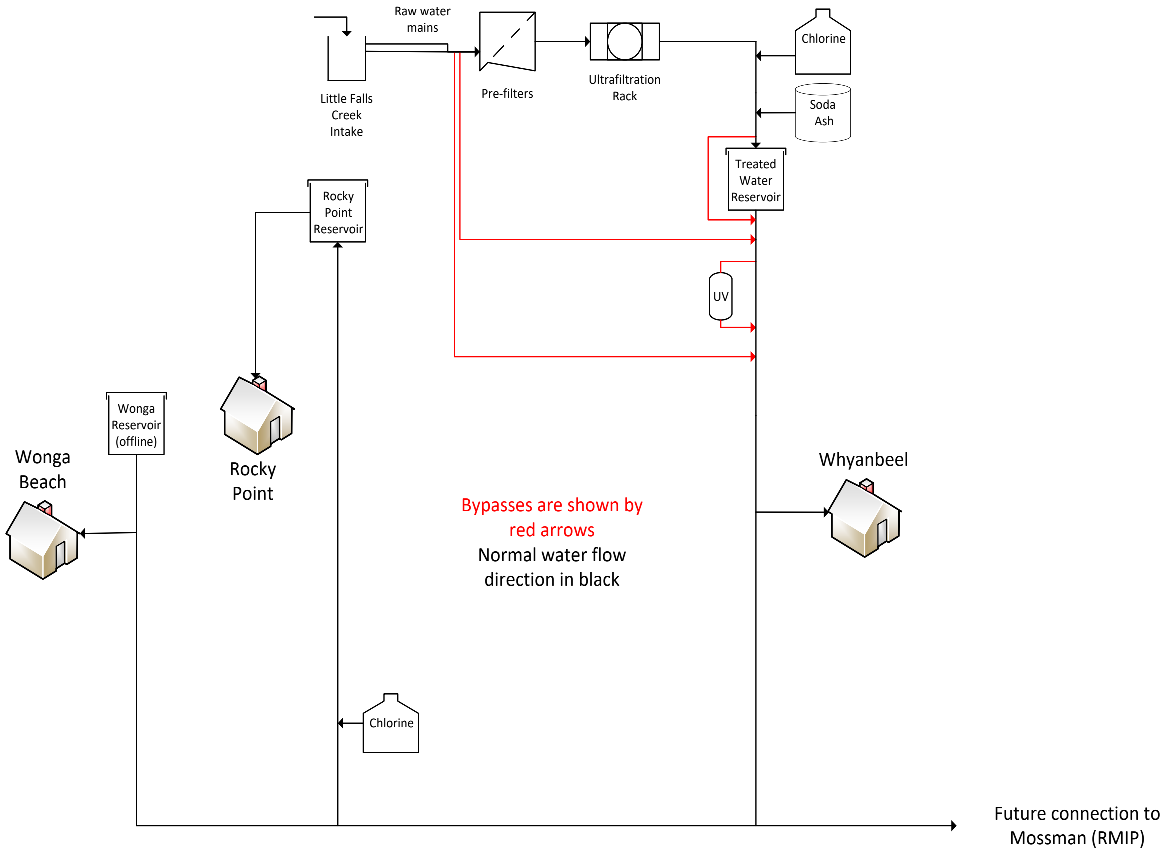
The intake channel has been built into the rock bed, and it diverts raw water flow to a series of Johnson screens. The Johnson screens offer initial coarse filtering of the raw water prior to the raw water entering the raw water pipeline and removing all solids (generally sand and leaf matter) in excess of 1 mm in diameter. The screens are designed to be self-cleaning but are inspected 3 times per week, 52 weeks per year and cleaned as required.

Screened water gravity feeds (0.5 km) to the WTP through two raw water mains. At the WTP, 2 raw water booster pumps (1 duty 1 standby) pump water to the ultrafiltration membranes.

Turbidity is measured using an online turbidity meter which is located at the WTP and provides the control turbidity for WTP shutdown. Operationally, the Whyanbeel WTP shuts down when raw water turbidity exceeds 5 NTU. The water treatment plant can operate at higher turbidity's (for example in extended periods of high demand) if necessary, but this comes at the expense of membrane life, and increases the frequency of cleaning. As there is sufficient treated water supply, there is generally no need to operate outside this level.

The Water license 500313 for Little Falls Creek provides for an annual allocation of 630 ML. It is possible to bypass the Whyanbeel WTP and provide raw water directly to the community. This was the original configuration of this scheme, but it is not intended to be used into the future.

Figure 8 — Whyanbeel WTP Schematic



Prefiltration

Prefilters are operated in the same manner as described for Mossman WTP. It is not possible to bypass the pre-filters at Whyanbeel.

Ultrafiltration

The treatment plant uses 1 rack of 36 Koch polysulfone ultrafiltration membrane cartridges with a nominal size cut-off of 100000 Daltons.

The Ultra Filtration process at Whyanbeel is identical to the Mossman WTP with the exception that the single rack and greater storage volume of treated water allow the plant to operate with a raw water turbidity cutoff of 5 NTU rather than 30 NTU.

Environmental discharge

Whilst the Whyanbeel WTP is not an environmentally relevant activity, Douglas Shire Council still has an obligation not to cause general environmental harm. As such we ensure that only uncontaminated prefilter backwash, and water only backwash water is discharged to the creek at no more than 10% difference to background water quality. Chemically enhanced backwash and CIP waters are stored onsite and tankered to Port Douglas under a trade waste approval.

Membrane integrity – direct testing

Membrane integrity is evaluated every 24 hours in accordance with the CCP procedure. If the UF rack fails the integrity check it is immediately taken off line for inspection and repair.

Trending data and outcomes of the integrity check cycle are monitored to pre-determine UF cartridge maintenance/repair intervals allowing preventive maintenance to occur as appropriate. Nonetheless, there is sufficient production and storage capacity of treated water that the rack can normally remain offline until it is repaired.

Membrane integrity – indirect testing.

The permeate turbidity is monitored and managed in accordance with the CCP procedure. Where the permeate turbidity exceeds 0.15 NTU, the UF rack is taken offline and undergoes a PDT to determine if there is a breach of the membranes.

The ultrafiltration rack can be bypassed – but this is not intended to be used. Permeate is directed to the clear water reservoir.

Chlorination

Disinfection is achieved by gas chlorination (2*70 kg chlorine gas cylinders) configured as duty standby with automated switchover in accordance with the CCP procedure. The system utilises a set point based vacuum chlorine gas draw off injector disinfection system to chlorinate the treated water reservoir.

pH adjustment

Sodium carbonate is dosed to increase the pH, and increase alkalinity of the treated water. 15% batched sodium carbonate solution is dosed (Deplox 5 analyser, set point control) at ~0.03 ml/L to increase the pH in accordance with the OCP procedure.

(Ultraviolet disinfection)

The original WTP design was for UF and UV only. UV disinfection is achieved by the use of Hanovia totally encapsulated in pipe-line UV systems. The UV systems have been designed to meet treatment plant maximum flow design capacity and achieve a minimum dose rate of 12 mJ/cm^2. This dose rate is sufficient for 3.5 log reduction of protozoa, and ~4 log reduction for most bacteria. This dose rate is not sufficient to provide any additional barrier for viruses.

The UV units are not currently operational but physically remain. There is an intent to consider renewal of the UV units in the 2018/19 financial year.

Reticulation

Water is reticulated, under gravity from the treated water reservoir to the Whyanbeel scheme. Network maps showing sampling locations are shown on page 55. There is one operational reservoir at Rocky Point. There is an additional reservoir available at Wonga Beach, which is normally offline. (This reservoir is vermin proofed and roofed – and will be brought online when demand requires it, or for contingency in cyclones.) It is intended to install a recirculation chlorination system at this reservoir in the future.

Table 6 — Whyanbeel Reticulation

Scheme	Total Length	% of total	Length (km)	Material	Age Range
Whyanbeel	66.3 km	48.16	31.9	PVC	1972-2009
		42.63	28.3	AC	1972-1996
		5.08	3.37	DICL	1994
		2.74	1.82	HDPE	1972-1993
		1.39	0.92	Poly	1972

The Rocky Point reservoir receives its flow from the Whyanbeel plant Wonga beach water main via two pumps 1 duty 1 standby that pump the water to the reservoir.

There are no areas of low pressure in Whyanbeel, and PRVS are used to reduce pressures to <600kPa.

There are 2 mains from Whyanbeel to Wonga Beach – a higher pressure main feeds to Rocky Point, and a lower pressure feed to Wonga Beach. There are closed interconnections between the mains, with PRVs in place to protect the older AC mains.

There is an improvement item to complete the connection to the Mossman Port Douglas scheme that will provide supply security to either system.

Table 7 — Reservoir Details - Whyanbeel Scheme

Scheme	Reservoir	Capacity (ML)	Material	Roofed	Vermin Proof	(Re) chlorination	Alarms
Whyanbeel	Whyanbeel Clearwater	3.5	Concrete	Y	Y	Y	Chlorine high and low level. Reservoir level
	Rocky Point Reservoir	1	Concrete	Y	Y	Y	Chlorine high and low level. Duty pump start/ stop. Reservoir level
	Wonga Beach Reservoir	2	Concrete	Y	Y	N	Reservoir level

Redosing

Redosing of chlorine occurs at the Rocky Point reservoir. Current operations use a recirculation system on the Rocky Point reservoir that doses using calcium hypochlorite eroders with set point operation.

Redosing is operated in accordance with the CCP procedure.

Figure 9 — Whyanbeel Clearwater Reservoir

Daintree drinking water scheme

The Daintree water treatment plant is a 0.49 ML/d design treatment plant, with a large daily flow range from 60.4 – 492 kL/d. The small WTP is not considered an environmentally relevant activity.

Intake:

The Daintree intake is located on Intake creek, and council is licensed (License # 408446) to extract a maximum of 0.3 ML/day, (80 ML annually) at a rate not exceeding 6 L/s. Council may not take water if the flow downstream of the intake is less than 5 L/s.

The intake channel has been built into the rock bed and it diverts raw water flow to a coarse screen with a hole size of approximately 15mm. The screen offers initial coarse filtering of the raw water prior to the raw water entering the raw water pipeline and removes sticks and leaf matter. The screen is inspected once per week (more if required and accessible), and cleaned as required.

Screened water gravity feeds (4.0 km) to the WTP through one raw water main. The available head is sufficient to provide feed water to the Daintree WTP Raw water reservoir 200KL which then feeds 2 raw water booster pumps 1 duty 1 standby that pump water to the ultrafiltration membranes.

Turbidity is measured using an online turbidity meter which is located at the WTP and provides the control turbidity for WTP shutdown.

The current turbidity limit is 5 NTU. The water treatment plant can operate at higher turbidity's (for example in extended periods of high demand) if necessary, but this comes at the expense of membrane life, and increases the frequency of cleaning.

It is possible to bypass the Daintree WTP and provide raw water directly to the community. This was the original configuration of this scheme, but it is not intended to be used into the future, except under emergency scenarios. Council is currently constructing a bore to provide alternate supply for this scheme. The bore supply will be added to the raw water reservoir, and all treatment processes will remain identical.

Contingency Bore

A groundwater bore has been drilled (construction detail in Appendix B) and will be commissioned as a contingency water source during 2018. Pumping tests indicate that the bore should sustainably yield 6.5 L/s. Water quality testing for a full range of standard water analysis and 19 metals (total and dissolved) do not indicate that there is any parameter of concern (most parameters are near the instrument detection limit). The results are presented in Appendix B. The bore water has low pH and alkalinity that may require pH adjustment if the bore is used as the sole water source, however this is not the intent.

In general the expectation is that once commissioned, the bore will supplement the Intake Creek Supply, and will be turned over at least weekly to maintain water quality in the raw water line. The bore would be brought online in the event that the flow in intake Creek reduced below our licensed extraction level, or the intake was damaged in adverse weather events

Raw water reservoir

Raw water enters the raw water reservoir. This tank detains the water and allows sediment to settle, reducing the turbidity load to the WTP. The raw water tank is cleaned annually to prevent sediment build up. When commissioned,. the bore will feed the raw water tank.

Pre-filtration

Raw water is further filtered to 200 microns through pre-filters. The pre-filters run continuously and are cleaned by automated backwashing (typically every 10 minutes depending on raw water turbidity) to ensure constant feed of raw water to the treatment plants. The pre-filters are arranged in banks to provide a duty/ standby operation and are designed to provide raw water flow to meet 100% of the treatment plant design capacity.

The pre-filters are removed and inspected to assess serviceability once every 12 months. Backwash water supply is from the raw water supply and is directed back to the water course. It is possible to bypass the pre-filters at Daintree.

Ultrafiltration

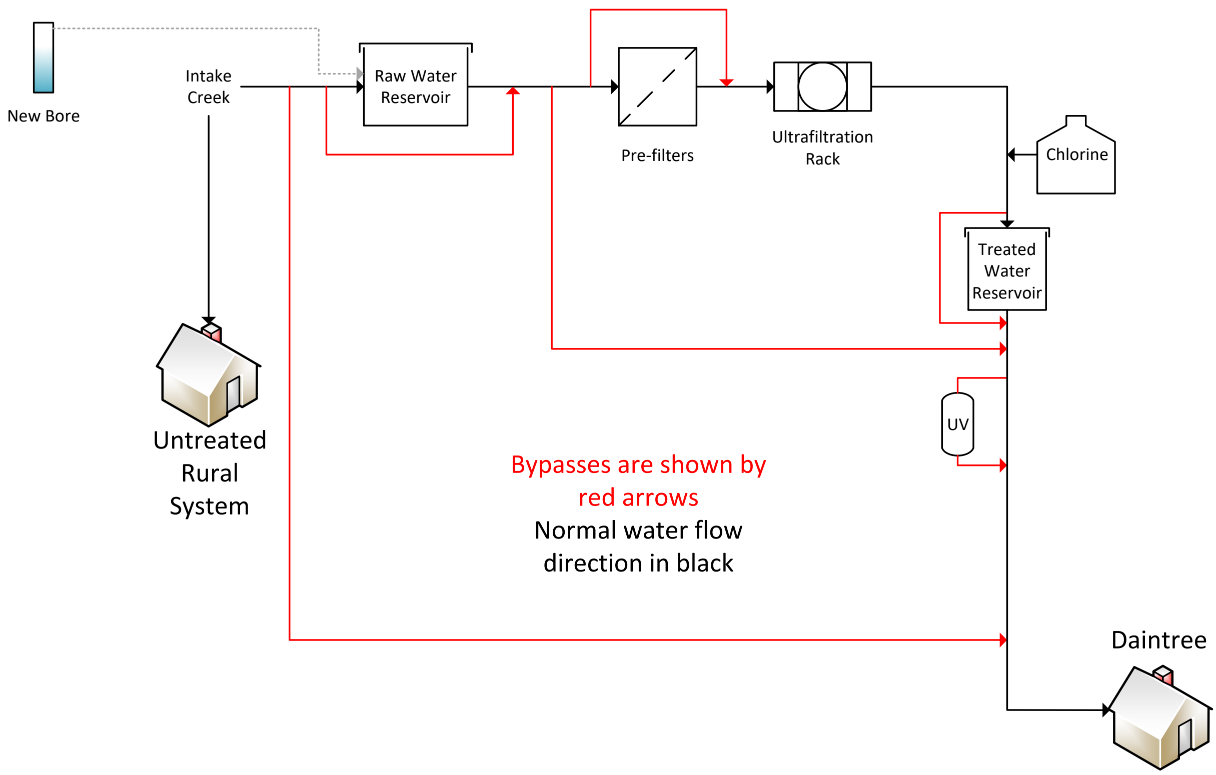
The treatment plant uses 1 rack with 6 available positions for Koch polysulfone ultrafiltration membrane cartridges with a nominal size cut-off of 100000 Daltons. The number of cartridges used can be changed depending on operational requirements and demand. The Daintree water treatment has a maximum design capacity of 0.49 ML per day.

The Ultra Filtration process is fully automated and includes its own main control panel which operates UF inlet/outlet valves, recirculation pumps, backwash supply pumps and a Chemical Enhanced Backwashes (CEB), and Clean In Place (CIP) system including chemical dosing equipment. Critical process equipment is installed with a duty/ standby capacity to minimise disruptions to the water treatment process.

Operation and monitoring of the Ultra filtration treatment plants is via a PLC/SCADA system with a Citec user interface for process operation, monitoring and alarming functions.

The cleaning of the cartridges is via an automated backwashing sequence that utilises water only backwashing typically required every 40 minutes. The frequency of backwashing is determined by the operator by observing trending values of the Trans-Membrane Pressure (TMP's) in relation to production flow set points and raw water inflow turbidity.

Figure 10 — Daintree WTP Schematic



Currently, no CEBs are performed at Daintree due to the discharge being to the Daintree River. Only CIP's are performed with the waste water being collected in the chemical holding tank then pumped out and transported by road Tanker to the Port Douglas waste water plant.

A clean in place (CIP) utilises a heated cleaning solution of either citric acid, caustic or a combined caustic/chlorine solution. These are used to remove both organic and inorganic fouling. A CIP is typically undertaken on the rack twice per month.

At the completion of a CIP the UF rack is backwashed and rinsed and tested to ensure all traces of chemicals are removed prior to placing the UF rack back into service. Testing is performed on the UF rack by means of sampling the retentate and permeate header water and conducting in house lab testing for pH and free chlorine levels. Test limit results for free chlorine < 0.1 mg/L and a pH result equivalent to the raw water pH value (typically 6.5 to 7.5) must be achieved prior to placing the UF rack back into service. Additional rinse cycles can be performed to ensure test results are within defined limits.

Membrane integrity – direct testing

Membrane integrity is evaluated every 24 hours (of elapsed production time) by undertaking an automated pressure decay test (PDT). Membrane integrity monitored and managed in accordance with the CCP procedure.

Membrane integrity – indirect testing.

The treated water reservoir turbidity is monitored using a turbidity monitor capable of 0.001 NTU resolution, and managed in accordance with the CCP procedure.

Chlorination

Disinfection is achieved through chlorination. Current operations use a recirculation system on the treated water 400KL reservoir that doses sodium hypochlorite with a set point control mode of operation.

The target for chlorine is typically 1.0 mg/L with operator alerts at lower 0.7 mg/L and upper 2.0 mg/L. This target range does change operationally, for example, depending on season. There are two critical limits associated with chlorination. The operator can initiate a WTP production shutdown if the chlorine level in the clear water tank drops below 0.2 mg/L. This ensures that viruses and bacteria are deactivated. Similarly, there is a high level critical limit that is set at 4.0 mg/L to prevent high chlorine from exceeding the health guideline value.

It is possible to manually chlorinate raw water and it is also possible to bypass chlorination. This is not used under normal operation.

(Ultraviolet disinfection)

The original WTP design was for UF and UV only. UV disinfection is achieved by the use of Hanovia totally encapsulated in pipe-line UV systems. The UV systems have been designed to meet treatment plant maximum flow design capacity and achieve a minimum dose rate of 12 mJ/cm2. This dose rate is sufficient for 3.5 log reduction of protozoa, and ~4 log reduction for most bacteria. This dose rate is not sufficient to provide any additional barrier for viruses.

The UV units are not currently operational but physically remain. There is an intent to consider renewal of the UV units in the 2018/19 financial year.

Reticulation

Water is reticulated, under gravity to the Daintree scheme directly from the 400KL treated water reservoir at the plant – there are no additional reservoirs.

There is a relatively low turnover in this scheme, in the past this has led to low chlorine residuals in the reticulation system. Over the past 6 months, DSC has gradually increased the chlorine dose to the 1 mg/L target, which is translating into detectable residuals at the Shire Hall. There is great sensitivity in this community to chemicals in their water supplies, so changes are made slowly so as to acclimatise the consumers without resulting in increased opposition to chlorination. Network maps showing sampling locations are under Element 5.

Water quality data

Douglas Shire Council undertakes water quality testing of raw, treated, (reservoirs) and reticulation. Data has been statistically analysed, and a summary of the available data (in some cases since 2008) has been presented in Appendix A. The Drinking Water Quality Management Plan Report is the normal method by which our data is reported publicly.

In addition to the parameters identified in those tables, DSC has previously also undertaken testing to inform the management of the water supplies. For example, we have undertaken monitoring for *Cryptosporidium* and *Giardia* in the raw water, with infrequent low level positive detections that demonstrate their presence in the catchment. Similarly, we have undertaken testing for *Naeglaria* in the reservoirs, but have not detected this pathogen. Given the focus on operational monitoring ensuring the effectiveness of treatment barriers, we no longer consider it necessary or cost effective to continue to monitor for these pathogens. Rather, we emphasise the optimal operation of our treatment barriers.

DSC has also undertaken monitoring for disinfection by-products within the reservoirs. The highest level detected was at Rocky Point Reservoir, with only 150 mg/L, which is well below the ADWG health guideline value. Future THM monitoring will be moved to the furthest extents of the reticulation network, and if a similar pattern emerges, we may discontinue THM monitoring altogether.

Of note, with over 1262 *E. coli* samples, 3 post treatment samples were positive. 1 in the Flagstaff reservoir in Dec 2014 and 1 in the Mossman Post UV sample in March 2015, and a May 2016 sample at Cooya. All three samples were collected in very adverse weather conditions, and are thought to be the result of contamination of the samples, rather than reflecting the water quality at the time. Incidents that occurred prior to chlorination of these schemes are no longer considered relevant.

Water quality data in general indicates that the treatment processes are very effective at reducing or eliminating hazards.

Risk methodology

Douglas Shire Council has adopted a risk methodology based on the "Preparing a Drinking Water Quality Management Plan Supporting Information, September 2010" documentation provided by the Queensland Water Supply Regulator.

There are some minor differences to the published version in that the consequence descriptor for catastrophic has been quantified, and the uncertainty descriptors tailored to reflect the data availability in these schemes.

Public Health Risk Matrix and Definitions

The public health risk matrix used for the risk assessment is presented below. Medium and Low risks are acceptable - High and Extreme risks should be reduced by implementing risk improvement actions.

Table 8 — Risk Matrix

Public Health Risk Matrix — Likelihood / Consequence		Insignificant	Minor	Moderate	Major	Catastrophic
		Isolated aesthetic exceedence - little operational disruption	Local asthetic exceedence, potential isolated breach of chemical health parameter	Widespread aesthetic exceedences, or repeated breaches of chronic health guidelines	Potential acute health impact, no outbreak expected	Potential acute health impact, declared outbreak likely
Almost Certain	Occurs daily to weekly	Medium 6	High 10	High 15	Extreme 20	Extreme 25
Likely	1-4 occurrences per month	Medium 5	Medium 8	High 12	High 16	Extreme 20
Possible	1-11 occurrences per year	Low 3	Medium 6	Medium 9	High 12	High 15
Unlikely	1 occurrence per 1-5 years	Low 2	Low 4	Medium 6	Medium 8	High 10
Rare	<1 occurrence per 5 years	Low 1	Low 2	Low 3	Medium 5	Medium 6

Table 9 — Uncertainty Descriptors

Uncertainty Level	Uncertainty descriptor
Certain	The processes involved are thoroughly understood and supported by very extensive on site knowledge covering multiple drought and flood cycles, and/or high frequency (weekly or better) water quality monitoring data.
Confident	The processes involved are well understood and supported by extensive on site knowledge of more than one drought and flood cycle, and/or monthly water quality data
Reliable	There is a good understanding of the process which is supported by quarterly water quality data and operational experience that covers drought and flood years.
Estimate	The process is reasonably well understood, and data covers seasonal and drought and flood cycles.
Unreliable	The process is not well understood, and water quality data does not cover seasonal variations for drought and flood years.

Methodology

The entire risk assessment process is conducted over three stages. These include

1. Hazard identification,
2. Unmitigated risk assessment, and
3. Mitigated risk assessment.

As Douglas Shire Council has 3 schemes with a very similar treatment train, the risk assessment was undertaken for all 3 schemes simultaneously, but taking into account any individual differences.

The relevant hazards were identified from previous versions of the DWQMP, water quality data, incident history, known water quality issues, and experience of the hazard identification team. The hazards that were considered are listed in the unmitigated risk assessment table in the following section.

After a hazard is identified, the likely sources were identified. This sometimes resulted in the identification of specific schemes where the hazard was significantly different to another. Where this is the case, the different schemes were considered separately for their unmitigated public health risk (the same hazard is identified on multiple lines).

For each hazard, an unmitigated risk was determined by first determining the consequence of the hazard, and then considering the likelihood that the hazard would result in that consequence. The unmitigated risk assumes that a person consumes the water with the hazard present and no treatment in place. (In some cases, such as overdose of treatment chemicals, this simplistic definition is broadened to assume that the hazard is introduced to the water supply with no further control measures after the hazard has been introduced).

The consequence definitions are adhered to strictly, such that any hazards that could result in an acute health risk (for example pathogens), must have either a major or catastrophic consequence. On the contrary, parameters with chronic health risks, such as manganese or trace level pesticides, will have either minor or moderate consequences. The ADWG does not provide guidance on acute chemical risks, and none have been identified in this process.

Once the consequence and likelihood were assigned, the Public Health Risk was determined using the matrix in the next section. An uncertainty is also assigned to demonstrate the level of confidence in the assessment.

Douglas Shire Council considers that a Public Health Risk of medium or below is acceptable. If an unmitigated risk was determined to be low, this was not carried forward to a mitigated risk assessment. Hazards with unmitigated risks of medium or above are generally carried forward to the scheme specific risk assessments, detailed in the individual scheme based plans.

For the mitigated risk assessment, the hazards and the sources of the hazards/ hazardous events are then separated out to consider where in the treatment process that the hazard can eventuate as a risk. This is done to examine failure modes for individual process elements. Where a hazard is present, the preventive measures that are intended to minimise the risk are identified.

The effectiveness of the identified measure, given the hazardous event is then assessed. Where an unmitigated risk is unacceptable, and reduced, the operational procedure used to manage the risk is identified. Again, an uncertainty is assigned. If the mitigated risk remains unacceptable, or there is no operational procedure, a risk management improvement item was identified.

Hazard identification and risk assessment

A hazard identification team was assembled in June 2015 to identify the hazards that are present across any or all schemes. Members of this team were also involved in the water supply system description and analysis. Following agreement on the hazards that are present, the unmitigated risks were evaluated. The hazard identification team that was involved in this process is detailed in the table overleaf.

During the Hazard identification workshop, available raw water quality data, and operational knowledge was used to inform the workshop conclusions.

An unmitigated risk was then assigned for each hazard, considering any differences in types of schemes that may change the unmitigated risk rating. The hazard identification and unmitigated risk assessment is presented in the following pages.

2017 Risk review

Following the audit in 2017, we conducted a desktop review of the completed RMIP actions, updated the current risks, and identified risk improvement items that had either been deferred or have been recently added to the infrastructure programs.

The risk methodology remained identical, but the risk register was updated to include Mitigated Risk 2017. In addition, completed risk assessment items were now added to the preventive measures, and Comments 2017 were added to contextualise the current level or risk.

The RMIP (the final columns of the risk register) has similarly been updated to remove items that have been completed, and to include those relevant items that are required to mitigate unacceptable risks. The relevant unmitigated risks above are passed forward to the scheme by scheme mitigated risk assessment. In this case, relevant generally means that the hazard is present for that type of scheme, with an unmitigated risk of medium or above. Low risks identified above are not considered further, as they are not considered to pose a public health risk within the timeframe for plan review where these outcomes will be revisited.

Some asset management issues have been included as whole of system risks (Failure of supply in Mossman/ Port Douglas due to drought). In these cases, we have been very conservative in the application of the likelihood as the consequence of loss of supply is so severe. For example, whilst it may actually be rare that we are unable to supply the Mossman/ Port Douglas scheme, we have assessed the likelihood as "unlikely". This is partially to differentiate from the Daintree and Whyanbeel schemes, but also because we believe it essential for supply security to develop an alternate water source in this scheme.

As stated above, following determination of the mitigated risk, we identified if we have a robust implemented documented procedure for that process that ensure that the measures are effective. As appropriate, we have also assessed and documented whether the barrier was a critical control point. This is described more fully in the following section.

Table 10 — Risk Assessment Participants 2015 and 2017

Participant	Position	2015 or 2017 workshop	Water Industry/ Risk Management Experience
Paul Hoye	General Manager Operations (2015)	2015	22 years, Previously an EHO, food safety auditor, HACCP training. 20 years in DSC
Wouter van der Merwe	Manager Water and Wastewater	2015	30 years water industry, 18 months in DSC. Formal risk training.
Henry Maro	Team Leader Water Treatment	2015 and 2017	20 water industry, with 8 years at DSC. Cert 3 in water and wastewater, risk assessments undertaken previously
Samadhi Senior	Technical Officer Water and Wastewater.	2015	5 years in council/ water, risk assessment
Mark Howarth	Team Leader, Water Reticulation	2015	37 years with council/ water. Risk assessment experience.
Matt Govorko	Water Operator	2015	10 years water industry, DSC. Cert 3, council risk assessments.
Steve Davis	Water Operator	2015	4 years DSC and water industry, Cert 3, council risk assessments
Tony Kadwell	Technical Officer	2015	28 years, Cert 3 Reticulation. Previous risk training
Dr Michael Lawrence - Bligh Tanner	Facilitator	2015 and 2017	>10 years in water industry, formal ADWG training, water quality management systems auditor.
Dr Nicholas Wellwood	General Manager Operations (2017)	2017	Engineer, 30 years in water industry, formal risk training
Peter White	Coordinator Water and Wastewater	2017	12 years in council in water and wastewater, risk assessment experience
Marie Lawson	Administration Officer - Water and Wastewater	2017	12 years in DSC, initial drinking water risk assessment

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Table 12 – Unmitigated Risks

Hazard	Type of Hazard	Sources of Hazard	Unmitigated Risk			Uncertainty	Comments	Treatment Barrier/s
			Consequence	Likelihood	Risk			
Bacteria/Virus	Biological	Native animals in catchment, ineffective disinfection	Catastrophic	Almost Certain	Extreme 25	Certain	More likely than protozoa, but low risk of human-human pathogenic forms. Zoonotic disease more likely.	Protected catchment, chlorination (UV)
Bacteria/Virus	Biological	Ingress into reservoirs/ water mains, insufficient residual disinfection	Catastrophic	Likely	Extreme 20	Confident	Reservoir integrity requires constant attention to ensure that this is managed	Reservoir integrity, residual disinfection, redosing, mains break procedures.
Cyanobacteria	Biological	Algal bloom	Minor	Rare	Low 2	Confident	Shaded intakes, high relief in the catchment, constant flow. Will not build up.	Protected catchment
Protozoa	Biological	Native animals in catchment, ineffective UF	Catastrophic	Almost Certain	Extreme 25	Confident	Possible, but high concentrations of human pathogenic forms not considered likely	Protected catchment, UF
Protozoa	Biological	Ingress into reservoirs/ water mains	Catastrophic	Likely	Extreme 20	Reliable	Possible, but high concentrations of human pathogenic forms not considered likely	Protected catchment, UF
Amoeba (Naeglaria, Acanthamoeba etc)	Biological	Ingress into reservoirs/ water mains, insufficient residual disinfection	Major	Possible	High 12	Estimate	if present likely impact to only single person	Residual disinfectant, mains repair procedure
Chlorate	Chemical	Chemical breakdown	Moderate	Likely	High 12	Confident	Currently not a guideline value, and phasing out hypochlorite solutions.	Moving to gas chlorination
Chlorine	Chemical	Chemical overdose	Moderate	Almost Certain	High 15	Confident		SCADA control of dosing
DBPs	Chemical	Elevated organics and long detention times	Moderate	Likely	High 12	Reliable	Low organic loading and tight membranes reduce formation potential	UF, stable water, low doses of chlorine, multiple redosing points in longer reticulation systems.
Heavy metals	Chemical	Natural geology	Moderate	Rare	Low 3	Reliable		Nil required
Hydrocarbons	Chemical	Illegal disposal of fuel etc	Moderate	Rare	Low 3	Confident	Single issue on lot at Wonga beach - but potential to leach through mains.	Nil required
Iron	Chemical	Natural geology, sediment	Minor	Unlikely	Low 4	Reliable		Raw water intake CCP, UF
Lead	Chemical	Pipework	Moderate	Possible	Medium 9	Reliable	Some lead joints in old pipework (mossman gorge intake). Not believed to be any service connection lead left, when identified it is replaced.	Old mains replacement program
Manganese	Chemical	Natural geology	Moderate	Rare	Low 3	Reliable		Raw water intake CCP, UF
Pesticides	Chemical	Limited use in catchment	Moderate	Rare	Low 3	Reliable		Nil required
Scaling	Chemical	tds or organics in raw water	Minor	Likely	Medium 8	Confident		CIPs and CEBs.
Taste and odour	Chemical	Algae blooms	Minor	Unlikely	Low 4	Confident		UF
Taste and odour	Chemical	Regrowth in reticulation	Minor	Likely	Medium 8	Confident		
Alkalinity	Chemical	Potential change in ratio of surface runoff to springs	Minor	Unlikely	Low 4	Reliable	Change in alkalinity appears to drive pH change in AC mains	Nil - but affects water stability in reticulation
High pH	Chemical	Interaction with AC mains	Minor	Almost Certain	High 10	Confident	As pH increases in AC mains, residual disinfection becomes less effective	Long term replacement of AC mains
Low pH	Chemical	Naturally occurring, chlorine gas	Minor	Almost Certain	High 10	Reliable	Annual pH drop at end of dry season typically < 6.5. Addition of chlorine gas may lower pH further - Whyanbeel has required pH adjustment as a result. Mossman may require in future, but acceptable pH to date.	Sodium carbonate dosing at Whyanbeel, monitoring of operation at Mossman to identifiy if this is also required.
Colour	Physical	Naturally occurring	Minor	Possible	Medium 6	Confident		Raw water intake CCP, UF
Temperature	Physical	Seasonal	Minor	Likely	Medium 8	Certain	Chlorine consumption, regrowth	Nil required
Turbidity	Physical	Rainfall events	Minor	Almost Certain	High 10	Certain		Raw water intake CCP, UF
Turbidity	Physical	Sloughing of biofilm, resuspension of sediment in reservoirs/mains	Minor	Possible	Medium 6	Reliable		Mains flushing program, stable disinfection regime
Radioactivity	Radiological	Natural geology	Moderate	Rare	Low 3	Confident		Nil required
Failure of supply	Whole of System	Drought (Mossman/ Port Douglas)	Catastrophic	Unlikely	High 10	Reliable		Investigating alternate source
Failure of supply	Whole of System	Drought	Catastrophic	Rare	Medium 6	Reliable		

Hazard	Type of Hazard	Sources of Hazard	Unmitigated Risk			Uncertainty	Comments	Treatment Barrier/s
			Consequence	Likelihood	Risk			
Failure of supply	Whole of System	Landslide at raw water intake (Daintree)	Catastrophic	Possible	High 15	Estimate	Likely able to put pump in plunge pool for raw water supply	
Failure of supply	Whole of System	Flood/ repeated storms resulting in WTP shutdown	Catastrophic	Unlikely	High 10	Reliable	Successive storms have shut down production twice in 10 years to the point of being unable to treat enough water to supply consumers.	
Failure of supply	Whole of System	Cyclone	Catastrophic	Possible	High 15	Confident		Generators, cyclone preparedness plans, DMP.
Failure of supply	Whole of System	Loss of power	Catastrophic	Possible	High 15	Confident	Port Douglas worst area, others can be gravity fed under most circumstances	
Reduced supply	Whole of System	Demand exceeds capacity	Catastrophic	Almost Certain	Extreme 25	Reliable	This is based off longer term considerations - so while we currently have sufficient capacity, if nothing is done, this is the case over 3-5 years.	Build system capacity and reticulation inter-linkages
Operator error	Whole of System	Untrained/ overworked/ mistake	Catastrophic	Almost Certain	Extreme 25	Confident		Staff training
Sabotage/ Terrorism	Whole of System	Any chemical or microbiological hazard	Catastrophic	Possible	High 15	Estimate		Regular inspections, security fenciing, security contract.
WTP fire	Whole of System	Electrical fire	Catastrophic	Rare	Medium 6	Reliable		

Table 13 – Mitigated Risk Assessment summary.

Process Step	Hazardous Event	Hazards managed by same barriers	Unmitigated Risk	Primary preventive measure	Other Preventive Measures	2015 Risk	Mitigated 2017			Uncertainty	Comments 2015	Comments 2017	CCP?	Documented Procedure	Risk Management Improvement Plan 2017		
							Consequence	Likelihood	Risk				Y/N		2017/18	Proposed 2018/19 FY	2019/20 FY or beyond
Catchment	Present in catchment - animals	Bacteria and virus	Extreme 25	Disinfection	(UV)	Medium 6	Catastrophic	Rare	Medium 6	Certain	considered as whole of treatment in absence of failure			SCADA			
	Present in catchment - animals	Protozoa	Extreme 25	UF	(UV)	Medium 6	Catastrophic	Rare	Medium 6	Confident	considered as whole of treatment in absence of failure			SCADA			
	Storm events	Loss of supply due to high turbidity	High 10	Raw water turbidity trigger		Medium 6	Catastrophic	Rare	Medium 6	Confident	considered as whole of treatment in absence of failure			SCADA			
Raw Water Feed	Raw water main break	Failure of supply	High 10	Multiple intakes Mossman	mains break procedure	Medium 6	Catastrophic	Rare	Medium 6	Confident	network operators have extensive experience mitigating lack of formal procedure			CRC mains break procedure available, needs to be updated			
	Blocked Johnson screen	Failure of supply	High 10	Intake checked daily	sufficient treated water capacity to last 1 day.	Medium 6	Catastrophic	Rare	Medium 6	Reliable	Screens block in flood events, Daintree access depends on river conditions, but can operate for 3 days without access.		N	Required	Project to line remaining area of race and angle Johnston screens to allow more self cleaning		
	Raw water UF feed pump failure (Daintree/ Whyanbeel)	Failure of supply	High 10	1 day supply treated water, spares available	duty standby	Medium 6	Catastrophic	Rare	Medium 6	Certain	spare pumps available on site			SCADA alarms on reservoir levels			
	Loss of Raw water reservoir at Daintree due to subsidence	Failure of supply	High 10	Stabilisation works to be completed		High 10	Catastrophic	Rare	Medium 6	Reliable	not happened, but eroding slope requires remediation. Activate DMP	Stabilistion completed in 2017. Continue to observe for any other signs of erosion on site.					
	Blocked prefilters	Failure of supply	High 10	Duty standby prefilter operation		Medium 6	Catastrophic	Rare	Medium 6	Confident	running plant without prefilters ultimately can lead to blocked UF and loss of supply. Mossman automatically increases backwash frequency based on turbidity.	Johnson screen to be replaced at Rex Creek, race lining to be completed, raw water scour valves to be replaced		SCADA raw water deviation alarm on UF allows identification.			
	Turbidity above limit	Turbidity	High 10	Raw water turbidity trigger	UF	Low 2	Minor	Rare	Low 2	Confident	running plant without prefilters ultimately can lead to blocked UF and loss of supply		N	OCP in plan			
Ultrafiltration	Loss of integrity	Protozoa, turbidity	Extreme 25	24 hr PDT	Continuous turbidity monitoring	High 10	Catastrophic	Rare	Medium 6	Confident	Mossman WTP butterfly valves have been leaking causing failures in PDT even when membrane thought to be intact.	butterfly valves replaced, and spares now kept. CCP being adhered to strictly	Y	PDT CCP			
	Loss of integrity	Protozoa, turbidity	Extreme 25	Continuous turbidity monitoring	24 hr PDT	High 10	Catastrophic	Rare	Medium 6	Confident	Mossman turbity currently combined - hence sensitivity for faiilure of a single rack is reduced	turbidity meters on individual racks, will alter CCP to 15 minute delay to match draft HBT guidance.	Y	Turbidity CCP			
	Loss of integrity	Protozoa, turbidity	Extreme 25	Continuous turbidity monitoring	24 hr PDT	High 10	Catastrophic	Rare	Medium 6	Confident	on treated turbidity, not permeate at daintree and whyanbeel	turbidity meters are now on permeate, will alter CCP to 15 minute delay to match draft HBT guidance.	Y	Turbidity CCP			
	Membrane scaling reducing plant capacity	Reduced supply	Medium 8	Regular backwashes, including CEB/ CIP as required		Medium 6	Minor	Possible	Medium 6	Reliable	Whyanbeel WTP dosing system can have issues.			TMP monitored, high-high alarm for each rack.			
ph Adjustment (Whyanbeel)	pH < 6.5	Low pH, corrosion	High 10	Sodium carbonate dosing			Minor	Unlikely	Low 4	Confident		Whyanbeel Sodium Carbonate dosing system installed late 2017	N	pH Adjustment OCP			
Disinfection	Overdose	Chlorine	High 15	Alerts at 2 mg/L, critical at 4 mg/L (dosing system shutdown)		Low 3	Moderate	Rare	Low 3	Confident			Y	High CCP			
	Insufficient dose	Bacteria/virus	Extreme 25	Disinfection		Medium 6	Catastrophic	Rare	Medium 6	Confident	1 spare pump shared across schemes. Gas chlorination projects will make more dosing pumps available as spares.		Y	Low CCP			
	Chemical breakdown	Chlorate	High 12	Nil currently		High 12	Moderate	Possible	Medium 9	Reliable	WHO 0.8 mg/L, potential 0.3 mg/L guideline	Chlorate research project demonstrates that under normal operation, chlorate is typically <0.3 mg/L. Likelihood dropped to possible for all schemes. Gas chlorine to be installed in June 2017					

Process Step	Hazardous Event	Hazards managed by same barriers	Unmitigated Risk	Primary preventive measure	Other Preventive Measures	2015 Risk	Mitigated 2017 Consequence	Mitigated 2017 Likelihood	Mitigated 2017 Risk	Uncertainty	Comments 2015	Comments 2017	CCP? Y/N	Documented Procedure	Risk Management Improvement Plan 2017: 2017/18	Risk Management Improvement Plan 2017: Proposed 2018/19 FY	Risk Management Improvement Plan 2017: 2019/20 FY or beyond
	Chemical breakdown	Chlorate	High 12	Nil currently		High 12	Moderate	Possible	Medium 9	Reliable							
	Chemical breakdown	Chlorate	High 12	Nil currently		High 12	Moderate	Possible	Medium 9	Reliable		Decision to leave Daintree as sodium hypochlorite until guideline value changes. Will commence chlorate testing when there is a health guideline.					
	Ineffective disinfection due to turbidity	Bacteria	High 10	UF		Medium 6	Catastrophic	Rare	Medium 6	Certain	UF shutdown at 0.15 NTU, unlikely to ever exceed 1 NTU			Turbidity CCP for UF			
UV	Low dose	Protozoa	Extreme 25	UF	UV	Medium 6	Catastrophic	Rare	Medium 6	Confident	If UF operating, UV is a redundant barrier. Risk prior to UV is mitigated and already medium 6.		N	Not a ccp, but procedure in DWQMP			
		Bacteria	Extreme 25	UF/ chlorination	UV	Medium 6	Catastrophic	Rare	Medium 6	Confident	UF removes some bacteria, and chlorination is more effective with sufficient CT at these plants		N	Not a ccp, but procedure in DWQMP			
	Reduces chlorine effectiveness	Bacteria	Extreme 25	Chlorination alert at 0.7 mg/L, critical at 0.2 mg/L	UV	Medium 6	Catastrophic	Rare	Medium 6	Confident	dose rate is normally sufficient to compnsate for this demand, but increases the risk of lower than desired chlorine concentration. UV is both unnecessary, and potentially counterproductive			Chlorination CCP			
Treated water storage/ Reservoirs	Ingress into reservoirs	Bacteria/virus	Extreme 20	Primary disinfection, redosing at Craiglie		Medium 6	Catastrophic	Rare	Medium 6	Confident	intgrity of Craiglie Roof compromised, but compensated for by disinfection barrier.		N	Required			
	Ingress into reservoirs	Protozoa	Extreme 20	Integrity at Craiglie		Extreme 20	Catastrophic	Likely	Extreme 20	Estimate	Craiglie roof compromised	Repairs undertaken to rectify hatch. Still some holes in roof. On hold whilst Crees Road reservoir being constructed. Roof to be replaced after Crees Road online.	N	Required		Craiglie Reservoir roof replacement delayed until Crees Road Reservoir constructed for supply security reasons	
	Ingress into reservoirs	Protozoa	Extreme 20	Integrity and sealing		High 15	Catastrophic	Rare	Medium 6	Estimate	requires continual attention. No removal process for protozoa post WTP.	Reservoir inspection program is now in place. Have sealed Flagstaff, Rocky Point and Whyanbeel.	N	Required			
	Ingress into reservoirs	Bacteria/virus	Extreme 20	Primary disinfection, hypo dosing at Rocky Point		Medium 6	Catastrophic	Rare	Medium 6	Confident	Telemetry and alarming essential		N	Required			
	Ingress into reservoirs	Bacteria/virus	Extreme 20	Primary disinfection, manual redosing at Flagstaff Res		Medium 6	Catastrophic	Rare	Medium 6	Confident	redosing at Flagstaff is manual using chlorine tablets. Daily site visits	Calcium hypochlorite dosing	N	Required			
	Ingress into reservoirs	Bacteria/virus	Extreme 20	Primary disinfection, no redosing (Cooya)		High 10	Catastrophic	Unlikely	High 10	Reliable	Note Cooya Reservoir currently not in use - will be commissioned under PCWR126	Water supply assessment to be undertaken to determine if reservoirs should be brought online	N	Required	Not required as reservoir is not normally used		
	Ingress into reservoirs	Bacteria/virus	Extreme 20	Primary disinfection, no redosing		High 10	Catastrophic	Unlikely	High 10	Estimate	Wonga Mowbray, Cassowary - are offline and not normally used. Manual dosing would be required to ensure safe water	Water supply assessment to be undertaken to determine if reservoirs should be brought online	N	Required	Not required as these are not normally used		
	Ingress of amoeba	Amoeba	High 12	Disinfection as above items	Integrity	Medium 5	Major	Rare	Medium 5	Reliable	reservoirs consistently above 0.5 mg/L		N	CCP for chlorine			
Reticulation	Ingress of contaminated water	Bacteria/virus	Extreme 20	Network pressure, residual disinfection, mains break procedure		Medium 6	Catastrophic	Rare	Medium 6	Confident	HPC counts low across all schemes, and while Daintree residual can be low, there have been very few issues with water quality. Requires vigilance		N	Formalise flushing			
	Ingress of contaminated water	Protozoa	Extreme 20	network pressure, mains break procedure		Medium 6	Catastrophic	Rare	Medium 6	Reliable	procedure emphasised, toolbox talk reminders		N	CRC mains break procedure			
	Power failure	Failure of supply	High 15	Power supply generally robust. Many areas gravity fed.		Medium 6	Catastrophic	Rare	Medium 6	Confident	Craiglie main area at risk - however, power outages are rare, and not normally long duration						
	Increasing pH impacting residual disinfection	Bacteria/virus	Extreme 20	network pressure, reservoir integrity, mains break procedure	Replacement of AC mains	High 10	Catastrophic	Rare	Medium 6	Reliable	while pH increases, there needs to be a concurrent contamination event for this to actually result in the adverse outcome.	*E coli* results sufficient to demonstrate that this risk is actually rare.					

Process Step	Hazardous Event	Hazards managed by same barriers	Unmitigated Risk	Primary preventive measure	Other Preventive Measures	2015 Risk	Mitigated 2017			Uncertainty	Comments 2015	Comments 2017	CCP?	Documented Procedure	Risk Management Improvement Plan 2017		
							Consequence	Likelihood	Risk				Y/N		2017/18	Proposed 2018/19 FY	2019/20 FY or beyond
	change in flow rate, reservoir run low, disturbing sediment in pipe	turbidity	Medium 6			Low 4	Minor	Unlikely	Low 4	Confident	Very low turbidity, and retic network has low HPC counts. Not a common occurrence.						
	long water age	DBPs	High 12	Low organics in source water, effective removal, low chlorine doses		Low 2	Minor	Rare	Low 2	Confident	Low level detections in reservoirs justifies a reduction in sampling for THMs in verification monitoring program. Will do investigative sampling at far ends of reticulation.	Targeted sampling of likely worst case situations. Detections all low level that do not raise concerns that this is an issue in any scheme		Managed by ensuring UF and chlorination effective			
	backflow - e.g. from customer meters or standpipes	protozoa	Extreme 20	system integrity, backflow prevention on new installations		High 10	Catastrophic	Unlikely	High 10	Estimate	Port Douglas all replaced, other areas do have old meters than may not have backflow prevention	Audit has been undertaken to ensure all valves tested as per schedule. Installations are being initiated as required. Some standpipe locations are uncontrolled, not sufficiently monitored and enforced. Ongoing.		Need to develop			Long term meter replacement strategy
Redosing	overdose	chlorine	High 15	alerts at 2mg/L, critical at 4 mg/L (redosing shutdown)		Medium 6	Moderate	Unlikely	Medium 6	Reliable	Craiglie		Y	CCP on monitored reservoir			
Redosing	overdose	chlorine	High 15	alerts at 2mg/L, critical at 4 mg/L (redosing shutdown)		Medium 6	Moderate	Unlikely	Medium 6	Reliable	Flagstaff/Rocky Point		Y	Required, but not CCP. Is OCP.			
	insufficient dose	bacteria/virus	Extreme 20	disinfection alarms at 0.7 and critical 0.2 mg/L	primary disinfection provides residual in most cases. Small top-up.	Medium 6	Catastrophic	Rare	Medium 6	Confident	Craiglie		N	Documented in OCPs			
	insufficient dose	bacteria/virus	Extreme 20	disinfection daily inspects	primary disinfection provides residual in most cases. Small top-up.	High 10	Catastrophic	Rare	Medium 6	Confident	Flagstaff, Rocky Point	Flagstaff and Rocky point have calcium hypochlorite eroders in place.		Documented in OCPs			
System Wide	SCADA/ telemetry failure	Protozoa	Extreme 25	treated water in system.		High 10	Catastrophic	Rare	Medium 6	Reliable	Cyclone Oswald knocked out communications, version not fully supported as outdated. If long term, may need to consider DMP.	CITEC all upgraded across all pplants					
	Demand exceeds supply	Limited supply	Extreme 25	Asset planning		High 10	Catastrophic	Unlikely	High 10	Reliable	Mossman Port Douglas scheme - Planning over next 10 years to ensure risk is low	Larger Whyanbeel / Mossman interconnection being designed. Water supply assessment to determine need to bring old reservoirs online etc.		Asset management plan	Project to replace existing interconnection with possible 225 main. Water Supply Assessment project to determine appropriate reticulation management		
	Demand exceeds supply	Limited supply	Extreme 25	Asset planning		High 10	Catastrophic	Unlikely	High 10	Reliable	Mossman Port Douglas scheme	Reservoir at Crees Road contract awarded		Asset management plan	Reservoir under construction		
	WTP Fire	Failure of supply	Medium 6	Can provide raw water with BWA.		Medium 6	Catastrophic	Rare	Medium 6	Reliable	Would need to activate disaster plan						
	Drought (Mossman)	Failure of supply	High 10	Restrictions leading to Wet season	seeking alternate source	High 10	Catastrophic	Rare	Medium 6	Estimate	Drought frequency increasing and population increasing. Has not happened but becoming more likely	Whyanbeel Mossman connection to be installed within 6 months - supply not likely to be impacted in this timeframe, and resilience after will be increased.					
	Flood	Failure of supply	High 10	Generally only impacts raw water quality		Medium 6	Catastrophic	Rare	Medium 6	Reliable	Can operate WTP at higher turbidities if necessary - will increase backwash frequency and impact capacity.			DMP			
	Flood	Failure of supply	High 10	Daintree Intake		High 10	Catastrophic	Rare	Medium 6	Reliable	Floods have previously damaged intake.	Access to intake improved, alternate supply bore is being commissioned				Daintree bore to be commissioned	
	Landslip Daintree intake	Failure of supply	High 15	Daintree Intake		High 10	Catastrophic	Unlikely	High 10	Estimate	would use plunge pool for supply in interim. T piece in main to facilitate this.	Access to intake improved, alternate supply bore is being commissioned				Daintree bore to be commissioned	

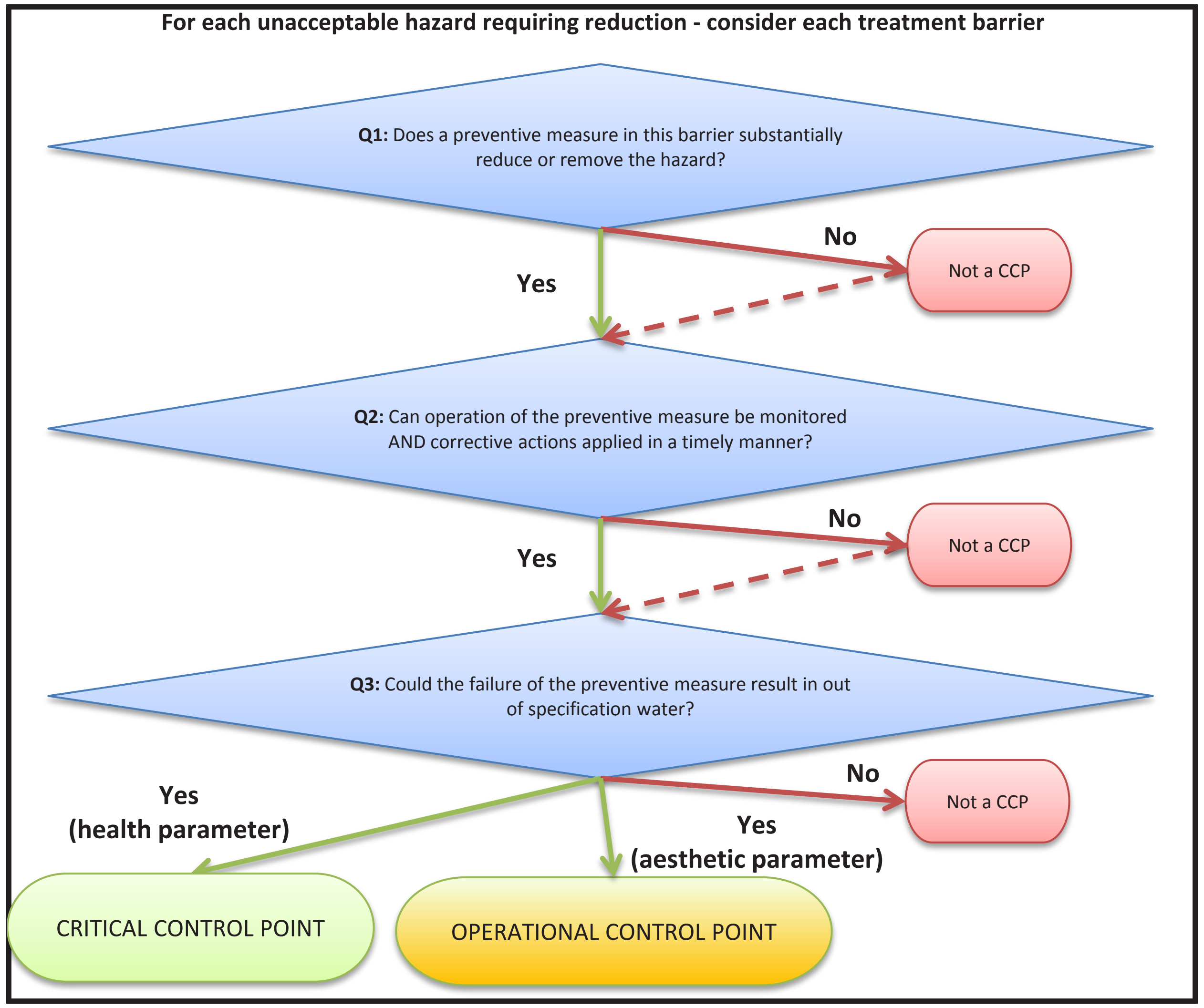
Process Step	Hazardous Event	Hazards managed by same barriers	Unmitigated Risk	Primary preventive measure	Other Preventive Measures	2015 Risk	Mitigated 2017				Comments 2015	Comments 2017	CCP?	Documented Procedure	Risk Management Improvement Plan 2017		
							Consequence	Likelihood	Risk	Uncertainty			Y/N		2017/18	Proposed 2018/19 FY	2019/20 FY or beyond
	Cyclone	Failure of supply	High 15	DMP	interconnection of Mossman and Whyanbeel schemes	High 10	Catastrophic	Unlikely	High 10	Reliable	Activate DMP if WTP knocked out completely (eg Daintree). Otherwise use interconnection.			Business continuity plan and hazard checklists	Project to replace existing interconnection with possible 225 main. Water Supply Assessment project to determine appropriate reticulation management		
	operator error	any	Extreme 25	training, experience, mentoring		High 10	Catastrophic	Unlikely	High 10	Estimate	Look at National Certification framework for operator training.			HR training register	HR training register	Formalise Water operations professional development.	Develop procedures listed as required
	accidental use of bypass	protozoa and bacteria	Extreme 25	valves identified as permanently closed, tagged out.		Medium 6	Catastrophic	Rare	Medium 6	Confident	Need to ensure all closed valves are tagged, and consider what valves need locking out.	Valves are tagged out, but could still accidentally be opened. Locking out or reducing access to be considered.			More securely lock out bypass to prevent accidental use.		
	loss of knowledge	All	Extreme 25			High 15	Catastrophic	Possible	High 15		Develop mentoring system, capture assets in GIS system					Formalise Water operations professional development. Ground truth GIS.	Local government structure plan

Element 3: Preventive measures for drinking water quality management – Critical control points

For hazards that are unacceptable without treatment, but acceptable following treatment using a robust barrier, the process was assessed to determine whether the process was a critical control point. This is included in the risk register on the previous pages. The CCP decision tree opposite was used to determine CCPs.

The actual CCP procedures are included in the following pages.

Table 14 — CCP Decision Tree



Raw Water Operational Procedure - Whyanbeel WTP

DOUGLAS SHIRE COUNCIL

What is measured	Where or how is it measured	What is the control point	What are the hazards	Record Keeping
Raw Water Turbidity	Turbidity at any of intake, raw water main or WTP inlet. Measured online by online turbidity meters	WTP Inlet	Turbidity	SCADA records

Adjustment Limit
Turbidity > 20 NTU
Extraction at License

- Shut down plant at 20 NTU
- Check supply volumes to ensure that there is sufficient treated water supply
- If treated water supply is low, contact Team Leader
- Do not restart unless authorised by Team Leader or raw water turbidity is < 20 NTU
- If plant required to operate, reduce production as low as possible to retain adequate supply
- If extraction is at license limit contact Manager
- Consider need to implement water restrictions to comply with extraction license
- Do not operate above extraction limits without written authorisation from Co-ordinator or Manager

Target
Turbidity < 5 NTU
Extraction within license

- Operator receives alarm and paging
- Consider weather event and treated water volumes
- If appropriate reduce plant flow or cease production
- If treated water volumes are low or demand high, continue to treat water
- Extraction limits to be monitored manually.
- Adjust plant production to ensure extraction is below license limits

Water License Extraction Limits

Little Falls Creek Flow Rate (L/s)	Maximum Extraction Rate (L/s)
≤10	0
11-20	5
21-40	10
71-80	20
61-80	30
81-100	40
101-150	50
>151	60

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DATE	XX

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Raw Water Operational Procedure - Mossman WTP

DOUGLAS SHIRE COUNCIL

What is measured	Where or how is it measured	What is the control point	What are the hazards	Record Keeping
Raw Water Turbidity	Turbidity at any of intake, raw water main or WTP inlet. Measured online by online turbidity meters	WTP Inlet	Turbidity	SCADA records

Adjustment Limit
Turbidity > 30 NTU
Extraction at License

- Shut down plant at 30 NTU
- Do not restart unless authorised by Team Leader or raw water turbidity is <30 NTU
- If plant required to operate, reduce production as low as possible to retain adequate supply
- If extraction is at license limit contact Manager
- Consider need to implement water restrictions to comply with extraction license
- Do not operate above extraction limits without written authorisation from Co-ordinator or Manager

Target
Turbidity <20 NTU
Extraction within license

- Operator receives alarm and paging
- Consider weather event and treated water volumes
- If appropriate reduce plant flow or cease production
- If treated water volumes are low or demand high, continue to treat water
- Extraction limits to be monitored online.
- Adjust plant production to ensure extraction is below license limits

Water License Extraction Limits

≤50	0
51-60	5
61-70	15
71-80	20
81-100	30
101-120	50
121-140	70
141-160	80
161-200	100
201-250	125
251-300	150
301-350	175
351-400	200
401-450	225
541-500	250
501-550	275
551-600	300
601-650	325
651-700	350
701-739	370
>740	370

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Raw Water Operational Procedure Daintree WTP

DOUGLAS SHIRE COUNCIL

What is measured	Where or how is it measured	What is the control point	What are the hazards	Record Keeping
Raw Water Turbidity	Turbidity at any of intake, raw water main or WTP inlet. Measured online by online turbidity meters	WTP Inlet	Turbidity	SCADA records

Adjustment Limit
Turbidity > 20 NTU
Extraction at License

- Shut down plant at 20 NTU
- Check supply volumes to ensure that there is sufficient treated water supply
- If treated water supply is low, contact Team Leader
- Do not restart unless authorised by Team Leader or raw water turbidity is < 5 NTU
- If plant required to operate, reduce production as low as possible to retain adequate supply
- If extraction is at license limit contact Manager
- Consider need to implement water restrictions to comply with extraction license
- Do not operate above extraction limits without written authorisation from Co-ordinator or Manager

Water License Extraction Limits

≤5	0
>5	6
Maximum Daily Volume	0.3 ML
Maximum Annual Volume	80 ML

Target
Turbidity <5 NTU
Extraction within license

- Operator receives alarm and paging
- Consider weather event and treated water volumes
- If appropriate reduce plant flow or cease production
- If treated water volumes are low or demand high, continue to treat water
- Extraction limits to be monitored manually
- Adjust plant production to ensure extraction is below license limits

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Direct Membrane Integrity Pressure Decay Test Critical Control Point Procedure

DOUGLAS SHIRE COUNCIL

What is measured	Where or how is it measured	What is the control point	What are the hazards	Record Keeping
Pressure decay	Automated PDT program run every 24 hours of filter rack operation	Membrane Filter Racks	Pathogens, turbidity	SCADA records of PDTs, manually record results of tests on daily operational sheet and in operational data spreadsheet

Critical Limit
> 1.5 kpa/min

- Automatic shut down of failed UF rack
- Follow all adjustment procedures as appropriate
- Review reservoir levels (SCADA) to determine if community can be supplied from existing storage until situation is resolved
- Check that Turbidity Critical Limit was continually met since previous passed PDT - if so, no action required.
- If turbidity CCP was also compromised, Environmental Technical Officer (or Water operator) to arrange daily water quality monitoring at treated water reservoir for:
  1. pH
  2. turbidity
  3. *E. coli*
  4. Total and free chlorine

- Report breach to Coordinator Water and Wastewater on CCP reporting form
- If situation cannot be resolved, and rack must be brought online to ensure continuity of supply Coordinator Water and Wastewater or General Manager Operations to;
  - Provide written direction to Water Treatment Operators or Team Leader
  - Contact Regulator on 1300 596 709 if required
- General Manager Operations to determine corrective action/incident management if required. This may include actions such as:
- 1. Restart plant under increased monitoring conditions and increased chlorine

  OR

- 2. Restart plant with boil water alert

Adjustment Limit
> 1 kpa/min

- Take rack offline
- Conduct manual PDT and observe for signs of bubbles
- If bubbles observed mark with electrical tape to signal need for maintenance/ repair
- Note the estimated number of leaking straws on the UF rack repair sheet and provide to Team Leader
- If no, or minimal bubbles are observed, this may be an indication of leaking valves/ pipework. Conduct full system check of relevant valves and pipework.
- Fix any identified leaks if possible, or report on UF rack repair sheet and keep rack offline
- On receipt of UF rack repair sheets, Team Leader to schedule repairs as appropriate

- Racks can only be returned to service if the PDT result on a manual or automatic test is < 1 kpa/min
- Provide weekly report to Coordinator Water and Wastewater indicating which racks have exceeded PDT limits, and repairs that were required/ need to replace spare parts.

Target Criterion
< 1 kpa/min

- Record results of each pressure decay test in daily operational sheet
- Enter results in operational monitoring spreadsheet and check trends for any increasing trend or sudden jump in pressure decay
- If increasing trend or jump, consider scheduling a manual PDT to observe for leaks if time permits.
- If manual PDT undertaken, take actions as per adjustment limit actions above
- Record observations in plant diary so other operators are aware of actions that have been taken

The action and critical limits are based on demonstrating that the ultrafiltration membranes achieve a 3.0 log reduction of Cryptosporidium under the proposed Health Based Targets Framework.

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Indirect Membrane Integrity Permeate Turbidity Critical Control Point Procedure

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What is measured	Where or how is it measured	What is the control point	What are the hazards	Record Keeping
Individual rack permeate turbidity	Continuous online turbidity and weekly manual grab samples	Membrane Filter Racks	Pathogens, turbidity	SCADA records. Manually record grab sample results on daily operational sheet and in operational data spreadsheet

Critical Limit

> 0.15 NTU

Immediate for grab sample, or with 15 minute delay for online monitoring

- Automatic shut down of failed UF rack
- Follow all adjustment procedures as appropriate
- Review reservoir levels (SCADA) to determine if community can be supplied from existing storage until situation is resolved
- If rack did not shut down automatically after 15 minute delay, and water with >0.15 NTU may have entered reticulation, Environmental Technical Officer (or Water operator) to arrange daily water quality monitoring at treated water reservoir for:
  1. pH
  2. turbidity
  3. *E. coli*
  4. Total and free chlorine
- Report breach to Coordinator Water and Wastewater on CCP reporting form
- If situation cannot be resolved, and rack must be brought online to ensure continuity of supply Coordinator Water and Wastewater or General Manager Operations to;
  - Provide written direction to Water Treatment Operators or Team Leader
  - Contact Regulator on 1300 596 709 if required
- General Manager Operations to determine corrective action/incident management if required. This may include actions such as:
- 1. Restart plant under increased monitoring conditions and increased chlorine

  OR
- 2. Restart plant with boil water alert

Adjustment Limit

> 0.1 NTU

Immediate for grab sample, or with 15 minute delay for online monitoring

- Take rack offline
- Review reservoir levels (SCADA) to determine if community can be supplied from existing storage until situation is resolved
- Take manual permeate turbidity sample to confirm result
- If significantly different, clean and recalibrate turbidity meter and resample
- If grab sample confirms value is close to or exceeds 0.1 NTU, conduct manual PDT and observe for signs of bubbles
- If bubbles observed mark with electrical tape to signal need for maintenance/ repair
- Note the estimated number of leaking straws on the UF rack repair sheet and provide to Team Leader
- If no, or minimal bubbles are observed, this may be an indication of leaking valves/ pipework. Conduct full system check of relevant valves and pipework.
- Fix any identified leaks if possible, or report on UF rack repair sheet and keep rack offline
- On receipt of UF rack repair sheets, Team Leader to schedule repairs as appropriate
- Racks may be returned to service if the PDT result on a manual or automatic test is < 1 kpa/ min and turbidity is <0.1 NTU
- If rack does not pass, and water supply security is of concern, immediately complete CCP reporting form and send to Coordinator Water and Wastewater of General Manager Operations.
- Provide weekly report to Coordinator Water and Wastewater indicating which racks have exceeded PDT limits, and repairs that were required/ need to replace spare parts.

Target Criterion

< 0.1 NTU

- Record results of manual grab sample in daily operational sheet
- Enter results in operational monitoring spreadsheet and check trends
- Ensure turbidity meters are maintained (cleaned and calibrated) as per normal schedule
- Record any observations in plant diary

The action and critical limits are based on demonstrating that the ultrafiltration membranes achieve a 3.0 log reduction of Cryptosporidium under the proposed Health Based Targets Framework.

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pH adjustment - Whyanbeel Operational Control Point Procedure

DOUGLAS SHIRE COUNCIL

What is measured	Where or how is it measured	What is the control point	What are the hazards	Record Keeping
pH in recirculation line from Whyanbeel Reservoir	Continuous online monitoring at WTP, weekly grab samples	Soda Ash Dosing system	Chlorine sensitive pathogens	SCADA records, grab sample in daily operational monitoring sheet and spreadsheet

Operational Limit
pH <6 or > 7.5

- Automatic alarms (shut down of soda ash dosing at high pH)
- Follow all adjustment procedures as appropriate
- Do not restart Soda Ash Dosing until the cause of the overdose has been rectified.
- Report exceedence to Coordinator Water and Wastewater on CCP reporting form
- if pH < 6, re-establish soda ash dosing
- if pH > 7.5 cease dosing and allow low pH water to reduce the pH of the reservoir - but normal operation can continue
- If pH > 9, report an incident to Regulator as disinfection may be compromised

Adjustment Limit
pH < 6.5 or > 7

- Immediate manual retest
- Check online instrument calibration
- If pH <6.5 Check chemical supply and all dosing lines (e.g. for blockages or leaks), and if dosing system operating correctly, increase dose rate
- if pH > 7, reduce soda ash dose rate
- Review previous chlorine results as recorded on operational check sheet
- Notify Team Leader Water Quality
- Record actions in plant diary
- Report actions to Coordinator Water and Wastewater in weekly report

Target Criterion
pH 6.5-7

- Plant visual inspection, including checking soda ash dosing system.
- Normal dose rate is 0.03 mL/L of 15% soda ash (sodium carbonate)
- Equipment checks and chemical volume
- WTP water sampling and testing
- weekly grab sample (compare to online instrument)
- Record results in operational sheet and spreadsheet
- Instrument maintenance and calibration as required

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Chlorination (Primary and Re-dosing) Critical Control Point Procedure

DOUGLAS SHIRE COUNCIL

What is measured	Where or how is it measured	What is the control point	What are the hazards	Record Keeping
Free chlorine in treated water reservoir and reticulation network reservoirs	Continuous online monitoring at WTPs Craiglie, Rocky Point and Flagstaff Reservoirs, weekly manual grab samples	Chlorine dosing system	Chlorine sensitive pathogens	SCADA records, grab sample in daily operational monitoring sheet and spreadsheet

Critical Limit

< 0.2 mg/L or > 4.5 mg/L

online for > 15 min

- Automatic alarms (shutdown of dosing at high levels)
- Follow all adjustment procedures as appropriate
- Check reservoir chlorine levels to ensure within adjustment limit
- Consider need to adjust target at Reservoirs or need to manually dose reservoirs
- On breach of low level critical limit, Environmental Technical Officer (or Water Operator) to arrange water quality monitoring at reticulation sampling locations for:
  1. pH
  2. turbidity
  3. *E. coli*
  4. Total and free chlorine
- On breach of high level critical limit, Environmental Technical Officer (or Water operator) to arrange water quality monitoring at reticulation sampling locations for:
  1. Total and free chlorine

- Report breach to Coordinator Water and Wastewater on CCP reporting form
- If situation cannot be resolved, Coordinator Water and Wastewater or General Manager Operations to;
  - Provide written direction to Water Treatment Operators or Team Leader
  - Contact Regulator on 1300 596 709 if required
- General Manager Operations to determine corrective action/incident management if required. This may include actions such as:
- 1. Consider need to take reservoir offline

  OR
- 2. Calculate chlorine contact time in conjunction with UF operation to inform need to consider issuing boil water alert

Adjustment Limit

< 0.7 mg/L or > 2 mg/L

online for > 15 min

- Immediate manual retest
- Check online instrument calibration
- Check chemical supply and all dosing lines (e.g. for leaks)
- Resolve any identified issue
- Review previous chlorine results as recorded on operational check sheet
- Notify Team Leader Water Quality
- Record actions in plant diary

- Report actions to Coordinator Water and Wastewater in weekly report

Target Criterion

1.0 - 1.5 mg/L

- Plant visual inspection, including checking chlorine dosing system.
- Equipment checks and chemical volume (e.g. weight of cylinders, remaining liquid or solid)
- WTP water sampling and testing
- weekly grab sample (compare to online instrument)
- Record results in operational sheet and spreadsheet
- Instrument maintenance and calibration as required

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Element 4: Operational procedures and process control

Operational monitoring is based off the OCP and CCP procedures. Where possible these procedures are directly embedded into the SCADA system. This removes some of the risk that the procedure is not implemented as the SCADA system will send pages and alarms to operators, or shut down processes automatically.

Corrective actions

Corrective actions are undertaken as defined in the CCP tables. Where manual tests indicate that water quality is outside the CCP action limits, the benchtop instruments are recalibrated and the sample retested. If the sample still fails, the online instrumentation is recalibrated.

Breaches of action limits always result in operators taking the appropriate actions to bring the process back within normal operational limits, and reporting to the Team Leader as per the CCP procedures and the incident and emergency response plan.

If a critical limit is breached, the CCP actions are implemented, and the Manager Water and Wastewater is informed as soon as possible. This is defined as an operational action under the incident and emergency response plan, but may be escalated to a reportable incident if necessary.

Equipment capability and maintenance

Online instruments are calibrated and maintained according to manufacturer specifications. Calibrations are also conducted when operators identify differences between online and benchtop instruments.

Element 5: Verification of drinking water quality

Purpose and principles

Verification monitoring has been comprehensively reviewed, and altered on the following basis.

Demonstrating a safe supply

- CCPs – the CCPs are in place to ensure that the ultrafiltration membranes are intact. This is done by two complimentary CCPs, the indirect (continuous turbidity) and direct (pressure decay test) limits ensure at least 3 log reduction of *Cryptosporidium*, and allow credit to be claimed for bacterial and viral reduction
- Chlorination CCP is then in place to ensure that any remaining bacteria and viruses are inactivated.
- If the chlorination CCP is breached on the low critical limit, a stated action is to undertake additional *E. coli* sampling.

As the chlorination CCP applies at the WTP (ensuring a primary kill) and is duplicated in the reticulation reservoirs, there is continuous online monitoring of chlorine residuals. As such, if the plants are operated with the CCPs within the target ranges, we have high confidence that the water supply is safe.

Supporting programs

1) Reservoir inspections are undertaken regularly to ensure that the reservoirs are intact and that any points of ingress are repaired.

2) Network operations have a routine flushing program that ensures that the primary mains into the reticulation zones are regularly flushed. This is typically monthly in each zone. Mains are flushed until the chlorine residual is above 0.2 mg/L.

3) Operators undertake regular reticulation chlorine testing in the reticulation network and initiate ad hoc flushing when the residual is <0.2 mg/L.

As chlorine residual is used as the mechanism to ensure safe water, *E. coli* testing is not likely to result in positive tests at the reservoirs, or the water treatment plant.

Therefore, WTP *E. coli* samples are no longer considered necessary, except when investigating an incident.

Similarly, reservoirs have SCADA alarms for action and critical limits, and are operated under the same chlorination CCP as at the WTPs. Again, these are not considered as high priorities to monitor as frequently as previously.

Instead, the focus is to ensure that the individual reticulation zones are monitored regularly with monthly sampling at the reservoirs. The number of sampling sites has been reduced to one per reticulation zone rather than the previous 2-3.

PHR Requirement:

The PHR is a provider based requirement based on population. The minimum requirement under the PHR is based on Douglas Shire having a population of 16544. The PHR requires 1 *E. coli* sample per week for populations above 5000, with an additional monthly *E. coli* sample required for every 5000 people that exceed 5000 population. For a population of 16544, the minimum requirement is 1 per week and 2 per month, or a grand total of 76 *E. coli* samples.

Sampling locations

The sampling locations for each scheme are shown on maps in the following pages. The table opposite indicates the frequency of monitoring. The monitoring locations are chosen to be representative of the water delivered to customers (reservoirs) or to identify problems (end of reticulation zones). The balance of sites ensures we can demonstrate we produced safe drinking water.

External laboratory samples and parameters

+ Raw water is monitored quarterly for Alkalinity, Ca, Colour, EC, F, Hardness, Mg, pH, K, Silica, Na, SO4, turbidity, Fe, Mn, TDS, TON, TN, NH_4.
+ Monthly samples are taken from reservoir locations for Alkalinity, pH, and *E. coli*.
+ Reticulation samples are analysed monthly for colour, pH, *E coli*, Cu, Fe and Mn.

Internal testing and parameters

Raw water is sampled monthly for *E coli*.

Reticulation samples are tested for pH, chlorine, and *E. coli* (Colilert) as indicated in the table opposite (external samples taken in lieu of internal samples on that week). We sample every week of the year, alternating between the identified sample locations.

The parameters monitored allow DSC to observe trends in water quality throughout the schemes, and has (in the example of changing pH) led to the replacement of aging AC mains that result in increasing pH in reticulation.

Similarly, by monitoring for iron,manganese, and alkalinity, we can observe changes in the reticulation network over time.

Event based and investigative monitoring

Douglas Shire Council will also initiate investigative water quality sampling if there are events likely to impact on water quality.

For example, Council undertook investigative THM monitoring under the previous DWQMP, and all results were consistently below 200 mg/L. As stated in the previous DWQMP, this was a trigger point to cease THM sampling.

If there are events that occur in the catchment or reticulation network we will undertake monitoring to identify the cause of the issues, and take actions as described in the incident response plan.

Response to exceedance

Where any exceedance of the water quality criteria is identified, this activates the incident and emergency plan, and is immediately treated as a **Reportable incident or emergency**. We will report events as required under the conditions of approval of the DWQMP.

Scheme by scheme monitoring locations

Sampling locations are identified in the following maps:

Table 15 — Verification Monitoring Locations

Mossman/Port Douglas (pop < 15000)	Raw	Reservoir	Retic
Mossman Intake	Monthly		
Cassowary – Bunn's Corner			Alternate weeks
Cooya Beach - Northern End - Boat Ramp			Alternate weeks
Craiglie - Reef Park Reservoir		Monthly	
Flagstaff - Reservoir No. 2 Pump Station Tap		Monthly	
Four Mile Beach - Barrier Street			Monthly
Four Mile Beach - Esplanade			Alternate weeks
Mossman - Davis Park in front of Church			Alternate weeks
Mowbray – Connolly Road			Monthly
Newell Beach - Esplanade - T-Intersection			Alternate weeks
Crees Road		(Monthly when commissioned)	
Whyanbeel (pop < 5000)	Raw	Reservoir	Retic
Whyanbeel Intake	Monthly		
Rocky Point Pump Station			Alternate weeks
Rocky Point Reservoir		Monthly	
Wonga Beach - Bells Park			Alternate weeks
Daintree (pop < 1000)	Raw	Reservoir	Retic
Daintree Intake	Monthly		
Daintree - Shire Hall			Alternate weeks
TOTAL	*36 - not counted to PHR requirement as raw water*	36	232

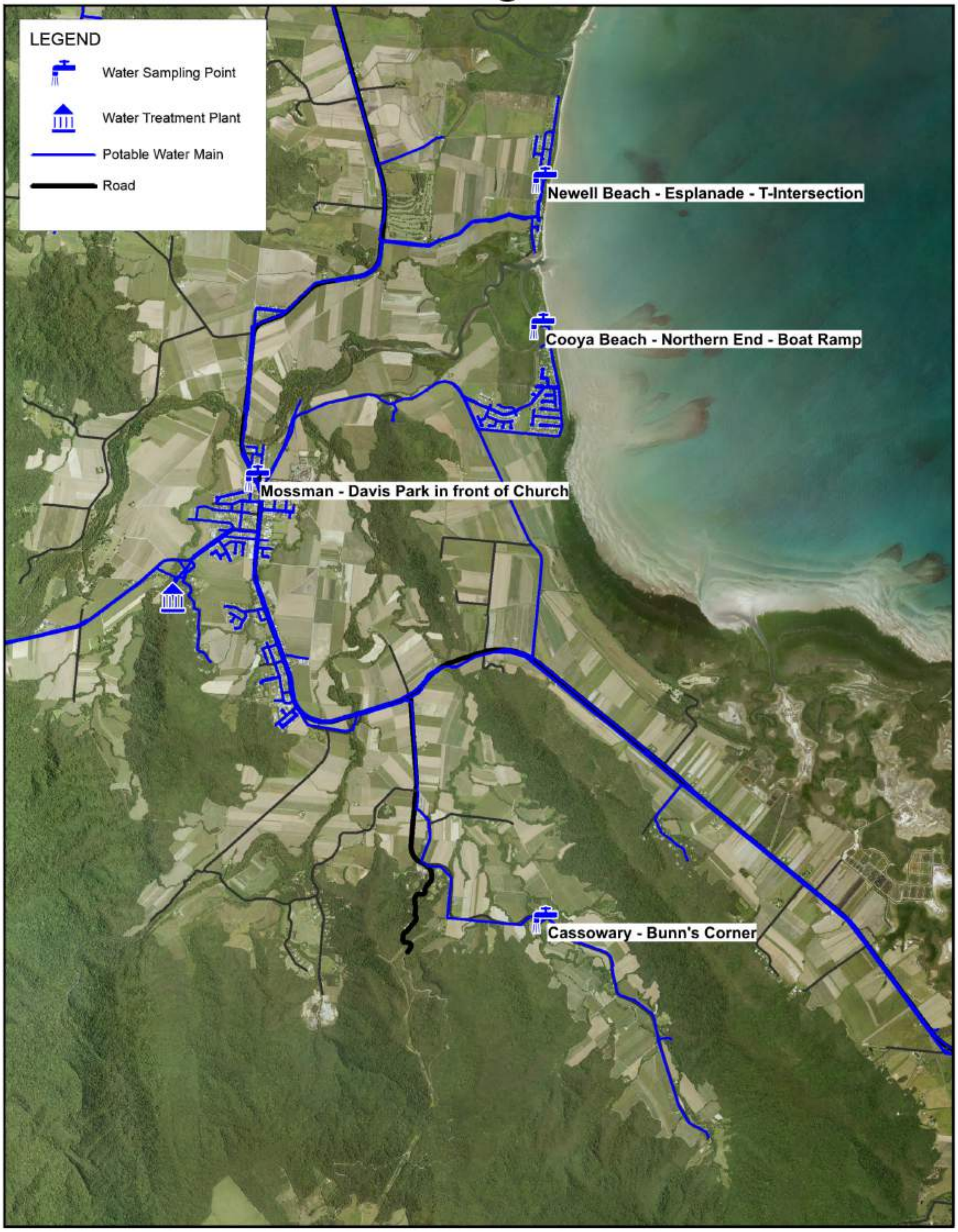
Alternate Weeks - in Whyanbeel means that samples are taken weekly, alternating between the 2 Retic sites. In Daintree, samples are taken every 2 weeks at the Shire Hall. In Mossman/Port Douglas, each site is sampled in every two week period, with samples taken for at least 2 sites every week. Monthly samples are additional to this.

In this way each scheme meets the PHR in its own right, well above minimum requirements.

Quality Assurance

At least every 3 months, duplicate *E. coli* samples will be taken from 4 sites and sent to the external laboratory to compare with the internal Colilert samples.

Mossman drinking water scheme



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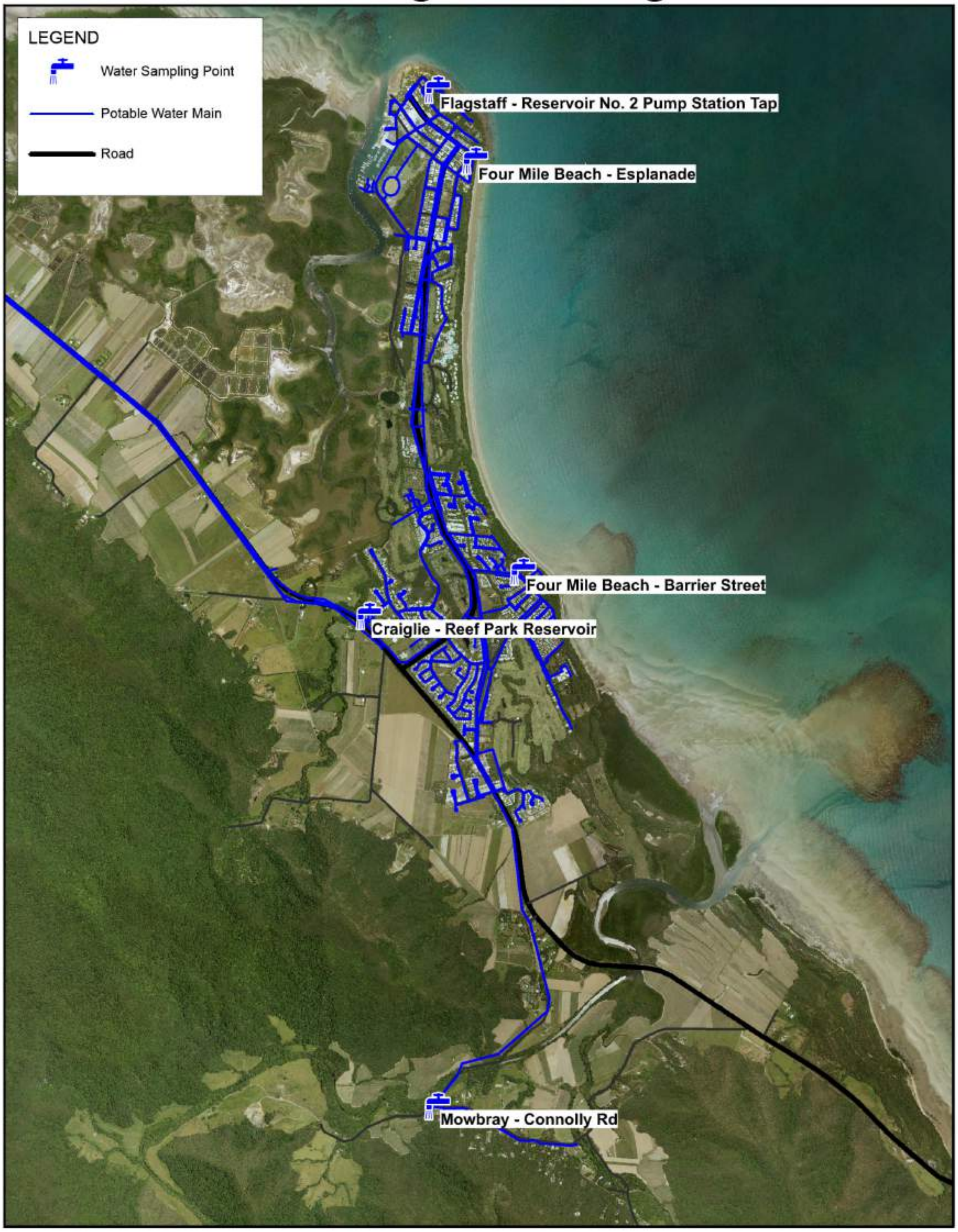
Scale
1cm = 600 m at A4

Map Grid of Australia
Zone 55 (GDA94)

N
W E
S

Figure 11 — Mossman sampling locations

Mossman - Port Douglas drinking water scheme



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Scale
1cm = 450 m at A4
Map Grid of Australia
Zone 55 (GDA94)

N W E S

Figure 12 — Port Douglas sampling locations

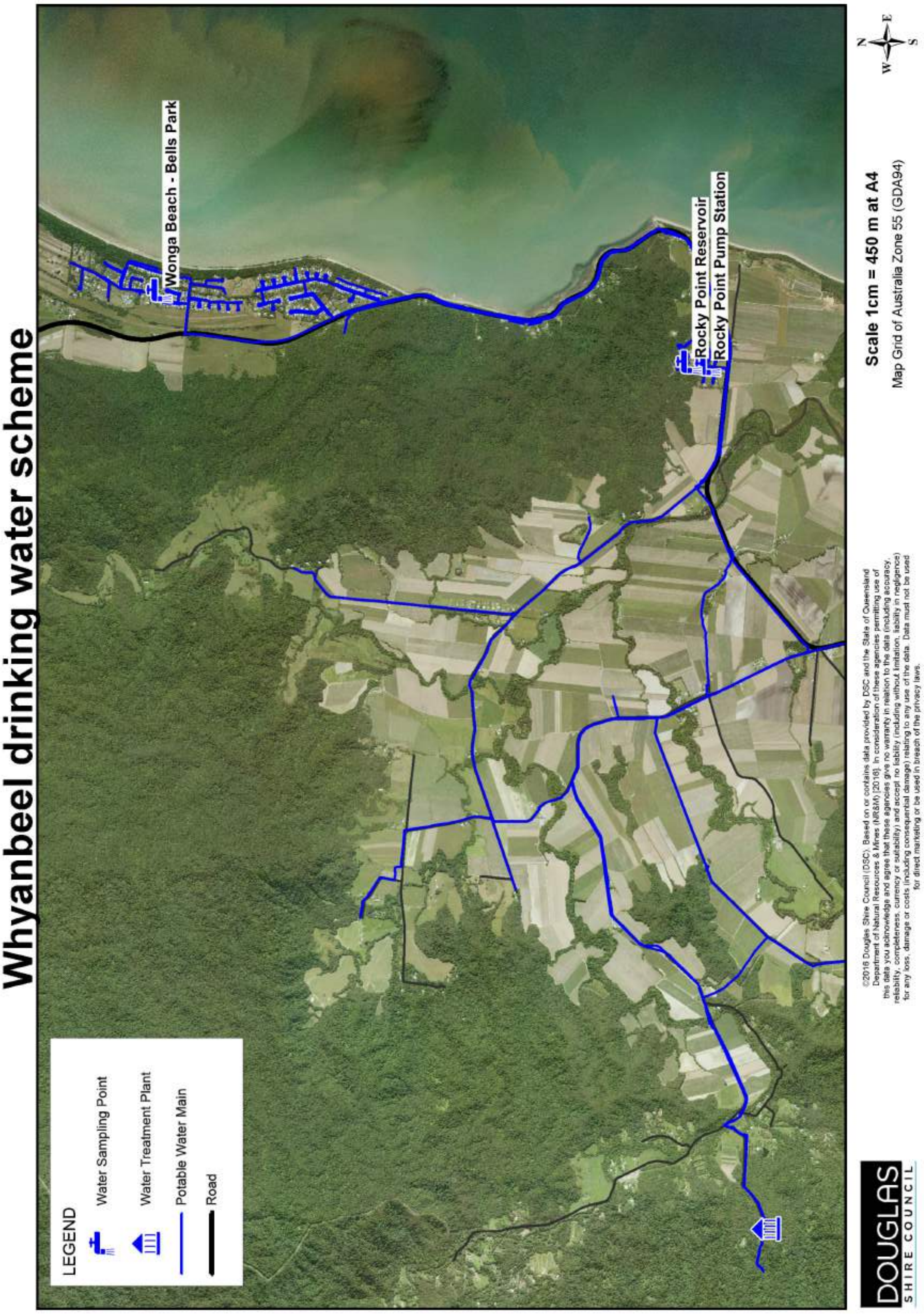
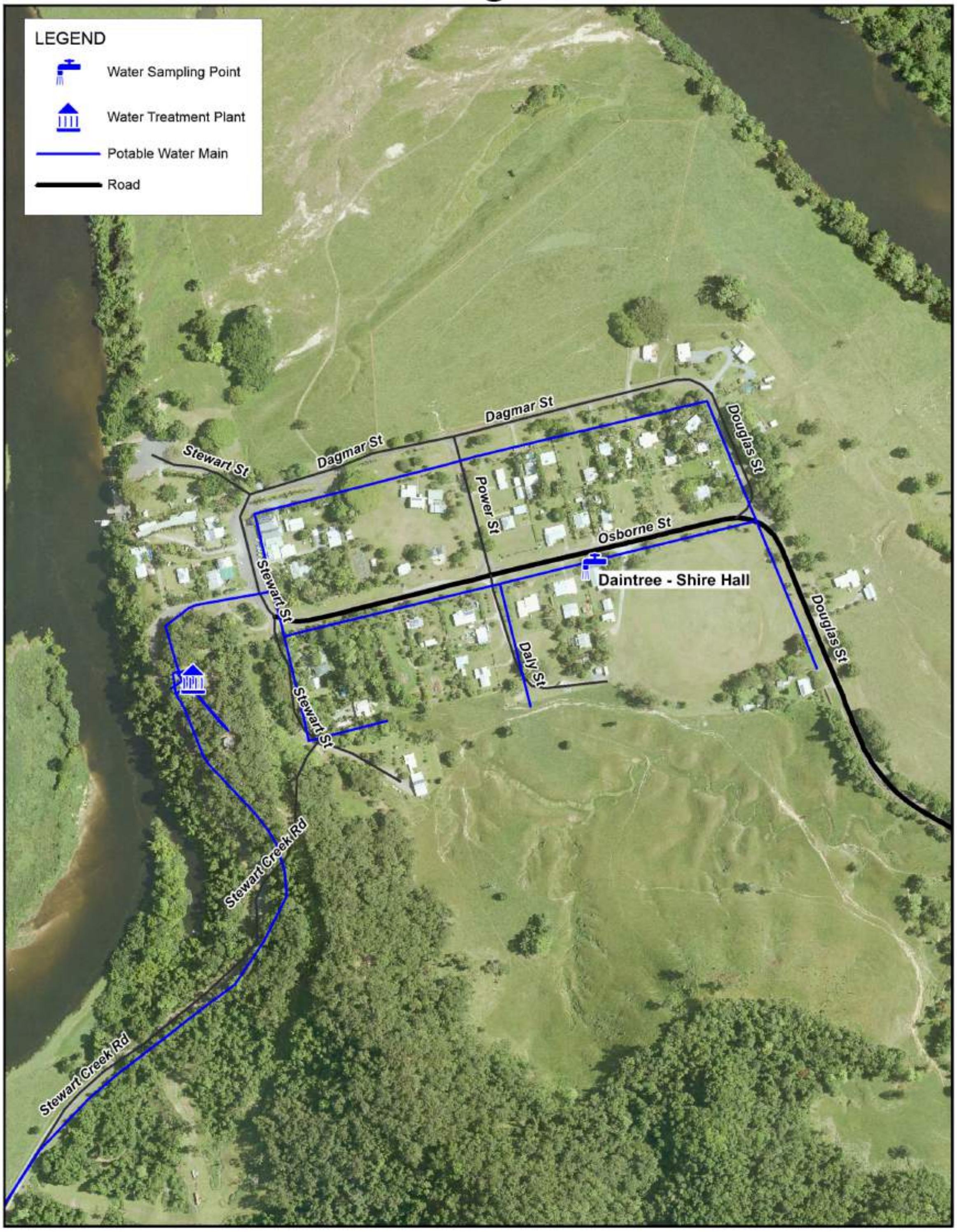


Figure 13 — Whyanbeel sampling locations

Daintree drinking water scheme



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Scale
1cm = 50 m at A4

Map Grid of Australia
Zone 55 (GDA94)

N
W E
S

Figure 14 — Daintree sampling locations

Element 6: Incident and emergency response

Levels of Incident are as defined below:

+ High – Declared Disaster
+ Medium – Incidents and Emergencies
+ Low – Operational Action

Alert Level	Description	Key management response(s)	Position(s) responsible
High: **Declared Disaster**	Declared disaster. Examples include a cyclone or a significant flood.	Activate disaster management plan.	CEO
Medium: **Incidents and Emergencies**	Exceedance of ADWG health guideline value Outbreak of waterborne disease Detection of a parameter with no water quality criteria that may have an adverse effect on public health An event which is beyond the ability of DSC to control and may have an adverse effect on public health. Loss of water supply for >6 hours.	Activate incident response plan. Ensure all control measures identified in the DWQM Plan are functioning effectively.	Coordinator Water and Wastewater Team Leader Water, Technical officer Water and Wastewater
Low: **Operational Action**	Exceed operational limit Exceed critical limit, but not ADWG Health Guideline. Effectively managed by the water treatment team undertaking operational actions in line with our DWQMP.	Ensure all barriers are functioning effectively. Check and act upon operations and maintenance records and procedures. Take appropriate actions to rectify situation.	Team Leader Water WTP operators

Table 11 — Emergency response levels

Operational actions

At this level, operational actions are required to manage the issue and prevent escalation.

Issues at this level are identified by implementation of the Critical Control Point Procedures. Corrective actions will be taken according to the specific CCP - either at the adjustment or at the critical limit.

Exceedance of a critical limit does not automatically escalate a CCP response to the next incident and emergency level if the water quality criteria are not breached.

Reportable incident or emergency

At this level, there is a potential for an adverse public health impact (or environmental harm).

These issues are identified through either operational or verification monitoring of the processes and water quality, or where there has been a significant widespread treatment or reticulation network failure resulting in the loss (or likely loss) of water supply for a period >6 hours. When identified, these issues are escalated as required.

In general the Team Leader Water still manages the incident, but in close consultation with the Coordinator Water and Wastewater.

Appropriate corrective actions will be identified, and implemented as soon as practicable to minimise the effect of the incident.

Flow charts indicating DSC actions to detections of exceedances of water quality criteria are included in the following pages.

Incidents at this level are reportable to the Regulator. Douglas Shire Council will inform the Regulator within 3 hours of becoming aware of the incident (3 hours allows sufficient time to investigate the cause of the incident and commence corrective actions as soon as possible). Advice may be directly sought from Queensland Health if we believe expert health advice is required.

Resampling: A resample will be arranged immediately (prior to corrective actions) for any parameter where the initial sample did not meet the ADWG health guideline value and another sample taken when corrective actions have been implemented.

Declared disaster

The CEO and the Coordinator of the local Disaster Management Group activate the Disaster Management Plan/ a Disaster is declared by the State Government.

This requires coordination across DSC departments and requires external resourcing and support from agencies, such as Department of Emergency Services, Department of Energy and Water Supply, Department of Health, local disaster management groups, emergency responders like QFRS, Police.

When a Disaster Management Group is stood up, drinking water quality management actions will be taken as necessary to respond to the requirements of the Disaster Coordinator. The Manager Water and Wastewater is a core member of the Local Disaster Management Group (LDMG), and will report directly to the Coordinator of the LDMG on water requirements.

While every effort will be made to continue to implement the Drinking Water Quality Management Plan, Disaster Management actions may take precedence. Every effort will be made to keep the Regulator informed of the situation as soon as practicable.

Example incident responses

The following flow charts demonstrate the Douglas Shire Council Incident Response for *E. coli* or chemical health exceedances.

Douglas Shire Council has also developed Boil Water Alert and Do Not Drink Alert templates, and are developing a communication strategy to best ensure these Alerts are disseminated as soon as possible in the event that they are required. Example templates follow (document number 460573)

Alert Level	Key management response(s)	Brief summary of actions	Documented Plans & Procedures
High: **Declared Disaster**	Activate disaster management plan.	Notify CEO Coordinate internal notification, investigation and response of water related aspects Consider what community notification is needed (if any) e.g. do not drink alert, boil water alert or bottled/emergency water distribution Notify Regulator of escalation from incident/event or of standalone emergency as soon as practicable	Disaster management plan.
Medium: **Incidents and Emergencies**	Activate incident response plan. Ensure all barriers identified in the DWQMP are functioning effectively.	Notify Manager Water and Wastewater Notify Regulator of any reportable incidents immediately (within 3 hours). Ensure all control measures identified in the DWQMP are functioning effectively Commence investigation Arrange for re-samples to be taken (where required) Implement appropriate immediate remediation actions, (this may include hand dosing reservoirs, flushing of mains, or isolation of affected areas) Consider what community notification is needed (if any) e.g. do not drink alert, boil water alert or bottled/emergency water distribution Review associated laboratory reports and operational records In case of customer complaints, coordinate investigation and resolution, including obtaining water samples where required	Incident response plan (this document) DSC DWQMP
Low: **Operational Action**	Ensure all operational steps identified in the DWQMP are functioning effectively. Check and act upon operations and maintenance records and procedures.	Notify Team Leader Water. Review operations and maintenance records for anomalies Commence investigation to determine cause, if not identifiable through operational records Investigate immediate remediation actions Increase operational monitoring frequency where required	Operations and maintenance records and procedures. DSC DWQMP. Routine monitoring

Table 16 — Summary of responses

E. coli Response Process and Decision Tree

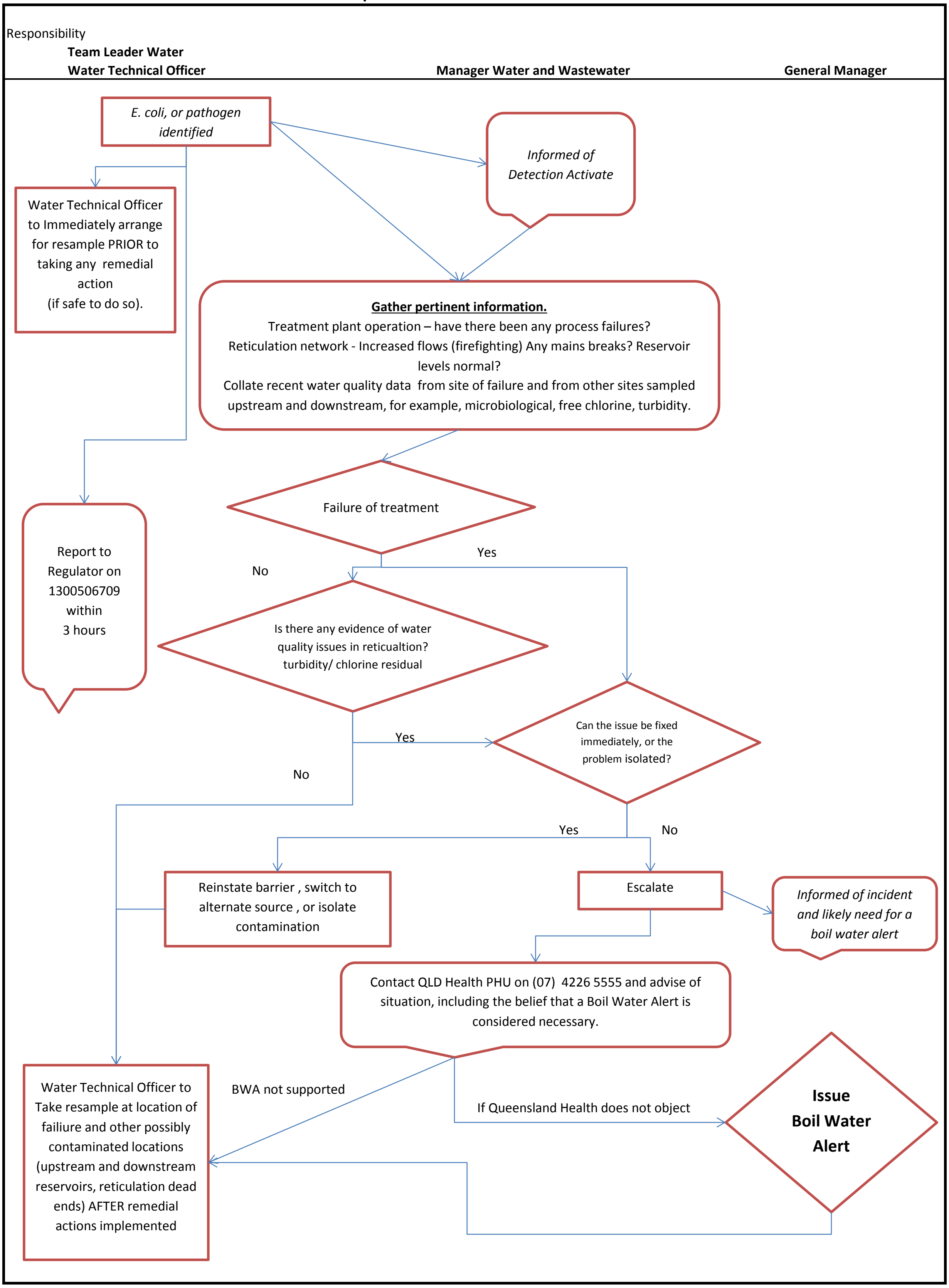


Figure 15 — E coli response protocol

Chemical Parameter Response Process and Decision Tree

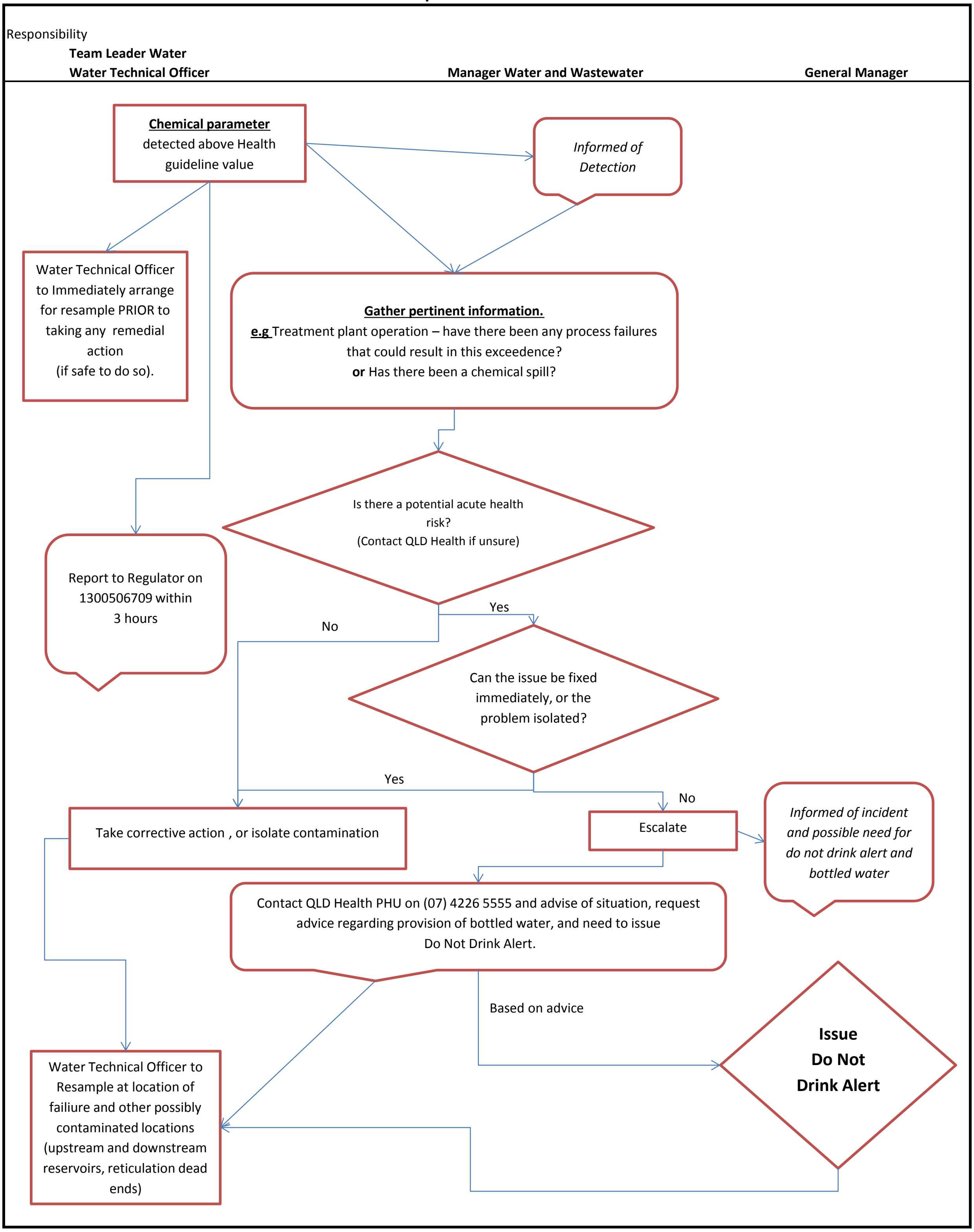


Figure 16 — Chemical exceedence response protocol

Boil Water Alert – detection of *E. coli*
DATE IN EFFECT

Douglas Shire Council advises that consumers in << **Delete any areas that are DEFINITELY not affected** Daintree, Whyanbeel, Rocky Point, Wonga Beach, Cassowary, Mowbray, Craiglie, Port Douglas, Mossman, Cooya Beach, Newell Beach, >> should boil all drinking water until further notice.

Regular monitoring has detected the presence of *E. coli* bacteria in your water supply. *E. coli* itself is generally not harmful but its presence in drinking water does indicate that the water supply *could be* contaminated with organisms that could cause gastrointestinal disease.

As a precaution you are advised that water used for consumption should be brought to the boil (for example in a kettle). Water should be transferred to a clean container with a lid and refrigerated or allowed to cool before use.

Boiled or bottled water should be used for:

- Drinking,
- Preparing or cooking food or drinks,
- Making baby formula,
- Making ice or,
- Brushing teeth.
- Babies and toddlers should be sponge bathed.
- Children should take boiled or bottled water to school.

Be careful to avoid being scalded when handling hot water.

Dishes can be washed in a dishwasher, or can be washed in hot soapy water and dried before using.

Residents can continue to shower and wash clothes as normal.

Douglas Shire Council is working hard with Queensland Health to fix the problem.

Further information has been published on Councils website.

DOUGLAS SHIRE COUNCIL

DO NOT DRINK ALERT
DATE IN EFFECT

Douglas Shire Council advises that consumers in << **Delete any areas that are DEFINITELY not affected** Daintree, Whyanbeel, Rocky Point, Wonga Beach, Cassowary, Mowbray, Craiglie, Port Douglas, Mossman, Cooya Beach, Newell Beach, >> to DO NOT DRINK tapwater until further notice.

Douglas Shire Council is concerned that the water supply may have been contaminated with (WHAT). And that the water supply may not be safe for consumption.

If you have consumed the water and are feeling unwell, contact your family doctor or Queensland Health on 13 HEALTH.

Bottled will be provided at:
LOCATION
and TIME

OR
Drinking water will be available for collection at:
LOCATION
and TIME

Douglas Shire Council is working hard with Queensland Health to fix the problem.

Further information has been published on Councils website.

(Contact person?)

Element 7: Employee awareness and training

Employee awareness

Water treatment operators are essential to ensure the safe operation of water treatment plants, and in implementing the actions identified in this plan. In an effort to engage operators, much of the development of these plans was done in conjunction with operators. It is intended that the drinking water quality management plan becomes a useful document within council that is implemented by the operators, but equally used by managers to demonstrate the need for change, and justify budgetary expenditure. It is an expectation of Council and the Coordinator of Water and Wastewater that this plan is understood and implemented by relevant staff.

An additional requirement is that staff are aware of their environmental obligations. As such, this plan includes details of how staff are to ensure that they do not cause general environmental harm, nor act contrary to our integrated environmental authority.

Water treatment staff are aware of the actions that they may take at the water treatment plant intakes, and into the World Heritage Catchment, and are also aware that discharges can impact on the Great Barrier Reef.

Employee training

Plant operators and Network (reticulation system) operators were instrumental in developing and reviewing this plan. Operators ensured that the scheme description and operational details were correct and actively participated in the risk workshop. In so doing, this ensured that they are familiar with the plan and their requirements under the plan.

Internal training for operational staff is conducted by way of Toolbox Talks. These are short group information sessions that ensure staff know their responsibilities and are made aware of any changes that affect their daily work processes and tasks.

Douglas Shire Council maintains a list of the relevant qualifications and certifications of operational staff, and intends to further formalise training programs. For example, we are aware of the industry push towards the National Certification Framework for Water Treatment Plant Operators, and will investigate obtaining the appropriate units of competency for all operational staff over the next 2 year DWQMP review period. This is consistent with the intent of the draft guidance note just released by the Regulator. Specific environmental training may also be considered.

Element 8: Community involvement and awareness

Council is aware of the importance of keeping our customers informed of significant issues, and significant improvements. Council has engaged with our customers directly, through community meetings, and continues to update the information on our website to provide information. Council clearly states the level of service that customers can expect through our published customer service standards.

Other information is provided at

http://douglas.qld.gov.au

Specific water related issues are included in our council alerts. Council encourages two-way communication, and includes relevant contact details on our webpage.

Element 9: Research and development

Council undertakes a number of activities that can be considered as research and development. For example, the testing, validation and optimisation of new equipment prior to placing it into service.

Council recognises that there is further scope to formalise activities such as the validation of existing barriers. This may become essential if the ADWG adopts microbiological health based targets.

Health based target initial assessment

The Catchment (World Heritage Protected Area with minimal or no human activity) is conservatively rated as a Category 2 catchment on the basis of elevated *E. coli* results in raw water.

The CCPs for these schemes ensure that we can claim the maximum allowable log reductions for ultrafiltration, and 4 log reduction for bacteria and viruses from chlorination. UV may not be necessary (except in Whyanbeel where, if UF had to be operated outside of the PDT CCP as there is only one rack, if the turbidity was <1 NTU, UV would compensate).

This will be further explored if health based targets are required to be assessed under the Queensland legislative requirements.

Element 10: Documentation and reporting

There are numerous elements of documentation and reporting that are essential to the safe management of the drinking water supply.

Record Keeping

Primarily, Douglas Shire Council uses a system called MagiQ to manage documents and records. This is essentially the same as the previous InfoExpert documentation system. MagiQ has the capability to 'publish' versions to ensure staff members only access the approved and up to date version of documents, there is also the capability to track the history of access to a document in the event of changes being made without prior approval. Records can also have comments within the version field to allow updates and review to be tracked against the version changes.

Douglas Shire Council has Administration Instructions dealing with record keeping and security. There is also a manual available regarding how to use the MagiQ system.

All documents in MagiQ are accessible by management, team members and other internal staff. A copy of the latest version and the relevant documents that apply to their work are available in hard copy, for example, on notice boards within the depot and plants.

Records, and as developed, procedures are saved into MagiQ where they receive a unique document number.

In addition to the MagiQ system, there are other methods in which records are collected and stored. At the Water Treatment Plants, daily sheets are manually filled out to record operational parameters, and these are stored in hard copy at the WTP. WTP monthly and quarterly reports are provided to the Manager of Water and Wastewater electronically, and are captured in MagiQ.

Continuous online operational data is captured and stored by the SCADA system. The current system retains 12 months of data to allow operators to look at annual trends, and archives all older data.

Verification monitoring data is entered weekly into MagiQ, and quarterly and annual reports are prepared by the Technical Officer Water and Wastewater and signed off by the Manager. The Manager Water and Wastewater also reports quarterly to Councilors on all water matters.

All records are kept in accordance with Public Records Act requirements.

Procedures

The key procedures for the safe operation of the Douglas Shire Council drinking water schemes are the Critical Control Point Procedures. These procedures identify the daily tasks of the operators, and the action and critical responses that are required to prevent a barrier from going out of control.

Main Break Repair, Reservoir Inspection and Flushing Procedures are in draft, and will be finalised in 2017.

Reporting processes are the responsibility of the Water Quality Team Leader and Technical Officer and signed off by the Manager Water and Wastewater.

Element 11: Evaluation and audit

Long-term evaluation of water quality results and audit of the drinking water quality management are required to determine whether preventive strategies are effective and whether they are being implemented appropriately. These reviews enable performance to be measured against objectives and help to identify opportunities for improvement.

Long -term evaluation of results

Water quality has been assessed as part of the risk assessment process and will continue to be reviewed on an annual basis and prior to reviews, budgeting process and strategic planning process.

Annual water quality summaries will be included in the Drinking water quality management plan report, and this data used to inform future reviews of the DWQMP.

The long-term evaluation of results will include:

- critical control point performance
- water quality data results
- incident history and response
- levels of service
- actions against the improvement plan

Audits

Auditing is the systematic evaluation of activities and processes to confirm that objectives are being met. It includes assessment of the implementation and capability of management systems. Auditing provides valuable information on those aspects of the systems that are effective, as well as identifying opportunities for improvement.

Regulatory audits.

There is a regulatory requirement to audit the DWQMP, in accordance with the approval of the DWQMP. The frequency is currently every 4 years. Douglas Shire Council has not yet been required to undertake a regulatory audit. When a regulatory audit is conducted, it shall be undertaken in as required. The audit timetable was recently changed to align with the wider Far North Queensland Regional Organisation of Councils, and it is expected that this audit date will remain.

Internal audits

Douglas Shire Council may also undertake internal audits periodically to satisfy ourselves that we are consistently and demonstrably providing safe water. Where an internal audit is undertaken, the audit outcomes will not be provided to the regulator, or made public.

Internal audits may address any aspect of drinking water management, for example:

+ implementation of CCPs and responses to exceedances
+ progress against the Improvement Plan
+ record keeping
+ data collection and management, including reporting requirement

Drinking water quality management plan report

The drinking water quality management plan report will be prepared as per the guideline, and will be published on Councils website to provide customers information on our service.

Element 12: Review and continual improvement

Review

There is a regulatory requirement to review the DWQMP biannually. The current review and amendment of the DWQMP has been conducted following the external audit of our DWQMP, even though the audit noted no non-conformances.

Council may review more frequently if we believe the DWQMP needs to be updated.

Continual improvement – risk management improvement plan

The purpose of the drinking water quality management plan is to identify and manage risks to the services. Improvements are continually being made to water treatment plants and include both larger items identified in the risk management improvement program, and smaller changes to operation or monitoring.

Where council identifies improvements that can be made, they are implemented. As improvements are intended to reduce the risks to the schemes, this is good management practice. Over time, this will result in slight differences between the management plan and actual operations. This should be expected.

Where outcomes of the scheme by scheme risk assessments resulted in mitigated risks that were above medium, risk management improvement items have been identified.

These are listed in the final 3 columns of the mitigated risk assessment tables.

The items have been prioritised according to budget cycles. Where an item is required immediately, DSC will undertake actions as soon as practical. Otherwise, items are identified as occurring in particular financial years, as this aligns with Council budget cycles.

Note: items in the risk management improvement program are indicative of an action that would be suitable to manage the risk. Where alternative measures can be introduced that will similarly result in a reduction of the risk, these alternate actions may take the place the identified items.

As stated, the RMIP informs the capital and operational works planning process. This is done by using the risk assessment and its outcomes, and deciding upon the appropriate actions to minimise risks into the future. The Coordinator, Water and Wastewater and the General Manger, Operations are intimately involved in developing the budget, and communicating it to the Council Executive and the Councilors.

The current council is aware of how the DWQMP is developed, and the linkages of capital works projects to identified risks. It is the intent of Douglas Shire Council to continue to engage with Councilors to ensure that the risk management improvement items are prioritised. However, this is dependent on the council, and their decisions regarding budget allocation. Where council does not approve budget items, they will be revisited as required, but may not occur in the stated timeframe. Nonetheless, Council is committed to delivering safe drinking water.

Appendix A - Water Quality Data

Water Quality Data (2009-2017) *Water Quality Data (Reticulation, Reservoirs, Treatment and Raw)*								
Mossman Reticulation	*(Cassowary Bunn's Corner, Cooya Bougainvillea, Cooya Nth End, Craiglie Teamsters Park, 4mile Barrier St, 4mile Esplanade, Mossman Davis Park, Mossman Showgrounds, Mowbray Connolly Rd, Newell Esplanade, Newell Jetty, PD Rex Smeal Park)*							
E.coli (MPN/100mL) Reticulation	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	-	-	<1	<1	<1	<1	<1	<1
Max	-	-	<1	<1	1	<1	1	<1
Min	-	-	<1	<1	<1	<1	<1	<1
Count	-	-	537	526	522	524	618	626
95th %ile	-	-	<1	<1	<1	<1	<1	<1
Free Chlorine (mg/L) Reticulation	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	0.31	0.41	0.45	0.62	0.54	0.61	0.46	0.67
Max	3.9	1.1	1.9	2.4	1.2	1.2	1.07	1.3
Min	0.01	0.01	0.01	<0.1	<0.1	<0.1	<0.1	<0.1
Count	653	514	536	526	472	422	617	626
5th %ile						<0.1	<0.1	<0.1
95th %ile	0.7	0.8	0.9	1	0.92	0.92	0.89	1.1
pH (pH unit) Reticulation	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	8.6	8.5	8.2	7.9	7.7	7.64	7.76	7.87
Max	9.6	9.7	9.6	9.4	9.2	9.6	9.42	10.06
Min	6.3	7.2	7.2	7.1	6.8	6.6	6.7	6.7
Count	533	522	537	526	490	525	603	626
95th %ile	9.4	9.3	9	8.6	8.6	8.48	8.78	8.8
Colour (PCU) Reticulation	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	2.7	1.9	1.6	1.8	1.3	<1	<5	<5
Max	46	13	4.5	8.4	5.3	5	5	<5
Min	1	1	<1	<1	<1	<1	<5	<5
Count	311	219	537	526	486	71	154	156
95th %ile	4.9	3.1	2.8	3.4	4	5	<5	<5
Turbidity (NTU) Reticulation	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	0.6	0.25	0.1	0.1	0.1	<0.10	<0.5	<0.5
Max	31	3.1	1	5.7	0.3	2	14	1.1
Min	0.1	0.1	<0.10	<0.10	<0.10	<0.10	<0.5	<0.5
Count	232	135	537	526	494	208	154	156
95th %ile	1.25	0.63	0.2	0.2	0.2	0.1	0.5	0.6

Iron (mg/L) Reticulation	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	0.6	0.25	0.1	0.1	0.1	<0.10	<0.5	0.005
Max	31	3.1	1	5.7	0.3	2	14	0.053
Min	0.1	0.1	<0.10	<0.10	<0.10	<0.10	<0.5	<0.005
Count	232	135	537	526	494	208	154	156
95th %ile	1.25	0.63	0.2	0.2	0.2	0.1	0.5	0.019
Manganese (mg/L) Reticulation	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	-	-	0.001	<0.01	0.02	<0.01	<0.005	<0.005
Max	-	-	0.025	0.02	0.03	<0.01	<0.005	<0.005
Min	-	-	<0.001	<0.01	<0.01	<0.01	<0.005	<0.005
Count	-	-	253	505	349	71	154	156
95th %ile	-	-	0.004	0.02	0.03	<0.01	<0.005	<0.005
Mossman Reservoir	*(Craiglie Reef Park Reservoir, Flagstaff Reservoir)*							
E.coli (MPN/100mL) Reservoir	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	-	-	<1	<1	<1	<1	<1	<1
Max	-	-	<1	<1	<1	1	<1	<1
Min	-	-	<1	<1	<1	<1	<1	<1
Count	-	-	106	105	104	106	105	104
95th %ile	-	-	<1	<1	<1	<1	<1	<1
Free Chlorine (mg/L) Reservoir	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	0.65	0.48	0.64	0.77	0.73	0.72	0.79	0.94
Max	1.9	0.93	1.9	2.8	1.4	1.21	2.1	1.33
Min	0.01	0.01	0.03	<0.10	<0.10	<0.10	0.14	0.26
Count	103	97	106	105	96	103	105	104
5th %ile	-	-	-	-	-	0.17	0.37	0.61
95th %ile	1	0.8	1.15	1.2	1.2	1.18	1.11	1.17
pH (pH unit) Reservoir	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	8.2	8.3	8.2	7.7	7.5	7.5	7.25	7.53
Max	9.5	9.5	9.3	8.7	8.5	8.5	8.52	8.4
Min	7	7.4	7.1	7.1	7	6.4	6.44	6.4
Count	90	98	106	105	90	105	101	104
95th %ile	9.4	9.4	9.1	8.5	8	8.21	7.75	8.2
Mossman Treatment	*(WTP Mossman Pre UV, WTP Mossman Post UV, WTP Port Pre UV, WTP Port Post UV)*							
E.coli (MPN/100mL) Treatment	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	-	-	<1	<1	<1	<1	<1	<1
Max	-	-	<1	<1	<1	1	<1	<1
Min	-	-	<1	<1	<1	<1	<1	<1
Count	-	-	157	168	153	156	158	116
95th %ile	-	-	<1	<1	<1	<1	<1	<1

Free Chlorine (mg/L) Treatment	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	-	-	0.91	1	0.91	0.9	0.89	1.1
Max	-	-	2.2	2.6	1.3	1.13	1.31	1.6
Min	-	-	0.2	0.38	0.34	0.085	0.54	0.68
Count	-	-	137	113	89	102	106	104
5th %ile	-	-						0.77
95th %ile	-	-	1.38	1.3	1.2	1.04	1.13	1.4

pH (pH unit) Treatment	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	-	-	7.2	7.2	7.1	7.3	7.3	7.64
Max	-	-	7.7	8.5	7.3	7.92	8.55	8.4
Min	-	-	6.6	6.9	6.9	6.5	6.7	6.4
Count	-	-	137	113	92	113	102	104
95th %ile	-	-	7.5	7.4	7.2	7.8	7.63	8.2

Mossman Raw *(Rex Creek Intake)*

E.coli (MPN/100mL) Raw	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	-	-	45	46	9	14	10.75	19
Max	-	-	>100	>100	12	37	34	34
Min	-	-	5	3	6	4	1	10
Count	-	-	4	5	4	5	4	4
95th %ile	-	-	94	>100	12	34	34	34

pH (pH unit) Raw	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	-	-	7.1	7.1	7.1	6.84	6.78	7.08
Max	-	-	7.2	7.2	7.3	7.1	6.8	7.8
Min	-	-	6.9	6.9	6.9	6.5	6.7	6.4
Count	-	-	4	5	4	16	4	14
95th %ile	-	-	7.2	7.2	7.3	7.1	6.8	7.8

Colour (PCU) Raw	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	-	-	14.4	7.3	5.8	10.2	9	7
Max	-	-	27	8.8	7.2	15	15	10
Min	-	-	4.4	5.7	3.3	5.5	5	<5
Count	-	-	4	5	4	3	4	4
95th %ile	-	-	25.4	8.7	7.1	14.5	15	10

Turbidity (NTU) Raw	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	-	-	1.5	0.6	0.4	0.5	6.75	<0.5
Max	-	-	2.5	1.1	0.6	5.3	25	1.1
Min	-	-	0.4	0.3	0.3	0.1	<5	<0.5
Count	-	-	4	5	4	17	4	14
95th %ile	-	-	2.5	1	0.6	2.02	25	1.1

Iron (mg/L) Raw	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	-	-	0.082	0.03	0.02	0.013	0.024	0.02
Max	-	-	0.094	0.05	0.024	0.036	0.037	0.022
Min	-	-	<0.05	<0.02	<0.02	<0.02	0.015	0.016
Count	-	-	4	5	4	3	4	4
95th %ile	-	-	0.093	0.05	0.023	0.033	0.037	0.022

Manganese (mg/L) Raw	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	-	-	0.002	<0.01	<001	<0.01	<0.005	<0.005
Max	-	-	0.004	<0.01	<0.01	<0.01	<0.005	<0.005
Min	-	-	0.001	0.001	<0.01	<0.01	<0.005	<0.005
Count	-	-	4	5	4	3	4	4
95th %ile	-	-	0.004	<0.01	<0.01	<0.01	<0.005	<0.005
Whyanbeel Reticulation	*(Rocky Point Pump Station, Wonga Bells Park, Wonga Marling Dr Bus shelter)*							
E.coli (MPN/100mL) Reticulation	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	-	-	<1	<1	<1	<1	<1	<1
Max	-	-	<1	1	7	<1	<1	<1
Min	-	-	<1	<1	<1	<1	<1	<1
Count	-	-	162	209	154	160	154	156
95th %ile	-	-	<1	<1	<1	<1	<1	<1
Free Chlorine (mg/L) Reticulation	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	0.31	0.41	0.47	0.29	0.39	0.36	0.37	0.73
Max	2.6	4.4	8.2	1	1.9	1.25	1.5	1.46
Min	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1
Count	233	208	162	209	146	157	154	156
5th %ile						<0.10	<0.1	0.28
95th %ile	0.94	1.3	1.4	0.6	0.8	0.92	0.81	1.1
pH (pH unit) Reticulation	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	8.2	8.6	8	8.1	7.7	7.69	7.95	7.87
Max	10	10.1	9.4	9.7	8.9	9.31	9.08	9.1
Min	6.9	6.9	7	7.2	7.1	6.5	6.8	6.6
Count	212	211	162	209	144	159	153	156
95th %ile	9.6	9.6	9.2	9.3	8.7	9.01	8.83	8.81
Colour (PCU) Reticulation	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	2.3	1.4	1.8	2.5	1.3	<1	<5	<5
Max	16	2.5	13	21	3.9	1.4	<5	<5
Min	1.1	1	<1	<1	<1	<1	<5	<5
Count	92	42	162	156		38	39	39
95th %ile	3.6	2.1	3.2	4.6	3	1.1	<5	<5
Turbidity (NTU) Reticulation	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	0.28	0.15	0.2	<0.10	0.1	<0.10	<0.5	<5
Max	4.6	0.4	3.2	4.9	0.8	0.2	<0.5	0.7
Min	0.1	0.1	<0.10	<0.10	<0.10	<0.10	<0.5	<5
Count	59	51	162	156	145	62	39	39
95th %ile	0.61	0.25	0.4	0.3	0.3	<0.10	<0.5	0.6

Iron (mg/L) Reticulation	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	0.11	0.07	0.11	0.09	0.05	<0.02	0.02	0.017
Max	0.21	0.09	0.47	0.7	0.17	0.053	0.046	0.07
Min	0.06	0.06	<0.05	<0.02	<0.02	<0.02	<0.005	<0.005
Count	8	4	75	150	108	24	39	39
95th %ile	0.19	0.09	0.3	0.22	0.1	0.047	0.042	0.044
Manganese (mg/L) Reticulation	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	0	0	0.001	<0.01	0.02	<0.01	<0.005	<0.005
Max	0	0	0.02	0.03	0.03	<0.01	<0.005	<0.005
Min	0	0	<0.001	<0.01	<0.01	<0.01	<0.005	<0.005
Count	8	21	75	150	108	24	39	39
95th %ile	0	0	0.01	0.01	0.03	<0.01	<0.005	<0.005
Whyanbeel Reservoir	*(Rocky Point Reservoir)*							
E.coli (MPN/100mL) Reservoir	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	-	-	<1	<1	<1	<1	<1	<1
Max	-	-	<1	<1	<1	3	<1	<1
Min	-	-	<1	<1	<1	<1	<1	<1
Count	-	-	110	49	85	52	53	52
95th %ile	-	-	<1	<1	<1	<1	<1	<1
Free Chlorine (mg/L) Reservoir	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	0.31	0.34	0.29	0.33	0.23	0.71	0.72	0.95
Max	2.8	0.8	3	1.4	1.8	1.49	2.2	1.39
Min	0.01	0.02	<0.10	<0.10	<0.10	<0.10	0.19	<0.10
Count	49	51	110	49	84	51	53	52
5th %ile						<0.10	0.24	0.55
95th %ile	0.7	0.61	0.6	0.74	0.56	1.08	1.03	1.3
pH (pH unit) Reservoir	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	7.2	0	8.4	7.4	7.9	7.13	7.34	7.51
Max	7.8	0	10	8	9.6	7.58	8.49	8.4
Min	6.9	0	7	7.2	7.1	6.6	6.6	6.6
Count	51	0	110	49	77	52	51	52
95th %ile	7.6	0	9.9	7.8	9.1	7.43	8.03	8.2
Whyanbeel Treatment	*(Whyanbeel Pre UV, Whyanbeel Post UV)*							
E.coli (MPN/100mL) Treatment	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	-	-	<1	<1	<1	<1	<1	<1
Max	-	-	<1	<1	<1	<1	<1	<1
Min	-	-	<1	<1	<1	<1	<1	<1
Count	-	-	87	53	100	106	105	64
95th %ile	-	-	<1	<1	<1	<1	<1	<1

Free Chlorine (mg/L) Treatment	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	-	-	0.88	0.92	0.83	0.96	0.9	1.04
Max	-	-	1.5	2	1.3	1.34	1.46	1.5
Min	-	-	0.48	0.27	0.36	0.67	0.44	0.69
Count	-	-	54	53	49	51	53	52
5th %ile	-	-				0.69	0.68	0.77
95th %ile	-	-	1.24	1.2	1.1	1.12	1.11	1.4
pH (pH unit) Treatment	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	7	7.1	7	7	7	7.1	7.05	7.5
Max	7.5	7.5	7.4	7.4	7.2	8.56	7.81	8.6
Min	6.5	6.7	6.7	6.8	6.8	6.3	6.6	6.3
Count	56	53	53	53	47	64	51	52
95th %ile	7.3	7.3	7.2	7.2	7	7.58	7.63	8.2
Whyanbeel Raw	*(Whyanbeel Intake)*							
E.coli (MPN/100mL) Raw	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	-	-	44	54	44	52	102	17
Max	-	-	>100	>100	130	>100	260	29
Min	-	-	16	6	14	12	27	10
Count	-	-	3	4	4	4	4	5
95th %ile	-	-	92	>100	113	97	260	29
pH (pH unit) Raw	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	-	6.7	6.6	6.7	6.6	6.54	6.48	6.53
Max	-	6.9	6.7	6.8	6.7	7	6.5	7
Min	-	6.4	6.5	6.5	6.4	6.1	6.4	6.2
Count	-	9	3	4	4	18	4	15
95th %ile	-	6.9	6.7	6.8	6.7	6.99	6.5	6.9
Colour (PCU) Raw	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	-	-	15.3	12.4	8.6	11.2	10	11.25
Max	-	-	20	17	9.2	15	15	15
Min	-	-	7	8.6	9.2	15	5	10
Count	-	-	3	4	4	3	4	4
95th %ile	-	-	19.9	16.4	9.2	14.5	15	15
Turbidity (NTU) Raw	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	-	-	1.4	0.9	0.6	0.36	4.23	<0.5
Max	-	-	2.8	2.2	0.7	2.8	15	2.1
Min	-	-	0.4	0.5	0.3	<0.1	<0.5	<0.5
Count	-	-	3	4	4	18	4	15
95th %ile	-	-	2.6	1.9	0.7	1.19	15	0.9
Iron (mg/L) Raw	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	-	-	0.085	0.06	0.03	0.03	0.031	0.032
Max	-	-	0.117	0.12	0.032	0.04	0.037	0.035
Min	-	-	<0.05	0.03	0.027	0.02	0.026	0.028
Count	-	-	3	4	4	3	4	4
95th %ile	-	-	0.114	0.11	0.03	0.04	0.037	0.035

Manganese (mg/L) Raw	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	-	-	0.002	<0.01	<0.01	<0.01	<0.005	<0.005
Max	-	-	0.003	<0.01	<0.01	<0.01	<0.005	<0.005
Min	-	-	0.001	0.001	<0.01	<0.01	<0.005	<0.005
Count	-	-	3	4	4	3	4	4
95th %ile	-	-	0.003	<0.01	<0.01	<0.01	<0.005	<0.005

Daintree Reticulation *(Daintree Shire Hall)*

E.coli (MPN/100mL) Reticulation	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	-	-	<1	<1	<1	<1	<1	<1
Max	-	-	<1	<1	<1	<1	<1	<1
Min	-	-	<1	<1	<1	<1	<1	<1
Count	-	-	55	51	50	54	52	52
95th %ile	-	-	<1	<1	<1	<1	<1	<1

Free Chlorine (mg/L) Reticulation	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	0.3	0.13	0.12	0.17	0.2	0.2	0.64	0.84
Max	1.6	0.3	0.3	0.4	0.37	0.71	1.16	1.4
Min	0.01	0.01	<0.10	<0.10	<0.10	<0.10	0.2	0.5
Count	45	53	55	51	50	53	52	52
5th %ile						<0.10	0.4	0.6
95th %ile	0.9	0.28	0.25	0.31	0.36	0.62	0.85	1.14

pH (pH unit) Reticulation	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	7.7	7.7	7.8	7.7	7.7	7.46	7.53	7.65
Max	8.2	7.9	9	7.9	8	7.9	7.96	8.6
Min	7.4	7.3	7.5	7.5	7.3	6.75	7.03	6.9
Count	53	55	55	51	48	54	51	52
95th %ile	7.9	7.9	8.3	7.8	7.8	7.74	7.81	8.23

Colour (PCU) Reticulation	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	3.3	1.5	<1	<1	1.3	<1	<5	<5
Max	15	3.8	2.1	1.8	2.1	4.1	5	<5
Min	1.1	1	<1	<1	<1	<1	<5	<5
Count	47	29	55	51	48	13	13	13
95th %ile	7.5	3.3	1.3	1	1.8	1.64	5	<5

Turbidity (NTU) Reticulation	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	0.54	0.18	0.1	0.1	0.1	0.11	<0.5	<0.5
Max	2.5	0.6	0.2	0.6	0.3	0.6	0.7	0.9
Min	0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.5	<0.5
Count	37	32	55	51	50	21	13	13
95th %ile	1.34	0.49	0.2	0.2	0.2	0.4	0.7	<0.5

Iron (mg/L) Reticulation	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	0.11	0.07	<0.05	<0.02	<0.02	0.03	0.008	0.005
Max	0.21	0.09	<0.05	0.03	<0.02	<0.02	0.031	0.012
Min	0.06	0.06	<0.05	<0.02	<0.02	<0.02	<0.005	<0.005
Count	8	4	55	49	37	8	13	13
95th %ile	0.19	0.09	<0.05	0.02	<0.02	0.08	0.031	0.009
Manganese (mg/L) Reticulation	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	0	0	<0.001	<0.01	<0.01	<0.01	<0.005	<0.005
Max	0	0	<0.001	<0.01	<0.01	<0.01	<0.005	<0.005
Min	0	0	<0.001	<0.01	<0.01	<0.01	<0.005	<0.005
Count	8	21	55	49	37	8	13	13
95th %ile	0	0	<0.001	<0.01	<0.01	<0.01	<0.005	<0.005
Daintree Treatment	*(Daintree Pre UV, Daintree Post UV)*							
E.coli (MPN/100mL) Treatment	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	-	-	<1	<1	<1	<1	<1	<1
Max	-	-	<1	<1	<1	<1	<1	<1
Min	-	-	<1	<1	<1	<1	<1	<1
Count	-	-	107	106	103	104	105	64
95th %ile	-	-	<1	<1	<1	<1	<1	<1
Free Chlorine (mg/L) Treatment	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	0.67	0.31	0.28	0.28	0.33	0.5	0.96	1.01
Max	4.6	0.5	0.5	0.62	0.51	0.98	1.39	1.68
Min	0.14	0.19	<0.10	<0.10	<0.10	0.1	0.67	0.6
Count	53	54	87	54	49	51	53	52
5th %ile						0.29	0.69	0.8
95th %ile	1.88	0.41	0.4	0.47	0.43	0.85	1.29	1.22
pH (pH unit) Treatment	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	7.5	7.5	7.5	7.5	7.6	7.4	7.41	7.4
Max	7.8	8.6	7.7	8.2	7.7	8.3	7.74	8.19
Min	7.2	7.2	7.2	7.4	7.4	6.93	7.02	6.6
Count	54	53	87	54	48	66	51	52
95th %ile	7.7	7.6	7.6	7.6	7.7	7.69	7.64	7.9
Daintree Raw	*(Daintree Intake, Daintree Raw)*							
E.coli (MPN/100mL) Raw	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	-	-	52	89	66	39	141.3	252
Max	-	-	>100	>100	160	88	340	770
Min	-	-	27	72	23	10	30	24
Count	-	-	4	5	4	3	3	4
95th %ile	-	-	92	>100	144	81	340	770

pH (pH unit) Raw	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	-	7.3	7.4	7.5	7.5	7.37	7.27	7.14
Max	-	7.3	7.5	7.7	7.6	7.6	7.3	7.5
Min	-	7.1	7.2	7.3	7.3	7.2	7.2	6.6
Count	-	9	4	5	4	3	3	5
95th %ile	-	7.3	7.5	7.7	7.6	7.57	7.3	7.5

Colour (PCU) Raw	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	3.2	1.5	38.6	13.6	14.3	12	18.3	8.75
Max	15	3.8	>70	19	24	15	45	15
Min	1.1	1	5.9	9.2	53	10	10	<5
Count	47	29	4	5	4	3	3	4
95th %ile	7.4	3.3	>70	18.4	22.5	14.6	45	15

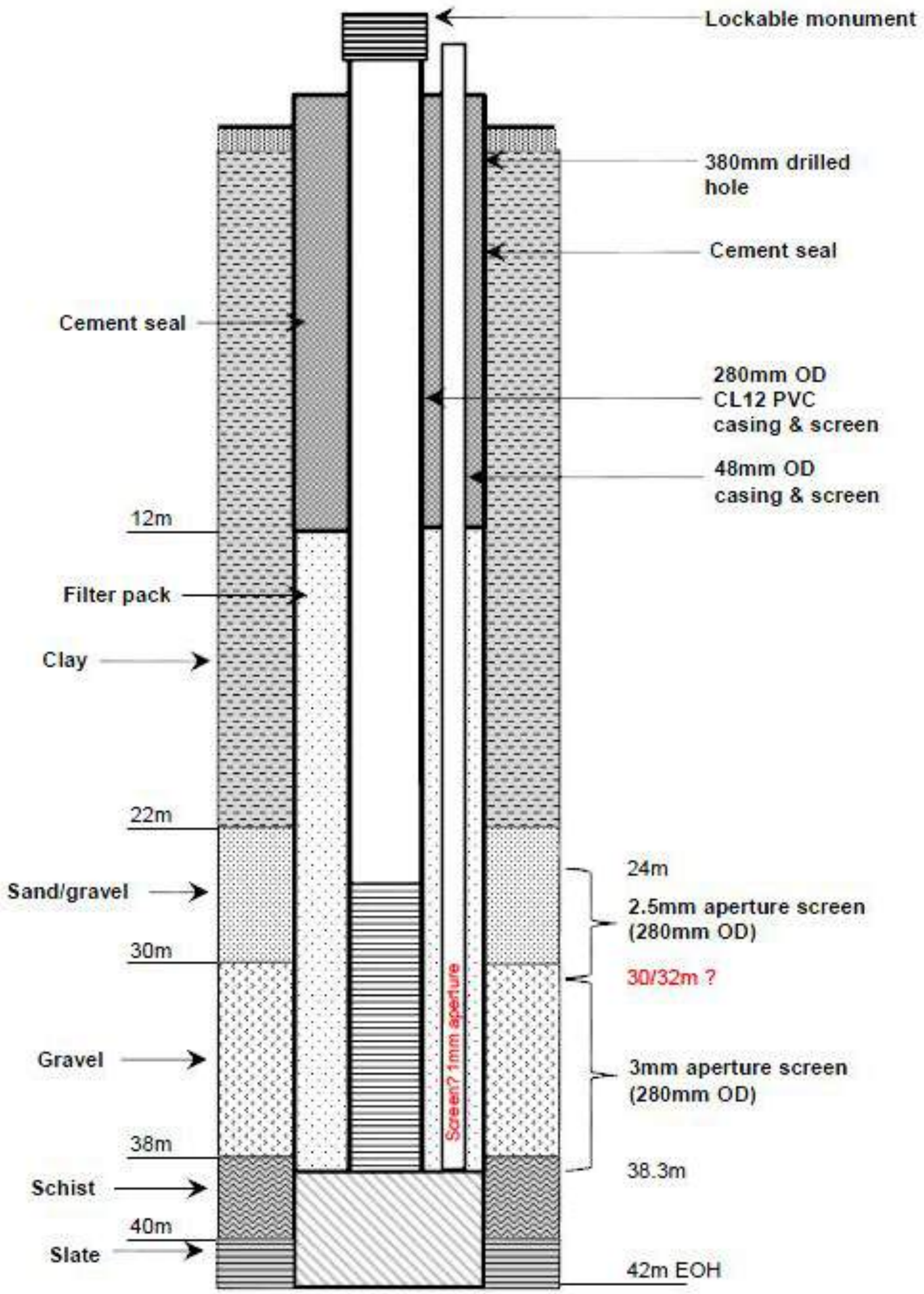
Turbidity (NTU) Raw	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	-	1.56	13.6	1.4	1.4	0.8	18.4	1.22
Max	-	2.7	45	2.9	2.6	1.2	52	1.9
Min	-	0.9	0.6	0.9	0.7	0.6	1.3	0.6
Count	-	9	4	5	4	3	3	5
95th %ile	-	2.58	39.4	2.6	2.4	1.14	52	1.9

Iron (mg/L) Raw	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	-	0.16	0.37	0.19	0.162	0.176	0.24	0.173
Max	-	0.25	0.67	0.28	0.28	0.28	0.4	0.27
Min	-	0.11	0.13	0.14	0.098	0.1	0.14	0.09
Count	-	6	4	5	4	3	3	4
95th %ile	-	0.24	0.65	0.27	0.264	0.267	0.4	0.27

Manganese (mg/L) Raw	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Avg	-	0	0.007	0.008	<0.1	<0.1	0.002	<0.005
Max	-	0.01	0.017	0.01	<0.1	<0.01	0.007	0.008
Min	-	0	0.001	0.003	<0.1	<0.1	<0.005	<0.005
Count	-	6	4	5	4	3	3	4
95th %ile	-	0.01	0.015	0.01	<0.1	<0.1	0.007	0.008

Appendix B - Daintree Bore Details

Bore 00241



Daintree Bore Water Quality (Pumping Tests)

Analytes	Unit	ADWG (2011)		Detection Limit	Sample start	Sample end
		Health	Aesthetic		CE124583 R0	CE124648 R0
Water quality parameters						
Total Dissolved Solids Dried at 175-185°C	mg/L			10	35	16
Electrical conductivity at 25°C	µS/cm			2	41	46
pH			6.5 - 8.5	0.1	5.9	6.2
Total Hardness as CaCO3	mg/L		200	1	4	6
Bicarbonate Alkalinity as CaCO3	mg/L			5	6	8
carbonate Alkalinity as CaCO3	mg/L			5	<5	<5
Hydroxide Alkalinity as CaCO3	mg/L			5	<5	<5
Total Alkalinity	mg/L			5	6	8
Turbidity	NTU			0.5	<0.5	<0.5
Nutrients and Pathogens						
Nitrate Nitrogen (NO3 as N)	mg/L	50		0.005	0.74	1.2
Nitrite Nitrogen (NO2 as N)	mg/L	3		0.005	<0.005	<0.005
Ammonia Nitrogen (NH3 as N)	mg/L		0.5	0.005	<0.005	<0.005
E.coli	MPN/100mL			1	<1	<1
Total Coliforms	MPN/100mL			1	76	3
Heterotrophic Plate Count (HPC) at 35 °C	CFU/mL			1	170	<10
Dissolved Metals						
Aluminium	mg/L		0.2	0.005	0.008	0.01
Arsenic	mg/L	0.01		0.003	<0.003	<0.003
Barium	mg/L	2		0.005	0.032	0.04
Beryllium	mg/L	0.06		0.0001	0.0003	0.0004
Boron	mg/L	4		0.005	<0.005	<0.005
Cadmium	mg/L	0.002		0.0001	<0.0001	<0.0001
Chromium	mg/L	0.05		0.001	0.0011	<0.0010
Cobalt	mg/L			0.001	0.002	0.002
Copper	mg/L	2	1	0.001	0.002	<0.001
Iron	mg/L		0.3	0.005	<0.005	<0.005
Lead	mg/L	0.01		0.001	<0.001	<0.001
Manganese	mg/L	0.5	0.1	0.005	0.007	0.01
Mercury	mg/L	0.001		0.00005	<0.00005	<0.00005
Molybdenum	mg/L	0.05		0.001	<0.001	<0.001
Nickel	mg/L	0.02		0.001	0.001	0.001
Selenium	mg/L	0.01		0.003	<0.003	<0.003
Strontium	mg/L			0.005	0.005	0.008
Vanadium	mg/L			0.001	<0.001	<0.001
Zinc	mg/L		3	0.005	<0.005	0.007
Total Metals						
Aluminium	mg/L		0.2	0.005	0.012	0.014
Arsenic	mg/L	0.01		0.003	<0.003	<0.003
Barium	mg/L	2		0.005	0.032	0.041
Beryllium	mg/L	0.06		0.0001	0.0003	0.0004
Boron	mg/L	4		0.005	<0.005	<0.005
Cadmium	mg/L	0.002		0.0001	<0.0001	<0.0001
Chromium	mg/L	0.05		0.001	0.001	<0.001
Cobalt	mg/L			0.001	0.002	0.002
Copper	mg/L	2	1	0.001	0.001	<0.001
Iron	mg/L		0.3	0.005	0.005	<0.005
Lead	mg/L	0.01		0.001	<0.001	<0.001
Manganese	mg/L	0.5	0.1	0.005	0.007	0.01
Mercury	mg/L	0.001		0.00005	<0.00005	<0.00005
Molybdenum	mg/L	0.05		0.001	<0.001	<0.001
Nickel	mg/L	0.02		0.001	0.001	0.002
Selenium	mg/L	0.01		0.003	<0.003	<0.003
Strontium	mg/L			0.005	0.005	0.008
Vanadium	mg/L			0.001	<0.001	<0.001
Zinc	mg/L		3	0.005	<0.005	0.007
Dissolved Ions						
Calcium	mg/L			0.2	<0.2	0.3
Magnesium	mg/L			0.1	0.9	1.2
Potassium	mg/L			0.1	0.8	1.1
Sodium	mg/L			0.5	5.3	5.1
Total Ions						
Calcium	mg/L			0.1	0.2	0.3
Magnesium	mg/L			0.1	0.9	1.2
Potassium	mg/L			0.1	0.8	1.1
Sodium	mg/L			0.5	5.4	5.1

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