Yarrabah Aboriginal Shire Council

Drinking Water Quality Management Plan

January 16

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Yarrabah Aboriginal Council

The Yarrabah Aboriginal Council considers this document contains matters relating to the business and financial affairs of Yarrabah Aboriginal Council and its disclosure may be contrary to the public interest under section 49 and Schedule 4 of the *Right to Information Act 2009* (RTI Act). Yarrabah Aboriginal Council would therefore be substantially concerned if this document was to be released publicly. Given this, Yarrabah Aboriginal Council provides this copy of the Drinking Water Quality Management Plan to the recipient agency on the understanding that if the agency receives a Right to Information (RTI) request that captures this document; it will formally consult with Yarrabah Aboriginal Council under section 37 of the RTI Act before a decision is made on the RTI request.

Document Status					
Date	Revision	Description	Author	Checked	Approved
July 2012	1	For review	Vincent Schrieber and Darrell Geary		
January 2013	2	Incorporating comments from DEWS	Vincent Schrieber		
December 2015	3		Vincent Schreiber	Shahab Katebi	Janelle Menzies

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Yarrabah Drinking Water Quality Management Plan

1. Registered Service Details

Service Provider: Yarrabah Aboriginal Council

Contact details: 56 Sawmill Road, Yarrabah QLD 4871

Phone: (07) 4056 9120; Fax: (07) 40569167

SPID: 152

Service details:

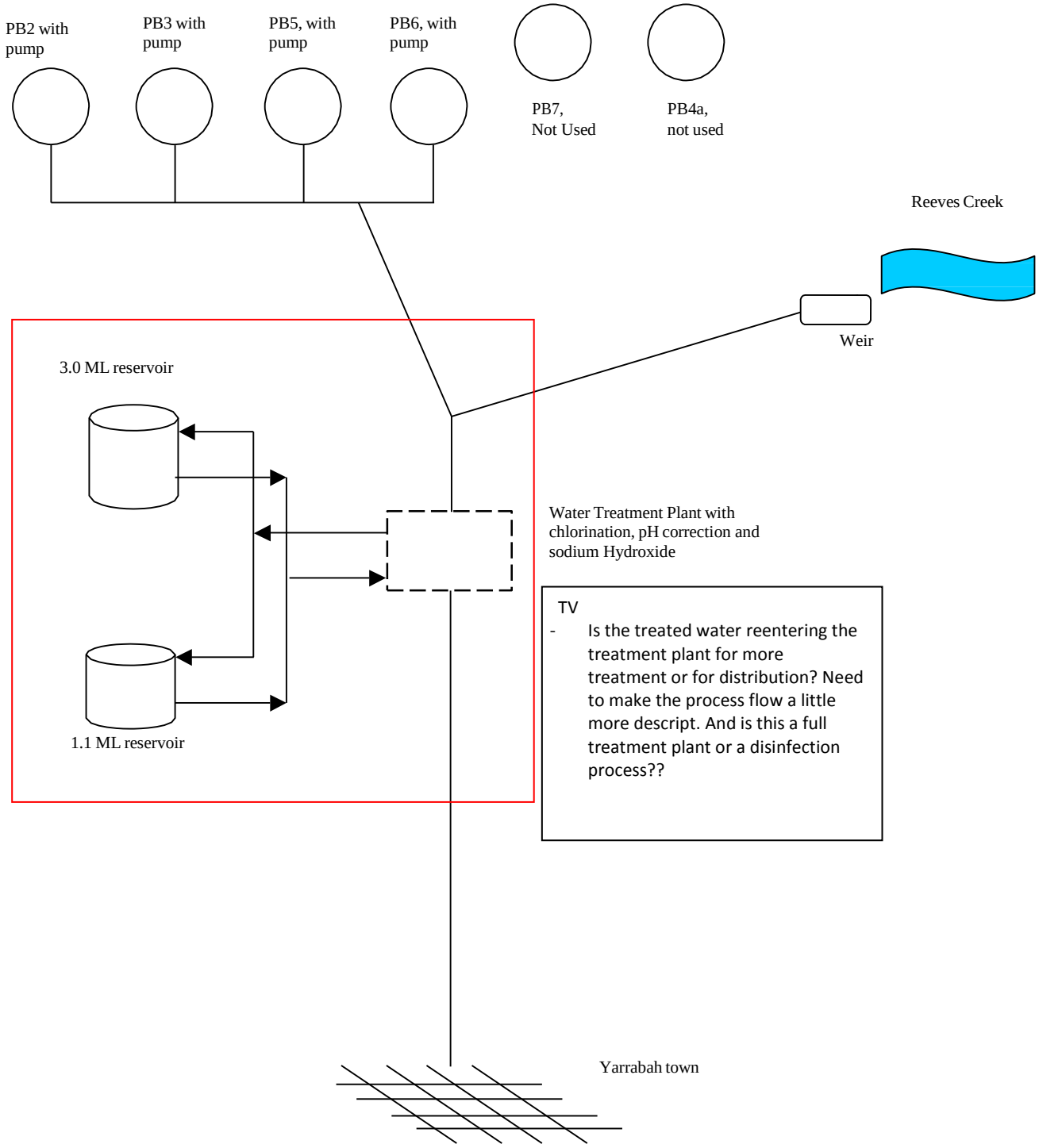
Scheme name	Operator	Communities served	Current			Projected in 10 years		
			Population	Connections	Demand ML/d	Population	Connections	Demand ML/d
Yarrabah	Yarrabah Aboriginal Shire Council	Yarrabah	4500	750	1.7	5500 (approx.)	850 (approx.)	2.0 (approx.)

Note: the highlighted sections has been update/amended

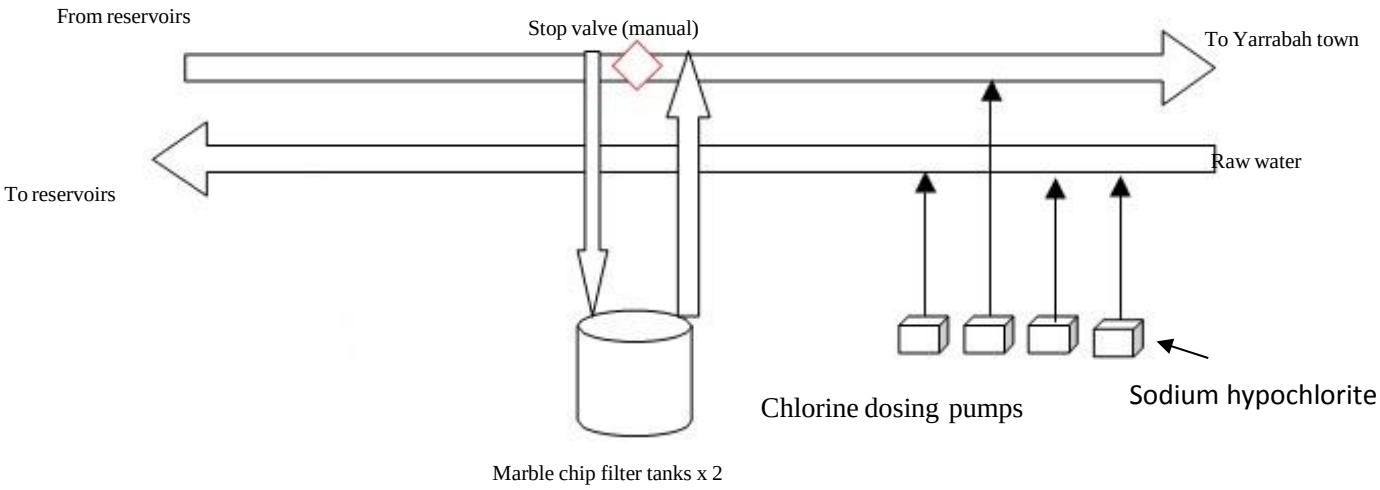
2. Details of Infrastructure

Schematics Overall

Schematic



Water Treatment Plant Schematic



Water Supply Description

The Council is responsible for the provision, operation and maintenance of infrastructure used to source, treat and transport potable water to the community residents for domestic and community purposes.

The scheme is a relatively simple treatment and supply system. It involves sourcing water from a local creek (Reeves Creek) and four bores. The surface water supply is transported to the treatment plant under gravity and the submersible bore water pumps transport raw water to the treatment plant. Both sources are used during normal operations. However, the creek supply is taken off-line during rain events, as there is no treatment process to remove/reduce turbidity (such as filtration)

Water is stored in 2 concrete reservoirs as disinfected that can currently supply the whole community through a reticulated gravity system.

The bores are relatively deep at 45 m with secured bore heads and casing. It is not expected that surface water events rapidly reach the groundwater. The creek intake is high up in the terrain where there are no development or animal farming. So the intake catchment is well protected and quite pristine. Furthermore, the creek supply is taken off-line during rain events to ensure water with increased turbidity does not get into the supply system. For these reasons, currently there is no treatment (except disinfection) for the water supply. The water treatment process consists of PH correction and disinfection. Disinfection is done via direct injection of sodium hypochlorite on the upstream side of the storage reservoir (primary disinfection through 2 injection inlets) and one re-dose point on the downstream side when the water is fed to the community. One is the primary disinfection point dosed in the raw water pipe. The other is a re-dose as an additional security measure to maintain residual levels as water leaves the reservoirs. Due to the acidity of the raw water, pH correction is done via a sodium hypochlorite tubes on the downstream side of the reservoir.

There are water meters for residential houses to measure usage. The water reticulation mains extend throughout the main town site supplying all residents and community facilities with treated potable water. In addition there are approximately 24 fire hydrants located around the community.

The infrastructure details and more information on the scheme are provided in the following tables.

Infrastructure details

Sources

Reeves Creek

	Reeves Creek
Type	Weir
% of supply	70
Reliability	The small size of the weir and relatively small size of the creek means that in the dry season (summer 2-3 months) the creek may have an unreliable flow. During this period of no or low flow, the weir supply is shut off.
Intake details	Screened inlet chamber. Fixed level off-take. Raw water flows from the intake weir under gravity through a 225mm diameter PVC pipe.
Source pipeline	Underground for most of the length so not susceptible to damage by vandalism, landslides, falling trees and fire.
Intake pipe age range	Installed in 2008.
Intake protection	Protected through screens from debris, floods damage.
Operation	Gravity fed but flow controlled through an altitude valve which responds to levels in the reservoirs. Currently, the altitude valve is not working and will be repaired (later mentioned in the improvement program). The flow is controlled manually for now.
Water quality issues	Generally good quality water, except when it rains the turbidity becomes high. Low pH which is corrected to control corrosion and aggressively. No issues with algal blooms.

Bore supply

	PB2	**PB3**	**PB5**	**PB6**
Location	Bukki Road			
Aquifer type and area[1]	Consists of alluvial and colluvial (hill wash) sediments, which form a low lying flat valley plain about 7km long and ~3km wide between two ridges of granite. In the center of the valley the sediments may be up to ~120m thick. Semi-confined. Located south east of town, in a low- lying area adjacent to swampland.			
% of supply	7.5 (approx.)	7.5 (approx.)	7.5 (approx.)	7.5 (approx.)
Reliability	Recharge to this system would be via direct infiltration of rainfall with some additional contribution from overland flow and ephemeral creeks draining off the ridges. Assumed that There are no seasonal impacts on groundwater supplies[1]. Satisfactory supply.			
Pump type	Grundfos			
Capacity	25L/s	13.25L/s	25L/s	22L/s
Bore depth (m)	45 (approx.)	45 (approx.)	45 (approx.)	45 (approx.)
Bore head details	Raised above ground, well cased and concrete slab around.			
Casing material	PVC			
Operation	Automatically controlled via SCADA and are switched on and off when level sensors in the reservoir detect low (10%) or high (97%) water levels. 70% level in reservoir – 3 bores are operating; 75% level – 2 bores are operating; 80% level – 1 bore is operating and 97% - bores shut off.			
Water quality issues	Generally good quality water. Low pH which is corrected to control corrosion and aggressivity. Has some low level of natural fluoride and iron, but not to a level of any health concern.			

[1] - Information obtained from Graham Herbert, Principal Project Officer Hydrology, Water Services, Ayr, Queensland Government.

Bore 1 is present but has never been commissioned, while Bore 4a was installed to replace Bore 4 which collapsed and is now defunct. However, bore PB4a is not yet equipped. Bore PB7 use has been discontinued. It is a back-up bore which will be equipped if the demand begins to exert stress on current bores (not currently the case).

Treatment

Name	Yarrabah Water Treatment Plant
Process	Chlorination (to kill harmful bacteria and provide residual disinfection), pH correction (marble chip filter for corrosion control) and fluoridation (for dental health).
Capacity	Flow meter had been installed on June 2015 which assist Yarrabah Aboriginal Shire Council to monitor water production and usage of Water
Chemicals added	Sodium hypochlorite (chlorination) purchased as liquid.
Bypass / variation	The chlorinated water can bypass the marble chip filter (if filter is taken off line due to failure, has never happened), controlled through manual stop valve. Bypassing chlorination is not possible.

Primary Disinfection

Location	At water treatment plant (chlorine shed) prior to reservoirs
Type	Injection
Target residual level	1.5mg/L
Duty / standby	2 pumps
Dosing arrangement	Fixed, done manually at the moment. Will be linked to SCADA to trigger start through bore pumps. Weir supply will remain on manual arrangement. Dosing pump is not overloaded, there is duty/standby as well.
Chlorine storage and turnover	Sodium hypochlorite is purchased as 10% w/v available chlorine. Generally more concentrated solutions (>13%) are instable and can form chlorate. The chlorine containers are stored indoors so that no direct sunlight hits the containers. The chlorine stock usually last for a period of 2 months, and there is always sufficient stock available at hand. High quality chlorine is purchased from Elite Chemicals Company to ensure there are no or minimum impurities.
Alarms	Currently daily testing of chlorine is done.

Re-dose Disinfection

Location	At water treatment plant (chlorine shed) after reservoirs
Type	Injection
Target residual level	1.5mg/L
Duty / standby	1 pump
Dosing arrangement	Fixed. done manually at the moment. Will be linked to SCADA to trigger start through bore pumps. Weir supply will remain on manual arrangement. Dosing pump is not overloaded.
Alarms	Not currently. Currently daily testing of chlorine is done.

Distribution and Reticulation

Reservoirs

Name	Reservoir 1 and Reservoir 2
Capacity	1.1 ML and 3ML
Roofed	Yes
Vermin-proof	Yes
Runoff from roof	Directed away, opening on top has raised lip which is then securely covered.
Cleaning	Annually by Council Water Crew
Filling	Controlled through SCADA (automatic). Low level (10%) and high level (97%)

Pipes

Pipe material(s)	Reticulation includes a 300mm AC main from the chlorination shed to the town plus 150mm, 100mm and 50mm AC, DICL or uPVC.
Age range	Old pipes. Long-term planning is to replace all AC pipes with PVC.
Length of mains	15 km
Issues with dead ends	No
High pressure issues	Yes, causes main breaks
Low pressure issues	No
Flushing	Monthly

Key Stakeholders

Organization	Relevance	How the stakeholder is engaged
Yarrabah community	Consumers or customers	Informed of water quality issues when required through leaflets, letterbox, community notice and radio. Vulnerable customers such as the hospital are informed simultaneously as it is a small community.
Elite Chemical Company (chemical suppliers)	Good quality chemicals, availability and supply of stock	Provider has confidence in chemical supplier as it is a reputable company with good record.
Mareeba pump and irrigation company	Pumps and spare parts	Provider has confidence in supplier as it is a reputable company with good record.
Electricity company	For pumping water from bore fields	Ergon company agreement with Government for essential services.
Office of Water Supply Regulator (OWSR)	Regulator	Consulted during development of DWQMP, water quality incidents reported to OWSR
Council	Overall management, budget and finances	Kept up to date and informed of water operations. Approval for DWQMP.
BAS(Building and Assets Services)	Consumer end plumbing	Responsible for plumbing issues inside households
Queensland Health	Health regulator	Provides advice for drinking water incidents when required.
Kamatzu	For generator servicing	Makers of the generator hence contracted for servicing yearly.
Cairns Regional Council Water Lab	Verification testing	Provides results for verification monitoring. Samples collected and sent to them for analysis.

3. Identify Hazards and Hazardous Events

Water Quality Information

The water quality results for the parameters tested are provided below.

Year	Location	Parameter	Unit	No. of samples	MinValue	MaxValue
2009	Reticulation	pH	pH Units	8	6.2	7.3
2009	Reticulation	Turbidity	NTU	8	0.2	1

Year	Location	Parameter	Unit	No. of samples	MinValue	MaxValue
2010	Reticulation	pH	pH Units	18	6.5	6.9
2010	Reticulation	Turbidity	NTU	9	0.3	1.3
2010	Reticulation	HPC	CFU/100mL	16	1	100

Year	Location	Parameter	Unit	No. of samples	MinValue	MaxValue
2011	Reticulation	pH	pH Units	21	6.2	10.3
2011	Reticulation	Turbidity	NTU	4	0.4	0.6
2011	Reticulation	HPC	CFU/100mL	14	0	110

Year	Location	Parameter	Unit	No. of samples	MinValue	MaxValue
2012	Reticulation	pH	pH Units	33	6.1	7.2
2012	Reticulation	Turbidity	mg/L	11	0.1	0.1
2012	Reticulation	HPC	CFU/100mL	18	1	2

Year	Location	Parameter	Unit	No. of samples	MinValue	MaxValue
2013	Reticulation	pH	pH Units	24	6.2	6.9
2013	Reticulation	Turbidity	mg/L	17	0.1	0.3
2013	Reticulation	HPC	CFU/100mL	24	<1	2

Year	Location	Parameter	Unit	No. of samples	MinValue	MaxValue
2014	Reticulation	pH	pH Units	24	6.3	7.8
2014	Reticulation	Turbidity	mg/L	17	0.1	0.3
2014	Reticulation	HPC	CFU/100mL	24	<1	2

Year	Location	Parameter	Unit	No. of samples	MinValue	MaxValue
2015	Reticulation	pH	pH Units	18*	6.2	7.5
2015	Reticulation	Turbidity	mg/L	18*	0.1	0.2
2015	Reticulation	HPC	CFU/100mL	18*	<1	2

Note: For 2015 the results are for the period January to September

The results show that the treatment process is well managed. The pH range shows that pH is mostly controlled. Detection of low pH is managed as per the operational monitoring section of the Plan. The maximum turbidity value for 2009-2012 was 2.9 NTU, which is acceptable and below the operational limit for Yarrabah and the ADWG aesthetic guideline value at 5 NTU. The heterotrophic plate count is measured to check the cleanliness of the system and aimed to be kept as low as possible. Maximum reached was 300 CFU/100 mL in 2012, but system is flushed monthly to keep this under control.

The *E.coli* incidents are provided below under Incident History. *E. coli* had been tested at monthly intervals previously currently E.coli have been test weekly

Incident History (reported to OWSR)

Date	*Incident Description*
29/07/09	*E. coli* detections at multiple points in the reticulation. Boil Water Alert was issued. Creek was put back into use following sufficient water flow. Free chlorine levels were low. Free chlorine levels increased and *E.coli* testing increased to weekly frequency. Only one chlorine dose point at that time.
15/12/10	*E. coli detected at the Police station. Proper flushing was not done prior to sample collection. Station can be subject to low flow and turnover which dissipates chlorine. One chlorine pump was not working, which was then changed and chlorine residual increased. Longer flushing to be also done. Only one chlorine dose point at that time.*
29/03/12	*E. coli detections at multiple points. Boil Water Alert issued. Fault with chlorine dosing pipe. Pipe replaced and mains flushed. Consecutive sampling showed no E. coli detections. Only one chlorine dose point at that time. Two more dose points were then subsequently installed.*
18/08/15	*Ran out Chlorine Hydroxide 10%, Boil Water Alert issued. Investigation report has sent to DEWS*

SnapshotMonitoring

The Snapshot Monitoring Program is being facilitated by OWSR to assist Providers gather source water quality information to assist in the identification of possible hazards from the catchment.

Yarrabah has taken part in the Program since September 2011 and monitoring weekly the water with the results shown in the tables below. The results indicate that the sources have low pH, <7.0 (not of health concern but is corrected for corrosion prevention).

There are no issues with other trace metals of health concern (such as arsenic, fluoride, manganese); results are significantly below health limit concern. Reeves Creek does show high true color at the time of sampling, but the supply is taken off line during rainy periods.

Snapshot Monitoring Results (September 2011)

Sample Description	Aluminum	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Molybdenum
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	0.2	0.003	0.01	2	0.06	4	0.002	0.05		2	0.3	0.01	0.5	0.05
Bore 5	< 0.003	< 0.0001	0.0006	0.0067	< 0.0001	0.029	< 0.0001	< 0.0001	< 0.0001	0.024	0.097	0.0002	0.022	< 0.0001
Bore 6	< 0.003	< 0.0001	< 0.0003	0.0098	< 0.0001	0.02	< 0.0001	< 0.0001	< 0.0001	< 0.001	0.11	< 0.0001	0.012	< 0.0001
Reeves Creek	0.058	< 0.0001	0.0015	0.0026	< 0.0001	0.018	< 0.0001	< 0.0001	< 0.0001	< 0.001	0.045	< 0.0001	0.0006	< 0.0001
Bore 2	< 0.003	< 0.0001	< 0.0003	0.0074	< 0.0001	0.02	< 0.0001	< 0.0001	< 0.0001	0.016	0.024	0.0002	0.011	< 0.0001

Sample Description	Nickel	Selenium	Silver	Strontium	Thallium	Titanium	Uranium	Vanadium	Zinc	Conductivity	pH	Temperature	Total	Alkalinity
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	uS/cm		Deg C	mg/L as	mg/L CaC
	0.02	**0.01**	**0.1**				**0.017**		3		6.5-8.5			
Bore 5	< 0.0001	< 0.0010	< 0.001	0.039	< 0.0001	< 0.001	< 0.0001	0.0002	0.002	167	6.87	22	27	52
Bore 6	0.0002	< 0.0010	< 0.001	0.017	< 0.0001	< 0.001	< 0.0001	< 0.0001	0.004	125	6.59	22	19	30
Reeves Creek	0.0003	< 0.0010	< 0.001	0.0051	< 0.0001	< 0.001	< 0.0001	< 0.0001	0.003	80	6.84	22	8.2	11
Bore 2	0.0003	< 0.0010	< 0.001	0.014	< 0.0001	< 0.001	< 0.0001	< 0.0001	0.014	101	6.5	22	17	26

Sample Description	Silica	TDS	True Colour	Turbidity	Sodium	Potassium	Calcium	Magnesium	Bicarbonate	Carbonate	Chloride	Fluoride	Nitrate	Sulphate
	mg/L	mg/L	Hazen	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	80	600	15	5	180						250	1.5	50	500
Bore 5	56	144	1	<1	23	3.7	7.6	2	63	0	16	0.34	<0.5	3.8
Bore 6	46	111	5	1	16	3	6	0.9	37	0	15	0.14	<0.5	5.5
Reeves Creek	18	60	29	<1	12	1.6	1.7	1	13	0	15	0.08	<0.5	4.6
Bore 2	43	101	3	1	14	3	5.1	1	31	0	14	0.17	<0.5	4

Customer Services

Customer complaints are lodged to the Council office from where it reaches the Superintendent of Works (SOW). The SOW then contacts the Supervisor Essential Services to inform him of the compliant and for corrective actions. A procedure for recording complaints and resolutions needs to be developed and implemented. This is part of the improvement program.

Catchment Characteristics

Summary Description

Yarrabah is situated in the valley between Mission Beach and Oombunghi Beach, approximately 10km directly east of Cairns, hence is close to the coast. Yarrabah falls in the Mulgrave-Russell Basin (see map below). However, the Reeves Creek catchment is a distinct catchment that drains directly into the Coral Sea.

Basin-wide characteristics

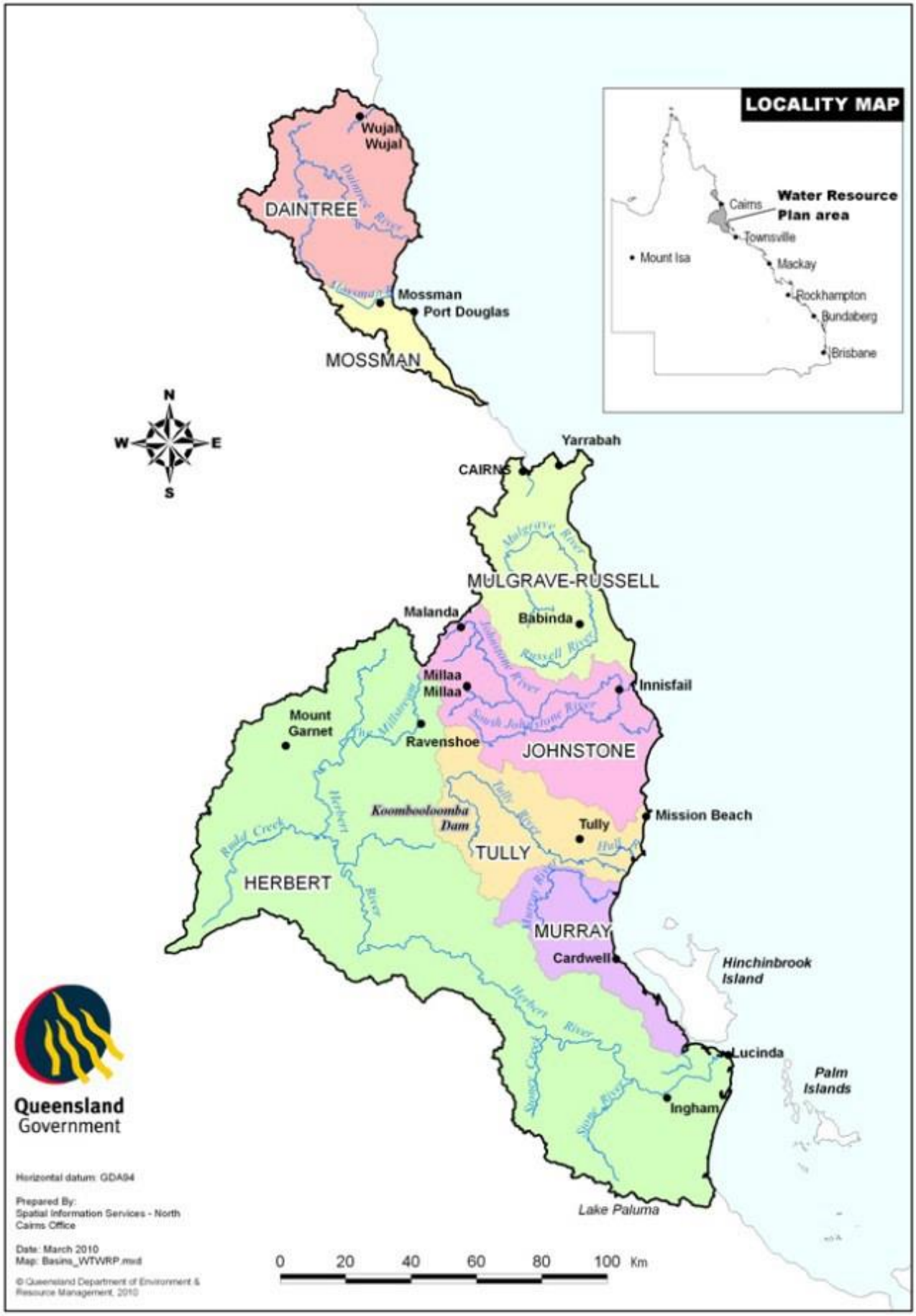
Characteristics	Details
Mulgrave-Russell River Basin area	1,983.97 km^2
Main townships	Cairns CBD and southern suburbs of Cairns, Gordonvale, Babinda and Yarrabah
Major land use and industry across basin	Sugarcane farming and sugar production
Water allocation	As Yarrabah is not in the Cairns Coast sub-artesian area, the Yarrabah Aboriginal Council is not required to hold licenses for its town water supply bores.
Rainfall	Relatively high average annual rainfall across the catchment, with much of the catchment area receiving an average of 4000 mm or more of rain each year.

Yarrabah area is mostly rural with residential houses. There are no farming or industrial processes in the community. The bore holes are relatively isolated from the houses; no houses within a 6 km radius of the bores. The sewage system is reticulated and treated. The sewage treatment plant is located a considerable distance away from any bore site.

The bore heads are all raised about a 1 meter with concrete slab around the bores. All bores are fenced and locked. ND150, a biodegradable pesticide, is sprayed near the fence line to control weeds.

Local catchment area

Characteristics	**Details**
Yarrabah local government area	157.29 km^2 (exact area of Reeves Creek catchment is not known)
Topography	Low lying flat valley plain. The bores are on higher ground than the town area.
Soil type	Alluvial and colluvial sediments.
Incidence of major flooding	Yes, during cyclone Larry (2010) and cyclone Yasi (2011). There was no flooding in the bore areas. Water was present in the water treatment plant, but below level at which dosing pumps are located.
Incidence of major bushfires	No incidences
Land use	Residential rural. Very low level of development across the main aquifer area. The most productive bores are located in area that is under pine forest plantation.
Agriculture, industry, mining, farming	No
Potential sources of microbial and chemical contamination in the catchment	*Bores:* Microbial – brief local pooling. Chemical – No Radiological - not suspected *Reeves Creek:* Microbial – surface run-off. Chemical – No Radiological - not suspected



Map showing the location and spread of the Mulgrave-Russell catchment and Yarrabah.

Hazard Identification and risk assessment team

Name	Position	Expertise and system knowledge
Vincent Schrieber	Essential Services Supervisor	System operator with 11 years of experience. Overall understanding of the water supply, hazards and hazardous events, and operations.
Selina Ansey	Occupational Health and Safety Officer	Experience with risk assessment. With Council for 1 years, previous 4 years risk assessment experience
Stephen Canendo	Environmental Health Officer	Experience with Environmental Health for previous 19 years

Note: Tasleem Hasan (OWSR Senior Project Officer) facilitated a workshop for Yarrabah water staff on 9-10 July 2012 to assist with hazard identification and risk assessment.

4. Assessment of Risk

Methodology

The methodology used for the risk assessment has been adopted from the OWSR Preparing a Drinking Water Quality Management Plan Supporting Information (Sept 2010).

Maximum risk assumes no preventive measures in place (i.e. no treatment is done); and residual risk includes the existing preventive measures.

Likelihood	Descriptors
Rare	Occurs less than or equal to once every 5 years
Unlikely	Occurs more often than once every 5 years and up to once per year
Possible	Occurs more often than once per year and up to once a month (12/yr)
Likely	Occurs more often than once per month (12/yr) and up to once per week (52/yr)
Almost Certain	Occurs more often than once per week (52/yr)

Consequence	Descriptors
Insignificant	Isolated exceedance of aesthetic parameter with little or no disruption to normal operation
Minor	Potential local aesthetic, isolated exceedance of chronic health parameter
Moderate	Potential widespread aesthetic impact or repeated breach of chronic health parameter
Major	Potential acute health impact, no declared outbreak expected
Catastrophic	Potential acute health impact, declared outbreak expected

	Consequence				
	Insignificant	**Minor**	**Moderate**	**Major**	**Catastrophic**
Almost certain	Medium (6)	High (10)	High (15)	Extreme (20)	Extreme (25)
Likely	Medium (5)	Medium (8)	High (12)	High (16)	Extreme (20)
Possible	Low	Medium (6)	Medium (9)	High	High
Unlikely	Low	Low	Medium (6)	Medium (8)	High
Rare	Low	Low	Low	Medium (5)	Medium (6)

Level of Uncertainty	Definition
Certain	There is 5 years of continuous monitoring data, which has been trended and assessed, with at least daily monitoring; or The processes involved are thoroughly understood.
Confident	There is 5 years of continuous monitoring data, which has been collated and assessed, with at least weekly monitoring or for the duration of seasonal events; or There is a good understanding of the processes involved.
Reliable	There is at least a year of continuous monitoring data available, which has been assessed; or There is reasonable understanding of the processes involved.
Estimate	There is limited monitoring data available; or There is limited understanding of the processes involved.
Uncertain	There is limited or no monitoring data available; or The processes are not well understood.

Acceptable Risk

Low residual risks are considered as acceptable risks, and have appropriate control measures to manage the risks for continuous improvement. Medium (and higher) risks have been associated with an Improvement action.

A few low residual risks also have an improvement action where it was decided that the action would strengthen the performance of the existing operational or control measures.

Hazard identification, risk assessment and uncertainty matrices

Catchment and source infrastructure

Bores

Hazard	Hazardous event	Max risk			Existing preventive measures / barriers	Res risk			Uncertainty	Risk management improvement action
		Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level		
Bacteria (harmful)	Local pooling or surface runoff (rainfall) causing ingress of animal faeces	Catastrophic	Possible	High	Borehead is raised above the ground, with concrete slab around bore, 4mx2m (dimension of the fence). Bores are at higher elevation. Chlorination at two points (primary and re-dose).	Minor	Unlikely	Low	Confident	
	Effectiveness of casing	Catastrophic	Possible	High	PVC casing. Concrete cased. Chlorination at two points.	Minor	Unlikely	Low	Confident	
	Borehead design (not raised)	Catastrophic	Possible	High	Borehead is raised above the ground, with concrete slab around bore. Chlorination at two points.	Minor	Unlikely	Low	Confident	
Protozoa (cyrpto and giardia)	Local pooling or surface runoff (rainfall) ingress of animal faeces	Catastrophic	Possible	High	Borehead is raised above the ground, with concrete slab around bore. Bore area fenced with no animals within 100 m radius of bores. Chlorination at two points.	Minor	Unlikely	Low	Reliable	
	Effectiveness of casing	Catastrophic	Possible	High	PVC casing. Concrete cased. Chlorination at two points.	Minor	Unlikely	Low	Reliable	

Hazard	Hazardous event	Max risk			Existing preventive measures / barriers	Res risk			Uncertainty	Risk management improvement action
		Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level		
	Borehead design (not raised)	Catastrophic	Possible	High	Borehead is raised above the ground, with concrete slab around bore. Chlorination at two points.	Minor	Unlikely	Low	Reliable	
Pesticide residues	Spraying around bore fence	Moderate	Possible	Medium	Use of ND150 which is a biodegradable pesticide. Not sprayed during rainy or windy periods. Sprayed only at fence line. Borehead is raised above the ground, with concrete slab around bore.	Minor	Unlikely	Low	Reliable	
Nitrate	Surface runoff (rainfall)	Moderate	Possible	Medium	Sewage is reticulated to treatment plant. No residential houses near bores (bores isolated 6km radius). No use of fertilisers since there is no farming.	Minor	Rare	Low	Reliable	
Fluoride	Natural geology	Moderate	Possible	Medium	Not present at levels of health concern (from snapshot monitoring data). Fluoride dosing done later is managed (discussed later).	Minor	Unlikely	Low	Confident	
Salinity	Over-pumping	Moderate	Possible	Medium	Use of Reeves Creek as major source to manage aquifer sustainably.	Minor	Unlikely	Low	Reliable	

Hazard	Hazardous event	Max risk			Existing preventive measures / barriers	Res risk			Uncertainty	Risk management improvement action
		Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level		
					Bores are run alternatively.					
Iron (aesthetic)	Natural geology	Moderate	Possible	Medium	Not present at levels of concern (from snapshot monitoring data).	Minor	Unlikely	Low	Reliable	
No water	Electrical failure	Moderate	Possible	Medium	Presence of mobile generators to pump water. Reservoir storage able to supply water to consumers for up to 4 days until urgent repairs. Ergon company agreement with Government for essential services.	Minor	Unlikely	Low	Confident	
	Pump failure	Moderate	Possible	Medium	Four bores available. Repairs done as soon as possible in Mareeba. Reservoir storage able to supply water to consumers until urgent repairs.	Minor	Rare	Low	Confident	
Metals of concern (As, Mn)	Natural geology	Minor	Rare	Low	Not naturally present as from snapshot monitoring data.	Minor	Rare	Low	Estimate	Comment: Based on snapshot monitoring data.
Radionuclides	Natural geology	Minor	Rare	Low	Not naturally present.	Minor	Rare	Low	Estimate	Comment: Based on snapshot monitoring data.

Reeves Creek

Hazard	Hazardous event	Max risk			Existing preventive measures / barriers	Res risk			Uncertainty	Risk management improvement action
		Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level		
Bacteria (harmful)	Surface runoff (rainfall) with animal and bird access faeces	Catastrophic	Possible	High	Creek supply is shut down during rainy periods/season. Intake point at high terrain where animals have not been seen. Chlorination at two points (primary and re-dose).	Minor	Unlikely	Low	Confident	Investigate possibility of raw water turbidity testing and setting levels at which supply is ceased with respect to rainfall events.
	Access to people (swimming, faeces)	Catastrophic	Possible	High	There is no swimming allowed at the weir and "no swimming" sign posts are erected for awareness and warning. Penalty is imposed for anyone caught.	Minor	Rare	Low	Confident	
Protozoa (cyrpto and giardia)	Surface runoff with animal and bird access faeces	Catastrophic	Possible	High	Creek supply is shut down during rainy periods/season. Intake point at high terrain where animals have not been seen. Chlorination at two points (primary and re-dose).	Minor	Unlikely	Low	Reliable	
Nitrate	Surface runoff (rainfall)	Moderate	Possible	Medium	Intake point is at high terrain with no activities (housing, farming) close by.	Minor	Rare	Low	Reliable	
Turbidity	Surface runoff, low flow due to intermittent creek. Can shield	Major	Possible	High	Creek supply is shut down during rainy periods/season.	Minor	Unlikely	Low	Reliable	

Hazard	Hazardous event	Max risk			Existing preventive measures / barriers	Res risk			Uncertainty	Risk management improvement action
		Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level		
	bacteria and be an aesthetic issue)				Chlorination at two points (primary and re-dose).					
Cyanobacteria toxins	Algal blooms caused by stratification, eutrophication.	Minor	Possible	Medium	There have not been algal blooms observed historically. Creek supply can be shut down if blooms are observed and only bore supply used.	Insignificant	Rare	Low	Reliable	
No water	Dry months and drought	Moderate	Possible	Medium	Four bores to supply water. PB4a will be commissioned. PB7 drilled as long-term planning for sustainable resource management.	Minor	Unlikely	Low	Confident	Commission PB4a as additional water source.
	Intake screen blockages	Moderate	Possible	Medium	Remove vegetative litter and debris from weir and screen opening monthly.	Minor	Unlikely	Low	Confident	
	Raw water intake pipe break	Moderate	Possible	Medium	Raw water intake pipe PVC and is underground so not susceptible to damage. Reservoir storage able to supply water to consumers until urgent repairs.	Minor	Rare	Low	Confident	
Metals of concern (As, F, Mn)	Natural geology	Minor	Rare	Low	Not naturally present or present at levels of no concern as from snapshot monitoring data.	Minor	Rare	Low	Estimate	Comment: Based on snapshot monitoring data.

Hazard	Hazardous event	Max risk			Existing preventive measures / barriers	Res risk			Uncertainty	Risk management improvement action
		Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level		
Radionuclides	Natural geology	Minor	Rare	Low	Not naturally present.	Minor	Rare	Low	Estimate	Comment: Based on snapshot monitoring data.

Treatment process

Hazard	Hazardous event	Max risk			Existing preventive measures / barriers	Res risk			Uncertainty	Risk management improvement plan
		Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level		
Fluoridation										
Fluoride	Over dose	Moderate	Possible	Medium	In-line fluoride analyser showing concentration which is used to manage dose rate daily. In-line analyser calibrated daily. Dose pump sizing to reduce potential for overdosing.	Minor	Unlikely	Low	Reliable	
	Under dose	Insignificant	Possible	Low	In-line fluoride analyser showing concentration which is used to manage dose rate daily. In-line analyser calibrated daily.	Insignificant	Unlikely	Low	Reliable	
	Dose pump failure so no dose	Insignificant	Possible	Low	Dosing pump is checked daily to ensure it is working.	Insignificant	Unlikely	Low	Reliable	
	No fluoride chemical	Insignificant	Possible	Low	Chemical stock is checked daily to ensure there is sufficient stock.	Insignificant	Unlikely	Low	Reliable	
pH correction (marble chip)										
pH (for corrosion control)	Marble chips not added (re-stocked) in the tanks	Minor	Possible	Medium	Monthly pH testing done and results used to add more marble chips.	Minor	Unlikely	Low	Reliable	

Hazard	Hazardous event	Max risk			Existing preventive measures / barriers	Res risk			Uncertainty	Risk management improvement plan
		Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level		
					Visual inspection done weekly to determine need for adding marble chips (if chips have become small and weathered).					
	Equipment failure	Minor	Possible	Medium	Equipment is visually checked daily and maintained.	Minor	Unlikely	Low	Reliable	

Disinfection process

Hazard	Hazardous event	Max risk			Existing preventive measures / barriers	Res risk			Uncertainty	Risk management improvement plan
		Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level		
Primary dose point										
Chlorine	Over dosing	Moderate	Possible	Medium	Free chlorine is tested daily by the operations staff and dose re-adjusted as needed.	Minor	Unlikely	Low	Confident	
Bacteria (harmful)	Under dose of chlorine / no chlorine caused by pipe burst (injector line) and equipment breakdown. High turbidity	Catastrophic	Possible	High	3 pumps available. Daily chlorine testing results. Visual checks by operators and manual adjustments. One re-dose point further downstream.	Moderate	Unlikely	Medium	Confident	Connect pumps to SCADA to control operation.
	Insufficient contact time	Major	Possible	High	Sufficient mixing and contact time available through presence of 2 reservoirs. > 30 minutes before water reaches first customer. Re-dose done.	Minor	Unlikely	Low	Confident	

Hazard	Hazardous event	Max risk			Existing preventive measures / barriers	Res risk			Uncertainty	Risk management improvement plan
		Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level		
Disinfection by-products (THM)	High organic content in creek supply.	Moderate	Possible	Medium	Remove vegetative litter and debris from weir monthly. Supply shut down during rainy periods.	Moderate	Possible	Medium	Estimate	Investigate possibility for periodical testing of THM to re-assess risk level.
Chlorate	Chlorine stock storage and turnover	Moderate	Possible	Medium	Sodium hypochlorite is purchased as 10% w/v available chlorine. The chlorine containers are stored indoors so that no direct sunlight hits the containers. High quality chlorine is purchased from Elite Chemicals to ensure there are no or minimum impurities.	Minor	Unlikely	Low	Estimate	Comment: Action to reduce chlorate is being done to the best possible and practical means. It is realised that disinfection should not be compromised, as non-disinfected water poses significantly greater risk than chlorate.

Reservoirs

Hazard	Hazardous event	Max risk			Existing preventive measures / barriers	Res risk			Uncertainty	Risk management improvement plan
		Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level		
Bacteria (harmful)	No cover / not vermin proofed (overflow pipes)	Major	Possible	High	Well covered and sealed.	Minor	Unlikely	Low	Confident	
	Seepage through roof cover	Major	Possible	High	Roof runoff directed away.	Minor	Unlikely	Low	Confident	
	Reservoir condition and integrity (cracks) enabling ingress	Major	Possible	High	Reservoirs in very good condition.	Minor	Rare	Low	Confident	
	Low turnover, long detention	Major	Possible	High	Chlorine re-dose point downstream.	Minor	Unlikely	Low	Confident	
Turbidity (can lead to bacterial shielding from chlorine)	No periodic cleaning (sludge layer) / High chlorine demand	Major	Possible	High	Reservoirs are cleaned thoroughly yearly. Chlorine re-dose at reservoir outlet.	Minor	Unlikely	Low	Confident	
No water	No or low water in reservoirs	Moderate	Possible	Medium	SCADA controlled and alarmed to enable filling at low levels.	Minor	Rare	Low	Confident	

Reticulation

Hazard	Hazardous event	Max risk			Existing preventive measures / barriers	Res risk			Uncertainty	Risk management improvement plan
		Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level		
Bacteria (harmful)	Pipe breaks / main breaks (age, pressure)	Major	Possible	High	Reactive maintenance.	Minor	Possible	Medium	Reliable	Change AC pipes to PVC.
	Low or negative pressure / backflows	Major	Possible	High	System is always pressurised (no history of issues).	Minor	Rare	Low	Confident	
	Dead end storages, long detention	Major	Possible	High	No dead end issues. Monthly flushing of system.	Minor	Unlikely	Low	Confident	
Turbidity	Pipe breaks / main breaks (age, pressure)	Moderate	Possible	Medium	Reactive maintenance.	Minor	Possible	Medium	Reliable	Change AC pipes to PVC.
Metals – (leaching due to low pH)	Leaching from joints/solders – households	Moderate	Possible	Medium	pH correction. Monthly pH tests to guide corrective actions.	Minor	Unlikely	Low	Confident	
No water	Pipe breaks / main breaks (age, pressure)	Moderate	Possible	Medium	Reactive maintenance.	Minor	Possible	Medium	Reliable	Change AC pipes to PVC.

Whole of Service

Hazard & Hazardous event	Max risk			Existing preventive measures / barriers	Res risk			Uncertainty	Risk management improvement plan
	Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level		
Bad or poor chemical (chlorine) quality - ineffective disinfection leading to presence of harmful bacteria	Major	Rare	Medium	Chemical purchased from reputable company in Cairns, with good record. Provider has confidence in chemical supplier.	Insignificant	Rare	Low	Almost certain	
No chemical - no disinfection leading to presence of harmful bacteria	Major	Rare	Medium	Visual checks for stock at hand guiding the ordering.	Insignificant	Rare	Low	Confident	
Untrained staff (formally) - no or poor water treatment leading to presence of harmful bacteria and water of poor aesthetic quality	Catastrophic	Possible	High	On the job training. Experience. Supervision and guidance by Manager.	Minor	Possible	Medium	Confident	Investigate possible opportunity for formal training for existing staff.
Water quality data storage and summary	Moderate	Possible	Medium	Data is recorded in paper and filed. Electronic copy received from Cairns laboratory and filed.	Minor	Possible	Medium	Confident	Investigate possibility of having an administrative assistant for data recording and storing in electronic format.
Vandalism and terrorism - introduction of harmful bacteria or toxic chemicals	Major	Rare	Medium	Well fenced and secured bores and treatment plant facility. Visual checks by operators. .	Minor	Rare	Low	Confident	
Electricity shut down - no water and treatment process. Flooding causing no electricity.	Moderate	Rare	Low	Mobile generators present and maintained. Ergon company agreement with Government for essential services. 2 large reservoirs providing relief for short term.	Minor	Rare	Low	Confident	
Staff safety (chemical handling) - injured staff or absent staff leading to poor operation of plant and	Major	Rare	Medium	Safety equipment (PPE) used by staff. Safety	Minor	Rare	Low	Confident	

Hazard & Hazardous event	Max risk			Existing preventive measures / barriers	Res risk			Uncertainty	Risk management improvement plan
	Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level		
treatment processes causing presence of harmful bacteria, water of poor aesthetic quality and no water.				documentation. On the job training. Staff experience.					
Lack of transport availability to conduct operational checks and water quality sampling	Moderate	Possible	Medium	One vehicle available for water operations staff.	Minor	Possible	Medium	Confident	Investigate possibility of having at least 2 dedicated vehicles for use by Essential Services team.
Inability to control SCADA operations and to receive fault alarms remotely (away from work machine)	Moderate	Possible	Medium	SCADA control on work machine.	Moderate	Possible	Medium	Confident	Essential Services Supervisor needs a laptop with SCADA installed for remote operations.

5. Managing Risks

Risk Management Improvement Program

The risk management improvement actions from the hazard identification and risk assessment matrices have been reproduced below to formulate a risk management improvement program.

The priority level has been classified as low (3), medium (2) or high (1). High priority has been assigned to a hazard that can have immediate impact on public health (so basically harmful bacteria). High priority items will be addressed as soon as possible.

Low priority has been assigned to infrastructure improvements that would not impact public health in relatively short term, and budget for which will have to be negotiated. Medium priority has been given to operational improvements that will optimize the system performance.

Catchment and source infrastructure

Hazard	Hazardous event	Risk management improvement action	Priority	Timeframe	Status	Responsibility
No water	Dry months and drought	Commission PB4a as additional water source.	2	June 2013	Completed	Essential Services
Bacteria (harmful)	Surface run-off	Investigate possibility of raw water turbidity testing and setting levels at which supply is ceased with respect to rainfall events.	1	June 2013	Completed	Essential Services Supervisor

Disinfection process

Hazard	Hazardous event	Risk management improvement	Priority	Timeframe	Status	Responsibility
Bacteria (harmful)	Under dose of chlorine / no chlorine caused by pipe burst (injector line) and equipment breakdown. High turbidity	Connect pumps to SCADA to control operation.	1	Dec 2012	Completed	Essential Services Supervisor
Disinfection by-products (THM)	High organic content in creek supply.	Investigate possibility for periodical testing of THM to re-assess	2	Dec 2012	Completed	Essential Services Supervisor

Reticulation and Distribution

Hazard	Hazardous event	Risk management improvement action	Priority	Timeframe	Status	Responsibility
Bacteria (harmful) Turbidity No Water	Pipe breaks / main breaks (age, pressure)	Change AC pipes to PVC. through to town Reticulation System	3	Dec 2014	Completed	SOW

Whole of Service

Hazard and Hazardous event	Risk management improvement action	Priority	Timeframe	Status	Responsibility
Untrained staff (formally)	Investigate possible opportunity for formal training for existing staff.	1	Dec 2012	Completed	CEO
Information management – data storage	Investigate possibility of having an administrative assistant for data recording and storing in electronic format.	2	June 2013	Completed	CEO
Lack of transport availability	Investigate possibility of having at least 2 dedicated vehicles for use by Essential Services team.	2	June 2013	completed	CEO
Inability to control SCADA operations remotely	Essential Services Supervisor needs a laptop with SCADA installed for remote operations.	1	Dec 2012	Completed	CEO
Lack of means to determine plant production (capacity)	Install flow meters at the water treatment plant	2	June 2013	completed	CEO and SOW
No proper documented procedures for customer services	Develop and maintain a proper complaints register (complaints and resolution)	2	June 2013	Completed	SOW
Lack of written operating procedures	Development of written operating procedures as identified in the operation and maintenance procedures section.	2	Dec 2014	Completed	Essential Services Supervisor and Occupational Health and Safety Officer

[SWO – Superintendent of Works; CEO – Chief Executive Officer]

Note: For the development of standard operating procedures the timeframe indicates by when all SOPs will be developed. However, OWSR will be informed during annual reporting of SOPs which are developed towards the completion of the Improvement Plan action.

Following Training implemented to the water crew team:

Certification	Number of Persons	Year
Certification III	2	2014
Certification II	3	2014

Operation and maintenance procedures

The following table provides the list of documented procedures used by the Yarrabah Provider.

Procedure	Version date	Comments
Operations and maintenance procedures, including reticulation mains, reservoirs, weir, water sampling transportation, completion of checklists (daily and weekly; monthly and yearly).	June 2002	Has not been revised
Operations and Maintenance manual – fluoride dosing plant	28/01/2012	New
Fluoride operating instructions and log sheets	28/01/2012	New

The Essential Services Supervisor is responsible for informing the SWO on revision requirements, the procedures are changed on June 2013. Currently, the June 2002 version of the operations and maintenance procedures is up-to-date with current work practices and hence has not been scheduled for revision.

The operations and maintenance procedures, checklists and log sheets are accessible by all operational staff. Hard copies are available for recording and filing in the Essential Services Supervisor's office.

The procedures yet to be written or documented include (improvement program item):

- Chlorine dosing
- Marble chip filter replaced with Sodium Hydroxide ,PH correction
- Flushing of mains (dead ends) and reservoirs
- Cleaning of reservoirs
- Repair of mains/pipes for leaks and breakages
- Water sampling and in-house testing
- Response to customer complaints
- SCADA operational philosophy

Process for implementing the procedures

Ensuring that operational procedures are carried out appropriately is the responsibility of the operators and the Essential Services Supervisor. Staff members are trained in procedures relevant to their role through induction and on the job training and guidance by the Essential Services Supervisor.

It the responsibility of the Essential Services Supervisor to ensure that the procedures are understood and implemented by operational staff. To ensure staff understand and adhere to procedures, the Essential Services Supervisor undertakes visits to inspect work daily. The site inspections are done to check and ensure that procedures are been followed and to identify any emerging issues.

Management of incidents and emergencies

The process for managing drinking water incidents and emergencies are described in the tables below. The first table provides the overview (alert level, description, key response and positions responsible). The second table gives the summary of actions and procedures.

All level 1 and 2 alerts are notified to the Essential Services Supervisor, who remains on call by mobile phone and Council Phone Number on 07 4056 9120 / 0448 025 218/ 0447 744 264 The water staff has received on the job training on incident and emergency response protocols in order to operate as required, with overall supervision and management provided by the Essential Services Supervisor.

Management of Incident and Emergency Levels – Overview

Alert Level	Description	Key management response(s)	Position(s) responsible
Level 3: Emergency	• outbreak of waterborne disease • declared disaster or emergency situation by the Council or state/national government *Requires coordination across the Council departments and is likely to require external resourcing and support from agencies, such as Office of the Water Supply Regulator, Queensland Health, local disaster management groups, emergency responders QFRS, Police*	Activate Council disaster management plan *Refer to summary of actions and procedures*	CEO. SOW and Essential Services Supervisor part of the team.
Level 2: Incident	• non-compliance (typically against the ADWG values) • event (anything that has happened or is likely to happen, in relation to a drinking water service that may have an adverse effect on public health). Examples include natural disaster (flood, drought), bushfire, inability to operate system within acceptable operational limits, contamination of source water, contamination of treated water, terrorism. *Incident is managed within the team responsible for drinking water operations and management in line with the Yarrabah DWQM Plan. In some cases, it may require coordination across the Council departments and external resources and support, such as from OWSR, Queensland Health.*	Activate drinking water incident response and reporting protocols. Ensure all control measures identified in the DWQM Plan are functioning effectively. Disaster management plan on standby. *Refer to summary of actions and procedures*	Essential Service Supervisor through the Superintendent of Works.
Level 1: Operational exceedance	• Exceedances of operational limits (as per the operational monitoring section of the Plan). *Incident is managed within the water operations team. An incident is not declared and the issue can be managed in line with the DWQM Plan.*	Ensure all operational steps identified in the DWQM Plan are functioning effectively. Check and act upon operations records. Incident response and reporting protocols on standby. *Refer to summary of actions and procedures*	Operational staff under supervision from Essential Services Supervisor

Management of Incident and Emergency Levels – Summary of Actions and Procedures

Alert Level	Key management response(s)	Brief summary of actions	Documented Plans & Procedures
Level 3: Emergency	Activate disaster management plan	• CEO to notify Council and assemble team • Coordinate notification, investigation and response of water related aspects • Consider what community notification / messaging is needed (e.g. do not drink alert, boil water alert or bottled/emergency water distribution) • Coordinate community messaging, for e.g. boil water alert, do not drink alert as required • Notify OWSR as soon as practicable	Disaster management plan, including communications protocols.
Level 2: Incidents	Activate drinking water incident response and reporting protocols. Ensure all control measures identified in the DWQM Plan are functioning effectively. Disaster management plan on standby.	• Essential Services Supervisor to advice the Superintendent of Works. • Report incident to OWSR within the required timeframe • Ensure all control measures identified in the DWQM Plan are functioning effectively. • Commence investigation to determine cause if not traceable through the DWQM Plan • Arrange for re-samples to be taken where required • Instigate immediate remediation actions, including isolation of affected area where possible • Review associated laboratory reports and operational records. • In case of customer complaints, coordinate investigation and resolution, including obtaining water samples where required • Disaster management plan is on standby if the need arises.	Incident response and reporting protocols (i.e. OWSR Water Quality and Reporting Guideline). Yarrabah DWQM Plan.
Level 1: Operational exceedence	Ensure all operational steps identified in the DWQM Plan are functioning effectively. Check and act upon operations and maintenance records. Incident response and reporting protocols on standby.	• Operations staff to notify Essential Services Supervisor. • Review operations and maintenance records for anomalies • Commence investigation to determine cause, if not identifiable through operational records • Instigate immediate remediation actions • Ensure all control measures identified in the DWQM Plan are functioning effectively. • Increase operational monitoring frequency where required • Ensure incident response and reporting protocols are on standby if the need arises.	Operations and maintenance procedures (these are not documented so are part of the Improvement Plan). Yarrabah DWQM Plan.

Service Wide Support – Information Management Water

Quality Information

The water quality data from the Cairns laboratory are received electronically in their laboratory reporting format and stored electronically in the SOW's computer and also as hard copies. The operational monitoring data are recorded on log sheets and filed in the Essential Services Supervisor's office.

5 year old data are archived through Council system. The collation and storing of verification monitoring data will be improved (electronically) for ease of access, decision making and annual summary of water quality reporting requirements for OWSR (part of improvement program).

Process for incident reporting

The incident response and reporting protocols (mentioned earlier under the management of incident and emergencies section) have been adopted from the OWSR Drinking Water Service Provider Monitoring and Reporting Requirement guidelines.

This is summarized as below:

Incident	**Reporting requirements (to OWSR)**
Detection of *E. coli*, detection of a pathogen, failure to meet ADWG health guideline values	By telephone within 3 hours of receipt of test results
Radiological (exceed levels described in the notice)	By telephone within 3 hours of receipt of test results
Parameters with no ADWG guideline value	Written confirmation within 24 hours
An event likely to affect water quality	By telephone as soon as practicable

6. Operational and Verification Monitoring

Operational Monitoring

The operational monitoring for Yarrabah contains a planned sequence of measurements and observations to ensure that the system is operating within the set performance limits and the process elements are controlled.

The process step where testing is done, the parameter tested and the logic for testing the parameter is stated below:

Water treatment plant (chlorine shed):

- Free chlorine – ensure sufficient free chlorine is maintained in the system, check chlorine levels to guide re-dose rate, ensure that chlorinator is working properly, ensure reservoir is not causing high chlorine demand
- pH - ensure that the marble chip system is working properly for pH correction. Monthly test is sufficient as pH is not a parameter of health concern and the raw water is not excessively acidic.
- E.coli- by weekly check to ensure that the system is working properly .

Reticulation network (Jilgi, Djenghi, Aged hostel, police station, Council office, state school, workshop street):

- Free chlorine – ensure sufficient free chlorine is maintained in the system.

In-line fluoride analyzer:

- Fluoride - ensure that the dosing is working properly and dosing as required.

The sampling locations with their GPS coordinates are listed below:

LAT	LONG	Sampling locations
-16.97823500	145.90146200	Jillgi
-16.94451400	145.88696300	Djenghi
-16.93007300	145.87621100	Aged Hostel
-16.92250300	145.87341100	Chlorine shed
-16.92151000	145.87220200	Police station
-16.91179700	145.86970400	Council Office
-16.90595900	145.86460700	State School
-16.90975400	145.87617600	Workshop Street

The table below summarizes the operational monitoring, with target and critical limits and how excursions are managed.

Process step / location in system	Parameter	Associated hazard	Sampling			Target limit	Action if target limit is not met	Critical limit	Action if critical limit is exceeded
			Frequency	Method	Analysis				
Water treatment plant	Free chlorine (and total chlorine)	Harmful bacteria	Daily	Palin Test	In-house	1.5mg/L	Re-adjust the dose rate (primary). Check chemical container.	<0.1mg/L, >5mg/L	Re-adjust the dose rate at plant. Check chemical container. Ensure free chlorine level is within target range. If >5mg/L then flush system and report to OWSR.
	pH	Optimum pH	Monthly	Palin Test	In-house	6.5-8.0	Check operations of the marble chip.	NA	
Reticulation points	Free chlorine (and total chlorine)	Harmful bacteria	Daily	Palin Test	In-house	1.5 mg/L at the network extremities (Jillgi – southern; State school – northern and Workshop street – Eastern).	Re-adjust the dose rate (re-dose). Check chemical container.	<0.1mg/L, >5mg/L	Re-adjust the dose rate at the re-dose point. Check chemical container. Ensure free chlorine level is within target range. If >5mg/L then flush system and report to OWSR.

Visual Checks, Observations and Inspections:

Visual inspections and checks (observations) are also conducted as part of the operational monitoring to ensure that preventive measures function as required and that total reliance is not only on water quality testing.

The visual checks and inspections done include:

- Fence integrity around bores - weekly by operations team.
- All chlorinators and fluoride dosing pumps are working properly - daily by operations team.
- Reservoir levels – visual only when power outage (not able to view SCADA)
- Bore pumps - weekly by operations team

Operational monitoring	**Frequency**
Weir	
Remove vegetative litter and debris from weir	Monthly
Check structural integrity (report concerns to Supervisor immediately)	Monthly
Bores	
Check bore operations	Daily
General site maintenance and fence integrity check	Monthly
Inspection and testing of switchboards (by electrician)	Monthly
Treatment Plant and reservoirs	
Check chlorinator and chlorine stock	Daily
General site maintenance, ensure site is secure and fences maintained.	Monthly
Inspection of reservoirs for leaks, overflow or vandalism	Monthly
Clean out reservoirs, service float sensors, repair any corrosion	Yearly
Inspection and testing of switchboards (by electrician)	Monthly
Reticulation	
Check for leaks	Daily (drive by)

SCADA System:

The SCADA system assists with operational monitoring. It sends a message (alarm) on the Essential Services Supervisor's computer on failures around bore pumps, fluoride dosing pump and reservoir levels. These also guide corrective actions in "real time".

Verification Monitoring (Reportable to OWSR)

The verification monitoring for Yarrabah is used to confirm that safe water is delivered to customers in compliance with the ADWG and Public Health Act. The verification monitoring also verifies that the preventive measures stated in the DWQMP are functioning effectively.

The parameter tested and the logic for testing the parameter is stated below:

- *E. coli* - indicator for recent faecal contamination (harmful bacteria) and treatment efficiency.
- Heterotrophic plate counts - indicates system cleanliness, post treatment ingress or presence/formation of biofilms.
- pH - for corrosion control
- Turbidity - aesthetic and chlorine demand, pipe breaks/leaks.
- Fluoride - verification for in-line analyser.

The table below summarises the verification monitoring, with target and critical limits and how excursions are managed.

Parameter	ADWG or regulation value	Associated Hazard	Frequency	Analysing authority	Response to exceedances
			Reticulation network (areas as identified earlier)		
E. coli	< 1 cfu/100mL	Bacteria (harmful)	Weekly	Cairns Regional Council Water Lab – NATA accredited	Report to OWSR. Re-sample. Investigate cause and rectify. Adjust chlorine dose rate at all points.
Heterotrophic plate counts (HPC)	NA	System cleanliness, post treatment ingress, biofilms	Monthly	Cairns Regional Council Water Lab – NATA accredited	Aimed to be kept as low as possible. Investigate cause and rectify. Adjust chlorine dose rate at all points.
pH	6.5-8.0 (not of health concern)	Corrosion	Weekly	Cairns Regional Council Water Lab – NATA accredited	Re-sample using in-house kit. Check marble filter operations. Investigate cause and rectify.
Turbidity	5 NTU (not of health concern)	Aesthetic, chlorine demand	Monthly	Cairns Regional Council Water Lab – NATA accredited	Re-sample using in-house kit. Check system integrity and for any ingress. Investigate cause and rectify.
Fluoride	1.5 mg/L	Fluoride	Monthly	Cairns Regional Council Water Lab – NATA accredited	Report to OWSR. Re-sample. Investigate cause and rectify. Calibrate in-line analyser and adjust fluoride dose rate.

Water Sampling and Result Analysis

All operational monitoring is done by the operations team in-house using the Palin test (chlorine and turbidity) and TPS WP 91 meter (pH). The in-house equipment is checked for calibration by the operations staff and sent for servicing into Cairns (when alarm for servicing shows up on the equipment).

The verification monitoring is also done by operations team. The samples for *E. coli* testing, HPC, pH, turbidity are collected and tested in-house by ESO's crew in Yarrabah and also collected monthly and transported to the Cairns laboratory in eskys.

The operations team act upon the operational monitoring parameters as described above (action if critical limit is exceeded). The Essential Services Supervisor assesses and analyses the water quality results as they become available, while keeping an overview of all monitoring and excursions.

Operations staffs have received on the job training on proper sampling, analysis and testing procedures by the Essential Services Supervisor. Written procedures around these will be developed and have been stated in the Improvement Program.