Cook Shire
COUNCIL

Laura

Drinking Water Quality Management Plan

BLIGH
TANNER

+ DOCUMENT CONTROL SHEET

Bligh Tanner Pty Ltd
ABN 32 061 537 666

Level 9
269 Wickham Street
PO Box 612
Fortitude Valley
Qld 4006 Australia

T +61 7 3251 8555
F +61 7 3251 8599
blightanner@blightanner.com.au
blightanner.com.au

+ DOCUMENT

Laura Site Based DWQMP

+ JOB NUMBER

2015.521.400

+ PROJECT CONSULTANT

Dr Michael Lawrence

+ CLIENT

Cook Shire Council

+ CLIENT CONTACT

Robyn Maddalena

REGISTERED SERVICE PROVIDER: **COOK SHIRE COUNCIL**
ADDRESS: **10 FURNEAUX ST**
COOKTOWN, QLD, 4895
P.O. BOX 3

CONTACT DETAILS: **PHONE: 07 4069 5444**
FAX: 07 4069 5423
E.MAIL MAIL@COOK.QLD.GOV.AU

SPID. **511**

VERSION	AUTHOR	REVIEWED	APPROVED	DATE
V4	Michael Lawrence	Robert Fenn		29 March 2016
V4.1	Michael Lawrence	Robert Fenn	Robert Uebergang	15 April 2016
V4.2	Reviewed by Robyn Maddalena	Les Treloar/Wal Welsh	Robert Uebergang	23 April 2018

© Bligh Tanner Pty Ltd 2016

+ CONTENTS

LIST OF FIGURES

LIST OF TABLES

+ GLOSSARY

Term	Definition
ADWG	Australian Drinking Water Guidelines 2011
CSC	Cook Shire Council
DERM	Former Department of Environment and Resource Management
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 LAURA

1.1 Overview

Laura is a small community of ~125 people located approximately 80 km west from Cooktown; however, it is 150 km by road. The scheme is a bore scheme with 2 operational bores with aeration, microfiltration and chlorination for treatment.

1.2 Climate Summary

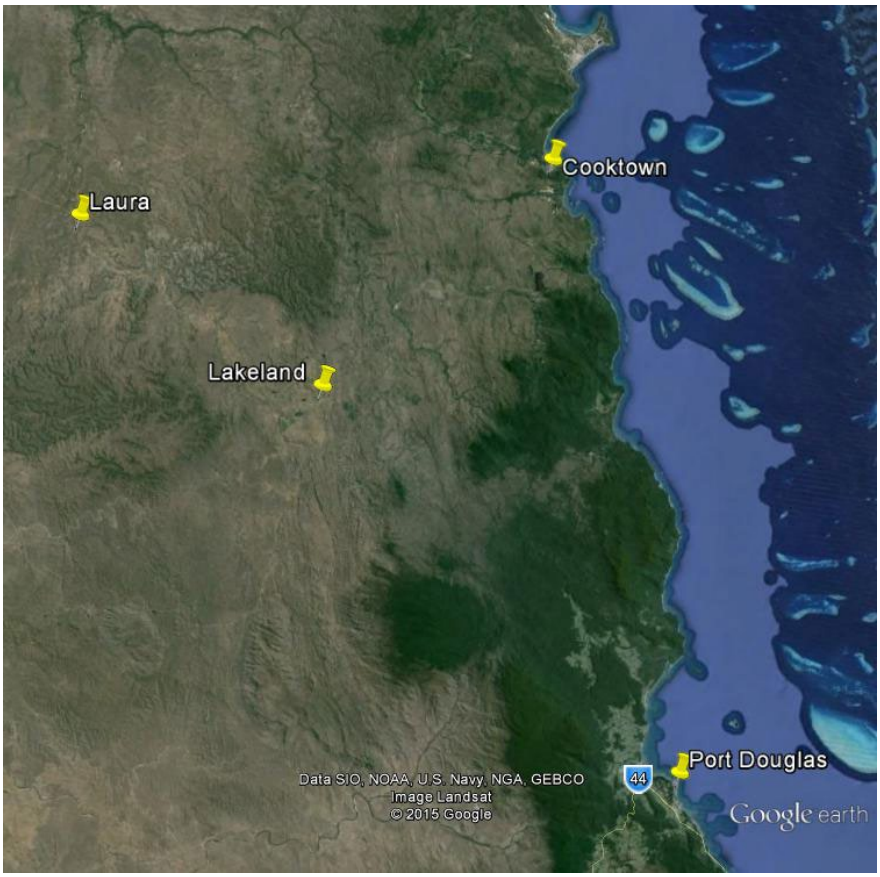
Laura is drier than Cooktown, but also has distinct wet and dry seasons. In general, there is little to no rain from around March/ April until the following wet season in December/ January.

Table 1 Laura Post Office Rainfall 1897-2015

Summary statistics for all years Information about climate statistics

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	230.7	247.5	176.2	35.3	9.3	9.2	3.4	2.4	3.0	16.6	58.5	149.6	932.6
Lowest	0.0	7.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	346.8
5th %ile	57.3	46.5	28.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.0	492.6
10th %ile	87.6	91.0	39.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	29.7	586.2
Median	212.4	251.3	147.1	19.8	2.0	1.5	0.0	0.0	0.0	3.3	33.8	115.9	928.1
90th %ile	380.6	395.5	336.2	80.1	31.3	30.3	9.1	5.8	7.9	52.3	154.5	314.3	1305.7
95th %ile	462.3	469.2	406.2	129.2	45.8	49.5	22.8	11.9	15.8	80.7	192.7	373.0	1435.7
Highest	786.4	596.6	540.3	252.6	78.8	94.9	54.4	78.7	54.3	141.2	331.7	433.7	1649.8

Figure 1 Location of Laura



2 INFRASTRUCTURE – LAURA

The Laura scheme uses bore water that is high quality with the exception of elevated levels of iron. The water treatment processes are primarily required to remove iron.

2.1 Laura Bores

Laura scheme utilises 2 bores located at the WTP site. Bore 2 was sunk first and is a 200 m deep bore with a diameter of 150mm. Council engaged a bore driller to ream out the bore to 200mm diameter in 1995, but the drill bit became stuck at ~35m, and the driller abandoned his drill bit. Subsequent attempts to remove the drill bit were also unsuccessful, however, a camera was passed down the borehole and showed that water can pass by the drill bit. Nonetheless, the stuck bit does limit the maximum depth of the bore pump, and lowers the yield of the bore. Hence Bore 2 is now predominantly used as a backup supply.

Bore 1 was drilled in 1996 to a depth of 150 m, through the Gilbert River and Dalrymple Sandstone. Bore 1 has a plastic casing, is grouted to a depth of 28 m, and taps aquifers at 70-76 and 118 to 148m depth. Water quality of the bore is very good with the exception of high levels of dissolved iron that require treatment.

Figure 2 Location of Infrastructure

2.1.1 Aeration and chemical oxidation (chlorination)

Due to the high iron in the raw water, raw water is dosed with chlorine prior to the water entering the top of the aeration tower which is mounted above a 22kL settling tank. A minimum of 0.8mg/L of chlorine residual in the settling tank is required to complete the oxidation process. The chlorine system is a recirculation system that operates continually to maintain 0.9 mg/L in the aeration tank.

2.1.2 Filtration

Filtration is through 2 x US Filter / Memcor 6M10V CMF Micro-Filtration units. Each unit has a bank of 6 membranes with a combined flow rate of 4.8 L/s. Each unit is backwashed (automatically) every 30 minutes of run time, and has a CIP (Clean in Place) every 168 Hrs of operation with citric acid. The

units have an annual "Full Service" by an external company, with Cook Shire staff performing intermediate maintenance; an electrician is also available as required. Both units are individually PLC controlled, both units receive a common Start / Stop signal, but either unit can be stopped independent of the other for maintenance or other reasons. 2 reciprocating air compressors supply the compressed air requirements of the 2 plants.

Both units are linked to the SCADA and can be monitored / controlled by water staff in Cooktown.
The filtrate from both units is pumped directly to the 300kL reservoir.

2.1.3 Disinfection

A second recirculation chlorination system operates on the Main Reservoir; however as the residual after treatment is normally already greater than the set point, the second chlorinator essentially works as a fully redundant backup for the oxidation chlorination step.

2.1.4 High Level Tanks

There are 2 x 48 kL poly tanks on a 10m high tank stand. The overhead tanks are filled with chlorinated water by the night pump as and when required. Water flows to the mains from the high level tanks at any time whilst the pressure pumps are not operating which includes night time. Only 1 tank is currently filling to ensure water is turned over regularly. A sampling point is available on the outlet of the tank for the monitoring of free chlorine residual.

2.1.5 Pressure pumps

A bank of 4 Grundfos CR8 – 40 vertical multistage pumps supply the pressure for the reticulation mains, these are all controlled through the PLC with input from the pressure sensor. One of the pumps becomes the daily duty pump, which runs continuously all day with the others cutting in and out as required, the duty pump is rotated daily to distribute wear & tear. This arrangement generally maintains mains pressure around 350 KPA and with all 4 pumps operating can supply approximately 18L/s The pumps pump directly into the reticulation mains with a flow meter recording the instantaneous flow as well as the accumulated total volume.

2.1.6 SCADA

The SCADA was setup to monitor and operate the Laura Water Treatment Plant as it's an unmanned facility. The SCADA shows equipment status, e.g. running, off or faulted, levels of most tanks, process air pressure, mains pressure flow rates and accumulated values, plant voltage and amps draw as well as all the details available from the filtration units.
Trending of numerous parameters is also available and via password protection operating parameters can be altered.

2.1.7 Reticulation Mains

The reticulation mains (installed by Cook Shire Council) were installed in 1996 and are all UPVC or poly, with a maximum of 400KPA available this is well within the pressure rating of the pipes (1200KPA) and consequently we have no leaks or bursts since their commissioning, the mains have regular scouring to promote healthy mains.

The reticulation mains in the Ang-Gnarra sub division which were installed by Ang-Gnarra contractors, (both sides of the Peninsula Development Road) were completed, inspected, pressure tested and signed off as being fully compliant by Cook Shire in August 2013

Table 2 Infrastructure details

Component		Laura
Sources	Name	*Laura*
	Type	*Bore 1*
	% of supply	*100*
	Reliability	*Has run constantly since 1996 with no supply issues*
	Water quality issues	*Elevated levels of iron in the raw water*
	Name	*Laura*
	Type	*Bore 2*
	% of supply	*0*
	Reliability	*Back up bore for bore 1*
	Water quality issues	*Elevated levels of iron in the raw water*
Bore Head Details	Year Bore/s Sunk	*1994*
	Bore Casing size	*150mm*
	Bore Casing Material	*CI 12 PVC with steel protection at the top*
	Sealed to prevent surface water ingress	*Yes, All the Bore Casings are typically 600mm above surface level & encased in concrete preventing surface water ingress*
	Sealed to prevent vermin (frogs / snakes etc.) from entering bore	*Yes, All bores sealed to prevent vermin (frogs / snakes etc.) from entering the bore*
	Aquifer Name	*Gilbert River Formation – Sub Artesian*
Sourcing Infrastructure	Type (pumped/gravity/equipped bore/etc)	*Electric submersible pumps fitted to each Bore*
	Description	*Both bores are at a depth of 200 metres, bore 2 has a drill bit stuck at approximately 36 metres and the bore pump is set above this level. The driller had no success removing the stuck bit.*
Laura Treatment Plant	Process	*Process comprises of Aeration, micro filtration and chlorination*
	Design Capacity (20 hr operation)	*0.36 ML/d*
	Daily flow range	*0.92 to 0.377 ML/d*
	Chemicals added	*Sodium Hypochlorite*
	Standby chemical dosing facilities (Y/N)	*No Duty /Standby, but there are 2 dosing pumps that inject Hypo into 2 separate locations. Both are PLC Controlled*
	Water sourced from and %	Water is sourced 100% from the bores
	% of average day demand provided % of scheme supply Distribution area supplied	100% 100%
	Bypasses / Variations	No
Disinfection(Primary)	Location Type Dose rate	*Laura Treatment Plant – Aeration Tank* *Sodium Hypochlorite Dosing* *Unknown (Dosing to maintain target residual level) PLC Controlled*
	Target residual levels	*0.8mg/L*
	Duty/standby	*No*
	Dosing arrangements	*PLC controlled with feedback from free chlorine residual analyser*

Component		Laura
	Alarms	*Yes (high and low chlorine)*
	Auto shut-off arrangements	*Primary dosing shuts down when chlorine residual target setpoint is reached , recommences dosing if target residual falls below target setpoint*
Disinfection (Secondary)	Location	*Laura Treatment Plant – Main Reservoir*
	Type	*Sodium Hypochlorite Dosing*
	Dose rate	*Unknown (Dosing to maintain target residual level)*
	Target residual levels	*0.8mg/L*
	Duty/standby	*No*
	Dosing arrangements	*PLC controlled with feedback from free chlorine residual analyser*
	Alarms	*Yes (high and low chlorine)*
	Auto shut-off arrangements	*Secondary dosing shuts down when chlorine residual target setpoint is reached , recommences dosing if target residual falls below target setpoint*
Storage Reservoir	Capacity (ML)	0.3 ML
	Roofed (Y/N)	Yes
	Vermin-proof (Y/N)	Yes
	Runoff directed off roof (Y/N)	Yes

2.1.8 Detailed Process Steps

Assuming the Clean Water Reservoir is full to start with.

The pressure pumps run continuously supplying the mains pressure to the township, the duty pump runs for 24 hrs, (duty pump is rotated daily) whilst the other 3 pumps cut in / out as required these are PLC controlled based on mains pressure i.e. If the demand suddenly increases and the pump/s currently running cannot maintain the pressure, then the mains pressure drops, this then starts the next pump in the queue, if that is still not sufficient to maintain the pressure then another will start, up till all 4 are running. Alternatively when the demand decreases the additional pumps will stop one by one until there is only the one left. There are 3 pressure accumulators to smooth out the stop / starts of the pumps, This 4 pump pumping unit whilst it does work, it is not as efficient and smooth as the 3 phase units with their variable speed drives and the ability to ramp the motors down with low flows.

Laura is serviced with a SWER (Single Wire Earth Return) Power line from Lakeland, this limits all electric infrastructures to single phase, so VSD pumps are not an option.

The Reservoir is drawn down by the pressure pumps. When the Reservoir level gets to 1.84m this then starts the 2 Memcor microfiltration plants, these draw chlorinated water from the aeration tank, filter the water through the micro filtration plants, and pumps the filtrate back to the clean water reservoir. When the water is lowered in the settling tank from the full level of 2.45m down to 2.25m the large bore pump starts (Bore1) this water passes through an aerator to the settling tank. The settling tank is chlorinated to the chlorine residual setpoint. As more raw water enters the aeration tank the chlorine residual decreases. There is a small pump constantly recirculating water with a chlorine residual analyser reading the chlorine level from the recirculated water. As the chlorine residual falls then the chlorinator will start pumping in sodium hypochlorite to raise the chlorine residual. This process continues until the clean water reservoir reaches the full level (2.44m) the first to stop is the 2 Memcor micro filtration plants, the bore continues to run until the aeration tank reaches its full level (2.45m) then stops. The sodium hypochlorite dosing pump will run until the target level is reached then stop.

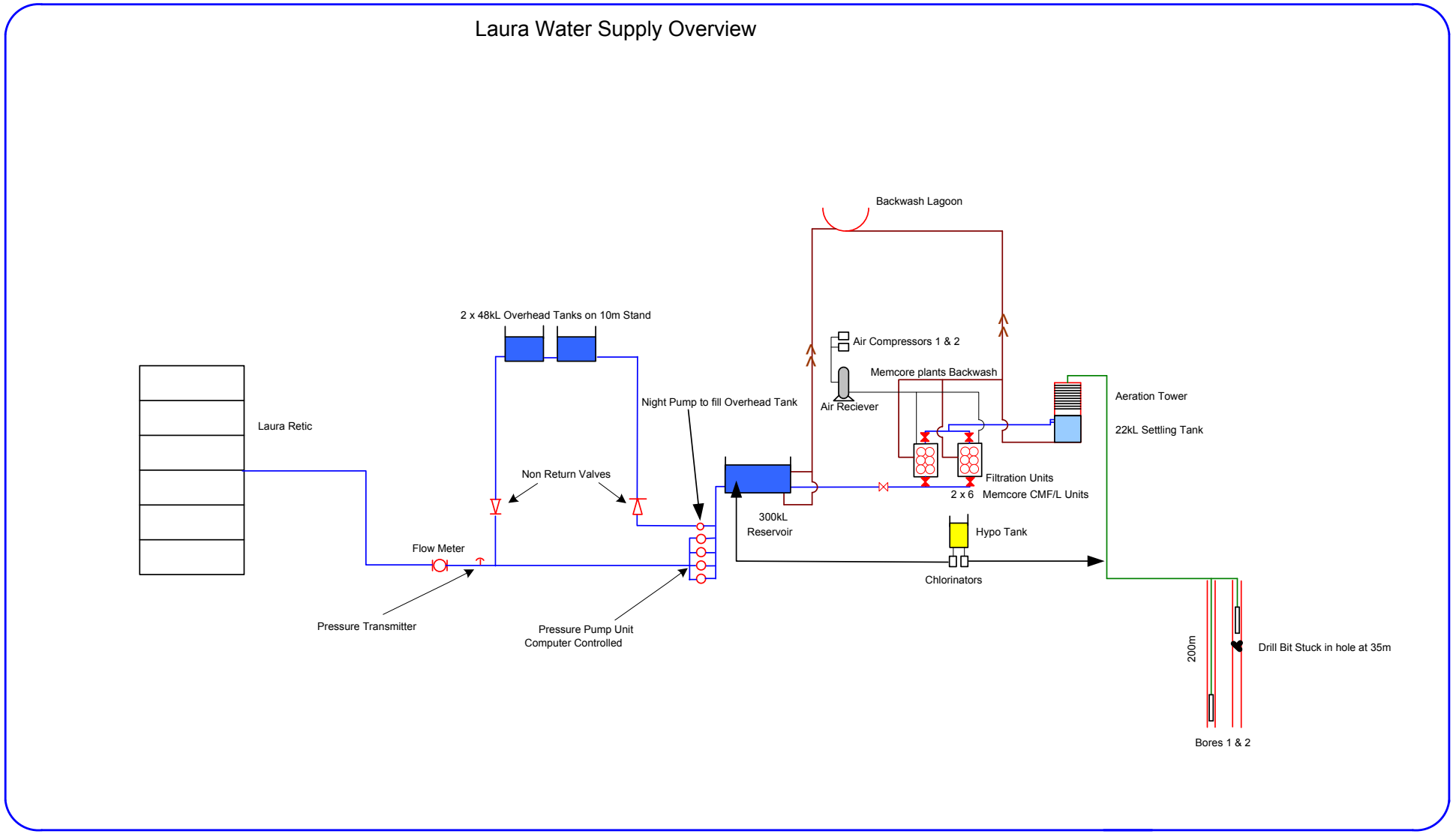
There are another 2 pumps (Duty / Standby) constantly recirculating water from the clean water reservoir with a second chlorine residual analyser reading the chlorine level from the recirculated reservoir water. As the chlorine residual falls then the second chlorinator will start pumping in Sodium hypochlorite to raise the chlorine residual.

The 2 Micro filtration Memcor plants together can produce water at the rate of 4.8 L/s whilst the bore pump produces more than 5L/s so consequently has been throttled back to match the plant output. Once started the plant runs for anywhere between 6 – 18 hrs / day depending on demand and the season.

The night time flow rate has been reduced to below 0.5 L/s and the daytime flow rates are now generally less the 2.0 L/s these are less than half of the previous figures.

The only chemicals used for water treatment at Laura are sodium hypochlorite and citric acid for CIPs.

Figure 3 Catchment to tap schematic – Laura



3 RISK ASSESSMENT

3.1 Laura Mitigated Risk Assessment

Following the hazard identification and unmitigated risk assessment detailed in the overarching plan, the Laura 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 3 Laura Risk Assessment

Laura 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			Immediate (17/18 FY)	2018/2019 FY	19/20 or later
Bores	Ingress into bore	bacteria and virus	High 16	Microfiltration disinfection	borehead sealed and inspection program	Major	Rare	Medium 5	Reliable	Final water has passed through microfiltration.			
	Ingress into bore	protozoa	High 16	microfiltration	borehead sealed and inspection program in place	Major	Rare	Medium 5	Confident				
	Septic contamination of aquifer	bacteria and virus	High 12	Disinfection	Microfiltration	Major	Unlikely	Medium 8	Certain				
	Septic contamination of aquifer	protozoa	Extreme 16	microfiltration	CED sewerage system operational in Laura	Major	Unlikely	Medium 8	Confident	Laura Wastewater CED scheme is operational. Septic tanks now overflow into CED system			

Laura 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			Immediate (17/18 FY)	2018/2019 FY	19/20 or later
	Bore pump failure	Failure of supply	Medium 6	Back up bore	Water restrictions can be implemented	Minor	Possible	Medium 6	Confident	Laura - heavily reliant on bore 1, bore pump 2 operates, and can supply with restrictions			
Aeration	Under dose chlorine	Iron	High 10	Chlorine addition	aerator will remove some iron in absence of chlorine, MF will remove a large percentage of iron	Minor	Possible	Medium 6	Confident	Water has good turbidity but high in colour in event of aeration failure			
Microfiltration	Filter breakthrough	Protozoa	Extreme 20	TMP monitored.	Membranes replaced in 2016	Moderate	Unlikely	Medium 6	Reliable	Annual servicing of membranes			
	Filter breakthrough	turbidity	Medium 6	Monthly turbidity monitoring	TMP monitored	Minor	Possible	Medium 6	Reliable		On-line turbidity meter on the final water		
	membrane fouling	restrict supply	Medium 8	Daily production monitored	CIPs done weekly	Minor	Unlikely	Low 4					
Disinfection	overdose	Chlorine	High 15	Target 0.5-1.3 mg/L critical at 4 mg/L and on-line analyser	Alarms and auto dialler	Minor	Possible	Medium 6	Confident	SCADA monitoring, and EDAC call outs			

Laura 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			Immediate (17/18 FY)	2018/2019 FY	19/20 or later
	insufficient dose	bacteria/virus	High 10	Target 0.5-1.3 mg/L	On-line analyser plus on screen alarms and EDAC call out	Moderate	Unlikely	Medium 6	Confident	Laura has 2 locations for chlorination plus bore water source (not surface water)			
	chemical breakdown	chlorate	High 12			Moderate	Likely	High 12	Unreliable			Begin THM sampling of final water	If chlorate is found, investigate solutions.
	ineffective disinfection due to turbidity	bacteria	High 10	Microfiltration	Disinfection plus low turbidity in raw water (bore water)	Minor	Rare	Low 2	Estimate	Iron floc can be cause of turbidity if membrane failed.			
Treated water storage/ Reservoirs	Ingress into reservoirs	bacteria virus	Extreme 20	Integrity and sealing	disinfection	Major	Unlikely	Medium 8	Confident	Reservoirs have been sealed			Laura reservoir to be considered for replacement after Lakeland
	Ingress into reservoirs	Protozoa	Extreme 20	Integrity and sealing	Reservoir inspection program	Major	Unlikely	Medium 8	Estimate	Reservoirs have been sealed			
	ingress of amoeba	amoeba	High 12	disinfection as above items	integrity	Major	Unlikely	Medium 8	Reliable	disinfection maintained in reticulation			
Reticulation	ingress of contaminated water	Bacteria virus	Extreme 20	network pressure, residual disinfection	mains break procedure	Major	Unlikely	Medium 8	Reliable	weekly reticulation monitoring	develop procedure to flush on low chlorine		

Laura 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			Immediate (17/18 FY)	2018/2019 FY	19/20 or later
	ingress of contaminated water	protozoa	Extreme 20	network pressure	mains break procedure	Major	Unlikely	Medium 8	Reliable		develop procedure to flush on low chlorine		
	Stagnant water in Laura High level reservoir	bacteria	Extreme 20	turnover through nightly shutdown of retic pumps	One reservoir off line	Major	Unlikely	Medium 8	Estimate	Currently do not meet minimum pressure overnight.	Install sampling point to monitor chlorine to ensure sufficient disinfection residual		
	biofilm growth	opportunistic pathogens	High 15	flushing program		Major	Rare	Medium 5	Estimate	Disinfection maintained.			
	Power failure	Failure of supply	High 12	Generators can run pressure pumps to get water to town	Water to town will come from elevated tanks is generator is not on	Moderate	Possible	Medium 9	Confident	SWER line more at risk			Generators may be required to run supply
	change in flow rate, reservoir run low, disturbing sediment in pipe	turbidity	Medium 6	Disinfection residual		Insignificant	Possible	Low 3	Confident				
	backflow	protozoa	Extreme 20	system integrity, backflow prevention on new installations		Major	Rare	Medium 5	Estimate				Taggle meters
System Wide	WTP Fire	Failure of supply	High 10	DMP		Catastrophic	Rare	Medium 6	Reliable				
	Cyclone	Failure of supply	High 10	DMP		Catastrophic	Rare	Medium 6	Reliable				

Laura 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			Immediate (17/18 FY)	2018/2019 FY	19/20 or later
	operator error	any	Extreme 25	training, experience, mentoring	All operators have Cert III in water operations	Major	Unlikely	Medium 8	Estimate	Checklists in place for operations at plant. Procedures currently being developed			
	Missing procedures	All	Extreme 25			Major	Possible	Medium 9		need to take staff offline to write procedures to mitigate risks			

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 4 Operational Limits used by operators/ SCADA.

Process Step / Location in System	Parameter	Operational Monitoring	Target Range	Monitoring Frequency	Operator Intervention Range	Report to Supervisor Range	Corrective Actions/ Comments
Final Treated Water	Iron	Y	 > 0.3 mg/L 0.2– 0.3 mg/L <0.2mg/L	Quarterly	0.15 – 0.2 mg/L	<0.2 mg/L	• Raw chlorine Dosing not correct / Raw dosing fault / Raw Chlorine Analyser Fault • Low Chlorine tank levels • Filtration membrane failure
	Free Chlorine Residual	Y	 <0.4 >3mg/L 0.4 – 0.6 and 2 - 3mg/L 0.6 -1.8 mg/L	Daily online analyser. Weekly hand held free chlorine meter	<0.6 and >2 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.

Table 5 Formal documented procedures used by CSC

Location	Documented procedure Name	S.O.P. No	Last Revision or Implementation	Process for implementing the procedure Activity and Frequency	Comments
Treatment	Chlorine Analyser Maintenance Procedure	WS0005	19/12/2017	Distributed to Relevant staff and training records through toolbox talks	This is a current Procedure
	Safe Handling of sodium hypochlorite	WS0001	12/12/2017	Distributed to Relevant staff and training records through toolbox talks	This is a current Procedure
	Performing a CIP	WS 0014	31/01/2018	Distributed to Relevant staff and training records through toolbox talks	This is a current Procedure
Reticulation	Water main new installation	WS0011	19/12/2017	Distributed to Relevant staff and training records through toolbox talks	This is a current Procedure
	Water mains repairs	WS0002	18/12/2017	Distributed to Relevant staff and training records through toolbox talks	This is a current Procedure
	Water service repairs	WS0013	19/12/2017	Distributed to Relevant staff and training records through toolbox talks	This is a current Procedure
	Water Mains Flushing / Scouring	WS0006	23/3/2012	Distributed to Relevant staff and training records through toolbox talks	This is a current Procedure
	Water Sampling	WS0008	10/12/2012	Distributed to Relevant staff and training records through toolbox talks	This is a current Procedure
	Water Reservoirs – Cleaning	WS0007	2/10/2012	Distributed to Relevant staff and training records through toolbox talks	This is a current Procedure
	Water Service – New installation	WS0010	19/12/2017	Distributed to Relevant staff and training records through toolbox talks	This is a current Procedure
	Water testing for Coliforms and E.coli	WS0009	31/01/2018	Distributed to Relevant staff and training records through toolbox talks	This is a current Procedure
	E.Coli detection reporting (to regulator)	WS0015	31/01/2018	Reporting by Manager only	This is a current Procedure

5 OPERATIONAL AND VERIFICATION MONITORING

Operational monitoring is 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 and NATA registered laboratory where CSC do not have the facilities to analyse parameters. Where any value exceeds the ADWG health guideline in treated or reticulated water, the Manager Water and Wastewater is immediately informed and the regulator is informed. A procedure is available for reporting E. coli detection to the regulator. The operational monitoring undertaken by CSC includes total coliforms and E. coli, colour, dissolved oxygen, electrical conductivity, pH, total dissolved solids, total hardness, turbidity and water temperature.

Operational monitoring is also undertaken by a NATA registered laboratory. This includes physical/chemical parameters and metals in the reticulation system, raw bore water and final water leaving from the Lakeland reservoir. A pesticide scan is done on Army bore yearly. 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 reported to the regulator.

Verification monitoring is undertaken to ensure that the analysis done by CSC is correct. *E coli* samples are taken weekly and analysed by CSC. Every three months the E.coli sample is split and sent to a NATA registered laboratory for analysis. Results are compared via the SWIM database Verification monitoring data is reported in our annual report.

5.1 Sampling Locations

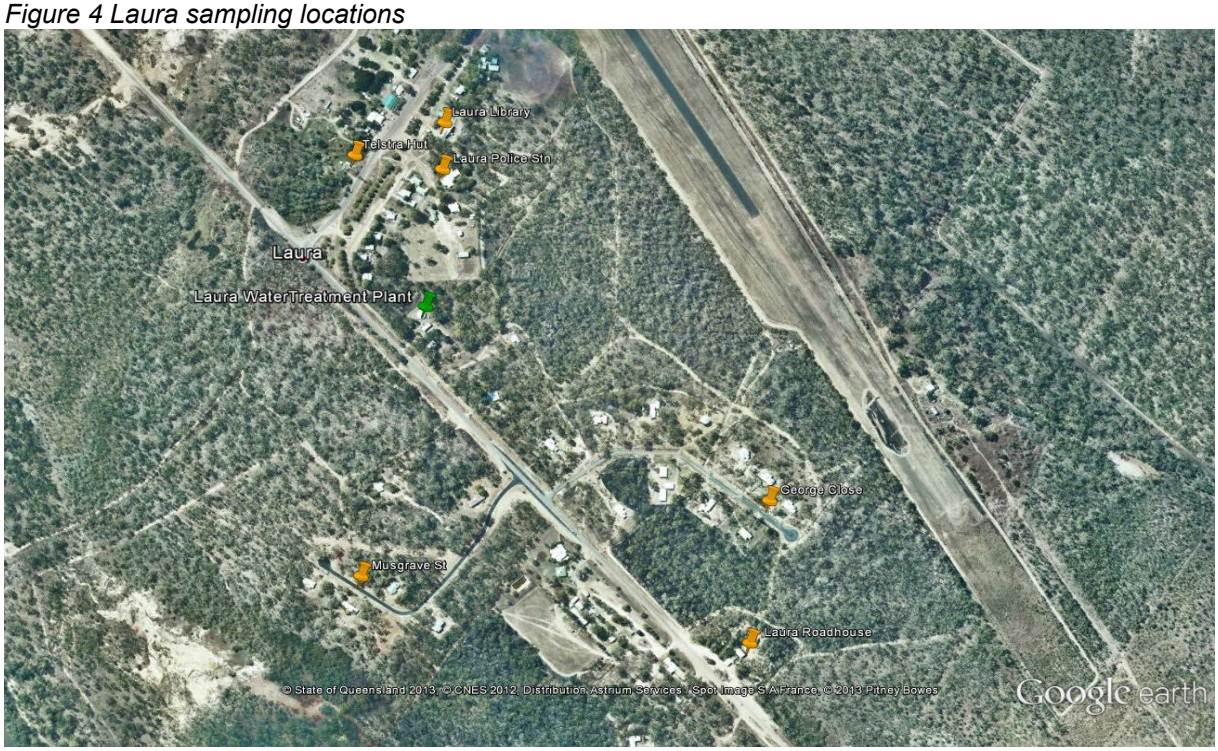
Operational monitoring occurs at a number of steps through the WTP process, and these are identified in the tables that follow.

Additionally, there are sample locations for both operational and verification monitoring that are located throughout the reticulation network. These are detailed below.

Table 6 Reticulation sample locations

Sample Location Name	Street Name	Site Chosen Because	GPS Coordinates *
Laura Roadhouse	Peninsula Development Rd	End of the line.	15°33'59.10"S - 144°27'3.32"E
Telstra Hut	Terminus St	Towards the end of the line.	15°33'32.89"S - 144°26'42.73"E
Laura Library	Terminus St	Ease of access	15°33'31.15"S - 144°26'47.43"E
Laura Police Stn	Gladwell Court	Centrally located	15°33'33.67"S - 144°26'47.32"E
End of George Close	George Close	Towards the end of the line.	15°33'51.48"S - 144°27'4.35"E
End of Musgrave St	Musgrave St	Towards the end of the line.	15°33'55.55"S - 144°26'43.10"E

Figure 4 Laura sampling locations



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

Table 7 Verification monitoring

Process Step / Location in System	Parameter	Sampling			Is this sample Verified by a NATA registered Lab	Operational Monitoring Comments
		Location	Frequency	Type		
Raw Water Composite Bore Sample	Physical / Chemical Analysis. Includes parameters: pH, Electrical Conductivity, Alkalinity, Sulphate, Chloride, Ca, Mg, Na, K, Fluoride, Total Hardness, SAR, L.I., Turbidity, Colour apparent, TDS, Salinity & Silica	Bores	Quarterly	Grab Sample	Y	NATA registered laboratory.
	Metals, Suite of 15 Includes As, Ba, Be, Cd, Cr, Co, Cu, Pb, Ni, Se, Fe, Mn, V, Zn, Hg.	Bores	Quarterly	Grab Sample	Y	NATA registered laboratory.
Treatment Plant Final	Physical / Chemical Analysis. Includes parameters: pH, Electrical Conductivity, Alkalinity, Sulphate, Chloride, Ca, Mg, Na, K, Fluoride, Total Hardness, SAR, L.I., Turbidity, Colour apparent, TDS, Salinity & Silica	WTP Final water to town	Quarterly	Grab Sample	Y	NATA registered laboratory.
	Metals, Suite of 15 Includes As, Ba, Be, Cd, Cr, Co, Cu, Pb, Ni, Se, Fe, Mn, V, Zn, Hg.	WTP Final water to town	Quarterly	Grab Sample	Y	NATA registered laboratory.
	Coliforms / E.coli	WTP Final water to town	Weekly	Grab Sample	Y	IDEXX Colisure method. Analysed at the Annan Water Treatment Plant by Cook Shire Council staff. Verified quarterly at NATA registered lab.
Reticulation	Physical / Chemical Analysis. Includes parameters: pH, Electrical Conductivity, Alkalinity, Sulphate, Chloride, Ca, Mg, Na, K, Fluoride, Total Hardness, SAR, L.I., Turbidity, Colour apparent, TDS, Salinity & Silica	Various Samples sites in the reticulation system. See Table 6.	Quarterly	Grab Sample	Y	NATA registered laboratory.
	Metals, Suite of 15 Includes As, Ba, Be, Cd, Cr, Co, Cu, Pb, Ni, Se, Fe, Mn, V, Zn, Hg.				Y	

	pH	Various Samples sites in the reticulation system. See Table 6.	Monthly	Grab Sample	Y	Samples analysed at the Annan Water Treatment Plant by Cook Shire Council staff. Verified quarterly at a NATA registered lab.
	Temperature				N	
	Alkalinity				Y	
	Turbidity				Y	
	Colour				Y	
	Electrical Conductivity				Y	
	Total Dissolved Solids				Y	
	Total Hardness				Y	
	Chlorine - Residual				Y	
	Coliforms / E.coli	Various Samples sites in the reticulation system. See Table 6.	Weekly	Grab Sample	Y	IDEXX Colisure method. Analysed at the Annan Water Treatment Plant by Cook Shire Council staff. Verified quarterly at NATA registered lab.

Verification samples for *E.coli* are split in half. Half is analysed by CSC Annan Staff using IDEXX and the other half is sent to a NATA certified laboratory.

Physical/Chemical samples are verified quarterly. Samples are split in half. Half is analysed by CSC Annan Staff and the other half is sent to a NATA certified laboratory.

All water samples are collected by either the Reticulation staff, or 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, and analysed by NATA accredited Laboratories (Cairns Regional Council Water Quality Laboratory at present).

In the event that a parameter being analysed exceeds the ADWG health guidelines, it is reported to regulation as per procedure WS0015.

6 WATER QUALITY CHARACTERISATION

Table 8 Raw water quality details

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
				Max. Value	Avg. Value	Min. Value		
Alkalinity	Laura Raw Bore Sampled from the Bores	1 July 2015 to 30 June 2017	8	96	77.5	63		
Calcium			8	5.7	4.3	2.8		
Chloride			8	55	27.4	17		
Colour Apparent			8	70	23.7	5		
Electrical Conductance			8	320	227.5	180		
Fluoride			8	0.17	0.15	0.13		
Total Hardness			8	18.0	14.1	9.0		
Magnesium			8	1.0	0.8	0.6		
pH			8	7.9	7.2	6.7		
Potassium			8	3.3	2.9	2.5		
Silica - Reactive			8	24	18.3	15		
Sodium			8	53	35.6	8.9		
Total Dissolved Solids			8	190	136	110		
Sulphate			8	4.8	4.1	3.6		
Turbidity			8	28	11.5	0.5		
Aluminium - *mg/L*			1	0.01	0.01	0.01	*0.2 mg/L*	
Arsenic *mg/L*			9	0.003	0.003	0.003	*0.01 mg/L*	
Barium *mg/L*			9	0.370	0.18	0.270	*2.0 mg/L*	
Beryllium *mg/L*			9	0.0001	0.0001	0.0001	*0.06 mg/L*	
Cadmium *mg/L*			9	0.0001	0.0001	0.0001	*0.002 mg/L*	
Chromium *mg/L*			9	0.001	0.001	0.001	*0.05 mg/L*	
Cobalt *mg/L*			9	0.001	0.001	0.001		
Copper *mg/L*			9	0.023	0.005	0.001	*1.0 mg/L*	
Iron *mg/L*			9	1.800	0.615	0.005	*0.3 mg/L*	
Lead *mg/L*			9	0.001	0.001	0.001	*0.01 mg/L*	
Manganese *mg/L*			9	0.190	0.084	0.005	*0.1 mg/L*	
Nickel *mg/L*			9	0.004	0.002	0.001	*0.02 mg/L*	
Selenium *mg/L*			9	0.003	0.003	0.003	0.01 mg/L	
Vanadium *mg/L*			9	0.005	0.003	0.005		
Zinc *mg/L*			9	0.490	0.060	0.005	3.0 mg/L	

Initial and subsequent testing has not revealed any parameter to be of concern to date, however annual sampling will continue, in the future the detection of any parameters and the concentrations will determine what action will be required

Table 9 Final Treated Water Quality (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
				Max. Value	Avg. Value	Min. Value		
Alkalinity - *mg/L CaCO3*	Laura Final Treated Water Sampling Tap	1 July 2015 to 30 June 2017	8	87	81.0	68.0		
Calcium - *mg/L*			8	6.3	6.05	4.6		
Chloride - *mg/L*			8	31.0	15.1	23.0	250 - *mg/L*	0
Colour Apparent - *Pt- Co*			8	5	5	5	15 – *Pt/Co*	0
Electrical Conductance			8	260	239	210		
Fluoride - *mg/L*			8	0.19	0.17	0.14	1.5 - *mg/L*	0
Total Hardness - *mg/L CaCO3*			8	20.0	17.8	15.0	200 - *mg/L*	0
Magnesium - *mg/L*			8	1.1	1.0	0.8		
pH			8	8.0	7.7	7.4	6.5 – 8.5	0
Potassium - *mg/L*			8	3.2	3.1	2.9		
Silica – Reactive - *mg/L*			8	26.0	22.9	18.0		
Sodium - *mg/L*			8	45.0	42.7	37.0	180 - *mg/L*	0
Total Dissolved Solids - *mg/L*			8	160	147	130	600 - *mg/L*	0
Sulphate - *mg/L*			8	4.1	3.8	3.6	250 - *mg/L*	0
Turbidity – *NTU*			8	0.5	0.5	0.5	5 - *NTU*	0
Arsenic *mg/L*			4	0.003	0.003	0.003	0.01 - *mg/L*	0
Barium *mg/L*			4	0.340	0.238	0.010	2.0 - *mg/L*	0
Beryllium *mg/L*			4	0.0001	0.0001	0.0001	0.06 - *mg/L*	0
Cadmium *mg/L*			4	0.0001	0.0001	0.0001	0.002 - *mg/L*	0
Chromium *mg/L*			4	0.001	0.001	0.001	0.05 - *mg/L*	0
Cobalt *mg/L*			4	0.001	0.001	0.001	0.01 - *mg/L*	0
Copper *mg/L*			4	0.042	0.038	0.001	2.0 - *mg/L*	0
Iron *mg/L*			4	0.031	0.021	0.005	0.3 - *mg/L*	0
Lead *mg/L*			4	0.001	0.001	0.001	0.01 - *mg/L*	0
Manganese *mg/L*			4	0.100	0.029	0.005	0.1 - *mg/L*	0
Nickel *mg/L*			4	0.001	0.001	0.001	0.02 - *mg/L*	0
Selenium *mg/L*			4	0.003	0.003	0.003	0.01 - *mg/L*	0
Vanadium *mg/L*			4	0.005	0.003	0.001		
Zinc *mg/L*			4	0.078	0.040	0.025	3.0 - *mg/L*	0

Table 10 Final Treated Water quality (Analysed by Cook Shire Council - Annan Lab)

	pH	Temperature °C	Electrical Conductivity uS/cm	Dissolved Oxygen mg/L	Colour Pt/Co Units	Turbidity NTU	Total Dissolved Solids mg/L	Total Hardness as mg/L CaCO3	Chlorine Residual mg/L
Count	23	5	23	23	23	23	8	23	23
Max	7.42	27.5	992.0	8.16	6.0	0.49	160.0	26	1.40
Min	6.59	17.7	237.1	1.87	0	0.01	127.3	15	0.40
Avg	7.41	23.08	297.8	5.94	4.1	0.17	140.8	32.2	0.80

A Review of the Final Treated Water data shows the Final water to be of a High Quality with all parameters within guideline values. Water quality complaints are a rarity. Samples taken

Table 11 Summary of Treated Water quality details – Laura Final Water (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
				Max. Value	Avg. Value	Min. Value		
Alkalinity - *mg/L CaCO3*	Various Locations within the Laura Reticulation as per Table 6	01 July 2015 – 30 June 2017	8	87.0	81.1	68.0		
Calcium - *mg/L*			8	6.3	5.5	4.6		
Chloride - *mg/L*			8	31.0	29.3	23.0	250 - *mg/L*	0
Colour Apparent - *Pt- Co*			8	5	5	5	15 *Pt/Co*	0
Electrical Conductance			8	260	238.7	210		
Fluoride - *mg/L*			8	0.19	0.17	0.14	1.5 - *mg/L*	0
Total Hardness - *mg/L CaCO3*			8	20	17.7	15.0	200 *mg/L*	0
Magnesium - *mg/L*			8	1.1	1.0	0.80		
Ph			8	8.0	7.72	7.4	6.5 – 8.5	0
Potassium - *mg/L*			8	3.2	3.1	2.9		
Silica – Reactive - *mg/L*			8	26.0	22.9	18.0		
Sodium - *mg/L*			8	45.0	42.2	37.0	180 *mg/L*	0
Total Dissolved Solids - *mg/L*			8	160	147	130	600 *mg/L*	0
Turbidity *NTU*			8	0.5	0.5	0.5	<5 NTU	0
Sulphate - *mg/L*			8	4.1	3.8	3.6	250 *mg/L*	0
Arsenic *mg/L*			4	0.003	0.003	0.003	0.01 *mg/L*	0
Barium *mg/L*			4	0.340	0.238	0.010	2 *mg/L*	0
Beryllium *mg/L*			4	0.0001	0.0001	0.0001	0.06 *mg/L*	0
Cadmium *mg/L*			4	0.0001	0.0001	0.0001	0.002 *mg/L*	0
Chromium *mg/L*			4	0.001	0.001	0.001	0.05 *mg/L*	0
Cob alt *mg/L*			4	0.001	0.001	0.001		
Copper *mg/L*			4	0.042	0.020	0.001	2.0 *mg/L*	0
Iron *mg/L*			4	0.031	0.021	0.005		
Lead *mg/L*			4	0.001	0.001	0.001	0.01 *mg/L*	0
Manganese *mg/L*			4	0.100	0.029	0.005		
Nickel *mg/L*			4	0.001	0.001	0.001	0.02 *mg/L*	0
Selenium *mg/L*			4	0.003	0.003	0.003	0.01 *mg/L*	0
Vanadium *mg/L*			4	0.005	0.003	0.001		
Zinc *mg/L*			4	0.078	0.040	0.005	3.0 *mg/L*	0

Table 12 Summary of Treated Water quality details (Laura Reticulation) (Analysed by Cook Shire Council)
These are sampled from the Laura Reticulation, at various locations and analysed at the Annan Lab by CSC

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
				Max. Value	Avg. Value	Min. Value		
Chlorine residual (Free) *mg/L*	Various Locations within the Laura Reticulation	01 July 2015 – 30 June 2017	23	1.40	0.8	0.40	<5	0
Colour Apparent - *Pt- Co*			23	6.0	4.1	0	15 – *Pt/Co*	0
Dissolved Oxygen *mg/L*			23	8.16	5.9	1.87		
Electrical Conductance			23	992	298	237		
Total Hardness - *mg/L CaCO3*			23	30	32.2	15	200 - *mg/L*	0
pH			23	7.4	7.13	6.59	6.5 – 8.5	0
Total Dissolved Solids - *mg/L*			8	160	141	127	600 - *mg/L*	0
Turbidity *NTU*			23	0.49	0.16	0.01	<5 NTU	0

Table 13 Summary of Total E.coli detected – Laura Reticulation

Parameter	Sampling Location	Time Period	No of samples analysed in time period	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		
Escherichia coli	Various Locations within the Laura Reticulation	1/07/2015 – 30/6/2017	122	0	Escherichia coli should not be detected in any 100 mL sample of drinking water.	0

Table 14 Summary of Laura Treatment Plant daily chlorine residual readings

	SCADA on line Chlorine readings (mg/L)
Count	720
Max	3.02
Min	0.04
Avg	0.96
No of samples recorded as below 0.3	0

The Laura chlorine residual level on the SCADA is typically > 1 mg/L. Where chlorine levels are below 0.8 we review operations, as iron removal may not be effective. Date Range: 01/07/2015– 30/06/2017