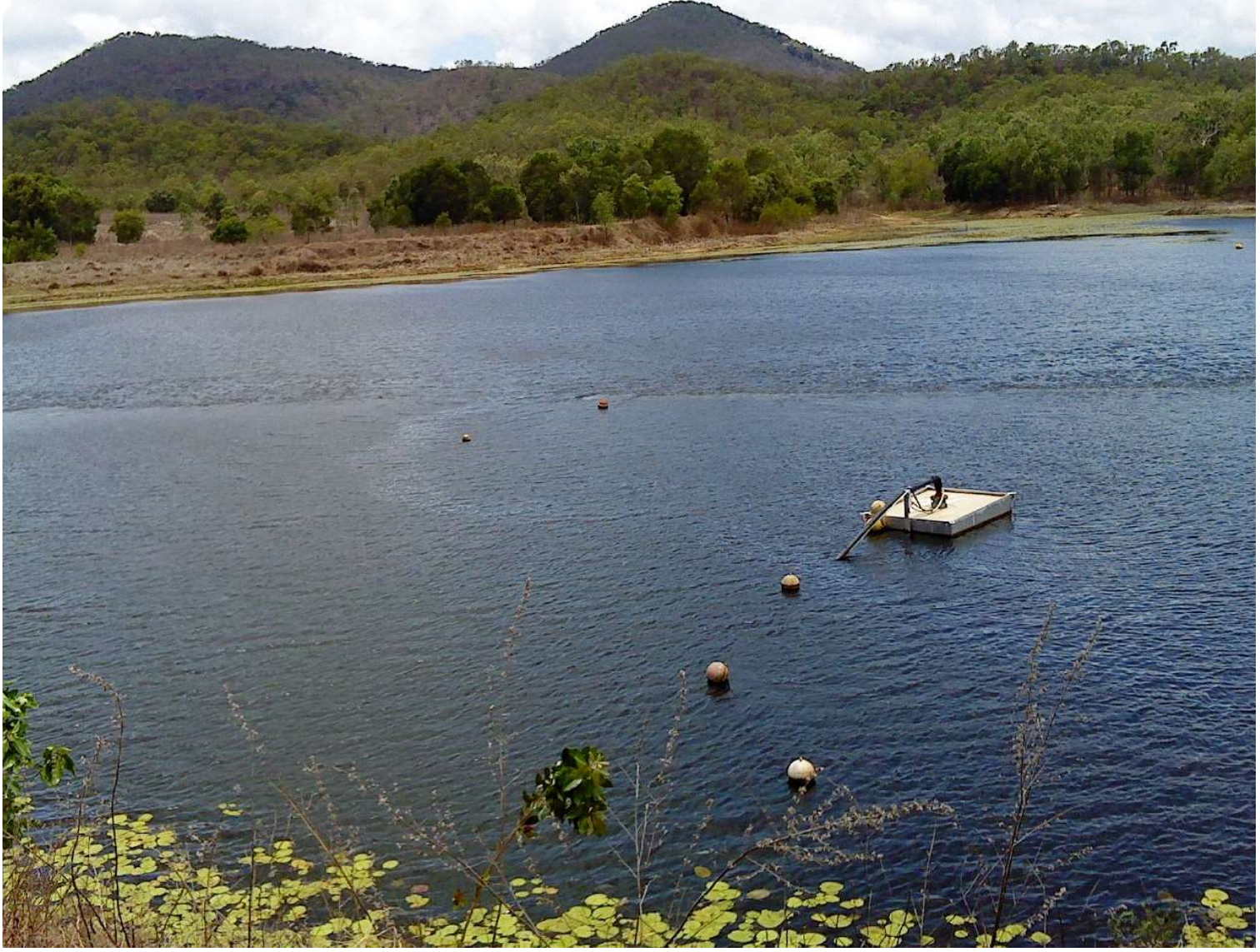

Cook Shire COUNCIL

Coen

Drinking Water Quality Management Plan

+ DOCUMENT CONTROL SHEET

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VERSION	AUTHOR	REVIEWED	APPROVED	DATE
V4	Dr Michael Lawrence (Bligh Tanner)	Robert Fenn		29 March 2016
V4.1	Dr Michael Lawrence	Robert Fenn	Robert Uebergang	15 April 2016
V4.2	Reviewed by Dr Robyn Maddalena	Les Treloar/Wal Welsh	Robert Uebergang	23 April 2018
V4.3	Reviewed by Dr Robyn Maddalena	Wal Welsh/Cath Hocking	David Klye	10 December 2019
V4.4	Reviewed by Dr Robyn Maddalena	Wal Welsh/Cath Hocking	David Klye	31 March 2020
V4.5	Reviewed by Dr Robyn Maddalena	Wal Welsh/Cath Hocking	David Klye	31 January 2021
V5	Reviewed by Dr Robyn Maddalena	Wal Welsh/Cath Hocking	Peter Tonkes	1 June 2022

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+ GLOSSARY

Term	Definition
ADWG	Australian Drinking Water Guidelines 2011
CSC	Cook Shire Council
DWDMW	Department of Regional Development, Manufacturing and Water
DWQMP	Drinking Water Quality Management Plan
PHR	Public Health Regulation 2005
RMIP	Risk Management Improvement Program
QH	Department of Health Queensland
WSR	Water Supply Regulation
WS(SR)A	Water Supply (Safety and Reliability) Act 2010

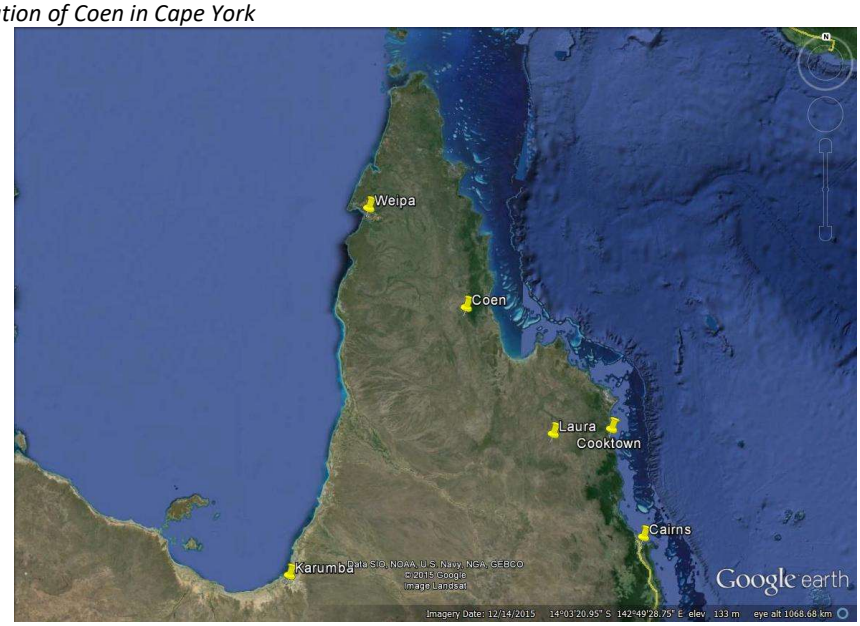
1 COEN

1.1 Overview

Coen is a small (~328 people) and very remote and isolated community in Cape York, approximately 400 km from Cooktown, and 250 km from Weipa on the unsealed Peninsula Development Road. This road is the main road route into the mining areas around Weipa. Despite its small size, Coen is a service centre for many other smaller communities in the Cape. However, due to the remoteness of Coen, and the proximity to major mining areas, few people with skills and qualifications remain in Coen, with the result that even minor breakdowns can be difficult to rectify. We therefore have a high reliance on the skills of the WTP operators to undertake preventive maintenance, and to identify and rectify faults promptly.

The community of ~250 will to grow over the next 10 years to approximately 305, with a corresponding increase in water demand from the current 0.3 ML/day to 0.35 ML/day.

Figure 1 Location of Coen in Cape York



Climate: Coen has a distinct wet and dry season and is isolated during the wet season. As a result, it is self-sufficient. The airport remains open most of the time and is accessible unless the Coen River is in flood. Due to this, the water treatment plant maintains critical spares on site, and stores sufficient water treatment chemicals from November/ December to last for ~4-5 months.

Table 1. Coen Rainfall Statistics (Coen Mission Strip, BOM, 1942 – 2018)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	306.4	373.6	387.8	162.2	63.9	37.2	29.5	19.9	15.0	26.9	71.8	183.8	1684.2
Lowest	27.0	28.8	61.8	7.2	1.6	0.0	2.6	0.0	0.0	0.0	2.2	13.6	732.5
5th %ile	81.1	84.2	95.1	17.7	10.6	3.0	4.4	1.1	0.5	0.6	4.6	14.3	965.3
10th %ile	93.6	151.0	110.2	36.4	14.0	8.8	6.1	2.2	1.1	1.3	5.3	20.3	1218.0
Median	259.4	363.8	299.6	102.6	38.0	29.6	30.4	12.1	8.4	12.3	40.5	144.6	1658.6
90th %ile	545.8	614.3	796.0	429.9	104.3	82.2	58.6	38.7	39.5	61.0	174.8	410.0	2373.6
95th %ile	578.5	634.9	937.7	468.9	235.6	99.5	65.6	62.3	40.6	95.4	226.7	478.4	2408.4
Highest	720.0	866.4	995.4	560.6	299.4	109.3	73.4	83.0	51.2	197.2	479.6	615.0	2560.9

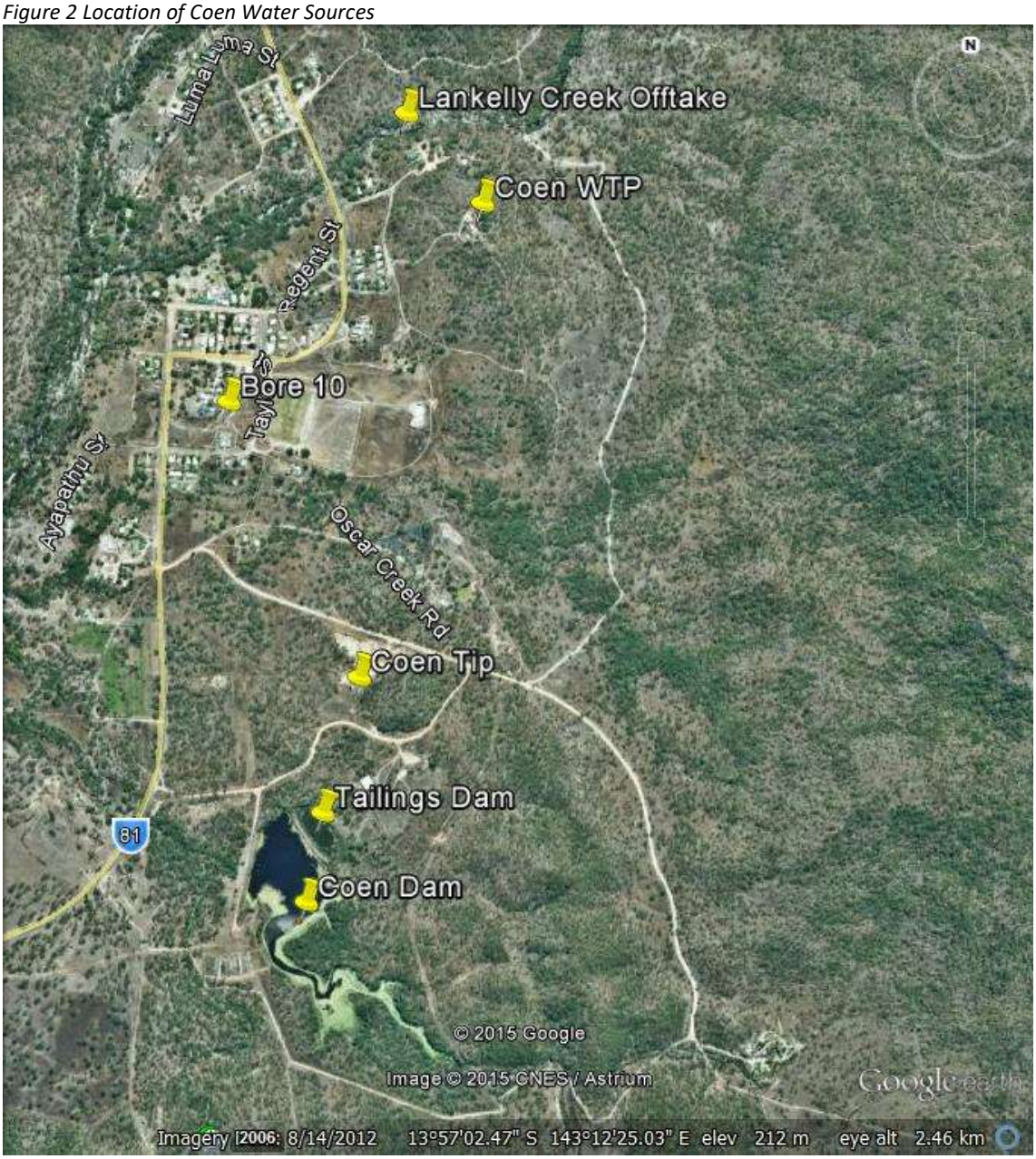
Table 2. Coen Rainfall Statistics (Coen Airport, BOM, 2000 – 2022)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	311.3	321.9	380.5	158.3	49.8	35.6	21.1	14.8	8.9	23.9	62.2	170.7	1546.5
Lowest	95.4	25.8	99.2	14.6	12.0	0.6	1.2	0.4	0.0	0.0	0.6	12.4	578.8
5th %ile	109.4	78.9	99.6	15.6	12.8	2.2	4.2	1.6	0.6	0.9	4.1	13.0	815.3
10th %ile	118.2	98.6	137.6	42.4	14.2	8.2	7.0	2.1	1.0	1.8	5.5	14.3	945.4
Median	241.4	295.3	331.0	94.8	33.2	22.4	15.0	11.2	6.2	16.0	44.5	84.1	1569.1
90th %ile	497.0	522.2	722.4	404.2	97.4	100.6	41.5	24.8	21.0	44.6	152.8	340.5	2224.9
95th %ile	579.2	543.2	901.6	410.6	137.8	102.4	43.7	34.7	24.8	85.8	156.1	398.0	2262.2
Highest	606.0	831.8	915.0	436.2	267.8	105.6	54.4	69.8	36.6	98.0	316.4	817.6	2273.8

1.2 Water Sources

Coen has three water sources that supply the town's requirements. These include, in order of preference of use, the Lankelly Creek, Coen Dam, and the Coen bore fields.

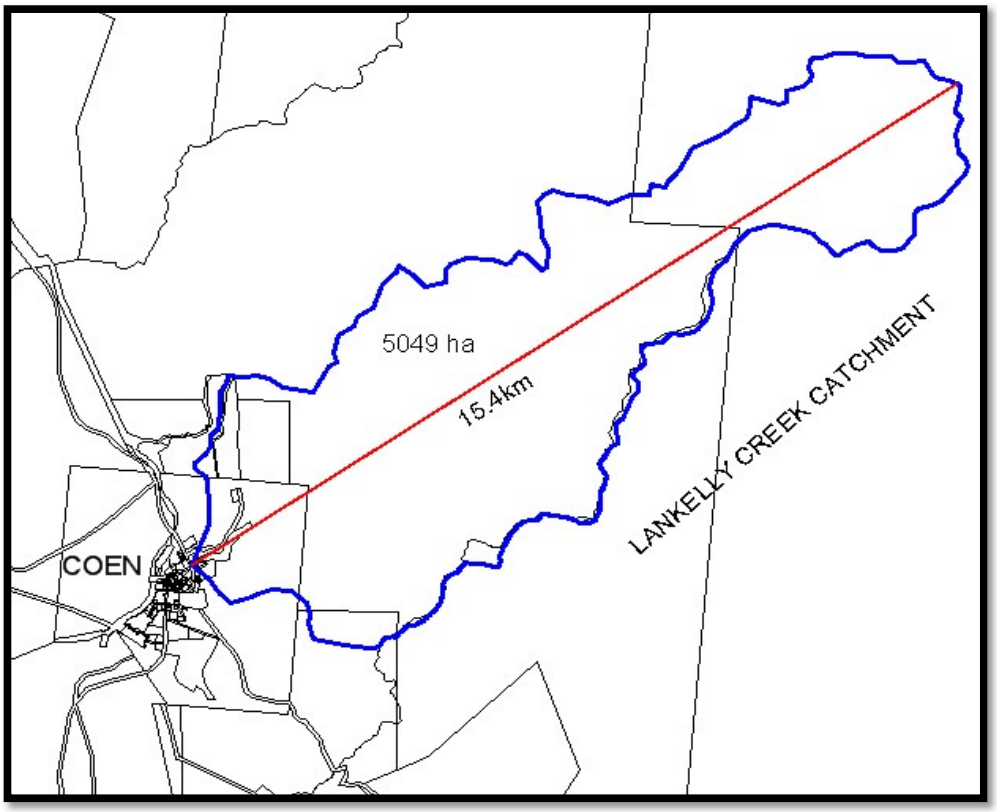
Figure 2 Location of Coen Water Sources



1.3 Lankelly Creek

When the Lankelly Creek is running, this is the preferred water source for Coen. However, the Lankelly Creek only runs for approximately half the year, depending on the season, as such it provides 40-50% of the Coen water supply. The Lankelly Creek originates high in the rainforest of the McIllwrath Range in KULLA (Kaanju, Umpila, Lama Lama, Ayapthu) national parks approximately 15km to the east of the township. The catchment area of approx. 5000 ha is in pristine rainforest and due to the terrain has very limited human impact. Nonetheless, there is some activity near the offtake, and there are a few cattle in the catchment.

Figure 3 Lankelly Creek Catchment

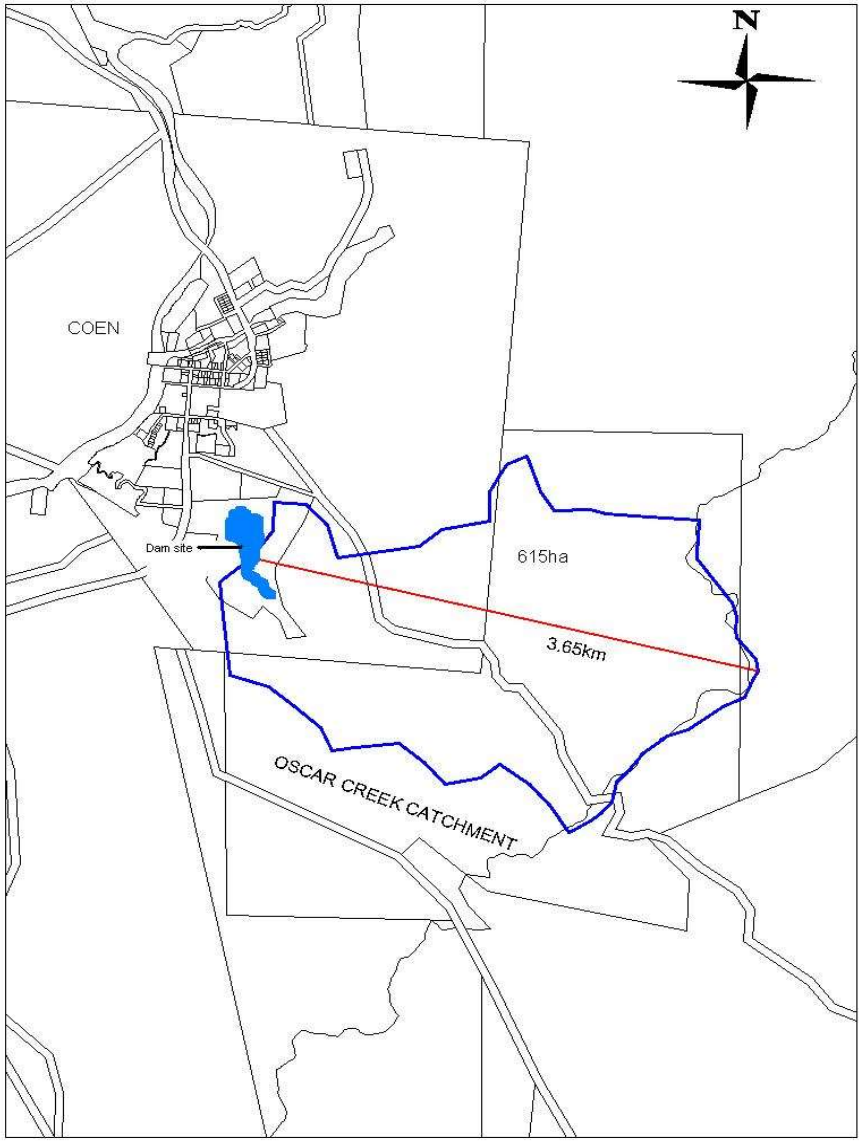


1.4 Coen Dam

The Coen Dam is located ~1.5 km South of Coen on the Oscar Creek. The dam was originally built for a gold mine, but was purchased by Council in the 1990s to ensure that Coen had sufficient water supply. The dam capacity is unknown. The dam fills annually, and the water quality is good, as can be seen in the Google Earth image (Figure 2), the dam has significant amounts of lilies but this is not an issue and coverage has not increased for numerous years. The dam can be subject to blooms of cyanobacteria, but not annually and treated with algaecide if required. The dam catchment also originates in the McIllwraith Range in KULLA national parks.

Figure 2 also shows that the water supply dam has a tailings dam immediately adjacent, and the Coen tip is located in a separate sub-catchment north of the dam.

Figure 4 Coen Dam Catchment



1.5 Coen Bore Fields

The Coen bores provide water to the town when the Lankelly Creek and Coen Dam turbidity is high after a rain event in the wet season. Bores 5 and 10 have yields of ~2L/s and Shepherd's Bore has a yield of ~1 L/s. The bores are unable to provide the full supply during the dry season.

The bore report cards for these bores contain almost no information on the date drilled, the depth, or the strata. However, all are believed to be ~50-60 m deep, and tapping the Lankelly Adamellite.

The bores are all located in sheds, with the bore head elevated ~60 cm above ground level. Inspections are done on the sealed bores six monthly to ensure integrity is maintained at all times.

Bore 10 is fitted with 2 pressure lift pumps that pump water from the tank at bore 10 to the reservoir at the water treatment plant. Bore water is chlorine in the water tank at bore 10.

Bores 5 and 10 are recharged with treated water when the Lankelly Creek supply is used, and records maintained of the volume recharged.

Figure 5 Location of Coen Bores

2 INFRASTRUCTURE

2.1 Raw water intakes

2.1.1 Lankelly Creek

The Lankelly Creek intake consists of a concrete intake well structure built on the side of the Lankelly Creek. The intake has a Johnston Screen that prevents any debris damaging the two submersible pumps that operate as duty/ standby to pump water to the WTP. In the dry season, the Lankelly Creek is usually low turbidity (<5 NTU) and the DAF plant is bypassed directly into the raw water tank to minimise electricity costs.

At the commencement of flows in the Lankelly Creek, the turbidity can be higher, and in these cases, the Lankelly Creek water is treated through the DAF similar to the situation from Coen Dam.

The selection of treatment is at the discretion of the operator.

2.1.2 Coen Dam

Coen Dam operates two raw water pumps at the Coen Dam (duty standby arrangements). The raw water pumps are submersible type bore pumps that have a shroud fitted for cooling purposes. They are located in pontoons approximately 20 m from the Dam wall.

A 100m uPVC pipeline 2 km long delivers this water to the treatment plant (directly to the DAF plant).

2.2 Treatment Process

2.2.1 Process Steps - Lankelly Creek

The process starts when the Clean Water Reservoir either reaches the “Low Level” set point, or an operator overrides the set point to initiate a start.

The Treatment Plant will start automatically on demand, whatever time of the day or night, however it is preferred to control the start (usually early in the morning) so that the operators are working and can monitor treatment processes and perform their daily water quality tests.

The first step of the plant start up is the plant feed pump starts draw down the Raw Water Reservoir. The Lankelly works off a rocker arm switch that has a ball float that pulls it down to start the raw water pumps and stops when the raw water tank is full. The Alum and Caustic chemical dosing pumps start as soon as the plant finishes its first initial start-up backwash.

The primary feed pump draws water from this tank, lowering its level until the Raw Water Start level is reached. This starts the on duty Raw Water pump located in the bottom of the Intake structure in Lankelly Creek.

The chemical dosing skid includes:

- 2x Soda ash dosing pumps
- 2 x Alum dosing pumps
- 2 x Caustic dosing pumps

Soda ash is used intermittently. Soda ash is used to increase the pH in the final water going to the reservoir. Soda ash also slightly raises the alkalinity of the raw water.

There are duty / standby soda ash dosing pumps of 0.065L/m capacity the operator can also select the pump to be on duty. Soda ash is made into an 8% solution from 25 kg bags, and made up in a 1000 litre tank; this generally lasts for several weeks.

There are 2 alum dosing pumps 2 of 0.065 L/m capacity. Alum is the primary coagulant.
There are 2 caustic dosing pumps (duty/standby) of 0.065L/m capacity. Caustic Soda is used a pH adjustment during the coagulation process.

The duty / standby alum dosing pumps are alternated weekly. This is done manually by the operator.
Liquid alum is now used at the Coen T/Plant and is purchased and supplied in 24 tonne lots as a 47% solution and stored in bulk tanks in Cooktown. 1000L bulkibins are transported to Coen during the dry season and 2 of them are stored there as back up over the wet season. A bulk alum (2200L capacity) storage tank is located in the DAF Shed and alum is transferred to the treatment plant via a transfer pump, when the operator requires it, into a 500L holding tank.

Raw water pumped from the raw water reservoir is dosed with alum and soda ash, which then passes through a spiral chemical mixer prior to the roughing filter. The Lankelly can also be treated through the DAFF.

The roughing filter is a pressure vessel approximately half filled with anthracite which is the filter media. From the roughing filter the water then passes through to the feed tank and from there to the Memcor Continuous Micro Filtration unit at a rate of 7 L/s via the secondary plant feed pump. This rate can be varied by the operator as the raw water pumps have a flow rate of 5.5l/s into the raw water tank. From the CMF plant, the treated water is dosed with caustic soda if the pH of the final water is too low.

At the Coen Water Treatment Plant the filtration process is fully automated and controlled by a PLC.
The plant is manned during working hours, and is currently required to run an average of 12 hrs daily. Cook Shire Council operates the plant during the day while its manned that way an operator is on hand should something malfunction.

At the Coen Treatment Plant roughing filter backwashes can be initiated:

- Manually
- Filter run time, (Operator can set this time)
- Head loss across the filter.

Granular media filtration performance can be monitored by sampling the effluent from the roughing filter and checking the turbidity.

Backwash water is sourced from the raw water tank as the turbidity is less than 5 NTU straight from the creek.

Backwashes for the CMF are done on time, transmembrane pressure or operator initiated. Air is used to backwash with only a small amount of water from feed tank used to rinse the membranes. Membrane cleans are done using chlorine or citric acid. The CMF has annual maintenance program when all maintenance is undertaken.

Final water from the plant goes directly to the clean water reservoir. Two recirculation pumps, duty/standby, are connected to the outlet of this tank and recirculate the water within the reservoir. A sodium hypochlorite injector is located on the outlet side of the pumps as well as a sample point for the chlorine analyser. The hypo pumps are controlled by the analyser to a set point that is operator controlled, usually between 0.8 to 1.0 mg/L. This system works very efficiently and maintains a constant residual 24 hours a day.

2.2.2 Process Steps-Coen Dam

The process starts when the clean water reservoir either reaches the "Low Level" set point, or an operator overrides the set point to initiate a start.

The treatment plant will start automatically on demand, whatever time of the day or night, however it is preferred to control the start (usually early in the morning) so that the operators are working and can monitor treatment processes and perform their daily water quality tests.

The first step of the plant start up is the plant feed pump starts draw down the raw water reservoir. The alum and caustic chemical dosing pumps start as soon as the plant finishes its first initial start-up backwash.

The first step of the plant start up is the plant feed pump starts draw down the Raw Water Reservoir. The Coen Dam raw pumps works off a rocker arm switch that has a ball float that pulls it down to start the raw water pumps and stops when the raw water tank is full. The Alum and Caustic chemical dosing pumps start as soon as the plant finishes its first initial start-up backwash.

A 100m uPVC pipeline 2 km long delivers this water to the treatment plant and directly to the Dissolved Air Flotation (DAF) inlet chamber. This chamber is injected with liquid alum and has a mixer fitted to ensure the chemical is well blended with the incoming raw water. From the mixing chamber the water passes through two 150mm transfer pipes into the filtrate tank. The outlet side of these pipes have three nozzles which inject an air saturated solution in which the tiny bubbles lift the flocculent particles to the surface of the tank. This saturated solution is formed in a separate pressure vessel (dispersion vessel) where clean water from the end of the filtrate tank is mixed with high pressure air to form the air saturated solution.

The filtered material called scum is then intermittently drawn off by a series of scrapers which ultimately end up in the backwash dam. The scrapers run time and frequency is operator adjusted, depending on the turbidity of the raw water.

The filtered water from the DAF then flows into the raw water tank where it is then drawn off and filtered in the same process described above for the Lankelly raw water.

2.2.3 Process Steps-Coen Bores

This system consists of three bores - Bore 5, Bore 10 and Shephard's Bore. All three are approximately 50m deep and are equipped with Grundfos submersible pumps. They all feed into a header tank of approximately 8,000 L in capacity which is located adjacent to Bore 10. Bore 5 and 10 have a flow rate of approximately 2L/sec while Shephard's bore is only about 1L/sec.

In the shed in which Bore 10 is housed are two Southern Cross centrifugal lift pumps, which draw the water from the header tank and pump it directly into the town reticulation network. The water is injected with sodium hypochlorite on the outlet manifold of these pumps and the level monitored by the operator to the desirable set point, usually between 0.5mg/L and 0.7mg/l.

The water that is not used by the consumers makes its way back to the clean water reservoir and if it reaches full capacity, will send a signal via telemetry back to the lift pumps and turn them off. This system is fully automated, but due to the output over demand usually doesn't keep up with the usage.
This system is basically used as a backup to the other two supplies and is used to either blend with one of the others so it gets use each year, or is used if either one of the other supplies is offline due to maintenance requirements.

Each year whilst on the Lankelly Creek supply, each bore is recharged for several months to ensure each aquifer has sufficient supply for later in the year when the bores are more likely to be used.
No treatment of the bore water is necessary as each one meets the ADWG.

Figure 6 Catchment to tap schematic – Coen

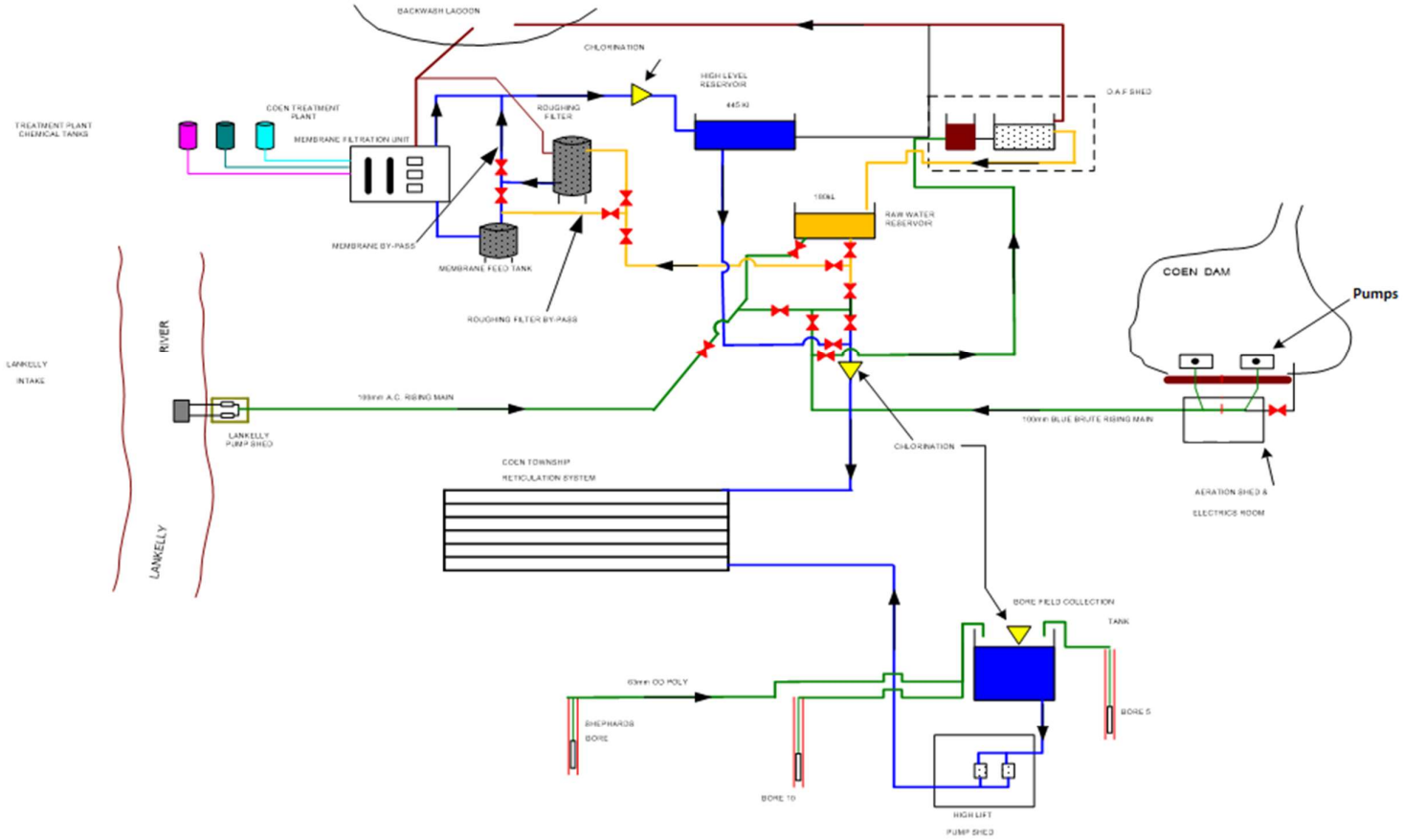


Figure 7 Coen Water Treatment Plant Schematic Overview

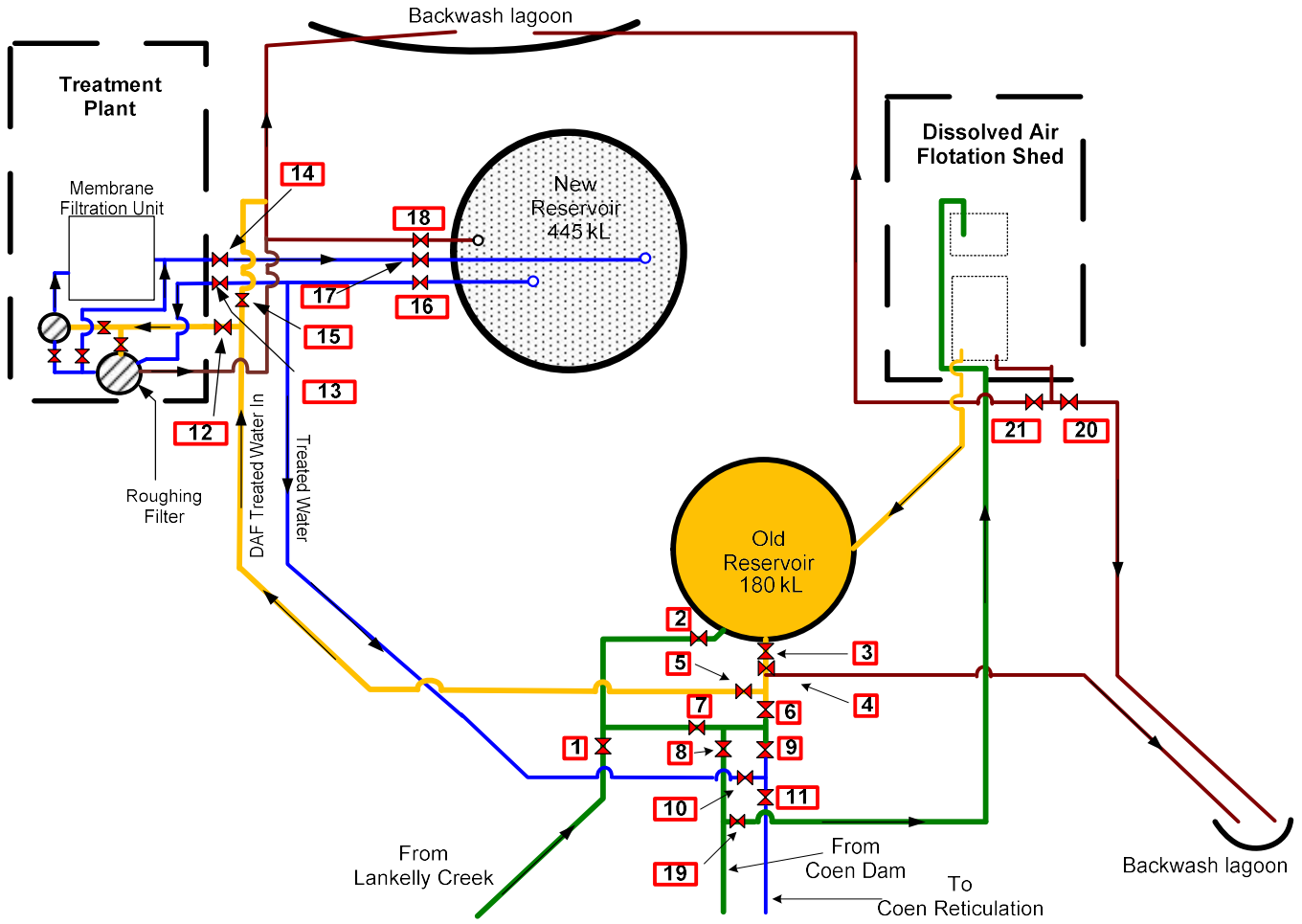


Figure 8 Coen Treatment Plant Process Overview

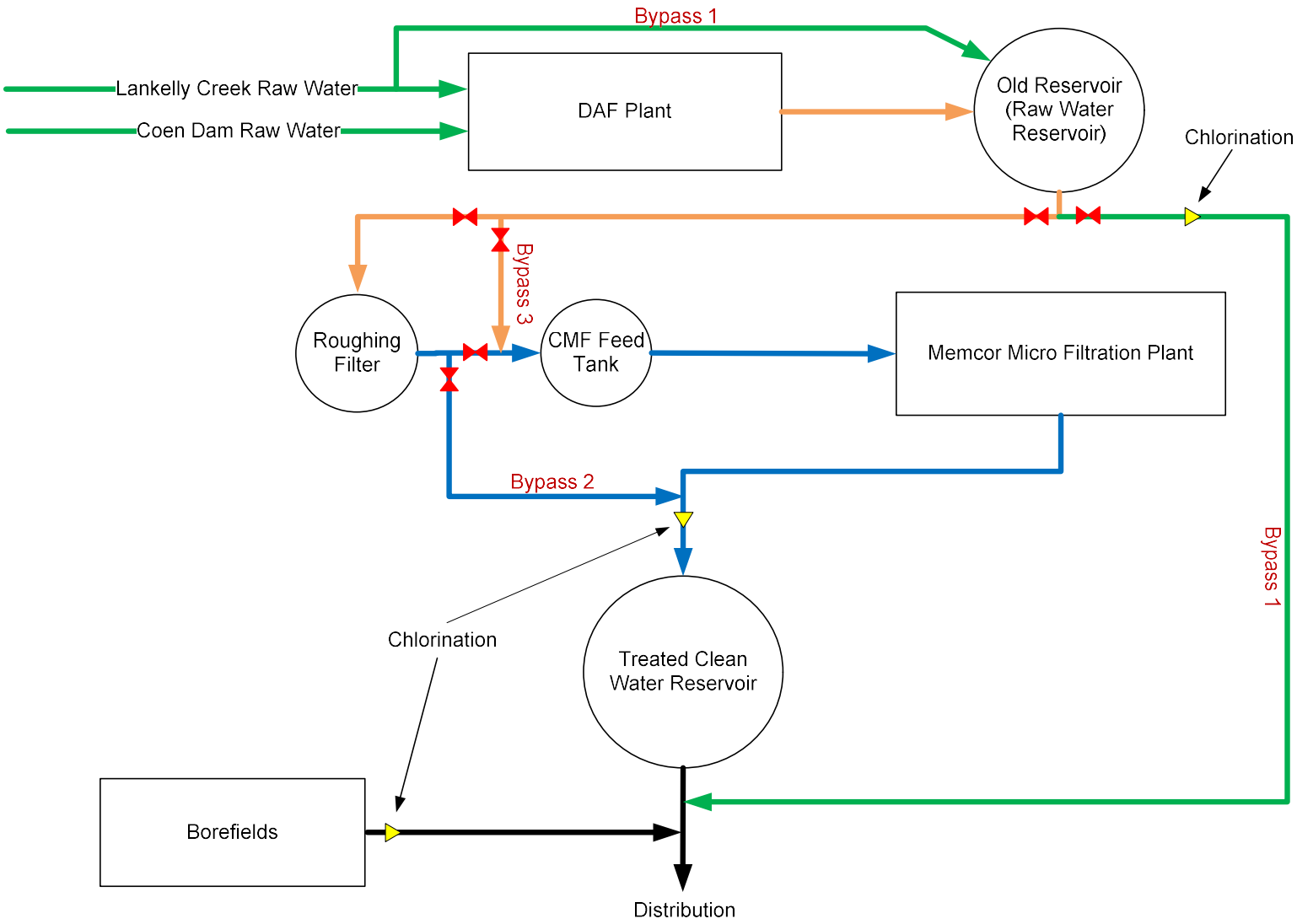
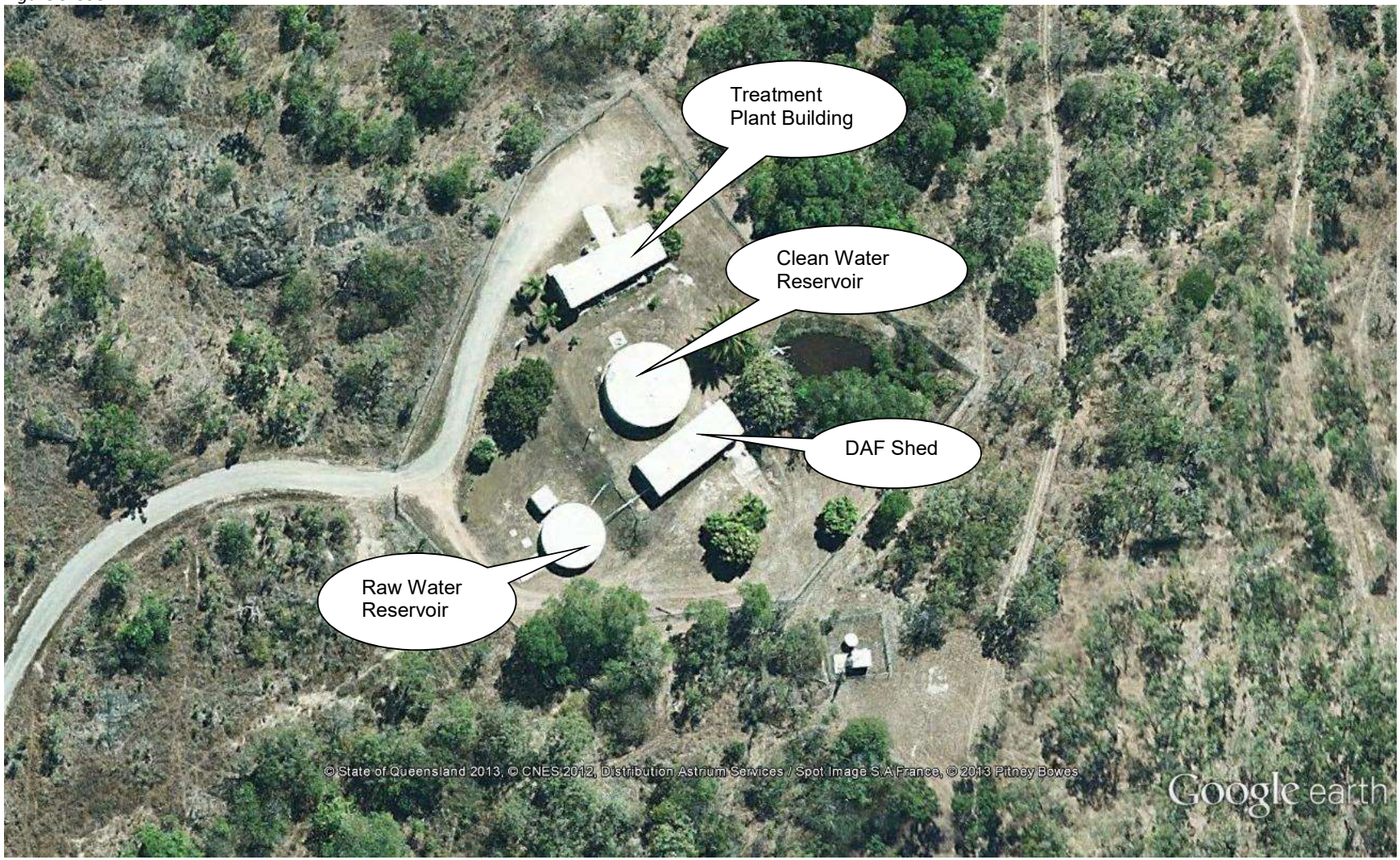


Figure 9 Coen WTP



2.3 Valving arrangements for different supply options

The Valve arrangement at the Old Coen Reservoir and at the T/Plant is quite complex, but allows for different intake scenario's, and treatment options. Raw water comes from either the Lankelly Creek or the Coen Dam, or the Borefields can be supplied direct into the distribution with chlorination.

The Lankelly Creek can be treated either using the DAF plant (usually when the raw water has high turbidity's – Wet season) or without the DAF plant (usually when the raw water has low turbidity's – Dry Season). Considerable power savings can be made by not using the DAF plant during the dry season as the Lankelly Creek water quality is particularly good and requires little treatment.

The DAF plant is always used when treating the Coen Dam water as organic material in the Coen Dam water tends to seriously reduce the roughing filter run times, whereas the DAF plant removes the organic material entirely prior to the roughing filter, followed by the membrane micro filtration plant.

Table 3 Scenario 1 Treat Raw Water from the Lankelly Using the DAF Plant

Valve No	Valve Position	Comments
1	Open	Allows Raw Water from the Lankelly
2	Closed	Prevents Raw water entering the Old Reservoir
3	Open	Allows DAF Treated Water out of the Old Reservoir
4	Closed	Only opened when Scouring / Draining the Old Reservoir
5	Open	Allows DAF Treated Water out of the Old Reservoir and on to the Treatment plant
6	Closed	Prevents DAF Treated water from entering the Reticulation as well as preventing Lankelly Raw water from entering the Old Reservoir
7	Open	Allows Lankelly Raw water to travel to the DAF Plant
8	Open	Allows Lankelly Raw water to travel to the DAF Plant
9	Closed	Prevents Raw water from entering the Reticulation
10	Open	Allows Treated water into the Reticulation
11	Open	Allows Treated water into the Reticulation
12	Open	Allows DAF Treated water into the T/Plant
13	Open	Allows Treated water from the New Reservoir back to the Roughing Filter for Backwashing
14	Open	Allows Treated water into the New Reservoir
15	Closed	Allows DAF Treated water through to the Backwash Lagoon
16	Open	Allows Treated water out of the New Reservoir
17	Open	Allows Treated water into the New Reservoir
18	Closed	Only opened when Scouring / Draining the New Reservoir
19	Open	Allows Lankelly Raw water to travel to the DAF Plant
20/21	Open / Closed	Either 20 or 21 open the other closed depending on which B/wash lagoon is being used

Table 4 Scenario 2 Treat Raw Water from the Lankelly without using the DAF Plant

Valve No	Valve Position	Comments
1	Open	Allows Raw Water from the Lankelly
2	Open	Prevents Raw water entering the Old Reservoir
3	Open	Allows Raw Water out of the Old Reservoir
4	Closed	Only opened when Scouring / Draining the Old Reservoir
5	Open	Allows Raw Water out of the Old Reservoir and on to the Treatment plant
6	Closed	Prevents Raw water from entering the Reticulation
7	Closed	Allows Lankelly Raw water to travel to the DAF Plant
8	Closed	Prevents Lankelly water from going back to the Coen Dam
9	Closed	Prevents Raw water from entering the Reticulation
10	Open	Allows Treated water into the Reticulation
11	Open	Allows Treated water into the Reticulation
12	Open	Allows Raw water into the T/Plant
13	Open	Allows Treated water from the New Reservoir back to the Roughing Filter for Backwashing
14	Open	Allows Treated water into the New Reservoir
15	Closed	Allows DAF Treated water through to the Backwash Lagoon
16	Open	Allows Treated water out of the New Reservoir
17	Open	Allows Treated water into the New Reservoir
18	Closed	Only opened when Scouring / Draining the New Reservoir
19	Closed	Prevents Lankelly Raw water to travel to the DAF Plant
20/21	Open / Closed	Either 20 or 21 open the other closed depending on which B/wash lagoon is being used

Table 5 Scenario 3 Treat Raw Water from the Coen Dam using the DAF Plant

Valve No	Valve Position	Comments
1	Closed	Isolates Raw Water from the Lankelly
2	Closed	Prevents Raw water entering the Old Reservoir
3	Open	Allows DAF Treated Water out of the Old Reservoir
4	Closed	Only opened when Scouring / Draining the Old Reservoir
5	Open	Allows DAF Treated Water out of the Old Reservoir and on to the Treatment plant
6	Closed	Prevents DAF Treated water from entering the Reticulation
7	Closed	Controls flow Direction
8	Closed	Prevents Dam water from going any further forcing Dam water to the DAF Plant via valve 19
9	Closed	Prevents DAF Treated water from entering the Reticulation and prevents Treated water from entering the Old Reservoir
10	Open	Allows Treated water into the Reticulation
11	Open	Allows Treated water into the Reticulation
12	Open	Allows DAF Treated water into the T/Plant
13	Open	Allows Treated water from the New Reservoir back to the Roughing Filter for Backwashing
14	Open	Allows Treated water into the New Reservoir
15	Closed	Allows DAF Treated water through to the Backwash Lagoon
16	Open	Allows Treated water out of the New Reservoir
17	Open	Allows Treated water into the New Reservoir
18	Closed	Only opened when Scouring / Draining the New Reservoir
19	Open	Allows Lankelly Raw water to travel to the DAF Plant
20/21	Open / Closed	Either 20 or 21 open the other closed depending on which B/wash lagoon is being used

2.4 Bypasses

2.4.1 The Lankelly bypass

Bypass Trigger: Total Treatment Failure

Most Probable cause: Lightning Strike / Severe Electrical or Mechanical Fault

From the early 80's to the mid 90's Coen's Water came solely from the Lankelly creek, untreated but chlorinated and or from the Borefields, again untreated but chlorinated. In the event of a total treatment failure, then the Lankelly Creek water can be supplied directly into the reticulation with chlorination, this method is not a normal practice, but can be achieved in an emergency and will be done in consultation with Queensland Health as a Boil Water Alert may be required. This method of Supply from the Lankelly Creek can only be used during the "Dry Season". This bypass requires constant monitoring of the Chlorine residuals in the Reticulation with chlorine dose rate adjustments, as required.

2.4.2 The Raw Water or DAF Treated water bypass

Bypass Trigger: Membrane Filtration Unit Failure

Most Probable cause: Electrical / Mechanical Fault

This is not a normal practice, but can be achieved during a mechanical or in most cases an electrical failure, and including lightning strikes which can happen particularly during the "Wet Season".

The remoteness of Coen often extends the time that a mechanical or electrical fault can be repaired as there is limited technical and electrical expertise in Coen. The Wet season adds the accessibility problem as the road to Coen can be closed due to flooding or wet & boggy conditions during the wet.

Table 6 Membrane Filter By Pass Valve configuration

Valve No	Valve Position	Comments
AV 4.3	Closed	This valve configuration enables the Membrane Filter to be Bypassed. (To disable the Bypass the valve positions are reversed i.e. Valve AV 4.3 is to be Open & Valve AV4.7 is to be Closed)
AV 4.7	Open	

2.4.3 The raw water or DAF treated water Roughing Filter bypass

Bypass Trigger: Roughing Filter control, or ancillary equipment failure

Most Probable cause: Electrical / Mechanical Fault

The roughing filter has its own PLC, pumps, valves etc., and is independent from the membrane filtration plant. This has been an advantage in the past as there are not a lot of conditions that affect both plants, except total power failure. Generally, this part of the plant is less complex than the membrane filtration unit and is easier to work on, whereas the membrane plant requires specialist annual servicing and at times specific replacement parts.

The ability to bypass the roughing filter has also proven in the past to be very useful.

Table 7 Roughing Filter Bypass Valve configuration.

Valve No	Valve Position	Comments
22	Open	This valve configuration enables the Roughing Filter to be Bypassed. (To disable the Bypass the valve positions are reversed i.e. Valve 22 is to be Closed & Valve AV4.5 is to be Open)
AV 4.5	Closed	

Table 8 Infrastructure Details – Coen

Lankelly Creek	
Name	Lankelly Creek
Type	Surface Water
% of supply	40-50
Reliability	Lankelly Creek stops flowing each year between July to November, depending on the preceding Wet Season
Water quality issues	High Turbidity levels after Storm events / Flooding
Coen Dam	
Type	Dam
% of supply	50-60
Reliability	Dam fills up after every Wet Season. Only used after Lankelly stops flowing or is too turbid.
Water quality issues	Seasonal Blue-Green algae (Not every year), naturally occurring Arsenic & Iron
Coen Borefield	
Type	Network of Bores
% of supply	Backup Only
Reliability	Recharged annually with treated water from the Lankelly Creek.
Water quality issues	Total Hardness & TDS Higher than Desirable
Bore 5 and Bore 10	
Year Bore/s Sunk	Approx. 1978
Bore Casing size	150mm

Bore Casing Material	PVC
Sealed to prevent surface water ingress	Yes, Located inside a building
Sealed to prevent vermin (frogs / snakes etc.) from entering bore	Yes
Aquifer Name	Lankelly Adamellite
Bore Head Details (Shephard's)	
Year Bore/s Sunk	Unknown
Bore Casing size	150mm
Bore Casing Material	PVC
Sealed to prevent surface water ingress	Yes, Located inside a building
Sealed to prevent vermin (frogs / snakes etc.) from entering bore	Yes
Aquifer Name	Lankelly Adamellite
Source Infrastructure	
Lankelly	Fixed concrete intake in the creek with two electric submersible pumps pumped through to the Coen Reservoir
Dam	Two floating pontoons with electrical submersible pumps anchored to fixed position
Bores	Electrical equipped submersible pumps fitted in each Bore, bore depths are less than 50 metres
Are there any sources that **do not** undergo treatment prior to supply?	Coen Bores are disinfected only.
Coen Treatment Plant	
Process	Process comprises of aeration (Coen dam only) dissolved air floatation (DAF) pressure filtration, micro filtration, and chlorination
Design Capacity (20 hr operation)	0.45 ML/day
Daily flow range	0.13 ML/d (Wet Season) – 0.35ML/d (Dry Season)
Chemicals added	Soda Ash (if required), Liquid Alum, Sodium Hypochlorite and Caustic Soda if required
Standby chemical dosing facilities (Y/N)	Yes
Water sourced from and %	Water is sourced 60% from the Coen dam and 40% from the Lankelly Creek, and the bores are generally used as a standby
% of average day demand provided	100%
% of scheme supply Distribution area supplied	100%
Bypass	
Bypass 1	The Lankelly can bypass all filtration treatment by manual operation of several valves to achieve the bypass. The Raw water from the intake is pumped to the raw water reservoir. From there it can be directed into the reticulation system via several manual valves where it is chlorinated before leaving the T/Plant grounds
Bypass 2	The Raw Water or DAF Treated water can be filtered through the Roughing Filter and bypass the Membrane Filtration Unit (CMF)

Bypass 3	The Raw Water or DAF Treated water can be filtered through the Membrane Filtration Unit (CMF) bypassing the Roughing Filter
Are there any sources that **do not** undergo disinfection prior to supply?	No
Disinfection Coen WTP	
Location	Coen Treatment Plant
Type	Sodium Hypochlorite Dosing
Target residual levels	0.9 mg/L
Duty/standby	Yes
Dosing arrangements	Controlled by the feedback from free chlorine residual analyser
Alarms	No, Staff on site during working hours and weekends
Auto shut-off arrangements	Controlled by the free chlorine residual analyser with control set points.
Trended on SCADA	No
Distribution and Reticulation System	
Pipe material	A.C. UPVC & Poly
Age range	A.C. up to 30 Y.O. All new Water mains installed since 1995 have been UPVC with a few small Poly lines
Approx. % of total length	A.C. 80%, UPVC 10%, Poly 10%
Areas where potential long detention periods could be expected	1 Area near National Parks Offices has the potential for long detention periods
Areas where low water pressure (e.g. < 12 m) could be expected during peak or other demand periods)	No areas of low water pressure
Coen Clean Water Reservoir	
Capacity (ML)	0.445 ML
Roofed (Y/N)	Yes
Vermin-proof (Y/N)	Yes
Runoff directed off roof (Y/N)	Yes
Coen Raw Water Reservoir	
Capacity (ML)	0.18ML
Roofed (Y/N)	Yes
Vermin-proof (Y/N)	Yes
Runoff directed off roof (Y/N)	Yes
Bore 10 Reservoir	
Capacity (ML)	20 kL
Roofed (Y/N)	Yes
Vermin-proof (Y/N)	Yes. New tank
Runoff directed off roof (Y/N)	Yes

3 RISK ASSESSMENT

3.1 Coen Mitigated Risk Assessment

Following the hazard identification and unmitigated risk assessment detailed in the overarching plan, the Coen Scheme risk assessment was undertaken, following the same methodology. Individual process failures were considered, and the mitigated risks calculated. The risk assessment is presented below.

Table 9 Coen Risk Assessment for Risk Management Improvement Plan

Coen Water													
Process Step	**Hazardous Event**	**Hazards managed by same barriers**	**Unmitigated Risk**	**Primary preventive measure**	**Other Preventive Measures**	**Mitigated**			**Uncertainty**	**Comments**	**Risk Management Improvements**		
						Consequence	**Likelihood**	**Risk**			**2022/2023**	**2023/2024**	**2024/2025**
Coen Dam Catchment	Animals in catchment	bacteria and virus	Extreme 20	disinfection	Coen Dam fenced, DAF, filtration, MF	Major	Unlikely	Medium 5	Certain	Considered as whole of treatment in absence of failure			
Coen Dam Catchment	Present in catchment - animals	protozoa	Extreme 20	MF	Coen Dam fenced, DAF, filtration, MF	Major	Unlikely	Medium 5	Confident	Considered as whole of treatment in absence of failure			
Coen Dam Catchment	Cross contamination from Coen Landfill.	hazardous waste	Medium 9	Landfill is in a different catchment area		Moderate	Rare	Low 3	Estimate	Groundwater contamination most likely issue.			
Coen Dam Catchment	Hydrocarbons in Coen Dam	Hydro-carbons	High 12	Car bodies have been removed from catchment	DAF, filtration, MF	Moderate	Rare	Low 3	Estimate				
Coen Dam Catchment	Cyanobacterial bloom	Cyano-bacteria	Medium 8	DAF and coagulation flocculation	filtration, MF, disinfection	Minor	Rare	Low 2	Reliable	Small blooms most years, but not every year			

Coen Water

Process Step	Hazardous Event	Hazards managed by same barriers	Unmitigated Risk	Primary preventive measure	Other Preventive Measures	Mitigated			Uncertainty	Comments	Risk Management Improvements		
						Consequence	Likelihood	Risk			2022/2023	2023/2024	2024/2025
Coen Dam Catchment	Cyanobacterial toxins	Toxins	High 12	oxidation (chlorine and sufficient contact time)	multiple supplies	Moderate	Rare	Low 3	Reliable	Toxin not common			
Coen Dam Catchment	Arsenic in raw water	Arsenic	Medium 9	DAFF Alum Coagulation	Micro-filtration	Moderate	Rare	Low 3	Certain	Raw value is marginally over the ADWG guideline value Average value is 0.115mg/L.			
Lankelly Creek Catchment	Animals in catchment	bacteria and virus	Extreme 20	disinfection	(DAF) filtration, MF	Minor	Possible	Medium 6	Certain				
Lankelly Creek Catchment	Present in catchment - animals	protozoa	Extreme 20	MF	(DAF) filtration	Minor	Possible	Medium 6	Confident	Cattle numbers in catchment very low			
Bores	Ingress into bore	bacteria and virus	Extreme 20	Disinfection	Bore-head sealed. Bores inspected every 6 months	Catastrophic	Rare	Medium 6	Certain	Backup supply. Raw water E.coli testing			
Bores	Ingress into bore	protozoa	Extreme 20	Bore-head sealed	Bore-head sealed. Bores inspected every 6 months	Catastrophic	Rare	Medium 6	Confident				
Bores	Bore pump failure	Failure of supply	High 12	multiple supplies		Minor	Rare	Low 2	Confident				
Bore Recharge	Bore Recharge	chemical	Medium 6	Recharge on Lankelly only		Minor	Rare	Low 2	Certain	Years of records show that risk from chemical contamination is very rare			

Coen Water

Process Step	Hazardous Event	Hazards managed by same barriers	Unmitigated Risk	Primary preventive measure	Other Preventive Measures	Mitigated			Uncertainty	Comments	Risk Management Improvements		
						Consequence	Likelihood	Risk			2022/2023	2023/2024	2024/2025
Bore Recharge	Bore Recharge	protozoa	Extreme 20	Recharge on treated Lankelly water only	Procedure in place for recharging bores	Minor	Rare	Low 2	Reliable				
Raw Water Feed	Raw water main break	Failure of supply	High 10	3 sources	mains break procedure WS0002	Minor	Rare	Low 2	Confident	Crews available to fix critical issues			
Raw Water Feedv	Raw water pump failure	Failure of supply	High 10	3 sources	duty standby	Minor	Rare	Low 2	Certain	spare pumps available on site			
DAF	Under dose alum	Protozoa, turbidity	Extreme 20	Coagulation available in plant	Clarifier monitoring Micro - filtration Online treated water turbidity meter	Major	Rare	Medium 5	Confident				
DAF	Overdose alum	Aluminium	Medium 6	clarifier monitoring	MF	Minor	Unlikely	Low 4	Confident				
DAF	poor floc due to low alkalinity	Protozoa	Extreme 20	soda ash dosing when required for pH adjustment low cattle numbers in catchment	MF	Catastrophic	Rare	Medium 6	Estimate	not used all the time - changes depending on raw water. Operators monitor alkalinity and determine when required.			
DAF	overflow of DAF sludge into raw water tank	Protozoa	Extreme 20	daily monitoring	Roughing filter and MF treatment following DAF	Moderate	Unlikely	Medium 6	Estimate	Plant checklist includes cleaning of probe to ensure this does not occur			

Coen Water

Process Step	Hazardous Event	Hazards managed by same barriers	Unmitigated Risk	Primary preventive measure	Other Preventive Measures	Mitigated			Uncertainty	Comments	Risk Management Improvements		
						Consequence	Likelihood	Risk			2022/2023	2023/2024	2024/2025
DAF	Bypass	Protozoa	Extreme 20	Manual change valves. Valve configuration documented.	MF	Catastrophic	Rare	Medium 6	Reliable		Suggest that during WTP upgrade, Valves are tagged and locked to prevent accidental bypass. Upgrade depends on funding. Low priority for tagging.		
Roughing Filtration (when MF operating)	Filter breakthrough	Protozoa	Extreme 20	MF	roughing filter	Catastrophic	Rare	Medium 6	Reliable	Serves as a prefilter. Main barrier is MF.			
Roughing Filtration (when MF operating)	Filter breakthrough	turbidity	Medium 6	MF	roughing filter	Minor	Rare	Low 2	Confident		Filter media needs to be replaced.		
Roughing Filtration (when MF operating)	Filter bypass	Protozoa	Extreme 20		MF	Catastrophic	Rare	Medium 6	Reliable				
Roughing filter (No MF)	Filter breakthrough	Protozoa	Extreme 20	conventional filtration	SCADA system in place with autodialler call out	Catastrophic	Rare	Medium 6	Reliable	Online turbidity meter. Current daily monitoring.			
Roughing filter (No MF)	Filter breakthrough	turbidity	Medium 6	disinfection	roughing filter	Minor	Unlikely	Low 4	Confident			Filter media to be renewed	

Coen Water

Process Step	Hazardous Event	Hazards managed by same barriers	Unmitigated Risk	Primary preventive measure	Other Preventive Measures	Mitigated			Uncertainty	Comments	Risk Management Improvements		
						Consequence	Likelihood	Risk			2022/2023	2023/2024	2024/2025
Roughing filter (No MF)	Filter bypass	Protozoa	Extreme 20	Valve configurations are documented		Major	Unlikely	Medium 8	Reliable				
Micro-filtration	Filter breakthrough	Protozoa	Extreme 20	membrane integrity (Pressure decay tests), Roughing filter	TMPs monitored	Catastrophic	Rare	Medium 6	Confident	Annual servicing of membranes. Membranes replaced in 2016/2017 financial year			
Micro-filtration	Filter breakthrough	turbidity	Medium 6	membrane integrity (Pressure decay tests)	Online turbidity meter	Minor	Rare	Low 2	Confident	Annual servicing of the membranes.			Membrane replacement program
Disinfection	overdose	Chlorine	High 15	Daily checks at WTP and Reservoirs. Online analyser.	PLC plus SCADA/ autodialler for high chlorine	Minor	Unlikely	Low 4	Confident				
Disinfection	insufficient dose	bacteria/virus	Extreme 25	Daily checks at WTP and Reservoirs. Online analyser. MF	Two pumps - no auto changeover - PLC plus SCADA/ autodialler for low chlorine	Catastrophic	Rare	Medium 6	Confident				
Disinfection	Dosing pump failure	bacteria/virus	Extreme 25	Dual hypo pumps		Moderate	Unlikely	Medium 6	Reliable			SCADA upgrade includes auto change over for chlorine pumps –	SCADA upgrade includes auto change over for chlorine pumps – funding dependent

Coen Water

Process Step	Hazardous Event	Hazards managed by same barriers	Unmitigated Risk	Primary preventive measure	Other Preventive Measures	Mitigated			Uncertainty	Comments	Risk Management Improvements		
						Consequence	Likelihood	Risk			2022/2023	2023/2024	2024/2025
												funding dependent	
Disinfection	ineffective disinfection due to turbidity	bacteria	High 10	disinfection	filtration	Catastrophic	Rare	Medium 6	Confident				
Disinfection	chemical breakdown	chlorate	High 12			Moderate	Possible	Medium 9	Reliable	Chlorate over 0.8 mg/L has occurred		Investigate options for chlorate minimizatio n	
Bore Disinfection	overdose	Chlorine	High 15	Daily checks , fixed rate dosing		Moderate	Unlikely	Medium 6	Confident				
Bore Disinfection	insufficient dose	bacteria/virus	Extreme 25	Daily checks at WTP and Reservoirs.	Sealed bores	Catastrophic	Rare	Medium 6	Confident	New tank installed at Bore 10 and new dosing lines no longer above ground		Additional SCADA EDAC auto dialler (funding not approved	Additional SCADA EDAC autodialled
Bore Disinfection	Dosing pump failure	bacteria/virus	Extreme 25	Daily checks, spare on site	Sealed bores	Catastrophic	Rare	Medium 6	Reliable	spare pump available at Coen, Additional SCADA will include free chlorine concentration at the reservoir		Additional SCADA EDAC auto dialler (funding not approved	Additional SCADA EDAC autodialled
Treated water storage/ Reservoirs	Ingress into reservoirs	bacteria/virus	Extreme 20	Integrity and sealing.	residual chlorine	Catastrophic	Rare	Medium 6	Confident	Main treated water reservoir is new, and integrity is good.			

Coen Water

Process Step	Hazardous Event	Hazards managed by same barriers	Unmitigated Risk	Primary preventive measure	Other Preventive Measures	Mitigated			Uncertainty	Comments	Risk Management Improvements		
						Consequence	Likelihood	Risk			2022/2023	2023/2024	2024/2025
										Reservoirs are inspected every 6 months.			
Treated water storage/ Reservoirs	Ingress into Bore 10 Tank	bacteria/virus	Extreme 20	Integrity and sealing.	residual chlorine	Catastrophic	Rare	Medium 6	Confident	New tank at Bore 10			
Treated water storage/ Reservoirs	Ingress into reservoirs	Protozoa	Extreme 20	Integrity and sealing		Catastrophic	Rare	Medium 6	Reliable	Main treated water reservoir is new, and integrity is good.			
Treated water storage/ Reservoirs	ingress of amoeba	amoeba	High 12	Integrity and sealing	residual chlorine	Major	Rare	Medium 5	Reliable	Main treated water reservoir is new, and integrity is good.			
Reticulation	Ingress of contaminated water	bacteria/virus	Extreme 20	network pressure, residual disinfection	mains break procedure WS 0002; Low chlorine flushing procedure WS006	Major	Unlikely	Medium 8	Confident				
Reticulation	ingress of contaminated water	protozoa	Extreme 20	network pressure	mains break procedure WS0002	Major	Unlikely	Medium 8	Reliable				
Reticulation	biofilm growth	opportunistic pathogens	High 15	flushing program		Moderate	Rare	Low 3	Confident				

Coen Water

Process Step	Hazardous Event	Hazards managed by same barriers	Unmitigated Risk	Primary preventive measure	Other Preventive Measures	Mitigated			Uncertainty	Comments	Risk Management Improvements		
						Consequence	Likelihood	Risk			2022/2023	2023/2024	2024/2025
Reticulation	Power failure	Failure of supply	High 15	Coen has independent power supply (generators) but can still lose for short periods	1-2 days treated water supply available to gravity feed	Moderate	Rare	Low 3	Confident	Ergon responsible.			
Reticulation	change in flow rate, reservoir run low, disturbing sediment in pipe	turbidity	Medium 6	Disinfection residual mains flushing	Reservoir low level alarm Multiple days storage in reservoir	Insignificate	Possible	Low 3	Confident				
Reticulation	Backflow	protozoa	Extreme 20	system integrity, backflow prevention on new installations		Major	Rare	Medium 5	Estimate	Taggle meters investigated and not currently viable for Cook Shire due to total number of connections at this stage			
System Wide	WTP Fire	Failure of supply	High 10	Activate DMP.		Catastrophic	Rare	Medium 6	Reliable				
System Wide	Drought	Failure of supply	High 10	3 sources		Catastrophic	Rare	Medium 6	Estimate				
System Wide	Flood	Failure of supply	High 10	Generally only impacts raw water quality		Moderate	Rare	Low 3	Reliable	Lankelly and Oscar Creek flood each year			
System Wide	Lightning Strike	Interference with electronic equipment	High 16	Lightning protection in place		Moderate	Possible	Medium 9	Reliable	Lightning strikes have occurred about 3 times per wet season	SCADA/electrical upgrade includes additional lightning	SCADA/electrical upgrade includes additional lightning	SCADA/electrical upgrade includes additional lightning protection in

Coen Water													
Process Step	**Hazardous Event**	**Hazards managed by same barriers**	**Unmitigated Risk**	**Primary preventive measure**	**Other Preventive Measures**	**Mitigated**			**Uncertainty**	**Comments**	**Risk Management Improvements**		
						Consequence	**Likelihood**	**Risk**			**2022/2023**	**2023/2024**	**2024/2025**
											protection in electrical component	protection in electrical component	electrical component
System Wide	Cyclone	Failure of supply	High 15	DMP		Catastrophic	Rare	Medium 6	Reliable				
System Wide	Operator error	any	Extreme 25	training, experience, mentoring	All current operators have Cert III in water operations	Moderate	Rare	Low 3	Estimate				
System Wide	Complete plant bypass	protozoa and bacteria	Extreme 25	Staff training	Valve configuration plans available on site	Major	Rare	Medium 5	Confident	Has not happened accidentally, bypass can be used in case of major failures.			
System Wide	Cybersecurity	Cyber attack	High 12	Gateway software	Anti-virus and threat detection software	Major	Rare	Medium 5	Reliable	Individual log in to SCADA		SCADA/ Electrical upgrade	SCADA/ Electrical upgrade

3.2 Coen Risk Management Improvement Plan

Table 10 Coen Risk Management Improvement Plan

Process Step/Component	Hazard	Risk Management Improvements	Priority for implementation	Responsible Person	Year
DAF Plant	Protozoa	• Valves should be tagged and locked to prevent accidental bypass. This may be done as part of the treatment plant upgrade however scope has not been finalized	Medium	Project Manager	2023/2024 Funding dependant

Roughing Filter	Turbidity	• Filter design does not allow safe filter media inspection or replacement. This should be addressed in the treatment plant upgrade however scope has not been finalized. Investigation shows that filter is still producing good turbidity water and is followed by membrane replacement.	High	Project Manager	2023/2024 Funding dependant
Roughing Filter (no MF)	Protozoa	• Filter design does not allow safe filter media inspection or replacement. This should be addressed in the treatment plant upgrade however scope has not been finalized. Investigation shows that filter is still producing good turbidity water and is followed by membrane replacement.	High	Project Manager	2023/2024 Funding dependant
Microfiltration	Turbidity	• Membrane will be due for replacement	Low	Manager Water and Wastewater	2024/2025
Disinfection and Bore water disinfection	Bacteria/Virus	• SCADA/WTP upgrade will include auto change over for chlorine pumps.	High		2023/2024 Funding dependant
Disinfection	Chlorate	• Investigate additional solutions.	Medium		On-going
System Wide	Lightning Strike	• SCADA/electrical upgrade/WTP upgrade will include additional lightning protection on electronic and electrical components	High		2023/2024 Funding dependant

3.3 Cybersecurity

The Cook Shire Council's network is set up to detect cybersecurity breaches. The breach is identified through the internal network security monitoring tools which includes gateways and anti-virus threat detection.

In the instance of a cybersecurity attack that gets through, the Council IT department would try to detect its origin, look at removing the computer from the network, restore information from backups.

To date, there have been no detectable cyber-attacks on our SCADA systems in Council.

Changes made to the Water Section in the cyber security space include, separate log in for individual employees when logging onto the SCADA system and the end of support for Windows 7 which has forced Council to migrate SCADA control software to the Windows 10 operating system.

All cyber security incidents/breaches are reported to the QGCIO. The details for the QGCIO are:
Queensland Government Information Security Virtual Response Team (QGISVRT).
Phone: 07 3215 3951
Email: qgisvrt@qld.gov.au
Website: www.qgcio.qld.gov.au

3.4 Outcome of recent incidents

Recent incidents for the Coen Water Scheme from 01 January 2021 to 31 March 2022.

Table 11 Recent water quality incidents

Date sample taken	Place	Parameter	Concentration	Action Plan
07 October 2021	Coen Depot	Chlorate	1.10 mg/L	Flushing of water main in town and continued monitoring of chlorate
01 March 2020	Coen	E.coli	Not done	Airplane disruptions during Covid 19 meant samples could not get to Cairns for analysis. In house Colisure analysis has now been introduced into Coen with quarterly E. coli verification to a NATA registered lab.

3.5 Chlorate Management Plan

The chlorate management plan below is based on the qldwater Chlorate Fact Sheet – Managing Chlorate Residuals.

Table 12 Chlorate Management Plan

Potential mitigation action	Action	Future Action
Reduce age of chlorine		
Work with supplier to reduce chlorate in source material	Coen orders 16 x 200L drums chlorine at a time. This is approximately a three month supply (also supplied to the Coen STP). Before the wet season, 5 months of supply is purchased	No action

	in case the road is closed. Chlorine is not currently tested for solution strength or pH.	
Work with supplier to minimise the time from manufacture to delivery and use	Coen is a remote community in Cape York. This would be difficult to achieve.	No action
Increase turn-over/delivery of hypochlorite	Coen is a remote community in Cape York. This would be difficult to achieve. Population is 328.	No action
Replace oversized tanks	Coen has 1 x 400L tank. This is filled as required. Operator is on-site during the day.	No action
Reduce rate of chlorate formation prior to use		
Dilute stock concentrations	Chlorine is diluted 200 chlorine to 180 water.	Action complete
Store solution in cool area and out of direct sunlight	Coen chlorination system is inside the WTP shed. It is out of direct sunlight. The roller door to the treatment plant is up during the day and there are louvres on the opposite wall to provide air flow through the WTP.	No action
Control the pH of stored hypochlorite solutions at pH 11-13, even after dilution	Action: This option will be investigated.	Investigate
Rinse sodium hypochlorite storage tanks between refills	When the chlorine tank is low, small amount of chlorine left is discarded. Tank is cleaned out each time before refilled with chlorine. This occurs on average every 3-4 weeks.	Continue
Ensure processes and maintenance are optimized		
Optimise the chlorination process to avoid high doses of chlorine	Set point for Chlorine disinfection levels in Coen is 0.9 mg/L. This cannot be lower and still maintain disinfection to the end of the mains.	No action
Optimize the coagulation, flocculation, sedimentation, filtration processes to reduce chlorine demand	Water goes through a Dissolved air floatation unit, coal filter and then through membrane filtration. Alum is used as coagulant. Water is very low in alkalinity which makes the floc very small. Optimization of the plant has been done over its 27 year life span.	No action
Reduce chlorine demand of reservoirs and networks caused by biofilm and sediment	Coen reservoir is cleaned every two years. Water mains are flushed once a year. The water team does not have the capacity to increase the frequency of these options.	No action
Explore alternative disinfection options		
Converting to disinfection using chlorine gas	This option is considered too dangerous. The WTP is situated on a hill above town. Qldwater Disinfection Options for Water Service Providers Guidance Paper lists chlorine gas as high risk for very small remote places.	No action
Convert to onsite generation of chlorine	This will be investigated	Investigate
Additional Council Actions		
Chlorate samples taken every three months	Sampling includes E. coli and therefore the tap is sterilized before samples are taken. Staff have two options. Option 1 is the use of alcohol wipes to sterilize the tap. Samples can then be taken (including chlorate) or Option 2 is to take the chlorate	Continue

	sample, then sterilize the tap with liquid chlorine and then take the E. coli sample last.	
Chlorate detected	If chlorate is detected, the regulator and QH will be notified	Continue
Chlorate detected in two consecutive samples	If chlorate is detected in two consecutive samples then a "do not consume" notice will be discussed with QH. This is considered a long-term exceedance.	Continue

4 OPERATIONAL PROCEDURES

In general CSC has few specific documented procedures for each process step as required under the ADWG. However, the operational limits are well defined, and actions are understood by the WTP operators. The following table forms the basis of more comprehensive operational procedures that will be developed over time.

Table 13 Coen WTP Operational Limits

Process Step /Location in System	Parameter	Operational Monitoring	Target Range	Monitoring Frequency	Operator Intervention Range	Report to Supervisor Range	Corrective Actions/ Comments
Treatment Plant Final Filtered Water	pH	Y	 <6.6 or > 8.4 6.6 - 6.8 or 7.6 - 8.4 6.8 – 7.6	Generally daily	<6.6 or >8.4	<6.5 or >8.5	• If low pH, check caustic dosing pump (or soda ash) Malfunction of caustic pump will cause pH to fall. • If high pH, check caustic dosing pump (or soda ash). The caustic dose rate may be too high. Check alum pump. If alum pump malfunctions and caustic is still being pumped then pH will be high.
	Turbidity	Y	 > 2 > 0.3 – 1 NTU < 0.2 NTU	Generally daily	0.3 – 1 NTU	>1 NTU	• If turbidity is over 0.3 NTU, chemical dosing may not be correct. Corrective actions include: ○ check alum pump, ○ check dose rate, ○ perform jar testing, ○ reset plant to new dose if required, ○ retest turbidity. • Plant will shut down at 2 NTU
	Chlorine - Residual	Y	 <0.4 & >3mg/L 0.4 – 0.6 and >2mg/L 0.6 -1.8 mg/L	Generally daily	<0.6 or >2.0 mg/L	<0.4 and >3 mg/L	• If chlorine is above 2.0mg/L - Check operation of chlorine dosing equipment. Check chlorine analyser is reading accurately using hand held analyser. Decrease chlorine dose as chlorine may have been added without dilution. • If chlorine is below 0.4mg/L - Check operation of chlorine dosing equipment, ensure no air bubbles in chlorine line. Check chlorine tank levels to ensure sufficiently chlorine. Check chlorine analyser using hand held unit. Increase chlorine dose.
	Colour	Y	 > 12 Hu 2 – 12 Hu <2 Hu	Generally weekly	2 – 12 Hu	>12 Hu	• Chemical Dosing not correct / Coagulation pH not at optimum point (5.8 - 6), perform jar testing to determine correct chemical doses, reset plant to new dose, retest Colour

	Aluminium	Y	 >0.15 mg/L 0.05 - 0.15 mg/L 0.0 -0.05 mg/L	Generally weekly	0.05 – 0.15 mg/L	>0.15 mg/L	• Chemical Dosing not correct / Coagulation pH not at optimum point (5.8 - 6), perform jar testing to determine correct chemical doses, reset plant to new dose, retest Aluminium

Documented procedures for Water and Wastewater are listed below:

Table 14 Cook Shire Council Water and Wastewater procedures

Number	Documented Procedure Name	Date of last revision	Area
WS 0001	Safe Handling of Sodium Hypochlorite	2021	All
WS 0002	Water Main Repairs	2021	Reticulation
WS 0003	DWQMP Annual Report Creation	2021	Admin
WS 0004	SWIM Annual Report Creation	2021	Admin
WS 0005	E. Coli Detection Reporting	2021	Admin
WS 0006	Water Mains Flushing and flushing for Low reticulation free chlorine residual	2021	Reticulation
WS 0007	Water Reservoir Cleaning	2021	Reticulation
WS 0008	Water Sampling	2021	Reticulation
WS 0009	Water Testing Coliforms & E.coli Analysis	2021	Annan Lab
WS 0010	Water Service - New Installation	2021	Reticulation
WS 0011	Water Mains - New Installation	2021	Reticulation
WS 0012	CIP Procedure Laura	2021	Treatment
WS 0013	Water Service Repairs	2021	Reticulation
WS 0014	Operation Procedure for Lakeland WTP	2021	Reticulation
WS 0015	Chlorine Analysers Maintenance Procedure	2021	Treatment
WS 0016	Jar Testing Procedure	2021	Treatment
WS 0017	Incident Notification	2021	Admin
WS 0018	Coagulation & Flocculation	2021	Treatment
WS 0019	Flow meter Calibration	2021	Admin
WS 0020	Working around sewage	2021	Sewage
WS 0021	High Pressure Sewer Cleaning	2021	Sewage
WS 0022	Troubleshooting DAF Plant Coen	2021	Treatment
WS 0023	Running the Coen Bore field	2021	Treatment

WS 0024	Recharging the Coen Bores	2021	Treatment
WS 0025	Using Hydrochloric Acid (Splash Park)	2021	Reticulation
WS 0026	Wastewater Sampling at the Coen STP (NATA lab)	2021	Sewage
WS 0027	Cleaning Baskets	2021	Sewage
WS 0028	Dealing with high flow at the Cooktown STP	2021	Sewage
WS 0029	Lakeland WTP Generator	2021	Treatment
WS 0030	Cooktown STP Generator	2021	Sewage
WS 0031	Detection of a chemical parameter above ADWG	2021	Admin
WS 0032	Splash Park Procedure	2021	Reticulation
WS 0033	Cyclone Preparation procedure - Lakeland, Laura and Cooktown (Using bore fields)	2021	Reticulation/Treatment
WS 0034	Cyclone Preparation procedure - Lakeland, Laura and Cooktown (not using the bore fields)	2021	Reticulation/Treatment
WS 0035	Cyclone Preparation procedure - Coen	2021	Reticulation/Treatment
WS 0036	Procedure in the event of environmental Incident	2021	Sewage
WS 0037	Boiled water alert (Media coordinator)	2021	Media liaison
WS 0038	Fire Service configuration and metering procedure	2021	Admin and Reticulation
WS 0039	E. coli analysis using Idexx	2021	Annan and Coen WTPs
WS 0040	High Level new chlorine analyser maintenance at the High Level Reservoir	2021	Reticulation
WS 0041	Power Outage at the Cooktown STP	2021	Cooktown Sewage
WS 0042	Pressure Decay Test Coen WTP	2021	Coen WTP
WS 0043	Pressure Decay Test Laura WTP	2021	Laura WTP
WS 0044	Lock out, tag out procedure	2021	All
WS 0045	Chemical Batching – Soda Ash – Annan WTP	2021	Annan WTP
WS 0046	Chemical Batching – Lime – Annan WTP	2021	Annan WTP
WS 0047	Chemical Batching – Alum – Annan WTP	2021	Annan WTP
WS 048	Running the Annan Generator	2021	Annan WTP

WS 0049	Activating bypass of two filters during	2021	Annan WTP
WS 0050	Sludge removal from the Annan sedimentation basin	2021	Annan WTP
WS 0051	Chemical Batching – Poly – Annan WTP	2021	Annan WTP
WS 0052	Run Annan WTP on 2 filters	2021	Annan WTP
WS 0053	Change or modify ABB drawers at Cooktown STP	2021	Cooktown STP
WS 0054	Water meter reading	2021	Reticulation/Rates
WS 0055	Sodium Hypochlorite concentration test	2021	Annan WTP
WS 0056	Annan Water Treatment Plant – Water testing procedure	2021	Annan WTP
WS 0057	Water sampling process for One Drive	2021	Reticulation and Treatment Plants
WS 0058	Clean Y strainer	2021	Annan WTP
WS 0059	Bore Flushing	2021	Bores
WS 0060	Septic waste disposal at the Cooktown STP	2021	Cooktown STP
WS0061	DAF Maintenance Procedure	2021	Coen WTP
WS 0062	Calibrate 4670 Turbidity meter	2021	Water Treatment Plants

5 OPERATIONAL AND VERIFICATION MONITORING

Operational monitoring is the monitoring undertaken by CSC to ensure that the water treatment barriers are operating effectively. This monitoring provides confidence that we are producing safe water. Operational monitoring is conducted by the WTP operators. Where any value exceeds the ADWG health guideline in treated or reticulated water, the Manager Water and Wastewater is immediately informed – this initiates a Medium level incident.

Verification monitoring is undertaken to ensure that the water that we supplied to our customers did meet the ADWG health guideline values. *E coli* sampling is predominantly internal, and all other monitoring is undertaken externally. Certificates of analysis are reviewed immediately upon receipt, and if a value exceeds the ADWG Health Guideline value, the Manager Water and Wastewater is informed, and the incident and emergency response activated (this is defined as a Medium level incident). Verification monitoring data is reported in our annual report.

5.1 Sampling Locations

Operational monitoring occurs at a number of steps through the WTP process, and these are identified in the tables that follow.

Additionally, there are sample locations for both operational and verification monitoring that are located on the trunk main, at reservoirs, and in the reticulation network. These are detailed below.

Table 15 Reticulation sample locations

Sample Location Name	Street Name	Site Chosen Because	GPS Coordinates *
Kindy Corner	Cnr Peninsular Dev. Rd and Reservoir Rd	Water Main "Tees" at this point and close to the Kindy	13°56'38.31"S - 143°12'11.52"E
Heritage House	Regent Street	Ease of access and in the centre of the town	13°56'39.41"S - 143°11'56.84"E
Coen School	Taylor Street	Central, and close to the School	13°56'43.83"S - 143°11'59.12"E
Cultural Centre	Shephard Street	Towards the "End of Line"	13°56'58.55"S - 143°11'53.53"E
Guest House	Regent Street	Central and "Ease of Access"	13°56'39.19"S - 143°12'2.22"E
Old National Parks Office	Coleman Close	Towards the "End of Line"	13°56'23.50"S - 143°11'57.44"E
Lutheran Church	Off Port Stewart Road	Towards the "End of Line"	13°56'58.37"S - 143°12'1.14"E
CSC Depot	Lankelly Drive	Towards the "End of Line"	13°56'27.13"S - 143°12'17.21"E
Okalaka Street	Okalaka Street	Across bridge on the northern side of town	13°56'24"S - 143°12'05"E

- * GPS co-ordinates extracted from Google Earth

The above sample locations give a good cross section of the town including the dead end areas as shown in the figure below.

Figure 10 Reticulation sampling locations

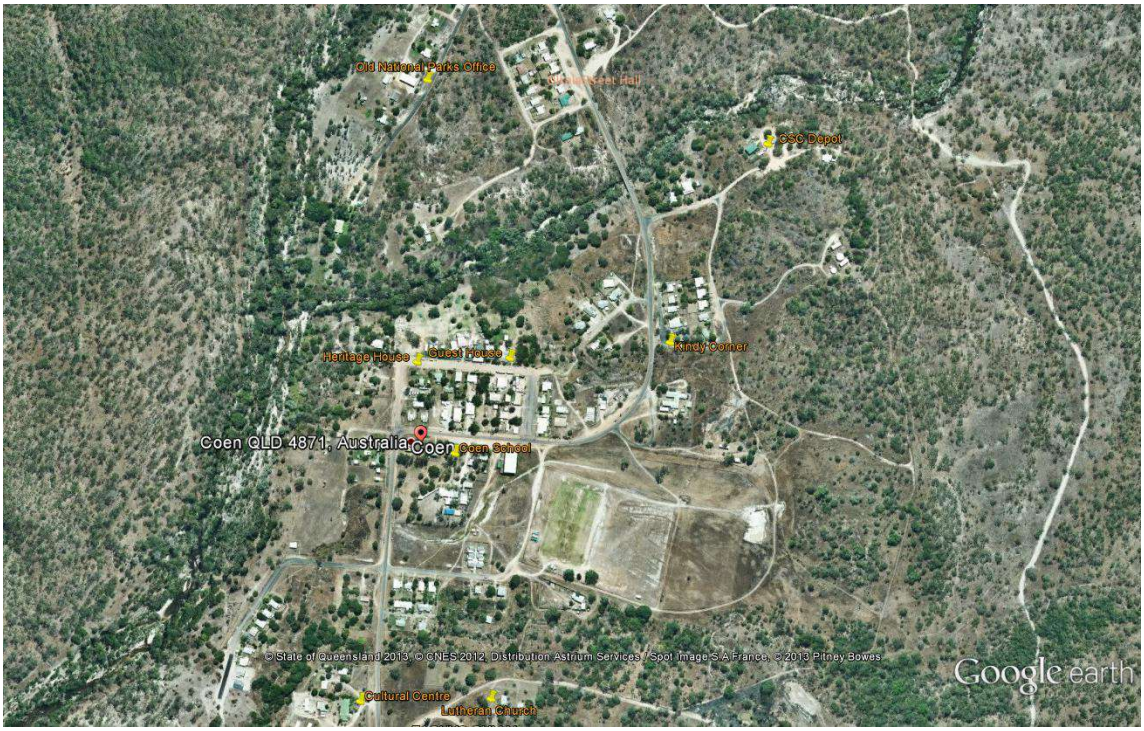


Table 16 Operational/Verification monitoring tables

Process Step / Location in System	Parameter	Sampling			Is this sample Verified by a NATA registered Lab	Operational Monitoring Comments
		Location	Frequency	Type		
Treatment Plant Raw water	pH	Coen Raw Water tap	Daily	Grab	Y	Analysed by Cook Shire Council staff at the Coen WTP. Verified quarterly by NATA registered lab
	Alkalinity		Weekly	Grab	Y	
	Turbidity		Daily	Grab	Y	
	Colour		Daily	Grab	Y	
	Electrical Conductivity		Weekly	Grab	Y	
Treatment Plant Raw water	**Physical / Chemical Analysis.** pH, Electrical Conductivity, Alkalinity, Chloride, Ca, Mg, Na, Fluoride, Total Hardness, Turbidity, Colour apparent, Salinity & Silicon	Straight from water source	Quarterly	Grab Sample	Y	N.A.T.A. Certified Lab
	Metals Analysis Includes parameters: As, Ba, Cd, Co, Cu, Fe, Mn, Ni		Quarterly	Grab Sample	Y	N.A.T.A. Certified Lab
Coen Bores	E. coli	Individual bore: Shepard's bore Bore 5 Bore 10	Yearly	Grab Sample	N	Coen Lab
	Physical / Chemical Analysis. pH, Electrical Conductivity, Alkalinity, Chloride, Ca, Mg, Na, Fluoride, Total Hardness, Turbidity, Colour apparent, Salinity & Silicon	Bore 10 combined bore sample	Yearly	Grab Sample	Y	N.A.T.A. Certified Lab
	Metals Analysis Includes parameters: As, Ba, Cd, Co, Cu, Fe, Mn, Ni	Bore 10 combined bore sample	Yearly	Grab Sample	Y	N.A.T.A. Certified Lab
Treatment Plant Final Filtered Water	pH		Daily	Grab	Y	Analysed by Cook Shire Council staff at the Coen WTP. Verified quarterly at a NATA registered lab
	Alkalinity		Weekly	Grab	Y	
	Turbidity		Daily	Grab	Y	
	Colour		Daily	Grab	Y	
	Electrical Conductivity		Weekly	Grab	Y	
	Free Chlorine Residual		Daily	Continuous / Grab	N	

	Aluminium	Coen Final Treated Water tap	Weekly	Continuous / Grab	Y	Verified Twice a year by NATA registered lab
	Free Chlorine Residual		On Line	Continuous/ Grab	N	Chlorine residual on display on Chlorine analyser in dosing room
	Physical / Chemical Analysis. pH, Electrical Conductivity, Alkalinity, Chloride, Ca, Mg, Na, Fluoride, Total Hardness, Turbidity, Colour apparent, Salinity & Silicon		Quarterly	Grab Sample	Y	N.A.T.A. Certified Lab
	Metals Analysis Includes parameters: As, Al, Ba, Cd, Co, Cu, Fe, Mn, Ni		Quarterly	Grab Sample	Y	N.A.T.A. Certified Lab
	Total Coliforms and E. Coli		Weekly	Grab Sample	Y	Analysed by CSC Coen Lab
Coen Reticulation	Chlorine Residual	9 Locations in Coen Systematically rotated through sites in table 10. One site per month	Monthly	Grab Sample	Y	Analysed by Cook Shire Council staff at the Coen WTP. Verified quarterly by NATA registered lab
	pH		Monthly	Grab Sample	Y	
	Turbidity		Monthly	Grab Sample	Y	
	Colour		Monthly	Grab Sample	Y	
	Electrical Conductivity		Monthly	Grab Sample	Y	
	Alkalinity		Monthly	Grab Sample	Y	
	Physical / Chemical Analysis. pH, Electrical Conductivity, Alkalinity, Chloride, Ca, Mg, Na, Fluoride, Total Hardness, Turbidity, Colour apparent, Salinity & Silicon		Quarterly	Grab Sample	Y	N.A.T.A. Certified Lab
	Metals Analysis Includes parameters: As, Al, Ba, Cd, Co, Cu, Fe, Mn, Ni		Quarterly	Grab Sample	Y	N.A.T.A. Certified Lab
	Trihalomethanes including Chloroform, Bromodichlormethane, Dibromochloromethane, Bromoform and Total Trihalomethanes. Oxyhalides including chlorate		Quarterly	Grab Sample	Y	N.A.T.A. Certified Lab
	Total Coliforms and E. Coli	As above. Two samples per week	Weekly	Grab Sample	Y	CSC Coen Lab. Verified quarterly by NATA registered lab

- Samples that are verified in a NATA registered Lab for physical/chemical are split in half. Half is analysed by CSC staff at the Coen WTP and the other half is sent to a NATA certified laboratory.
- All water samples are collected by the Water Treatment Plant operators all of which have had the appropriate training to collect water samples. Samples collected for verification are transported to Cairns by Air / Road Transport, and analysed by NATA accredited Laboratories, currently Cairns Regional Council.

6 WATER QUALITY CHARACTERISATION

6.1 Review of the Coen Raw Water data

Table 17 Coen Raw Bore Water Quality (Analysed by NATA Lab)

Parameter	Sampling Location	Time Period	No of samples taken in time period	Summary of results		
				Min Value	Max Value	Avg Value
Alkalinity mg/L	Coen Bores Sampled from the Bores	1 July 2017 to 31 March 2022	5	16.0	260.0	103.9
Calcium mg/L			5	2.4	77.0	27.1
Chloride mg/L			5	7.7	209.0	102.6
Colour Apparent Pt/Co			5	14.0	110.0	50.7
Electrical Conductance µS/cm			5	1.4	1,400.0	405.6
Fluoride mg/L			5	0.09	1.10	0.04
Total Hardness mg/L			5	9.8	340.0	118.0
Magnesium mg/L			5	0.69	37.0	12.4
pH			5	7.0	7.9	7.3
Potassium mg/L			5	1.0	2.9	1.8
Salinity mg/L			5	40.0	690	280
Silicon mg/L			5	13.0	54.0	29.1
Sodium mg/L			5	9.0	190.0	76.5
Total Dissolved Solids mg/L			5	78.0	780.0	326.0
Sulphate mg/L			5	1.7	22.0	9.2
Turbidity NTU			5	1.1	22.0	8.9

Table 18 Coen Dam Raw Water Quality (Analysed by NATA Lab)

Parameter	Sampling Location	Time Period	No of samples taken in time period	Summary of results		
				Min Value	Max Value	Avg Value
Ammonia Nitrogen	Coen Dam Raw Water Sampled from the Coen Dam	1 July 2017 to 31 March 2022	18	0.020	0.070	0.24
Nitrate (LIMS CALC)			19	0.010	0.06	0.02
Nitrite mg/L			21	0.010	0.010	0.010
Alkalinity mg/L			27	9.6	260.0	29.8
Calcium mg/L			27	0.97	73.0	5.14
Chloride mg/L			27	5.1	260.0	18.79
Colour Apparent Pt/Co			27	2.1	150.0	59.2
Electrical Conductance µS/cm			27	41.0	1400.0	126.86
Fluoride mg/L			27	0.07	1.1	0.19
Total Hardness mg/L			27	5.8	320.0	22.19
Magnesium mg/L			27	0.83	33.0	2.26
pH			27	6.90	9.70	7.43
Potassium mg/L			27	0.74	5.0	1.2
Salinity (psu)			19	33	72.1	44.03
Silicon mg/L			19	33	70	40
Sodium mg/L			27	4.8	170.0	16.84
Total Dissolved Solids mg/L			27	65.0	790.0	100.48
Sulphate mg/L			27	1.0	22.0	2.43
Turbidity NTU			27	0.2	54.0	15.1
Arsenic mg/L			24	0.0080	0.0403	0.0189
Barium mg/L			24	0.0070	0.1560	0.0426
Beryllium mg/L			24	0.0001	0.0010	0.0003
Cadmium mg/L			24	0.0001	0.0069	0.0005
Chromium mg/L			24	0.0002	0.0010	0.0006
Cobalt mg/L			24	0.0005	0.0050	0.0008
Copper mg/L			24	0.0010	0.1650	0.0114
Iron mg/L			24	0.0400	1.5500	0.4541
Lead mg/L			24	0.0005	0.0030	0.0011
Manganese mg/L			24	0.0010	1.000	0.1438
Mercury mg/L			23	0.00006	0.00006	0.00006
Nickel mg/L			24	0.0001	0.0177	0.0013
Selenium mg/L			24	0.0020	0.0050	0.0028
Vanadium mg/L			24	0.0001	0.0010	0.0005
Zinc mg/L			24	0.0020	0.1190	0.0196

Parameter	Sampling Location	Time Period	No of samples taken in time period	Summary of results		
				Min Value	Max Value	Avg Value
Cylindrospermopsin ug/L			4	0.20	9.3	2.5
Cylindrospermopsis raciborskii cells/ml			10	145	139,340	24,120

Table 19 Coen Lankelly Creek Raw Water quality (Analysed by NATA Lab)

Parameter	Sampling Location	Time Period	No of samples taken in time period	Summary of results		
				Min Value	Max Value	Avg Value
Alkalinity mg/L	Coen Lankelly Raw Water Sampled from the River	1 July 2017 to 31 March 2022	6	8.4	15.0	10.1
Calcium mg/L			6	0.70	7.40	1.78
Chloride mg/L			6	13.0	22.0	15.6
Colour Apparent Pt/Co			6	15.0	36.0	21.9
Electrical Conductance µS/cm			6	62.0	100.0	74.3
Fluoride mg/L			6	0.03	0.11	0.06
Total Hardness mg/L			6	5.0	33.0	9.6
Magnesium mg/L			6	0.76	3.60	1.25
pH			6	6.8	7.2	7.1
Potassium mg/L			6	1.1	15.0	3.1
Salinity (psu)			6	35.0	52.0	40.0
Sodium mg/L			6	9.1	54.0	16.2
Sulphate mg/L			6	1.0	1.6	1.1
Total Dissolved Solids mg/L			6	55.0	68.0	68.0
Turbidity mg/L			5	1.2	3.3	1.8
Arsenic mg/L			22	0.001	0.023	0.002
Barium mg/L			22	0.007	0.023	0.011
Beryllium mg/L			22	0.0001	0.001	0.0002
Cadmium mg/L			22	0.0001	0.0069	0.0003
Chromium mg/L			22	0.0002	0.001	0.0004
Cobalt mg/L			22	0.0005	0.005	0.0007
Copper mg/L			22	0.0010	0.1650	0.0053
Iron mg/L			22	0.0400	0.6240	0.1302
Lead mg/L			22	0.0005	0.0005	0.0006
Manganese mg/L			22	0.0010	0.1250	0.0105
Mercury mg/L			4	0.00006	0.00006	0.00006
Nickel mg/L			22	0.0020	0.005	0.0023
Selenium mg/L			22	0.0020	0.005	0.0023
Vanadium mg/L			22	0.0001	0.001	0.0003
Zinc mg/L			22	0.0020	0.1190	0.1132

6.2 Review of the Coen Treated Water data

Table 20 Coen WTP Final Treated Water quality (Analysed by NATA Lab)

Parameter	Sampling Location	Time Period	No of samples taken in time period	Summary of results			Australian Drinking Water Guidelines guideline value (2011)	No of samples exceeding Australian Drinking Water Guidelines guideline value
				Min Value	Max Value	Avg Value		
Alkalinity - mg/L CaCO3	Coen Final Treated Water Sampling Tap	1 January 2017 to 31 March 2022	35	6.3	44.0	20.7		
Calcium - mg/L			35	0.86	6.3	2.4		
Chloride - mg/L			35	6.6	24.0	17.1	250 mg/L	0
Colour Apparent - Pt- Co			35	1.0	6.6	2.0	15 Pt/Co	0
Electrical Conductance			35	83.0	180.0	128.8		
Fluoride - mg/L			35	0.05	0.19	0.1	1.5 mg/L	0
Total Hardness - mg/L CaCO3			35	5.2	22.0	12.6	200 mg/L	0
Magnesium - mg/L			35	0.71	2.30	1.28		
pH			35	7.0	8.0	7.5	6.5 – 8.5	0
Potassium - mg/L			35	0.73	2.0	1.21		
Salinity - mg/L			35	44	89.2	65.6		
Sodium - mg/L			35	13.0	31.0	19.56		
Silicon mg/L			16	11.0	21.0	16.6		
Total Dissolved Solids - mg/L			35	60.0	120.0	84.9	600 mg/L	0
Sulphate - mg/L			35	1.0	15.0	10.7	250 mg/L	0
Turbidity – NTU			35	0.1	0.5	0.2	≤5 NTU	0
Arsenic mg/L			23	0.0002	0.006	0.002	0.01 mg/L	0
Barium mg/L			23	0.002	0.023	0.126	2.0 mg/L	0
Beryllium mg/L			23	0.0001	0.0010	0.0003	0.06 mg/L	0
Cadmium mg/L			23	0.0001	0.0001	0.0001	0.002 mg/L	0
Chromium mg/L			23	0.0002	0.001	0.0005	0.05 mg/L	0
Cobalt mg/L			23	0.0005	0.001	0.0006	0.01 mg/L	0
Copper mg/L			23	0.0010	0.0160	0.0032	2.0 mg/L	0
Iron mg/L			23	0.008	0.031	0.013	0.3 mg/L	0
Lead mg/L			23	0.0005	0.0010	0.0006	0.01 mg/L	0
Manganese mg/L			23	0.0002	0.2040	0.0145	0.5 mg/L	0
Mercury mg/L			20	0.00006	0.0001	0.00006	0.001 mg/L	0
Nickel mg/L			23	0.0005	0.001	0.0006	0.02 mg/L	0
Selenium mg/L			23	0.0020	0.0050	0.0028	0.01 mg/L	0
Vanadium mg/L			23	0.00001	0.001	0.0004		
Zinc mg/L			23	0.005	0.037	0.0111	3.0 mg/L	0

Table 21 Coen WTP Final Treated Water quality (Analysed by CSC Coen WTP Operators)

	pH	Turbidity NTU	Colour Pt/Co Units	Alkalinity mg/L	Aluminium mg/L	Electrical Conductivity uS/cm²	Free Chlorine Residual mg/L
Count	1,694	1,694	1,657	109	190	110	1,691
Min	6.07	0.00	0.0	0.9	0.0	24.0	0.31
Max	7.79	2.81	100	59.0	0.28	264.1	4.00
Average	6.94	0.38	2.5	16.7	0.04	146.0	0.98

Dates sampled: 1 January 2017 to 31 March 2022

6.3 Review of the Coen Reticulation Water data

Table 22 Coen Reticulation Treated Water quality (Analysed by NATA Lab)

Parameter	Sampling Location	Time Period	No of samples taken in time period	Summary of results			Australian Drinking Water Guidelines guideline value (2011)	No of samples exceeding Australian Drinking Water Guidelines guideline value
				Min Value	Max Value	Avg Value		
Alkalinity mg/L CaCO3	Various Locations within the Coen Reticulation	1 January 2017 to 31 March 2022	34	6.4	230.0	35.1		
Calcium mg/L			34	1.3	58.0	7.2		
Chloride mg/L			34	10.0	180.0	28.6	250 - mg/L	0
Colour Apparent Pt- Co			34	1.0	8.8	2.7	15 – Pt/Co	0
Electrical Conductance			34	82.0	1100.0	195.8		
Fluoride mg/L			34	0.04	0.78	0.16	1.5 - mg/L	0
Total Hardness mg/L CaCO3			34	5.7	250.0	29.3	200 - mg/L	1
Magnesium mg/L			34	0.43	26.0	2.78		
pH			34	7.2	8.0	7.6	6.5 – 8.5	0
Potassium mg/L			34	0.75	1.80	1.16		
Salinity mg/L			31	40	540	100		
Sodium mg/L			34	13.0	120.0	26.1	180 - mg/L	0
Total Dissolved Solids mg/L			34	60.0	620.0	122.1	600 - mg/L	1
Sulphate mg/L			34	5.8	19.0	11.3	250 - mg/L	0
Turbidity NTU			34	0.03	1.50	0.46	≤5 - NTU	0
Arsenic mg/L			18	0.0002	0.0038	0.0018	0.01 mg/L	0
Barium mg/L			18	0.002	0.033	0.012	2 mg/L	0
Beryllium mg/L			18	0.0001	0.0001	0.0001	0.06 mg/L	0
Cadmium mg/L			18	0.0001	0.0001	0.0001	0.002 mg/L	0
Chromium mg/L			18	0.0002	0.001	0.0005		
Cobalt mg/L			18	0.0005	0.001	0.0006		
Copper mg/L			18	0.001	0.031	0.007	2 mg/L	0
Iron mg/L			18	0.008	0.107	0.019		
Lead mg/L			18	0.0005	0.0011	0.0006	0.01 mg/L	0
Manganese mg/L			18	0.0002	0.0512	0.0053	0.5 mg/L	0
Mercury mg/L			18	0.00006	0.00006	0.00006	0.006 mg/L	0
Nickel mg/l			18	0.0005	0.001	0.0006	0.02 mg/L	0
Selenium mg/L			18	0.002	0.005	0.003	0.01 mg/L	0
Vanadium mg/L			18	0.0001	0.0037	0.0007		
Zinc mg/L			18	0.005	0.041	0.013		

Table 23 Coen Reticulation Total Coliforms & E.coli (Analysed by NATA Lab and Coen Lab)

Parameter	Sampling Location	Time Period	No of samples analysed in time period	Summary of results		Australian Drinking Water Guidelines guideline value (2011)	No of samples exceeding Australian Drinking Water Guidelines guideline value
				No of Samples where E.coli was Detected	No of Samples where Total Coliforms were Detected		
Escherichia coli	**Various Locations within the Coen Reticulation**	1 January 2017 to 31 March 2022	584	0	-	**<1 CFU/100ml**	0

Table 24 Coen Reticulation Trihalomethanes and Chlorates (Analysed by NATA Lab)

Parameter	Unit	No of Samples collected	Summary of Results			ADWQ Guidelines Value (2011)	No of Samples exceeding ADWG or WHO		Time period
			Min. Value	Max. Value	Avg. Value		Health	Aesthetic	
Chloroform	µg/L	15	5	19	36	<250 µg/L	0	-	1 October 2018 to 31 March 2022
Bromodichloromethane	µg/L	15	5	22	11	<250 µg/L	0	-	
Dibromochloromethane	µg/L	15	5	5	5	< 250 mg/L	0	-	
Bromoform	µg/L	15	5	10	6	<250 µg/L	0	-	
Total Trihalomethanes	µg/L	15	8	47	15	<250 µg/L	0	-	
Chlorate	mg/L	15	0.161	1.690	0.573	<0.7 mg/L*	5	-	

Table 25 Coen Raw water E. Coli (Analysed by Coen WTP Lab)

Parameter	Sampling Location	Time Period	No of samples analysed in time period	Summary of Results		
				Min. Value	Max. Value	Avg. Value
Escherichia coli	**Coen Dam**	1 July 2018 to 31 July 2022	119	0	98	15
Escherichia coli	**Lankelly Creek**	1 July 2018 to 31 July 2022	59	2	970	90
Escherichia coli	**Bores**	1 July 2018 to 31 July 2022	32	1	150	32