MOUNT ISA CITY COUNCIL

DRINKING WATER QUALITY MANAGEMENT PLAN

MARCH 2013

DOCUMENT AND VERSION CONTROL

The Drinking Water Quality Management Plan (DWQMP) is a controlled document. The signed document and version control sheet at the front of the document indicate the current version. Information within the appendices is to be updated as follows:

- Action plans 6-12 months (review with annual reporting requirement)
- Sub-plans 1-3 years
- Associated policies 1-5 years
- Business management plan 1-3 years

Revisions to individual pages or sections of the DWQMP will be indicated by a revision number and date added to the footer of the page, and noted in the version control table.

VERSION CONTROL SHEET

Date	Description	Version & Update Ref	Appendix or Page No.	Approved Initials
May 2012	Final	Version 1	All	
November 2012	Revision	Version 1.1	Section 3.2	
March 2013	Revision	Version 2.0	Mulitple	

TABLE OF CONTENTS

LIST OF APPENDICES

TABLE OF FIGURES

LIST OF TABLES

MOUNT ISA CITY COUNCIL
DRINKING WATER QUALITY MANAGEMENT PLAN

1 INTRODUCTION

This is the Drinking Water Quality Management Plan (DWQMP) for potable water schemes managed by the Mount Isa City Council (MICC); Mount Isa and Camooweal. This plan has been developed in accordance with the requirements of Section 93(3) of the *Water Supply (Safety and Reliability) Act 2008* (the Act). The DWQMP addresses the content requirement of the *Queensland Drinking Water Quality Management Plan Guideline* (the Guideline) (DERM 2010) and has been structured to follow the Guideline.

This plan contains (or references) all of the policies, procedures, and registers that are required to maintain drinking water quality for the MICC water supply systems. This plan refers to the four supporting documents listed below:

- Risk Assessment Report 2012
- Water Quality Report 2012
- Monitoring Plan 2012
- Improvement Plan 2012

1.1 SCOPE OF THE DWQMP

The Act requires that all drinking water service providers have an approved DWQMP in place. Section 95(1) of the Act states that each service provider must prepare a DWQMP for the provider's drinking water service and apply to the regulator for approval of the plan. Section 95(3) requires that the plan must be prepared in accordance with the Guideline. A DWQMP must address the following mandatory requirements, as outlined in Section 95 (3) of the Act:

- State the registered services to which the plan applies;
- Include details of the infrastructure for providing the services;
- Identify the hazards and hazardous events the drinking water service provider considers may affect the quality of water to which the services relate;
- Include an assessment of the risks posed by the hazards and hazardous events;
- Demonstrate how the drinking water service provider intends to manage the risks posed by the hazards and hazardous events; and
- Include details of the operational and verification monitoring programs under the plan, including the parameters to be used for indicating compliance with the plan and the water quality criteria for drinking.

Throughout the plan, grey boxes highlight parts of the Guideline that each section covers. Some sections that have been included are *Best Practice Recommendations* according to the Guideline. These are based on the Australian Drinking Water Guidelines (ADWG) elements that reflect current practices and promote safe supply of drinking water but are not requirements under the Act.

This DWQMP applies to the drinking water distribution service provided by the MICC for Mount Isa and the entire supply scheme for Camooweal. The MICC is a customer of the Mount Isa Water Board (MIWB) who supplies bulk potable water to a number of customers in the Mount Isa area. There are three major customers who are supplied drinking water from the MIWB and are as follows:

- The MICC is responsible for the distribution of drinking water to the city of Mount Isa (Figure 1). The city itself covers an area of 43,310 km^2 and has a population of around 22,000.
- The MICC is also responsible for the treatment and distribution of drinking water to Camooweal, a remote township with a population of 300 people.

Figure 1 The City of Mount Isa. Camooweal is 190 km North-West of Mount Isa on the Barkly Hwy.

1.2 REGISTERED SERVICE DETAILS

Criteria
The Plan must contain information on the registered service, including the:

- Service provider identification number (SPID)
- Service provider name and contact details – if the service provider is not the operator, then the operator's name and contact details must also be provided
- Name of each scheme to which the Plan applies
- Name of the communities that are supplied including the current and future (next 10 years) populations, connections and demands.

With the introduction of the *Water Supply (Safety & Reliability) Act 2008 (QLD),* water service providers are required to register as a drinking water service provider for the delivery of a drinking water service. The MICC is registered as a medium-sized drinking water service provider and details are in Table 1.

The population for the Mount Isa Statistical Local Area (SLA) for 2010 was 21,994 people according to the Australian Bureau of Statistics (ABS 2011). The Mount Isa SLA extends from just east of Mount Isa west to the Northern Territory border and encompasses Camooweal, Barkly and Gunpowder townships.

Table 1 Service Provider Details

Service Description		Details
Service Provider Identification Number (SPID):		91
Service Provider Name and contact details		Mount Isa City Council PO Box 815 23 West Street Mount Isa QLD 4825 Tel: 07 4747 3200 Fax: 07 4747 3209 Email: city@mountisa.qld.gov.au
Scheme that the plan refers to:		Mount Isa Drinking Water Supply System Camooweal Drinking Water Supply System
Communities served	**Current Population**	**Connections**
Mount Isa	21,994*	6335 (residential) 569 (commercial)
Camooweal	300**	100

* Bureau of Statistics 2010
** MICC

The Office of Economic and Statistical Research in May 2011 released the projected population 20 years into the future. Projections indicate the expected population of the Mount Isa City Council (therefore including Camooweal) by 2016 to be between 24,067 and 29,142 people (see Table 2).

The Mount Isa population is very reliant on the activities of the neighbouring Xstrata Mount Isa Mines (XMIM) who employs over 4,000 people. XMIM released a statement in May 2011 announcing that, although they plan to phase out the copper smelting operations, they intend to expand mining and concentrate production providing long-term employment to the area.

Table 2 Proposed Population Projection for Mount Isa from the Office of Economic and Statistical Research (Queensland Treasury) released in May 2011

	Projected population			Average annual change (medium series)	
	Low series	Medium series	High series	Number	Per cent
2011	22,228	22,338	22,523	245	1.1
2016	22,873	23,544	24,292	241	1.1
2021	23,490	24,858	26,180	263	1.1
2026	23,764	25,865	27,656	201	0.8
2031	24,067	26,927	29,142	212	0.8

Details of the schemes' projected demands are included in the Strategic Asset Management Plan (SAMP). Table 3 gives a summary of the proposed projected demand study carried out by Maunsell Australia in 2004 taken from the SAMP. Maunsell proposed that water demand could increase by 13,785 ML/a by 2014 due to a proposed development at Healy Heights and Gliderport. These developments have not yet commenced but will, however, need to be considered once approval is given.

Table 3 Water Supply Demand Projections for Mount Isa and Camooweal (Maunsell Australia)

Water Supply Services				
Mount Isa Water Supply Scheme				
Year	**Water Demand Average Day (ML/a)**			
	Base	Proposed Development		Total (Upper Limit)
		Healy Heights & Gliderport	Town Common	
Current	9,014	78	0	9,092
5 years	9,380	739	2,464	12,583
10 years	9,761	739	3,285	13,785
Camooweal Water Supply Scheme				
Water Demand Average Day (ML/a)				
Current	**5 years**	**10 years**		
127.8	127.8	127.8		

Figure 2 demonstrates that, although the population is gradually increasing, there has been an underlying decrease in water consumption over the past three years indicated by the black trend line. Two possible reasons for this are the water restrictions permanently imposed on the town and the reduction in water allowances for each home. The chart shows seasonal use patterns, with consumption higher during the dry winter months and lower in the wet summer months. Figure 3 displays the reliability of the system's source water, Lake Moondarra and Lake Julius. By comparing the two charts– consumption vs lake levels – a relationship between water use and rainfall can be observed. In summer, where the lakes suddenly rise to full capacity, consumption decreases. This is most likely due to lower outdoor water usage.

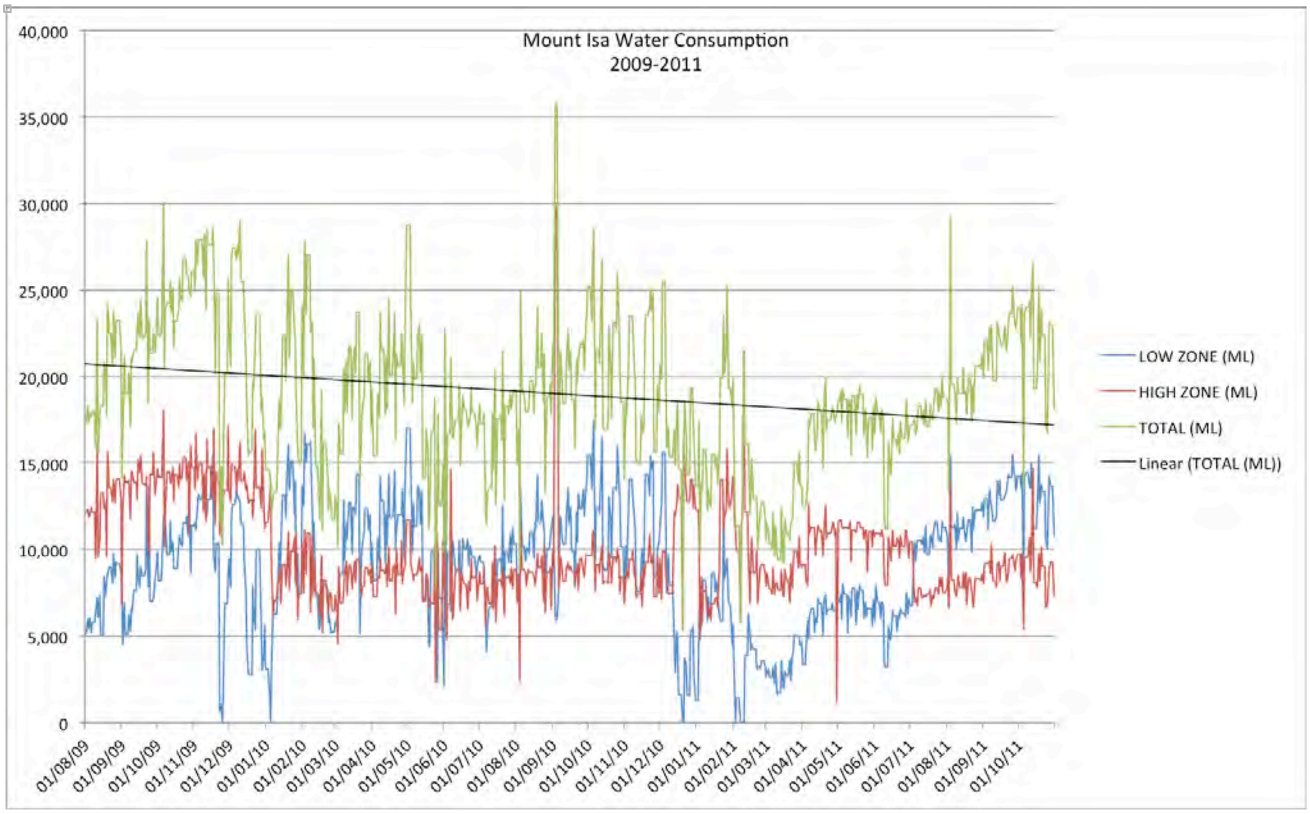


Figure 2 Chart Showing Water Consumption for High Zone, Low Zone and the Total (the black trend line indicates a possible decline in consumption over the past three years)

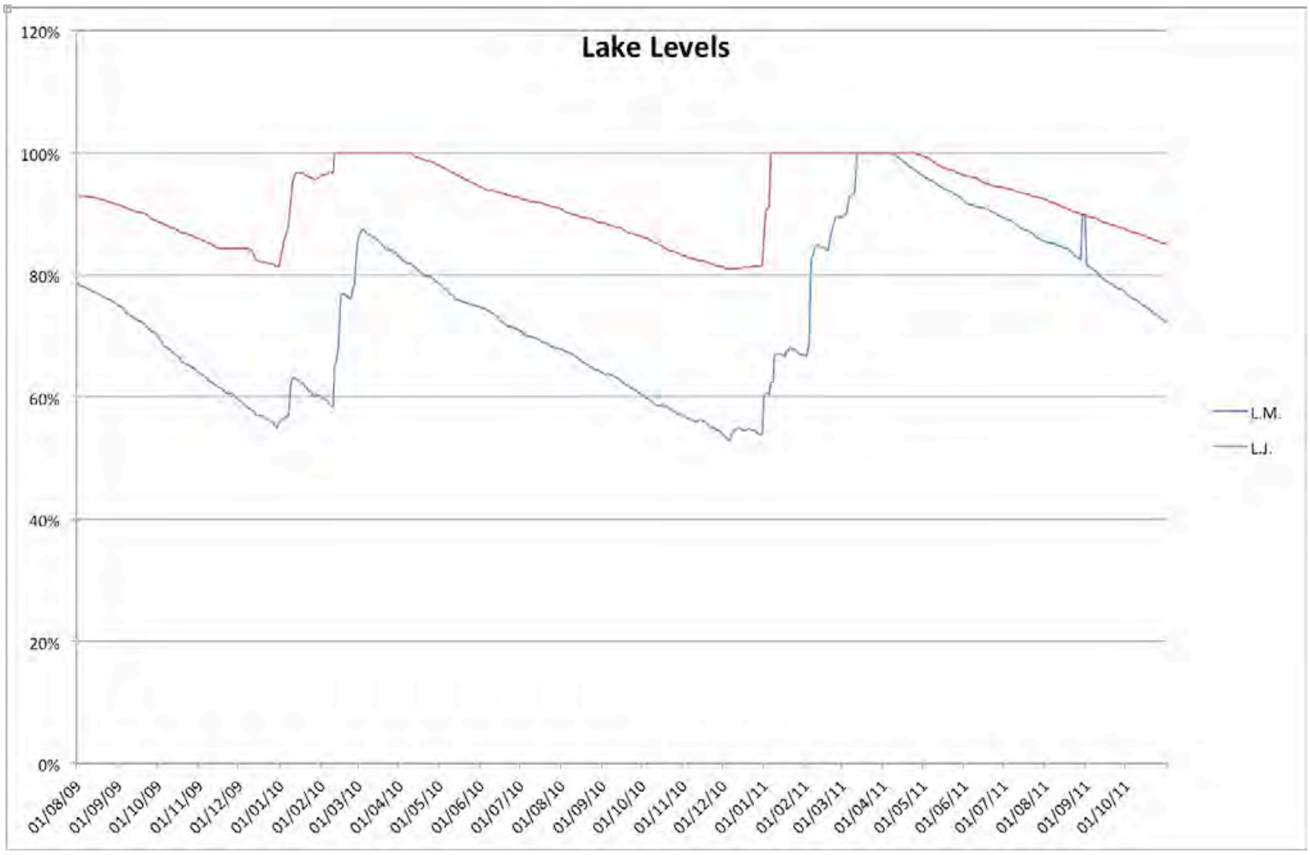


Figure 3 Chart Showing the Reliability of the Source Water from Lake Moondarra and Lake Julius

There is little information available on the water level of the groundwater at Camooweal. The bore has consistently supplied water since 1897 with few reported water quality issues. It is reported on the Australian Government website that the sustainable yield of the Georgina Unincorporated Area and the groundwater abstracted from its resources has not been quantified. However, it is estimated that the present abstraction levels are much less than maximum abstraction possible without any regional depletion of the groundwater resource. It is estimated that abstraction is between 30 and 70% of the sustainable yield (Australian Government 2009)

1.3 MOUNT ISA CITY COUNCIL

MICC operates the water supply and sewerage schemes in Mount Isa and Camooweal. Camooweal township is located at a distance of 190km from Mount Isa. The Water and Sewerage Schemes are a part of MICC's long-term vision of adopting a responsible and environmental practice and developing a vibrant and healthy community.

MICC has improved the quality of its water and sewerage management practice over recent years, however the problems of attracting staff in the Mount Isa environment have created a number of barriers to maintaining an efficient organisational structure. The organisational structure of the MICC Water Supply Sector is shown in Figure 4.

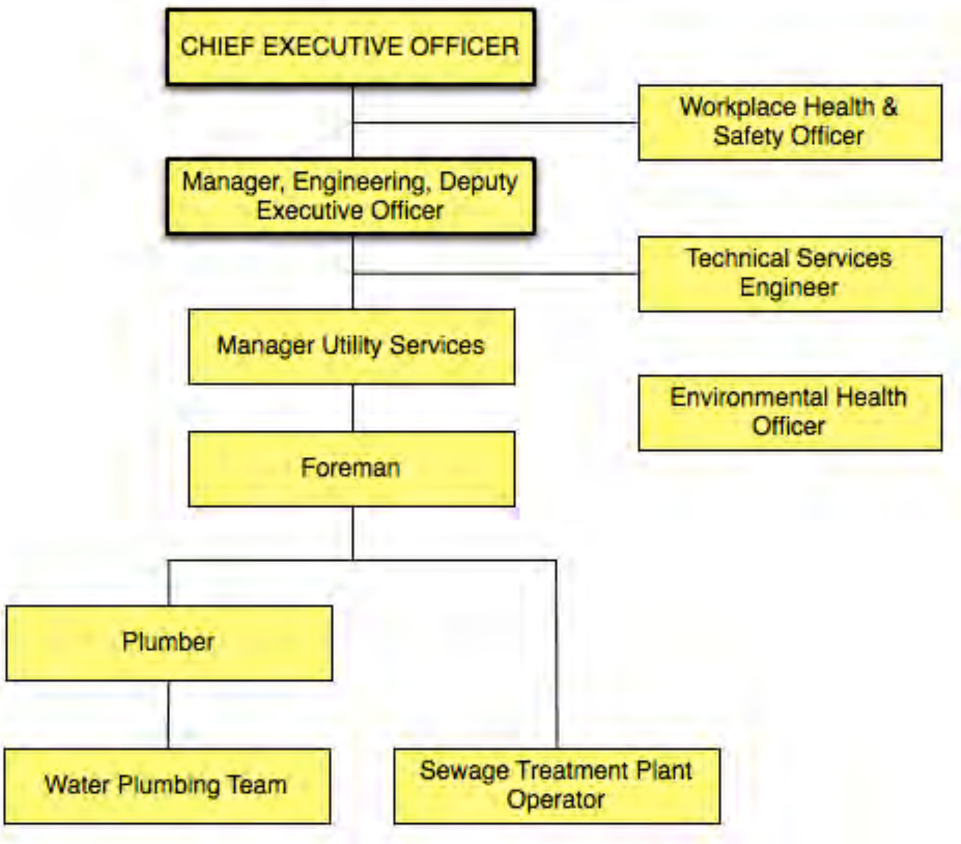


Figure 4 Organisational Structure – Water Supply Services (MICC 2012)

2 COMMITMENT TO DRINKING WATER QUALITY MANAGEMENT

Best Practice Recommendations

The ADWG states that organisational support and long-term commitment by senior executives is the foundation to implementation of an effective system for drinking water quality management. Successful implementation requires:

- An awareness and understanding of the importance of drinking water quality management and how decisions affect the protection of public health;
- The development of an organisational philosophy that fosters commitment to continual improvement and cultivates employee responsibility and motivation; and
- The ongoing and active involvement of senior executives to maintain and reinforce the importance of drinking water quality management to all employees as well as those outside the organization.

Senior executives should ensure that their actions and policies support the effective management of drinking water quality (e.g. appropriate staffing, training of employees, provision of adequate financial resources, active participation and reporting to the Chief Executive Officer).

2.1 DRINKING WATER QUALITY POLICY

MICC has a strong commitment to Drinking Water Quality Management. This has been demonstrated in the form of a Water Quality Policy approved by the Council and endorsed by the Chief Executive Officer of MICC and is attached in Appendix A.

This policy has been communicated to all staff and is available in both hardcopy and digital formats – the latter can be found on the organisation's IT intranet.

2.2 REGULATORY AND FORMAL REQUIREMENTS

2.2.1 Regulatory Scope

Under Section 92 of the Act, it is an offence to carry out a drinking water service without an approved Drinking Water Quality Management Plan (DWQMP).

A summary of all the relevant regulatory and other formal requirements relevant to MICC in addition to the Act is provided in the Legal and Other Requirements Register as shown in Appendix B.

There is also a Legislative and Other Requirements Register included in the MICC's Total Management Plan (TMP) that outlines the Council's responsibilities under a number of Acts that are listed and explained.

The Act and the Guideline outline the mandatory content of a DWQMP. These requirements are listed in Section 1 of this Plan. MICC prescribes that all treated water must comply with the ADWG water quality criteria.

2.2.2 Employee Responsibilities

The Chief Executive Officer is responsible for implementing and maintaining this DWQMP.

Those employees within the Water Supply Service Organisational Structure with responsibilities directly related to water quality management have those requirements relevant to their position reflected in their Position Description (PD).

The Drinking Water Policy provides a commitment to ensuring that managers, employees and contractors are aware of their responsibility to implement this plan. This DWQMP states where there are relevant responsibilities.

2.2.3 Identifying and Communicating Regulatory Changes

It is the responsibility of the Chief Executive Officer to ensure regulatory compliance. Changes to legislation and formal requirements are identified by notification from the Department of Environment and Resource Management through a subscription with the Queensland Parliamentary Council. Changes to the *Legal and Other Requirements Register* are made accordingly. If a change in legislation requires a change in practice, the owner of the relevant procedure is notified and changes are made accordingly.

Any changes to this DWQMP due to regulatory and formal requirements are to be communicated to relevant managers, employees and contractors.

2.3 ENGAGING STAKEHOLDERS

The Guideline requires information on key stakeholders for most sections of the plan. An overview is presented here.

Stakeholders are any entity that could possibly increase/decrease water quality risks. Several aspects of drinking water quality management require involvement with other agencies and stakeholders. Similarly, consultation with relevant health and other regulatory authorities is necessary for establishing many elements of a DWQMP, such as monitoring and reporting requirements, emergency response plans and communication strategies. This means establishing two-way communication paths with State Government Departments, MICC’s customers, contractors and providers.

A *Stakeholder and Communication Register* has been developed as shown in Appendix C, which identifies all stakeholders who could affect (or be affected by) decisions or activities of the MICC. The register lists each stakeholder’s contact details, their commitment and involvement with water quality, the frequency of communication between parties and the method of communication. The register is divided into two parts: details for incoming communication and details for outgoing communication. This register is maintained as required.

There are a number of stakeholders who could be classed as sensitive receptors and should be alerted immediately of water quality incidents that could affect their health. These include such customers as the hospital, nursing homes and kindergarten/prep schools. A list of sensitive receptors with phone numbers is located at the Council office.

3 DETAILS OF INFRASTRUCTURE FOR PROVIDING THE SERVICE

Criteria

The Plan must describe the details of the infrastructure for each scheme including the following:

- A schematic layout
- Source details
- Treatment process details for each drinking water source
- A description of any variations to process operation (for example, bypassing a process step)
- A schematic(s) representing the treatment process(es)
- Any sources that do not undergo a treatment process must be identified and an explanation as to why no treatment process exists must be provided
- Disinfection process(es) for each drinking water source
- Any sources that do not undergo a disinfection process must be identified and an explanation as to why no disinfection process exists must be provided
- Details of the distribution and reticulation system
- Key stakeholders, who have been actively involved in the management of drinking water quality, and their relevance

MICC is the local water distribution authority for both Mount Isa and Camooweal. These are two separate systems, the former a lake source and the latter a bore system. Details of the infrastructure for both systems are provided in detail in the SAMP. For the purpose of this plan, relevant details are in the following sections.

3.1 MOUNT ISA

3.1.1 Overview

To supply the township of Mount Isa, the MICC receives treated water from the MIWB before distributing to its approximately 22,000 consumers. Water for the Mount Isa City Water Supply is obtained from two dammed storages – Lake Julius and Lake Moondarra – on the Leichhardt River to the north of the city. Water is pumped from the lakes, owned by SunWater and Xstrata, respectively, by the MIWB. It is treated via a natural filtration system, pumped to the Mount Isa Terminal Reservoir (MITR) and disinfected before water is supplied separately to Mount Isa City and to the adjacent XMIM. From there, the Council is responsible for the distribution system (see Figure 5).

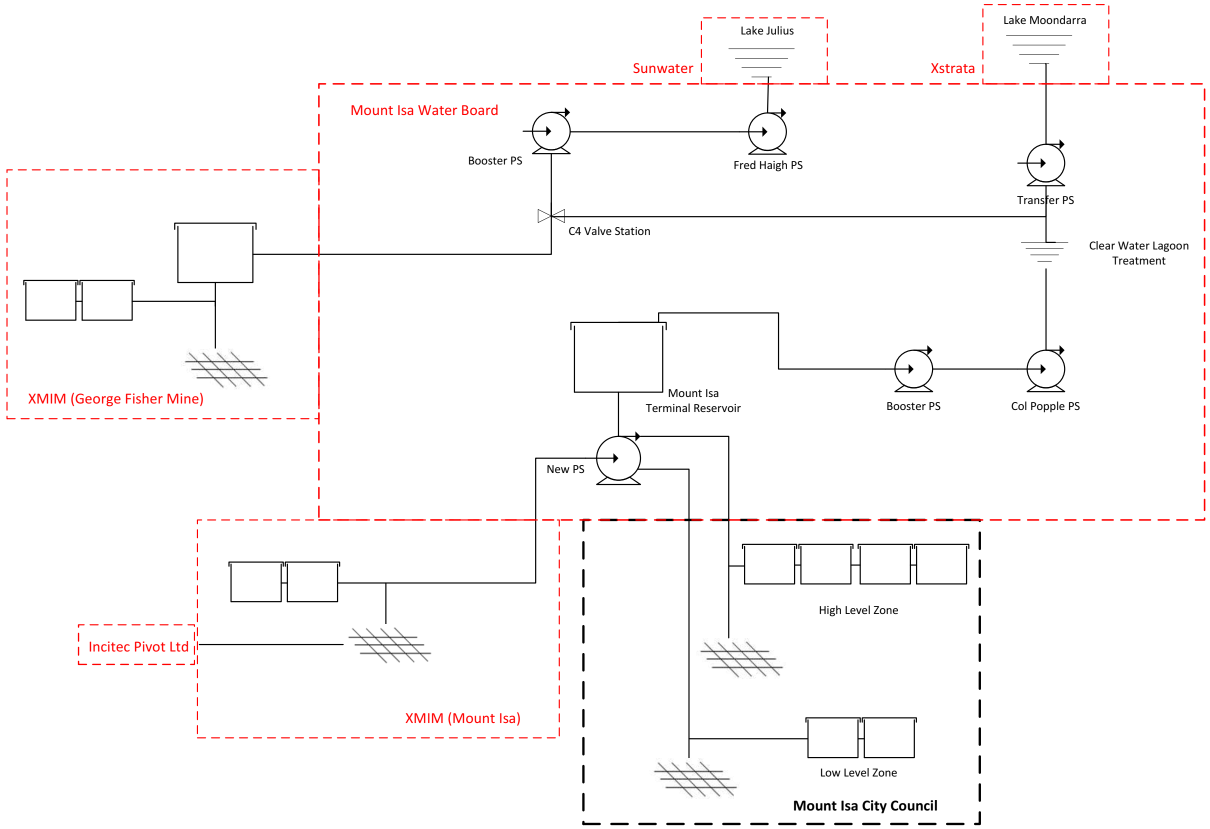


Figure 5 Mount Isa Water Supply Scheme Showing all Major Stakeholders Including the MICC

3.1.2 Process Description

The distribution system is divided into a high level zone serving the development on the hills in the south and east, and a low level zone serving development in the north and central parts of the city. The two zones have separate supply pumps at MITR with separate supply mains and reservoirs. The mains in each zone are interconnected at several locations and are normally isolated to prevent flow between zones.

Pumps at the interconnection points between the two zones were originally provided to boost flows from the low level zone to the high level zone. The subsequent construction of the separate supply from the MITR to the high level service reservoirs has obviated the need for the booster pumps. The booster pumps have, however, been retained to provide a means of emergency supply to the high level zone from the low level supply.

Figure 6 provides a schematic of the distribution system. Distribution maps showing topography and engineering designs are attached in Appendix D and were used to assist in the preparation of the Plan.

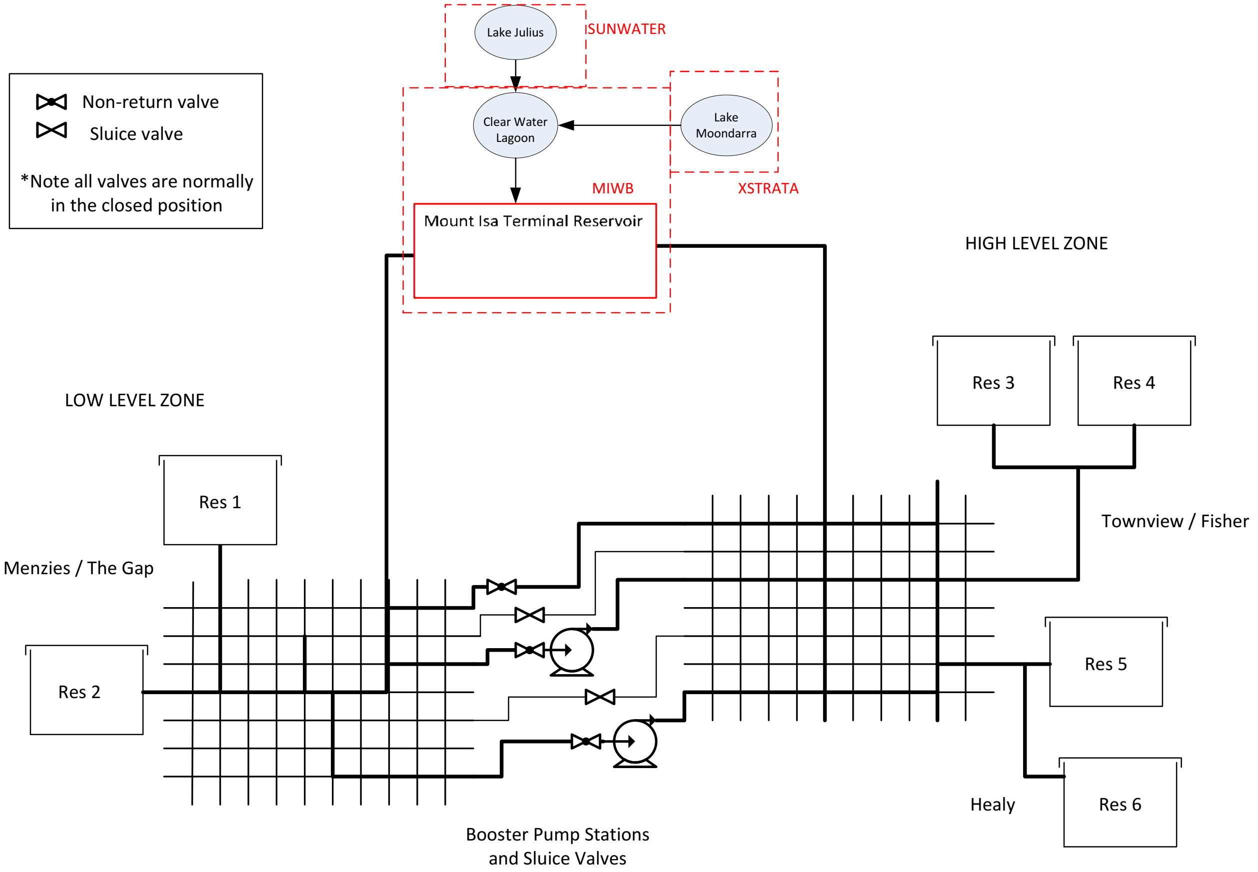


Figure 6 Mount Isa City Council Water Distribution System Schematic

3.1.3 Asset Details

3.1.3.1 Pipelines

There are 175km of water mains in Mount Isa. Details of the pipe assets are shown in Table 4. A large portion of the reticulation was constructed in the 1960s at a time when asbestos cement pipes were used in this type of network. The performance of asbestos cement pressure pipes has proven to be variable, with significant failures occurring in some areas, while other areas are still performing adequately. It is expected that the failure rate in asbestos cement pipes will increase.

Pipe renewal is based on repair history. Repair history and records indicate "scattered" repairs, rather than a consistent failure of individual pipes. This has led to a targeted replacement program. Small diameter pipelines are replaced on failure.

Areas to the far south and far north of the city at the end of the trunk mains are dead ends and can have long detention times although they do get flushed out by tankers collecting water. The worst areas for long detention times are Nathan Street in the north, and south of 23rd Avenue in the south.

Table 4 Distribution and Reticulation Infrastructure Information

Distribution and reticulation	Mount Isa
Pipe material	Asbestos cement pipes being replaced by MDPE
Age range	1960-present (see Table 5)
Approximate total length	175km of mains
Areas where potential long detention periods could be expected	Areas to the far south and the far north of the city at the end of the trunk mains are dead ends and can have long detention times. They get flushed out by tankers collecting water. Reservoirs have an inlet and outlet at the top so some water could potentially become aged at the bottom of the tank.
Areas where low water pressure (eg < 12 m) could be expected during peak or other demand periods)	n/a

Condition assessment information is in Table 5 in the form of expected economic life.

Table 5 Mount Isa Assets: Age and Life Expectancy

Asset type	Est. age (years)	Expected Economic life (years)	Remaining Life (years)
Storage – Reservoir 1	60	100	40
Storage – Reservoirs	38	100	62
Reticulation – Steel Pipes	50	100	50
Reticulation – MDPE	9	90	89
Reticulation – Asbestos Cement	50	70	20
Pump Stations	6 6 4	20 20 20	24 24 26
Fittings – Fire Hydrants	22	60	38
Fittings – Valves	28	60	32
Fittings – Flow meters	1	20	19

3.1.3.2 Storages

Water supplied from the MITR travels via two separate trunk mains. Water is distributed to reticulation before reaching the reservoirs. The reservoirs serve as storage and provide pressure. There are six reservoirs in total and it is estimated that there is just above a day's storage of water in the MICC reticulation system, as detailed in Table 6.

The Low Zone water supply contains Reservoirs 1 & 2 and is controlled by a low and high level in Reservoir 1. MIWB's control system operates the MITR pumps based on these settings. The top water level in Reservoir 2 is lower than Reservoir 1. A hydraulic valve controls the level of Reservoir 2 to prevent it overflowing. The inlet valve shuts when the reservoir reaches full level and opens again when the level drops.

The High Zone has Reservoirs 3, 4, 5 and 6, which all have the same Top Water Level (TWL). Water is distributed evenly to each of the reservoirs and is controlled by the high and low levels of Reservoir 3. All reservoirs have a common inlet/outlet, which is not ideal for mixing and may increase water age. It is possible that water sitting at the top of the reservoir has poorer water quality including lower chlorine levels, DO and pH.

The reservoirs are fitted with metal sheeting roofs with box gutters to catch run-off. The box gutters are welded to the overflow pipe inside the reservoir, and water then runs into a stormwater drain.

Table 6 Mount Isa Reservoir Details

	Res 1	Res 2	Res 3	Res 4	Res 5	Res 6
Capacity (ML)	7.7	8.5	6.8	9.1	1.1	1.25
Elevation (m)	382	375	400	405	405	406
Diameter (m)	37.8	32.1	32.1	36.4	13.8	14.5
Height (m)	7.5	11.2	9.4	9.4	8.1	8.1
TWL (m)	6.7	9.7	7.9	7.9	7.3	7.3
Roofed	Y	Y	Y	Y	Y	Y
Vermin-proof	Y	N	Y	Y	Y	Y
Run-off directed off roof	Y	Y	Y	Y	Y	Y

3.1.3.3 Disinfection and Chemical Dosing

Calcium hypochlorite (powder chlorine) is dosed into the reservoirs when chlorine is low. There are no formal rechlorination facilities at present for the distribution system. When a low chlorine result is detected, 5kg of chlorine is manually dosed into the appropriate reservoir.

3.1.3.4 Pump Stations

There are two pumps – a large Thompson Lewis pump on Stanley Street and a smaller unit on East Street – each installed with non-return valves. The purpose of these pumps is to transfer water from the low level zone to the high level zone in the event of a loss of pressure in the high level zone. No such incident has been reported in over ten years. There is also a reflux valve installed on the main at Buckley Street, which automatically allows water to flow from the low level zone, if there is a loss of pressure in the high level zone. The pumps have not been operated for at least 10 years and would require considerable effort to bring them back online.

In normal operation the Stanley St Pump Station's 12-inch sluice valve is open and the reflux is closed by high level pressure. A diagram of this pump can be found on page 3 of Appendix D (it is labelled as the High Level Zone Booster Pump Station). The sluice valve on the East Street Pump Station is closed under normal operation.

3.1.3.5 Fittings

- **Valves** are installed to isolate sections of the reticulation network to minimise the impact of pipe failure and facilitate network repairs. A reflux valve is installed on the main at Buckley St. Under normal operation the sluice valve is open and the reflux valve is closed by high pressure.

- **Hydrants** are used to draw off water from water mains for firefighting purposes, flow testing, scouring pipes to remove sediments and to flush dead ends in the network.

- **Water meters** measure the water flow for the purpose of monitoring water usage, water losses and charges for extraordinary usage?

3.2 CAMOOWEAL

3.2.1 Overview

Camooweal currently has three reliable sub-artesian bores used as water sources. Bore 1 was drilled in 1897, whereas bores 2 and 3 were drilled in February 2012. Camooweal's annual water consumption, being a small township of 300 people, is 128 ML/a. A bore (now refered to as Bore 4) was drilled in 1960 but this has been unreliable and has now been disconnected. Figure 7 shows a schematic of the scheme.

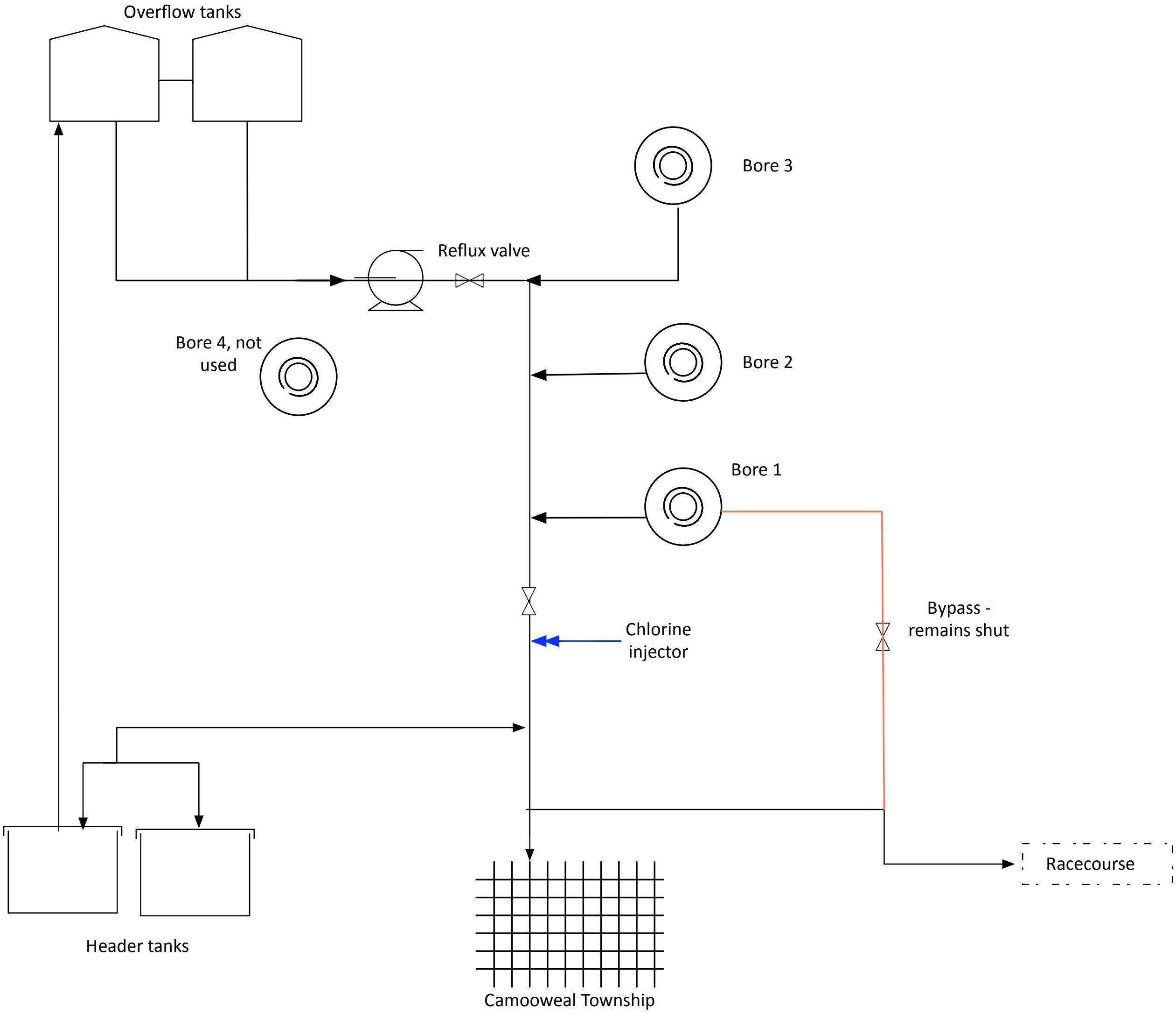


Figure 7 Camooweal Water Supply System

The Camooweal supply has been restricted to human consumption only. In the past, there have been issues with illegal connections on the main for watering cattle. This issue has been resolved.

3.2.2 Process Description

The bore pumps deliver water which gets injected with chlorine for disinfection before continuing on either to the elevated reservoir or straight through to the town reticulation. Chlorination is undertaken using chlorine gas. The elevated reservoirs have a low level auomatic switch which signals the bore pumps on, and a high level shut-off to stop the pumps when full. The bore pumps alternate on each cycle weekly so each bore supplies the same volume of water to the scheme based on the current pumping rates. The configuration enables the bores to supply the following proportion to the Camooweal scheme: Bore 1 – 34%, Bore 2 – 33% and Bore 3 – 33%. There are alarms for pump faults.

If there is a high demand for water when the reservoir is low and the bore pumps are operating, water will travel directly to town without going via the reservoirs. Overflow tanks collect any overflow from the elevated reservoir if the auto shut-off fails.

3.2.3 Asset Details

Condition assessment information is shown in Table 7 in the form of expected economic life.

Table 7 Camooweal Assets: Age and Expected life

Asset type	Est. Age (years)	Expected economic life (years)	Remaining Life (years)
Headworks Bore 1	77	88	11
Headworks Bores 2 & 3	0	88	88
Chlorination Plant	1	25	24
Elevated Reservoirs	56	80	24
Reticulation – Steel Pipes	70	96	26
Reticulation – MDPE	0-10	93	83-93
Fittings – Fire hydrants	44	79	35
Fittings – Valves	53	85	32
Fittings – Pressure relief	73	50	23

3.2.3.1 Bores and Pumps

Bore Card Reports for bores 1 and 3 contain the registration details of as well as casing details, strata log details and a water analysis from 1985, 1987 and 2012. Table 8 summarises the relevant data for this report. Bores 1 and 3 were drilled by DERM, bore 2 was drilled by Norrie Drilling Services.

Bore 1's collar and casing are shown in Figure 8. The borehead is raised above the ground level to provide protection from surface runoff. Possible access point for stormwater can be seen. However, local pooling or flooding is not an issue. The Water Quality Report discusses this further. The submersible bore pump has a capacity of 300 L/min. The pressure pump system is subject to power outages and surges are common in the area. The council has emergency generators available in the case of power outages.

Bores 2 & 3 have been drilled and brought online in 2012. The boreheads are well raised above the ground, with concrete slab around the borehead. This prevents ingress of any surface runoff (contamination) into the aquifer through the borehead. The bores are also quite deep. The capacity for the new bore pumps is 6 L/s.

Bore 4 (originally known as Bore 2) has been redundant for more than six months. The bore pump was cavitating as it was drawing water faster than it could replenish itself.

Table 8 Bore Details

Detail	Bore 1	Bore 2	Bore 3
Location	Water Storage Compound	Water Storage Compound (at 2 m distance from Bore 1)	Camooweal Sporting Ground
Drilled	1897	2012	2012
Depth	89.6m	102 m	96 m
Aquifer description	See Section 4.2.2	See Section 4.2.2	See Section 4.2.2
Depth and thickness	See Section 4.2.2	See Section 4.2.2	See Section 4.2.2
Confined/unconfined	Confined Sub-artesian	Confined Sub-artesian	Confined Sub-artesian
Response to events on surface	Unknown	Unknown	Unknown
Casing depth	89.6m	102 m	96 m
Material	Steel	PVC casing	PVC casing
Age	77 yrs	< 1 year	< 1 year
Borehead details to prevent contamination	Where the bore meets the surface there is an iron collar approximately 100mm above ground to prevent contaminants entering.	The boreheads are well raised above the ground, with concrete slab around the borehead.	The boreheads are well raised above the ground, with concrete slab around the borehead.

3.2.3.2 Disinfection

A multistage Illawarra pump draws raw water from the main when the bore pump starts. This carrier water is chlorinated using a Siemens chlorinator and is injected back into the main prior to the elevated reservoir.

The chlorine cylinder stands on a set of scales and is manually weighed and manually changed over. There are two spare chlorine cylinders in the storage. Camooweal uses only two cylinders per year. If a complaint is received, the council will adjust the chlorine. The council is proposing to put in a telemetry system with an online alarm.

The dosing arrangement is fixed, but the dose rate can be adjusted, as required, to ensure a free chlorine concentration of 0.7 mg/L is maintained in the reticulation.

3.2.3.3 Pipelines

Camooweal has 4.2kms of mains varying in size from 75 to 150mm servicing a population of 300 people (see Table 9). It is believed that there are no areas of long detention in the reticulation because some residents leave taps continuously running. This means that there is a continuous turn-over of freshly pumped water and a good turnover in the reservoirs. However, there are potentially dead ends at Austral Street and Nowranie Street. Detention time for chlorination is an issue as the first customers to receive water are only a matter of metres away.

Table 9 Distribution and Reticulation Infrastructure Information

Distribution and Reticulation	Camooweal
Pipe material	MDPE, Steel
Age range	0-10, 70 years
Approximate total length	4.2km of mains
Areas where potential long detention periods could be expected	Austral Street and Nowranie Street
Areas where low water pressure (eg < 12 m) could be expected during peak or other demand periods)	None

3.2.3.4 Storages

The two elevated reservoirs have a combined storage capacity of 44,000L. There are two new overflow tanks now on-site which have not yet been connected. These replace an old overflow tank that served the same purpose. If the auto shut-off on the header tanks fail, water is able to overflow into these tanks. A pump located after the overflow tanks facilitates water from these tanks to be pumped to town via the chlorine injector.

Table 10 Reservoir Storage

Camooweal	Header Tanks	Overflow Tanks
Capacity	22,000L X2	45400L x2
Elevation	18m	Ground
TWL	1.6m	3210mm
Roofed	Yes	Yes
Vermin-proof	Yes	Yes
Run-off directed off roof	Yes	Yes

4 IDENTIFYING HAZARDS AND HAZARDOUS EVENTS

Section 95(3)(b)(iii) states: 'identify the hazards and hazardous events which the drinking water service provider considers may affect the quality of the water to which the services relate'.

A comprehensive analysis of health hazards which are likely to enter the potable water supply ensures Drinking Water Service Providers are aware of the types of public health impacts associated with their drinking water supply and provides a basis to ensure the subsequent risk assessment is realistic and relevant.

4.1 WATER QUALITY INFORMATION

Criteria

- The Plan must include a summary of the analysis and interpretation of available and relevant water quality information.
- Where multiple providers are involved in providing the water supply, the above summary must (to the best of their knowledge) include relevant water quality information on the immediate upstream (for example, bulk supplier) and/or immediate downstream (for example, distributor) system(s).

A review of historical water quality data can assist in understanding source water characteristics and system performance both over time and following specific events, such as heavy rainfall. This can aid the identification of hazards and aspects of the drinking water system, which may require improvement. Water quality should be reviewed at least annually and used to inform the risk assessment.

Water quality data from routine conditions as well as complaints, exceedences and climatic information have been collected and reviewed. The supporting document *Water Quality Report 2012* contains graphical representations and summary tables of the data for both systems, which was utilised in the risk assessment process to help identify hazards, hazardous events, and long-term trends in water quality.

In summary, monitoring of the Mount Isa system over the past five years has shown that the distribution system is susceptible to contamination. A number of bacteriological detections, especially in the reservoirs, suggest contamination (on occasion) occurs during rain events with one possibility due to wash-in through holes in roofs. The variability of chlorine entering the distribution is also cause for some concern, as the MICC has no control over chlorine levels.

Water supplied to the MICC from the MIWB is generally of high quality, however this is an unfiltered system and a number of parameters are a concern, especially during events. MIWB water quality is impacted by two main events – rainfall and lake turnover – where spikes in turbidity, pH, dissolved oxygen and iron have been recorded in the potable water. This additional load may impact disinfection and increase the potential for pathogens. In addition, disinfection by-products are a concern due to the inability to remove organics.

4.2 CATCHMENT CHARACTERISTICS

Criteria

The catchment characteristics for each system's water source must be documented in the Plan. This includes a description of:

- Catchment area or groundwater recharge area
- Topography
- Main geological features
- Climatic features
- Land use

4.2.1 Mount Isa

Mount Isa is situated on the Leichhardt River in Queensland approximately 340km south of the Gulf of Carpentaria and 883km west of Townsville. The Leichhardt River is the source of water for Mount Isa. Its catchment covers an area of approximately 33,000km^2 with a mean run-off of 2,179,000 ML/a (Southern Gulf Catchments 2010). Mount Isa is 40km downstream of the headwaters of the Leichhardt River, which rises in the Selwyn Ranges. The river flows north through the city of Mount Isa, northeast 15km to Lake Moondarra and 60km to Lake Julius. It is joined by a number of tributaries before entering the Gulf of Carpentaria.

The country surrounding Mount Isa is classed as rough spinifex hills with spinifex hummock grassland and mixed open woodland on low rocky hills and open red country with gravelly alluvium on limestone ridges. Dominant vegetation includes snappy gums, Cloncurry box, whitewood, western bloodwood and corkwoods. The soils are deep loamy red earths and red clays with poor structure which limits infiltration during heavy rain. The steepness of the rocky outcrops makes much of the land unsuitable for grazing and, therefore, subject to mining (Queensland Government 2010).

The Leichhardt River catchment receives most of its rainfall during storm events, which means that for most of the time it is dry. Contaminants build up on ground surfaces and are then washed into the river system during a storm event.

Within the catchment, there are a number of activities, which are possible sources for contamination of this drinking water supply system. The main industry in the catchment is mining. The mines, located directly adjacent to the city (Figure 9), produce copper, lead and zinc, and fumes from the copper smelter are used to make sulphuric acid. Hazards related to mining include the transportation of these products through the catchment, spills and contaminated stormwater, the possibility of containment or tailings, dams overflowing, and the storage of hazardous chemicals including petrochemicals.

Low-density cattle grazing is widespread in the catchment and on the perimeter of the two lakes. In Mount Isa, a number of sites could possibly affect raw water quality including the council and mines' wastewater treatment plants, the landfill site and airport.

Camping and recreational water activities are popular at Lake Moondarra, which adds to the list of hazard sources and includes illegal dumping, recreational access and septic systems.

Figure 9 South-West View of the City of Mount Isa with the Adjacent Xstrata Mine

Raw water can be sourced from either Lake Julius or Lake Moondarra. Lake Moondarra is the preferred and primary supply, while Lake Julius is used as a secondary source. Historically, neither lake has run dry.

Water is pumped from the lakes to the Clear Water Lagoon. Before the lagoon, the water goes through an aeration flume where water is naturally aerated, then to the settling pond where coagulated sediments drop out (if coagulant is in use) and then through a natural filtration system of reed beds.

Water is pumped from Clear Water Lagoon (via the Col Popple Pump Station) to the Mount Isa Terminal Reservoir. Chlorine dosing occurs just downstream of the Col Popple Pump Station for primary disinfection. Water entering MITR is chlorinated again to a set point leaving MITR.

The MITR holds the treated water supply for the township of Mount Isa.

4.2.2 Camooweal

Camooweal is a small town located on Rockland Station 188km north-west of Mount Isa and 12km east of the Northern Territory border. The town lies on the Barkly Highway with the Georgina River (Figure 10) adjacent to the west of town. The MICC provides local government services for Camooweal including water and wastewater services.

The population is only a few hundred people, however in the cooler months, it is a major stopping point for travellers heading to the Northern Territory or coming back west into Queensland, with tens of thousands of tourists stopping to use the commercial and public services. Events at the cattle yards/racecourse located south of the town also swell the population for a couple of weekends each year. The fluctuation in population is probably the number one concern for meeting water quality requirements, as it is unpredictable.

Camooweal is situated on the edge of two bioregions. The town itself sits inside the same bioregion as Mount Isa – the Northwest Highlands with the same red soil. A couple of kilometres out of town on the western bank of the Georgina River, the country changes to the Mitchell Grass Downs bioregion. The geology on the western bank is a black soil flat plain of Cainozoic origin typical of the Barkly Tablelands.

The main land use in the area is cattle grazing. Bushfires are common in the areas surrounding Camooweal.

A number of activities in the township have the potential, although small, to affect groundwater quality. There is an airstrip located to the north of town, a waste tip east of town, a diesel power station on the eastern side of town that contains three 55,000L diesel tanks and a service station and council machinery depot in the town centre. The risks from these are related to spills and groundwater infiltration.

Residents have septic systems connected to a central effluent collection system. Evaporation ponds, located approximately a kilometre north of the town centre, are used to dispose of the effluent. Water evaporates quickly in the dry heat, however in the winter months, the ponds fill up quickly due to the increase in tourists. It is not likely any infiltration occurs that could affect the water quality of the aquifer. There are no known leakages of septic tanks. Floods in the area have never gone close to the evaporation ponds.

Figure 10 Georgina River Adjacent to the Township of Camooweal

The Georgina River groundwater area (represented in red) below covers an area of 54,440km^2. The Australian Government website *Australian Natural Resources Atlas* (last updated in 2009) states that there is no data for water allocation or water use, nor has a sustainable yield for the Georgina groundwater been quantified. However, it is estimated that the present abstraction levels are much less than maximum abstraction possible without any regional depletion of the groundwater resources.

Groundwater resources in the Georgina are contained within four aquifers. These are alluvial, porous rock, fractured rock and carbonate rock aquifers. The carbonate aquifers are important for groundwater resources with the two main ones being the Thorntonia Limestone and the Camooweal Dolomite. The Camooweal Dolomite is extensive and the depth to the top of the aquifer varies from 64m to 183m. Bore yields of up to 7.5 L/s have been recorded however the average is 2 l/s. "Groundwater supplies are reliable and of good quality" (Australian Government 2009). The three (3) Camooweal town bores tap into the same aquifer, Camooweal Dolomite.

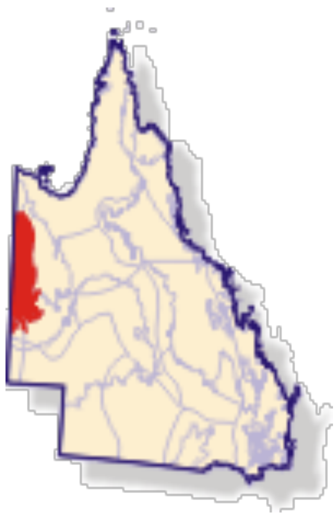


Figure 11 Georgina Basin

The majority of groundwater occurs in the fractures or in sandy beds within the dolomite. The fractures occur as joints, open bedding planes, and solution-widened cavities.

A paper by S. Eberhard (2003) highlights an important consideration in relation to groundwater recharge in the Camooweal area. The paper is attached as Appendix E. The paper explores the hydrology, geomorphology and speleogenesis (origin and development of caves) of the area surrounding the township of Camooweal, which includes Nowranie Caves, Kalkadoon Cave and Niggle Cave to name a few. To summarise, groundwater recharge appears to be restricted to areas where the clay soils have been stripped back and the underlying carbonate bedrock is exposed, which most obviously occurs at cave entrances. These act as the major groundwater recharge points in the area and recharge is therefore highly localised and dependent on the wet season rainfall events leading to surface water runoff in the cave catchments. Point source inflows in cave entrances are susceptible points for injection of contaminants into the groundwater system. The paper also reports the occurrence of dumping of rubbish in the past at Niggle Cave and Tar Drum Sink. This issue has been discussed in the *Water Quality Report 2012* and addressed in the *Risk Assessment Report 2012*.

4.3 HAZARD IDENTIFICATION

Criteria
The hazards and hazardous events (together with the sources of the hazards and hazardous events) that could adversely affect water quality must be documented in the Plan, including those affecting the:

- Catchment
- Sourcing infrastructure
- Treatment plants
- Disinfection process(es)
- Distribution system.

When multiple providers are involved, the Plan must (to the best of their knowledge) include the hazards and hazardous events together with the sources of these hazards and hazardous events associated with the operations and water quality management processes of the other entities' systems which the provider considers could impact on the service.

The whole of service hazards and hazardous events and the sources of the hazards and hazardous events must be documented in the Plan.

The Plan must detail the personnel (i.e. position) responsible for the hazard identification and risk assessment process, their roles and responsibilities and how knowledge of the actual day-to-day operation of the system(s) has been included in this process (see Section 5).

4.3.1 Identifying and Documenting Hazards and Hazardous Events

Hazards and hazardous events are based on:

- Information gathered in Section 3 – Source information;
- Information gathered in Section 4.1.1 – Water quality information;
- Information gathered in Section 4.1.2 – Catchment characteristics; and
- Hazards added through water treatment or reticulation such as treatment chemicals – Section 2
- MIWBs risk assessment

This section is covered in the Risk Assessment Report 2012 and and the Risk Assessment Register, as a supporting document. A summary of the report follows.

Hazard sources for both Mount Isa and Camooweal are as follows:

- back flow
- ingress through reservoir roof or low-pressure zone or air valves
- main breaks

- maintenance – hygiene procedures
- cross contamination
- incorrect material usage
- contaminated chemicals
- wilful contamination
- chemical addition
- change in flow

Hazardous events in Mount Isa that could have an effect on water quality are as follows (these do not include catchment and source hazardous events which are related to MIWB):

Reservoirs
- deterioration of water quality in reservoirs as a result of variable residence times
- vandalism or wilful contamination
- poor mixing within reservoir
- disturbance of sediment
- stagnation
- vermin
- ingress or wash-in of contaminated water

Pump stations
- sediment disturbance on start-up

Pipelines
- ingress of non-potable water
- backflow
- high flow changes in flow rate or direction in pipelines
- dead ends

Whole of system
- formation of disinfection by-products
- incompatible materials
- malicious contamination
- lack of resources
- loss of power

Multiple providers are involved in the delivery of the Mount Isa water supply. Upstream providers, MIWB, XMIM and Sunwater, are responsible for the source water and its treatment. Any hazards and hazardous events associated with the MIWB operations have been considered in this risk assessment.

MIWB have previously identified their hazards and hazardous events relevant to their part of the process and passed on this information during the MICC risk assessment. XMIM and Sunwater do not require a DWQMP and have not undertaken an assessment of hazards. Relevant information regarding the lakes was identified by the risk assessment undertaken by the MIWB.

Hazardous events that could have an effect on the Camooweal water supply are as follows:

Bores
- surface water infiltration

Disinfection
- failure of chlorination system insufficient contact time
- overdosing of chlorine

Header tanks
- stagnation
- vermin

Reticulation
- ingress of non-potable water

- stagnation including dead ends

Whole of system

- wilful contamination
- formation of DBPs
- incorrect valving
- lack of resources
- loss of power

5 ASSESSMENT OF RISKS

Criteria
Details of the risk assessment results for each system's identified hazards and hazardous events must be documented in the Plan, including:

- Key stakeholders who have been actively involved in the risk assessment process, their role and the rationale for inclusion.
- Where multiple providers are involved, the Plan must (to the best of their knowledge) explain how the relevant maximum and residual risk assessment results from other provider's service(s) have been considered.

For the purpose of this assessment, hazards include microbial, physical, chemical and radiological agents. The process that MICC follows is:

- Assembly of the risk assessment team, which is:
  - Multi-disciplinary, including staff from all areas of operations; and
  - Includes at least one member with formal risk assessment training or equivalent experience or skills, the remaining members of the team receive an introduction to the risk assessment process, prior to commencing the risk assessment.
- In a workshop with the Risk Assessment Team, the following steps are undertaken:
  - Analysis of the process flow diagram, describing processes;
  - Review of background information and related work, which includes the characterisation of raw water from the MIWB and the inherent risk for Mount Isa;
  - Identification of microbial, physical, chemical and radiological hazards;
  - Identification of contamination sources and hazardous events;
  - Assessment of maximum risk using the risk methodology;
  - Identification of preventive measures and the assessment of residual risk using the risk methodology;
  - Evaluation of significant risks and identification of required further risk treatments; and
  - Identification and review of critical control points (CCPs) by assessing each of the preventive measures used to reduce risk using a CCP Decision Tree.

This section of the DWQMP describes the risk methodology. Implementation of the methodology and details of the risk assessment and the Risk Assessment Team are described in the *Risk Assessment Report 2012*.

5.1 METHODOLOGY

In this risk assessment methodology, three different types of risks are identified:

Inherent risk
This is the level of risk in MICC's water sources (i.e. treated water from MIWB or bore water at Camooweal).

Maximum risk
This is the risk involved without existing barriers/preventive measures in place. Therefore, maximum risk is the inherent risk plus any additional sources of hazards/hazardous events due to MICC's treatment and/or distribution network.

Residual risk
This is the level of risk after current barriers and preventive measures are taken into consideration, which is the risk at point of supply.

For this risk assessment, a risk that was medium (8) or greater was deemed to be significant. Significant maximum risks require adequate risk mitigation to be in place and robust operational procedures. Significant residual risks identify a gap in risk mitigation and require further risk treatments to bring the level of risk down to an acceptable level.

In order to have consistency throughout the Mount Isa water supply system, the MICC has adopted the same risk scoring methodology as the MIWB. This will allow for the transfer of risk where required.

Risk scores were assessed using a likelihood and consequence risk matrix shown in Table 11. The risk score is the intercept of likelihood and consequence.

Table 11 Risk Matrix

Likelihood	Consequence				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost certain	Medium (6)	High (10)	High (15)	Extreme (20)	Extreme (25)
Likely	Medium (5)	Medium (8)	High (12)	High (16)	Extreme (20)
Possible	Low (3)	Medium (6)	Medium (9)	High (12)	High (15)
Unlikely	Low (2)	Low (4)	Medium (6)	Medium (8)	High (10)
Rare	Low (1)	Low (2)	Low (3)	Medium (5)	Medium (6)

Source: DERM 2010b

In identifying risk, the fist step is to determine the consequence of the hazardous event. The consequence categories used are defined in Table 12

Table 12 Consequence Descriptors

Consequence	Descriptor	Definition
1	Insignificant	Isolated exceedence of aesthetic parameter with little or no disruption to normal operation
2	Minor	Potential local aesthetic, isolated exceedence of chronic health parameter
3	Moderate	Potential widespread aesthetic impact or repeated breach of chronic health parameter
4	Major	Potential acute health impact, no declared outbreak expected
5	Catastrophic	Potential acute health impact, declared outbreak expected

Source: DERM 2010b

Followiing the identification of the consequence, the likelihood of that consequence materialising was determined using the likelihood categories defined in Table 13. To assist in the categorisation of hazardous events, a unit was considered to be a day (e.g. a seasonal event that lasted a week was considered to happen seven times per year and would have been defined as possible).

Table 13 Likelihood Descriptors

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

Source: DERM 2010b

For each risk assessment, the level of uncertainty in the assessment was identified using the definitions in Table 14 as a guide.

Table 14 Uncertainty Descriptors

Level of Uncertainty	Descriptor	Definition
1	Certain	• There are 5 years of continuous monitoring data which have been trended and assessed, with at least daily monitoring or • The processes involved are thoroughly understood
2	Confident	• There are 5 years of continuous monitoring data which have been collated and assessed, with at least weekly monitoring (or for the duration of seasonal events) or • There is a good understanding of the processes involved
3	Reliable	• There is at least a year of continuous monitoring data available which has been assessed or • There is a reasonable understanding of the processes involved
4	Estimate	• There is limited monitoring data available or • There is limited understanding of the processes involved
5	Uncertain	• There is limited or no monitoring data available or • There is no understanding of the processes involved

Source: DERM 2010b (modified)

The risk assessment is recorded in a risk register and is included in the *Risk Assessment Report 2012*. Currency of the risk assessment will be maintained by the MICC with the following items triggering a review:

- 12 months following the last complete review of the risk assessment;
- A non-compliance or water quality incident; or
- An exceedence of a CCP critical limit.

5.2 INHERENT RISK

The risks present in the system are reflective of the catchment and nature of the treatment processes. These are the risks inherently in the water, which needs to be managed by MICC's infrastructure, where possible.

5.2.1 Mount Isa

The MIWB supply bulk treated water to MICC. The water quality risk experienced by MICC at the point of supply is equivalent to the residual risk recorded by MIWB. Inherent risk has been provided by the MIWB and is presented in full in the *Risk Assessment Report 2012*. Significant inherent risks are presented in Table 15.

Table 15 Significant Mount Isa Inherent Risk

Hazards	Maximum Risks	Uncertainty
Bacteria	High (12)	Confident
Colour	Medium (9)	Reliable
DBPs	Medium (9)	Estimate
Dissolved Oxygen	Medium (8)	Reliable
Iron	Medium (9)	Certain
Manganese	Medium (9)	Confident
Protozoa	High (12)	Uncertain
Viruses	Medium (8)	Reliable

MIWB's Improvement Plan demonstrates how the MIWB will address these risks identified in their risk assessment and the short and long-term management measures including timeframes of implementation. Pathogens are of the greatest concern for MICC, however, it is understood that the MIWB risk assessment was conservative.

5.2.2 Camooweal

In Camooweal, the inherent risk is considered to be the risk in the bore water. Significant inherent risks are presented in Table 16.

Table 16 Significant Camooweal Inherent Risk

Hazards	Maximum Risks	Uncertainty
Bacteria	High (12)	Reliable
Hardness	High (12)	Reliable

Pathogens are of the greatest concern. It is noted that the bore water is naturally hard.

5.3 MAXIMUM RISK

The maximum risk is the inherent risk, plus any additional risks introduced by the treatment process and any problems with the system's integrity. Identifying the maximum risk helps to put into perspective the implications to population health, if a particular hazard is not removed or controlled.

Full details of the maximum risk assessments are shown in the *Risk Assessment Report 2012*. It is the maximum risk that must be managed by the MICC. Maximum risk has been assessed for each of the identified hazards.

5.3.1 Mount Isa

The risks that increased from inherent risk to maximum risk for Mount Isa are shown in **Table 17**.

Table 17 Increased Inherent Risks to Maximum Risks in Mt Isa

Hazards	Maximum Risks	Uncertainty
Bacteria	High (16)	Confident
Viruses	High (12)	Reliable
Chlorine	Medium (6)	Reliable
DBPs	High (12)	Uncertain
Iron	High (12)	Estimate
Manganese	High (12)	Estimate
Redced output volume	Medium (6)	Reliable
Taste and odour	Medium (6)	Reliable
Turbidity	Medium (9)	Confident

5.3.2 Camooweal

The risks that increased from inherent risk to maximum risk for Mount Isa are shown in Table 18.

Table 18 Increased Inherent Risks to Maximum Risks in Camooweal

Hazards	Maximum Risks	Uncertainty
Protozoa	Medium (8)	Estimate
Viruses	Medium (8)	Estimate

These two hazards have been identified as having a high maximum risk. They are not inherently present in the bores and are due to the possibility of contamination of water in the distribution system.

5.4 RESIDUAL RISK

Details of the residual risk assessment are shown in the *Risk Assessment Report 2012*.

Residual risk is determined once **existing** preventive measures and barriers have been applied. Residual risk is the level of risk a particular hazard is assessed as posing to drinking water, once the existing preventative measure/s have been applied. Barriers and preventative measures were identified during the risk assessment workshop for identified hazards.

In order to ensure that hazards and hazardous events are managed effectively, measures need to be in place to eliminate or reduce the associated risk. This DWQMP addresses this through the implementation of the following:

- Preventive measures that reduce the likelihood of contaminants being at concentrations which may cause harm to the consumer
- Multiple barriers – a series of barriers that ensure contaminants are at an acceptable level
- Critical control points – these are points in the system that can be monitored and action taken, to prevent the process going out of control leading to a non-compliant product, in good time.

Residual risk is determined using the methodology in Section 5.1.

It is important that all of the identified significant maximum risks are managed appropriately and that there are barriers in place to manage them. Those residual risks that have an unacceptable risk score require additional risk treatment.

Section 6.1.2 discusses preventive measures and barriers in further detail.

5.4.1 Mount Isa

As described in Section 3.1, the Mount Isa system encompasses the water distribution only. SunWater and XMIM undertake water collection and water treatment, and distribution is undertaken by MIWB.

The distribution element of the Mount Isa water scheme has two barriers: maintaining a chlorine residual and system integrity. The significant hazards that are managed by these barriers are shown in Table 19.

Table 19 Treatment Barriers for Significant Hazards in Mt Isa

Treatment Barrier	Significant Hazards Managed
Chlorine residual	• Bacteria • Cyanotoxins • Opportunistic pathogens • Problem algae/macrophytes • Viruses
System integrity	• Bacteria • Protozoa • Viruses • Colour • DO • Turbidity

Residual risk was assessed as the system currently operates, with the barriers in place and the preventive measures that maintain them. In this assessment, the impact of hazardous events were also taken into consideration. Hazards that are not managed to an acceptable level (Medium (8) and greater) are shown in Table 20.

Table 20 Significant Hazards in Mt Isa

Hazards	Maximum Risks
Bacteria	High (12)
Protozoa	High (12)
Viruses	Medium (8)
DBPs	High (12)
Iron	Medium (9)
Manganese	Medium (9)
Colour	Medium (9)
DO	Medium (8)
Turbidity	Medium (9)

The hazardous events that contribute to these hazards are shown in Table 21 and are further detailed in the *Risk Assessment Report 2012*. In addition, risk treatments undertaken to address these risks are detailed in the *Improvement Plan 2012*.

Table 21 Significant Hazardous Events in Mt Isa

Event	Limiting Hazard	Residual Risk
High flow and rapid changes in flow rate in pipelines leading to scouring and sloughing of slimes and sediment.	Turbidity	Medium (9)
The reaction of chlorine with organic material to create DBPs.	Disinfection by-products (e.g.. THMs, NDMA & HAAs)	High (12)
Loss of system knowledge and the ability to recruit skilled operators leading to inappropriate decision making, reduced knowledge and lack of maintenance of the system.	Protozoa	High (12)

It should be noted that a number of the hazards have a high residual risk due to the high inherent risk in the water supplied by the MIWB. The hazardous events that contribute to those are being addressed by the *Mount Isa Water Board Drinking Water Quality Management Plan – Improvement Plan 2011*.

Those hazardous events that have a residual risk of Medium (8) or greater are addressed in the *Mount Isa City Council Drinking Water Quality Management Plan – Improvement Plan 2012.*

5.4.2 Camooweal

As described in Section 3.2, the Camooweal system is chlorinated borewater. The scheme has two barriers, maintaining chlorine residual and system integrity. The significant hazards that are managed by these barriers are shown in Table 22.

Table 22 Treatment Barriers for Significant Hazards in Camooweal

Treatment Barrier	Significant Hazards Managed
Chlorine residual	Bacteria Viruses
System integrity	Bacteria Protozoa Viruses

Residual risk was assessed as the system currently operates, with the barriers in place and the preventive measures that maintain them. In this assessment, the impact of hazardous events were also taken into consideration. Hazards that are not managed to an acceptable level (Medium (8) and greater) are shown in Table 23.

Table 23 Significant Residual Risks in Camooweal

Hazards	Residual Risk
Bacteria	Medium (8)
Protozoa	Medium (8)
Hardness	High (10)

The hazardous events that contribute to these hazards are shown in Table 24 and are further detailed in the *Risk Assessment Report 2012*. In addition, risk treatments undertaken to address these risks are detailed in the *Improvement Plan 2012*.

Table 24 Significant Hazardous Events in Camooweal

Event	Limiting Hazard	Residual Risk
Surface water infiltration through recharge	Protozoa	Medium (8)
Failure of chlorination system (Insufficient C.t)	Bacteria	Medium (8)
Ingress of non-potable water	Bacteria	Medium (8)
Lack of Resources	Protozoa	Medium (8)

Those hazardous events that have a residual risk of Medium (8) or greater are addressed in the *Mount Isa City Council Drinking Water Quality Management Plan – Improvement Plan 2012.*

5.5 UNCERTAINTIES

The quality of information underpinning the risk assessment can vary. Hence, whilst the risk assessment process described (and the Guidelines) is a “qualitative” process, the confidence in the information that is used to determine each risk level is variable.

Assessing uncertainty provides an indication of the need to undertake further work or gather more data to ensure that the risk assessment is accurate and reliable. This work can be undertaken prior to the finalisation of the Plan or at a point in the future, in which case these activities should be reflected in the *Risk Management Improvement Program 2012*.

6 MANAGING RISKS

Criteria

- The Plan must contain an overall list of all the existing and proposed preventive actions or measures managed by the provider to achieve acceptable residual risks in the short and longer-term.
- Where the provider relies on an external organisation to manage a risk to their service, the Plan must document what the preventive actions or measures are, and what arrangements are in place with the external organisation to ensure the measures remain effective.

In order to ensure that hazards and hazardous events are managed effectively, measures need to be in place to eliminate or reduce the associated risk. This DWQMP addresses this through the implementation of the following:

- Preventive measures that reduce the likelihood of contaminants being at concentration which may cause harm to the consumer;
- **Multiple barriers** – a series of barriers that ensure contaminants are at an acceptable level; and
- **Critical control points** – these are points in the system that can be monitored and action can be taken to prevent the process going out of control leading to a non-compliant product.

It is important that all of the identified significant maximum risks are managed appropriately and that there are barriers in place to manage them. Barriers and preventive measures were identified during the risk assessment workshop for the identified hazards. This can be seen in detail in the risk assessment attached to the *Risk Assessment Report 2011* and a summary of the significant hazards is shown in Table 19

6.1 OPERATIONAL CONTROL

6.1.1 Existing Preventive Measures

Operational control is essential for the management of the drinking water supply system. In order to manage a process, it must be capable of being monitored and corrective action applied to ensure processes function within the defined operational envelope. Preventive measures have been defined along with monitoring and operational limits in Table 25. Control charts are attached in Appendix F for Total Plate Count and Total Coliform Count that demonstrate the rationale for the limits set for these parameters. The limits were based on the 95th percentile values for all of the reservoirs.

Within a process, a number of points may be identified as critical, where increased control is required to ensure a quality product. A CCP is defined as an activity, procedure or process that can be controlled and is essential to prevent a hazard or reduce it to an acceptable level. Not all activities are amenable to selection as critical control points. A CCP has several operational requirements, including:

- Operational parameters that can be measured and for which critical limits can be set to define the operational effectiveness of the activity (e.g. chlorine residuals for disinfection);
- Operational parameters that can be monitored frequently enough to reveal any failures in a timely manner (online and continuous monitoring is preferable); and
- Procedures for corrective action that can be implemented in response to deviation from critical limits.

The determination of CCPs was made using the decision tree in Figure 12 adapted from the ADWG (2004).

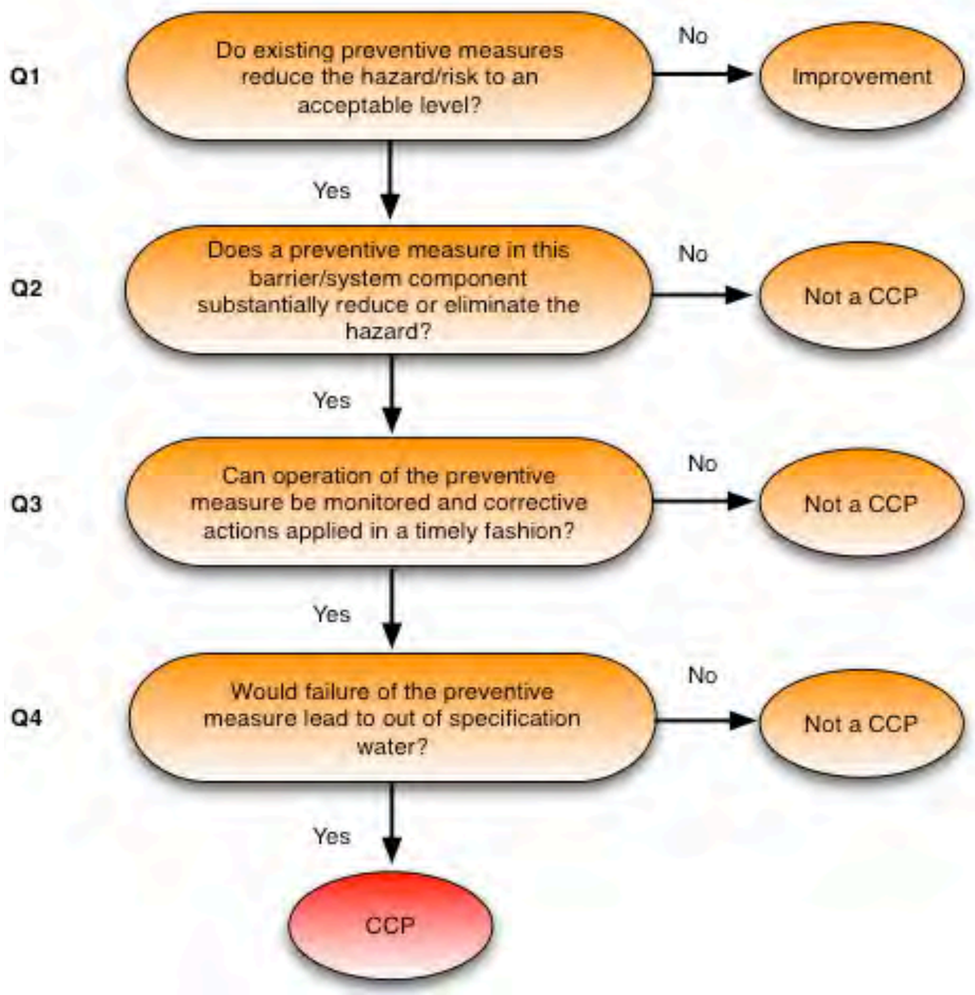


Figure 12 CCP Decision Tree

All process steps that managed a hazard with a maximum risk of *Medium (8)* or above were assessed to determine if they were a CCP for that hazard. There could be more than one CCP for a particular hazard. The identified CCPs are recorded in Table 25,.

CCPs are to be reassessed on the following triggers:

- At least every twelve months;
- If there is a significant change to the process;
- If the risk assessment is changed; and
- Upon breaching a CCP critical limit.

For each identified CCP, critical and alert limits were set and are defined as follows:

- **Critical Limit** – a set point that once exceeded the treatment process is taken to be out of control which may result in a non-compliant product and action must be taken to remedy the situation; and
- **Alert Limit** – a warning allowing an opportunity to take appropriate action to avert the breach of the critical limit.

A document titled *Critical Control Point Procedures* is attached as Appendix G, detailing the procedure specific to Mount Isa and Camooweal.

Table 25 Mount Isa & Camooweal Operational Controls

Preventive measure	Procedure/Control Details	What is the operational monitoring parameter?	How is it monitored?	Where is it monitored?	When is it monitored?	Who is responsible?	Target value for optimal performance	Is it a CCP?	Early warning limit for loss of control	Critical limit for unacceptable public health risk (if applicable)	Corrective action procedure
Chlorine residual	Water Quality Monitoring; Response to poor bacteriological results; Response to water quality complaints	Chlorine	Grab samples	Reservoirs	Weekly	Laboratory Assistant	0.7 – 1.5 mg/L	Yes	0.5 mg/L	0.2 mg/L	Manual dosing; Contact MIWB; Flushing CCP Procedure Appendix G
Security fences, locks on hatches	Table E-1 SAMP – Maintenance activities	Condition of fence	Visual inspection	Reservoirs; Camooweal Treatment Plant	Weekly	Pipelayer	Good condition	No			Improvement Plan
Management of reservoir levels	Reservoir Levels Procedure	Chlorine residual	Grab samples	Reservoirs	Weekly	Laboratory Assistant	0.7 – 1.5 mg/L	No			Improvement Plan
		HPC	Grab samples	Reservoirs	Weekly	Laboratory Assistant	360 cfu/100mL	No			
		Total Coliforms	Grab samples	Reservoirs	Weekly	Laboratory Assistant	12 cfu/100mL	No			
		E. coli	Grab samples	Mains	Following flushing (ie. Weekly)	Laboratory Assistant	+ve	No			
		THMs	Grab samples	Reservoirs	Weekly	Laboratory Assistant	0.2 mg/L	No			
		True Colour	Grab samples	Reservoirs	Weekly	Laboratory Assistant	5 HU	No			
Cleaning	Table E-1 SAMP – Maintenance activities	Turbidity	Grab samples	Reservoirs	Weekly	Laboratory Assistant	2.5 NTU	No			Improvement Plan
Sizing of the system to meet demand	Design	Chlorine	Grab samples	Reservoirs	Weekly	Laboratory Assistant	0.7 – 1.5 mg/L	No			n/a
Roof inspection	Table E-1 SAMP – Maintenance activities	Condition of roof	Visual inspection	Reservoirs	Monthly or event based	Plumber/ TA	Good condition	No			Improvement Plan

Preventive measure	Procedure/Control Details	What is the operational monitoring parameter?	How is it monitored?	Where is it monitored?	When is it monitored?	Who is responsible?	Target value for optimal performance	Is it a CCP?	Early warning limit for loss of control	Critical limit for unacceptable public health risk (if applicable)	Corrective action procedure
Flushing	Mains Flushing; Repairing Mains; Flow/pressure tests; Disconnection and restoration of supply	Turbidity	Grab samples	Mains	Following flushing (i.e.. Weekly)	Laboratory Assistant	2.5 NTU	No			Mains Flushing (SAMP App E)
		Chlorine	Grab samples	Mains	Following flushing (i.e.. Weekly)	Laboratory Assistant	0.7 mg/L	No			
		Colour	Grab samples	Mains	Following flushing (ie. Weekly)	Laboratory Assistant	5 HU	No			
		E. coli	Grab samples	Mains	Following flushing (ie. Weekly)	Laboratory Assistant	+ve	No			
Plumbing code for backflow connections and annual testing of vacuum breakers on hose lines	Plumbing Code	Annual tests of backflow devices	Test report	At each individual device	Annually	Licensed plumber	Compliance	No			n/a
AS/NZS 4020.	Testing of products for use in contact with drinking water	Assurance that the product meets Australian Standard.	Specified in contract	n/a	On purchase or receipt	Team Leader	Compliance Australian Standard watermark.	No			Improvement Plan
On the job training	Training Register	Competency	Training register through Human Resources; Inspection of individual's work	Onsite; Human Resources	Ongoing	Team Leader	Competency to undertake delegated tasks	No			Improvement Plan
Collar and casing on the bore	Inspection program	Turbidity	Grab samples	Bore water	Monthly	Laboratory Assistant	1 NTU	No			Improvement Plan

Preventive measure	Procedure/Control Details	What is the operational monitoring parameter?	How is it monitored?	Where is it monitored?	When is it monitored?	Who is responsible?	Target value for optimal performance	Is it a CCP?	Early warning limit for loss of control	Critical limit for unacceptable public health risk (if applicable)	Corrective action procedure
Inspection of cave entrances	Inspection program	Rubbish dumping	Visual	Cave entrances	To be decided (Improvement Plan)	Water staff	No rubbish	No			Improvement Plan

6.1.2 Proposed Preventive Measures

Any proposed preventive measures have been included in the *Mount Isa City Council Drinking Water Quality Management Plan – Improvement Plan* along with timeframes and responsibilities for their implementation.

6.1.3 Operation and Maintenance Procedures

Criteria
The Plan must contain, for each existing preventive measure identified in the risk assessment, as a measure for achieving the documented residual risk, a list of the documented operation and maintenance (or other) procedures that are required to ensure the integrity of the measures, including:

- Title;
- Date last revised;
- The process used for maintaining the documented procedures; and
- The process for implementing the procedures.

Operational procedures formalise the activities that are essential to ensure the provision of consistently good quality water. Detailed procedures that are required for the service and operation of processes and activities, including preventive measures and operational and verification monitoring procedures, are listed in Table 26. The list of procedures in Table 26 ensures that all significant risks are controlled by procedures in place.

Table 26 Documented Procedures for the Service

Document / Procedure	Status	Last revised
Incident reporting (adopted DERM Water Quality and Reporting Guideline Sept 2010)	Existing	n/a
Incident recording and closure (adopted DERM Form WSR503 v2)	Existing	n/a
Response to water quality complaints	Oct 2004	Has not been revised
Response to customer complaints	Oct 2004	Has not been revised
CCP procedure for chlorination	Developed as part of the DWQMP, Nov 2012	n/a
Water quality monitoring procedures (includes testing equipment calibration)	Existing as hard copies in the laboratory	To be revised (Improvement Plan)
Mains Hygiene	Improvement Plan	n/a
Management of reservoir levels	Improvement Plan	n/a
Reservoir cleaning program	Improvement Plan	n/a
Inspection program for cave sites, bores and reservoirs	Improvement Plan	n/a
Repairing mains and Flushing	Improvement Plan	n/a
Operations and Maintenance manual for day to day operations (includes chlorine dosing)	Improvement Plan	n/a

The Manager Utility Services is responsible for revision of procedures and documents, if procedures are changed or need to be upgraded. Currently, the procedures stated in the above table are up-to-date with current work practices and hence have not been scheduled for revision.

If there is a change in the operating practice then the relevant staff (e.g. Water Foreman) informs the Manager Utility Services to undertake the revision. All staff concerned have input into the revision/upgrade of documents/procedures. With the development of the DWQMP, the procedures will now be reviewed when the DWQMP is reviewed, if there is no need to revise it earlier.

The water quality monitoring procedures need to be revised and is part of the Improvement Plan. The version control of documents is maintained by the Manager Utility Services.

All operations and maintenance procedures and documents are accessible by operational staff as hard copies are all available on-site.

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

It the responsibility of the Manager Utility Services to ensure that the procedures are understood and implemented by operational staff.

6.1.4 Materials and Chemicals

The selection of materials and chemicals used in water systems is an important consideration as they have the potential to adversely affect drinking water quality.

These chemicals are all approved for use in drinking water, ADWG 2011. MICC procures its chemicals from Orica, which is a reputable chemical provider supplying high quality products. Table 27 shows the details.

Table 27 Chemical suppliers

Chemical	Supplier
Calcium hypochlorite (powder chlorine)	Orica
Chlorine gas	Orica

6.2 MANAGEMENT OF INCIDENTS AND EMERGENCIES

Criteria
The process for managing drinking water incidents and emergencies must be described in the Plan, including:

- Incidents and emergencies;
- The level of emergency (for example, green, amber, red or level 1, 2);
- Summary of action(s) taken for each level including emergency contacts;
- Internal and external communication processes and protocols including those with other key stakeholders that are actively involved; and
- Responsible positions.

When multiple providers are involved in providing drinking water, the Plan must explain how incidents and emergencies are managed between the entities.

6.2.1 Incident and Emergency Levels

Considered and controlled responses to incidents or emergencies that can compromise the safety of water quality are essential for protecting public health, as well as maintaining consumer confidence and the organisation's reputation. Although preventive strategies are intended to prevent incidents and emergency situations from occurring, some events cannot be anticipated or controlled, or have such a low probability of occurring that providing preventive measures would be too costly. For such incidents, there must be an adaptive capability to respond constructively and efficiently. MICC's framework for the management of incidents and emergencies are described in Tables 28-29.

Table 28 Incident and Emergency Levels and Descriptors

Incident/Emergency Level	Description of levels
Level 1 (Operational incident)	Exceedence of operational limits as per the operational monitoring section of the Monitoring Plan, including target and alert level of the CCPs. There is no non-compliance against the water quality criteria to impact public health. Incident is managed within the water operations team. An incident is not declared and the issue can be managed in line with the DWQM Plan without any additional assistance.
Level 2 (Water quality incident)	There is non-compliance against the water quality criteria (ADWG values) which may impact public health. Incident is managed within the team responsible for drinking water operations and management in line with the DWQMP. In some cases, it may require coordination across the Council departments and external resources and support, such as from the Water Supply Regulator, Queensland Health.
Level 3 (Emergency)	This is an event (anything that has happened or is likely to happen, in relation to a drinking water service that may have an adverse effect on public health). Examples include natural disaster (flood, drought), bushfire, inability to operate system within acceptable operational limits for extended period of time, contamination of source water, contamination of treated water, terrorism. Incident may require coordination across the Council departments and external resources and support, such as from the Water Supply Regulator, Queensland Health. It has the potential to create secondary issues more damaging than the actual incident.
Level 4 (Disaster)	There is an outbreak of waterborne disease or declared disaster situation by the Council or state/national government. Requires coordination across the Council departments and is likely to require external resourcing and support from agencies, such as the Water Supply Regulator, Queensland Health, local disaster management groups, emergency responders QFRS, Police.

6.2.2 Response to Incidents and Emergencies

A summary of the actions to be taken according to the level of the incident or emergency is provided in Table 29. All level 1-3 alerts are notified to the Utility Services Manager, who remains on call by mobile phone on 0417 607 531. The water staff have received on the job training on incident and emergency response protocols in order to operate as required, with overall supervision and management provided by the Utility Services Manager.

Table 29 Incidents and Emergencies, Actions to be Taken and Postions Responsible.

Level	Incident / Emergency	Actions to be taken	Positions Responsible
1	• Exceedence of operational limit as per the Operational Monitoring program. • Exceedence of CCP target and alert limits. • Minor water main bursts • Minor treatment plant process problem, resolved in less than 6 hours • Minor IT interruption – outage lasts less than a single working day	• Operations staff to notify Manager Utility Services. • Re-samples to be taken where required • Review operations and maintenance records for anomalies • Commence investigation to determine cause, if not identifiable through operational records • Instigate immediate remediation actions • Ensure all control measures identified in the DWQM Plan are functioning effectively. • Increase operational monitoring frequency where required • Manage minor faults in line with operational standards • Ensure incident response and reporting protocols are on standby if the need arises.	Water Foreman (under guidance from Utility Services Manager)
2	• Non-compliance against the ADWG value • Exceedence of CCP critical limit	• Report incident to Water Supply Regulator within the required timeframe (Appendix C DWQMP) • Contact MIWB to investigate possible problem with bulk supply (for Mount Isa Scheme) • Ensure all control measures identified in the DWQM Plan are functioning effectively. • Commence investigation to determine cause if not traceable through the DWQM Plan • Arrange for re-samples to be taken • Instigate immediate remediation actions, including isolation of affected area where possible • Review associated laboratory reports and operational records. • In case of customer complaints, coordinate investigation and resolution, including obtaining water samples where required • For non-compliance of bulk water supplied by MIWB at point of receipt, immediately notify MIWB and isolate supply if required. • Disaster management plan is on standby if the need arises. • Occurrence and rectification of these incidents to be reported to recorded and used for improvements.	Utility Services Manager (Manager Engineering kept informed)

Level	Incident / Emergency	Actions to be taken	Positions Responsible
3	• Event (as per Table 28). • Significant burst water main in CBD or interruption to supply for an extended period to medical facilities or public facilities/centres • Significant or total treatment plant failure for two days or longer (upstream provider) • Inability to access main offices or IT systems for an extended period, greater than 2 days • Industrial action affecting water operations • Wide spread power outage	• Report incident to Water Supply Regulator within the required timeframe (Appendix C DWQMP) • If deemed necessary, contact MIWB to keep them informed of the event (for Mount Isa Scheme) • Ensure all control measures identified in the DWQM Plan are functioning effectively. • If event has led to exceedence of water quality criteria then follows actions for Level 2. • In case of customer complaints, coordinate investigation and resolution, including obtaining water samples where required • Consider need for community notification / messaging as necessary (e.g. do not drink alert, boil water alert or bottled/emergency water distribution) • Disaster management plan is on standby if the need arises. • Manage the event to ensure safety and manage negative impacts on the community, the environment and Council • Occurrence and rectification of these incidents to be reported to recorded and used for improvements. • Communicate the details of the emergency to all other affected stakeholders within the water supply scheme	Utility Services Manager (Manager Engineering kept informed)
4	• Outbreak of waterborne disease • Declared disaster situation • Significant spill from a mine site resulting in major contamination and shut down of water services for an extended period of time	• Activate Council's Disaster Management Plan • Assemble team of appropriate professionals • Coordinate notification, investigation and response of water related aspects • Consider what community notification / messaging is needed (e.g. do not drink alert, boil water alert or bottled/emergency water distribution) • Coordinate community messaging, for e.g. boil water alert, do not drink alert as required • Notify Water Supply Regulator as soon as practicable (Appendix C DWQMP)	CEO (Utility Services Manager and Manager Engineering are part of the team)

6.2.3 Communication

Effective communication is vital in managing incidents and emergencies. External contact details are listed in the Stakeholder and Communication Register in Appendix C. The list of internal and external Emergency Contacts is present in Appendix H. The list is also located at the Mount Isa Council office, the laboratory and Camooweal chlorine shed.

For the Mount Isa scheme, the communication protocols between MICC and MIWB during water quality incidents and emergencies follows the reporting process to the Regulator, i.e. in the case of an incident when the Regulator is notified MIWB also contact MICC with the details. MICC monitors the situation such as check and maintain their free chlorine residual in the distribution. As necessary, the supply from the MIT reservoir would be shut off until MIWB rectify the problem. Similalry, if MICC have a water quality incident and they notify the Regulator, they also contact MIWB to investigate any possible issues with the bulk supply. The process of reporting water quality incidents to the Regulator is present in Appendix C.

An improvement action has been identified for MICC to formalise a water quality incident and emergency response plan, in line with the framework presented in Tables 28-29. This will also include formalising the communication protocols with MIWB during incidents and emergencies.

6.3 RISK MANAGEMENT IMPROVEMENT PROGRAM

Criteria
The Plan, through the program, must describe the management measures proposed for each unacceptable residual risk. The process for providing the relevant information to the regulator must also be described. The description must include:

- Measures, actions, strategies or processes
- Priority for implementation
- Timeframe
- Other factors, for example, responsibilities between the provider and third parties and/or other stakeholders.

An *Improvement Plan 2012* has been developed to ensure continual improvement of the MICC drinking water supply system. The plan addresses the need to improve the quality of the systems through improvements to the systems that were identified as a result of the risk assessment, and improvements to the management of the systems, identified by comparison of existing documents to requirements for the guidelines.

The Improvement Plan is a supporting document and will be updated based on internal and external audit results, plan reviews, non-conformances, incident and emergency feedback and future risk assessments.

6.4 SERVICE WIDE SUPPORT – INFORMATION MANAGEMENT

Criteria
The Plan must describe the information management, record keeping and reporting processes relevant to drinking water quality management, including how they address:

- Accessibility
- Currency
- Record retention requirements.

6.4.1 Management of Documentation and Records

This DWQMP contains/identifies all documents and records that are required for the management of drinking water quality.

All employees receive on-the-job training to ensure that they understand operating procedures, document management and record keeping requirements in accordance with this DWQMP.

MICC document and records are stored on Dataworks electronic filing system. Incoming documents are scanned and filed electronically and hard copies are filed in the relevant departments. Monitoring data is recorded in a soft format on an Excel spreadsheet every three to four days at the laboratory and emailed to the relevant water quality council employees for review before being saved to Dataworks in chronological folders. All staff have access to Dataworks. Documents go through the Senior Records Officer, the Executive and the Chief Executive Officer.

The Senior Records Officer is responsible for record retention and currency on Dataworks. Only current documents, including procedures are accessible by staff through Dataworks. This ensures that obsolete procedures are not used. The currency of any printed hard copy procedure on-site is the responsibility of the Manager Utility Services. Five year old data are archived through Council system. As new procedures will be developed for the service (section 6.1.3) the process for document currency and record retention will also be reviewed (Improvement Plan).

6.4.2 Reporting

Reporting includes the internal and external reporting of activities pertinent to the implementation and performance of drinking water quality management. External reporting is undertaken as detailed in the Stakeholder and Communication register in Appendix C. Internal drinking water quality reports include CCP Alert and critical limit notifications, water quality specification exceedances, internal audit reports and monthly water quality reports. Internal reporting of water quality is as follows:

- CCPs are reported as documented in the CCP Procedures (Appendix G)
- Monthly water quality and incident summary

7 OPERATIONAL AND VERIFICATION MONITORING PROGRAMS

7.1 OPERATIONAL MONITORING

Criteria
The Plan must contain details of the operational monitoring program, including:

- A link to the process step or operational function
- The parameter being tested
- Location of monitoring
- Frequency
- Summary of how excursions are managed and/or corrective action is taken.

The Plan must describe why the operational monitoring program is appropriate to confirm and maintain the effective operation of the existing preventive measures.

Operational monitoring includes the planned sequence of measurements and observations to assess and confirm the performance of preventive measures. Measurements are of operational parameters that will indicate whether processes are functioning effectively.

A supporting document, the *Monitoring Plan 2012*, has been developed as part of this DWQMP.

The monitoring plan outlines the parameters to be tested, the locations for monitoring and the frequency. Monitoring has been rationalised to ensure costs are achievable. The plan has been developed to ensure all areas of the distribution system water are represented including areas of short and long detention times and dead ends. The revised ADWG 2011 specifies that the primary advice for monitoring small remote supplies should emphasise on operational monitoring and barrier performance, rather than verification of water quality. The ADWG also states that when the short-term evaluation performance approach is applied, the response is more important than the detection.

7.2 CORRECTIVE ACTION

Procedures are essential for immediate corrective action in order to re-establish process control following failure to meet target criteria or critical limits. The procedures should include instructions on required adjustments, process control changes and additional monitoring. Responsibilities and authorities, including communication and notification requirements, should be clearly identified.

Corrective actions for non-conformances with CCP alert and critical limits are described in the CCP Procedures in Appendix G. Corrective actions for non-CCP operational monitoring are detailed in the *Monitoring Plan 2012*.

7.3 VERIFICATION MONITORING

Criteria
The Plan must contain details of the verification monitoring program including:

- The parameter being tested
- Location of monitoring
- Frequency
- Summary of how excursions are managed and/or corrective action is taken.

The Plan must also describe why the verification monitoring program is appropriate to confirm that the drinking water complies with the water quality criteria for drinking water (including the rationale for the choice of the parameters).

Verification of drinking water quality provides an assessment of the overall performance of the system and the ultimate quality of the drinking water being supplied to ‘customers’. Verification incorporates monitoring drinking water quality as well as assessment of consumer satisfaction.

Drinking water quality monitoring is a wide-ranging assessment of the quality of water as supplied to the consumer. It includes regular sampling and testing to assess whether water quality is complying with guideline values, any regulatory requirements or agreed levels of service.

Under the *Water Supply (Safety and Reliability) Act 2008* mandatory monitoring began on 1 January 2009 whereby any existing monitoring program at that time must continue for all systems until there is an approved DWQMP in place. The monitoring program developed under this DWQMP, which includes verification monitoring, is in the *Monitoring Plan 2012* and becomes the mandatory program upon approval.

In addition, the *Public Health Act 2005* and *Public Health Regulation 2008* has mandatory monitoring requirements. Monitoring must be undertaken for *Escherichia coli* in the reticulation system, at the frequency specified in Schedule 3A of the *Regulation*. Schedule 3A of the *Public Health Regulation* outlines the testing requirements.

The MICC collects verification monitoring samples for a limited range of parameters (to prevent duplication with the MIWB) and these are subjected to basic analyses in their own laboratory. MIWB is responsible for treatment of water and conduct their own verification monitoring.

7.3.1 Consumer Satisfaction/ Customer Complaints

Monitoring of consumer comments and complaints can provide valuable information on potential problems that may not have been identified by performance monitoring of the water supply system. Consumer satisfaction with drinking water quality is largely based on a judgment that the aesthetic quality of tap water is ‘good’, which usually means that it is colourless, free from suspended solids and has no unpleasant taste or odour.

Complaints from the general public go to MICC directly, as the supplier of drinking water to Mount Isa. Any complaints that MICC regards as related to the MIWB’s operations are forwarded to the MIWB for action. All complaints are recorded on the Complaints Form and are investigated.

Records of two ‘dirty water event’ complaints from 2011 are available. These include email trails and records of the emergency response actions.

8 LIST OF ABBREVIATIONS

ADWG	Australian Drinking Water Guidelines
CCP	Critical Control Point
DWQMP	Drinking Water Quality Management Plan
MDPE	Medium-Density Polyethylene
MICC	Mount Isa City Council
MITR	Mount Isa Terminal Reservoir
MIWB	Mount Isa Water Board
PD	Position Description
SAMP	Strategic Asset Management Plan
SLA	Statistical Local Area
SPID	Service Provider Identification Number
TCC	Total Coliform Count
TMP	Total Management Plan
TPC	Total Plate Count
TWL	Top Water Level
XMIM	Xstrata Mount Isa Mines

9 REFERENCES

Australian Bureau of Statistics 2011, *National Regional Profile: Mount Isa (C) (Local Government Area),* visited 7.12.2011, http://www.abs.gov.au/AUSSTATS/abs@nrp.nsf/Latestproducts/LGA35300Population/People12006-2010?opendocument&tabname=Summary&prodno=LGA35300&issue=2006-2010

Australian Government 2009, *Water resources – Availability – Queensland,* Australian Natural Resources Atlas, Natural Resource Topics, website last updated May 2009, http://www.anra.gov.au/topics/water/availability/qld/gmu-unincorporated-area-georgina.html

Australian Government Bureau of Meteorology 2010, *Flood warning system for the Leichhardt River,* visited 7.12.2011, http://www.bom.gov.au/hydro/flood/qld/brochures/leichhardt/leichhardt.shtml.

Department of Environment and Resource Management 2010a, *Drinking Water Quality Management Plan Guideline,* Urban Water Policy and Management, Queensland Government.

Department of Environment and Resource Management 2010b, *Preparing a Drinking Water Quality Management Plan Supporting Information,* Urban Water Policy and Management, Queensland Government.

Department of Environment and Resource Management 2010c. *Gulf Resource Operations Plan*, Queensland Government, Australia.

Department of Infrastructure and Planning 2008. *Queensland's future population,* 2008 edition, Queensland Government, Australia.

Eberhard, S. 2003, Nowranie Caves and the Camooweal Karst Area, Queensland: Hydrology, Geomorphology and Speleogenesis, with Notes on Aquatic Biota, *Helictite*, Vol.38, No.2, Pp 27-38

Mount Isa City Council 2010, *Where is Mount Isa and What is Her History?*, visited online 7.12.2011, http://www.mountisa.qld.gov.au/web/guest/where-is-mount-isa-and-what-is-her-history.

NHMRC & NRMMC 2011, *National Water Quality Management Strategy: Australian Drinking Water Guidelines.* 6th Ed., National Health and Medical Research Council and Natural Resource Management Ministerial Council, Australian Government, Canberra.

Queensland Government 2010, *Land types of Queensland Southern Gulf Version 1.2, 2008,* visited online 8.12.2011, http://www.southerngulf.com.au/index.php?element=SG12.pdf.

Southern Gulf Catchments 2010, *Leichhardt River Catchment,* visited online 7.12.2011, http://www.southerngulf.com.au/page/The%20Land#leichhardt.

APPENDIX A

WATER QUALITY POLICY

DRINKING WATER QUALITY POLICY

Mount Isa City Council is committed to managing its water supply effectively to provide a safe, quality product that consistently meets appropriate drinking water standards developed in accordance with the *Australian Drinking Water Guidelines.*

To achieve this objective in partnership with relevant stakeholders and regulatory agencies, **Mount Isa City Council** will:

- distribute water from service reservoirs to supply points for each customer reliably in sufficient quantity to meet peak demands in a manner which protects water from contamination. (Overview of Assets – TMP);
- use a risk-based approach in which potential threats to water quality are identified and balanced;
- develop contingency and incident response processes to deal with any water quality issues identified;
- ensure that all managers, employees and contractors involved in the supply of drinking water understand their responsibility to implement the *Drinking Water Quality Management Plan*;
- routinely monitor the quality of drinking water; use effective reporting mechanisms to provide relevant and timely information; and promote confidence in the water supply and its management;
- comply with the regulatory requirements of the *Water Supply (Safety and Reliability) Act 2008* (QLD) and aesthetic and health related criteria of the *Australian Drinking Water Guidelines 2004*; and
- provide publicly available information and reports on the quality of the drinking water supply and associated issues.

Mount Isa City Council will implement and maintain a drinking water quality management system to effectively manage the risks to drinking water quality.

All manager and employees involved in the supply of drinking water are responsible for understanding, implementing, maintaining and continuously improving the drinking water quality management system.

Dated Signed by Responsible Officer

APPENDIX B

LEGISLATIVE AND OTHER REQUIREMENTS REGISTER

LEGAL AND OTHER REQUIREMENTS REGISTER

Requirement	Authority/ Organisation	Detail	How Addressed by MICC	Responsibility
Common Law	Commonwealth	MICC will ensure that the water service is operated with a high level of transparency and the following items are addressed to minimise risk under common law: - Comply with relevant laws and industry codes and guidelines; - Have clear contractual arrangements between suppliers and users of drinking water; - Have an effective management system in place which considers risk, quality assurance and environmental issues; - Ensure the distribution network does not readily degrade the quality of water before supplying to the consumer; - Ensure that all employees involved in the operation are adequately trained and supervised; and - Accurately monitor and report results for drinking water quality.	Implement the DWQMP which outlines management systems that consider risk and QA, employee training and monitoring and reporting for drinking water quality.	Chief Executive
Environmental Protection Act 1994	Environmental Protection Agency	The Act aims to protect within the context of ecologically sustainable development through a wide range of tools. Under the Act, it is an offence to cause environmental harm unless it is permitted under a number of scenarios. However, the Act provides a defence (EP Act s 436(2)) for environmental harm if the environmental harm occurs as the result of a lawful activity and the operator complied with the general environmental duty. The Act states '*a person must not carry out any activity that causes, or is likely to cause, environmental harm unless the person takes all reasonable and practicable measures to prevent or minimise the harm*'. Therefore, MICC must ensure that the general environmental duty is followed, to minimise legal liability.	The Integrated Environmental Management System (IEMS) is in place to minimise environmental impacts that may occur from their activities, operations and services.	Chief Executive
Public Health Act 2005 / Regulation 2005	Queensland Health	Part 5A of the Act outlines provisions about drinking water including improvement notices and offences for supplying unsafe drinking water. The Public Health Regulation 2005 Schedule 3A outlines standards for the quality of drinking water. It specifies the frequency of sampling and acceptable values for *Escherichia coli* in the reticulation system and fluoride concentration.	Reports exceedences of the Public Health Act requirements to DERM who then report to Queensland Health.	Chief Executive
Water Act 2000	Department of Environment & Resource Management - Office of Water Supply Regulator	This Act provides for the sustainable management of water and other resources and the establishment and operation of water authorities. MICC is a Category 2 Water Authority and Registered Service Provider established under Chapter 4 of the Water Act 2000.		Chief Executive

Requirement	Authority/ Organisation	Detail	How Addressed by MICC	Responsibility
Water Supply (Safety and Reliability) Act 2008	Department of Environment & Resource Management - Office of Water Supply Regulator	This Act provides the framework to deliver sustainable water planning, allocation, management and supply processes and to ensure improved security for water resources in Queensland. The requirement for a water service provider to develop a drinking water quality management plan is made under this legislation. Under Section 630 of the Water Supply (Safety and Reliability) Act 2008, the regulator may issue a notice to a drinking water service provider requiring the provider to do any of the following: - to monitor the quality of water supplied from the provider's drinking water service; - to give the regulator reports, at stated intervals, about the results of the monitoring; - to give the regulator other reports about the operation of the drinking water service. The notice may require the above stipulations until an approved drinking water quality management plan is in place. The Office of the Water Supply Regulator has already issued a notice to all drinking water service providers requiring reports on the following incidents within certain timeframes: - Detection of *Escherichia coli* (*E. coli*); - Detection of a pathogen; - Fluoride greater than 1.5 mg/L; - Detection of chemical parameters that do not meet a healthy guideline value in ADWG; - Detection of radioactivity exceeding values in ADWG; - Detection of parameters for which there is no guideline value in ADWG; and - An event that has the potential to compromise the ability to adequately treat or provide drinking water. All incident reports must be made directly to the Office of the Water Supply Regulator.	As a water supplier, the MICC is addressing the requirements of the Act by: 1. Monitoring and reporting of drinking water quality to OWSR quarterly; 2. Preparing a DWQMP prior to 30 June 2012; and 3. Ongoing compliance with an approved DWQMP.	Chief Executive
Contract MICC - Water Quality Management Agreement	Mount Isa Water Board	This agreement acts as a contract between MIWB as the supplier and MICC as the customer. The agreement covers the water quality management services of the supplier to the customer and supersedes all earlier agreements. Under the agreement, the MIWB has obligations as the supplier to perform the Water Quality Management Services; and use its best endeavours to respond to all reasonable requests for information from MICC in relation to matters affecting water quality from MIWB.		Chief Executive
Drinking Water Guidelines - Regulatory guidelines 2010 made under the Water Supply (Safety and Reliability) Act 2008	Department of Environment & Resource Management - Office of Water Supply Regulator	The Water Quality and Reporting Guideline for a Drinking Water Service is the first regulatory guideline and: - Provides information on the water quality standards established by Queensland Health; - Establishes the minimum water quality criteria that applies to drinking water for parameters where Queensland Health has not set a standard; - Establishes reporting requirements related to drinking water quality: - First, in terms of their application whilst operating under a notice; - Second, when an approved Drinking Water Quality Management Plan is in place.	The MICC must prepare the DWQMP according to these guidelines.	Chief Executive
Australian Drinking Water Guidelines (ADWG)	NHMRC	The ADWG are intended to provide a framework for good management of drinking water supplies that, if implemented, will assure safety at point of use. The ADWG have been developed after consideration of the best available scientific evidence. They are designed to provide an authoritative reference on what defines safe, good quality water, how it can be achieved and how it can be assured.	The MICC use the ADWG values as the indicator of water quality being delivered to customers.	Chief Executive
Water Fluoridation Act 2008 and Regulation 2008	Department of Environment & Resource Management - Office of Water Supply Regulator	The Water Fluoridation Act was brought in in 2008 with the aim of having all of Queensland's public water fluoridated by 2012. As of 31 Dec 2012 the MIWB must add fluorideto the Mount Isa Water Supply.	No requirement. Camooweal has no requirement and MICC do not undertke water treatment in Mount Isa.	Chief Executive

APPENDIX C

STAKEHOLDER AND COMMUNICATIONS REGISTER

Stakeholder and Communication Register

Organisation	Contact	Accountability / Responsibility	Commitment / Involvement	Reporting	Frequency	Method
Department of Environment & Resource Management	Sector: Office of Water Supply Regulator Name: As available Contact No.: 07 3247 0357 Email:OWSR@derm.qld.gov.au Emergency contact 24hr reporting: 1300 596 709	Regulator	- Approve DWQMP - Issue notices about monitoring and reporting requirements to drinking water service providers - Set water quality criteria for parameters for which no standards have been set by Queensland Health - Enforce notices and DWQMPs and undertaking investigations and compliance actions	DWQMP review	TBA upon approval	Electronically
				External system audit	Biennial following DWQMP approval	Electronically
				E. coli detection	As required	Verbal communication within 3 hours and written confirmation within 24 hours. (The regulator will notify Queensland Health). If detected in the follow up sample verbal and written communication will need to be given. An incident management report is required on resolution
				Pathogen detection	As required	Verbal communication within 3 hours and written confirmation within 24 hours. (The regulator will notify Queensland Health). If detected in the follow up sample verbal and written communication will need to be given. An incident management report is required on resolution
				Detection of chemical value above ADWG guidelines	As required	Verbal communication within 3 hours and written confirmation within 24 hours. (The regulator will notify Queensland Health). If guideline values are breached in the follow up sample verbal and written communication will need to be given. An incident management report is required on resolution
				Detection of gross alpha or beta radioactivity above screening value	As required	Verbal communication within 3 hours and written confirmation within 24 hours. (The regulator will notify Queensland Health). If annual exposure from all radionuclides is breached verbal and written communication will need to be given. An incident management report is required on resolution
				Detection of parameter for which there is no ADWG value	As required	Verbal communication within 3 hours and completion of incident form within 24 hours
				An event likely to affect drinking water quality	As required	Verbal communication immediately, followed by the completion of the incident form

Organisation	Contact	Accountability / Responsibility	Commitment / Involvement	Reporting	Frequency	Method
				Quarterly water quality monitoring summaries	Quarterly	Electronic communication
Mount Isa Water Board	Name:Greg Stevens, CEO Contact No.: (7) 4740-1007 Email: gstevens@mountisawater.qld.gov.au	Upstream bulk water supplier	Individual supply contract	As per contract	As required	Electronic communication
	Name: Dolores Delizo, Water Quality and Environmental Service Engineer Contact No.: (7) 4747-3283 Email: ddelizo@mountisa.qld.gov.au		Water quality complaints	Non-compliant water quality	As required	Verbal communication within 3 hours and written confirmation within 24 hours
			Incidents and Emergencies	Events that could effect treatment of bulk water (eg. Sewer leak)	As required	Email or telephone as soon as practically possible. Written confirmation within 24 hours
	Name: Engineering Manager Contact No.: (7) 4740-1007 Email: @mountisawater.qld.gov.au		Operations Meetings	Operations Meetings	Monthly	Face to face meeting
Queensland Health	Sector: Tropical Public Health Unit Name: Alison Crombie Contact No.: (07 4744 9100) Email:alison_crombie@health.qld.gov.au	Public Health	- Setting drinking water quality standards under the Public Health Act / Regulation 2005 - Issuing and enforcing improvement notices where the safety of drinking water may be compromised - Issuing and enforcing public health orders where a public health risk is identified.	Any event likely to have an immediate affect on public health, or requiring a public health alert.	As required	Verbal communication immediately, followed by written confirmation.
Mount Isa Community	Sensitive Receptors - Dialysis patients Contact No: See list in Emergency Plan	Public Health	This group could be easily affected by poor water quality.	Any event that could have an immediate affect on this group.	As required	Telephone as soon as possible.
	Sector: ABC Radio - North West Queensland Contact No: (07) 4744 1311		Community announcements			

Outgoing

Organisation	Contact	Accountability / Responsibility	Commitment / Involvement	Reporting	Frequency	Method
Emergency Services Mount Isa (in a medical emergency call 000)	Sector: Mount Isa Police Station Contact No: (07) 4744 1111 Location: 7 Isa Street, Mount ISa Sector: Mt Isa Hospital Ph: (07) 4744 4444 Location: 30 Camooweal St, Mt Isa Sector: State Emergency Service, Mt Isa Ph: (07) 4743 2601 Location: Cnr Ryan an Davis Rd, Mt Isa	Emergency Services	Incidents and Emergencies	n/a	As required	Telephone as soon as possible.
Emergency Services Camooweal (in a medical emergency call 000)	Sector: Camooweal Police Station Contact No: (07) 4748 2148 Location: Nowranie St, Camooweal Sector: Camooweal Health Centre Ph: (07) 4748 2159 Location: Morrison St, Camooweal Sector: State Emergency Service, Mt Isa Ph: (07) 4743 2601 Location: Barkley St, Camooweal	Emergency Services	Incidents and Emergencies	n/a	As required	Telephone as soon as possible.

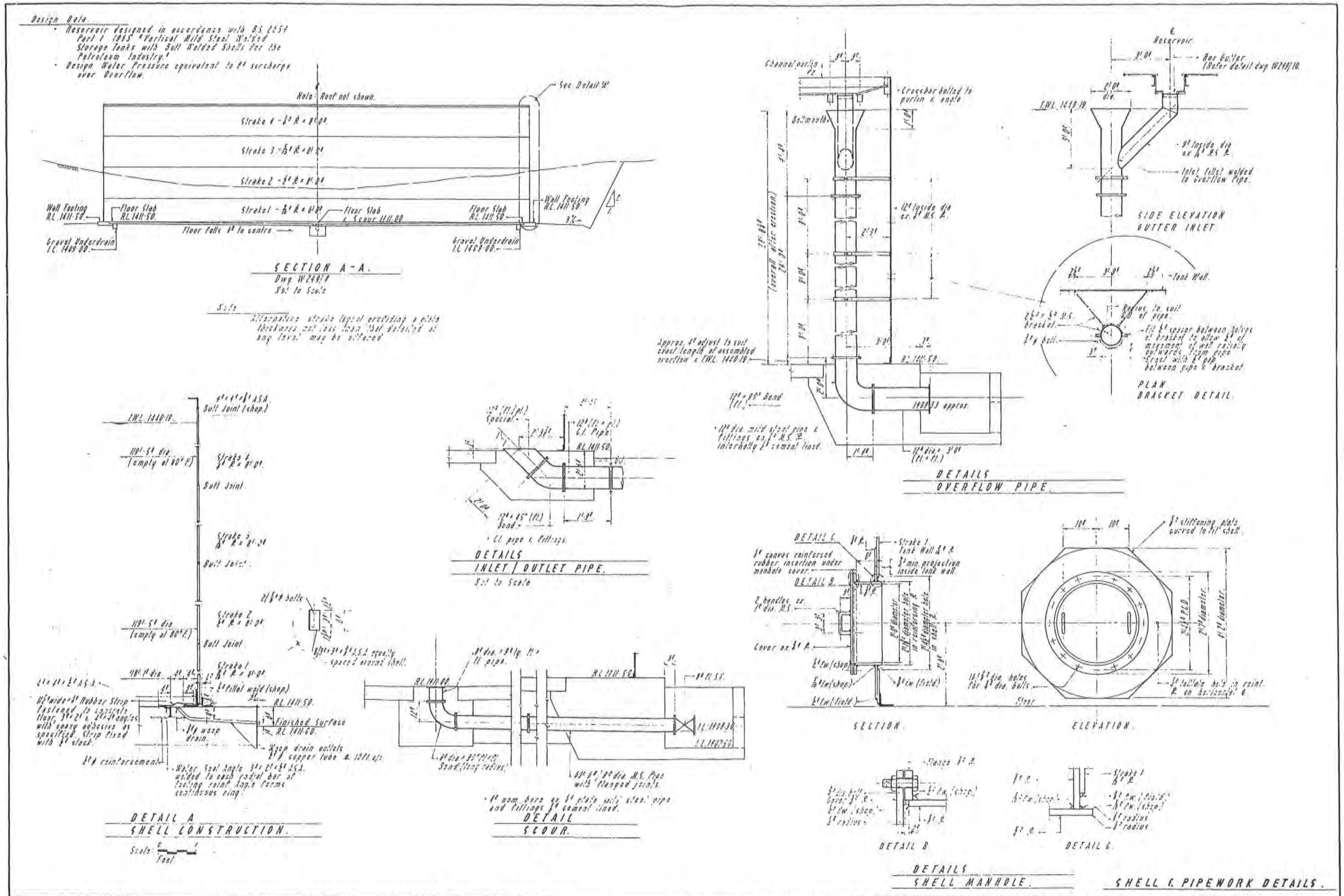
Outgoing

Stakeholder and Communication Register

Organisation	Accountability / Responsibility	Commitment / Involvement	MICC Contact	Communication	Frequency	Method
Department of Environment & Resource Management	Regulator	- Issue notices about monitoring and reporting requirements to drinking water service providers	Name: Emilio Cianetti, Deputy Chief Executive Oficer/ Director of Engineering Services email: ph: (07) 47473200	Issuing of notices	As required	Mail
Mount Isa Water Board	Upstream bulk water supplier	- Individual supply contract - Monthly operations meeting - Upstream provider	Name: Emilio Cianetti, Deputy Chief Executive Oficer/ Director of Engineering Services email: ph: (07) 47473200	As per contract	As required	Electronic communication
			Name: Wolfgang Zadravec, Environmental Health Officer email: wolfgangz@mountisa.qld.gov.au ph: (07) 47473200	Water quality complaints and issues	As required	Verbal communication
			Name: Mike Jones, Manager Utility Services email: mikej@mountisa.qld.gov.au ph: (07) 47473200	Incidents and Emergencies	As required	E-mail or telephone as soon as practically possible. Written confirmation within 24 hours
			Name: Mike Jones, Manager Utility Services email: mikej@mountisa.qld.gov.au ph: (07) 47473200	Operations Meetings	Quarterly	Face to face meeting
Queensland Health	Public Health	- Setting drinking water quality standards under the Public Health Act / Regulation 2005 - Issuing and enforcing improvement notices where the safety of drinking water may be compromised - Issuing and enforcing public health orders where a public health risk is identified.	Name: Emilio Cianetti, Deputy Chief Executive Oficer/ Director of Engineering Services email: ph: (07) 47473200	New legislation, standards, guidelines related to drinking water.	As required	Written communication
The public	Customers	- Consumers of the product	Name: Wolfgang Zadravec, Environmental Health Officer email: wolfgangz@mountisa.qld.gov.au ph: (07) 47473200	Water quality complaints	As required	Email or telephone

APPENDIX D

DISTRIBUTION SYSTEM ENGINEERING DRAWINGS



REVISIONS		
Nº	DATE	DESCRIPTION

NOTES
- All welding to be in accordance with A.S. CA.8. Part 1 1965. All vertical and horizontal joints of shell plates shall be Qualified Complete Penetration Butt Joints in accordance with [illegible]. Fillet welds ¼" unless otherwise detailed.
- Vertical shell joints to be displaced one third plate length each strake.
- All bolts to be heavy galv. mild steel.
- All flanges shall be to BSL 1954 - Table 'D'.
- Until completion of the roof structure with full wind bracing, the reservoir is not self supporting under design wind load. Adequate temporary bracing shall be provided to the top curb angle until completion of the roof.
- For additional notes ref. dwg. W249/8.

LEVEL DATUM	M.I.M. DATUM.		
REF. B.M.	B.M. 155. R.L. [illegible] T.B.M. REFER DWG. W249/5		
AZIMUTH			
FIELD B.		DESIGNED	[illegible]
LEVEL B.	[illegible]	DRAWN	[illegible]
PLOTTED		CHECKED	[illegible]

McINTYRE & ASSOCIATES
CONSULTING ENGINEERS
QUEENSLAND · AUSTRALIA

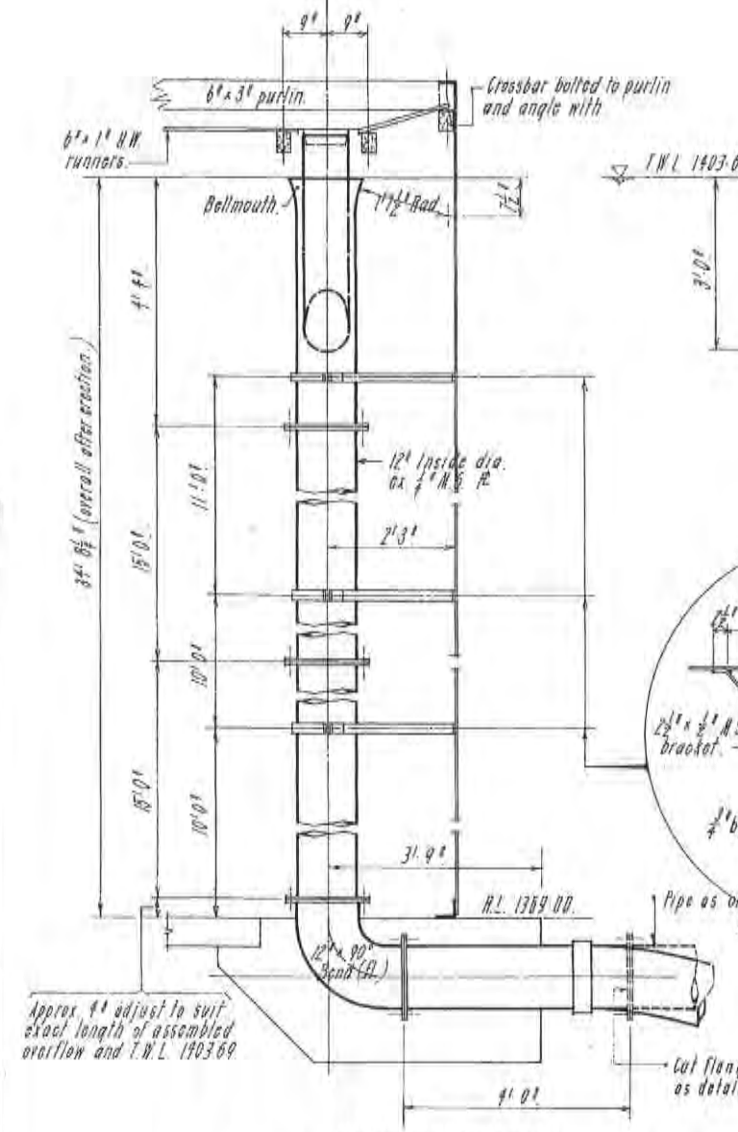
PASSED [signature]
DATE 24.5.71.

MOUNT ISA CITY COUNCIL
MOUNT ISA WATER SUPPLY
TRUNK DISTRIBUTION TO HIGH LEVEL ZONE
2 MG. RESERVOIR
SHEET 2 OF 3 SHEETS.

SCALE
U.O.N.

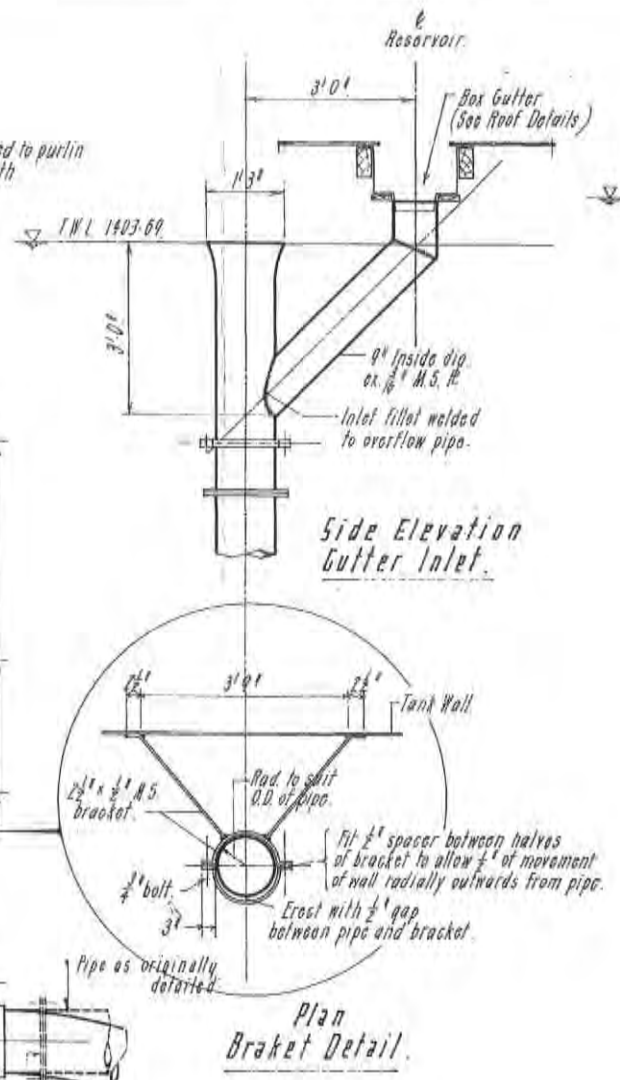
W 249/9

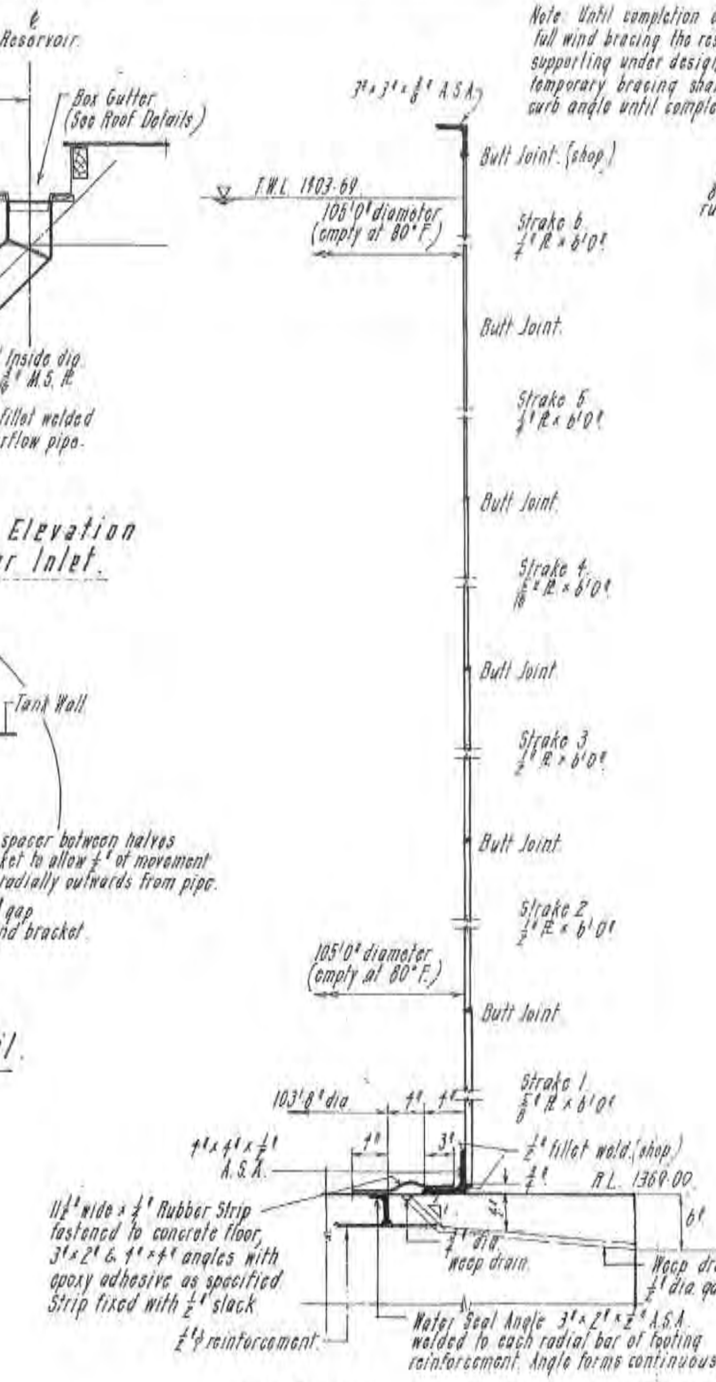
= L RES



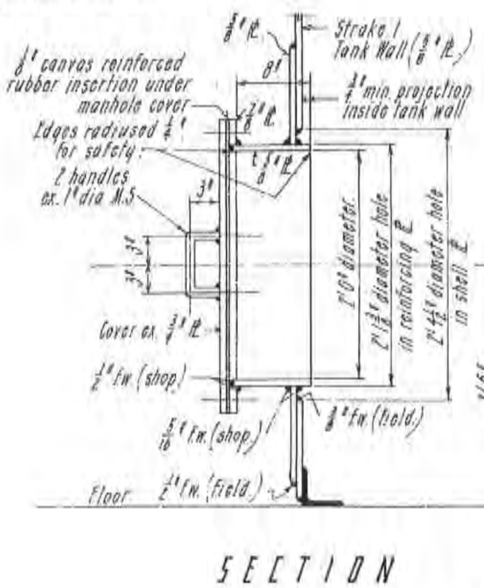
(12" dia mild steel pipe.)

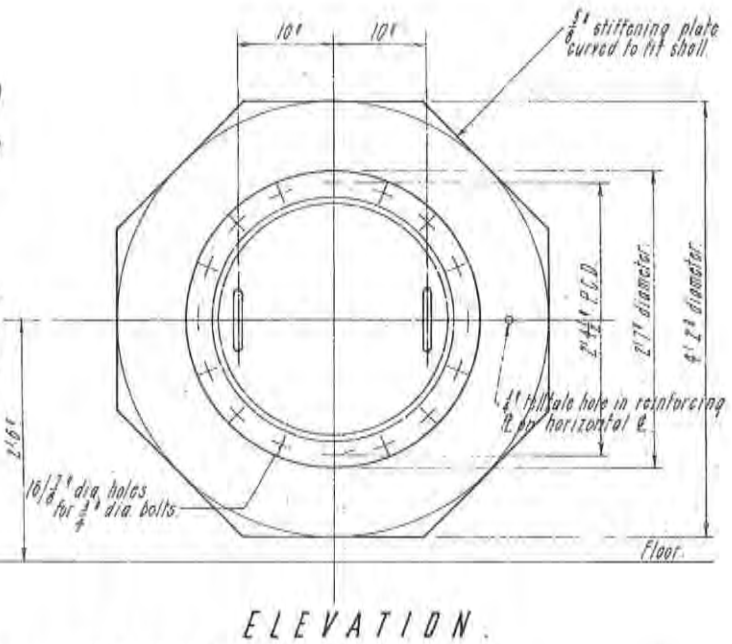
OVERFLOW PIPE DETAILS.
Scale: ½" - 1'0"





DETAIL A SHELL CONSTRUCTION.
Scale: 1" - 1'0"

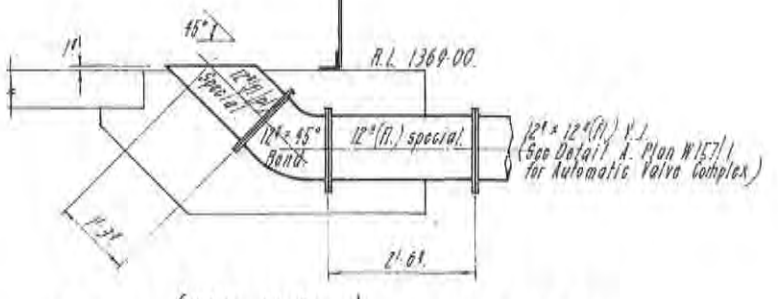




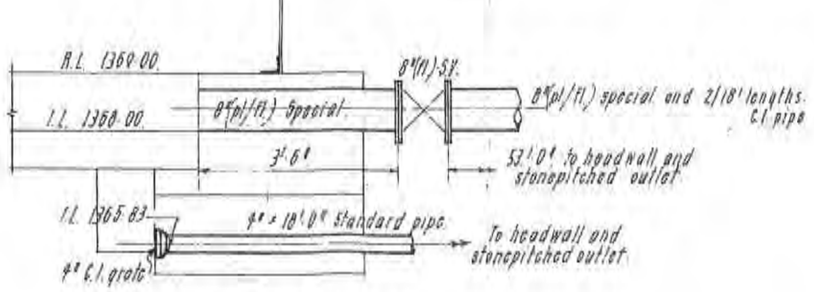
SHELL MANHOLE DETAILS
Not to Scale.

REINFORCEMENT BENDING DIAGRAM.

DESCRIPTION (dimensions overall.)	MARK.	DIA. & SPACING.	LOCATION.
1", 2'2", 6", 7", 3'5"	A1	½" @ 12"	Wall Footing.
1", Varies, 2'2", 7", Varies	A2 A3 A4.	½" @ 9"	Inlet/Outlet & Overflow.
1", 2'2", 6", 1'7", 3'5"	A5	½" @ 12"	Scour Outlet.
length to suit. lap 2'1", 52'6" rad average.	C1	⅝" @ 8"	Wall Footing.
length to suit.	D1	½" @ 12"	Floor Slab.
5'8", 6'2", 5'8", Varies	E1	½" @ 12"	Scour Channel.
2'1", 6'9", 2'1", 1'0"	E2	⅝" @ 8"	Scour Outlet.
2'1", 4'9", 2'1", 1'3"	E3	⅝" @ 8"	Inlet/Outlet & Overflow.
1'8", 2'4", 1'8", 7"	E4	½" @ 5" (deformed bars.)	Column Footing.
1'2", 6½" c/c, threaded 1¼"	F1	¾" H.D. bolts.	Column Footing.
2'6"	G1.	½" @ 12"	Floor Slab.



(12" dia. C.I. Pipe.)
INLET/OUTLET PIPE DETAILS
Scale: ½" - 1'0"



8" & 4" dia. C.I. Pipe.
SCOUR & UNDERDRAIN OUTLET PIPE DETAILS
Scale: ½" - 1'0"

Level Datum is M.I.M. Datum.
See Plan W 157/2 for construction notes.

McINTYRE & ASSOCIATES — CONSULTING CIVIL ENGINEERS

MOUNT ISA SHIRE COUNCIL.

MOUNT ISA TOWN WATER SUPPLY
1·9 M.G. RESERVOIR
SHELL & PIPEWORK DETAILS.

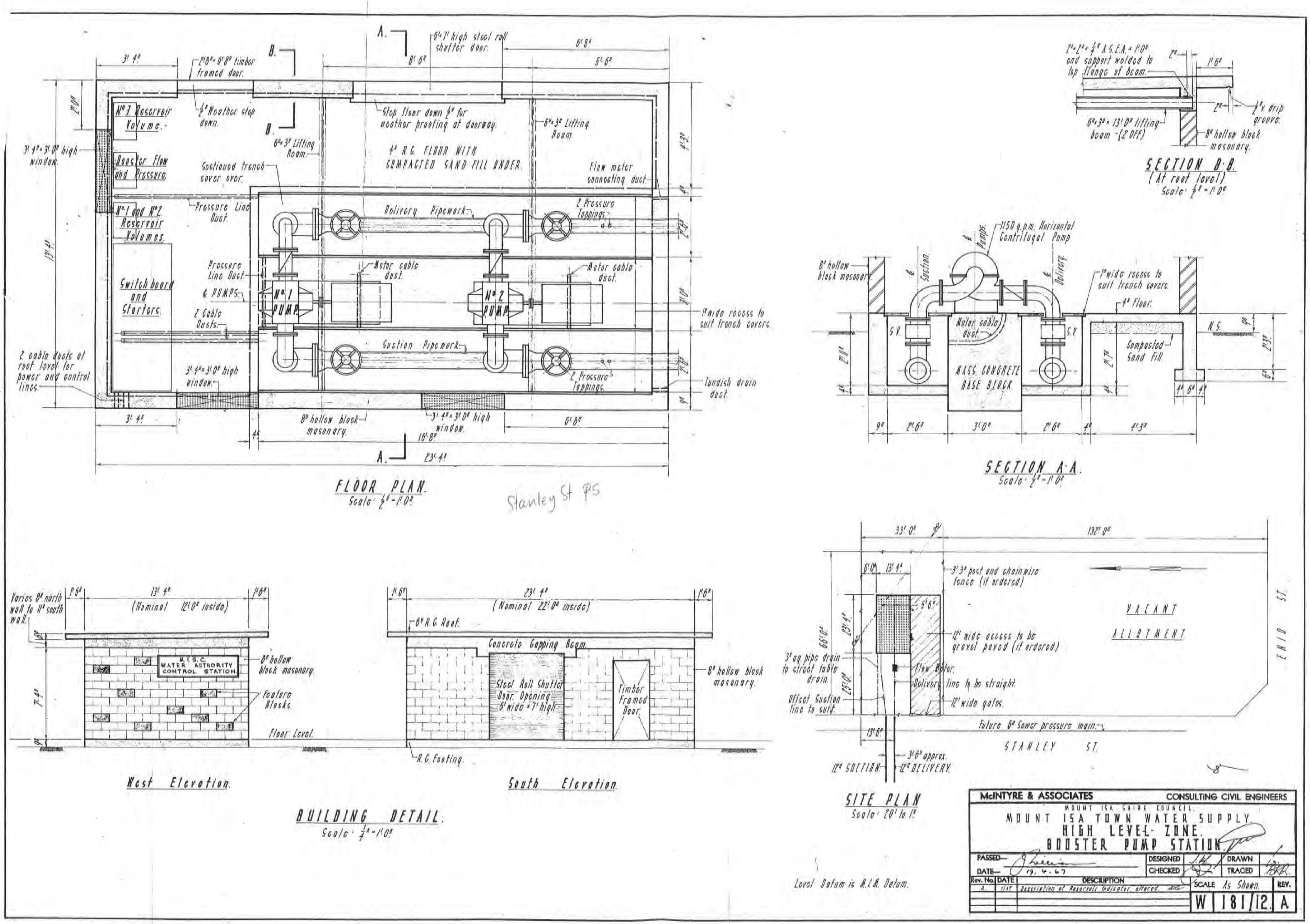
PASSED— [signature]		DESIGNED	AB/[initials]	DRAWN	J.D.G.
DATE— 14·11·66		CHECKED	[initials]	TRACED	J.D.G.

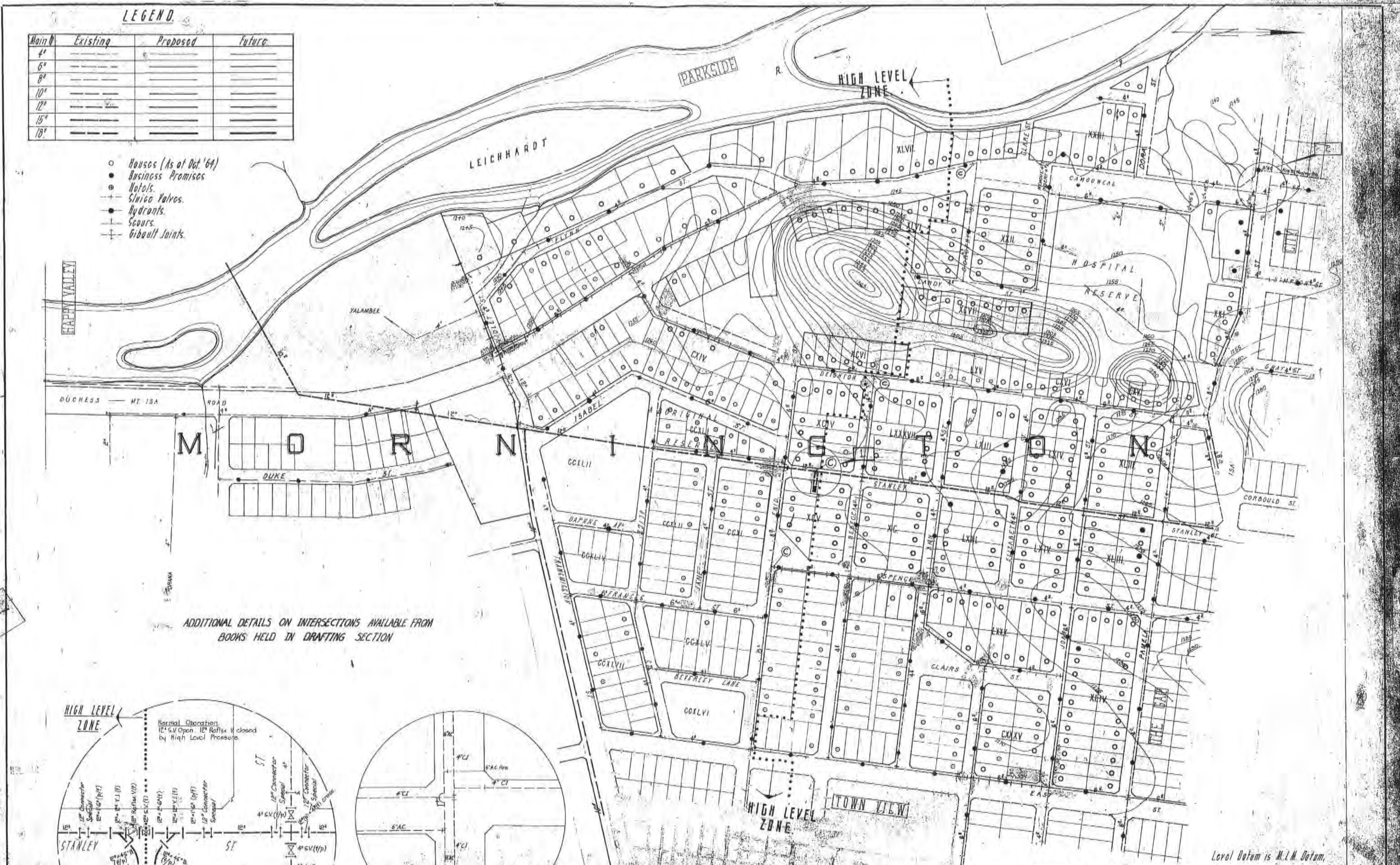
Rev. No.	DATE	DESCRIPTION
A	8·68	AMENDMENTS TO PIPEWORK.

SCALE: As Shown — REV. A

W 157/3 A

#7 RES


FLOOR PLAN.
Scale ¼" - 1'0"
Stanley St P/S
No 3 Reservoir Volume.
Booster Flow and Pressure.
No 1 and No 2 Reservoir Volumes.
Switch board and Starters.
3' 4" x 3' 0" high window.
2' 8" x 6' 8" timber framed door.
½" Weather stop down.
6' x 7' high steel roll shutter door.
Step floor down ½" for weather proofing at doorway.
6" x 3" Lifting Beam.
4" R.C. FLOOR WITH COMPACTED SAND FILL UNDER.
Sectioned trench cover over.
Flow meter connecting duct.
Pressure Line Duct.
Delivery Pipework.
2 Pressure Tappings.
Pressure Line Duct.
Motor cable duct.
℄ PUMPS.
No 1 PUMP
No 2 PUMP
2 Cable Ducts.
1" wide recess to suit trench covers.
Suction Pipework.
2 cable ducts at roof level for power and control lines.
Tundish drain duct.
8" hollow block masonry.
23' 4"
SECTION B-B.
(At roof level)
Scale ½" - 1'0"
2" x 2" x ¼" A.S.E.A. x 1'0" and support welded to top flange of beam.
6" x 3" x 13' 0" lifting beam - (2 OFF)
8" hollow block masonry.
⅛" drip groove.
SECTION A-A.
Scale ½" - 1'0"
1150 g.p.m. Horizontal Centrifugal Pump.
1" wide recess to suit trench covers.
4" Floor.
Motor cable duct.
MASS CONCRETE BASE BLOCK.
Compacted Sand Fill.
N.S.
S.V.
West Elevation.
South Elevation.
BUILDING DETAIL.
Scale ¼" - 1'0"
Varies 8" north wall to 11" south wall.
(Nominal 12' 0" inside)
(Nominal 22' 0" inside)
M.I.S.C. WATER AUTHORITY CONTROL STATION
8" hollow block masonry.
Feature Blocks.
Floor Level.
6" R.C. Roof.
Concrete Capping Beam.
Steel Roll Shutter Door. Opening 6' wide x 7' high
Timber Framed Door.
R.C. Footing.
SITE PLAN
Scale 20' to 1"
3' 3" post and chainwire fence (if ordered)
12' wide access to be gravel paved (if ordered)
3" ag. pipe drain to street table drain.
Flow Meter.
Delivery line to be straight.
Offset Suction line to suit.
12' wide gates.
Future 6" Sewer pressure main.
VACANT ALLOTMENT
ENID ST.
STANLEY ST.
3' 6" approx.
12" SUCTION
12" DELIVERY.
Level Datum is M.I.M. Datum.
McINTYRE & ASSOCIATES CONSULTING CIVIL ENGINEERS
MOUNT ISA SHIRE COUNCIL.
MOUNT ISA TOWN WATER SUPPLY.
HIGH LEVEL ZONE.
BOOSTER PUMP STATION.
PASSED
DATE 19. 4. 67
DESIGNED
CHECKED
DRAWN
TRACED
Rev. No. DATE DESCRIPTION
A. Description of Reservoir Indicator altered.
SCALE As Shown.
REV.
W 181/12. A



L	5.84	UPDATED	
K	4.72	[illegible]	

AMENDMENTS
A 13.12.63 Job W118 Anne St. Planned
B 18.10.64 - JOB W120 - Plans
C 15.7.66 - Job W166 planned
D 4.67 High Level Zone W181
E 12.67 Job W198

REMARKS

W122/A Reticulation of 1.12.63

F 6.68 Miscellaneous as const. additions
G 3-70 W 130 "As constructed." J.D.T.
H 9-71 W 181 "As constructed" NDM
J 6-71 Duke St. design appr.

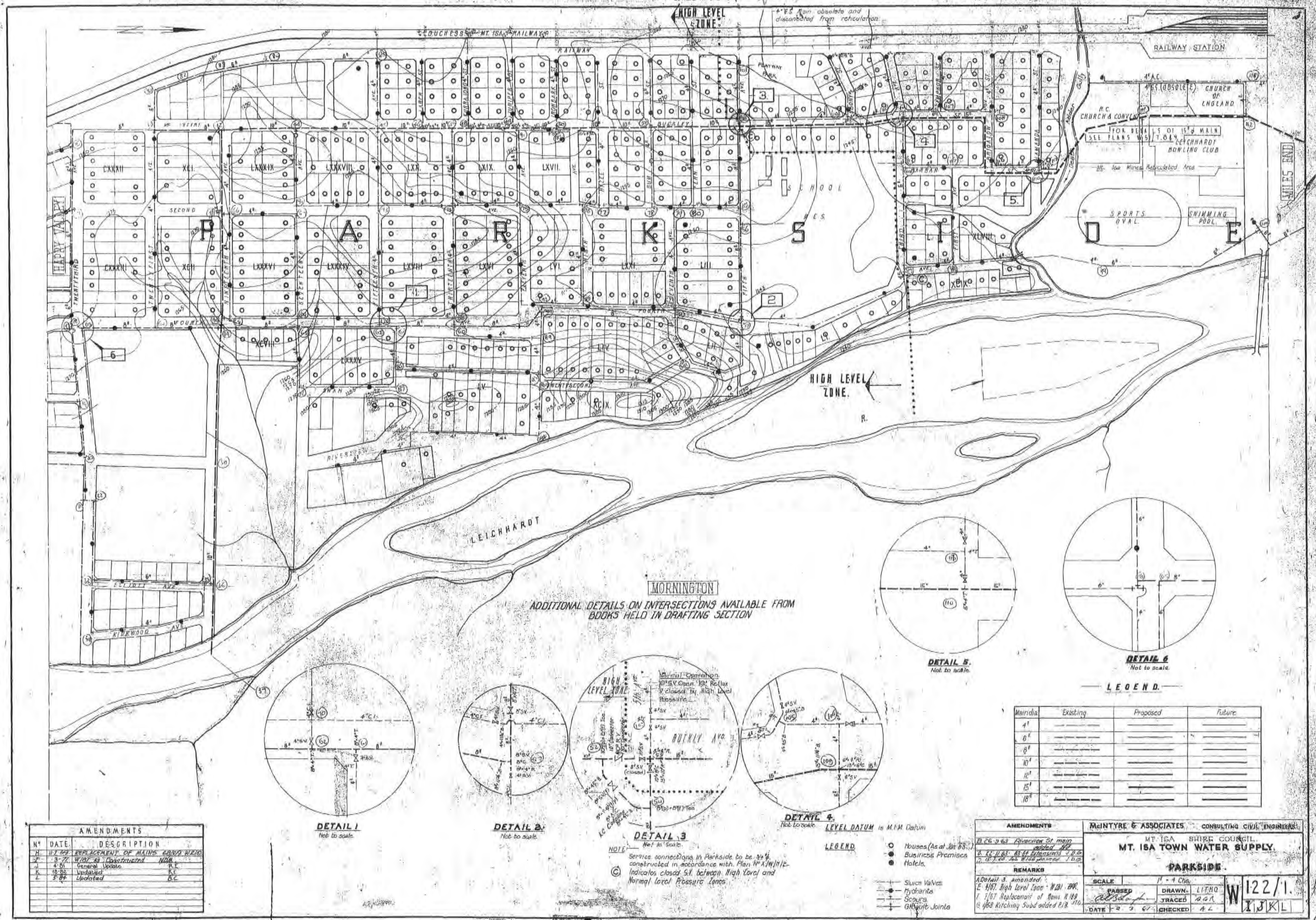
McINTYRE & ASSOCIATES CONSULTING CIVIL ENGINEERS

MT ISA SHIRE COUNCIL
MT. ISA TOWN WATER SUPPLY.
MORNINGTON

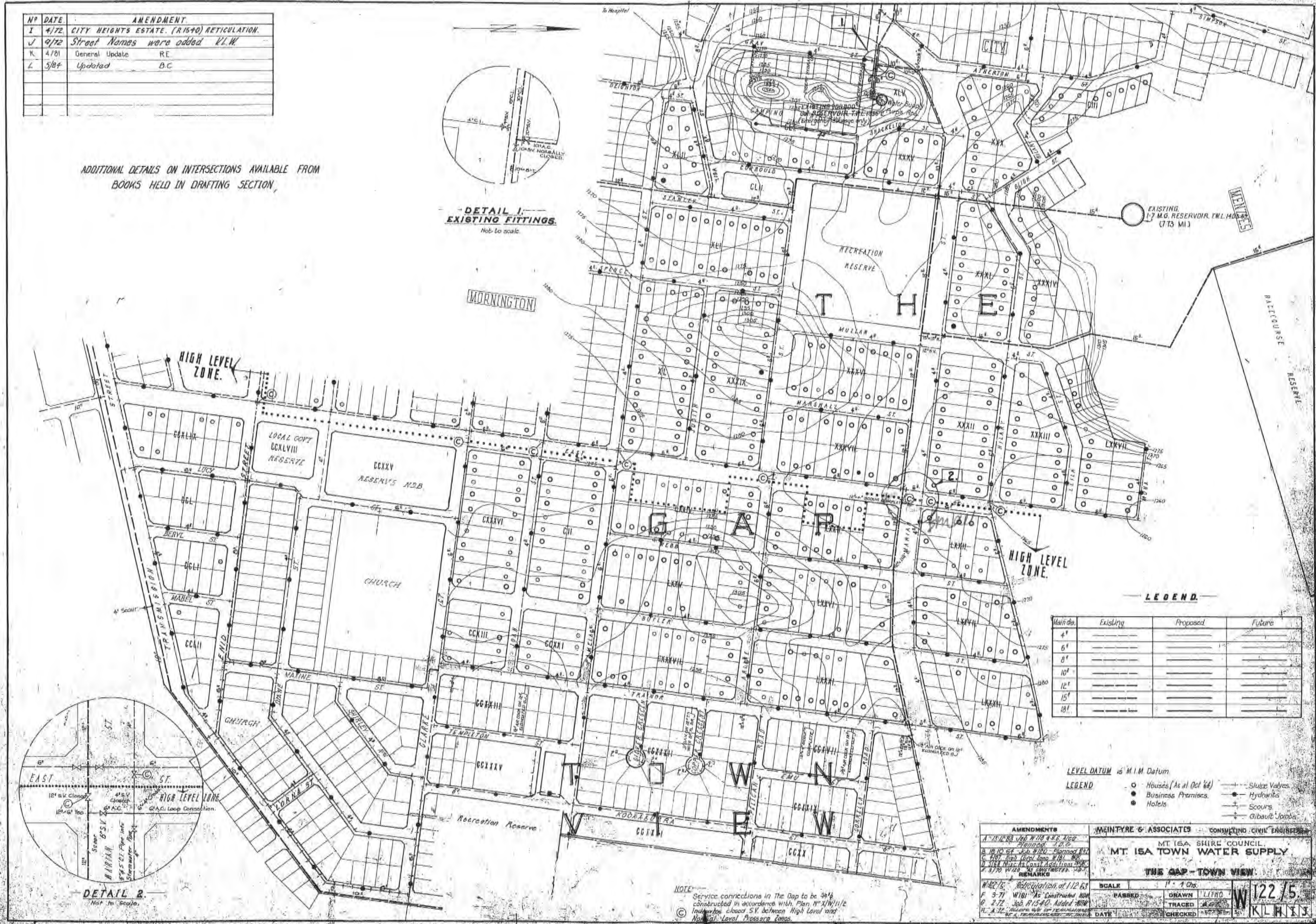
SCALE	1" = 4 Chs		
PASSED		DRAWN	LITHO
		TRACED	
DATE		CHECKED	

W 122/4 L

Notes: Service connections in Mornington to be 3/4" constructed in accordance with Plan No XW/112.
© Indicates closed S.V. between High Level and Normal Level Pressure Zones.



HIGH LEVEL ZONE
4" GS Main obsolete and disconnected from reticulation
DUCHESS - MT. ISA RAILWAY
RAILWAY
RAILWAY STATION
CHURCH OF ENGLAND
R.C. CHURCH & CONVENT
FOR DETAILS OF 15" Ø MAIN SEE PLANS W.S. 1.81
LEICHHARDT BOWLING CLUB
Mt. Isa Mines Reticulated Area
SCHOOL RES.
SPORTS OVAL
SWIMMING POOL
MILES END
HAPPY VALLEY
PARKSIDE
HIGH LEVEL ZONE.
LEICHHARDT R.
MORNINGTON
ADDITIONAL DETAILS ON INTERSECTIONS AVAILABLE FROM BOOKS HELD IN DRAFTING SECTION
DETAIL 1
Not to scale.
DETAIL 2.
Not to scale.
DETAIL 3
Not to Scale.
Normal Operation. 6" SV Open 10" Reflux V closed by High Level Pressure.
DETAIL 4.
Not to scale.
DETAIL 5.
Not to scale.
DETAIL 6
Not to scale.
LEGEND.
Main dia. | Existing | Proposed | Future
4" 6" 8" 10" 12" 15" 18"
LEVEL DATUM is M.I.M. Datum
LEGEND
Houses (As at Jan 68.)
Business Premises
Hotels.
Sluice Valves
Hydrants
Scours
Gibault Joints
NOTE
Service connections in Parkside to be 3/4" constructed in accordance with Plan No X/W/11/E.
© Indicates closed S.V. between High Level and Normal Level Pressure Zones.
AMENDMENTS
No | DATE | DESCRIPTION
H. | 11.7.69 | REPLACEMENT OF MAINS 68/69 W.210.
J. | 3.77 | W/131 As Constructed NDM.
J. | 4.81 | General Update B.C.
K. | 10.82 | Updated B.C.
L. | 5.84 | Updated B.C.
AMENDMENTS
B. 26.3.63 Riverview St main added
C. 22.11.63 63/64 Extensions
D. 15.7.65 Ward widening
REMARKS
A. Detail 3. amended.
E. 4/67. High Level Zone - W.131.
F. 5/67 Replacement of Mains W.189
G. 1/68 Kitching Subd added P.B.
McINTYRE & ASSOCIATES CONSULTING CIVIL ENGINEERS.
MT. ISA SHIRE COUNCIL.
MT. ISA TOWN WATER SUPPLY.
PARKSIDE.
SCALE 1" = 4 Chs.
PASSED
DRAWN. LITHO
TRACED A.G.R.
CHECKED A.L.
DATE 2.3.67
W 122/1.
I J K L



Nº | DATE | AMENDMENT
I | 4/72 | CITY HEIGHTS ESTATE. (R1540) RETICULATION.
J | 9/72 | Street Names were added V.L.W.
K | 4/81 | General Update R.E.
L | 5/84 | Updated B.C.
ADDITIONAL DETAILS ON INTERSECTIONS AVAILABLE FROM BOOKS HELD IN DRAFTING SECTION.
DETAIL 1. EXISTING FITTINGS.
Not to scale.
MORNINGTON
CITY
EXISTING 1·7 M.G. RESERVOIR. T.W.L. 1405·67 (7.73 Ml)
RECREATION RESERVE
RACECOURSE RESERVE
THE GAP
TOWN VIEW
HIGH LEVEL ZONE.
CHURCH
Recreation Reserve
DETAIL 2.
Not to Scale.
LEGEND.
Main dia. | Existing | Proposed | Future
4" 6" 8" 10" 12" 15" 18"
LEVEL DATUM is M.I.M. Datum
LEGEND
Houses (As at Oct '64)
Business Premises.
Hotels
Sluice Valves.
Hydrants
Scours.
Gibault Joints.
NOTE
Service connections in The Gap to be constructed in accordance with Plan Nº X/W/11/2
© Indicates closed S.V. between High Level and Normal Level Pressure Zones.
AMENDMENTS
A 23.12.63 Job W118 & W.G. Area Planned
B 18.10.64 Job W120 Planned
C 4/67 High Level Zone W181
D 3/68 Misc. As Const. Additions
E 8/70 W120 As Constructed
REMARKS
W122/1C Reticulation at 1.12.63
F 9-71 W181 As Constructed
G 2-72 Job R1540 Added
McINTYRE & ASSOCIATES CONSULTING CIVIL ENGINEERS
MT. ISA SHIRE COUNCIL.
MT. ISA TOWN WATER SUPPLY.
THE GAP - TOWN VIEW.
SCALE 1" : 4 Chs.
PASSED
DRAWN LITHO
TRACED
CHECKED
DATE
W 122/5.
K L H I J

APPENDIX E

S. EBERHARD SCIENTIFIC JOURNAL ARTICLE

Helictite, (2003) **38(2):** 27-38

Nowranie Caves and the Camooweal Karst Area, Queensland:
Hydrology, Geomorphology and Speleogenesis, with Notes on Aquatic Biota

Stefan Eberhard

2 Churchill Ave, Margaret River WA 6285

Abstract

Development of the Nowranie Caves includes both phreatic and vadose components, with prominent influences on cave geomorphology exerted by joints, bedding and past changes in watertable levels. Active circulation is occurring within a phreatic conduit at moderate depth (22-30 m) below the level of the present watertable. Slugs of flood water can penetrate well into the flooded section of the cave, and it appears that dissolutional enlargement of the conduit may be occurring under present conditions. Speleogenesis in Nowranie Caves incorporates deeper phreatic processes in addition to shallow phreatic (i.e. watertable) processes. A series of three fossil, or occasionally re-flooded, phreatic horizontal levels in the Nowranie Caves correspond with similar levels in other Camooweal caves, and reflect a regional pattern and multi stage history of watertable changes linked with cave development. The stacked series of cave levels may reflect episodic uplift, wetter climatic episodes, or a combination of both - possibly dating from early to mid Tertiary times. Caves and dolines are the major points for groundwater recharge in the Camooweal area, and these are susceptible points for injection of contaminants into the groundwater system. A climatic and distributional relict, and locally endemic, fauna is present in the groundwater. The Nowranie Caves, and Camooweal area generally, has conservation significance as a karst hydrogeological and ecological system that has preserved a history of regional landscape and faunal evolution in northern Australia during the Quaternary.

Keywords: Camooweal, karst, hydrology, geomorphology, speleogenesis, biota

Introduction

The Nowranie Caves (138^0 11' 05" East; 20^0 03' 05" South) are situated in the Camooweal karst area within the Barkly karst region in north-west Queensland and Northern Territory (Figure 1). This paper contributes specific information on the Nowranie Caves and the Camooweal karst area generally, following a mapping and diving expedition there during 2000. Information is presented on water physico-chemistry and aquatic biota. Major outcomes of the expedition were:

1) Discovery and mapping of extensive conduit development at 22-30 m depth below the watertable;

2) Mapping of Great Nowranie and Little Nowranie Caves, including differentiation of upper, mostly fossil, phreatic levels;

3) Investigation of geologic and hydrologic influences on cave development;

4) Collection of aquatic fauna and measurement of water physico-chemistry.

The aim of this paper is to document these discoveries and interpret them in relation to cave geomorphology, local and regional hydrology, speleogenesis, and biogeography.

Regional Description and Physiography

The Barkly karst region corresponds to the geographical feature known as the Barkly Tableland (Stewart 1954). The carbonate rocks are flat lying, well-bedded and well-jointed dolomites and limestones of the Early Palaeozoic Georgina Basin (de Keyser 1974). The Mesozoic and Cainozoic geology, karst and cave development are described by Grimes (1974, 1988).

The regional climate is arid to semi-arid, with some monsoonal influence. At Camooweal the mean annual maximum temperature is 32.5^{0}C and the mean annual minimum is 17.3 ^{0}C. Evaporation (annual 2744 mm/year) exceeds mean rainfall in every month of the year. Most rainfall occurs during summer, with the annual mean about 400 mm. The vegetation is a mosaic of treeless grasslands and low open savannah woodlands.

The Barkly karst region is an uplifted peneplain. The Camooweal karst area, located in the headwaters of the Georgina River and tributaries, contains the highest density of cave development in the Barkly region (Figure 1). About 60 karst features including dolines, streamsinks and 30 caves occur within an area of about 60 x 30 km in the vicinity of Camooweal township (Figure 2). At least ten caves intersect the regional watertable located about 70 m below the surface of the peneplain.

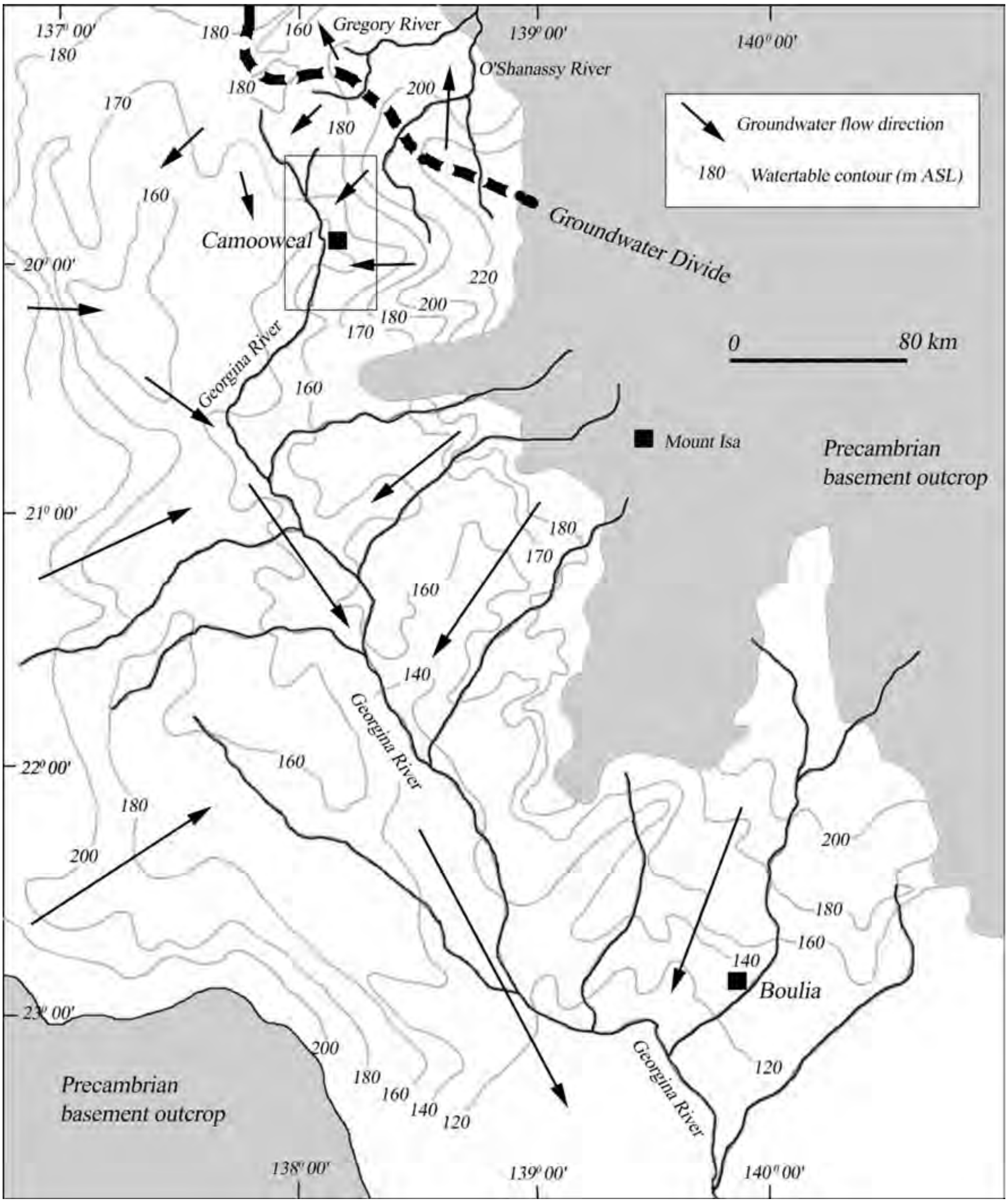


Figure 1. Southeastern Georgina Basin, showing surface drainage, watertable contours and inferred groundwater flow directions, including the groundwater divide inferred to exist between the headwaters of the Georgina River and Gregory –O'Shanassy Rivers. The Camooweal karst area (see Figure 2) is the area inside the box. Adapted from Randal (1978).

The Camooweal caves are located within 20 km, mostly on the eastern side, of the main channel of the Georgina River, which drains south through the Channel Country into the Lake Eyre Basin. A fully integrated surface drainage system is also present, whilst the extensive black soil cover restricts infiltration except where it has been stripped back to expose the carbonate surface (Grimes 1988). Where this has occurred then surface runoff may be diverted underground via cave entrances or sink points in dolines. The base of surface watercourses, and much of the peneplain surface generally, is otherwise sealed by the black clay soil that prevents downward leakage and diffuse recharge of the karst aquifer. Some surface runoff is detained in semi-permanent waterholes that may persist throughout the dry season, such as Nowranie Creek waterhole.

Geomorphology

Description of Nowranie Caves

The Nowranie Caves comprise Great Nowranie Cave (4C-6) and Little Nowranie Cave (4C-11). The entrances to the caves are situated 120 m apart, whilst a doline of 40 m diameter, with a depth of less than one metre, is located 200 m northwest of the cave entrances

Figure 2. Camooweal karst area showing surface drainage and locations (X) of karst features (caves, dolines, stream sinks), including features named in text. Adapted from U.Q.S.S. Map 141, compiled by R. Canty and K. Grimes (1979).

(Figure 3). Both caves descend in a stepped series of vertical shafts alternating with horizontal sections, to sump pools that represent the watertable lying at about 70 m below the surface of the plain (Figure 4).

Nearly 1.5 km of cave passage has been mapped so far, including 500 m of flooded passage explored by cave diving. Further diving exploration will undoubtedly extend the presently known length of the system, and possibly result in a navigable subterranean connection between Little Nowranie and Great Nowranie. Passages in these caves approach to within 50 m horizontally and 25 m vertically of each other.

Great Nowranie Cave captures overland flow which otherwise would drain into Nowranie Creek located 1.5 km away. Two shallow drainage gullies, each about 500 m in length, converge at the large collapse doline entrance of Great Nowranie Cave. The doline engulfs episodic surface runoff from the surrounding plain. Below the 18 m deep entrance pit (Figure 5), a large passage (Upper Level) with a width and height up to 10 m, extends in a northwest direction for some 100 m to a second shaft 14 m deep. Near the level of the top of the second pit a maze of passages extends laterally (Figure 6). This network is intersected by two other vertical pits that also connect to the next level (Middle) below. The Middle Level includes passage development as a tall canyon, and an elliptical tube 5 m wide and 3 m high (Figure 7). A third series of vertical shafts and a narrow fissure drop 15 m to the third horizontal level (Lower Level) just above the watertable. This level comprises tubular passages of 1-2 m diameter that are subject to regular back flooding.

At a sump pool at the watertable, a steeply inclined fissure descends to a depth of 30 m below the water surface, from which a horizontal conduit 3-4 m diameter trends initially in a southwesterly direction. The flooded conduit meanders considerably but then trends in a more southerly direction to a point reached by diving at 23 m depth and 500 m from the sump pool. The profile of the conduit resembles that of a phreatic loop (*sensu* White 1988) between 22 – 30 m water depth, with very gently rising and falling limbs of several hundred metres wavelength and shallow amplitude (maximum 8 m). Two side passages located at 90 m and 150 m from the start of the dive were partly explored in a northerly direction. The passage at 90 m intersected a vertical fissure that continued upwards beyond the depth of 21 m explored.

Little Nowranie Cave has comparatively smaller dimensions and spirals steeply downwards with little horizontal development between the vertical shafts. The levels of horizontal development roughly correspond with those in Great Nowranie. A deep sump pool at 70 m below the surface represents the local watertable, but this was not explored by diving during the 2000 expedition.

Cave Patterns

The Nowranie Caves exhibit a predominantly branchwork pattern of development (*sensu* Palmer 1991, 2000). The cave patterns

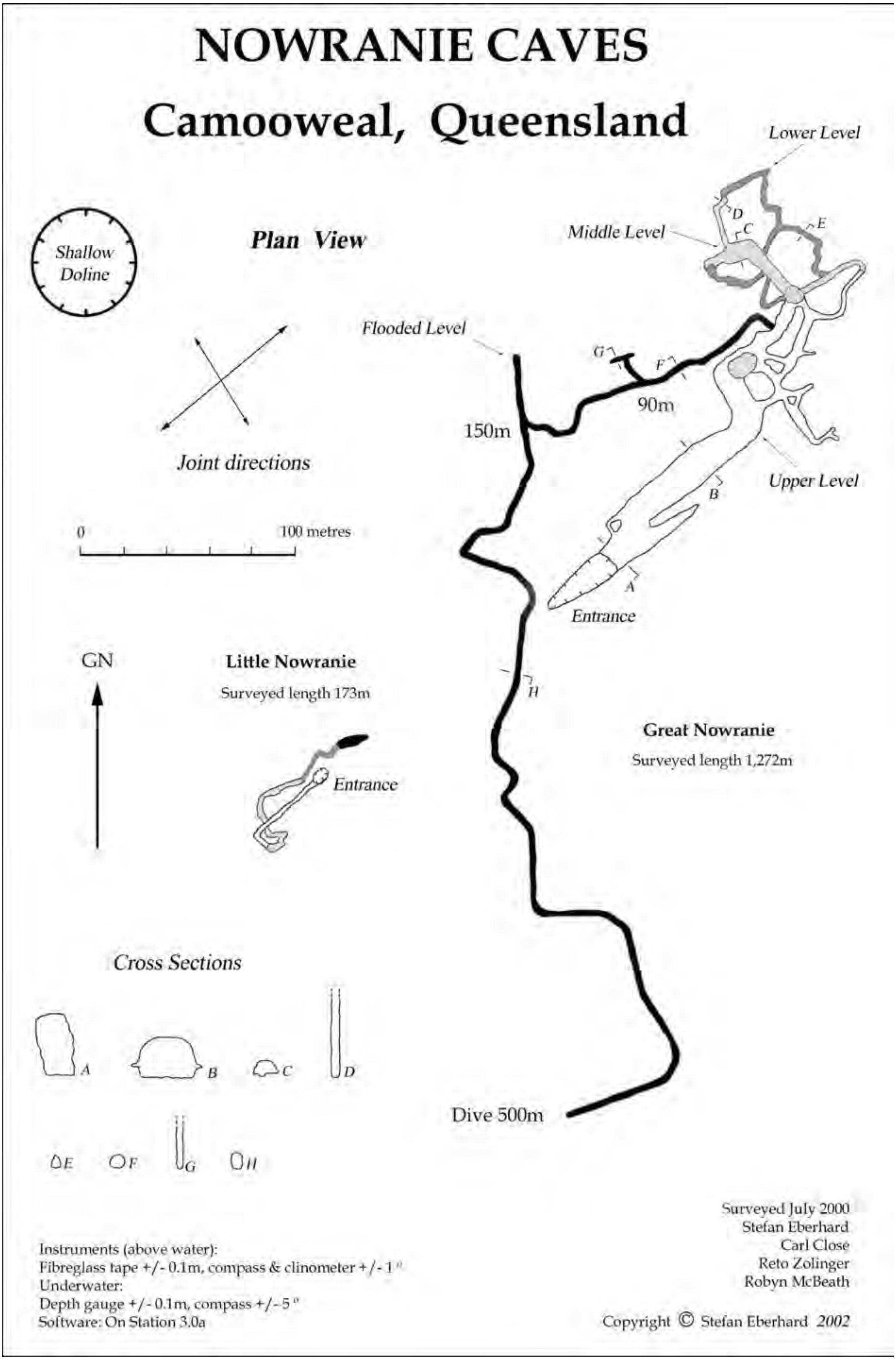


Figure 3: Plan of Nowranie Caves showing surveyed passages and levels, including joint directions.

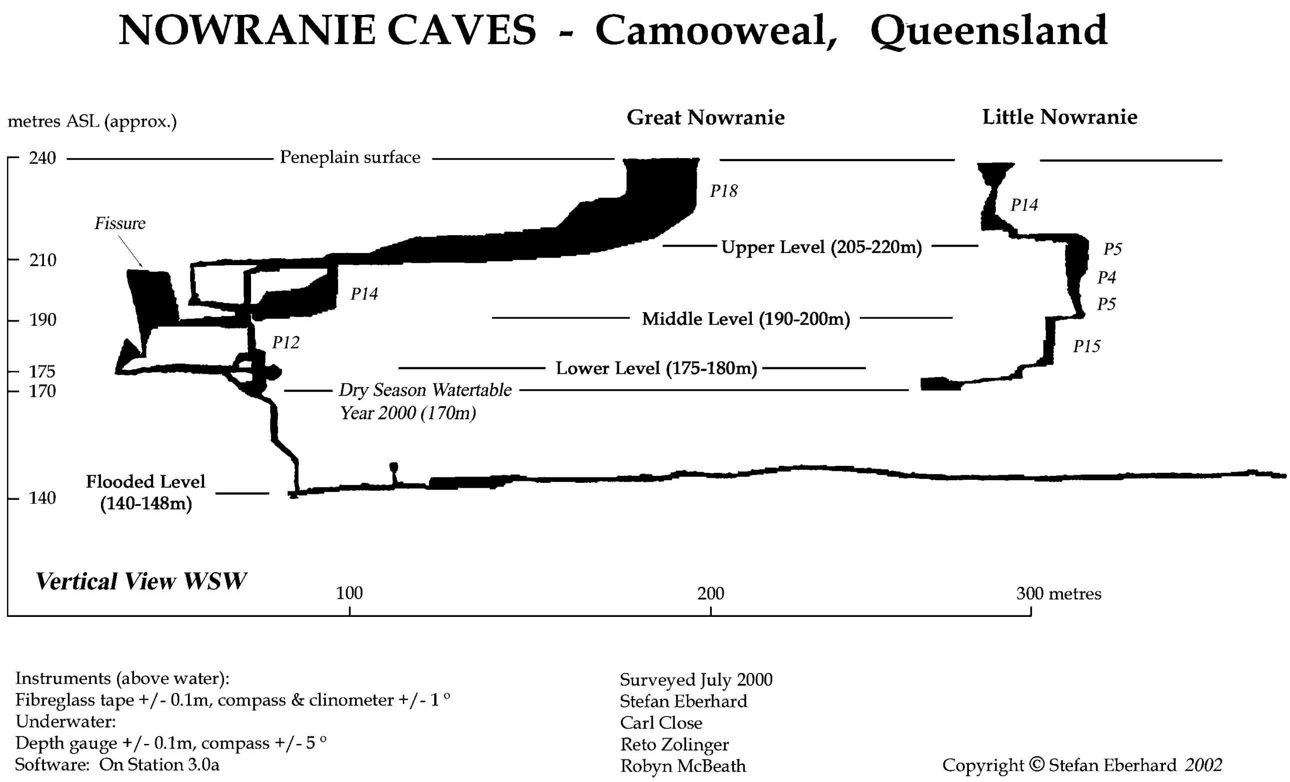


Figure 4: Projected profile view (projected onto a WSW plane) of Nowranie Caves showing elevation (in metres above sea level – m ASL) of the upper, middle and lower levels in relationship to the peneplain surface, present watertable, and the flooded conduit. Depth of vertical pitches (P) indicated in metres.

include angular alignments and irregular networks of passages controlled by jointing, in addition to curvilinear passages with minor anastomotic maze and spongework development. The cave morphology includes both phreatic and vadose components, with prominent influences on development exerted by joints, bedding and higher watertables in the past. A vertically stacked series of horizontal levels indicates a multi stage history of development linked with changes in watertable levels. Since lowering of the watertable there has been ongoing enlargement and modification of upper level passages by ephemeral vadose flows and back-flooding.

Stratigraphic and Structural Influences

Geologic structure and lithology can exert strong influences on cave development and morphology (Ford & Williams 1988, White 1988), and a number of such possible controls are evident in the development of Nowranie Caves. The majority of passage development above the present watertable occurs along a series of closely spaced parallel joints oriented at SW-NE (60-240^0 magnetic). The entrances of Great Nowranie and Little Nowranie Caves are developed along the same joint, whilst the plan survey indicates at least 5 parallel joints spaced about 5 to 20 m apart. Horizontal passages, some meandering but aligned approximately perpendicular to the major joint direction, connect sections of cave developed along separate joints. Another set of joints, aligned approximately SE-NW, is inferred to be influencing the perpendicular passage alignments (Figure 3). The joint planes are vertical

Figure 5. Great Nowranie Cave – view into upper level tunnel from base of 18m entrance pit. Note the influence on passage morphology of horizontal bedding and vertical / sub-vertical joint planes. Photo Stefan Eberhard.

to sub vertical, resulting in passage profiles that are either vertical, or steeply inclined fissures inclined at about 80^0 to vertical.

Cave Levels

A distinct series of coplanar, horizontal passage networks are developed at different levels, which are connected together by vertical pits or narrow fissures. The horizontal passages are clearly of phreatic origin, whilst the connecting shafts and fissures also appear to be of primary phreatic origin. Four distinct zones of horizontal phreatic tube development were identified. The levels, from highest to lowest, occur in relation to the present (2000) watertable (Figure 4):

+ 40-47 m (Upper Level);
+ 23-30 m (Middle Level);
+ 4-9 m (Lower Level);
- 22-30 m (Flooded Level).

The lowest phreatic level is a permanently flooded and presently active drainage conduit that is recharged by wet season runoff sinking into the entrance of Great Nowranie. The level above this (Lower Level), situated 4-9 m above the dry season watertable, is intermittently flooded by wet season runoff, probably on an annual or semi-annual basis as evidenced by fresh mud deposits. The Middle and Upper Levels are fossil phreatic passages, now drained, although they are still subject to dissolutional enlargement and modification by seasonal flooding which occasionally fills the system to a height of 40 m above the dry season watertable level.

Vertically extensive fissures, which are dissolutionally enlarged joints interpreted to be of primary phreatic origin, extend the full 70 m vertical range connecting the lowest flooded level to the uppermost horizontal level. Grimes (1988) reported vertical fissures connecting different levels in Five O'Clock Cave (4C-36), which he also interpreted to have been initiated phreatically, following a joint, although subsequently enlarged by vertical vadose flows. Dissolutional enlargement of these deep vertical fissures was evidently initiated at some depth below the watertable, and their development may have been synchronous with horizontal maze

Table 1. Comparison of levels between different caves (listed from north to south), including altitude of entrance on the peneplain (estimated from 20 m interval contour maps), metres below ground level (m BGL) to standing water level (SWL), and approximate altitudinal range of identified phreatic levels (Upper, Middle, Lower, Flooded). Altitudes are metres above present sea level (m ASL). The source and accuracy (standard ASF/BCRA grades) of cave survey information is indicated. Cave maps done by UQSS are held in records of the Chillagoe Caving Club and the Central Queensland Speleological Society. The maximum expected error for altitude values is +/- 5m.

Cave Name	Reference levels			Approx. altitudinal range of levels (m ASL)				Survey notes
	Entrance (m ASL)	**SWL** (m BGL)	**SWL** (m ASL)	**Upper**	**Middle**	**Lower**	**Flooded**	
Hassels 4C-3	245	75	170	absent	absent	absent	136-170	UQSS 1978, grades 2 to 5
Niggle 4C-15	240	70	170	?	?	175-190	140-170	Estimated, dived to 30m
Four Mile East 4C-13	240	73	167	217-221	201-203	171-173	<167	SSS 1970, grade 2
Canellan 4C-10	240	75	165	?	?	?	<165	UQSS, Bourke et al. 1969, grade 4
Great Nowranie 4C-6	240	70	170	205-212	190-194	177-179	140-170	Grade 4 survey, Eberhard et al. 2000
Little Nowranie 4C-11	240	70	170	215-217	191-193	173-178	<170	As above
Five O'Clock 4C-36	240	55 (perched) 70 (SWL)	170	218-220	195-200	184-187	<170	UQSS surveys 1974-78, grade 2 - 4
Marcus Mice 4C-34	240	68	172	223 +/-	?	?	159-172	UQSS 1978, grades 2 to 5
Spinifex 4C-33	240	Est. 70	170	?	?	?	130-170	Unsurveyed, dived to -40m
Kalkadoon 4C-18	240	75	165	?	?	?	<165	UQSS

Figure 6. Upper Level in Great Nowranie Cave showing network of horizontal phreatic tubes and the vertical shaft (14 m deep) which connects below to the Middle Level. The shaft and horizontal levels have subsequently been modified by seasonal vadose inflow waters and back-flooding. Photo Ken Grimes.

development (at different times and levels) in the shallow phreatic zone within a few metres of the watertable surface.

The levels identified in the Nowranie Caves correspond with similar levels in other Camooweal caves, thus reflecting a regional pattern and history of watertable changes linked with cave development. The different levels and their respective heights in relation to the local watertable and present sea level, are compared with other caves in the Camooweal area in Table 1. The altitude of cave entrances on the peneplain is about 240 m above present sea level (ASL). At least ten caves intersect the regional watertable located about 70 m below the surface of the plain at about 170 m ASL. The Upper, Middle and Lower Levels in the Nowranie Caves corresponds with similar levels recorded by Grimes (1988) in Five O'Clock Cave, located 1.5 km east. Three distinct phreatic levels at approximately similar elevations also occur in Four Mile East Cave (4C-13) located 14 km north. The concordance in levels between these different caves suggests they are of similar ages, and share a common evolutionary history of development.

Distinct levels are evident in five other deep Camooweal caves, although further survey work is needed to define the different levels in these caves (4C-10, 15, 18, 33, 34), however, it appears that these also reflect a general regional pattern. Extensive flooded horizontal conduits have still to be explored in other caves, although several sumps have been dived to depths between 30 – 40 m (4C-3, 15, 33) with exploration still incomplete in some of them.

An exception to the general pattern of cave morphology occurs in Hassels Cave (4C-3), which has the form of a single narrow vertical fissure with no upper-level horizontal phreatic development. This cave, which is a geographic isolate in the Camooweal area, may have been subject to different hydrogeological conditions during development, or it may be younger in age than the other caves.

Figure 7. Middle Level in Great Nowranie Cave – phreatic tube subsequently modified by lateral undercutting from vadose flood waters. The Flooded Level is a phreatic tube of similar dimensions. Photo Stefan Eberhard.

Hydrology

Recharge

Groundwater recharge appears to be more or less restricted to areas where the clay soils have been stripped back and the underlying carbonate bedrock exposed. This occurs in dolines and cave entrances that act as the major groundwater recharge points in the area, due to the impermeability of the black soil which prevents diffuse infiltration. Groundwater recharge is therefore highly localized and dependent on wet season rainfall events of sufficient intensity to cause surface runoff within the small cave catchment areas. When these precipitation events occur then rapid and direct recharge occurs, often associated with severe flooding of cave passages.

The catchment areas for groundwater recharge are relatively small in relation to the surface drainage system, and the size of the caves seems to reflect the size of the surface catchment around their dolines. The relatively large size of Great Nowranie Cave is attributed to a catchment area estimated at about 2 km^2, although the catchments of some other large caves such as Kalkadoon (4C-20) are smaller than this.

Point source inflows in dolines and cave entrances are especially susceptible points for injection of contaminants into the groundwater system. This risk is exacerbated when dolines and caves are utilized for dumping of rubbish such as occurred in the past at Niggle Cave (4N-15)and Tar Drum Sink (4N-12).

Water Physico-Chemistry

Water temperature was measured *in situ* with a divers underwater digital thermometer (+/- 1 ^{0}C). Water samples were collected for *in vitro* measurement of pH, conductivity and dissolved oxygen. Samples were measured within 24 hours of collection using calibrated portable instruments (WTW pH 320, WTW LF320 conductivity, and WTW OXI 320). Observations of water clarity and stratification were made during diving. Results are shown in Table 2.

The Nowranie sump waters were fresh (EC range 333 – 375 µS/cm @ 25^0 C) and oxygenated (DO range 20–40% saturated), with a measured pH range from 6.78 to 7.87. The waters varied in both temperature (range 26 - 29^0 C) and clarity along the longitudinal profile, as well as displaying distinct thermal stratification. The entire water column in the initial 150 m of the sump was isothermal at 26^0 C. Beyond 150 m distance into the sump an abrupt thermocline at about –25 m water depth separated cooler (26^0) underlying waters from warmer (29^0) upper waters. The thermocline also coincided with a distinct change in turbidity – the cooler bottom waters being turbid which limited diver visibility from 0 to 2 m , whilst the warmer waters above were 'crystal' clear and had excellent visibility (> 10 m). The turbid waters were interpreted as being a recent injection of cooler surface floodwater, that had displaced warmer less dense groundwaters upwards where flow conditions had been insufficient to cause mixing. The further reaches of the sump beyond 200 m penetration were generally warmer and clearer although isolated patches of cool turbid water were encountered. These might indicate the proximity of other vertical injection points, or be remnants of earlier slow-moving slugs of floodwater traversing the flow path within the Nowranie sump.

The mean annual surface temperature at Camooweal is about 25^0 C, whilst the geothermal gradient in the Nowranie area, mapped from boreholes by Randal (1978), is about 15 m per degree. The sump waters in Nowranie are about 100 m below the surface so the temperature of groundwaters in thermal equilibrium with the surrounding rock should be around 31.5^0 C, based on Randal's geothermal gradient. This is close to the 29^0 actually measured. The maximum water temperatures measured in the Nowranie sump fall within the range of air temperatures (28 – 30^0) typically measured in the deep zone of Camooweal caves (Halbert 1970, K. Grimes, pers. comm.).

The limited data on the water chemistry indicate that slugs of flood water can penetrate well into the flooded section of the cave, and since this water is probably undersaturated with respect to carbonate, it appears that dissolutional enlargement of the conduit is presently occurring.

Local Drainage Patterns

Local drainage patterns and flow directions within the Camooweal caves are indicated by the diving discoveries and surveys of the air-filled sections of caves. The major trend of base level flow in Great Nowranie and Five O'Clock Caves is southwards, although meanders and abrupt directional changes occur in these curvilinear conduits. Upper level passage development in Four Mile East Cave follows joints aligned SW-NE and WNW-ESE, whilst low level development just above the present watertable (The Bowel) directs flood overflow drainage towards the SW. In Marcus Mice Cave, a narrow vertical fissure at the level of the watertable extends for several hundred metres, apparently following a joint oriented approximately SW-NE. Hassels Cave is similarly developed as a narrow vertical fissure aligned roughly E-W, whilst diving in 1998 explored the fissure to 34 m water depth (S. Eberhard unpubl. data).

The drainage patterns in Kalkadoon Cave and Niggle Cave consist of ramifying distributary networks that radiate away from the entrance inflow area (Grimes 1988). In Niggle Cave the major flow is directed WSW from the entrance to a large sump at the Melting Pots which has been dived to 30 m depth. In Kalkadoon Cave, significant passage development of the CASA and UQSS Extensions suggests that major flow occurs in both southerly and westerly directions respectively, although passages also branch outwards in easterly and northerly directions as well. A pool in the UQSS West Passage may be the dry season watertable.

Regional Drainage Pattern

In the Camooweal area the regional watertable is intersected in the caves at an elevation of about 170 m above sea level (ASL). Within the level of error (+/-5 m) expected from land surface elevations interpolated from 20 m contour intervals on topographic maps (1: 100,000), and levels reduced from cave surveys which ranged in precision from ASF Grade 2 to 5, there is no obvious gradient in the watertable, at least in a north-south direction (Table 2). The deduced level of the watertable in Hassels Cave is similar to that in Four Mile East, Niggle and Canellan (4C-10) Caves located some 30 km south, as well as Nowranie and Marcus Mice (4C-18) Caves located 45 km south of Hassels. Thus the level of the watertable measured in the caves lies within the range for the regional watertable surface interpreted from measurements in bores made by Randal (1978).

A locally perched (+15 m) sump at about 185 m ASL occurs in Five O'Clock Cave. Beyond the sump a gently rising phreatic loop passage extends for 350 m before continuing in a gentle decline for a further 350 m to the brink of a shaft that drops about 15 m into a pool, presumably at the level of the regional watertable.

The destination of the groundwater draining the Camooweal karst remains somewhat of a mystery, there being no major springs in the immediate area. At Lawn Hill and Riversleigh located some 150 km north of Camooweal there occur large karst springs that emerge from the edge of the Barkly Tableland and drain northwards into the Gulf of Carpentaria via the Gregory and O'Shanassy Rivers (Drysdale 2001; Drysdale, Taylor & Ihlenfeld in press). The springs in the Lawn Hill – Riversleigh area are at elevations of between 135 to 170 m ASL, but they are in a separate sub-basin to the Georgina River. Randal (1978) mapped the regional watertable surface of the southeastern Georgina Basin from boreholes, and identified a groundwater divide at a minimum elevation of about 175 m ASL some 60 km north of Camooweal. From here the regional gradient of the watertable is southwards, so groundwater movement in the Camooweal karst must be in this direction (Figure 1).

Speleogenesis

The discovery in Nowranie Caves of an active phreatic conduit at 22-30 m depth below the present watertable is significant for understanding present and past hydrology within the Camooweal karst. It clearly shows that speleogensis in this karst incorporates deeper phreatic components in addition to watertable components.

The mixture of phreatic loops and watertable leveled components within the Nowranie Caves system resembles a Type 3 cave in the Four State Model for the development of common cave systems (Ford & Ewers 1978; Ford & Williams 1989). These types of cave are a mixture of shorter, shallower loops and quasi-horizontal canal (i.e. watertable) representing a higher state of fissure frequency and greater exploitation of joints and bedding planes than found in Type 2 (phreatic cave with multiple loops) and Type 1 (bathyphreatic cave). The discovery of an active phreatic conduit at moderate depth below the present watertable excludes the Nowranie Caves from classification as Type 4 (ideal watertable cave).

In a study of the depth of conduit flow in unconfined carbonate aquifers, Worthington (2001) found that the flow depth of conduits was directly proportional to flow path length and stratal dip. Deep conduit development was favored in steeply dipping strata for flow paths > 3 km, with steeply dipping strata aiding the flow of undersaturated water to depth along bedding planes. The absence of springs near to Camooweal indicates a long subterranean flow path, with a distance of ca. 400

Location	Distance (m from start of dive)	Water depth (m)	Temp (°C)	pH	Conductivity (µS/cm @ 250C)	DO (% Sat.)	Date
Great	0	0	26	6.78–6.89	340	20-40	30-6-00
Nowranie	0	-6	26	7.87	333	26	8-7-00
Cave	100	-26	26	-	-	-	3-7-00
	200	-25	28	-	-	-	3-7-00
	300	-24	29	-	-	-	3-7-00
	370	-25	29	-	-	-	3-7-00
	475	-23	29	7.49	375	30	7-7-00
Nowranie Ck Waterhole	-	0	18	7.96	540	100	1-7-00

Table 2. Physico-chemical characteristics of water measured at different depths and distance in Great Nowranie sump, compared with stagnant surface runoff waters in Nowranie Creek Waterhole.

km to the nearest likely output south of Boulia (Figure 1). This could help explain the existence of submerged phreatic passages well below the present watertable, although conduit depths at Camooweal are an order of magnitude less than the depths reached in some of the world's largest cave-spring systems developed in dipping limestones. In these systems depths of > 100 to 400 m are reached along flow path lengths of under 14 km. At Camooweal the inferred flow path length is an order of magnitude greater than these other systems, although the horizontal bedding dips would not be conducive to the development of deep conduits in the manner suggested by Worthington's model. At Camooweal, it seems that the flow path is able to follow joints to moderate depth.

The degree to which deeper phreatic and watertable speleogenetic processes may have been temporally coupled during the evolutionary development of the cave system remains to be fully elucidated. Deeper phreatic circulation, as opposed to shallow phreatic (i.e. within a few metres of the watertable) circulation, appears to dominate the present hydrological regime, however the upper horizontal levels indicate strong piezometric influences under elevated watertables in the past. The apparent absence of a similar zone of intense lateral dissolution at the level of the present watertable is somewhat puzzling in this regard, although such a zone may in fact be represented by the Lower Level which is only 4 – 9 m above the dry season watertable, and which is subject to re-flooding at annual or semi-annual intervals. Alternatively, the watertable may be in a state of flux and presently undergoing readjustment to a new, lower base level.

In Five O'Clock Cave, Grimes (1988) observed bedding control in the development of phreatic passage levels, with preferential enlargement along more soluble beds. Whilst it may be difficult to distinguish bedding and piezometric effects in these flat lying rocks, the occurrence of horizontal zones of intense dissolution and flat roofs to passages and chambers, suggests that this development occurred near to the watertable surface at the time, albeit under the influence of flat bedding. Spongework dissolution features at these levels indicate conditions of slow phreatic flow.

Assuming that the Upper, Middle and Lower Levels in the Nowranie Caves were developed near to the watertable surface at the time, then they represent palaeo watertables at circa 205-220, 190-200, and 175-180 m ASL. These are now perched, essentially fossil features, which are only occasionally subject to re-flooding. The levels are interpreted to represent discrete still-stand periods in the regional watertable history, with presumably younger still-stands developed at successively lower levels. However, the probability of deeper circulation needs to be considered in interpreting the different cave levels in relation to palaeo watertables and history of the region. Nonetheless, the upper horizontal levels are interpreted as lying close to the original watertable surfaces due to the enhanced dissolution in these zones.

The pattern of cave development throughout the Camooweal area is characterized by passages which extend away from cave entrances, and even bifurcate into smaller distributaries further away from the inflow point. This pattern implies that the caves are not collapse windows into underlying conduits that originated elsewhere, but are themselves the points of origin for speleogenesis. Caves occur only where the black soil cover is breached. Gaps in the black soil cover occur in a variety of settings, including dolines and the edges of limestone rises, in areas of more porous lateritic soil, and, sink points within, or beside, major stream courses (K. Grimes pers. comm.). Cave initiation is not suspected where the soil cover has not been breached, or leakage through it does not occur. The high density of caves and dolines in the Camooweal area may be because the black soil cover is not as extensive there as elsewhere in the Barkly region (Grimes 1988, Figure 1). Because the caves could only have started to form once the black soil cover was breached the caves must be younger than the black soil, although the origin and age of the soil remains uncertain.

Whilst speleogenesis post dates formation of the black soil, the timing of cave formation also remains poorly constrained. The Mesozoic and Cainozoic development of the area is discussed by Grimes (1974). East of Camooweal the limestones are overlain by thin Mesozoic sediments and lateritic soils, which developed on a mid Tertiary planar land surface. This surface was uplifted in mid and late Tertiary times, but the tableland has been subject to little erosion since then (Grimes op. cit.). Minimal downcutting of the Georgina River has occurred, although stream incision and dissection is continuing in the northern margins of the tableland. Most of the higher levels in the caves could have developed during wetter climates of the early - mid Tertiary, and they could have been drained during uplift of the peneplain in the mid - late Tertiary (Grimes 1988). The stacked series of cave levels indicate a multi stage history of cave development, which may reflect episodic uplift, wetter climatic episodes, or a combination of both. If sequential downward development of the cave levels occurred in response to uplift, then the lowest cave levels must have formed after the last uplift period and therefore cannot be older than late Tertiary. The upper cave levels must be somewhat older than this.

Aquatic Biota

Growths of red-brown filaments up to 50 mm long occur suspended from the ceiling in the warm waters beyond 200 m in the submerged passage of Great Nowranie (Figure 3). It is postulated that these might be colonies of filamentous, possibly iron metabolizing, bacteria. Similar colored deposits of flocculent matter on the floor of the 90 m side passage, and further into the sump, might also be partly bacterial in origin. Bacterially mediated conversion and precipitation of soluble ferrous iron (Fe^{2+}), into $Fe(OH)_3$, occurs rapidly at pH 7.5 – 7.7 (Boulton & Brock 1999), which is within the pH range measured in Nowranie sump waters.

One species of aquatic macro-invertebrate - an amphipod crustacean - was collected from Great Nowranie and Hassels (4C-3). The amphipods were most abundant near the beginning of the sump pools, presumably due to the supply of fresh food sources in the form of organic material (vegetation and animals) transported into the cave by gravity and flood waters.

The amphipod is a new, undescribed species of stygobite belonging to the genus *Chillagoe* (J. Bradbury pers. comm.). This new species is known only from this karst groundwater system, where it is likely to be endemic. It is morphologically similar to, but distinct from, *Chillagoe thea*, a species that inhabits the Chillagoe caves 600 km to the east of Camooweal (Barnard & Williams 1995, Bradbury & Williams 1997a).

Both species are stygobites and entirely restricted to their respective karstic groundwater habitats. The distributions of the Camooweal and Chillagoe species extends more to the north in Australia – by many hundreds of kilometres - than any surface aquatic amphipod. An explanation for this is that freshwater amphipods are not common in subtropical and tropical waters and only subterranean waters in these regions provide the low temperatures and more stable environmental conditions required to support amphipod populations (Bradbury & Williams 1997b).

Many groundwater invertebrates have strikingly restricted distributions, combined with low dispersal powers that set strong limits on their ranges (Strayer 1994). The Camooweal and Chillagoe species are derived from old freshwater ancestors that presumably once occurred on the surface at both locations in the distant past. Their biogeography reflects the general pattern observed for stygobiont amphipods of freshwater origin in Australia, that of geographically restricted ranges which coincide with areas of the continent not inundated by the sea during the Cretaceous marine transgression (Bradbury & Williams 1997a, b). The Cretaceous marine transgression inundated most of the land area between Camooweal and Chillagoe, so it is considered unlikely that stygobiont amphipods of freshwater origin will be found in the intervening area, although stygobionts with marine affinities might occur. If the Camooweal and Chillagoe species share a common ancestry, then this lineage of amphipods was presumably present in both regions prior to the Cretaceous marine transgression.

The timing of colonization of groundwater environments by this lineage remains uncertain, however Bradbury & Williams have suggested that a succession of favourable (wetter and colder) and unfavourable (drier and warmer) climates during the previous 65 million years or so, could have driven the surface populations to seek subterranean refugia. The surface dwelling ancestors became extinct whilst the subterranean populations survived and gradually evolved into new and highly specialized underground species. Thus, colonization of the Camooweal groundwaters presumably occurred at a time in the past when climatic conditions still remained favorable for surface-dwelling amphipods, whilst at the same time, karstification of the Camooweal carbonates had proceeded to the degree of providing a suitable groundwater habitat. Investigation of evolutionary relationships and divergence within the genus *Chillagoe,* might therefore help to constrain the ages of cave development at both Camooweal and Chillagoe.

Conclusions

1) The Nowranie Caves includes both phreatic and vadose components, with prominent influences on cave geomorphology exerted by joints, bedding and past changes in watertable levels.

2) Active circulation is occurring within a phreatic conduit at 22-30 m depth (140 – 148 m ASL) below the level of the present watertable (170 m ASL) in the Nowranie Caves. Slugs of flood water can penetrate well into the flooded section of the cave, and as these waters are probably dissolutionally aggressive, ongoing enlargement of the conduit may be occurring under present conditions.

3) The discovery of an active phreatic conduit at moderate depth below the present watertable in Nowranie Caves shows that speleogenesis in this karst incorporates deeper phreatic processes in addition to shallow phreatic (i.e. watertable) processes. Deep and shallow phreatic processes may have occurred synchronously.

4) A series of three fossil, or occasionally re-flooded, phreatic horizontal levels in the Nowranie Caves correspond with similar levels in other Camooweal caves, and reflect a regional pattern and multi stage history of watertable changes linked with cave development. The stacked series of cave levels may reflect episodic uplift, wetter climatic episodes, or a combination of both - possibly dating from early to mid Tertiary times.

5) Because of the impermeability of the black clay soils, which prevents diffuse infiltration, caves and dolines are the major groundwater recharge points in the Camooweal area. These sites are susceptible points

for injection of contaminants into the groundwater system.

6) A climatic and distributional relict fauna is present in the Camooweal karst groundwater. Colonization of the Camooweal groundwaters presumably occurred at a time in the past when climatic conditions remained favorable for surface-dwelling amphipods, whilst at the same time, karstification of the Camooweal carbonates had proceeded to the state of providing a suitable groundwater habitat.

7) The Nowranie Caves and Camooweal area generally, has conservation significance as a karst hydro-geological and groundwater ecosystem that has preserved a history of regional landscape and faunal evolution in northern Australia during the Quaternary.

Acknowledgements

Particular thanks and acknowledgement are due to Robyn McBeath for invaluable assistance in the field. Ken Grimes provided maps, and many helpful comments which greatly improved this manuscript. Additional helpful comments were provided by John Webb. Carl Close was a member of the dive team on the 2000 expedition. Cave maps were done by members of the University of Queensland Speleological Society (UQSS), Sydney Speleological Society, plus other groups and individuals.

References

BARNARD, J.L. & WILLIAMS, W.D., 1995: The taxonomy of Amphipoda (Crustacea) from Australian fresh waters: Part 2. *Records of the Australian Museum* **47:** 161-201.

BOULTON, A. J. & BROCK, M.A., 1999: *Australian freshwater ecology – processes and management.* Gleneagles Publishing, South Australia.

BRADBURY, J.H. & WILLIAMS, W.D., 1997a: The Amphipod (Crustacea) stygofauna of Australia: description of new taxa (Melitidae, Neoniphargidae, Paramelitida) and a synopsis of known species. *Records of the Australian Museum* **49:** 249-341.

BRADBURY, J.H. & WILLIAMS, W.D., 1997b: Amphipod (Crustacea) diversity in underground waters in Australia: an Aladdin's Cave. *Memoirs of the Museum of Victoria* **56(2):** 513-519.

DE KEYSER, F., 1974: A review of the middle Cambrian stratigraphy in the Queensland portion of the Georgina Basin. *Bureau of Mineral Resources Australia, Bulletin* **139:** 13-27.

DRYSDALE, R., 2001: Factors controlling the hydrochemistry of Louie Creek, a travertine-depositing stream in the seasonally wet tropics of northern Australia. *Marine and Freshwater Research* **52:** 793-804.

DRYSDALE, R., TAYLOR, M.P. and IHLENFELD, C. (in press) Factors controlling the chemical evolution of travertine-depositing rivers of the Barkly karst, northern Australia. *Hydrological Processes.*

FORD, D.C. & EWERS, R.O., 1978: The development of limestone cave systems in the dimensions of length and breadth. *Canadian Journal of Earth Sciences* **15:** 1783-98.

FORD, D.C. & WILLIAMS, P.W., 1989: *Karst geomorphology and hydrology*. Chapman and Hall, London.

GRIMES, K.G., 1974: Mesozoic and Cainozoic geology of the Lawn Hill, Westmoreland, Mornington, and Cape Van Dieman 1: 250,000 sheet areas, Queensland. *Bureau of Mineral Resources Australia, Record* 1974/106.

GRIMES, K.G., 1988: The Barkly karst region, north-west Queensland. *Preprints of Papers for the 17th Biennial Conference of the Australian Speleological Federation. Lake Tinaroo, Queensland.* pp. 16-24.

HALBERT, E., 1970: Meteorological aspects of Camooweal Caves. *Journal of the Sydney Speleological Society* **14(12):** 292-304.

PALMER, A.N., 1991: Origin and morphology of caves. *Geological Society of America Bulletin* **103:** 1-21.

PALMER, A.N., 2000: 'Hydrogeologic control of cave patterns' *in* Klimchouk, A.B., Ford, D.C., Palmer, A.N. and Dreybrodt, W. (Eds.) *Speleogenesis: evolution of karst aquifers.* National Speleological Society, Alabama, USA. pp. 77-90.

RANDAL, M.A., 1978: Hydrogeology of the southeastern Georgina Basin and environs. *Geological Survey of Queensland, Publication* 366.

STEWART, G.A., 1954: Geomorphology of the Barkly region. *CSIRO Land Research, Series* **3:** 42-58.

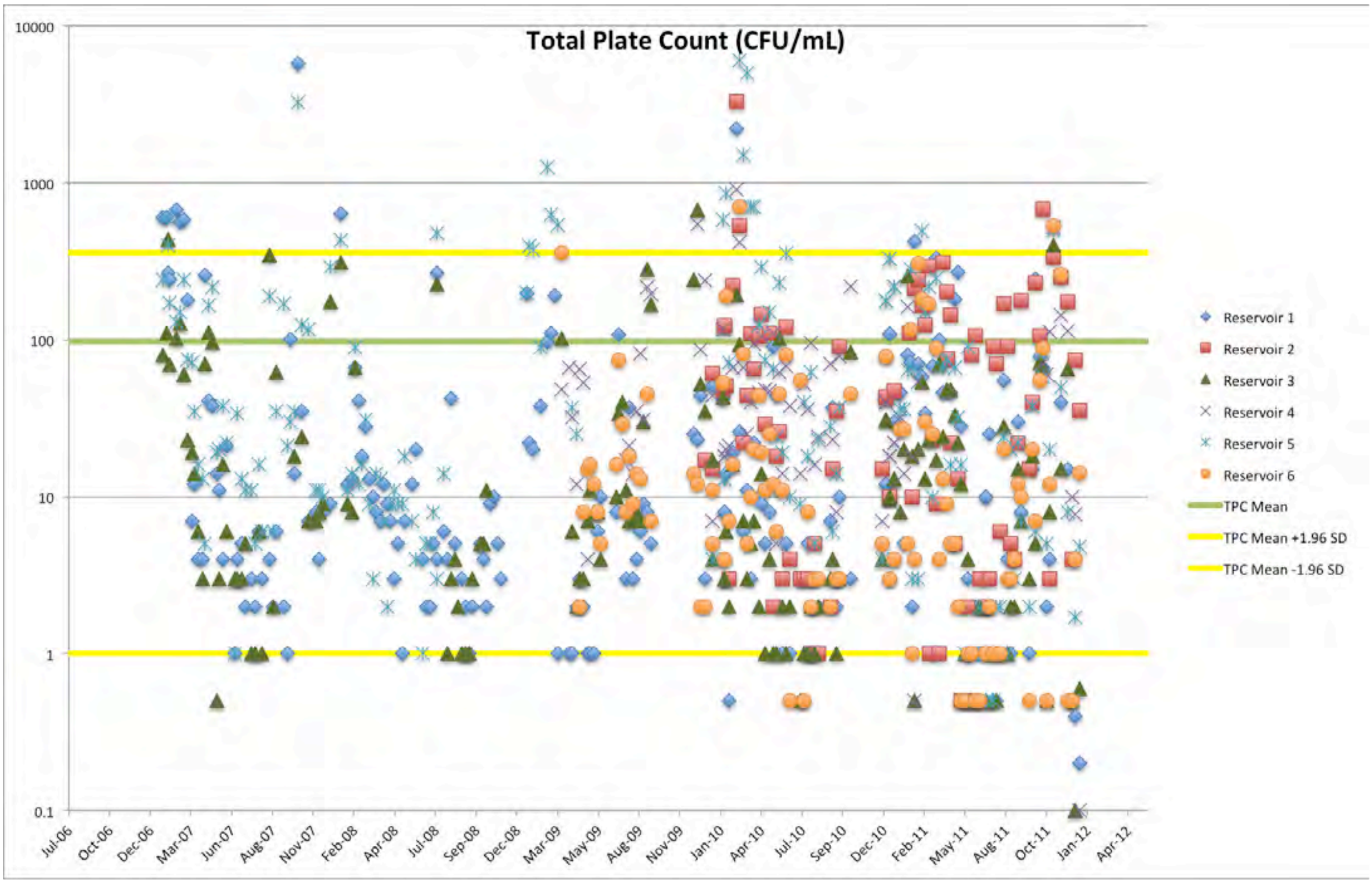
STRAYER, D.L., 1994: 'Limits to biological distributions in groundwater', pp. 287-310. *in* J. Gibert, D.L. Danielopol and J.A. Standford (eds), *Groundwater Ecology.* Academic Press, Inc. San Diego.

WHITE, W.B., 1988: *Geomorphology and hydrology of karst terrains.* Oxford University Press, New York.

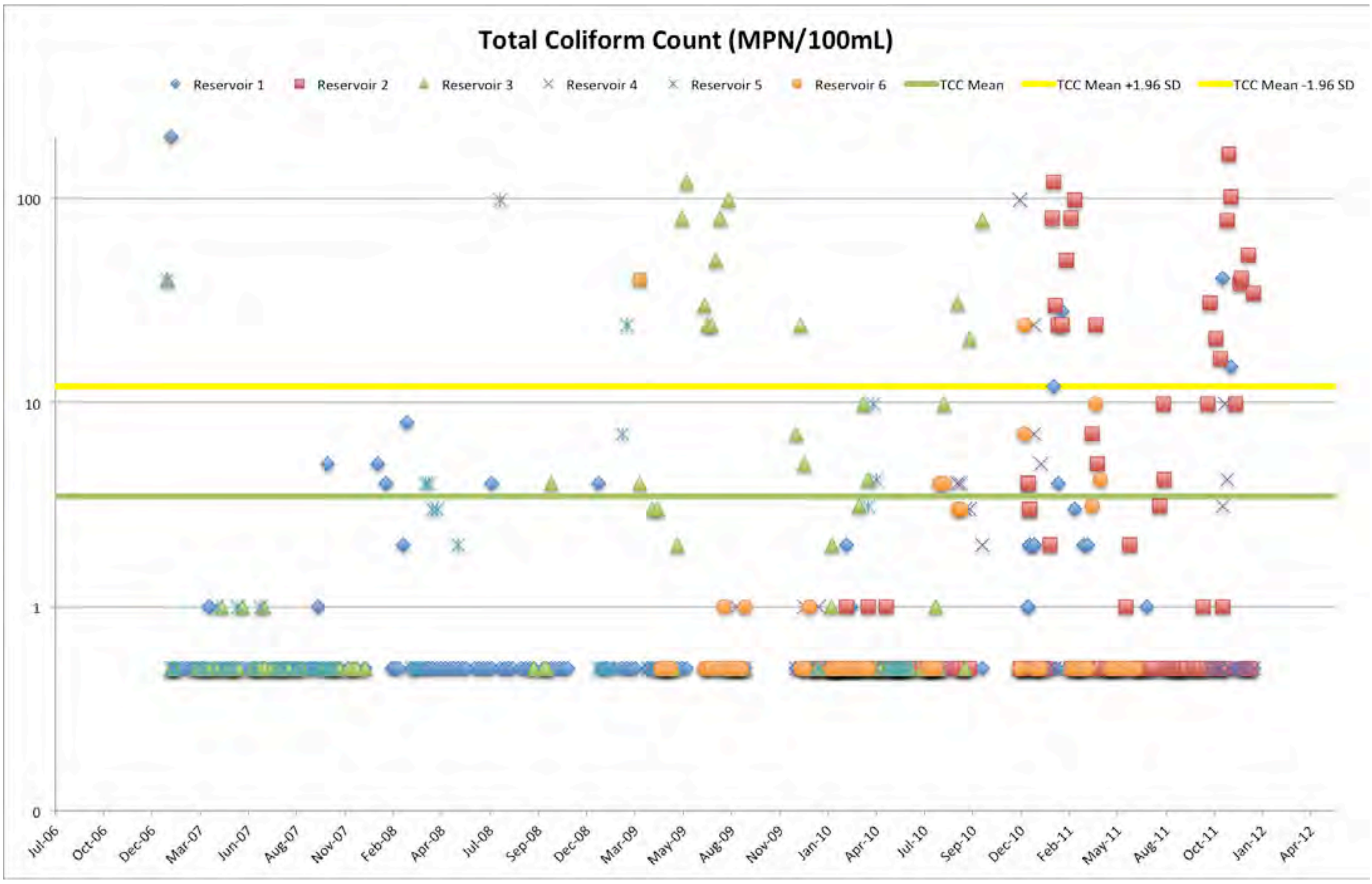
WORTHINGTON, S.R.H., 2001: Depth of conduit flow in unconfined carbonate aquifers. *Geology* **29:** 335-338.

APPENDIX F

CONTROL CHARTS



Total Plate Count (CFU/mL)
10000
1000
100
10
1
0.1
Jul-06
Oct-06
Dec-06
Mar-07
Jun-07
Aug-07
Nov-07
Feb-08
Apr-08
Jul-08
Sep-08
Dec-08
Mar-09
May-09
Aug-09
Nov-09
Jan-10
Apr-10
Jul-10
Sep-10
Dec-10
Feb-11
May-11
Aug-11
Oct-11
Jan-12
Apr-12
Reservoir 1
Reservoir 2
Reservoir 3
Reservoir 4
Reservoir 5
Reservoir 6
TPC Mean
TPC Mean +1.96 SD
TPC Mean -1.96 SD



Total Coliform Count (MPN/100mL)
Reservoir 1
Reservoir 2
Reservoir 3
Reservoir 4
Reservoir 5
Reservoir 6
TCC Mean
TCC Mean +1.96 SD
TCC Mean -1.96 SD
100
10
1
0
Jul-06
Oct-06
Dec-06
Mar-07
Jun-07
Aug-07
Nov-07
Feb-08
Apr-08
Jul-08
Sep-08
Dec-08
Mar-09
May-09
Aug-09
Nov-09
Jan-10
Apr-10
Jul-10
Sep-10
Dec-10
Feb-11
May-11
Aug-11
Oct-11
Jan-12
Apr-12

APPENDIX G

CCP PROCEDURES

MOUNT ISA CITY COUNCIL

DRINKING WATER QUALITY MANAGEMENT PLAN

CRITICAL CONTROL POINT PROCEDURES

MARCH 2013

DOCUMENT AND VERSION CONTROL

The DWQMP is a controlled document. The signed document and version control sheet at the front of the document indicate the current version. Information within the appendices is to be updated as indicated in Section 7 of the Guideline and as follows:

- Action plans 6-12 months (review with annual reporting requirement)
- Sub-plans 1-3 years
- Associated policies 1-5 years
- Business management plan 1-3 years

Revisions to individual pages or sections of the DWQMP will be indicated by a revision number and date added to the footer of the page, and noted in the version control table.

VERSION CONTROL SHEET

Date	Description	Version & Update Ref	Appendix or Page No.	Approved Initials
May 2012	Final	Version 1.0		JH
March 2013	Final	Version 2.0		TH

Contents

1 Introduction

Critical control points (CCPs) are a point, step or procedure at which control can be applied and which is essential to prevent or eliminate a hazard or reduce it to an acceptable level.

Appropriate selection of critical control points is an important consideration, as increased focus in process control (monitoring and documentation) for a water supply system will be directed toward these activities and processes. The identity and number of critical control points is system specific and will be determined by the range and magnitude of potential hazards and associated risks. Identification of critical control points may be aided by the use of a decision tree in the Drinking Water Quality Management Plan.

CCPs have several operational requirements, including establishing an appropriate monitoring regime specifying specific parameters and critical limits to ensure the process or activity operates effectively. Failure to meet a critical limit represents loss of control of the process and an unacceptable health risk, either directly, through the supply of unsafe water, or indirectly, where multiple critical control points exist, by exceeding the capacity of subsequent processes. Corrective actions must also be available to re-establish process control when criteria have not been met. If there is a deviation from a critical limit corrective actions also must be available to reduce the health risk from hazards present in the system (ADWG).

This document includes a procedure for the identification of CCPs, a register of CCPs and procedures of how to manage those CCPs.

2 Responsibilities

It is the responsibility of Manager of Engineering/ DOE to ensure that this document is up-to-date.

It is the responsibility of the Manager of Engineering/ DOE to ensure that CCPs are identified in accordance with this procedure.

It is the responsibility of Manager of Engineering/ DOE to ensure that the identified CCPs are appropriately implemented and managed.

3 Control Points

CCPs were identified in accordance with the DWQMP. One CCP was identified in the Mount Isa and Camooweal drinking water schemes, chlorine residual.

In Mount Isa the MICC manages the reticulation aspect of the scheme and in Camooweal the water supply is chlorinated bore water. In both of these schemes there are two important barriers: integrity, preventing contamination of stored water and maintaining a chlorine residual. The maintenance of a disinfection residual provides an active barrier to recontamination and confidence that the water has a low risk of pathogens.

Of the two barriers only the chlorine residual met the criteria of the CCP assessment.

4 CCP Procedures

The following tables identify the monitoring and corrective actions that are required at each CCP. CCP exceedences are to be reported using the *CCP Exceedence Form*.

CCP 1	Monitoring
Step: Reticulation **Hazard/s controlled:** Bacteria; opportunistic pathogens, viruses & chlorine **Preventive measures:** Appropriate residual set points	**What:** Free chlorine **Purpose:** To ensure there is sufficient chlorine to prevent recontamination **Where:** Reservoir samples **How:** Grab samples **When:** Twice weekly (Mount Isa) Fortnightly (Camooweal) **Who:** Sampler/Operator
Alert Limits	**Alert Correctional Measures**
Alert: < 0.5 mg/L	**What:** Immediately take a chlorine grab sample to verify the result. If possible boost chlorine levels. **Who:** Operator
	Reporting: Sample results and action taken – Operator to the Manager Utility Services
Critical Limits	**Critical Correctional Measures**
Critical: < 0.2 or > 5.0 mg/L for two consecutive samples	**What:** Immediately take a chlorine grab sample to verify the result. Rectify issue and boost chlorine to > 0.7 and < 5.0 mg/L. If feasible manually dose reservoir. If appropriate flush mains. **Who:** Operator
	Reporting: Sample results – Sampler/Operator to the Manager Utility Services Exceedence of CCP Critical Limit – Manager Utility Services to report to Manager Engineering/ DOE. For > 5.0 mg/L report to OWSR-DEWS.

APPENDIX H

EMERGENCY CONTACTS

Internal Emergency Contacts

Internal Contact Name	Phone Contact Details
Ash Cooke Foreman / Team Leader	0407 565 350
Emilio Cianetti Chief Executive Officer	07 4747 3281
Ella Warszcznski Laboratory Technician	07 4743 6085
Ricardo Marino Acting Director of Engineering Services	0427 379 260
Greg Hovi Plumbing Inspector	0417 745 720
Mike Jones Manager Utility Services	0417 607 531
Ellie Johnson Acting Manager Technical Services	07 4747 3274
Sandy Hansen Engineering Services Executive Assistant	07 4747 3251
Priviledge Mapiye Environmental Health Officer	0439 622 766

Mount Isa City Council Admin	07 4747 3200
Mount Isa Water Board Glenn de Vera, Water Quality and Environmental Services Engineer	0428 451 691

External Emergency Contacts

*** In a medical emergency call 000 ***

External Contact Name	Contact Details
Mount Isa Police	(07) 4744 1111
Mount Isa Hospital	(07) 4744 4444
Camooweal Police	(07) 4748 2148
Camooweal Health Centre	(07) 4748 2159
State Emergency Service	(07) 4743 2601

MOUNT ISA CITY COUNCIL

DRINKING WATER QUALITY MANAGEMENT PLAN

WATER QUALITY REPORT

MARCH 2013

DOCUMENT AND VERSION CONTROL

The Water Quality Report is a record and not a controlled document. The signed document and version control sheet at the front of the document indicates the latest report. A new report should be compiled each year.

VERSION CONTROL SHEET

Date	Description	Version & Update Ref	Appendix or Page No.	Approved Initials
May 2012	Final	Version 1.0	All	
November 2012	Revision	Version 1.1	Section 5.2	
March 2013	Revision	Version 2.0	Section 5.1.3, 5.2	

TABLE OF CONTENTS

TABLE OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

MOUNT ISA CITY COUNCIL
DRINKING WATER QUALITY MANAGEMENT PLAN

1 INTRODUCTION

1.1 PURPOSE

The purpose of this report is to analyse and interpret long-term monitoring data. The report will discuss trends and variances and the reasons for these as well as exceedences of guidelines and the reasons for these exceedences. This report supports the Drinking Water Quality Management Plan (DWQMP) and accompanying risk assessment.

1.2 SCOPE

This report examines the sample points located within the Mount Isa City Council's (MICC) area of operations. This includes all potable water sample points for the Mount Isa distribution system and raw and potable sample points for Camooweal.

Data from 2007 to present has been used for this analysis. Subsequently, this report should be revised to provide ongoing long-term trending. This will provide a useful tool for the ongoing monitoring of performance and forecasting of potential issues.

Exceedences in relation to the *Australian Drinking Water Guidelines* (ADWG) and the *Public Health Regulation* (2005) are provided in this report over the monitoring period.

1.3 REGULATORY REQUIREMENTS

The *Queensland Drinking Water Quality Management Plan Guidelines* (Department of Environment Resource Management 2010) (QDWQMPG) indicate that a process for long-term evaluation of trends in monitoring results must be included as part of the water provider's DWQMP. Section 3.7.1 states that commentary must be given on trends, exceedences, major variations and abnormal results and a summary of water quality complaints must be provided.

In relation to drinking water quality, the *Public Health Regulation 2005* requires mandatory monitoring and provides limits for both *E. coli* and fluoride (fluoridated supplies) levels. Also, under the Public Health Act 2005 under Section 57E, it is an offence for a drinking water service provider to supply drinking water that the provider knows, or reasonably ought to know, is unsafe. The Australian Drinking Water Guidelines (ADWG)(NHRMC & NRMMC 2011) is the definitive reference for drinking water quality in Australia and contains health and aesthetic limits for biological, chemical, physical and radioactive hazards. An assessment of safe water should be made against this water quality reference.

The *Water Supply (Safety and Reliability) Act 2008* requires drinking water service providers to prepare a drinking water quality management plan (DWQMP) unless a transitional phase applies. During the transitional phase, the drinking water service provider is required to monitor and report on water quality in accordance with notice from the regulator. All drinking water service providers have been sent this notice. In this notice, the definition of incident includes where the health-related water quality criteria in the ADWG are not met. In addition, it also includes detections of parameters where there are guideline values in the ADWG.

2 METHODOLOGY

The ADWG (NHMRC & NRMMC 2011) provides principles for interpreting water quality monitoring data. These have been followed in order to analyse data for the Mount Isa and Camooweal schemes.

In Part IV Information Sheet 3.3 Statistics – Statistical Principles, it states:

For determining averages, it is necessary to substitute the values at less than the detection limit with L/2 and to note that this substitution was made, as well as noting what proportion of data was below the detection limit – ADWG 2011. This was adopted for all parametric tests.

Two of the principles relevant to this analysis are explained below:

- Outliers – a small number of data points that were identified as being recorded incorrectly were removed. These were *E. coli* results recorded as <0.1 instead of <1.
- Limit of detection – for data points with results lower than the test method's lower limit of detection, recorded with a less than symbol (<), the L/2 equation was used, where L is the limit of detection (NHMRC & NRMMC 2011). Where values were recorded with a greater than (>) symbol, the value stated was used. Also, where a range was provided with a greater than (>) and less than (<) symbol used, the average of the two numbers was taken or the middle value used. Where a value with a symbol has been replaced using these rules, the symbol was recorded in order to ease the interpretation of the results. For example, for chlorine there were some results recorded as >4. The number 4 was used for the analysis, as the actual value is unknown and 4 was the closest known estimation. The number of data points that used a greater than (>) symbol were noted in the summary tables attached in Appendix A.
- Within the data set, there were some results recorded as TNTC (Too Numerous To Count). A specific number could not be assigned to these for use in the data analysis, therefore they were not counted. The summary tables (Appendix A) include a count for how many TNTC results were recorded at each sample point.

For both the Mt Isa and Camooweal schemes, series plots and tables of summary statistics are presented throughout this report to help with visualisation of the data set. All charts are plotted on a timescale. For charts with exponential increases, such as biological data, a logarithmic scale has been used to display the data in a useful way. Results were only charted if there were more than ten results and if there was any significant trends or findings.

To assess the performance of the water supply system, a number of statistical tests have been used and presented in tables. These are:

- non-parametric
  - min value
  - max value
  - count (number of results in the series, <, >, RANGE and TNTC).

- parametric
  - mean
  - standard deviation
  - 5th percentile
  - 95th percentile.

Summary tables can be found in Appendix A.

3 MONITORING

3.1 SAMPLE POINTS

Both water supply schemes operated by MICC in Mount Isa and Camooweal are monitored and controlled manually. This is due to the fact that MICC operates Mount Isa's reticulation system only and that the water supply scheme at Camooweal, which provides water to a small population of 300, is a very simple one (chlorinated bore water).

Sampling locations are positioned to represent water quality throughout the entire distribution system including reservoirs, dead ends, and customer consumption for Mount Isa, Table 1. Sampling locations for Camooweal
Table 2 are positioned to represent the treatment process from source water to tap.

For a distribution system, the most important operational monitoring parameter to test is the chlorine residual. Bacteriological tests are also monitored to verify performance.

The Mount Isa sampling locations are shown in Appendix B and are listed in Table 1. A number of the residential locations are rotated throughout the year for greater representation of the area and to keep within time constraints. There are a number of sampling sites that are not relevant to drinking water quality that have been excluded from this analysis.

Table 1 Mount Isa Sample Points

Zone Level	Location	Reference
Low	21 Milne Bay	22
Low	24 Jacobsen Crescent	12
Low	3 Gregory Street	23
Low	Barkly Highway School	10
Low	City Council	16
Low	Edna Medley Park	14
Low	Reservoir 1	2
Low	Reservoir 2	3
Low	Terminal Reservoir	1
High	12 Deighton Street	21
High	4 Topaz Street	24
High	5 Robin Road	25
High	58 Arline Street	11
High	8 Mack Crescent	26
High	Council Depot-Duchess Road	18
High	Reservoir 3	4
High	Reservoir 4	5
High	Reservoir 5	6
High	Reservoir 6	7
High	Selwyn Park	13

The data used for preparation of this report was collected over the period between January 2007 and December 2011.

Sampling is limited at Camooweal because it is a remote location, it has a small population and has a reliable fairly consistent groundwater supply. The sampling points are listed in Table 2. Note that the Bores 2 and 3 are very new (installed mid 2012) hence water quality data for them is limited. In this supply system, responding to customer complaints is considered as important as water quality monitoring. Council can respond to a water quality issue at Camooweal within 24 hours. There have been no recorded water quality complaints, except for when chlorine originally began to be added to the supply. The MICC have reinforced in the community the need for chlorine to ensure a safe drinking water supply.

Table 2 Camooweal Sample Points

Sampling Name	Location	Scheme Stage
Bore #1	WTP	Raw water
Bore #2	WTP	Raw water
Bore #3	Sporting Grounds	Raw water
Site 4	After chlorination	Disinfection
Site 5	Hospital	Reticulation
Site 6	Rotates	Reticulation

4 SYSTEM CHARACTERISITICS

4.1 MOUNT ISA

The Leichhardt River catchment receives most of its rainfall during storm events, which means that for most of the time it is dry. In terms of water quality, contaminants build up on ground surfaces and are then washed into the river system and lakes during a storm event. Storms mostly occur in the summer months as can be seen in Figure 1. This is relevant to the MIWB operations however, the quality of water supplied to MICC is closely related to the ability of MIWB to deal with contaminants following rainfall events.

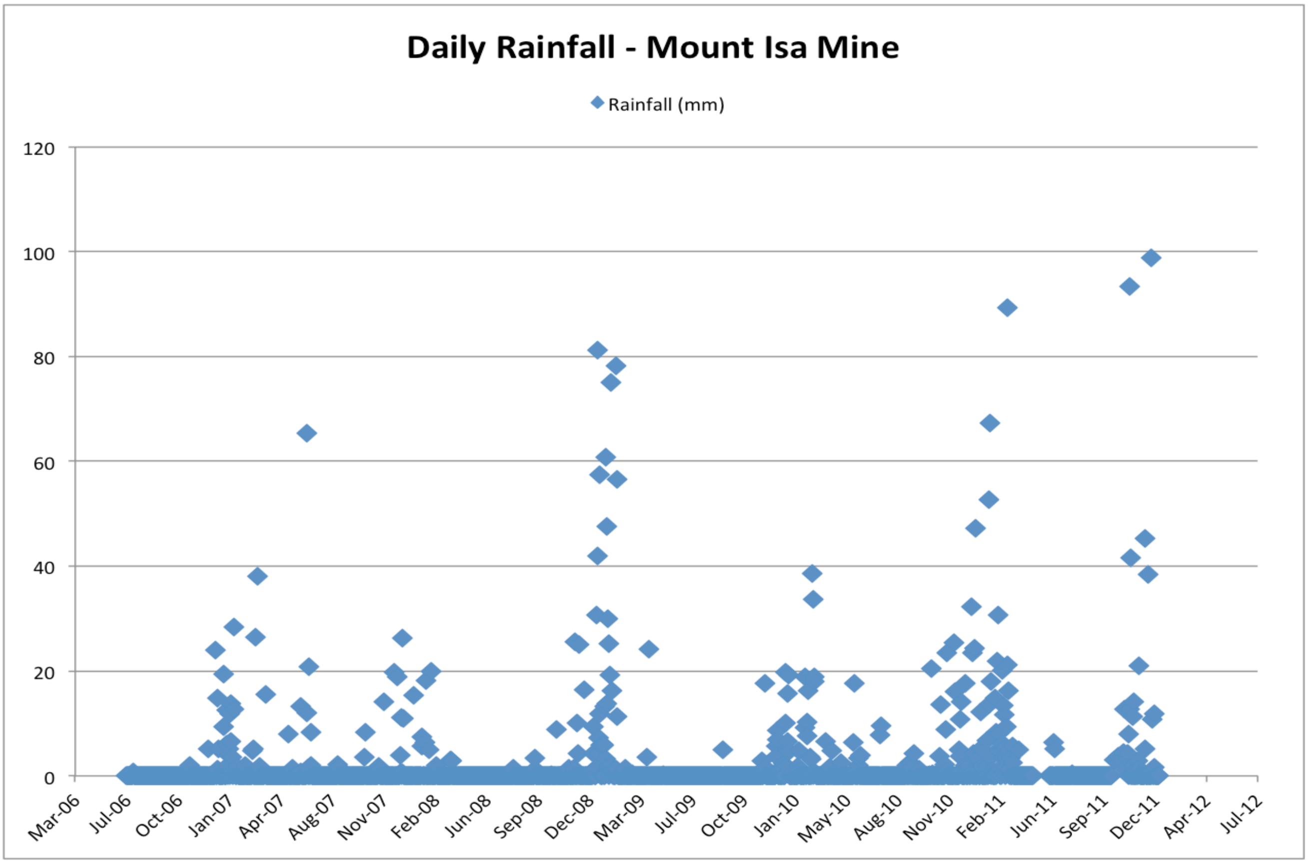


Figure 1 Rainfall at the Mount Isa Mines from the Bureau of Meterology 2011

The chart below (Figure 2) illustrates the effect of rainfall on lake levels, with both Lake Julius and Lake Moondarra replenishing their supplies in January/February of each year. This chart simply highlights the reliability of water supply for the Mount Isa scheme.

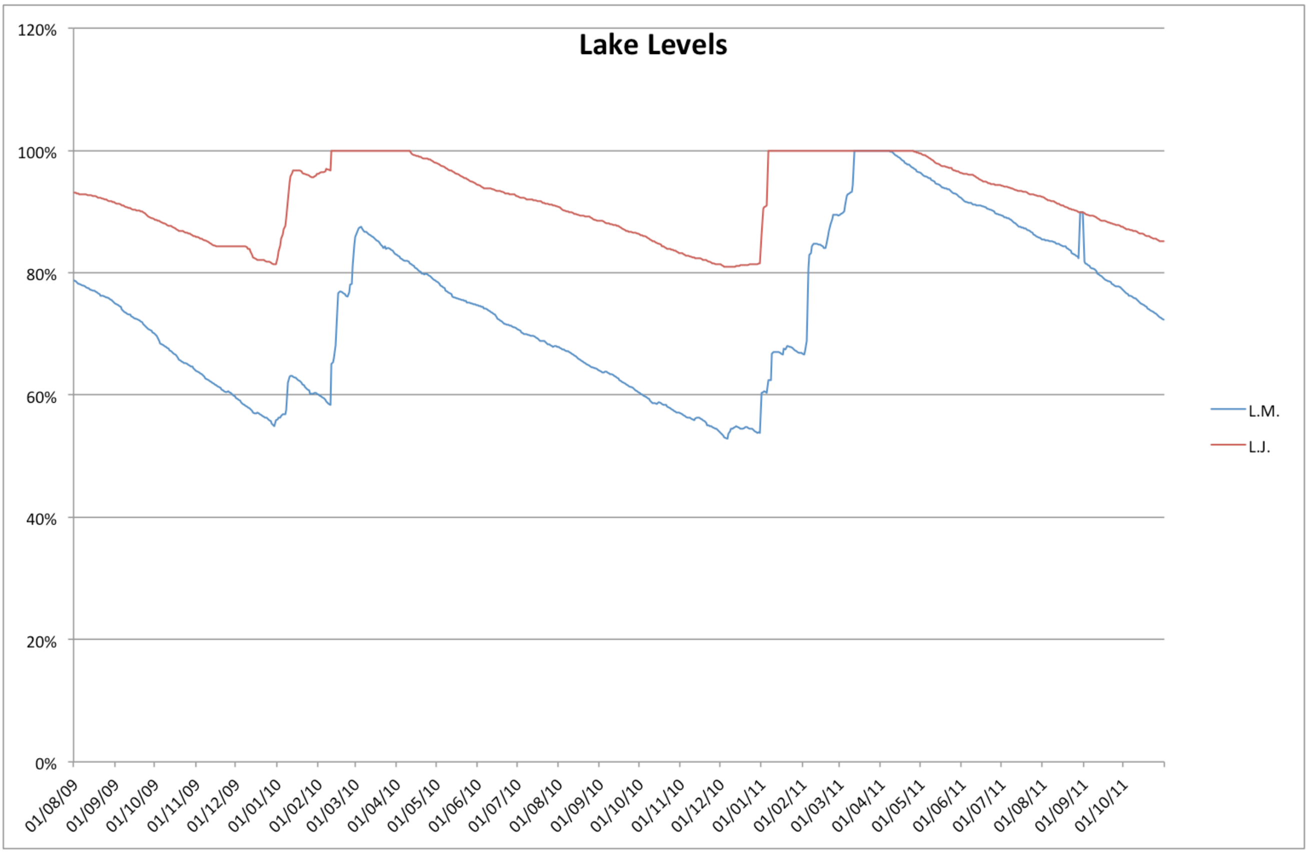


Figure 2 Water Supply Levels for Lake Julius and Lake Moondarra Over the Past 3 Years

Spikes in contaminants in the raw water are associated with storm events however, the water supply system is designed to eliminate this issue. Clear Water Lagoon is isolated from Lake Moondarra and holds up to four week's supply of naturally filtered water. When a storm event occurs, abstractions from Lake Julius and Lake Moondarra can be suspended to prevent Clear Water Lagoon from becoming contaminated, reversing the effect of storm events.

Characteristics of treated water being supplied to MICC are as follows:

- high iron and manganese
- low DO
- potentially high THMs
- some high turbidity and pH
- high risk of pathogens

The MIWB treatment system process uses natural filtration and does not reduce turbidity to levels of a conventional treatment system. Therefore, the build up of solids in the MICC reservoirs and mains is more likely than most filtrated systems.

4.2 CAMOOWEAL

Camooweal is situated 188km north-west of Mount Isa on the Barkly Tablelands in a geomorhpological area known as the Camooweal karst area. Camooweal is located in a different catchment area to Mount Isa. It lies to the east of the Georgina River and is classed as arid to semi-arid, with some monsoonal influence. Camooweal receives, on average, 402.9mm of rainfall across the year most of which occurs during summer (Bureau of Meteorology 2012). Evaporation exceeds mean rainfall in every month of the year. The vegetation is a mosaic of treeless grasslands and low open savannah woodlands (Eberhard 2003).

Camooweal's water supply is sourced from groundwater. The main bore is sunk into an extensive aquifer in the Camooweal Dolomite geological formation, with the depth to the aquifer varying from 64m to 183m. The MICC's bore is at a depth of 76m. The Australian Government Water Resources website (Australian Government 2009) states that the groundwater occurs in the fractures or in sandy beds within the dolomite. The fractures occur as joints, open bedding planes, and solution-widened cavities. It is possible that this could be a source of surface water contamination. Fractures in the rock will allow the free flow of water.

The Camooweal karst region contains a high density of caves. About 60 karst features include dolines, stream sinks and 30 caves within an area of about 60 x 30 km in the vicinity of Camooweal township (Figure 3). Dolines, cave entrances act as the major groundwater recharge points in the area. Groundwater recharge is highly localised and dependent on wet season rainfall events of sufficient intensity to cause surface runoff within the small cave catchment area (Eberhard 2003).

The general consensus is that the sub-artesian bore provides consistently good quality water, however, historically, there is limited data on the raw water quality for a range of parameters. At present, it is assumed the quality has remained consistent since the initial tests in 1897.

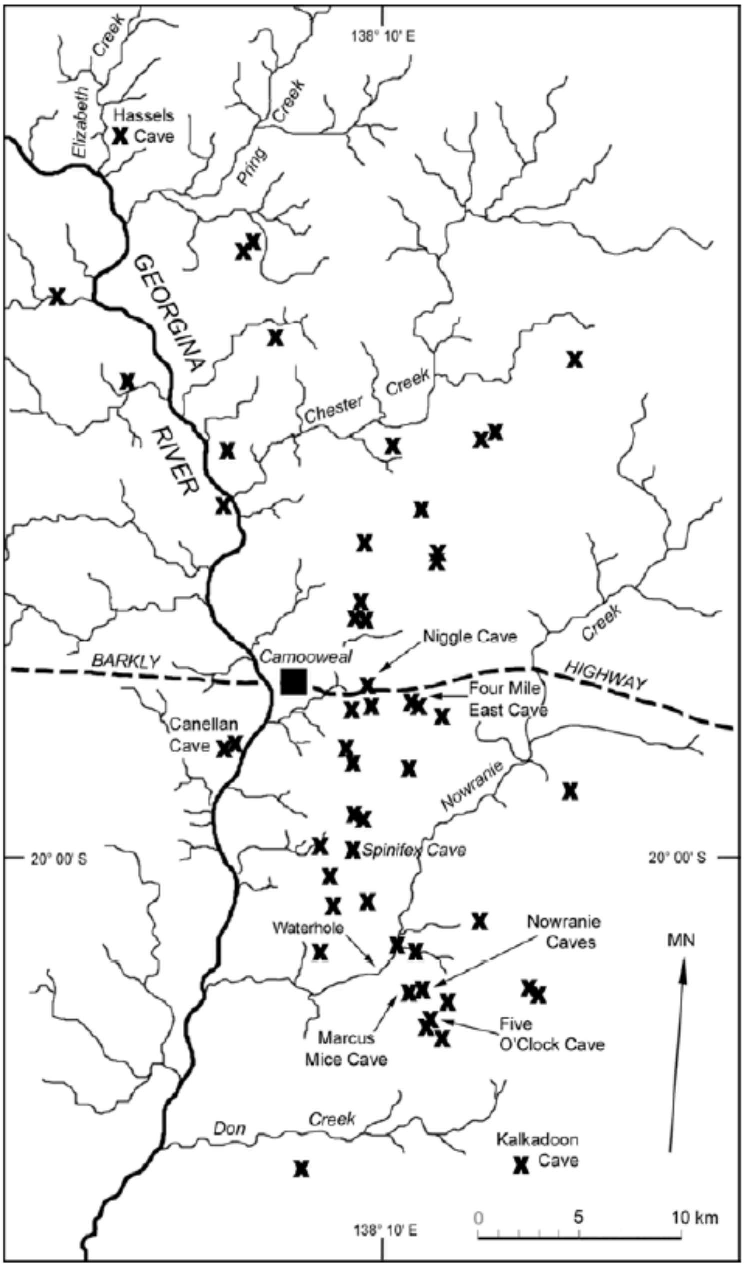


Figure 3 Camooweal Karst Area Showing Surface Drainage and Locations (X) of Karst Features (caves, dolines, stream sinks) Taken from Eberhard 2003.

5 DATA ANALYSIS

MICC monitors the following parameters **weekly** within the Mount Isa distribution system:

- Total Residual Chlorine (TRC)
- Free Available Chlorine (FAC)
- Total Plate Count (TPC)
- Faecal Coliform Count (FCC)
- Total Coliform Count (TCC)
- *E. coli*
- pH (only recently)

MICC monitors the following parameters **fortnightly** at Camooweal:

- TRC
- FAC
- pH
- temperature
- turbidity
- *E. coli*
- TPC
- TCC

Appendix A is a summary table of results from the data anaylsis, showing some basic statistics such as maximum, minimum and mean.

Total coliforms are monitored as an indicator of disinfection performance. Coliforms are environmental bacteria and are present naturally. *E. coli* is a subset of total coliforms and is specifically from the intestine of warm-blooded animals and is used as an indicator for the presence of pathogenic organisms of faecal origin including bacteria, viruses or protozoa. A broader indicator still, is Total Heterotrophic Plate Count (HPC or TPC). TPC or TCC were graphed depending on which showed more obvious trends. HPC measurements are used to indicate the effectiveness of the treatment process and as a measure of numbers of regrowth organisms that may or may not have sanitary significance (Bartram et al. 2003).

5.1 MOUNT ISA

5.1.1 Terminal Reservoir

This sample point verifies the quality of the water being delivered to MICC from MIWB. It should be used as a point of reference to confirm the quality of water received and notify the upstream provider of any potential issues. Data over the past three years shows:

- There were no *E. coli* detections.
- Chlorine average of 1.67 mg/L.
- The range was between 0.05 mg/L and 4 mg/L although both values originally had less than (<) and greater than (>) signs, hence the lowest and highest results are unknown.
- The standard deviation for chlorine was 0.78 mg/L. The control chart in Figure 4 illustrates the deviations above and below the mean, showing some variability in the chlorine levels.

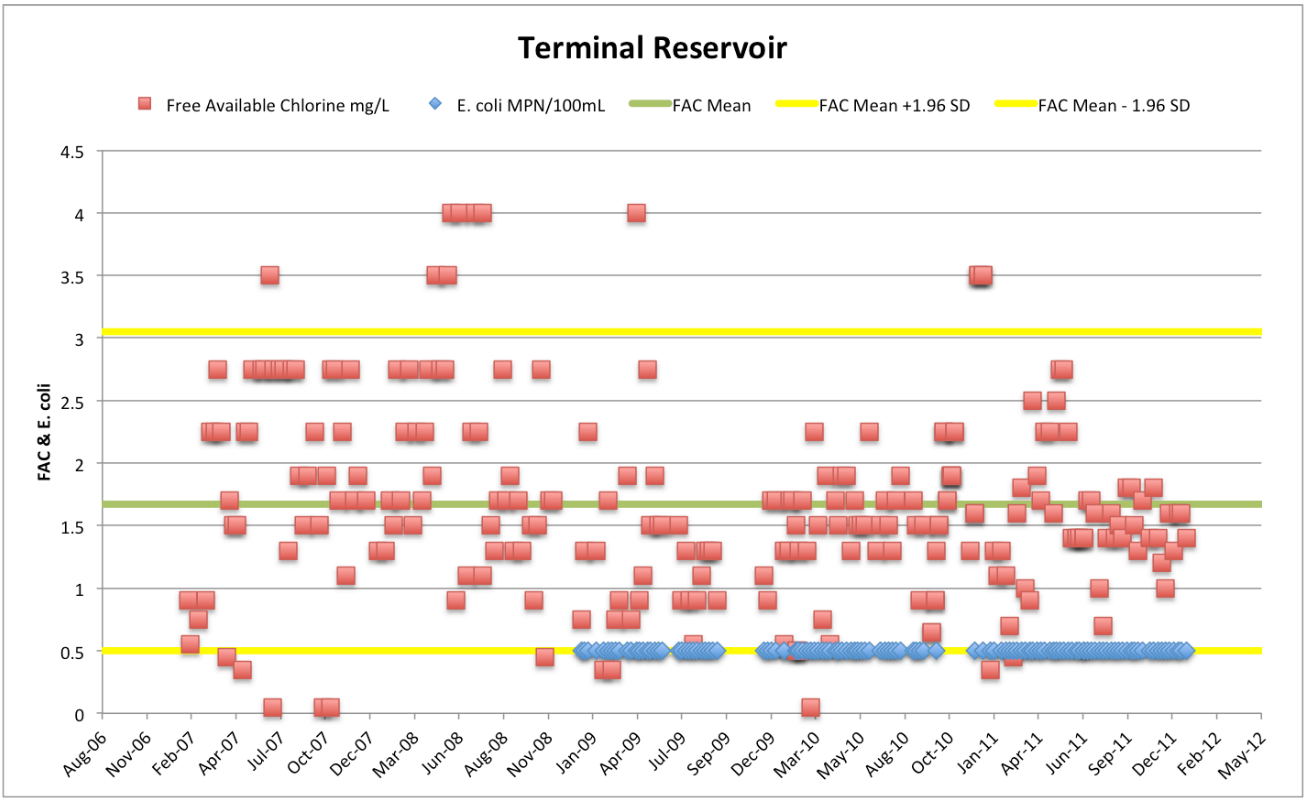


Figure 4 Control Chart for the Terminal Reservoir

Although there appears to be inadequate control on the residual chlorine level from MITR, disinfection appears to be satisfactory as no *E. coli* has been detected since monitoring commenced. Any detections from this point on in the system implies there is contamination entering the MICC system by other means than the original supply.

5.1.2 Reservoir 1

The following observations were made from the results for Reservoir 1:

- Average chlorine in Reservoir 1 was 0.24 mg/L
- There was one occasion in November 2007 where the value for chlorine was recorded as >4 mg/L (Figure 5). It appears that a large quantity of chlorine was dosed into the reservoir, probably due to low pre-existing levels.
- It should be noted that in September 2010 chlorine levels fell below 0.5 mg/L and stayed there for some months, which is when *E. coli* was detected.

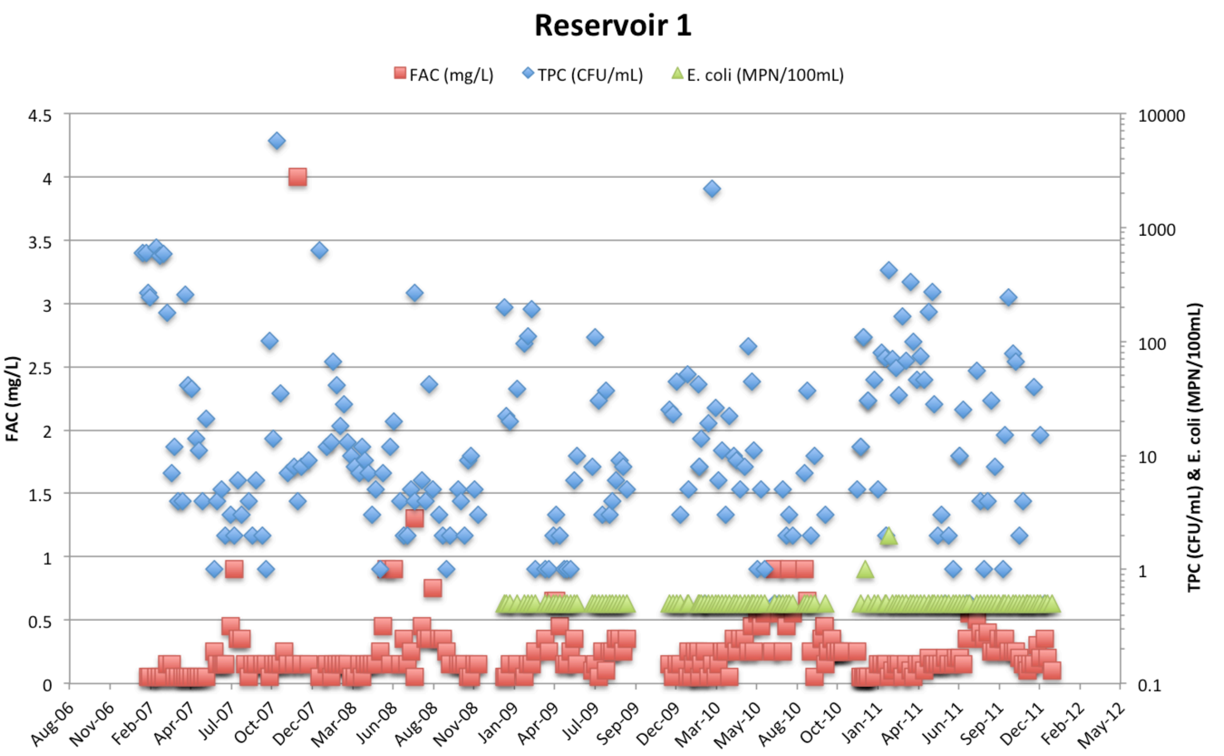


Figure 5 Monitoring Results for Reservoir 1

As shown by the chart in Figure 5, the relationship between TPC and chlorine levels is evident. Over the year of 2010, it can be seen that TPC fell as chlorine levels increased and rose again when chlorine levels fell below 0.5 mg/L.

5.1.3 Reservoir 2

The chart in Figure 6 shows the activity within the reservoir. In 2010 and 2011 incidences of *E. coli* were recorded from reservoir 2. Reservoir 2 was subsequently drained and cleaned. A dead bird was found in the reservoir when it was cleaned out. The incidences were resolved after cleaning and vermin proofing.

However, there is still poor mixing of water in the reservoirs as identified in the risk assessment, which can promote bacteriological contamination. In the summer months, it is more difficult to maintain chlorine residual due to elevated ambient temperatures. At the current mode of operation of Reservoir 2, adequate chlorine residual cannot be maintained due to poor mixing and variable residence time.

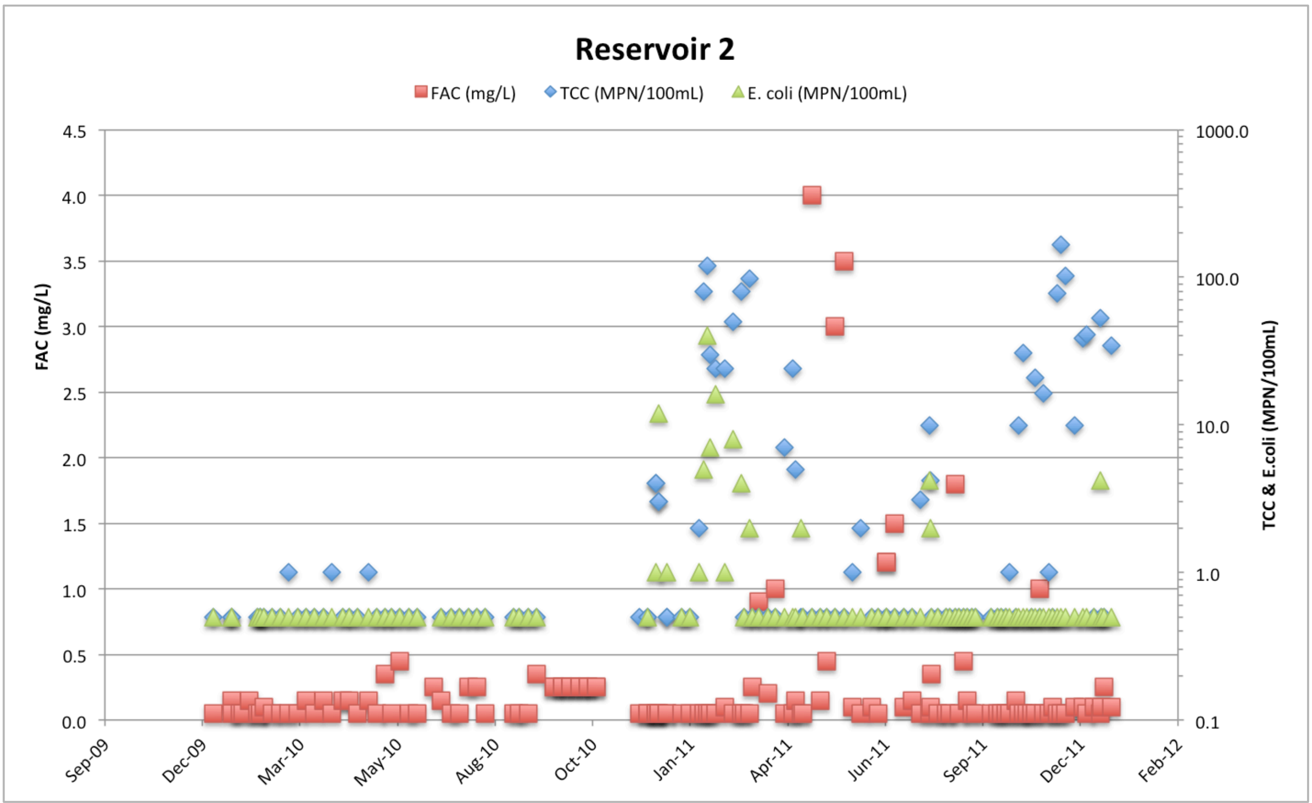


Figure 6 Monitoring Results for Reservior 2

The chlorine value used in this analysis was 4 mg/L as it was recorded as >4 mg/L in the raw data. It is unknown whether actual levels were above the health guideline of 5 mg/L.

5.1.4 Reservoir 3

The following observations were made from the results for Reservoir 3:

- In the summer of 2011, there was an *E. coli* event that corresponded with low chlorine.
- The maximum value for chlorine is only 1.2 mg/L and the average is 0.24 mg/L.
- It is unknown what caused the spike of chlorine in July 2011, however it is possibly due to a manual dose into the reservoir.

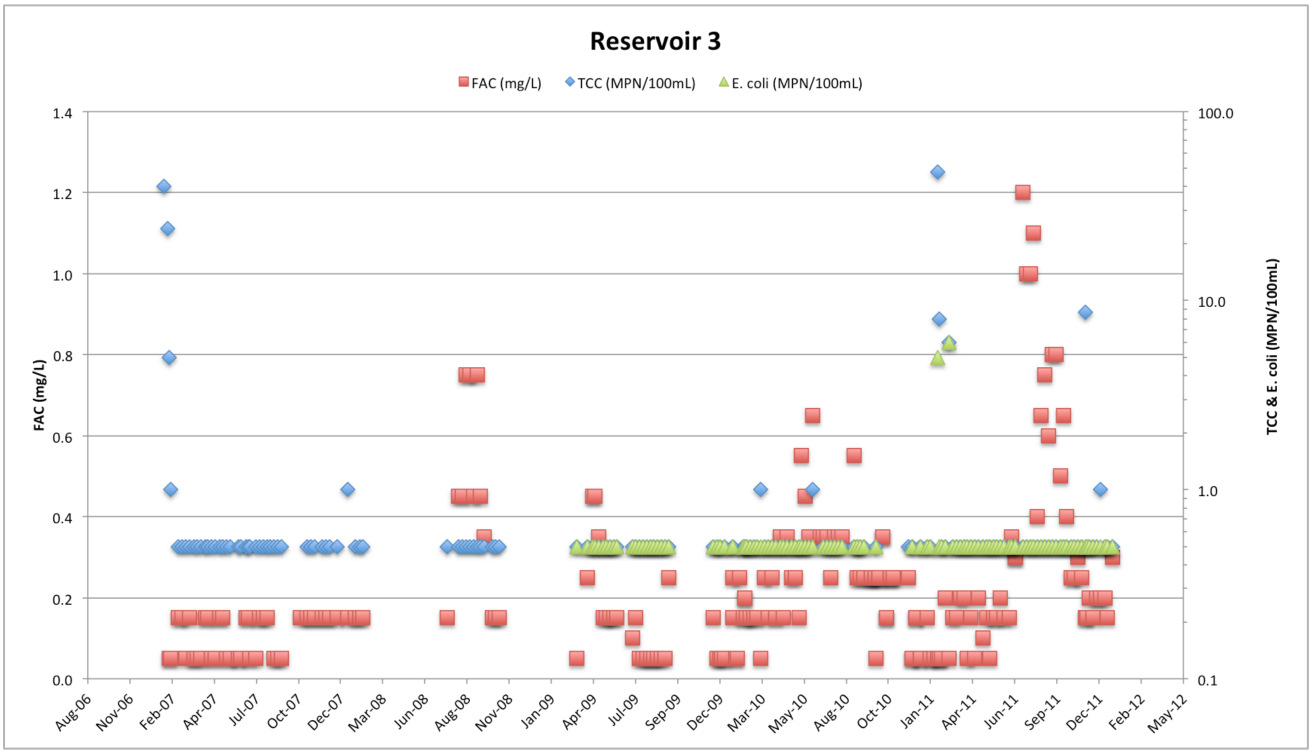


Figure 7 Reservoir 3 Monitoring Data

These results are similar to Reservoir 1 and Reservoir 2 in that the hot summer months cause the chlorine residual to dissipate more readily, thus causing an increase in coliform activity.

5.1.5 Reservoir 4

Observations were made for Reservoir 4 and are as follows:

- There were no *E. coli* detections in Reservoir 4 over the monitoring period between 2007 and 2011.
- Maximum chlorine was recorded as 3 mg/L (which is possibly erroneous) and a mean of 0.14 mg/L, which is the lowest mean recording for all sample points.
- The standard deviation for chlorine is 0.3 mg/L and 90% of the data is between 0.05 mg/L and 0.35 mg/L.
- There is no explanation for the gap in data from Jan 2011 to Oct 2011

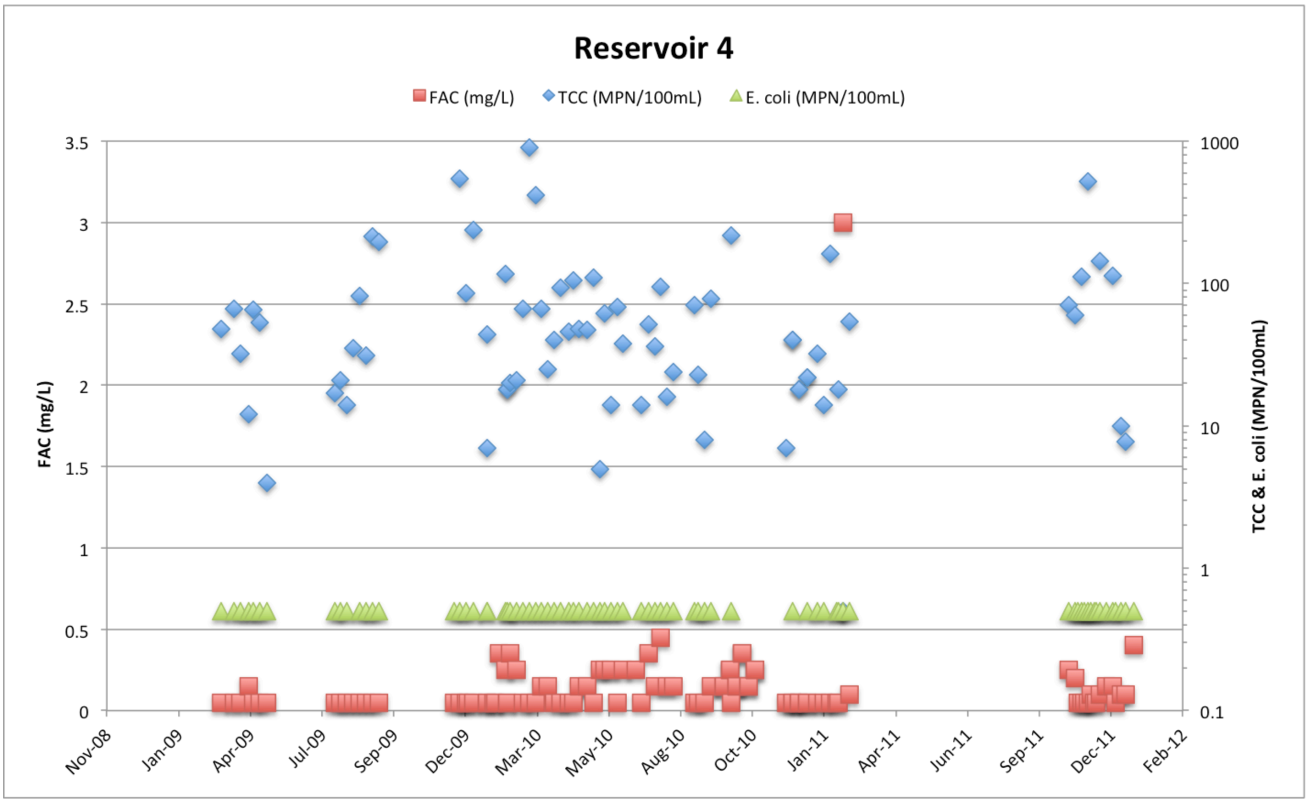


Figure 8 Reservoir 4 Monitoring Data

The fact that Reservoir 4 has had no *E. coli* detects and also the lowest average chlorine suggests that other factors of management of the reservoir have prevented contamination. It should be noted that the period when contamination is most likely to occur is not available.

5.1.6 Reservoir 5

Results for Reservoir 5 have shown the following:

- There was a detection of *E. coli* at Reservoir 5 in January 2011.
- A spike in chlorine levels in winter 2008 could be explained by manual dosing into the reservoir. The *E. coli* event occurred when chlorine levels dropped below 0.4 mg/L. The average chlorine result for Reservoir 5 was 0.19 mg/L, which is low compared to other sample points, with only Reservoir 4 recorded lower.
- There is missing data between July 2008 and January 2009 and also between April 2009 and January 2010 for unknown reasons.

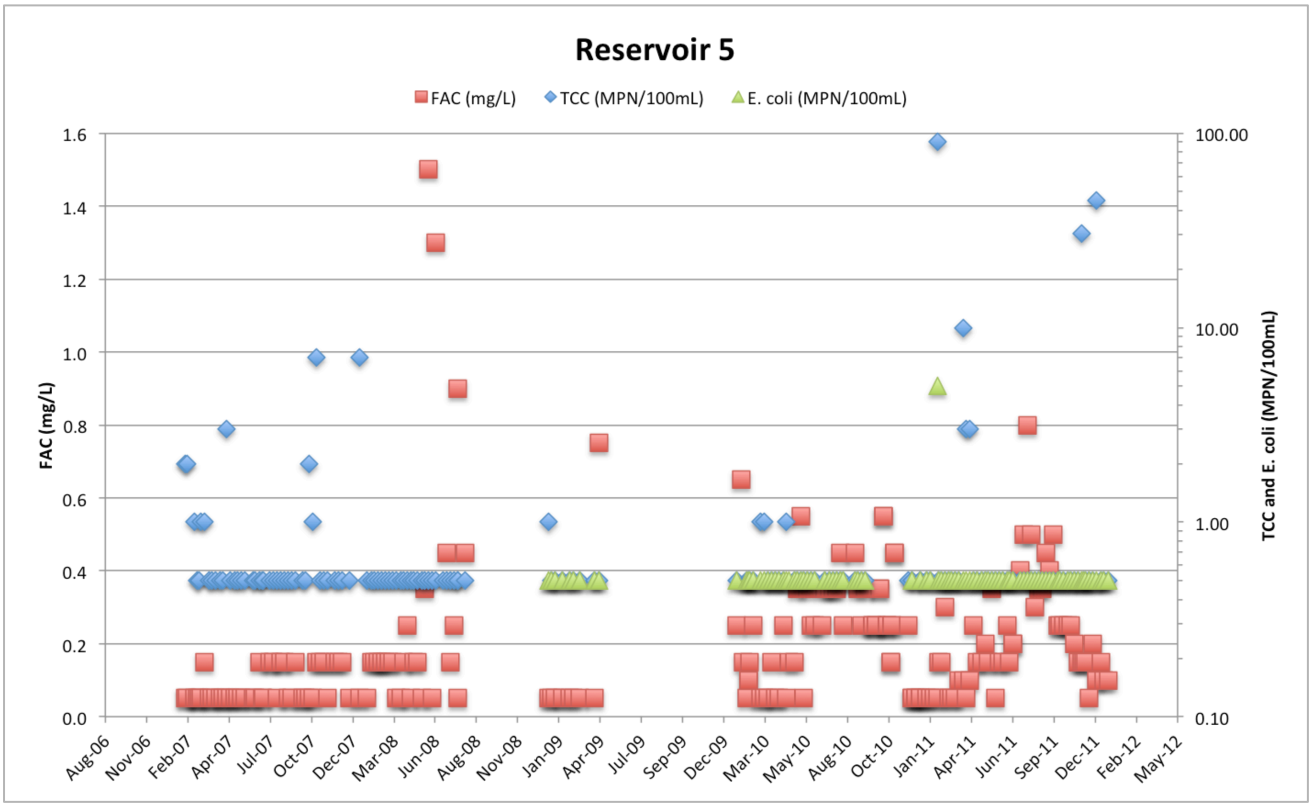
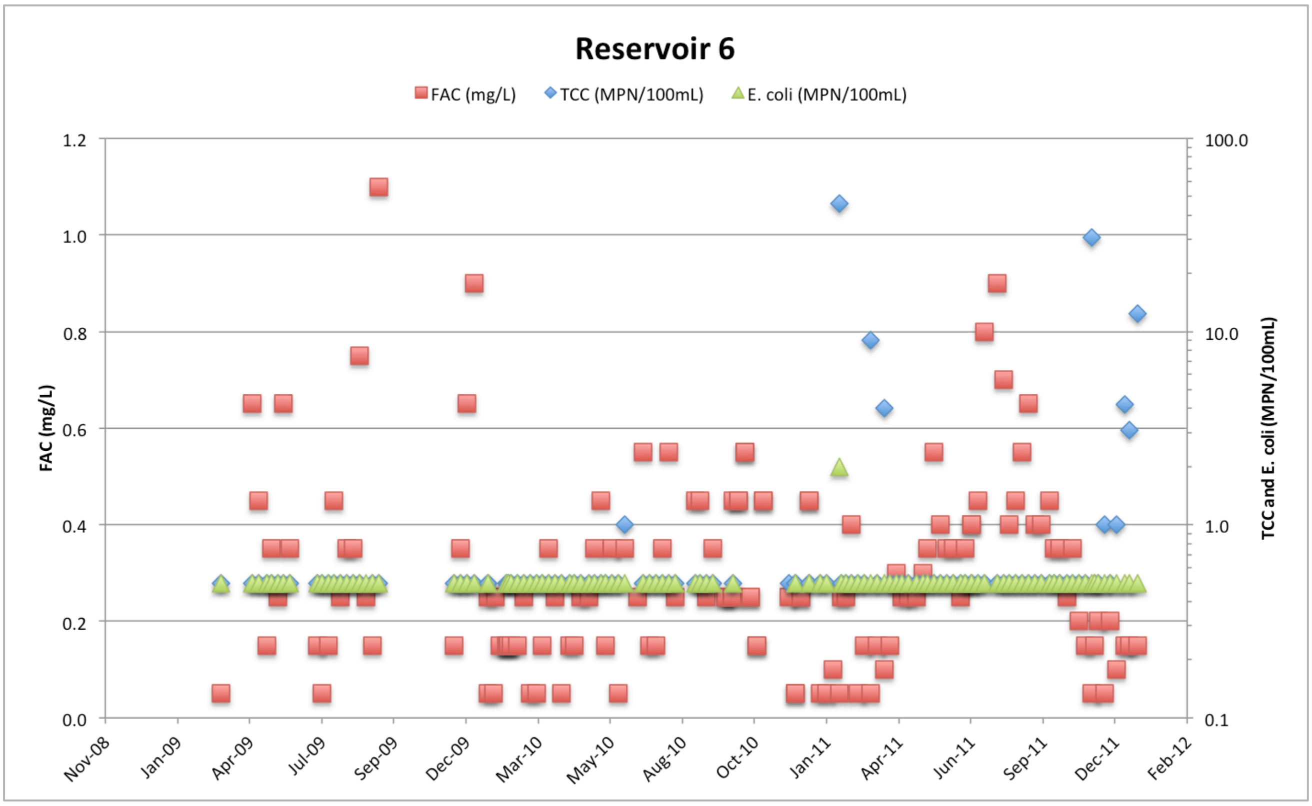


Figure 9 Monitoring for Reservoir 5

5.1.7 Reservoir 6

There was an *E. coli* detection in Reservoir 6 at the time of a rainfall event in January 2011 (Figure 1) and when chlorine was <0.1 mg/L. The combined effect of the loss of a barrier for contamination and the increased possibility of contaminated water overflow resulted in the inevitable event of *E. coli* contamination. The same effect can be observed at the end of 2011 where chlorine fell below 0.1 mg/L and TCC was recorded at higher levels. The average FAC for the monitoring period was 0.3 mg/L.



5.1.8 4 Topaz Street

Topaz Street is in the far south-west of Mount Isa township and is monitored as it is considered a dead end. The chart in Figure 10 has been included to provide some insight into the chlorine levels at the extremities of the reticulation. It is noted that there is a relationship between chlorine and TCC; whenever chlorine is low, coliform values increase. In mid-2009, after a period of consistent chlorine concentration of 1 mg/L for two months, TPC lowered from hundreds to tens of units/mL. The average FAC for this sample point was 0.23 mg/L. These results show that there is a constant low chlorine residual level in this area. Due to the levels of TPC, it is also evident that regrowth or contamination with environmental bacteria is occurring. This indicates that management of the system needs to be improved (Bartram et al. 2003). There was only one occasion where *E. coli* was detected and recorded as 1 MPN/100mL.

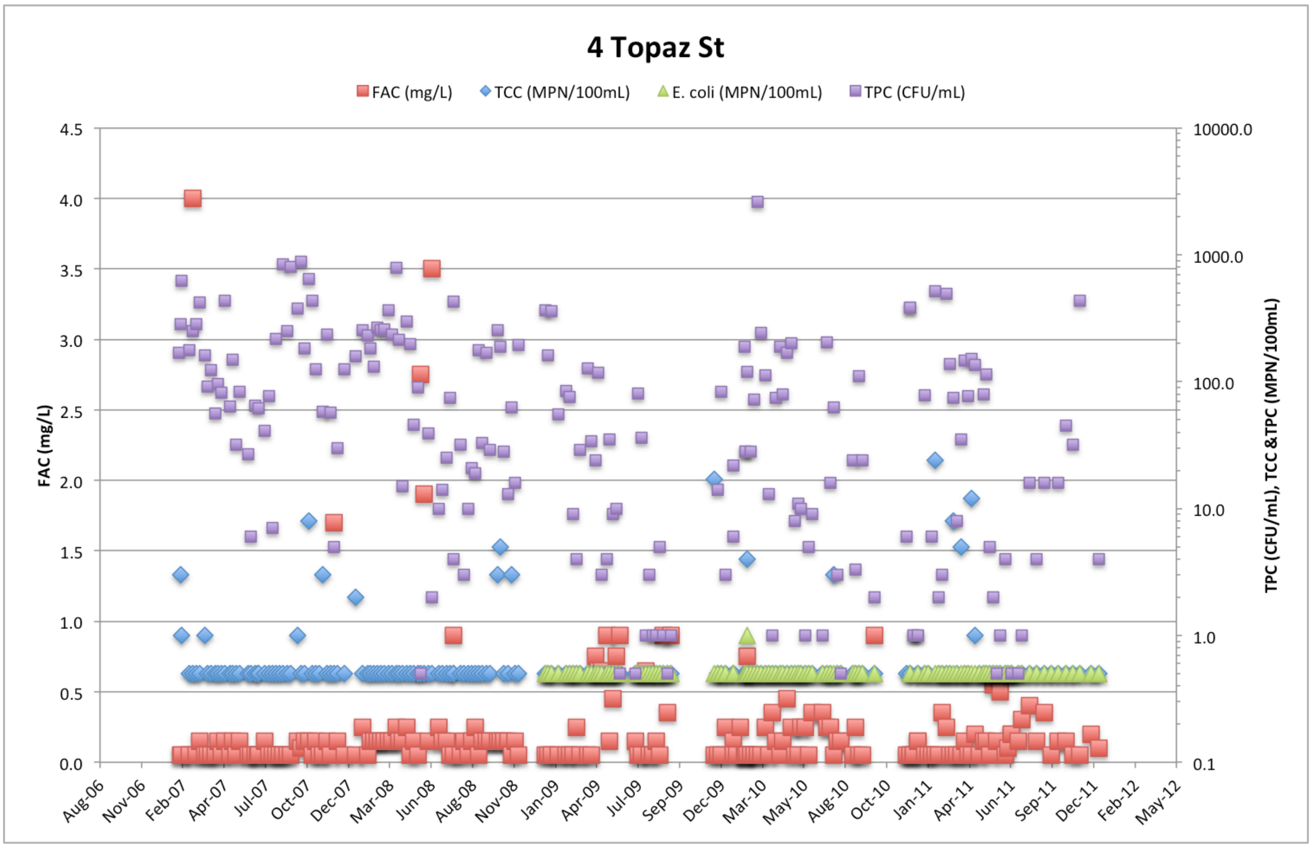


Figure 10 Monitoring for Topaz Street, south west of Mount Isa Township

5.1.9 Comparison Charts

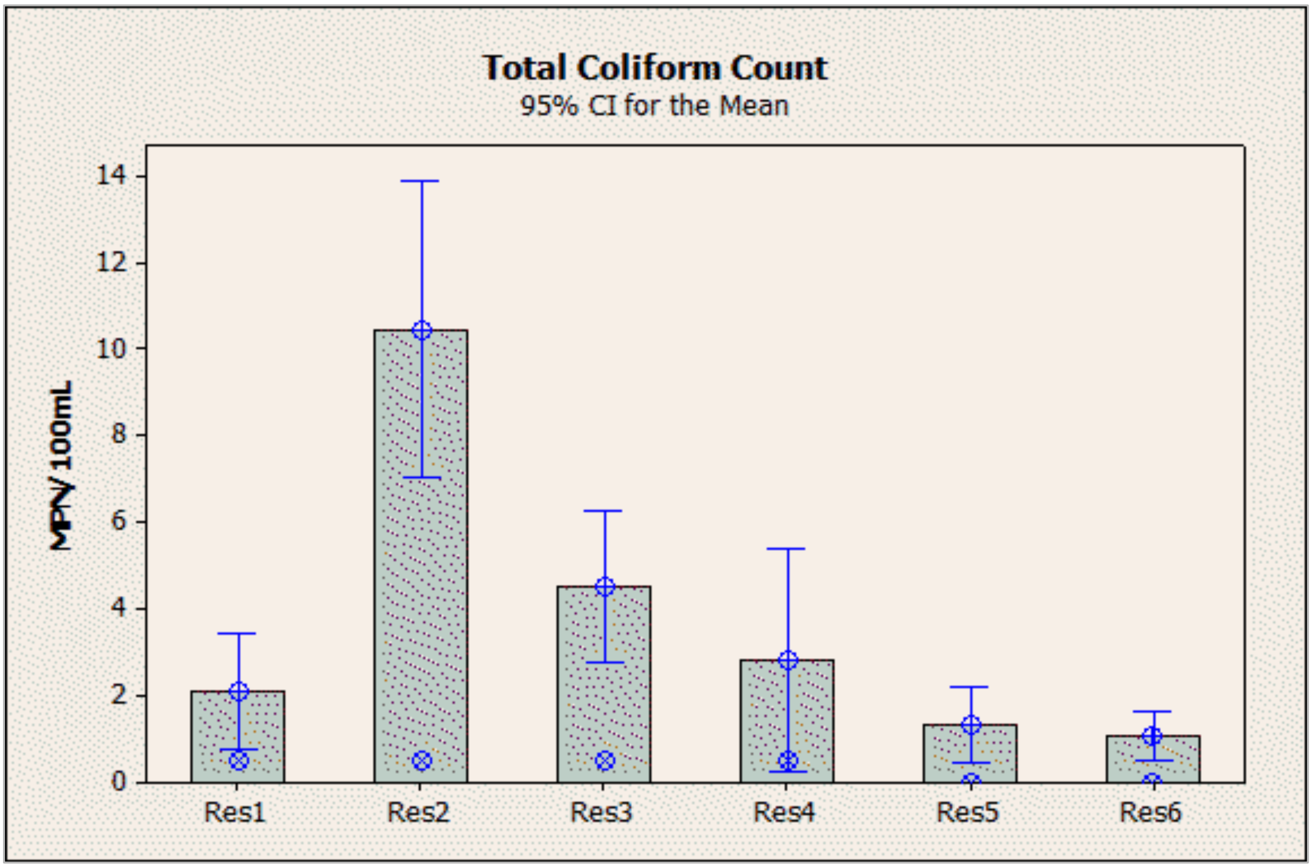
Interval Plots have been used to visualise the relationship between the means of all reservoirs for chlorine, TCC and TPC. The charts contain error bars that represent the 95% confidence intervals on either side of the mean, which is represented by the blue bars. The bars show the variability in the data.

The median is marked by a blue circle with a blue cross. In statistics, the median is described as the value separating the higher half of a sample or population from the lower half. In most of the following instances, the median is much lower than the mean. This is because of the distribution of the data.

5.1.9.1 Total Coliform Count

The interval plot in Figure 11 shows the differences in the mean between the reservoirs. The results for Reservoir 2 agree with anecdotal evidence that this is the most problematic of all reservoirs with the highest average of total coliforms and variability by far. In statistics, if the error bars of two populations do not overlap, it can be concluded that the difference between the two means are statistically significant reiterating the significance of the count of coliforms in Reservoir 2 (Figure 11).

Figure 11 Comparision of Reservoir Total Coliform Counts



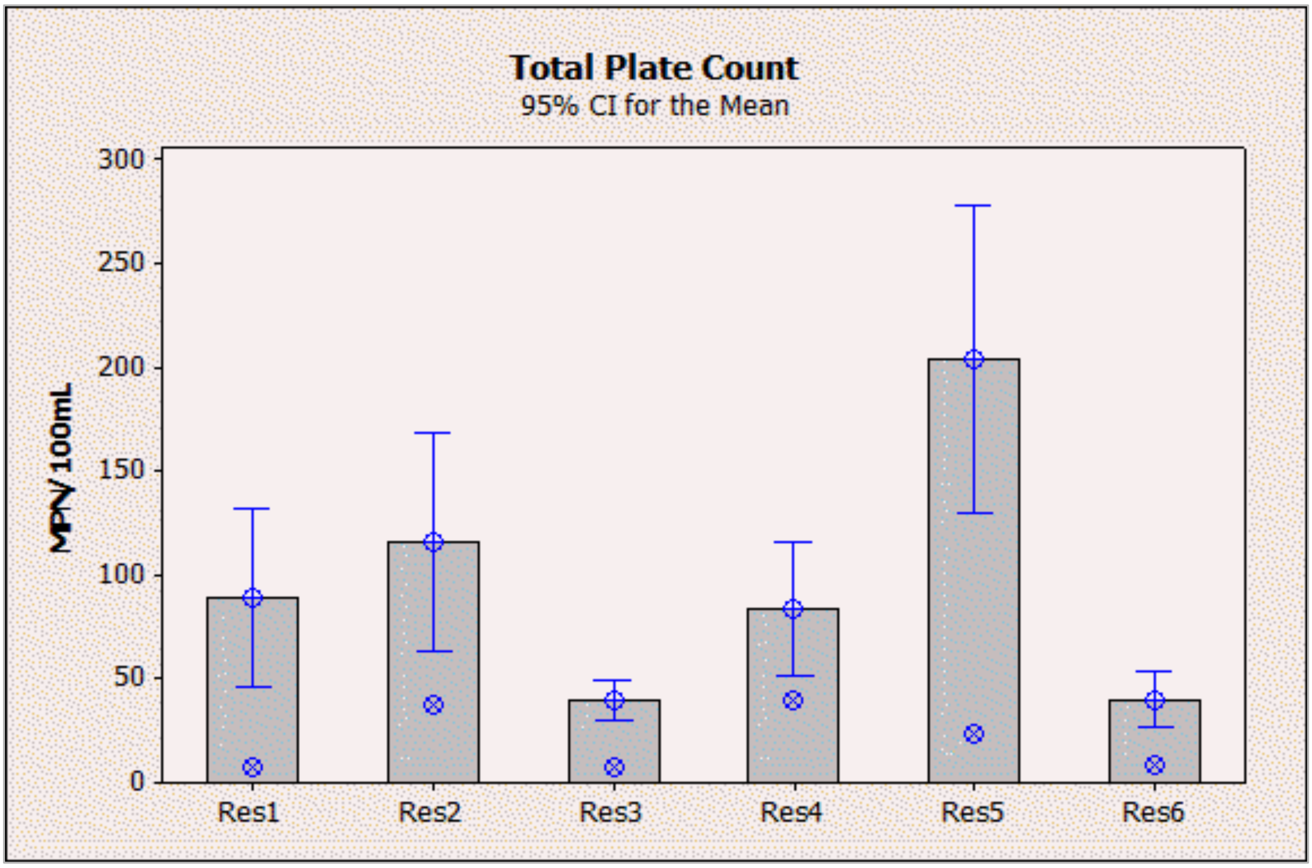


Figure 12 Comparison of Reservoir Total Plate Counts

HPC or TPC measurements are assumed to respond primarily to (and therefore provide a general indication of) distribution system conditions arising from stagnation, loss of residual disinfection, high levels of organic carbon in the water, higher water temperature and availability of particular nutrients (Bartram et. Al 2003). As was described at the start of Section 5, HPC is the broad group of microorganisms that require organic carbon for growth. They include bacteria, yeasts and moulds. This is important if the charts in Figure 11 and Figure 12 are to be interpreted. The TPC chart suggests that Reservoir 5 has significantly more microorganism growth than Reservoirs 1, 3, 4 and 6 but not necessarily the harmful kind. The reason for this may be that the storage is actually well contained so no harmful bacteria can enter (Figure 11) but may have poor chlorine residual and long detention time allowing for growth that is shown in Figure 12.

The hole in the roof at Reservoir 2 could explain the high TCC and *E. coli* detections, or potentially other harmful bacterial contamination. The HPC is reflective of the variable chlorine residual in Reservoir 2 that would allow some regrowth of all bacteria.

These charts highlight the importance of maintaining chlorine residual in the reservoirs.

5.1.9.2 Free Available Chlorine

Table 3 shows that chlorine levels across the network are mostly below 0.5 mg/L which is the desired level in accordance with the ADWG (NHMRC & NRMMC 2011).

Table 3 Rank of Average Chlorine Concentration

Sample Point	Mean FAC (mg/L)
Reservoir 4	0.15
Reservoir 5	0.19
4 Topaz Street	0.23
Reservoir 1	0.24
Reservoir 3	0.24
Reservoir 2	0.25
Reservoir 6	0.3
58 Arline Street	0.31
Barkly Highway School	0.38
24 Jacobsen Crescent	0.4
Selwyn Park	0.42
8 Mack Crescent	0.53
12 Deighton Street	0.55
3 Gregory Street	0.72
5 Robin Road	0.84
21 Milne Bay	1.2
Terminal Reservoir	1.67

A comparision of Figure 13 with Figure 1 shows that elevated chlorine concentrations occur after rain events. This is most likely due to the MICC manual dosing program whereby operators have (in the past) dosed a 5kg bag of chlorine into the reservoirs as a preemptive measure against high likelihood of contamination due to the rain event. Chlorine concentrations and rainfall comparison for the period November 2008 to February 2009, shows a chlorine drop to below 0.2 mg/L at a time when Mount Isa received 80 mm of rain for several days. The lack of a preemptive manual dose left the system exposed to regrowth or contamination of bacteria.

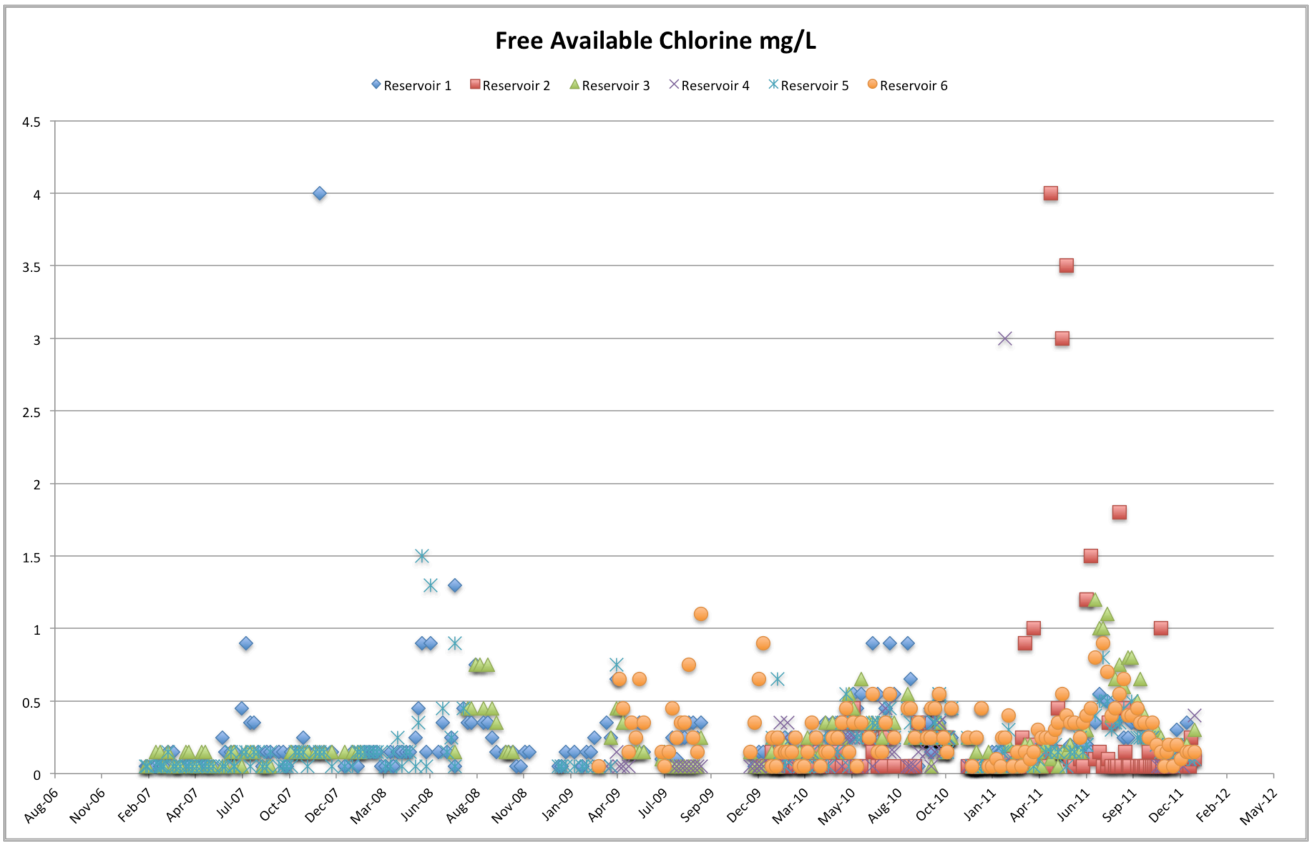


Figure 13 A Comparison of Reservoir Chlorine Concentrations

The interval plot in Figure 14 shows no significant difference between chlorine means in all reservoirs. This can be explained by the fact that the water comes from the same source, therefore no significant difference would be expected. Interestingly, depite the lowest average chlorine, Reservoir 4 has had no bacterial detections.

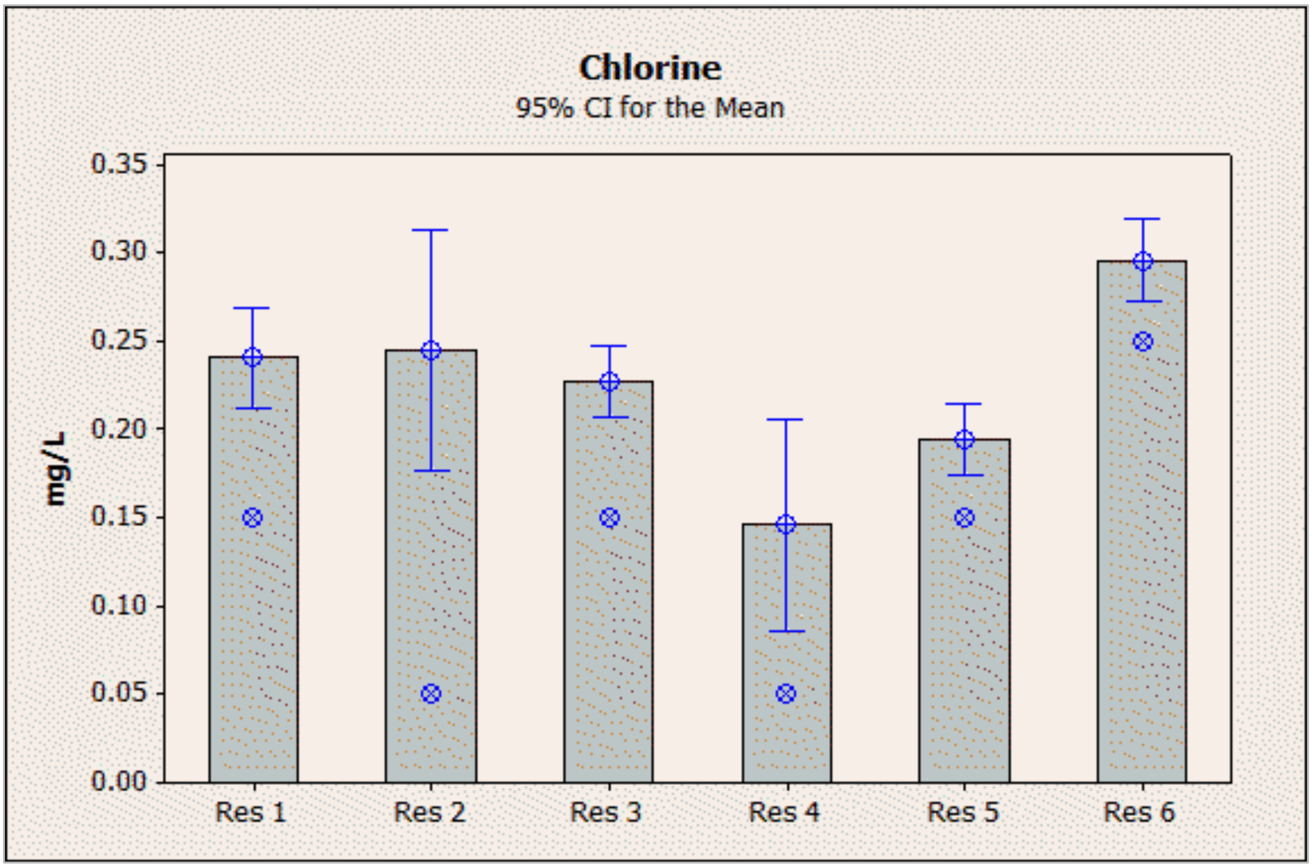


Figure 14 A Comparison of Reservoir Chlorine Concentrations

5.2 CAMOOWEAL

The limited data available for Camooweal, limits the understanding of the process that can be achieved from statistical analysis. Figure 15 shows TPC, TCC and *E. coli* results for Bore 1. The period between November 2010 and February 2011 appears to be a problem period (see Figure 15) as three *E. coli* detections were recorded. This is of interest as it corresponds with rainfall and therefore provides some evidence of surface water infiltration. Being an underground bore, there is limited opportunity for faecal contamination, therefore likely causes of bacterial detection may include surface water infiltration, contamination of the sample or surface runoff ingress through borehead. Raw water testing for the 2 new bores has not commenced yet but will begin after the Plan approval.

The Bore Card Report for the newly drilled bore 3 is attached as Appendix C. It contains the results for physical and chemical testing done in the aquifer water in February 2012. As all 3 bores in Camooweal access the same aquifer, the water quality data for bore 3 is representative of the aquifer. Bore Card data for the old bores at Camooweal also exist and these contain water quality testing results. All these testing results have been tabulated below.

Table 4 Water Quality Data for Camooweal Groundwater

Characteristic	Guideline value (ADWG)	Unit	Result (Sept 1985)	Result (June 1987)	Result (Feb 2012)
Alkalanity	n/a	mg/L	99	140	332
Aluminium	0.2 (A)	mg/L	n.t	n.t	2.10
Boron	n/a	mg/L	n.t	n.t	0.10
Calcium	n/a	mg/L	71	80	90.5
Bicarbonate	n/a	mg/L	120	170	400
Carbonate	n/a	mg/L	0.2	1.1	2
Chloride	250 (A)	mg/L	310	345	115
Copper	2 (H) 1 (A)	mg/L	n.t	n.t	0.02
Electrical Conductivity (EC)	n/a	µS/cm	1300	1350	1050
Flouride	1.5 (H)	mg/L	0.10	0.10	0.10
Hardness	200 (A)	mg/L	338	370	430
Iron	0.3 (A)	mg/L	0.04	0.02	1.69
Magnesium	n/a	mg/L	39	42	49.3
Manganese	0.5 (H) 0.1 (A)	mg/L	0	0	0.06
Nitrate	50 (H)	mg/L	69*	0	0.5
pH	6.5-8.5 (A)	mg/L	7.2	8.0	7.1
Sodium	180 (A)	mg/L	105	120	52
Sulphate	500 (H) 250 (A)	mg/L	2.5	21.0	1.0
Potassium	n/a	mg/L	8	1.6	6
Zinc	3 (A)	mg/L	n.t	n.t	0.04

A aesthetic H health n.t not tested * anomaly

As shown in Table 1, the Camooweal aquifer has no issues with any health related parameter tested. The acquifer has slightly hard water with dissolved solids as is expected of a karst system. Aluminium and iron have come out as high in the 2012 analysis, however, these are only aesthetic parameters and not of health concern. The Monitoring Plan has assigned testing of metals, which will give more data for future risk assessment reviews/revision.

With the sporadic data available there are no hazards of health concern.

The testing results in Table 4 show that there are no concerns or issues with the physical and chemical quality of the Camooweal aquifer. Hence the groundwater is only disinfected to provide barrier against bacterial contamination.

The possibility of surface water influences is explained in Eberhard (2003) which suggests that surface water run-off in the catchments of surrounding cave entrances such as Niggle Cave and Four Mile East Cave could cause contamination of the groundwater by recharge. The Tar Drum Sink, which is located just off the highway is where groundwater meets the surface and is also a possible source of contamination.

Over the reporting period, only six results were recorded for total and free chlorine. All free chlorine results were <0.1 mg/L and all total chlorine results were between 0.05 and 0.15 mg/ L.

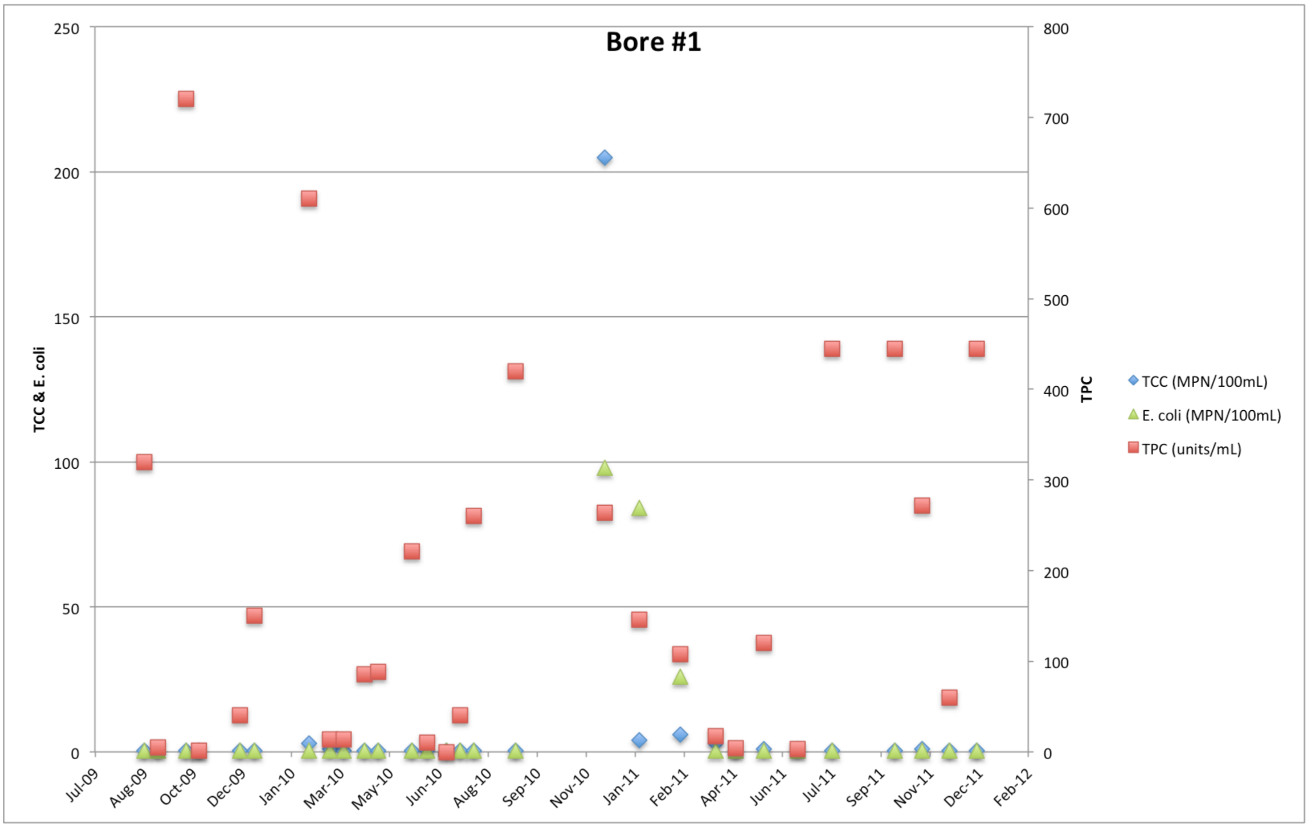


Figure 15 Bore 1 at Camooweal Water Quality Monitoring

5.3 NON-CONFORMANCES

Table 5 lists the number of non-conformances in a year for sample points that had non-conformances in the past. Results for *E. coli* only go back as far as 2009.

Table 5 ADWG Non-Conformances

Sample Point	Parameter	Date	Year	ADWG Non-conformances
Reservoir 1	*E. coli*	22 Dec	2010	1
Reservoir 1	*E. coli*	7 Feb	2011	1
Reservoir 2	*E. coli*	13, 20, 22 Dec	2010	3
Reservoir 2	*E. coli*	24, 28, 31 Jan 2, 7, 14, 21, 28 Feb 7 Mar 18 Apr 1, 2 Aug 19 Dec	2011	13
Reservoir 3	*E. coli*	31 Jan 21 Feb	2011	2
Reservoir 5	*E. coli*	31 Jan	2011	1
Reservoir 6	*E. coli*	31 Jan	2011	1
4 Topaz Street	*E. coli*	1 Feb	2010	1
Bore 1# (Camooweal)	*E. coli*	7 Dec	2010	1
Bore 1# (Camooweal)	*E. coli*	11 Jan 22 Feb	2011	2

6 CUSTOMER COMPLAINTS

There have been a number of dirty water complaints in Mount Isa over the past five years. Complaints are mainly to do with aesthetics including high turbidity and also iron and manganese issues. This is anecdotal evidence, as recorded complaints were not obtained for this report.

For Camooweal, the only complaints about water quality received have been about the addition of chlorine. This is more to do with resistance to the idea of its addition, than to the actual taste of the water. At 0.15 mg/L, there should be no “chlorine taste” in the water. There are reports of residents tampering with the chlorine injection equipment to stop it. Fences and “no authorisation” signs have been erected to dissuade this behaviour.

7 REFERENCES

Australian Government 2009, *Water resources – Availability – Queensland,* Australian Natural Resources Atlas, Department of Sustainability, Environment, Water, Population and Communities, website visited Jan 2012, http://www.anra.gov.au/topics/water/availability/qld/gmu-unincorporated-area-georgina.html

Bartram, J., Cotruvo, J., Exner, M., Fricker, C., Glasmacher, A. 2003, *Heterotrophic Plate Counts and Drinking-water Safety; The Significance of HPCs for Water Quality and Human Health,* World Health Organisation, London, UK.

Bureau of Meteorology 2011, *Daily Rainfall Mount Isa Mine,* website visited 2/03/2011,http://www.bom.gov.au/jsp/ncc/cdio/cvg/av?p_stn_num=037010&p_prim_element_index=18&p_display_type=statGraph&period_of_avg=ALL&normals_years=allYearOfData&staticPage=

Bureau of Meteorology 2012, *Climatic statistics for Australian locations – Summary Statistics Camooweal Township,* Australian Government, website visited 4/5/2012, http://www.bom.gov.au/climate/averages/tables/cw_037010.shtml

Eberhard, S. 2003, Nowranie Caves and the Camooweal Karst Area, Queensland: Hydrology, Geomorphology and Speleogenesis, with Notes on Aquatic Biota, *Helictite*, Vol.38, No.2, Pp 27-38

NHMRC & NRMMC 2011, National Water Quality Management Strategy: Australian Drinking Water Guidelines. 6th Ed., National Health and Medical Research Council and Natural Resource Management Ministerial Council, Australian Government, Canberra.

APPENDIX A – WATER QUALITY SUMMARY TABLES

Summary of Monitoring Data - Low Level Zone

Terminal Reservoir

*

PARAMETER	MIN	MAX	MEAN	STD DEVIATION	5th PERCENTILE	95th PERCENTILE	COUNT	COUNT		
								Range	<	>
Total Residual Chlorine (mg/L)	0.15	1.1	0.51	0.35	0.15	1.02	9	1	0	0
Free Available Chlorine (mg/L)	0.05	4	1.67	0.78	0.5	3.05	233	72	4	5
Total Plate Count (units/mL)	0.1	5258	43.68	369.67	0.5	78	205	0	22	0
Faecal Coliform Count (CFU/100mL)	0	1	0.49	0.10	0.5	0.5	94	0	91	0
Total Coliform Count (MPN/100mL)	0	200	1.50	13.68	0.5	0.5	213	0	170	1
E. coli (MPN/100mL)	0.05	0.5	0.49	0.06	0.5	0.5	122	0	122	0
pH	7.2	7.78	7.51	0.19	7.25	7.775	11	0	0	0

Reservoir 1

PARAMETER	MIN	MAX	MEAN	STD DEVIATION	5th PERCENTILE	95th PERCENTILE	COUNT	COUNT		
								Range	<	>
Total Residual Chlorine (mg/L)	0.15	20	0.57	1.86	0.15	0.9	112	106	0	0
Free Available Chlorine (mg/L)	0.05	4	0.24	0.31	0.05	0.595	232	162	51	2
Total Plate Count (units/mL)	0.2	5757	88.88	441.86	1	269.4	204	0	7	2
Faecal Coliform Count (CFU/100mL)	0	47	1.00	4.85	0.5	0.5	92	0	89	0
Total Coliform Count (MPN/100mL)	0	200	2.09	14.07	0.5	4	214	0	173	1
E. coli (MPN/100mL)	0.05	2	0.51	0.15	0.5	0.5	124	0	122	0
pH	7.28	7.88	7.62	0.20	7.29	7.836	12	0	0	0

Reservoir 2

PARAMETER	MIN	MAX	MEAN	STD DEVIATION	5th PERCENTILE	95th PERCENTILE	COUNT	COUNT		
								Range	<	>
Total Residual Chlorine (mg/L)	0.05	0.55	0.21	0.10	0.05	0.37625	94	80	6	0
Free Available Chlorine (mg/L)	0.05	4	0.25	0.57	0.05	1.07	134	39	75	1
Total Plate Count (units/mL)	0.5	3300	115.68	357.96	1	302.25	90	0	2	1
Faecal Coliform Count (CFU/100mL)	0.5	12	2.58	4.62	0.5	9.25	6	0	3	0
Total Coliform Count (MPN/100mL)	0.5	165.2	10.44	26.60	0.5	78.56	117	0	78	0
E. coli (MPN/100mL)	0.5	40	1.41	4.25	0.5	4.56	112	0	96	0
pH	7.25	7.8	7.63	0.19	7.33	7.7945	12	0	0	0

* Tables marked with an asterisk do not have an accompanying chart either because the count is too low or the chart does not demonstrate anything of significance.

Barkly Highway School

*

PARAMETER	MIN	MAX	MEAN	STD DEVIATION	5th PERCENTILE	95th PERCENTILE	COUNT	COUNT		
								Range	<	>
Total Residual Chlorine (mg/L)	0.15	0.15	0.15	#DIV/0!	0.15	0.15	1	1	0	0
Free Available Chlorine (mg/L)	0.1	0.6	0.38	0.21	0.135	0.6	8	0	0	0
Total Plate Count (units/mL)	0.5	350	64.50	129.65	0.65	270.8	7	0	0	0
Faecal Coliform Count (CFU/100mL)	0	0	#DIV/0!	#DIV/0!	#NUM!	#NUM!	0	0	0	0
Total Coliform Count (MPN/100mL)	0.5	0.5	0.50	0	0.5	0.5	8	0	0	0
E. coli (MPN/100mL)	0.5	0.5	0.50	0	0.5	0.5	8	0	0	0
pH	6.7	7.75	7.36	0.58	6.794	7.739	3	0	0	0

24 Jacobsen Cr

*

PARAMETER	MIN	MAX	MEAN	STD DEVIATION	5th PERCENTILE	95th PERCENTILE	COUNT	COUNT		
								Range	<	>
Total Residual Chlorine (mg/L)	0.3	0.3	0.30	#DIV/0!	0.3	0.3	1	0	0	0
Free Available Chlorine (mg/L)	0.1	1	0.40	0.29	0.12	0.86	9	4	0	0
Total Plate Count (units/mL)	0.5	212	46.75	71.19	1.025	158.8	8	0	0	0
Faecal Coliform Count (CFU/100mL)	0	0	#DIV/0!	#DIV/0!	#NUM!	#NUM!	0	0	0	0
Total Coliform Count (MPN/100mL)	0.5	2	0.67	0.50	0.5	1.4	9	0	0	0
E. coli (MPN/100mL)	0.5	0.5	0.50	0	0.5	0.5	9	0	0	0
pH	7.24	7.75	7.54	0.24	7.2715	7.747	4	0	0	0

21 Milne Bay

PARAMETER	MIN	MAX	MEAN	STD DEVIATION	5th PERCENTILE	95th PERCENTILE	COUNT	COUNT		
								Range	<	>
Total Residual Chlorine (mg/L)	0.15	1.3	0.48	0.29	0.15	1.1	38	34	0	0
Free Available Chlorine (mg/L)	0.05	4	1.20	0.90	0.05	2.75	200	158	17	3
Total Plate Count (units/mL)	0.5	1335	25.51	114.89	0.5	72.4	193	0	32	1
Faecal Coliform Count (CFU/100mL)	0	0.5	0.48	0.09	0.5	0.5	93	0	91	0
Total Coliform Count (MPN/100mL)	0	20.7	0.63	1.49	0.5	0.5	195	0	163	0
E. coli (MPN/100mL)	0.05	0.5	0.49	0.06	0.5	0.5	107	0	107	0
pH	7.3	7.78	7.478	0.19	7.31	7.724	5	0	0	0

* 3 Gregory Cr

PARAMETER	MIN	MAX	MEAN	STD DEVIATION	5th PERCENTILE	95th PERCENTILE	COUNT	COUNT		
								Range	<	>
Total Residual Chlorine (mg/L)	0.05	29	0.84	3.64	0.15	0.9	62	56	2	0
Free Available Chlorine (mg/L)	0.05	4	0.72	0.74	0.05	2.25	202	138	33	2
Total Plate Count (units/mL)	0.5	7039	166.25	706.95	0.5	588.5	191	0	31	2
Faecal Coliform Count (CFU/100mL)	0	0.5	0.49	0.07	0.5	0.5	92	0	91	0
Total Coliform Count (MPN/100mL)	0	94.5	1.03	6.71	0.5	0.5	197	0	165	0
E. coli (MPN/100mL)	0.05	0.5	0.49	0.06	0.5	0.5	109	0	109	0
pH	7.3	7.88	7.61	0.23	7.32	7.845	6	0	0	0

Summary of Monitoring Data - High Level Zone

Reservoir 3

PARAMETER	MIN	MAX	MEAN	STD DEVIATION	5th PERCENTILE	95th PERCENTILE	COUNT	COUNT		
								Range	<	>
Total Residual Chlorine (mg/L)	0.05	0.55	0.28	0.10	0.13	0.35	37	35	2	0
Free Available Chlorine (mg/L)	0.05	1.2	0.24	0.22	0.05	0.68	135	80	29	1
Total Plate Count (units/mL)	0.1	670	34.75	86.58	0.5	182.3	110	0	10	0
Faecal Coliform Count (CFU/100mL)	0.05	0.5	0.41	0.20	0.14	0.5	5	0	5	0
Total Coliform Count (MPN/100mL)	0.5	48	1.12	4.60	0.5	1	113	0	105	0
E. coli (MPN/100mL)	0.05	6	0.58	0.68	0.5	0.5	111	0	109	0
pH	7.15	7.84	7.60	0.21	7.23	7.807	12	0	0	0

Reservoir 4

*

PARAMETER	MIN	MAX	MEAN	STD DEVIATION	5th PERCENTILE	95th PERCENTILE	COUNT	COUNT		
								Range	<	>
Total Residual Chlorine (mg/L)	0.05	0.45	0.25	0.09	0.15	0.38	75	70	3	0
Free Available Chlorine (mg/L)	0.05	3	0.15	0.30	0.05	0.35	101	35	58	0
Total Plate Count (units/mL)	0.1	900	83.60	139.37	6.4	290.7	75	0	2	0
Faecal Coliform Count (CFU/100mL)	0.05	0.5	0.41	0.20	0.14	0.5	5	0	5	0
Total Coliform Count (MPN/100mL)	0.5	129.8	2.92	15.12	0.5	4.2	80	0	70	0
E. coli (MPN/100mL)	0.05	0.5	0.49	0.07	0.5	0.5	78	0	78	0
pH	7.28	7.8	7.62	0.20	7.29	7.789	12	0	0	0

Reservoir 5

PARAMETER	MIN	MAX	MEAN	STD DEVIATION	5th PERCENTILE	95th PERCENTILE	COUNT	COUNT		
								Range	<	>
Total Residual Chlorine (mg/L)	0.15	1.1	0.33	0.17	0.15	0.65	114	106	0	0
Free Available Chlorine (mg/L)	0.05	1.5	0.19	0.20	0.05	0.5	190	99	70	0
Total Plate Count (units/mL)	0.5	6000	203.73	678.93	1	627	163	0	4	6
Faecal Coliform Count (CFU/100mL)	0	1	0.49	0.10	0.5	0.5	78	0	76	0
Total Coliform Count (MPN/100mL)	0	90	1.69	8.03	0.5	2.55	170	0	145	0
E. coli (MPN/100mL)	0.05	5	0.54	0.46	0.5	0.5	96	0	0	0
pH	7.15	7.76	7.59	0.20	7.23	7.76	12	0	0	0

Reservoir 6

PARAMETER	MIN	MAX	MEAN	STD DEVIATION	5th PERCENTILE	95th PERCENTILE	COUNT	COUNT		
								Range	<	>
Total Residual Chlorine (mg/L)	0.15	0.65	0.27	0.11	0.15	0.395	32	29	0	0
Free Available Chlorine (mg/L)	0.05	1.1	0.30	0.20	0.05	0.65	136	102	17	0
Total Plate Count (units/mL)	0.5	700	40.16	99.00	0.5	184.4	110	0	10	1
Faecal Coliform Count (CFU/100mL)	0.05	0.5	0.41	0.20	0.14	0.5	5	0	5	0
Total Coliform Count (MPN/100mL)	0.5	46	1.44	5.26	0.5	3.415	114	0	104	0
E. coli (MPN/100mL)	0.05	2	0.51	0.15	0.5	0.5	113	0	112	0
pH	7.15	7.8	7.59	0.20	7.23	7.789	12	0	0	0

58 Arline St

*

PARAMETER	MIN	MAX	MEAN	STD DEVIATION	5th PERCENTILE	95th PERCENTILE	COUNT	COUNT		
								Range	<	>
Total Residual Chlorine (mg/L)	0.15	0.25	0.19	0.05	0.15	0.2425	4	3	0	0
Free Available Chlorine (mg/L)	0.05	0.8	0.31	0.23	0.05	0.6625	12	4	0	0
Total Plate Count (units/mL)	0.5	68	10.13	20.58	0.5	41.9	10	0	0	0
Faecal Coliform Count (CFU/100mL)	0	0	#DIV/0!	#DIV/0!	#NUM!	#NUM!	0	0	0	0
Total Coliform Count (MPN/100mL)	0.5	4.2	0.84	1.12	0.5	2.35	11	0	0	0
E. coli (MPN/100mL)	0.5	0.5	0.50	0	0.5	0.5	11	0	0	0
pH	6.98	7.85	7.51	0.32	7.08	7.808	5	0	0	0

Selwyn Park

*

PARAMETER	MIN	MAX	MEAN	STD DEVIATION	5th PERCENTILE	95th PERCENTILE	COUNT	COUNT		
								Range	<	>
Total Residual Chlorine (mg/L)	0.15	0.25	0.20	0.05	0.15	0.25	5	4	0	0
Free Available Chlorine (mg/L)	0.05	1.5	0.42	0.42	0.05	1.08	13	2	0	0
Total Plate Count (units/mL)	0.1	370	50.63	109.09	1.05	221.9	11	0	0	0
Faecal Coliform Count (CFU/100mL)	0	0	#DIV/0!	#DIV/0!	#NUM!	#NUM!	0	0	0	0
Total Coliform Count (MPN/100mL)	0.5	7.5	1.39	2.20	0.5	5.685	12	0	0	0
E. coli (MPN/100mL)	0.5	0.5	0.50	0	0.5	0.5	12	0	0	0
pH	6.92	8.55	7.65	0.52	7.0775	8.3275	6	0	0	0

12 Deighton Rd

PARAMETER	MIN	MAX	MEAN	STD DEVIATION	5th PERCENTILE	95th PERCENTILE	COUNT	COUNT		
								Range	<	>
Total Residual Chlorine (mg/L)	0.05	1.5	0.42	0.30	0.15	0.99	92	88	4	0
Free Available Chlorine (mg/L)	0.05	4	0.55	0.69	0.05	1.7	195	131	47	2
Total Plate Count (units/mL)	0.5	3719	75.99	295.03	0.5	378.95	188	0	18	1
Faecal Coliform Count (CFU/100mL)	0	0.5	0.48	0.09	0.5	0.5	92	0	90	0
Total Coliform Count (MPN/100mL)	0	13	0.62	1.03	0.5	0.5	192	0	171	0
E. coli (MPN/100mL)	0.05	0.5	0.49	0.06	0.5	0.5	103	0	103	0
pH	7.3	7.3	7.3	#DIV/0!	7.3	7.3	1	0	0	0

4 Topaz St

PARAMETER	MIN	MAX	MEAN	STD DEVIATION	5th PERCENTILE	95th PERCENTILE	COUNT	COUNT		
								Range	<	>
Total Residual Chlorine (mg/L)	0.05	0.75	0.26	0.13	0.05	0.45	147	129	12	0
Free Available Chlorine (mg/L)	0.05	4	0.23	0.47	0.05	0.885	203	95	97	1
Total Plate Count (units/mL)	0.5	2600	129.97	244.99	1	437	191	0	9	1
Faecal Coliform Count (CFU/100mL)	0	0.5	0.49	0.07	0.5	0.5	92	0	91	0
Total Coliform Count (MPN/100mL)	0	24	0.97	2.37	0.5	3	199	0	177	0
E. coli (MPN/100mL)	0.05	1	0.50	0.08	0.5	0.5	110	0	109	0
pH	7.3	7.74	7.548	0.18	7.33	7.726	5	0	0	0

5 Robin Rd

PARAMETER	MIN	MAX	MEAN	STD DEVIATION	5th PERCENTILE	95th PERCENTILE	COUNT	COUNT		
								Range	<	>
Total Residual Chlorine (mg/L)	0.15	45	1.54	6.71	0.15	1.1	44	42	0	0
Free Available Chlorine (mg/L)	0.05	4	0.84	0.70	0.05	1.9	203	161	16	1
Total Plate Count (units/mL)	0.5	4111	66.31	371.71	0.5	242.2	194	0	26	2
Faecal Coliform Count (CFU/100mL)	0	0.5	0.48	0.09	0.5	0.5	93	0	91	0
Total Coliform Count (MPN/100mL)	0	14	0.59	0.98	0.5	0.5	199	0	177	0
E. coli (MPN/100mL)	0.05	0.5	0.49	0.06	0.5	0.5	109	0	109	0
pH	7.3	7.8	7.562	0.21	7.32	7.78	5	0	0	0

8 Mack Cr

PARAMETER	MIN	MAX	MEAN	STD DEVIATION	5th PERCENTILE	95th PERCENTILE	COUNT	COUNT		
								Range	<	>
Total Residual Chlorine (mg/L)	0.05	1.3	0.37	0.22	0.15	0.9	99	97	2	0
Free Available Chlorine (mg/L)	0.05	4	0.53	0.66	0.05	1.7	204	127	55	2
Total Plate Count (units/mL)	0.5	3883	210.28	454.62	0.5	932.6	188	0	12	4
Faecal Coliform Count (CFU/100mL)	0	1	0.49	0.10	0.5	0.5	94	0	91	0
Total Coliform Count (MPN/100mL)	0	200	2.75	16.16	0.5	7	201	0	172	2
E. coli (MPN/100mL)	0.05	0.5	0.49	0.06	0.5	0.5	110	0	110	0
pH	7.3	7.77	7.576	0.20	7.33	7.764	5	0	0	0

Bore #1

PARAMETER	MIN	MAX	MEAN	STD DEVIATION	5th PERCENTILE	95th PERCENTILE	COUNT	Range	<	>
Free Chlorine mg/L	0.05	0.05	0.05	0	0.05	0.05	6	0	6	0
Total Chlorine mg/L	0.05	0.15	0.08	0.04	0.05	0.1375	6	1	4	0
pH	7	7.6	7.26	0.11	7.2	7.3	21	0	0	0
Temp °C	26.2	34.2	29.78	1.67	27.64	32.58	19	0	0	0
TPC units/mL	1	720	190.29	202.05	3.35	552.25	28	0	0	1
E.coli MPN/100mL	0.5	98	7.62	23.65	0.5	60.8	29	0	26	0
TCC MPN/100mL	0.5	205	8.10	37.89	0.5	5.2	29	0	20	0

Bore #2

PARAMETER	MIN	MAX	MEAN	STD DEVIATION	5th PERCENTILE	95th PERCENTILE	COUNT	Range	<	>
Free Chlorine mg/L	0	0	#DIV/0!	#DIV/0!	#NUM!	#NUM!	0	0	0	0
Total Chlorine mg/L	0	0	#DIV/0!	#DIV/0!	#NUM!	#NUM!	0	0	0	0
pH	7.3	7.3	7.30	#DIV/0!	7.3	7.3	1	0	0	0
Temp °C	0	0	#DIV/0!	#DIV/0!	#NUM!	#NUM!	0	0	0	0
TPC units/mL	10	920	213.40	396.03	11	752.4	5	0	0	0
E.coli MPN/100mL	0.5	25	5.40	10.96	0.5	20.1	5	0	4	0
TCC MPN/100mL	0.5	18	4.00	7.83	0.5	14.5	5	0	4	0

Distribution Point

PARAMETER	MIN	MAX	MEAN	STD DEVIATION	5th PERCENTILE	95th PERCENTILE	COUNT	Range	<	>
Free Chlorine mg/L	0.05	0.05	0.05	0	0.05	0.05	5	0	5	0
Total Chlorine mg/L	0.05	0.05	0.05	0	0.05	0.05	5	0	5	0
pH	7.2	7.4	7.28	0.07	7.2	7.36	9	0	0	0
Temp °C	28.6	35.2	30.51	2.21	28.67	34.01	8	0	0	0
TPC units/mL	11	156	51.92	43.88	12.65	129.05	12	0	0	0
E.coli MPN/100mL	0.5	146	13.75	41.83	0.5	73.4	12	0	10	0
TCC MPN/100mL	0.5	12	2.08	3.79	0.5	9.8	12	0	10	0

High Level Zone

Sample Point	PARAMETER	MIN	MAX	MEAN	STD DEVIATION	5th PERCENTILE	95th PERCENTILE	COUNT	COUNT			
									Range	<	>	TNTC
Reservoir 3	Total Residual Chlorine (mg/L)	0.05	0.55	0.28	0.10	0.13	0.35	37	35	2	0	0
Reservoir 3	Free Available Chlorine (mg/L)	0.05	1.2	0.24	0.22	0.05	0.68	135	80	29	1	0
Reservoir 3	Total Plate Count (units/mL)	0.1	670	34.75	86.58	0.5	182.3	110	0	10	0	1
Reservoir 3	Faecal Coliform Count (CFU/100mL)	0.05	0.5	0.41	0.20	0.14	0.5	5	0	5	0	0
Reservoir 3	Total Coliform Count (MPN/100mL)	0.5	48	1.12	4.60	0.5	1	113	0	105	0	0
Reservoir 3	E. coli (MPN/100mL)	0.5	6	0.59	0.68	0.5	0.5	109	0	107	0	0
Reservoir 3	pH	7.15	7.84	7.60	0.21	7.23	7.807	12	0	0	0	0
Reservoir 4	Total Residual Chlorine (mg/L)	0.05	0.45	0.25	0.09	0.15	0.38	75	70	3	0	0
Reservoir 4	Free Available Chlorine (mg/L)	0.05	3	0.15	0.30	0.05	0.35	101	35	58	0	0
Reservoir 4	Total Plate Count (units/mL)	0.1	900	83.60	139.37	6.4	290.7	75	0	2	0	2
Reservoir 4	Faecal Coliform Count (CFU/100mL)	0.05	0.5	0.41	0.20	0.14	0.5	5	0	5	0	0
Reservoir 4	Total Coliform Count (MPN/100mL)	0.5	129.8	2.92	15.12	0.5	4.2	80	0	70	0	0
Reservoir 4	E. coli (MPN/100mL)	0.5	0.5	0.50	0.00	0.5	0.5	76	0	76	0	0
Reservoir 4	pH	7.28	7.8	7.62	0.20	7.29	7.789	12	0	0	0	0
Reservoir 5	Total Residual Chlorine (mg/L)	0.15	1.1	0.33	0.17	0.15	0.65	114	106	0	0	0
Reservoir 5	Free Available Chlorine (mg/L)	0.05	1.5	0.19	0.20	0.05	0.5	190	99	70	0	0
Reservoir 5	Total Plate Count (units/mL)	0.5	6000	203.73	678.93	1	627	163	0	4	6	1
Reservoir 5	Faecal Coliform Count (CFU/100mL)	0	1	0.49	0.10	0.5	0.5	78	0	76	0	0
Reservoir 5	Total Coliform Count (MPN/100mL)	0	90	1.69	8.03	0.5	2.55	170	0	145	0	0
Reservoir 5	E. coli (MPN/100mL)	0.5	5	0.55	0.46	0.5	0.5	94	0	0	0	0
Reservoir 5	pH	7.15	7.76	7.59	0.20	7.23	7.76	12	0	0	0	0
Reservoir 6	Total Residual Chlorine (mg/L)	0.15	0.65	0.27	0.11	0.15	0.395	32	29	0	0	0
Reservoir 6	Free Available Chlorine (mg/L)	0.05	1.1	0.30	0.20	0.05	0.65	136	102	17	0	0
Reservoir 6	Total Plate Count (units/mL)	0.5	700	40.16	99.00	0.5	184.4	110	0	10	1	1
Reservoir 6	Faecal Coliform Count (CFU/100mL)	0.05	0.5	0.41	0.20	0.14	0.5	5	0	5	0	0
Reservoir 6	Total Coliform Count (MPN/100mL)	0.5	46	1.44	5.26	0.5	3.415	114	0	104	0	0
Reservoir 6	E. coli (MPN/100mL)	0.5	2	0.51	0.14	0.5	0.5	111	0	112	0	0
Reservoir 6	pH	7.15	7.8	7.59	0.20	7.23	7.789	12	0	0	0	0
58 Arline St	Total Residual Chlorine (mg/L)	0.15	0.25	0.19	0.05	0.15	0.2425	4	3	0	0	0
58 Arline St	Free Available Chlorine (mg/L)	0.05	0.8	0.31	0.23	0.05	0.6625	12	4	0	0	0
58 Arline St	Total Plate Count (units/mL)	0.5	68	10.13	20.58	0.5	41.9	10	0	0	0	1
58 Arline St	Faecal Coliform Count (CFU/100mL)	0	0	#DIV/0!	#DIV/0!	#NUM!	#NUM!	0	0	0	0	0
58 Arline St	Total Coliform Count (MPN/100mL)	0.5	4.2	0.84	1.12	0.5	2.35	11	0	0	0	0
58 Arline St	E. coli (MPN/100mL)	0.5	0.5	0.50	0	0.5	0.5	11	0	0	0	0
58 Arline St	pH	6.98	7.85	7.51	0.32	7.08	7.808	5	0	0	0	0
Selwyn Park	Total Residual Chlorine (mg/L)	0.15	0.25	0.20	0.05	0.15	0.25	5	4	0	0	0
Selwyn Park	Free Available Chlorine (mg/L)	0.05	1.5	0.42	0.42	0.05	1.08	13	2	0	0	0
Selwyn Park	Total Plate Count (units/mL)	0.1	370	50.63	109.09	1.05	221.9	11	0	0	0	1
Selwyn Park	Faecal Coliform Count (CFU/100mL)	0	0	#DIV/0!	#DIV/0!	#NUM!	#NUM!	0	0	0	0	0

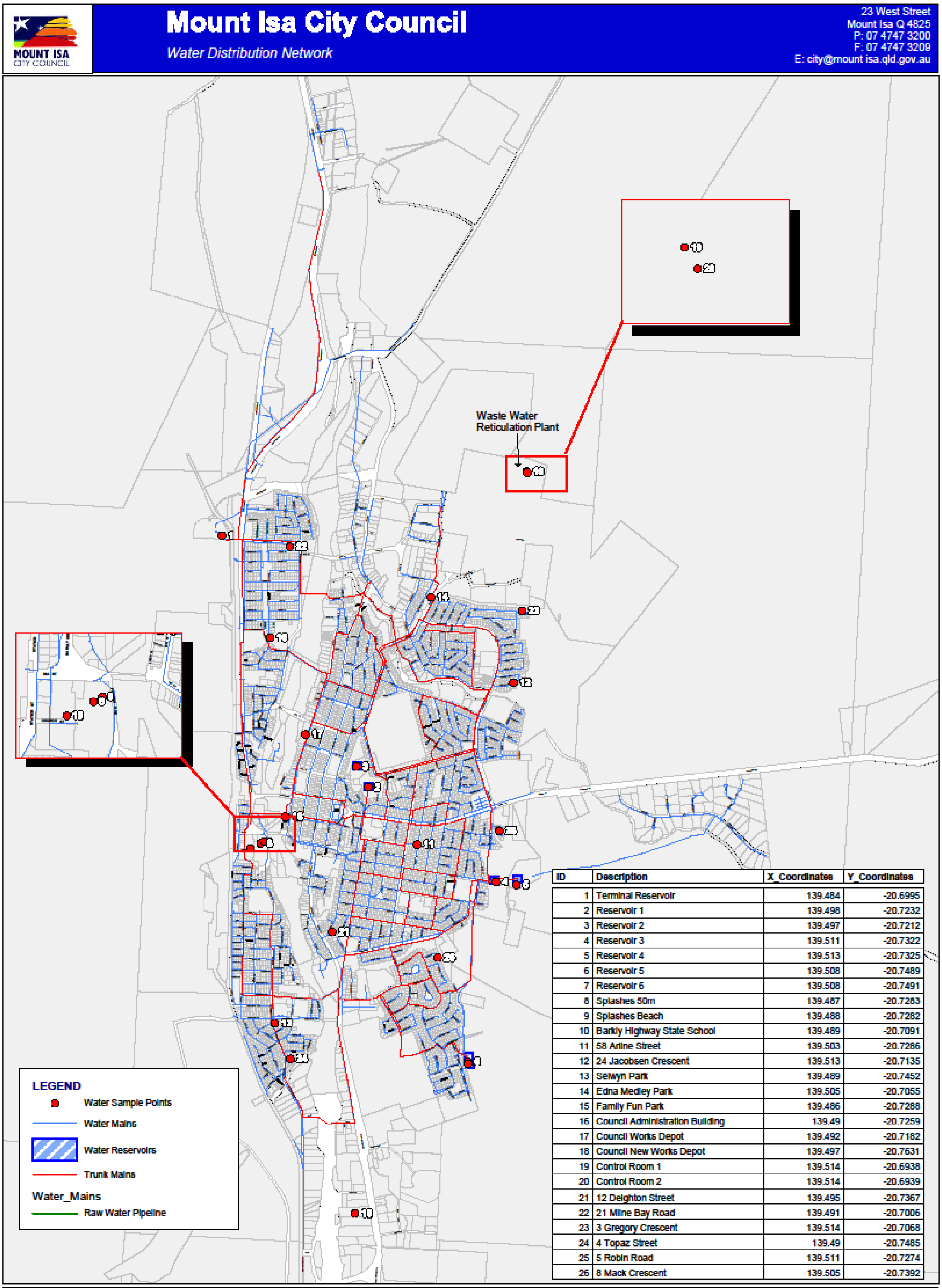
Selwyn Park	Total Coliform Count (MPN/100mL)	0.5	7.5	1.39	2.20	0.5	5.685	12	0	0	0	0
Selwyn Park	E. coli (MPN/100mL)	0.5	0.5	0.50	0	0.5	0.5	12	0	0	0	0
Selwyn Park	pH	6.92	8.55	7.65	0.52	7.0775	8.3275	6	0	0	0	0
12 Deighton Rd	Total Residual Chlorine (mg/L)	0.05	1.5	0.42	0.30	0.15	0.99	92	88	4	0	0
12 Deighton Rd	Free Available Chlorine (mg/L)	0.05	4	0.55	0.69	0.05	1.7	195	131	47	2	0
12 Deighton Rd	Total Plate Count (units/mL)	0.5	3719	75.99	295.03	0.5	378.95	188	0	18	1	1
12 Deighton Rd	Faecal Coliform Count (CFU/100mL)	0	0.5	0.48	0.09	0.5	0.5	92	0	90	0	0
12 Deighton Rd	Total Coliform Count (MPN/100mL)	0	13	0.62	1.03	0.5	0.5	192	0	171	0	0
12 Deighton Rd	E. coli (MPN/100mL)	0.5	0.5	0.50	0.00	0.5	0.5	101	0	103	0	0
12 Deighton Rd	pH	7.3	7.3	7.3	#DIV/0!	7.3	7.3	1	0	0	0	0
4 Topaz St	Total Residual Chlorine (mg/L)	0.05	0.75	0.26	0.13	0.05	0.45	147	129	12	0	0
4 Topaz St	Free Available Chlorine (mg/L)	0.05	4	0.23	0.47	0.05	0.885	203	95	97	1	0
4 Topaz St	Total Plate Count (units/mL)	0.5	2600	129.97	244.99	1	437	191	0	9	1	3
4 Topaz St	Faecal Coliform Count (CFU/100mL)	0	0.5	0.49	0.07	0.5	0.5	92	0	91	0	0
4 Topaz St	Total Coliform Count (MPN/100mL)	0	24	0.97	2.37	0.5	3	199	0	177	0	0
4 Topaz St	E. coli (MPN/100mL)	0.5	1	0.50	0.05	0.5	0.5	108	0	107	0	0
4 Topaz St	pH	7.3	7.74	7.548	0.18	7.33	7.726	5	0	0	0	0
5 Robin Rd	Total Residual Chlorine (mg/L)	0.15	45	1.54	6.71	0.15	1.1	44	42	0	0	0
5 Robin Rd	Free Available Chlorine (mg/L)	0.05	4	0.84	0.70	0.05	1.9	203	161	16	1	0
5 Robin Rd	Total Plate Count (units/mL)	0.5	4111	66.31	371.71	0.5	242.2	194	0	26	2	1
5 Robin Rd	Faecal Coliform Count (CFU/100mL)	0	0.5	0.48	0.09	0.5	0.5	93	0	91	0	0
5 Robin Rd	Total Coliform Count (MPN/100mL)	0	14	0.59	0.98	0.5	0.5	199	0	177	0	0
5 Robin Rd	E. coli (MPN/100mL)	0.5	0.5	0.50	0.00	0.5	0.5	107	0	107	0	0
5 Robin Rd	pH	7.3	7.8	7.562	0.21	7.32	7.78	5	0	0	0	0
8 Mack Cr	Total Residual Chlorine (mg/L)	0.05	1.3	0.37	0.22	0.15	0.9	99	97	2	0	0
8 Mack Cr	Free Available Chlorine (mg/L)	0.05	4	0.53	0.66	0.05	1.7	204	127	55	2	0
8 Mack Cr	Total Plate Count (units/mL)	0.5	3883	210.28	454.62	0.5	932.6	188	0	12	4	7
8 Mack Cr	Faecal Coliform Count (CFU/100mL)	0	1	0.49	0.10	0.5	0.5	94	0	91	0	0
8 Mack Cr	Total Coliform Count (MPN/100mL)	0	200	2.75	16.16	0.5	7	201	0	172	2	0
8 Mack Cr	E. coli (MPN/100mL)	0.5	0.5	0.50	0.00	0.5	0.5	108	0	108	0	0
8 Mack Cr	pH	7.3	7.77	7.576	0.20	7.33	7.764	5	0	0	0	0

Low Level Zone

Sample Point	PARAMETER	MIN	MAX	MEAN	STD DEVIATION	5th PERCENTILE	95th PERCENTILE	COUNT	COUNT			
									Range	<	>	TNTC
Terminal Reservoir	Total Residual Chlorine (mg/L)	0.15	1.1	0.51	0.35	0.15	1.02	9	1	0	0	0
Terminal Reservoir	Free Available Chlorine (mg/L)	0.05	4	1.67	0.78	0.5	3.05	233	72	4	5	0
Terminal Reservoir	Total Plate Count (units/mL)	0.1	5258	43.68	369.67	0.5	78	205	0	22	0	1
Terminal Reservoir	Faecal Coliform Count (CFU/100mL)	0	1	0.49	0.10	0.5	0.5	94	0	91	0	0
Terminal Reservoir	Total Coliform Count (MPN/100mL)	0	200	1.50	13.68	0.5	0.5	213	0	170	1	0
Terminal Reservoir	E. coli (MPN/100mL)	0.5	0.5	0.50	0.00	0.5	0.5	120	0	122	0	0
Terminal Reservoir	pH	7.2	7.78	7.51	0.19	7.25	7.775	11	0	0	0	0
Reservoir 1	Total Residual Chlorine (mg/L)	0.15	20	0.57	1.86	0.15	0.9	112	106	0	0	0
Reservoir 1	Free Available Chlorine (mg/L)	0.05	4	0.24	0.31	0.05	0.595	232	162	51	2	0
Reservoir 1	Total Plate Count (units/mL)	0.2	5757	88.88	441.86	1	269.4	204	0	7	2	1
Reservoir 1	Faecal Coliform Count (CFU/100mL)	0	47	1.00	4.85	0.5	0.5	92	0	89	0	0
Reservoir 1	Total Coliform Count (MPN/100mL)	0	200	2.09	14.07	0.5	4	214	0	173	1	0
Reservoir 1	E. coli (MPN/100mL)	0.5	2	0.52	0.14	0.5	0.5	122	0	122	0	0
Reservoir 1	pH	7.28	7.88	7.62	0.20	7.29	7.836	12	0	0	0	0
Reservoir 2	Total Residual Chlorine (mg/L)	0.05	0.55	0.21	0.10	0.05	0.37625	94	80	6	0	0
Reservoir 2	Free Available Chlorine (mg/L)	0.05	4	0.25	0.57	0.05	1.07	134	39	75	1	0
Reservoir 2	Total Plate Count (units/mL)	0.5	3300	115.68	357.96	1	302.25	90	0	2	1	5
Reservoir 2	Faecal Coliform Count (CFU/100mL)	0.5	12	2.58	4.62	0.5	9.25	6	0	3	0	0
Reservoir 2	Total Coliform Count (MPN/100mL)	0.5	165.2	10.44	26.60	0.5	78.56	117	0	78	0	0
Reservoir 2	E. coli (MPN/100mL)	0.5	40	1.41	4.25	0.5	4.56	112	0	96	0	0
Reservoir 2	pH	7.25	7.8	7.63	0.19	7.33	7.7945	12	0	0	0	0
Barkly Highway School	Total Residual Chlorine (mg/L)	0.15	0.15	0.15	#DIV/0!	0.15	0.15	1	1	0	0	0
Barkly Highway School	Free Available Chlorine (mg/L)	0.1	0.6	0.38	0.21	0.135	0.6	8	0	0	0	0
Barkly Highway School	Total Plate Count (units/mL)	0.5	350	64.50	129.65	0.65	270.8	7	0	0	0	1
Barkly Highway School	Faecal Coliform Count (CFU/100mL)	0	0	#DIV/0!	#DIV/0!	#NUM!	#NUM!	0	0	0	0	0
Barkly Highway School	Total Coliform Count (MPN/100mL)	0.5	0.5	0.50	0	0.5	0.5	8	0	0	0	0
Barkly Highway School	E. coli (MPN/100mL)	0.5	0.5	0.50	0	0.5	0.5	8	0	0	0	0
24 Jacobsen Cr	Total Residual Chlorine (mg/L)	0.3	0.3	0.30	#DIV/0!	0.3	0.3	1	0	0	0	0
24 Jacobsen Cr	Free Available Chlorine (mg/L)	0.1	1	0.40	0.29	0.12	0.86	9	4	0	0	0
24 Jacobsen Cr	Total Plate Count (units/mL)	0.5	212	46.75	71.19	1.025	158.8	8	0	0	0	1
24 Jacobsen Cr	Faecal Coliform Count (CFU/100mL)	0	0	#DIV/0!	#DIV/0!	#NUM!	#NUM!	0	0	0	0	0
24 Jacobsen Cr	Total Coliform Count (MPN/100mL)	0.5	2	0.67	0.50	0.5	1.4	9	0	0	0	0
24 Jacobsen Cr	E. coli (MPN/100mL)	0.5	0.5	0.50	0	0.5	0.5	9	0	0	0	0
24 Jacobsen Cr	pH	7.24	7.75	7.54	0.24	7.2715	7.747	4	0	0	0	0
21 Milne Bay	Total Residual Chlorine (mg/L)	0.15	1.3	0.48	0.29	0.15	1.1	38	34	0	0	0
21 Milne Bay	Free Available Chlorine (mg/L)	0.05	4	1.20	0.90	0.05	2.75	200	158	17	3	0
21 Milne Bay	Total Plate Count (units/mL)	0.5	1335	25.51	114.89	0.5	72.4	193	0	32	1	0
21 Milne Bay	Faecal Coliform Count (CFU/100mL)	0	0.5	0.48	0.09	0.5	0.5	93	0	91	0	0
21 Milne Bay	Total Coliform Count (MPN/100mL)	0	20.7	0.63	1.49	0.5	0.5	195	0	163	0	0

21 Milne Bay	E. coli (MPN/100mL)	0.5	0.5	0.50	0.00	0.5	0.5	105	0	105	0	0
21 Milne Bay	pH	7.3	7.78	7.478	0.19	7.31	7.724	5	0	0	0	0
3 Gregory Cr	Total Residual Chlorine (mg/L)	0.05	29	0.84	3.64	0.15	0.9	62	56	2	0	0
3 Gregory Cr	Free Available Chlorine (mg/L)	0.05	4	0.72	0.74	0.05	2.25	202	138	33	2	0
3 Gregory Cr	Total Plate Count (units/mL)	0.5	7039	166.25	706.95	0.5	588.5	191	0	31	2	2
3 Gregory Cr	Faecal Coliform Count (CFU/100mL)	0	0.5	0.49	0.07	0.5	0.5	92	0	91	0	0
3 Gregory Cr	Total Coliform Count (MPN/100mL)	0	94.5	1.03	6.71	0.5	0.5	197	0	165	0	0
3 Gregory Cr	E. coli (MPN/100mL)	0.5	0.5	0.50	0.00	0.5	0.5	107	0	107	0	0
3 Gregory Cr	pH	7.3	7.88	7.61	0.23	7.32	7.845	6	0	0	0	0

APPENDIX B – MOUNT ISA SAMPLING LOCATIONS



ID	Description	X_Coordinates	Y_Coordinates
1	Terminal Reservoir	139.484	-20.6995
2	Reservoir 1	139.498	-20.7232
3	Reservoir 2	139.497	-20.7212
4	Reservoir 3	139.511	-20.7322
5	Reservoir 4	139.513	-20.7325
6	Reservoir 5	139.508	-20.7489
7	Reservoir 6	139.508	-20.7491
8	Splashes 50m	139.487	-20.7283
9	Splashes Beach	139.488	-20.7282
10	Barkly Highway State School	139.489	-20.7091
11	58 Arline Street	139.503	-20.7286
12	24 Jacobsen Crescent	139.513	-20.7135
13	Selwyn Park	139.489	-20.7452
14	Edna Medley Park	139.505	-20.7055
15	Family Fun Park	139.486	-20.7288
16	Council Administration Building	139.49	-20.7259
17	Council Works Depot	139.492	-20.7182
18	Council New Works Depot	139.497	-20.7631
19	Control Room 1	139.514	-20.6938
20	Control Room 2	139.514	-20.6939
21	12 Deighton Street	139.495	-20.7367
22	21 Milne Bay Road	139.491	-20.7006
23	3 Gregory Crescent	139.514	-20.7068
24	4 Topaz Street	139.49	-20.7485
25	5 Robin Road	139.511	-20.7274
26	8 Mack Crescent	139.505	-20.7392

APPENDIX C – BORE CARD REPORT FOR BORE 3

GROUNDWATER DATABASE

DATE 19/11/2012

BORE CARD REPORT

REG NUMBER 100120040

REGISTRATION DETAILS

		BASIN	0012	LATITUDE	19-55-23	MAP-SCALE	
OFFICE	Longreach	SUB-AREA		LONGITUDE	138-07-18	MAP-SERIES	
DATE LOG RECD		SHIRE	5300-MT ISA C.	EASTING	198669	MAP-NO	
D/O FILE NO.	515/019/82	LOT	27	NORTHING	7794450	MAP NAME	
R/O FILE NO.		PLAN	WO30	ZONE	54	PROG SECTION	
H/O FILE NO.		ORIGINAL DESCRIPTION		ACCURACY	GPS	PRES EQUIPMENT	
				GPS ACC	10		
GIS LAT	-19.92307957	PARISH NAME	919-CAMOOWEAL			ORIGINAL BORE NO	
GIS LNG	138.1216827	COUNTY	WONOMO			BORE LINE	-
CHECKED	Y	PROPERTY NAME					
		FIELD LOCATION				POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	SF	DATE DRILLED	09/02/2012			DATA OWNER	
STATUS	EX	DRILLERS NAME	MATT, WILLIAM JOHARN			CONFIDENTIAL	N
ROLES	WS	DRILL COMPANY	DRM				
		METHOD OF CONST.	ROTARY AIR				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM	TOP (m)	BOTTOM (m)
X	10/02/2012	3	Grout			275	0.00	1.00
X	10/02/2012	4	Grout			215	1.00	5.00
X	10/02/2012	5	Cuttings or other fill betw een casing and h			215	5.00	30.00
X	10/02/2012	6	Gravel Pack	10.000	GR	215	30.00	96.00
A	10/02/2012	1	Polyvinyl Chloride	8.800	WT	150	0.00	79.00
A	10/02/2012	2	Perforated or Slotted Casing	2.500	AP	150	79.00	91.00

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
19	75.00	86.00	BEIGE OFF WHITE DOLOSTONE, WEATHERED, FRACTURED, MINOR FE STAINING; WATER
20	86.00	89.00	LIGHT BROWN GREY DOLOSTONE, WEATHERED, FRACTURED, FE STAINING; WATER
21	89.00	91.00	BEIGE OFF WHITE DOLOSTONE, WEATHERED, FRACTURED, FE STAINING; WATER

GROUNDWATER DATABASE

DATE 19/11/2012

BORE CARD REPORT

REG NUMBER 100120040

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
22	91.00	95.00	OFF WHITE GREY DOLOSTONE, WEATHERED, FE STAINING
23	95.00	96.00	BEIGE OFF WHITE DOLOSTONE, WEATHERED, MINOR FE STAINING
1	0.00	1.00	BROWN SANDY CLAY SOIL, DOLOSTONE FRAGMENTS
2	1.00	3.00	BEIGE OFF WHITE DOLOSTONE, VERY WEATHERED, MINOR FE STAINING
3	3.00	11.00	BEIGE OFF WHITE DOLOSTONE, WEATHERED, MINOR FE STAINING
4	11.00	14.00	LIGHT BROWN OFF WHITE DOLOSTONE, WEATHERED, FE STAINING
5	14.00	19.00	BEIGE OFF WHITE DOLOSTONE, WEATHERED, FE STAINING
6	19.00	24.00	LIGHT BROWN OFF WHITE DOLOSTONE, WEATHERED, FE STAINING
7	24.00	27.00	REDDISH LIGHT BROWN DOLOSTONE, WEATHERED, FE STAINING
8	27.00	34.00	BEIGE OFF WHITE DOLOSTONE, WEATHERED, FE STAINING
9	34.00	39.00	LIGHT BROWN GREY DOLOSTONE, WEATHERED, FE STAINING
10	39.00	44.00	BEIGE OFF WHITE DOLOSTONE, WEATHERED, MINOR FE STAINING
11	44.00	50.00	LIGHT BROWN GREY DOLOSTONE, WEATHERED, FE STAINING
12	50.00	53.00	BEIGE OFF WHITE DOLOSTONE, WEATHERED, MINOR FE STAINING
13	53.00	55.00	LIGHT BROWN OFF WHITE DOLOSTONE, WEATHERED, FE STAINING
14	55.00	63.00	BEIGE OFF WHITE DOLOSTONE, WEATHERED, MIN0R FE STAINING
15	63.00	64.00	LIGHT BROWN OFF WHITE DOLOSTONE, WEATHERED, FE STAINING
16	64.00	66.00	LIGHT BROWN GREY DOLOSTONE, WEATHERED, FE STAINING
17	66.00	72.00	BEIGE OFF WHITE DOLOSTONE, WEATHERED, MINOR FE STAINING
18	72.00	75.00	OFF WHITE GREY DOLOSTONE, WEATHERED, FRACTURED, MINOR FE STAINING; WATER

STRATIGRAPHY DETAILS

SOURCE	RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
DNR	1	0.00	1.00	QUATERNARY - UNDEFINED
DNR	2	1.00	96.00	CAMOOWEAL DOLOSTONE

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	72.00	91.00	DLMT			N	946US/COM	3.40	Y	CV	CAMOOWEAL DOLOSTONE

GROUNDWATER DATABASE

DATE 19/11/2012

BORE CARD REPORT

REG NUMBER 100120040

PUMP TEST DETAILS PART 1

PIPE	DATE	REC NO.	RN OF PUMP-BORE	TOP (m)	BOTTOM (m)	DIST (m)	METH	TEST TYPES	PUMP TYPE	SUCTION SET	Q PRIOR TO TEST	DUR OF Q PR	PRES ON ARRIV	Q ON ARRIV
A	10/02/2012	1	100120040	71.00	91.00		PUM							

PUMP TEST DETAILS PART 2

PIPE	DATE	REC	TEST DUR (mins)	SWL (m)	RECOV. TIME (mins)	RESID. DD (m)	MAX DD or P RED (m)	Q at MAX DD (l/s)	TIME TO MAX DD (mins)	Max Q (l/s)	CALC STAT HD (m)	DESIGN YIELD (l/s)	DESIGN BP (m)	SUCT. SET (m)	TMSY (m2/DAY)	STOR
A	10/02/2012	1		-68.00						2.50						

ELEVATION DETAILS

PIPE	DATE	ELEVATION	PRECISION	DATUM	MEASUREMENT POINT	SURVEY SOURCE
X	12-FEB-12	226.00	GPS	AHD	N	WGS 84

WATER ANALYSIS PART1

PIPE	DATE	RD	ANALYST	QAN	DEPTH (m)	RMK	SRC	COND (uS/cm)	pH	Si (mg/L)	TOTAL IONS	TOTAL SOLIDS	HARD	ALK	FIG. OF MERIT	SAR	RAH
A	10/02/2012	1	DNR	233237	86.00	AI	GB	1050	7.1		720.51	517.19	430	332	3.8	1.1	

WATER ANALYSIS PART 2

PIPE	DATE	RD	Na	K	Ca	Mg	Mn	HCO3	Fe	CO3	Cl	F	NO3	SO4	Zn	Al	B	Cu
A	10/02/2012	1	52.0	6.0	90.5	49.3	0.06	400.0	1.69	< 2.0	115.0	0.10	< 0.5	< 1.0	< 0.04	2.10	0.10	< 0.02

WATER LEVEL DETAILS

**** NO RECORDS FOUND ****

FIELD MEASUREMENTS

PIPE	DATE	DEPTH (m)	COND (uS/cm)	pH	TEMP (C)	NO3 (mg/L)	DO (mg/L)	Eh (mV)	ALK	METH	SOURCE
A	10/02/2012		980							PU	GB

** End of Report **

MOUNT ISA CITY COUNCIL

DRINKING WATER QUALITY MANAGEMENT PLAN

MONITORING PLAN

MARCH 2013

DOCUMENT AND VERSION CONTROL

The DWQMP and this supporting document are controlled documents. The signed document and version control sheet at the front of the document indicate the current version. Information within the appendices is to be updated as follows:

- Action plans 6-12 months (review with annual reporting requirement)
- Sub-plans 1-3 years
- Associated policies 1-5 years
- Business management plan 1-3 years

Revisions to individual pages or sections of the TMP will be indicated by a revision number and date added to the footer of the page, and noted in the version control table.

VERSION CONTROL SHEET

Date	Description	Version & Update Ref	Appendix or Page No.	Approved Initials
May 2012	Final	Version 1.0	All	
November 2012	Revision	Version 1.1	Section 3.2	
March 2013	Revision	Version 2.0	Section 5	

TABLE OF CONTENTS

LIST OF TABLES

LIST OF APPENDICES

MOUNT ISA CITY COUNCIL
DRINKING WATER QUALITY MANAGEMENT PLAN

1 INTRODUCTION

1.1 PURPOSE

Monitoring is an integral process for the delivery of safe water. Monitoring supports the management measures for identified risks and verifies that the barriers identified in the risk assessment, and the system as a whole, work effectively. The purpose of this monitoring plan is to document the strategies and procedures to follow for the water quality monitoring undertaken. The monitoring should measure compliance with applicable standards and guidelines and, for operational purposes, manage the water supply.

1.2 SCOPE

This monitoring program covers the operational and verification monitoring of the MICC's area of operations. The monitoring program takes into account the Mount Isa system as a whole as well as issues specific to the MICC that have been identified in the risk assessment. The program covers monitoring of the MICC operations from water received from MIWB through to the consumers' taps. Parameters measured are physical, chemical and biological, and are sampled and analysed either in the field or sent to a laboratory.

1.3 OBJECTIVES

The plan aims to:

- Provide an immediate indication of performance of the system
- Provide a program that includes appropriate indicators to identify failures in a timely manner and trigger short-term corrective actions
- Provide a data analysis to reveal potential for improvement.

2 REGULATORY FRAMEWORK

MICC is bound by a number of regulatory and formal requirements and standards set by regulatory agencies. Following, are the principal water quality monitoring requirements.

2.1 WATER SUPPLY (SAFETY AND RELIABILITY) ACT 2008

The *Water Supply (Safety and Reliability) Act 2008* requires that a water service provider, in this case the MICC, undertake monitoring of drinking water quality. Section 95(3)(b) of the Act states that the DWQMP must include operational and verification monitoring programs including parameters used for indicating compliance with the water quality criteria for drinking water.

The *Drinking Water Quality Management Plan Guideline 2010* supplied by DERM provides details of the program for compliance with the Act. The Guideline states that in the preparation of the DWQMP, the inclusion of a monitoring program for operation and verification monitoring will support the management measures for the identified risks.

The risk assessment that has been undertaken for the DWQMP identifies those hazards that may be of a health concern in relation to drinking quality.

2.2 PUBLIC HEALTH ACT AND REGULATIONS 2005

Queensland Health is the administrator for the *Public Health Act 2005* and the *Public Health Regulation 2005*. Section 57c of the Act states that drinking water is unsafe at a particular time if it would be likely to cause physical harm to a person who might later consume it, assuming nothing happened to it after that particular time and before being consumed by the person that would prevent it being used for its intended use. Under Section 57e of the Act, it is an offence for a provider to supply drinking water the provider knows, or reasonably ought to know, is unsafe. This requires an operator to undertake monitoring that would be reasonably expected to determine its safety.

In addition, the *Public Health Regulation 2005* sets specific standards for monitoring drinking water quality in Queensland. It sets the values and frequency for testing *Escherichia coli* in the reticulation system and the fluoride concentration at the point of addition.

2.3 AUSTRALIAN DRINKING WATER GUIDELINES 2011

The *Australian Drinking Water Guidelines* (ADWG) 2011 (NHMRC & NRMMC 2011) is the definitive reference for drinking water quality in Australia. It is a framework for the management of drinking water supplies, which applies to any water intended for drinking. It defines what safe, good water quality is, how it can be achieved and how it can be assured. To do this, ADWG provides a framework for monitoring programs, listing the parameters, location, frequency for sampling, plus limits. The ADWG provides two types of guideline values or limits:

- Health related guideline value (safe water)
- Aesthetic guideline value (good water)

The guidelines are not mandatory standards but are intended for use by agencies with responsibilities associated with drinking water supply including water regulators. The limits have been formalised by the Department of Environment and Resource Management (DERM) and require water service providers to report any breach of ADWG health related limits. In addition, it would be reasonable under the Public Health Act to undertake monitoring as prescribed in the ADWG.

3 MONITORING POINTS

Both water supply schemes operated by MICC, Mount Isa and Camooweal, are monitored manually using grab samples. The water quality monitoring points for the plan have been determined to provide operational control and verify water quality.

3.1 MOUNT ISA

The Mount Isa sample points have been selected to be representive of the distribution system for Mount Isa. All reservoirs were included because they are operationally important for water quality. All other points were carefully selected according to their position within the system for reasons including:

- extremities
- dead ends
- long detention times
- both high and low zones.

The Mount Isa sampling locations are mapped in Appendix A and are listed in Table 1.

Table 1 Sample Sites at Mount Isa

Zone	Sample Point #	Site Name	Location Type
L	1	Terminal Reservoir	Transfer point with MIWB
L	2	Reservoir 1	Reservoir
L	3	Reservoir 2	Reservoir
H	4	Reservoir 3	Reservoir
H	5	Reservoir 4	Reservoir
H	6	Reservoir 5	Reservoir
H	7	Reservoir 6	Reservoir
L	10	Barkly Highway School	Community Facility
H	11	58 Arline St	Residential
L	16	City Council	Community Facility
H	18	Council New Works Depot - Duchess Road	Light Industrial
H	21	12 Deighton St	Residential
L	23	3 Gregory St	Residential
H	24	4 Topaz St	Residential
H	26	8 Mack Cr	Residential
L	27	Kalkadoon	Residential
L	28	Corner of Rebecca and Spence St	Residential

3.2 CAMOOWEAL

Sampling at Camooweal is limited as it is a remote location, has a small population and has a fairly consistent reliable groundwater supply. As the ADWG (2011) states, it is the response that is more important than detection. This is because monitoring at Camooweal, especially for *E. coli,* cannot prevent unsafe water being supplied to consumers, as results are typically not available for days after collecting the samples, so that any corrective actions occur after the water has been supplied. This means responding to customer complaints in a timely manner is vital. For several reasons including those above, *E. coli* is sampled only fortnightly.

There are six sample locations listed in Table 2. Two samples are always taken in the reticulation. One sample is always at the Hospital located in Frances St (Site 5) and the other (Site 6) is rotated between several locations around Camooweal including the Service Station on corner of Austral St and the Barkly Highway, the Roadhouse on the Highway near Morrison St and the Public Hall, or the School near Nowranie St.

The Camooweal community is small and consumes only 128ML per annum.

Table 2 Camooweal sampling locations

Sample Point #	Site Location	Location Type
Bore #1	WTP	Raw Water
Bore # 2	WTP	Raw Water
Bore # 3	Sporting Grounds	Raw Water
Site 4	After chlorination	Process
Site 5	Hospital	Residential
Site 6	Rotates	Residential

4 OPERATIONAL MONITORING

Operational monitoring is undertaken to ensure that a system is operating within its performance limits. It should reflect the effectiveness of each process or activity within the system, including at critical control points (CCPs).

Operational monitoring aims to:

- Confirm the system is performing within the operational tolerance limits
- Control process elements
- Provide information for the implementation of corrective actions in the short-term.

A key characteristic of operational monitoring is that it should provide an immediate indication of performance to be able to be used to prompt immediate and short-term corrective actions to maintain drinking water quality. Furthermore, monitoring should be conducted with appropriate frequency to reveal any failures allowing sufficient time to act.

Operational monitoring is detailed along with performance criteria for a number of parameters. When undertaking operational monitoring, a normal operating envelope must be defined in order to identify when the process is out of control and action is required. A number of points in the system have been identified as being critical. These CCPs have specific procedures that identify requirements and specific corrective actions, should monitoring results be out of specification.

Result turn around should be as quick as realistically possible to allow any corrective actions to be taken in a timely fashion, but should be undertaken by competent personnel and with sufficient accuracy.

Operational limits have been set for both Mount Isa and Camooweal and are detailed in Section 6.1.1 of the DWQMP.

4.1 MOUNT ISA

In the case of the Mount Isa system, treated water is supplied by the MIWB. The MIWB have a DWQMP and monitoring water quality up to the point of supply. The MIWB undertakes water quality testing to ensure water meets appropriate health standards at the point of supply. The MIWB notify MICC if there are any risks to public health. The MICC monitoring program does not duplicate monitoring undertaken by the MIWB for parameters that would not change throughout the distribution system. The monitoring program is risk-based and monitors those parameters that are required to operate the MICC distribution system.

There are two important barriers in place for a reticulation system: a chlorine residual and system integrity. For a distribution system, the most important operational monitoring parameter to test is the chlorine residual. It can provide immediate feedback on the performance of both barriers and allow the timely application of corrective measures.

The *Mount Isa Operational Monitoring Program 2012* is attached in Appendix B.

4.2 CAMOOWEAL

The revised ADWG 2011 makes clear that when monitoring small remote supplies, the primary advice is that the emphasis should be on operational monitoring and barrier performance, not the verification of water quality. Also the ADWG 2011 short-term evaluation performance approach is applied, that is, the response is more important than the detection.

The monitoring for Camooweal has been kept pragmatic, focusing on barrier performance due to its remote location. There are two barriers in the Camooweal system, chlorination and system integrity.

The *Camooweal Operational Monitoring Program 2012* is attached in Appendix B.

5 VERIFICATION MONITORING

Whilst operational monitoring deals with each treatment process within the system, verification monitoring provides an assessment of the overall performance of the system and ultimately the quality of water at the point of supply. It confirms compliance with water quality criteria set by Queensland Health, DEWS and any other formal requirements.

Verification monitoring should be undertaken by a trained laboratory technician or qualified contractor. Monitoring must be undertaken to a level that can verify the appropriate criteria (i.e. the limit of reporting should be less than the specified criteria and must not be greater than the criteria).

The Manager Utility Services receives electronic copies of the verification testing results. The Manager is responsible for assessing and reviewing the data to ensure compliance. Results should be reviewed within 24 hours of receiving the lab reports. Any exceedences are managed in accordance with Level 2 Water Quality Incidents (explained in Section 6.2.2 DWQMP). The incident reporting process is mentioned in Appendix C of the DWQMP. Non-compliances are discussed with operational staff to inform and improve practices, and where needed to upgrade or update procedures.

The verification monitoring is deemed sufficient to indicate supply of safe quality drinking water. *E. coli* is tested at the specified frequency in the *Public Health Regulation* for the two schemes.

Verification testing is also done for other health related parameters of concern and testing of THM has been added to the monitoring program to inform risk level. A suite of heavy metals and pesticides will be tested quarterly to 3-yearly to inform of major changes in raw water quality and inform risk level (i.e. increase confidence level).

Verification monitoring is detailed in Appendix B.

6 EVENT-BASED MONITORING

Event-based monitoring is used to monitor the hazardous events, which could negatively impact upon water quality, and is required for the operation of preventive measures. Therefore, the focus of this monitoring plan is on events that impact raw water quality at Camooweal and treated water at Mount Isa.

There are a number of parameters that are shown in the verification monitoring table (Appendix C), which require event-based monitoring but are not included in this table. These parameters are those that do not fit into any of the existing event categories. Rather, they may be the result of an unpredictable specific event such as a spill or an accident. The following parameters would require monitoring in the event of an out-of-the-ordinary circumstance:

- Chlorine
- Turbidity
- DBPs
- *E. coli*

Frequency and location for sampling are unspecified and would depend on the nature of the event. An example is in the instance of a major rainfall event at Camooweal and potential for surface water contamination at the bore, turbidity and *E. coli* monitoring should increase to daily frequency during the event.

If an ADWG health limit is exceeded, then follow up monitoring must be undertaken. If an operational limit is exceeded, action must be taken to bring the process back to normal operation.

7 NON-POTABLE WATER SUPPLY

The MICC monitors water quality at a number of other sites besides those listed in Section 3. These are monitored for either recreational or environmental indicators, or for the Wastewater Treatment Plant and are not required to be reported under the DWQMP. The following points are currently monitored for chlorine, bacteriological and physical parameters.

Sample Point
Depot Creek
Davis Rd Crossing
Final Effluent Pump Well
Breakaway Creek
WWRP
Splash Beach
Splash 50m
Fun Park 1
Fun Park 2
Control 1
Control 2

8 SAMPLING

8.1 PROCEDURES

All sampling procedures are held in a hard copy folder at the laboratory and followed by staff.

8.2 QUALITY ASSURANCE AND CONTROL

Quality assurance is important to guarantee consistently reliable and legally defendable results, which meet accreditation or licencing and ensure customers are provided with the best quality water. The MICC has the following quality management systems in place:

- Water Quality Monitoring Procedures (needs to be revised, part of Improvement Plan)
- Blanks, duplicates and quality control standards in all batches of tests carried out

8.3 DATA MANAGEMENT

Field samples are sent to the MICC Laboratory for bacteriological and chemical testing. Results are recorded in an Excel spreadsheet with the sample number, date, time and location sampled, and any comments recorded. Spreadsheets are emailed weekly from the laboratory to the MICC where they are saved on the electronic DataWorks database in chronological folders.

9 REFERENCES

Australian Government Bureau of Meteorology 2011, *Daily Rainfall Mount Isa Mine,* visited 2/03/2011, http://reg.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=136&p_display_tye=dailyDataFile&p_startYear=2011&p_c=-176940480&p_stn_num=029126.

NHMRC & NRMMC 2011, National Water Quality Management Strategy: Australian Drinking Water Guidelines. 6th Ed., National Health and Medical Research Council and Natural Resource Management Ministerial Council, Australian Government, Canberra.

Queensland Government, DERM 2010, *Drinking Water Quality Management Plan Guideline*, Department of Environment and Resource Management, Queensland.

Public Health Regulation 2005, (Qld), (Austl.). Reprint No.2E January 2012

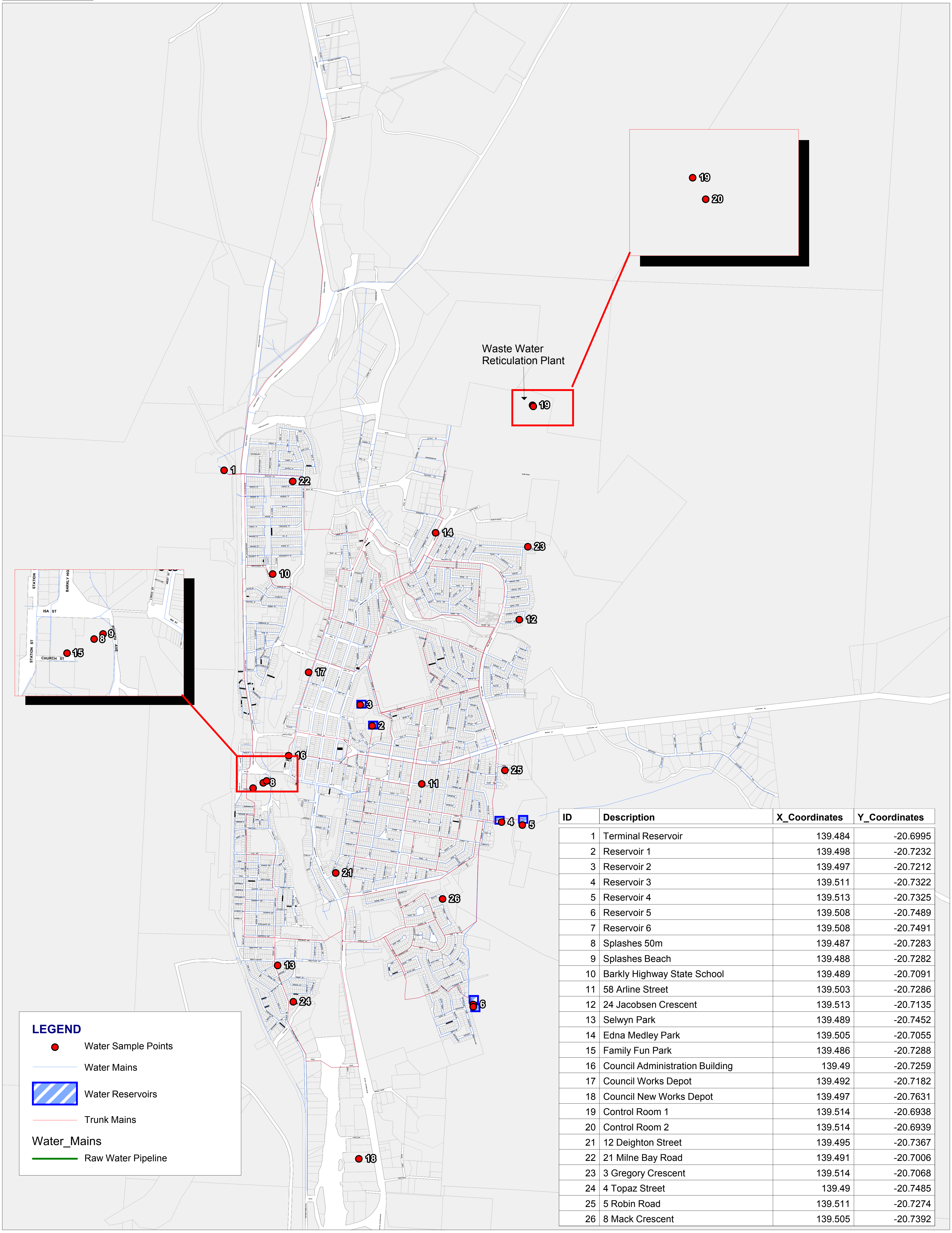
Water Supply (Safety and Reliability) Act 2008, (Qld), (Austl.). Reprint No.2A as in force 28 Oct 2011

APPENDIX A – MOUNT ISA SAMPLE POINT MAP

Mount Isa City Council

Water Distribution Network

23 West Street
Mount Isa Q 4825
P: 07 4747 3200
F: 07 4747 3209
E: city@mount isa.qld.gov.au



ID	Description	X_Coordinates	Y_Coordinates
1	Terminal Reservoir	139.484	-20.6995
2	Reservoir 1	139.498	-20.7232
3	Reservoir 2	139.497	-20.7212
4	Reservoir 3	139.511	-20.7322
5	Reservoir 4	139.513	-20.7325
6	Reservoir 5	139.508	-20.7489
7	Reservoir 6	139.508	-20.7491
8	Splashes 50m	139.487	-20.7283
9	Splashes Beach	139.488	-20.7282
10	Barkly Highway State School	139.489	-20.7091
11	58 Arline Street	139.503	-20.7286
12	24 Jacobsen Crescent	139.513	-20.7135
13	Selwyn Park	139.489	-20.7452
14	Edna Medley Park	139.505	-20.7055
15	Family Fun Park	139.486	-20.7288
16	Council Administration Building	139.49	-20.7259
17	Council Works Depot	139.492	-20.7182
18	Council New Works Depot	139.497	-20.7631
19	Control Room 1	139.514	-20.6938
20	Control Room 2	139.514	-20.6939
21	12 Deighton Street	139.495	-20.7367
22	21 Milne Bay Road	139.491	-20.7006
23	3 Gregory Crescent	139.514	-20.7068
24	4 Topaz Street	139.49	-20.7485
25	5 Robin Road	139.511	-20.7274
26	8 Mack Crescent	139.505	-20.7392

APPENDIX B – OPERATIONAL AND VERIFICATION MONITORING PROGRAM

Operational Monitoring

		Mount Isa							Camooweal	
Type	**Parameter**	**Terminal Reservoir**	**Reservoir 1**	**Reservoir 2**	**Reservoir 3**	**Reservoir 4**	**Reservoir 5**	**Reservoir 6**	**Bores**	**Post chlorination**
Disinfection residual	Chlorine	2W	2W	2W	2W	2W	2W	2W	n/a	F
Physical	pH	2W							F	F
Physical	Turbidity	2W	2W	2W	2W	2W	2W	2W	F	F

Key:
2W - twice weekly
F - fortnightly

Verification Monitoring

		Mount Isa																Camooweal		
									L	L	L	L	H	H	H	H	H	H			
Type	Parameter	Terminal Reservoir	Reservoir 1	Reservoir 2	Reservoir 3	Reservoir 4	Reservoir 5	Reservoir 6	Barkly Highway School	City Council	3 Gregory St	Kalkadoon	58 Arline St	Council New Works Depot - Duchess Road	12 Deighton St	4 Topaz St	8 Mack Cr	Corner of Rebecca and Spence St	Bores 1, 2, 3	Austral St	Beaumont St
Microbiological	E. coli								W*	W*	W*	W*	W^	W^	W^	W^	W^	W^		M	M
Microbiological	Total coliforms								W*	W*	W*	W*	W^	W^	W^	W^	W^	W^		M	M
Chemical	Free chlorine								W*	W*	W*	W*	W^	W^	W^	W^	W^	W^		M	M
Microbiological	HPC	M	M	M	M	M	M	M				M						M		M	M
Physical	pH											M						M		M	M
Physical	Turbidity											M						M		M	M
Metals	Iron	Q										Q						Q	Y		
Metals	Manganese	Q										Q						Q	Y		
DBPs	THMs	Q										Q						Q			
Physical	Hardness	Y																	Y		
Non-metal	Chloride	Y																	Y		
Non-metal	Sodium	Y																	Y		
Non-metal	Nitrate	Y																	Y		
Metals	Beryllium	3Y																	3Y		
Metals	Arsenic	3Y																	3Y		
Metals	Barium	3Y																	3Y		
Metals	Boron	3Y																	3Y		
Metals	Cadmim	3Y																	3Y		
Metals	Chromium	3Y																	3Y		
Metals	Copper	3Y																	3Y		
Metals	Iodide	3Y																	3Y		
Metals	Lead	3Y																	3Y		
Metals	Mercury	3Y																	3Y		
Metals	Molybdenum	3Y																	3Y		
Metals	Nickel	3Y																	3Y		
Metals	Selenium	3Y																	3Y		
Metals	Silver	3Y																	3Y		
Metals	Zinc	3Y																	3Y		
Non-metal	Fluoride	3Y																	3Y		
Chemical	Pesticides	3Y																	3Y		

Key:
L - low zone
H - high zone
W* - one sample weekly from the low zone, sampling sites rotate within low zone
W^ - one sample weekly from the high zone, sampling sites rotate within high zone
M - monthly
Q - quarterly
Y - yearly
3Y - every 3 years
Free chlorine is tested at the same time micro samples are taken
Total coliforms are done in the same test as *E. coli*

APPENDIX C – OPERATIONAL LIMITS AND EVENT BASED MONITORING

Operational Limits

	Site Name	Free chlorine (mg/L)	HPC (cfu/100mL)	Total Coliforms (cfu/100mL)	Turbidity (NTU)	E. coli
Mount Isa	Reservoirs	0.7 - 1.5	>360	>12	>2.5	+ve
Mount Isa	Reticulation	<0.7	>360	>12	>2.6	+ve
Camooweal	Bores	n/a	n/a	n/a	>1	n/a
Camooweal	Post Chlorination	0.7 - 1.5	>360	>12	>1	+ve
Camooweal	Reticulation	0.7 - 1.5	>360	>12	>2.5	+ve

Event Based Monitoring

Event	Parameter	Frequency	Location	
			Mount Isa	Camooweal Bores
Major rainfall event at Camooweal potential for surface water contamination at bore	Turbidity	Daily	N	Y

MOUNT ISA CITY COUNCIL

DRINKING WATER QUALITY MANAGEMENT PLAN:

RISK ASSESSMENT REPORT

MARCH 2013

DOCUMENT AND VERSION CONTROL

The DWQMP and this supporting document are controlled documents. The signed document and version control sheet at the front of the document indicate the current version. Information within the appendices is to be updated as follows:

- Action Plans: Every six to 12 months (review with annual reporting requirement)
- Sub-plans: Every one to three years
- Associated policies: Every one to five years
- Business management plan: Every one to three years

A revision number and date added to the footer of the page will indicate revisions to individual pages or sections of the Risk Assessment Report. The revisions will also be noted in the version control table.

VERSION CONTROL SHEET

Date	Description	Version & Update Ref	Appendix or Page No.	Approved Initials
May 2012	Final	Version 1.0	All	
March 2013	Revision	Version 2.0	Apeendix D	

TABLE OF CONTENTS

TABLE OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

MOUNT ISA CITY COUNCIL
DRINKING WATER QUALITY MANAGEMENT PLAN

1 INTRODUCTION

The *Water Supply (Safety & Reliability) Act 2008* (the Act) requires bulk water providers to prepare a Drinking Water Quality Management Plan (DWQMP). A significant component of this DWQMP is a water-quality risk assessment. The Act, in relation to risk assessments, states that a DWQMP must:

- identify the hazards and hazardous events that the drinking-water service provider believes may affect the quality of water to which the services relate
- include an assessment of the risks posed by the hazards and hazardous events
- and demonstrate how the drinking-water service provider intends to manage the risks posed by the hazards and hazardous events.

The Queensland DWQMP Guideline defines how compliance to the Act is to be achieved. It states that, in the preparation of the Mount Isa City Council (MICC) risk assessment, the above criteria for the identification of hazardous events and hazards must be met and documented in the report.

The Queensland DWQMP Guideline has additional criteria for the assessment of risks and are as follows:

- detail the risk assessment methodology used for each scheme
- details of the risk assessment results for each scheme's identified hazards and hazardous events must be identified
- describe key stakeholders involved in the risk-assessment process
- explain how relevant risk-assessment results for other (upstream) provider's services have been considered.

The first point above, "Details of the risk methodology," is addressed in the main DWQMP. How that methodology has been applied is described in this report, as well as how the remaining criteria will be addressed.

2 RISK ASSESSMENT TEAM

A team, which was judged to have appropriate knowledge and expertise to assess the risk for this system was assembled to undertake the risk assessment. This team included the operators of the water supply system, the manager responsible for the system and the water-quality officer. In addition, James Howey, for Viridis Consultants P/L, an expert in the area of water-quality risk assessment, was used to direct and facilitate the risk assessment. James is an Applied Chemist with a background in water and wastewater, specialising in risk assessment. His formal qualifications, relevant to this task, are as follows:

- BSc (Hons) Applied Chemistry
- MSc (Hons) Environmental Management
- RABQSA - Lead Drinking Water QMS Auditor

Relevant experience prior to this risk assessment:

- water-quality risk assessments of 40 SEQ WTPs
- preparation of three drinking-water quality-management plans
- preparation of six HACCP plans for WTPs
- risk assessment and HACCP plan preparation for a wastewater catchment
- preparation of recycled water management plans for 4 WWTPs
- water-quality risk assessment for the SEQ Water Grid, bulk water transport
- water-quality risk assessment of a retail water business.

James had previously developed the methodology and developed a template for its application, to give the best outcome for the MICC and comply with the Act. James collated existing information and populated a risk-assessment template. This was the starting point for the risk-assessment workshops, where expert opinion from the Risk-Assessment Team was used to review information and add detail.

A workshop for the risk assessment was held on the 2nd and 3rd of Feb 2012. Details of the workshop participants and the risk-assessment team are shown in Table 1 (below). Following completion of the draft risk assessment, additional stakeholders were invited to review the risk assessment and supply comment before finalisation.

This is a multiple-provider scheme: the Mount Isa Water Board (MIWB) supplies treated water in bulk to MICC. MIWB is classified as a *Large Water Service Provider* and was required to have its DWQMP approved by 1 July 2011. Therefore, a comprehensive assessment of the water quality leaving MIWB, to supply MICC, has been undertaken and was available for this risk assessment. For this reason, a representative from the MIWB was requested to be present at the MICC risk assessment.

Under the Gulf Resource Operations Plan (Department of Environment and Resource Management 2010a), SunWater and Mount Isa Mines Limited are the holders of resource operations licences for Lake Julius and Lake Moondarra, respectively. MIWB is the Distribution Operations Licence holder for the schemes. As such, the transfer of risk is solely from MIWB.

Table 1. Risk Assessment Team

Name	Organisation	Position	Expertise	Reason for inclusion	Method of involvement	Contact Email
Mike Jones	MICC	Manager, Utility Services	20+ years at MICC	Manager of water services	DWQMP Manager	mikej@mountisa.qld.gov.au
Greg Hovi	MICC	Water and Sewerage Project Coordinator/ Plumbing Inspector	29 years at MICC	Extensive knowledge of both systems	Workshop	water@mountisa.qld.gov.au
Shelly Sharma	MICC	Planning Engineer	Water quality	Water quality reports	Workshop	devteng@mountisa.qld.gov.au
Ash Cook	MICC	Team Leader	Operations	Operations knowledge	Workshop and implementation	ashleyc@mountisa.qld.gov.au
Greg Stevens	MIWB	Engineer Manager	20 years	Manager of the water system	Workshop	gstevens@mountisawater.qld.gov.au
Geraldine Hollyman	MICC	Cadet GIS/Asset Management Officer	3 years at MICC	Assets and GIS	Information requests	geraldineh@mountisa.qld.gov.au
James Howey	Viridis Consultants P/L	Director	Lead Drinking Water QMS Auditor	Workshop Facilitator and Water Quality expert	Workshop	james.howey@viridis.net.au
Belinda Crisp	Viridis Consultants P/L	Technical Officer	2 years DWQMPs	Preparation of DWQMP	Workshop	belinda.crisp@viridis.net.au

3 PROCESS

3.1 METHODOLOGY

The methodology used for the risk assessment is described in the DWQMP. This report includes a definition of the likelihood, consequence and risk level, an explanation of the acceptable risk level and the rationale for this selection.

The methodology is based on the premise that risk is defined as the likelihood of identified hazards causing harm in exposed populations in a specified timeframe, with consideration for the severity of the consequences (i.e. risk = likelihood x consequence) (NHMRC & NRMMC 2004).

3.2 INFORMATION USED TO INFORM THE RISK ASSESSMENT

Water-quality data analysis was undertaken for potable water monitoring and presented as charts to act as a reference throughout the risk-assessment workshop. This analysis provided information on:

- trends
- exceedences
- major variations
- abnormal results
- low number of results, or no results, for some relevant characteristics
- potential problems.

Water-quality data analysis is compiled in the Water Quality Report 2012.

A process flowchart and description is included in the DWQMP, Section 3. The workshop was also used to validate the process flowchart with operators of the system.

Anecdotal information was gathered during the workshop from managers, operators and stakeholders of the MICC water supply system.

3.3 UNDERTAKING THE RISK ASSESSMENT

The risk-assessment template was designed as a way to provide a structure for assessing the risk of hazards and hazardous events. There are three levels of risk, which are illustrated in Figure 1.

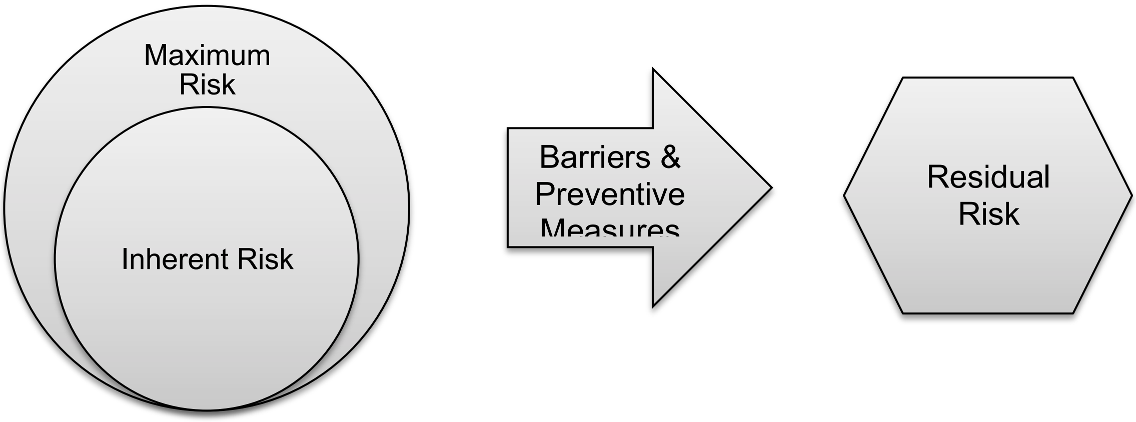


Figure 1 Risk Relationship

3.3.1 Inherent Risk

3.3.1.1 Mount Isa

For this scheme, the inherent risk is the risk in the water that is received by MICC from MIWB. The risk-assessment methodology used by the MICC and MIWB are identical; therefore, this allows for the transfer of risk directly from the MIWB risk assessment to MICC's.

The risk at the transfer point, MIWB to MICC, is the MIWB residual risk (risk passed to customer). The MIWB residual risk (in the source water received) was used as the inherent risk for the Mount Isa Scheme in this section as ,shown in Figure 2.

Inherent Risk *		
Hazard	Impact	Inherent Risk*
Biological		
Bacteria	H	High (12)
Cyanotoxins	H	Medium (6)
Opportunistic Pathogens (Naglaria & Legionella)	H	Medium (5)
Problem alga/ bacteria/ macrophytes	A	Low (1)
Protozoa	H	High (12)
Viruses	H	Medium (8)

Residual Risk from MIWB risk assessment

Figure 2 Inherent Risk Input for Mount Isa

3.3.1.2 Camooweal

For this scheme, the inherent risk is the risk in the water that is drawn from the bores. The inherent risk was calculated by the Risk-Assessment Team based on water-quality data relating to the bore water and details of the catchment and infrastructure.

Inherent Risk						
Hazard	Impact	Source	Consequence	Likelihood	Risk	Notes
Biological						
Bacteria	H	Cattle grazing; Sewerage Treatment Plant; Rubbish tip.	Major	Possible	**High (12)**	There were three high FCC recordings in Jan/Feb 2011. There is evidence of surface water impacts on the aquifer.
Cyanotoxins	H	None	Insignificant	Rare	**Low (1)**	Not an issue for ground water.
Opportunistic Pathogens (Naglaria & Legionella)	H	Environmental	Insignificant	Rare	**Low (1)**	Not considered to be an issue
Problem alga/ bacteria/ macrophytes	A	None	Insignificant	Rare	**Low (1)**	No history of iron bacteria.
Protozoa	H	Cattle grazing; Sewerage Treatment Plant.	Major	Rare	**Medium (5)**	Surface water influence on the aquifer - it is unknown whether the geology would act as a barrier for protozoa.

Figure 3 Inherent Risk Calculation for Camooweal

The inherent risk for Camooweal was calculated for each hazard, which are each located in the left-most column in Figure 3. For each of the hazards, potential sources were then identified. Based on the information gathered, consequence and likelihood were determined, and a risk score was calculated using the risk matrix. Notes in relation to this risk assessment were also taken.

3.3.2 Maximum Risk

Maximum risk is defined in the Queensland *Drinking Water Quality Management Plan Guideline* (Department of Environemnt and Resource Management 2010b) as the risk assuming no preventive measures are in place.

To assess maximum risk, additional sources of each hazard were identified across the scheme, in addition to those contributing to the inherent risk, e.g. the maintenance or scouring of a reservoir. Based on the additional sources, it was determined if this affected the consequence and likelihood for a particular hazard. The risk either passed through or was adjusted, based on the additional sources.

At this stage, the uncertainty of the risk assessment was determined for the inherent and maximum risk using the risk methodology.

Figure 4 illustrates how risk was transferred from inherent to maximum.

Inherent Risk *			Maximum Risk					
Hazard	**Impact**	**Inherent Risk***	**Source**	**Notes**	**Consequence**	**Likelihood**	**Risk**	**Uncertainty**
Biological								
Bacteria	H	High (12)	Back flow; Ingress through reservoir roof or low pressure zone or air valves in mains; Main breaks; Maintenance; Cross contamination; Willful contamination; Change of flow in a main or scouring a reservoir.	There has been some detections of E. coli, TC and HPC in the system. Build up of sediment or biofilm in the mains, can be dislodged from a change in flow releasing bacteria. Possible ingress through air valve pits and main breaks, especially if it is adjactent to a sewer main.	Major	Likely	High (16)	Confident
Cyanotoxins	H	Medium (6)	None	All of the MICC system is sealed and covered.	Moderate	Unlikely	Medium (6)	Confident
Opportunistic Pathogens (Naglaria & Legionella)	H	Medium (5)	Back flow; Detention time.	Back flow from hot water units that aren't managed appropriately; Environmental contamination of reservoirs.	Major	Rare	Medium (5)	Reliable

Figure 4 Maximum Risk Calculation

Risk increased with additional sources

Risk passes through

3.3.3 Residual Risk

Residual risk was calculated in a two-step process. A worksheet was developed to assess the risk of hazardous events as follows:

- The first step was to list components of the scheme, followed by the identification of possible hazardous events that could impact drinking-water quality.
- Following the identification the hazardous events, potential hazards were identified with hazards being previously identified in the inherent and maximum risk assessments. One hazard was selected as being the "Limiting Hazard," or the hazard that carried the greatest risk.
- Preventive measures were identified for the hazardous event and any monitoring that may identify the event.
- Taking into consideration available information, such as historical performance and monitoring data, the residual risk was calculated using the risk methodology.
- Comments were captured.
- The level of uncertainty of the risk assessment was determined using the risk assessment methodology.

An illustration of the hazardous event worksheet is shown in Figure 5.

Component	Hazardous Event	Potential Hazard		Limiting Hazard/s	Maximum Risk	Preventive Measures	Monitoring	Residual Consequence	Residual Likelihood	Residual Risk	Comments	Level of Uncertainty
Reticulation	Ingress of non-potable water	Ingress of contaminants through: - Pipe joints; - Air valves; - Leaking valves and hydrants; - Aging infrastructure; Ingress caused by loss of pressure in mains during: - Pipe burst; - Pipe repairs; - Very high flows (e.g. firefighting)	Bacteria; Taste & odour; Colour; Turbidity; Protozoa; Viruses; Toxic metals; Hydrocarbons; Toxins.	Bacteria	High (12)	Chlorine residual Flushing program following mains repairs		Major	Unlikely	Medium (8)	Old cast iron system, new areas are PVC. When the header tank was inadvertently switched off it caused the pressure in the retic to increase and resulted in a number of main breaks. The valving has now been locked out to prevent this in future. Normally there are minimal main breaks in the Camooweal system.	Reliable
	Stagnation including dead ends	Stagnant water in pipelines caused by: - Dead ends. - Pipes low water demands or moth balling.	Bacteria; Iron; Manganese; Colour; Dissolved oxygen; Taste and odour; Turbidity.	Bacteria	High (12)	Flu week Positive pressure prevents things getting in.	Targeted monitoring of dead ends.	Major	Rare	Medium (5)	Austral and Nowrani Streets are dead ends.	Reliable
Whole of system	Willful contamination	Intake of contaminated water that potentially cannot be treated.	Toxins; Hydrocarbons; Bacteria; Protozoa; Viruses; T&O; Pesticides.	Toxins	Medium (6)	Remote location Security fence.	Routine monitoring	Catastrophic	Rare	Medium (6)	In the past there have been people enter the site however it was to turn off the chlorine.	Reliable
	Formation of DBPs	Organics in the water reacting with chlorine disinfectant to form DBPs.	DBPs	Disinfection by-products (e.g. THMs, NDMA & HAAs)	Low (2)	None	None	Minor	Rare	Low (2)	The water is bore water and the level of organics would be naturally low. Therefore, DBPs aren't considered to be an issue.	Reliable
	Incorrect valving	Operation of valve incorrectly, resulting in contamination of treated water.	Bacteria; Viruses.	Bacteria	High (12)	Tank valves are locked out	None	Major	Rare	Medium (5)	There is a bypass of the chlorination facility operated by a valve. Bore pumps are controlled on the header tank levels, levels are set at a point that provides adequate turnover so stagnation is not an issue in normal operation. However it is possible to isolate the tanks which would cause the water in the tanks to stagnate and may be delivered to town when reinstated.	Reliable

Preventive measures reduce potential risk from hazardous event. However, it is still higher than the acceptable level of risk.

No effect on risk

Limiting hazard maximum risk, calculated in Section 3.3.2

Figure 5 Hazardous Event Worksheet

The second step in the residual risk process was to assess the effectiveness of the barriers in the scheme. The scheme barriers were identified, and the hazards managed by each of the barriers were indicated. Residual risk was then assigned to each of the hazards in the scheme risk assessment, as follows:

- Each hazard was considered sequentially.
- The Hazardous Event workbook was reviewed to determine if an event resulted in the hazard of concern being a limiting hazard.
- Monitoring and operational data were taken into consideration for each hazard.
- Based on the information gathered, a residual risk score was assigned for each hazard.
- Comments were captured.

Figure 6 is a representation of the process that was undertaken to determine residual risk.

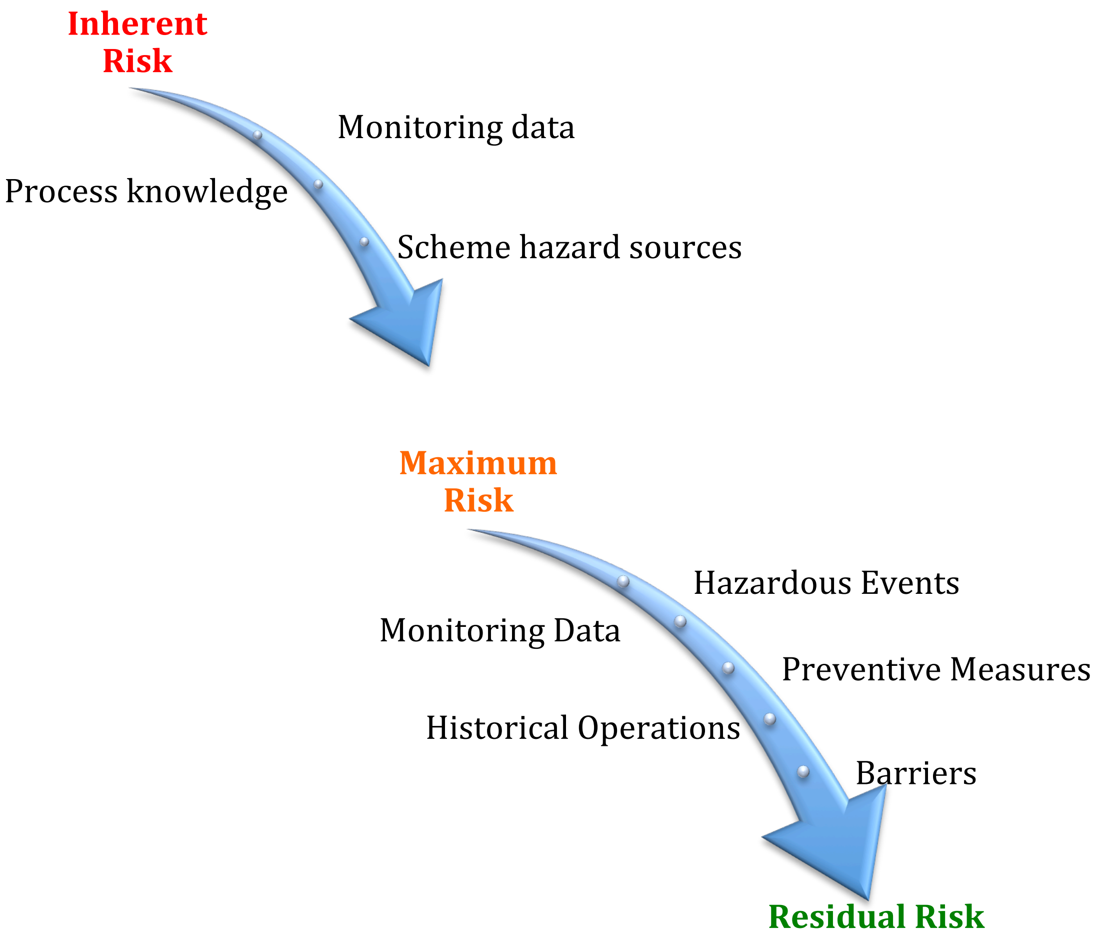
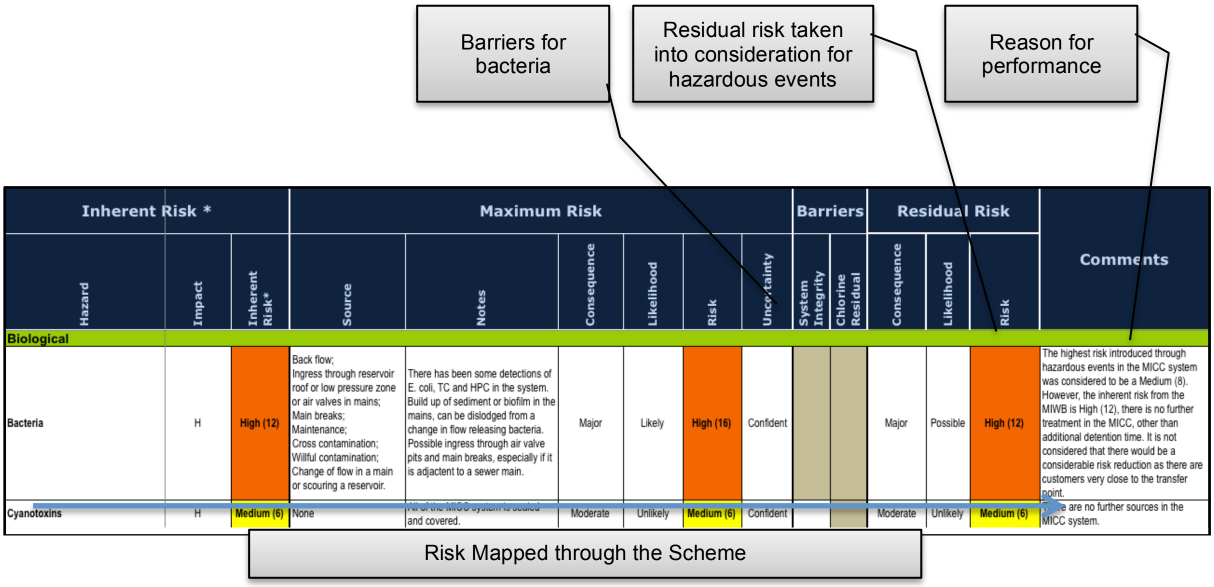


Figure 6 Residual Risk Process

Figure 7 illustrates the scheme risk assessment and how residual risk is calculated. The figure also illustrates how risk passes through the process, going from inherent to maximum to residual.

Unacceptable risks are addressed in the Improvement Plan 2012.



Inherent Risk *			Maximum Risk						Barriers		Residual Risk			Comments
Hazard	Impact	Inherent Risk*	Source	Notes	Consequence	Likelihood	Risk	Uncertainty	System Integrity	Chlorine Residual	Consequence	Likelihood	Risk	
Biological														
Bacteria	H	High (12)	Back flow; Ingress through reservoir roof or low pressure zone or air valves in mains; Main breaks; Maintenance; Cross contamination; Willful contamination; Change of flow in a main or scouring a reservoir.	There has been some detections of E. coli, TC and HPC in the system. Build up of sediment or biofilm in the mains, can be dislodged from a change in flow releasing bacteria. Possible ingress through air valve pits and main breaks, especially if it is adjactent to a sewer main.	Major	Likely	High (16)	Confident			Major	Possible	High (12)	The highest risk introduced through hazardous events in the MICC system was considered to be a Medium (8). However, the inherent risk from the MIWB is High (12), there is no further treatment in the MICC, other than additional detention time. It is not considered that there would be a considerable risk reduction as there are customers very close to the transfer point.
Cyanotoxins	H	Medium (6)	None	and covered.	Moderate	Unlikely	Medium (6)	Confident			Moderate	Unlikely	Medium (6)	are no further sources in the MICC system.

Figure 7 Residual Risk Calculation

4 INHERENT AND MAXIMUM RISKS

Inherent Risk is the level of risk in the raw water without treatment; i.e. if raw water was supplied to and drunk by consumers. This identifies the risk that is present and requires treatment by the process in place.

The QDWQMP describes maximum risk as risk without existing barriers in place; for example, treatment and/or disinfection. This is the maximum level of risk, and, in most instances, it is the same as the inherent risk. However, there are a number of parameters whereby the treatment process adds to the risk; these include such hazards as trihalomethanes and chlorine.

Inherent and Maximum risks are shown in Appendices A & B for Mount Isa and Camooweal, respectively.

4.1 MOUNT ISA

Significant inherent and maximum risks in the Mount Isa Scheme, as supplied by MIWB, are shown in Table 2.

Table 2. Significant Inherent Risks

Hazards	Inherent Risk	Maximum Risk	Uncertainty
Bacteria	High (12)	High (12)	Confident
Colour	Medium (9)	Medium (9)	Reliable
Disinfection By-Products	Medium (9)	High (12)	Estimate
Dissolved Oxygen	Medium (8)	Medium (8)	Reliable
Iron	Medium (9)	High (12)	Certain
Manganese	Medium (9)	High (12)	Confident
Protozoa	High (12)	High (12)	Uncertain
Turbidity	Medium (6)	Medium (9)	Confident
Viruses	Medium (8)	High (12)	Reliable

The main inherent risks in the water supplied by the MIWB are the pathogens, bacteria and protozoa. Both of these hazards have a high risk due to the lack of filtration on the supplied water. Protozoa is a potential issue due to such sources as the upstream wastewater treatment plant and cattle grazing in the catchment. Bacteria have been flagged due to moderate levels of turbidity at the point of disinfection. Issues identified by the MIWB are being addressed by their DWQMP Improvement Plan.

There are a number of hazards that have a higher Maximum Risk than Inherent Risk, due to additional hazard sources in the MICC system. These hazards and the additional sources were:

- disinfection by-products: sodium hypochloride addition; detention/reaction time; ingress of non-potable water containing DBP precursors
- iron: main breaks; maintenance; changes in flow-disturbing sediment
- manganese: main breaks; maintenance; changes in flow-disturbing sediment
- turbidity: main breaks; maintenance; change of flow in a main or scouring a reservoir
- viruses: maintenance, wilful contamination; mains breaks.

4.2 CAMOOWEAL

Significant inherent risks in the Camooweal Scheme are shown in Table 3

Table 3 Significant Inherent Risks – Camooweal Bores

Hazards	Inherent Risk	Maximum Risk	Uncertainty
Bacteria	High (12)	High (12)	Certain
Hardness	High (10)	High (10)	Reliable
Protozoa	Medium (5)	High (8)	Estimate
Viruses	Medium (5)	Medium (8)	Estimate

The Camooweal source water is groundwater bores, which have relatively good-quality water, in comparison to Mount Isa. The inherent risks are bacteria and hardness. Hardness is due to the natural geology. Due to the activities in the catchment, it is a possibility that the bores could be contaminated with bacteria from cattle grazing, the sewage treatment plant, the local tip or illegal dumping at Niggle Cave and Tar Drum Sink (Eberhard 2003).

There is an elevated Maximum Risk from protozoa and viruses as a result of potential contamination of the bores with surface water.

5 RESIDUAL RISK

The QDWQMP describes residual risk as the risk with existing barriers in place. Results of the residual risk assessment are used to prioritise resources to meet the desired level of service.

5.1 MOUNT ISA

The residual risk assessment is shown in Appendix A. Hazards that are not managed adequately and for which the risk remains above the acceptable risk threshold of Medium (6) are shown in **Table 4**. Hazardous events have been considered in the assessment of residual risk. The worksheet used to assess the impact of hazardous events is shown in Appendix C.

Table 4 Summary of Mount Isa Significant Residual Risks

Hazards	Residual Risk	Comment
Bacteria	High (12)	The highest risk introduced through hazardous events in the MICC system was considered to be a Medium (8). However, the inherent risk from the MIWB is High (12). There is no further treatment in the MICC, other than additional detention time. It is not considered that there would be a considerable risk reduction as there are customers quite close to the transfer point.
Protozoa	High (12)	There were two hazardous events in which protozoa were considered to be the limiting hazard. These were both training and resourcing issues. Hygiene practises require further proceduralisation, and it is difficult to recruit and keep skilled personnel.
Viruses	Medium (8)	Based on the barriers in place, it is not considered that the risk would be significantly greater than the inherent risk.
Disinfection By-Products	High (12)	DBP forms over a period of time in the presence of chlorine and organic material. The water in this system is susceptible to DBPs as it is unfiltered, and dissolved and suspended organics are not removed. DBPs have exceeded the ADWG limit at the MIWB's MITR Reservoir. These chemicals will continue to form in the MICC system, and it is likely that the ADWG limit will be exceeded more frequently.
Iron	Medium (9)	Known to have high levels of iron and manganese, although there is no data. There is anecdotal evidence that water from a dirty-water event was tested and revealed high levels of iron and manganese.
Manganese	Medium (9)	Known to have high levels of iron and manganese, although there is no data. There is anecdotal evidence that water from a dirty-water event was tested and revealed high levels of iron and manganese.
Colour	Medium (9)	High flow or changes in flow rate or direction in pipelines, disturbance of sediments in reservoirs and main breaks would impact this hazard, although colour was not the limiting hazard.
Dissolved Oxygen	Medium (8)	The sources in the MICC system are not considered major. The water from MIWB can be lower than the aesthetic limit, and it is not considered that significant aeration would occur.
Turbidity	Medium (8)	High flow, or changes in flow rate or direction in pipelines, disturbance of sediments in reservoirs, and main breaks, would impact this hazard, although turbidity was not the limiting hazard. In this instance, it is considered that the residual risk would not be reduced until these hazardous events are all managed effectively.

There are three hazards with a residual risk classified as High:

- bacteria;
- protozoa;
- disinfection by-products

5.2 CAMOOWEAL

The residual risk assessment is shown in Appendix B. Those hazards that are not managed adequately with a risk above the acceptable risk threshold of Medium (6) are shown in **Table 5**. Hazardous events have been considered in the assessment of residual risk. The worksheet used to assess the impact of hazardous events is shown in Appendix D.

Table 5. Summary of Camooweal Significant Risks

Hazards	Residual Risk	Comment
Bacteria	Medium (8)	Insufficient contact time was considered a potential issue. In high-demand periods, water bypasses the reservoir, and the first connection is not far from the WTP.
Protozoa	Medium (8)	Protozoa has been identified as an issue through maintenance practices and a lack of resources and surface infiltration.
Hardness	High (10)	Not considered an issue.

Hardness is the only High risk hazard, which has been accepted at this level as it is an aesthetic parameter.

6 DISCUSSION

The risk assessment process that has been adopted allows the risk for each hazard to be tracked through the treatment process. This has been visualised for Mount Isa and Camooweal in Figure 8 and Figure 9, respectively.

Figure 8 High Risks in the Mount Isa System

The first principle of the ADWG is: ***The greatest risks to consumers of drinking water are pathogenic microorganisms****. Protection of water sources and treatment are of paramount importance and must never be compromised.*

Water supplied to the MICC inherently contains a high risk of bacteria and protozoa. These hazards are not reduced any further in the MICC system. The MIWB is addressing these risks in its DWQMP Improvement Plan. The MICC will liaise with the MIWB to address these risks.

A hazard that increases in the MICC system to a High level is disinfection by-products (DBPs). These are formed when chlorine reacts with organic chemical precursors. Over time, DBPs increase in the water supply system, and the highest levels are often detected at the extremities of the supply. In reference to Principle 1 of the ADWG, disinfection must not be compromised for the management of DBPs.

Of the DBPs, trihalomethanes (THMs) are the group of chemicals that are considered to have the greatest risk. Additional monitoring of THMs will be required to assess and successfully manage this issue. MICC will again have to work with the MIWB to reduce this hazard. The most effective treatment is the removal of precursors prior to disinfection.

Figure 9 High Risks in the Camooweal System

The inherent risk in the Camooweal system is relatively low. The only hazard with High Residual Risk is hardness. The level of hardness in the water may cause excessive scaling on equipment with a heating element, such as kettles, irons and water heaters. However, this is considered to be an aesthetic hazard and has been accepted at this level; further treatment would not be cost-effective.

Bacteria and protozoa do have unacceptable risks potentially due to maintenance activities and a low contact time following chlorination. These issues will be addressed as a priority in this system.

An issue that affects both Mount Isa and Camooweal is the difficulty in recruiting and maintaining suitably qualified staff. Council must compete with the mines for staff and cannot match salary packages that are on offer. It is an ongoing issue that may not be resolved.

7 REFERENCES

Department of Environment and Resource Management 2010a. *Gulf Resource Operations Plan*, Queensland Government, Australia.

Department of Environment and Resource Management 2010b, *Drinking Water Quality Management Plan Guideline,* Urban Water Policy and Management, Queensland Government.

Eberhard, S. 2003, Nowranie Caves and the Camooweal Karst Area, Queensland: Hydrology, Geomorphology and Speleogenesis, with Notes on Aquatic Biota, *Helictite*, Vol.38, No.2, Pp 27-38

National Health & Medical Research Council and Natural Resource Management Ministerial Council. 2004. *National Water Quality Management Strategy: Australian Drinking Water Guidelines*. 6th Ed. Australia: NHMRC.

United States Environmental Protection Agency 2004, Comprehensive Surface Water Treatment Rules Quick Reference Guide: Unfiltered Systems, Office of Water.

Fayer, R. 2004. Review: Cryptosporidium: a water-borne zoonotic parasite, United States Department of Agriculture, Agricultural Research Service, Beltsville, USA.

8 GLOSSARY

ADWG	Australian Drinking Water Guidelines, published by the National Health and Medical Research Council (NHMRC).
Catchment	Area of land that collects rainfall and contributes to surface water (streams, rivers, wetlands) or to groundwater.
Critical control point	A point, step or procedure at which control can be applied and which is essential to prevent or eliminate a hazard or reduce it to an acceptable level.
Disinfection	The process designed to kill most microorganisms in water, including essentially all pathogenic (disease-causing) bacteria. There are several ways to disinfect, with chlorine being most frequently used in water treatment.
DWQMP	Drinking Water Quality Management Plan
E. Coli	Bacterium found in the gut; used as an indicator of faecal contamination of water.
Hazard	A biological, chemical, physical or radiological agent that has the potential to cause harm.
Hazardous event	An incident or situation that can lead to the presence of a hazard (what can happen and how).
HPC	Heterotrophic plate count: the number of colonies of heterotrophic bacteria grown on selected solid media at a given temperature and incubation period, usually expressed in number of bacteria per millilitre of sample.
Inherent risk	The risk in the source water without treatment barriers in place.
Maximum risk	Risk without existing barriers in place; for example, treatment and/or disinfection. This is the maximum level of risk and, in most cases, it is the same as the inherent risk. However, there are a number of parameters whereby the treatment process adds to the risk; these include such hazards as trihalomethanes and chlorine. Therefore, maximum risk is the total of the inherent risk plus the additional risks added during treatment.
Preventive measure	Any planned action, activity or process that is used to prevent hazards from occurring, or reduce them to acceptable levels.
Residual risk	The risk remaining after consideration of existing preventive measures.
Risk	The likelihood of a hazard causing harm in exposed populations in a specified time frame, including the magnitude of that harm.
SCADA	Supervisory Control and Data Acquisition
SLA	Service Level Agreement
Source water	Water in its natural state, before it is treated to make it suitable to drink.

APPENDIX A

MOUNT ISA SCHEME RISK ASSESSMENT

Mount Isa Scheme Risk

Inherent Risk *			Maximum Risk						Barriers		Residual Risk			Comments
Hazard	Impact	Inherent Risk*	Source	Notes	Consequence	Likelihood	Risk	Uncertainty	System Integrity	Chlorine Residual	Consequence	Likelihood	Risk	
Biological														
Bacteria	H	High (12)	Back flow; Ingress through reservoir roof or low-pressure zone or air valves in mains; Main breaks; Maintenance; Cross contamination; Wilful contamination; Change of flow in a main or scouring a reservoir.	There has been some detections of E. coli, TC and HPC in the system. Builds up of sediment or biofilm in the mains, can be dislodged from a change in flow-releasing bacteria. Possible ingress through air valve pits and main breaks, especially if it is adjacent to a sewer main.	Major	Likely	High (16)	Confident			Major	Possible	High (12)	The highest risk introduced through hazardous events in the MICC system was considered to be a Medium (8). However, the inherent risk from the MIWB is High (12), there is no further treatment in the MICC, other than additional detention time. It is not considered that there would be a considerable risk reduction as there are customers very close to the transfer point.
Cyanotoxins	H	Medium (6)	None	All of the MICC system is sealed and covered.	Moderate	Unlikely	Medium (6)	Confident			Moderate	Unlikely	Medium (6)	There are no further sources in the MICC system.
Opportunistic Pathogens (Naglaria & Legionella)	H	Medium (5)	Back flow; Detention time.	Back flow from hot-water units that aren't managed appropriately; Environmental contamination of reservoirs.	Major	Rare	Medium (5)	Reliable			Major	Rare	Medium (5)	There could be some potential for growth in the network. However, considering the reasonably low levels of environmental bacteria, pathogens monitored in the system it is not considered to be an issue at this time.
Problem alga/ bacteria/ macrophytes	A	Low (1)	None	All of the MICC system is sealed and covered.	Insignificant	Rare	Low (1)	Confident			Insignificant	Rare	Low (1)	There are no further sources in the MICC system.
Protozoa	H	High (12)	Maintenance; Wilful contamination; Ingress through reservoir roof or low-pressure zone or air valves in mains; Main breaks.	Vandalism and unauthorised access to reservoirs; Contamination of tools; Possible ingress through air valve pits and main breaks, especially if it is adjacent to a sewer main.	Major	Possible	High (12)	Reliable			Major	Possible	High (12)	There are two hazardous events where protozoa were considered to be the limiting hazard. There were both training and resourcing issues. Hygiene practices require further proceduralisation, and it is difficult to recruit and keep skilled personnel.
Viruses	H	Medium (8)	Maintenance; Wilful contamination; Main breaks.	Vandalism and unauthorised access to reservoirs; Possible ingress through air valve pits and main breaks, especially if it is adjacent to a sewer main. Contamination of tools.	Major	Possible	High (12)	Reliable			Major	Unlikely	Medium (8)	Based on the barriers in place it is not considered that the risk would be significantly greater than the inherent risk.
Chemical														
Aluminium	H	Low (4)	None	No sources in the MICC system.	Minor	Unlikely	Low (4)	Confident			Minor	Unlikely	Low (4)	No sources in the MICC system, therefore, MIWB risk follows through.
Arsenic	H	Low (4)	Mains break.	Naturally occurring in the geology.	Minor	Unlikely	Low (4)	Reliable			Minor	Unlikely	Low (4)	The mineralised arsenic is mainly insoluble. Therefore, it is not considered to be an issue.

Inherent Risk *			Maximum Risk						Barriers		Residual Risk			Comments
Hazard	Impact	Inherent Risk*	Source	Notes	Consequence	Likelihood	Risk	Uncertainty	System Integrity	Chlorine Residual	Consequence	Likelihood	Risk	
Chlorine	H	Low (2)	Chemical addition	Manual addition of chlorine to reservoirs.	Minor	Possible	Medium (6)	Estimate			Minor	Possible	Medium (6)	Shock dosing of reservoirs is a preventative measure for unacceptable levels of bacteria. Anecdotal evidence suggests that this practise is not managed well, and there is the possibility of an overdose.
Disinfection by-products (e.g.. THMs, NDMA & HAAs)	H	Medium (9)	Chemical addition; Detention time; Ingress of non-potable water (organic matter).	Chlorine is shock dosed if there are high bacteriological counts.	Moderate	Likely	High (12)	Uncertain			Moderate	Likely	High (12)	DBP form over a period of time in the presence of chlorine and organic material. The water in this system is susceptible for DBPs, as it is unfiltered and dissolved, and suspended organics are not removed. DBPs have exceeded the ADWG limit at MIWB's MITR Reservoir. These chemicals will continue to form in the MICC system, and it is likely that the ADWG limit will be exceeded more frequently.
Fluoride	H	Low (1)	None	Not added yet.	Insignificant	Rare	Low (1)	Confident			Insignificant	Rare	Low (1)	Fluoride is to be dosed by December 2012.
Cadmium	H	Low (2)	None	No sources in the MICC system.	Minor	Rare	Low (2)	Confident			Minor	Rare	Low (2)	No sources in the MICC system, therefore, MIWB risk follows through.
Zinc	A	Low (2)	Mains break	Naturally occurring in the geology.	Minor	Rare	Low (2)	Confident			Minor	Rare	Low (2)	At considered at risk at the aesthetic limit.
Nickel	H	Low (2)	None		Minor	Rare	Low (2)	Confident			Minor	Rare	Low (2)	No sources in the MICC system, therefore, MIWB risk follows through.
Copper	H	Low (2)	Mains break	Naturally occurring in the geology.	Minor	Rare	Low (2)	Confident			Minor	Rare	Low (2)	At considered at risk.
Lead	H	Low (4)	Mains break	Naturally occurring in the geology.	Minor	Unlikely	Low (4)	Confident			Minor	Unlikely	Low (4)	The lead mineral in Mount Isa is galena (lead (II) sulphide). This mineral is slightly soluble in soft slightly acidic water. It is practically insoluble in alkaline conditions.
Mercury	H	Low (4)	None	No sources in the MICC system.	Minor	Unlikely	Low (4)	Confident			Minor	Unlikely	Low (4)	No sources in the MICC system, therefore, MIWB risk follows through.
Hydrocarbons	H	Low (2)	Back flow; Incorrect materials	It is possible that hydrocarbons could leach out of materials used in the water system, if not correctly selected. Backflow from a third party is possible but unlikely, due to the nature of the system.	Minor	Rare	Low (2)	Confident			Minor	Rare	Low (2)	Sources in the MICC are not considered to be significant and would not increase the risk.
Hydrogen sulphide/sulphide	A/H	Low (1)	None	No sources in the MICC system.	Insignificant	Rare	Low (1)	Confident			Insignificant	Rare	Low (1)	No sources in the MICC system, therefore, MIWB risk follows through.
Iron	A	Medium (9)	Main breaks; Maintenance; Changes in flow.	Builds up in the mains, can be dislodged from change in flow. Iron levels in the water levels are moderately high due to the lack of a chemical coagulation process.	Moderate	Likely	High (12)	Estimate			Moderate	Possible	Medium (9)	Known to be high levels of iron and manganese, although there is no data. There is anecdotal evidence that water from a dirty-water event was tested and revealed high levels of iron and manganese.

Inherent Risk *			Maximum Risk						Barriers		Residual Risk			Comments
Hazard	Impact	Inherent Risk*	Source	Notes	Consequence	Likelihood	Risk	Uncertainty	System Integrity	Chlorine Residual	Consequence	Likelihood	Risk	
Manganese	A/H	Medium (9)	Main breaks; Maintenance; Changes in flow	Builds up in the mains, can be dislodged from change in flow.	Moderate	Likely	High (12)	Estimate			Moderate	Possible	Medium (9)	Known to be high levels of iron and manganese, although there is no data. There is anecdotal evidence that water from a dirty-water event was tested and revealed high levels of iron and manganese.
Nitrate & nitrite	H	Low (1)	None	No sources in the MICC system.	Insignificant	Rare	Low (1)	Confident			Insignificant	Rare	Low (1)	No sources in the MICC system, therefore, MIWB risk follows through.
Pesticides	H	Low (2)	Backflow	Household and farm spraying.	Minor	Rare	Low (2)	Confident			Minor	Rare	Low (2)	It is not considered that the sources identified would alter the risk.
Pharmaceuticals and EDCs	H	Low (1)	None	No sources in the MICC system.	Insignificant	Rare	Low (1)	Confident			Insignificant	Rare	Low (1)	No sources in the MICC system, therefore, MIWB risk follows through.
Sodium	A	Low (1)	None	No sources in the MICC system.	Insignificant	Rare	Low (1)	Confident			Insignificant	Rare	Low (1)	No sources in the MICC system, therefore, MIWB risk follows through.
Sulphate	H	Low (1)	None	No sources in the MICC system.	Insignificant	Rare	Low (1)	Confident			Insignificant	Rare	Low (1)	No sources in the MICC system, therefore, MIWB risk follows through.
Toxins	H	Medium (6)	Wilful contamination	Intentional contamination of the water supply.	Catastrophic	Rare	Medium (6)	Uncertain			Catastrophic	Rare	Medium (6)	This hazard covers a worst case scenario.
Physical														
Colour	A	Medium (9)	Main breaks; Maintenances; Change of flow in a main or scouring a reservoir.	Builds up in the mains, can be dislodged from change in flow. Scouring in reservoirs could occur if water is dropped down too fast during maintenance.	Moderate	Possible	Medium (9)	Reliable			Moderate	Possible	Medium (9)	High flow or changes in flow rate or direction in pipelines, disturbance of sediments in reservoirs and main breaks would impact this hazard, although colour was not the limiting hazard.
DO	A	Medium (8)	Main breaks; Maintenances; Change of flow in a main or scouring a reservoir.	Scouring in reservoirs could occur if water is dropped down too fast during maintenance. This suspension would consume available DO.	Minor	Likely	Medium (8)	Reliable			Minor	Likely	Medium (8)	The sources in the MICC system are not considered major. The water from MIWB can be lower than the aesthetic limit, and it is not considered that significant aeration would occur.
Hardness	Business Risk	Low (1)	None	No sources in the MICC system.	Insignificant	Rare	Low (1)	Confident			Insignificant	Rare	Low (1)	No sources in the MICC system, therefore, MIWB risk follows through.
pH	A/H	Medium (6)	None	No sources in the MICC system.	Minor	Possible	Medium (6)	Confident			Minor	Possible	Medium (6)	No sources in the MICC system, therefore, MIWB risk follows through.
Radiological	H	Low (1)	None	No sources in the MICC system.	Insignificant	Rare	Low (1)	Confident			Insignificant	Rare	Low (1)	No sources in the MICC system, therefore, MIWB risk follows through.
Reduced output volume	-	Low (2)	Mains break	If not attended to, it could lead to a loss of supply.	Minor	Possible	Medium (6)	Reliable			Minor	Rare	Low (2)	There are more than 24 hours' storage in the distribution.
Taste and odour	A	Low (2)	Overdosing of chlorine; Detention time.	Council manages all water quality complaints, which may account for T&O changes between the MIWB and MICC.	Minor	Possible	Medium (6)	Reliable			Minor	Possible	Medium (6)	Issues, such as aging water in dead-ends and overdosing chlorine, could lead to taste and odour issues.
Total dissolved solids		Low (3)	None	No sources in the MICC system.	Moderate	Rare	Low (3)	Confident			Minor	Rare	Low (2)	No sources in the MICC system, therefore, MIWB risk follows through.

Inherent Risk *			Maximum Risk						Barriers		Residual Risk			Comments
Hazard	Impact	Inherent Risk*	Source	Notes	Consequence	Likelihood	Risk	Uncertainty	System Integrity	Chlorine Residual	Consequence	Likelihood	Risk	
Turbidity	A	**Medium (6)**	Main breaks; Maintenances; Change of flow in a main or scouring a reservoir.	Builds up in the mains, can be dislodged from change in flow. Scouring in reservoirs could occur if water is dropped down too fast during maintenance.	Moderate	Possible	**Medium (9)**	Confident			Moderate	Possible	**Medium (9)**	High flow or changes in flow rate or direction in pipelines, disturbance of sediments in reservoirs and main breaks would impact this hazard, although turbidity was not the limiting hazard. In this instance it is considered that the residual risk would not be reduced until these hazardous events are all managed effectively.

If a hazard is not covered in the residual risk worksheet, the risk is passed through from the previous scheme element.
* Inherent risk supplied from the MIWB water quality risk assessment

APPENDIX B

CAMOOWEAL SCHEME RISK ASSESSMENT

Camooweal Scheme Risk

Inherent Risk							Maximum Risk					Barriers		Residual Risk			Comments
Hazard	Impact	Source	Consequence	Likelihood	Risk	Notes	Additional sources in treatment and distribution	Consequence	Likelihood	Risk	Uncertainty	System Integrity	Chlorine Residual	Consequence	Likelihood	Risk	
Biological																	
Bacteria	H	Cattle grazing; Sewerage Treatment Plant; Rubbish tip; Illegal tipping	Major	Possible	High (12)	There were three high FCC recordings in Jan./Feb. 2011. There is evidence of surface water impacts on the aquifer.	Back flow; Ingress through reservoir roof or low-pressure zone; Main breaks; Maintenance; Cross contamination; Wilful contamination; Change of flow in a main or scouring a reservoir.	Major	Possible	High (12)	Reliable			Major	Unlikely	Medium (8)	Insufficient Ct was considered a potential issue. In high-demand periods, water bypasses the reservoir, and the first connection is not far from the WTP.
Cyanotoxins	H	None	Insignificant	Rare	Low (1)	Not an issue for groundwater.	None	Insignificant	Rare	Low (1)	Certain			Insignificant	Rare	Low (1)	Not considered an issue.
Opportunistic Pathogens (Naglaria & Legionella)	H	Environmental Illegal tipping	Insignificant	Rare	Low (1)	Not considered to be an issue.	Back flow; Detention time.	Major	Rare	Medium (5)	Confident			Insignificant	Rare	Low (1)	Not considered an issue.
Problem alga/ bacteria/ macrophytes	A	None	Insignificant	Rare	Low (1)	No history of iron bacteria.	None	Insignificant	Rare	Low (1)	Certain			Insignificant	Rare	Low (1)	Not considered an issue.
Protozoa	H	Cattle grazing; Sewerage Treatment Plant Illegal tipping	Major	Rare	Medium (5)	Surface water influence on the aquifer; it is unknown whether the geology would act as a barrier for protozoa.	Maintenance; Wilful contamination; Ingress through reservoir roof or low pressure zone or air valves in mains; Main breaks.	Major	Unlikely	Medium (8)	Estimate			Major	Unlikely	Medium (8)	Protozoa has been identified as an issue through maintenance practices and a lack of resources and surface water infiltration.
Viruses	H	Sewerage Treatment Plant; Illegal tipping	Major	Rare	Medium (5)	Surface water influence on the aquifer; it is unknown whether the geology would act as a barrier for viruses.	Maintenance; Wilful contamination; Main breaks.	Major	Unlikely	Medium (8)	Estimate			Major	Rare	Medium (5)	Not considered an issue.
Chemical																	
Aluminium	H	None	Insignificant	Rare	Low (1)	No sources in the catchment.	None	Insignificant	Rare	Low (1)	Reliable			Insignificant	Rare	Low (1)	Not considered an issue.
Arsenic	H	None	Insignificant	Rare	Low (1)	No sources in the catchment.	None	Insignificant	Rare	Low (1)	Reliable			Insignificant	Rare	Low (1)	Not considered an issue.
Chlorine	H	None	Insignificant	Rare	Low (1)	No sources in the catchment.	Chemical addition	Minor	Rare	Low (2)	Reliable			Minor	Unlikely	Low (4)	Not considered an issue.
Disinfection by-products (e.g.. THMs, NDMA & HAAs)	H	None	Insignificant	Rare	Low (1)	No sources in the catchment.	Chemical addition; Detention time; Ingress of non-potable water (organic matter).	Minor	Rare	Low (2)	Reliable			Minor	Rare	Low (2)	Not considered an issue.
Fluoride	H	None	Insignificant	Rare	Low (1)	1987: 0.1 mg/L 1985: 0.1 mg/L	None	Insignificant	Rare	Low (1)	Reliable			Insignificant	Rare	Low (1)	Not considered an issue.
Cadmium	H	None	Insignificant	Rare	Low (1)	No sources in the catchment.	None	Insignificant	Rare	Low (1)	Reliable			Insignificant	Rare	Low (1)	Not considered an issue.
Zinc	H	None	Insignificant	Rare	Low (1)	No sources in the catchment.	None	Insignificant	Rare	Low (1)	Reliable			Insignificant	Rare	Low (1)	Not considered an issue.
Nickel	H	None	Insignificant	Rare	Low (1)	No sources in the catchment.	None	Insignificant	Rare	Low (1)	Reliable			Insignificant	Rare	Low (1)	Not considered an issue.
Copper	H	None	Insignificant	Rare	Low (1)	No sources in the catchment.	None	Insignificant	Rare	Low (1)	Reliable			Insignificant	Rare	Low (1)	Not considered an issue.
Lead	H	None	Insignificant	Rare	Low (1)	No sources in the catchment.	None	Insignificant	Rare	Low (1)	Reliable			Insignificant	Rare	Low (1)	Not considered an issue.
Mercury	H	None	Insignificant	Rare	Low (1)	No sources in the catchment.	None	Insignificant	Rare	Low (1)	Reliable			Insignificant	Rare	Low (1)	Not considered an issue.
Hydrocarbons	H	3 Service stations Illegal tipping	Insignificant	Rare	Low (1)	Service stations have underground tank.	Back flow; Incorrect materials.	Insignificant	Rare	Low (1)	Reliable			Insignificant	Rare	Low (1)	Not considered an issue.
Hydrogen sulphide/ sulphide	A/H	None	Insignificant	Rare	Low (1)	Not considered to be an issue; water does not have any unpleasant odour.	None	Insignificant	Rare	Low (1)	Reliable			Insignificant	Rare	Low (1)	Not considered an issue.

Inherent Risk							Maximum Risk					Barriers		Residual Risk			Comments
Hazard	Impact	Source	Consequence	Likelihood	Risk	Notes	Additional sources in treatment and distribution	Consequence	Likelihood	Risk	Uncertainty	System Integrity	Chlorine Residual	Consequence	Likelihood	Risk	
Iron	A	Natural geology	Insignificant	Rare	Low (1)	In 1987 iron was 0.02 mg/L and in 1985 it was 0.04 mg/L.	Main breaks	Insignificant	Rare	Low (1)	Reliable			Insignificant	Rare	Low (1)	Not considered an issue.
Manganese	A/H	Natural geology	Insignificant	Rare	Low (1)	Non-detected	None	Insignificant	Rare	Low (1)	Reliable			Insignificant	Rare	Low (1)	Not considered an issue.
Nitrate & nitrite	H	None	Insignificant	Rare	Low (1)	No sources in the catchment.	None	Insignificant	Rare	Low (1)	Reliable			Insignificant	Rare	Low (1)	Not considered an issue.
Pesticides (all types)	H	Illegal tipping	Insignificant	Rare	Low (1)	No sources in the catchment.	Back flow	Insignificant	Rare	Low (1)	Reliable			Insignificant	Rare	Low (1)	Not considered an issue.
Pharmaceuticals and EDCs	H	None	Insignificant	Rare	Low (1)	No sources in the catchment.	None	Insignificant	Rare	Low (1)	Reliable			Insignificant	Rare	Low (1)	Not considered an issue.
Sodium	A	None	Insignificant	Rare	Low (1)	No sources in the catchment.	None	Insignificant	Rare	Low (1)	Reliable			Insignificant	Rare	Low (1)	Not considered an issue.
Sulphate	H	None	Insignificant	Rare	Low (1)	No sources in the catchment.	None	Insignificant	Rare	Low (1)	Reliable			Insignificant	Rare	Low (1)	Not considered an issue.
Toxins	H	Illegal tipping	Insignificant	Rare	Low (1)	Malicious activity contaminating the water supply.	Wilful contamination	Catastrophic	Rare	Medium (6)	Uncertain			Catastrophic	Rare	Medium (6)	There has been a history of locals turning off the chlorine, but not contaminating the water. However, this has ceased since security has been increased.
Physical																	
Colour	A	None	Insignificant	Rare	Low (1)	No monitoring available	Main breaks; Maintenances.	Moderate	Rare	Low (3)	Reliable			Insignificant	Rare	Low (1)	Not considered an issue.
DO	A	None	Insignificant	Rare	Low (1)	No monitoring available	Main breaks; Maintenances.	Insignificant	Rare	Low (1)	Reliable			Insignificant	Rare	Low (1)	Not considered an issue.
Hardness	Business Risk	Dolomite geology	Minor	Almost certain	High (10)	From 1987 report, hardness was 370.	None	Minor	Almost certain	High (10)	Reliable			Minor	Almost certain	High (10)	Not considered an issue.
pH	A/H	None	Insignificant	Rare	Low (1)	Average at Bore #1 is 7.26	None	Insignificant	Rare	Low (1)	Reliable			Insignificant	Rare	Low (1)	Not considered an issue.
Radiological	H	None	Insignificant	Rare	Low (1)	No sources in the catchment.	None	Insignificant	Rare	Low (1)	Reliable			Insignificant	Rare	Low (1)	Not considered an issue.
Reduced output volume	-	None	Insignificant	Rare	Low (1)	There has been an issue with number 2 bore. However, Bore 1 has always had water.	Mains break	Insignificant	Rare	Low (1)	Reliable			Insignificant	Rare	Low (1)	Not considered an issue.
Taste and odour	A	Hardness	Insignificant	Rare	Low (1)	Water is acceptable, but does have a mineral taste.	Overdosing of chlorine; Detention time.	Moderate	Unlikely	Medium (6)	Reliable			Insignificant	Rare	Low (1)	Not considered an issue.
Total dissolved solids		Dolomite geology	Insignificant	Rare	Low (1)		None	Insignificant	Rare	Low (1)	Reliable			Insignificant	Rare	Low (1)	Not considered an issue.
Turbidity	A	Surface water intrusion	Insignificant	Rare	Low (1)	No monitoring available	Main breaks; Maintenances.	Moderate	Rare	Low (3)	Reliable			Insignificant	Rare	Low (1)	Not considered an issue.

If a hazard is not covered in the worksheet, the risk is passed through from the previous scheme element.

APPENDIX C

MOUNT ISA HAZARDOUS EVENT WORKSHEET

Mount Isa Residual Risk

Component	Hazardous Event	Potential Hazard		Limiting Hazard/s	Maximum Risk	Preventive Measures	Monitoring	Event Consequence	Event Likelihood	Event Risk	Comments	Level of Uncertainty	Risk Treatments	Risk Treatment Ref
Reservoirs	**Deterioration of water quality in reservoirs as a result of variable residence times**	Variable residence time may cause a loss of the disinfection residual. The system is not operated to manage retention times.	Bacteria; Turbidity; Taste and odour.	Bacteria	High (16)	Chlorine residual; Management of levels in reservoirs.	Chlorine residual; Biological monitoring.	Major	Unlikely	Medium (8)	This could happen up to once a year or more, whereby detention times cause a deterioration of water quality. Changes in demand are irregular, and it is hard to manage the system accordingly. There have been periods of no chlorine and some detections of E. coli in the reservoirs. At Reservoir 2, from Dec 2010 to Feb 2011, chlorine was recorded as <0.1mg/L; at the same time, there were more than 10 E. coli detections.	Confident	Mixing of water in the reservoirs will help to maintain a consistent quality. Investigate additional chlorine dosing.	WQ1, WQ2, WQ7
Reservoirs	**Vandalism or willful contamination**	Access by humans and willful contamination leading to potential poor quality water.	Bacteria; Viruses; Protozoa; Toxins.	Bacteria	High (16)	Chlorine residual; Security fences; Removal of access ladders; Locks on hatches; Security cameras.	Visual inspections; Chlorine residual.	Major	Rare	Medium (5)	Unauthorised access to the reservoirs has been achieved by climbing fences and using stairwell access. Recently, whirly birds from one reservoir were removed.	Confident	n/a	
Reservoirs	**Poor mixing within reservoir**	Poor mixing in a reservoir leading to pockets of reduced quality water.	Bacteria; Opportunistic pathogens; Turbidity; DBPs.	Bacteria	High (16)	None	Verification monitoring	Major	Unlikely	Medium (8)	Except for Reservoir 6, they all have a common inlet outlet. E. coli spikes in Reservoir 2 only over past year, possibly due to failed hydraulic valve. However, the variability of residuals and fast recolonisation of the reservoirs after shock dosing also suggest that poor mixing is an issue. Although, DBPs are not the limiting hazard. It is considered that poor mixing could lead to increased water ages and corresponding increases in DBP concentrations. No monitoring is currently undertaken for DBPs.	Estimate	Mixing of water in the tanks will help to maintain a consistent quality. Once mixing has been trialed, additional chlorine dosing should be investigated.	WQ1, WQ2
Reservoirs	**Disturbance of Sediment**	Stirring of foreign matter leading to a deterioration in water quality.	Bacteria; Viruses; Protozoa; Turbidity; Taste and odour; Colour; pH.	Bacteria	High (16)	Managing tank levels; Chlorine residual; Cleaning - reactive.	Verification monitoring	Major	Unlikely	Medium (8)	There have been no occasions where the reservoirs have scoured.	Reliable	Investigate a reservoir cleaning program.	WQ11
Reservoirs	**Stagnation**	Stagnation leading to deterioration of water quality and therefore; - Taste and odour issues. - Potential growth of bacteria in the system. - Loss of DO. - Change in pH potentially due to dissolution of assets.	Bacteria; Taste and odour; pH; DO.	Bacteria	High (16)	Sizing of the system to meet demand; Decommissioning and recommissioning procedures.	Monitor HPC, total chlorine and E. coli	Major	Rare	Medium (5)	There is potentially 1.5 days storage in the network, which should result in an acceptable water age. Reservoir 4 could possibly have a longer retention time, as it is behind Reservoir 3.	Reliable	n/a	
Reservoirs	**Vermin**	Access by animals (including birds) leading to: - Microbiological contamination, from animal droppings and dead animals. - Loss of disinfection residual due to additional chlorine demand.	Bacteria	Bacteria	High (16)	Chlorine residual; Sealed storages.	Visual inspections	Major	Unlikely	Medium (8)	A dead bird was found in Reservoir 2 when it was cleaned out.	Reliable	Inspection program to ensure tanks are secure.	WQ11
Reservoirs	**Ingress or wash-in of contaminated water**	Ingress of animals faecal matter and leaf litter via roof drainage leading to: - Microbiological contamination, from animal droppings, rotting vegetation. - Natural organic matter, e.g. leaf litter.	Bacteria; Protozoa; Colour; Taste and odour; Turbidity; Lead; Copper; DBPs; Sulphur.	Bacteria	High (16)	Chlorine residual; There is an inspection program for roofs.	Visual inspections	Major	Unlikely	Medium (8)	Main source is the box guttering. Slight potential for metals on roof to wash in, but, considering level of dilution that would occur, this would not likely exceed the ADWG limits.	Confident	Inspection program to ensure tanks are secure.	WQ11

Component	Hazardous Event	Potential Hazard		Limiting Hazard/s	Maximum Risk	Preventive Measures	Monitoring	Event Consequence	Event Likelihood	Event Risk	Comments	Level of Uncertainty	Risk Treatments	Risk Treatment Ref
Pumps Stations	**Sediment disturbance on start-up**	Change in flow direction, which would disturb sediment in the mains.	Turbidity; Bacteria; Protozoa; Viruses; Colour; Iron; Manganese.	Turbidity	Medium (9)	Flushing prior to operation; Servicing the pumps	Verification monitoring; Visual inspection.	Moderate	Rare	Low (3)	Pumps haven't been started up in 10 years. They are used to transfer water from the Low Zone to the High Zone. These zones are normally isolated, and the pumps are a contingency measure.	Confident	n/a	
Pipelines	**Ingress of non-potable water**	Ingress of contaminants through: - Pipe joints; - Air valves; - Leaking valves and hydrants; - Aging infrastructure. Ingress caused by loss of pressure in mains during: - Pipe burst; - Pipe repairs; - Very high flows (e.g. firefighting).	Bacteria; Taste & odour; Colour; Turbidity; Protozoa; Viruses; Toxic metals; Hydrocarbons; Toxins.	Protozoa	High (12)	Chlorine residual; Flushing program following mains repairs	Verification monitoring	Major	Possible	High (12)	On average, there are approximately five mains breaks per month. The same crews operate on water and sewer and occasionally use the same tools. There is currently no formal hygiene procedure in place, which is why the risk has been set as high.	Reliable	Develop mains hygiene procedure, looking at the usage of tools and the reinstating of repaired mains.	WQ11
Pipelines	**Backflow**	Backflow from a third party's asset: - Illegal connection (connection not to plumbing code); - Unintentional flow from a downstream entity's asset, due to operational error/ignorance. - Two-way operation of a main.	Bacteria; Opportunistic pathogens; Protozoa; Viruses; Hydrocarbons; Taste and odour; Pesticides; Fertilisers; Toxins.	Pesticides	Low (2)	Plumbing code for backflow connections and annual testing; Vacuum breakers on hose lines	No program currently in place	Minor	Rare	Low (2)	No major processing facilities are connected to the MICC. Major domestic issues are considered to be the greatest risk.	Confident	This was considered a low risk, but it was suggested that compliance reporting should be considered.	
Pipelines	**High flow or changes in flow rate or direction in pipelines**	High flow and rapid changes in flow rate in pipelines leading to scouring and sloughing of slimes and sediment.	Turbidity; Taste & odour; Bacteria; Toxic metals; Colour; Viruses; Protozoa; Aluminium; Iron; Manganese.	Turbidity	Medium (9)	None	Verification monitoring	Moderate	Possible	Medium (9)	Maintenance activities could cause a change in direction or flow rate when systems are isolated. The turbidity is caused by iron and manganese buildup.	Confident	Develop a procedure for isolating and flushing pipelines.	WQ11
Pipelines	**Dead ends**	Stagnant water in pipelines caused by: - Dead ends. - Pipes' low-water demands or mothballing.	Bacteria; Iron; Manganese; Colour; Dissolved oxygen; Taste and odour; Turbidity.	Turbidity	Medium (9)	Flushing program twice a week	Targeted monitoring of dead ends.	Minor	Unlikely	Low (4)		Confident	n/a	
e of System	**Formation of DBPs**	The reaction of chlorine with organic material to create DBPs.	Disinfection by-products (e.g. THMs, NDMA & HAAs)	Disinfection by-products (e.g.. THMs, NDMA & HAAs)	High (12)	None	None	Moderate	Likely	High (12)	There are no current controls for DBP formation. THMs have been detected above the ADWG limit at MITR by the MIWB. There are likely to be more exceedences in the MICC system, as DBPs form over time.	Reliable	Mixing of water in the tanks will help to maintain a consistent quality. Add THM monitoring to the program.	WQ1, WQ3
	Incompatible materials	Use of incompatible materials may cause release into water supply.	Toxins	Toxins	Medium (6)	Standard 4020.	None	Minor	Unlikely	Low (4)	Materials used should meet the standard.	Confident	n/a	
	Malicious contamination	The intentional contamination of the water supply.	Toxins; Hydrocarbons; Bacteria; Protozoa; Viruses; Taste and odour; Pesticides.	Toxins	Medium (6)	Security fences; Locked hatches; Cameras;	Routine monitoring	Catastrophic	Rare	Medium (6)	No history of such events.	Uncertain	n/a	

Component	Hazardous Event	Potential Hazard		Limiting Hazard/s	Maximum Risk	Preventive Measures	Monitoring	Event Consequence	Event Likelihood	Event Risk	Comments	Level of Uncertainty	Risk Treatments	Risk Treatment Ref
Whol	**Lack of Resources**	Loss of system knowledge and the ability to recruit skilled operators leading to inappropriate decision making, reduced knowledge and lack of maintenance of the system.	Turbidity; Bacteria; Protozoa; Toxic Metals.	Protozoa	**High (12)**	On-the-job training	None	Major	Possible	**High (12)**	This is a potential issue during maintenance because of a lack of understanding of the system.	Certain	It has been recognised that specialist staff can't be recruited and maintained at MICC, so a greater number of O&M contractors are being considered for the provision of services. A greater amount of training is to be provided to MICC staff.	WQ4
	Loss of power	Loss of treatment and water supply.	Reduced output volume	Reduced output volume	**Medium (6)**	None	None	Insignificant	Rare	**Low (1)**	The only issue would be if the hydraulic valve on Reservoir 2 failed in the open position, due to a loss of power.	Reliable	n/a	

APPENDIX D

CAMOOWEAL HAZARDOUS EVENT WORKSHEET

Camooweal Residual Risk

Component	Hazardous Event	Potential Hazard		Limiting Hazard/s	Maximum Risk	Preventive Measures	Monitoring	Event Consequence	Event Likelihood	Event Risk	Comments	Level of Uncertainty	Risk Treatments	Risk Treatment Ref
Bores	**Surface water infiltration**	Stormwater runoff ingress through bore casing and insecure borehead.	Viruses; Bacteria; Protozoa; Hydrocarbons; Turbidity; Colour.	Bacteria	High (12)	Collar and casing on the bore. Borehead raised well above the ground with concrete slab around.	Verification monitoring	Major	Rare	Medium (5)	Old borehead has an access point for stormwater but borehead is raised to prevent runoff entering the bore. There is some evidence of surface water infiltration in Bore 1; however, it is considered to be managed by chlorine. There is no data on turbidity to make sure it doesn't rise above 1 NTU.	Reliable	Inspection and required maintenance of the bore casing and borehead security to prevent ingress from stormwater runoff	WQ12
Bores	**Surface water infiltration through recharge**	Contaminated surface water may negatively impact water in the aquifer. Dumping of rubbish in surrounding caves could lead to groundwater contamination after rainfall event (see Eberhard 2003).	Viruses; Bacteria; Protozoa; Hydrocarbons; Turbidity; Colour.	Bacteria	High (12)	Site inspections of cave entrances, especially Niggle Cave and Tar Drum Sink.	Verification monitoring	Major	Rare	Medium (5)	There is some evidence of surface water infiltration in Bore 1; however, it is considered to be managed by chlorine. There is no data on turbidity to make sure it doesn't rise above 1 NTU.	Reliable	Educate public about connection between caves and groundwater.	WQ9
Bores	**Surface water infiltration through recharge**	Contaminated surface water may negatively impact water in the aquifer.	Viruses; Bacteria; Protozoa; Hydrocarbons; Turbidity; Colour.	Protozoa	Medium (8)	None	None	Major	Unlikely	Medium (8)	Unsure if natural geology filters oocysts. Turbidity not tested to see corelation with rainfall, indicating rapid surface water infiltration with potential protozoa contamination. Average concentration of oocysts can be estimated very roughly from information on the level of faecal pollution of the bore (WHO, 2009). Based on the E. coli results of Bore 1, crypto may be occasionally present at concentration estimated at 0.1 oocysts per litre.	Estimate	Monitor turbidity to see if there is a correlation between changes in turbidity and rainwater.	WQ13
Disinfection	**Failure of Chlorination system Insufficient C.t**	Pathogens in final water (failure of Cl system).	Bacteria; Virus.	Bacteria	High (12)	Security fence; Training and procedures.	Regular inspections including weight of chlorine bottle. Verification monitoring	Major	Unlikely	Medium (8)	The bore pumps are at a fixed speed, and the injector pump is also at a fixed speed. Need to make sure chlorinator is on the right set point. There has been an issue in the past where local residents have turned off the chlorine. Security has been improved, and fences have been erected. The first properties are a short distance from the TP, and adequate detention time may not be attained.	Confident	Program to install new chlorinator system is underway. A telemetry system is being investigated, which would be able to send alarms. Investigate Ct to first customer and implement changes, as appropriate.	WQ5, WQ6, WQ8
Disinfection	**Overdosing of Chlorine**	Cl outside ADWG Health limit; Taste & Odour complaints.	Chlorine; Taste & odour complaints.	Chlorine	Low (2)	Training and procedures.	Verification monitoring	Minor	Unlikely	Low (4)	High chlorine could be caused by vandalism or operator error.	Reliable	n/a	
Header tanks	**Stagnation**	Resulting in the loss of chlorine residual, allowing for potential contamination.	Bacteria; Taste and odour.	Bacteria	High (12)	Levels set appropriately for tank turnover. Valving locked out to prevent isolation of tanks.	Verification monitoring	Major	Rare	Medium (5)	Bore pumps are controlled on the header tank levels. Levels are set at a point that provides adequate turnover, so stagnation is not an issue in normal operation. However, it is possible to isolate the tanks, which would cause the water to stagnate, and may be delivered to town when reinstated. Bore pumps operate more than once a day, meaning the tanks' turnover.	Reliable	n/a	

Component	Hazardous Event	Potential Hazard		Limiting Hazard/s	Maximum Risk	Preventive Measures	Monitoring	Event Consequence	Event Likelihood	Event Risk	Comments	Level of Uncertainty	Risk Treatments	Risk Treatment Ref
Header tanks	**Vermin**	Vermin accessing the tanks and contaminating water.	Bacteria	Bacteria	**High (12)**	Sealed lid, lockable hatch.	Verification monitoring; Visual inspection.	Major	Rare	**Medium (5)**	Tanks are completely sealed.	Reliable	n/a	
Reticulation	**Ingress of non-potable water**	Ingress of contaminants through: - Pipe joints; - Air valves; - Leaking valves and hydrants; - Aging infrastructure. Ingress caused by loss of pressure in mains during: - Pipe burst; - Pipe repairs; - Very high flows (e.g. firefighting).	Bacteria; Taste & odour; Colour; Turbidity; Protozoa; Viruses; Toxic metals; Hydrocarbons; Toxins.	Bacteria	**High (12)**	Chlorine residual-flushing program following mains repairs		Major	Unlikely	**Medium (8)**	Old cast-iron system; new areas are PVC. When the header tank was inadvertently switched off, it caused the pressure in the retic to increase and resulted in a number of main breaks. The valving has now been locked out to prevent this in future. Normally, there are minimal main breaks in the Camooweal system.	Reliable	Develop mains hygiene procedure, looking at the usage of tool and the reinstating of repaired mains.	WQ14
	Stagnation including dead ends	Stagnant water in pipelines caused by: - Dead ends. - Pipes' low-water demands or mothballing.	Bacteria; Iron; Manganese; Colour; Dissolved oxygen; Taste and odour; Turbidity.	Bacteria	**High (12)**	Flushing program twice a week; Positive pressure prevents things from getting in.	Targeted monitoring of dead ends.	Major	Rare	**Medium (5)**	Austral and Nowrani Streets are dead ends.	Reliable	n/a	
Whole of system	**Wilful contamination**	Intake of contaminated water that potentially cannot be treated.	Toxins; Hydrocarbons; Bacteria; Protozoa; Viruses; T&O; Pesticides.	Toxins	**Medium (6)**	Remote location; Security fence.	Routine monitoring	Catastrophic	Rare	**Medium (6)**	In the past, there have been people enter the site; however, it was to turn off the chlorine.	Reliable	n/a	
	Formation of DBPs	Organics in the water reacting with chlorine disinfectant to form DBPs.	DBPs	Disinfection by-products (e.g.. THMs, NDMA & HAAs)	Low (2)	None	None	Minor	Rare	Low (2)	The water is bore water, and the level of organics would be naturally low. Therefore, DBPs aren't considered to be an issue.	Reliable	n/a	
	Incorrect valving	Incorrect operation of valve, resulting in contamination of treated water.	Bacteria; Viruses.	Bacteria	**High (12)**	Tank valves are locked out	None	Major	Rare	**Medium (5)**	There is a bypass of the chlorination facility operated by a valve. Bore pumps are controlled on the header tank levels, levels are set at a point that provides adequate turnover so stagnation is not an issue in normal operation. However, it is possible to isolate the tanks, which would cause the water in the tanks to stagnate, and may be delivered to town when reinstated.	Reliable	Valving is to be appropriately labelled and locked out, where appropriate.	
	Lack of Resources	Loss of system knowledge and the ability to recruit skilled operators leading to inappropriate decision making, reduced knowledge and lack of maintenance of the system.	Turbidity; Bacteria; Protozoa; Heavy Metals.	Protozoa	**Medium (8)**	On-the-job training	None	Major	Unlikely	**Medium (8)**	This is a potential issue during maintenance because of a lack of understanding of the system.	Certain	It has been recognised that specialist staff can't be recruited and maintained at MICC, so a greater number of O&M contracts are being considered for the provision of services. A greater amount of training is to be provided to MICC staff.	WQ4
	Loss of power	Loss of treatment and water supply.	Reduced output	Reduced output volume	Low (1)	None	None	Insignificant	Rare	Low (1)	not considered an issue.	Reliable	n/a	

MOUNT ISA CITY COUNCIL

DRINKING WATER QUALITY MANAGEMENT PLAN

IMPROVEMENT PLAN

MARCH 2013

DOCUMENT AND VERSION CONTROL

The DWQMP and this supporting document are controlled documents. The signed document and version control sheet at the front of the document indicate the current version. Information within the appendices is to be updated as indicated in Section 2 and as follows:

- Action plans 6-12 months (review with annual reporting requirement)
- Sub-plans 1-3 years
- Associated policies 1-5 years
- Business management plan 1-3 years

Revisions to individual pages or sections of the Improvement Plan will be indicated by a revision number and date added to the footer of the page, and noted in the version control table.

VERSION CONTROL SHEET

Date	Description	Version & Update Ref	Appendix or Page No.	Approved Initials
May 2012	Final	Version 1	All	
March 2013	Revsision	Version 2.0	Appendix A	

TABLE OF CONTENTS

LIST OF APPENDICES

MOUNT ISA CITY COUNCIL
DRINKING WATER QUALITY MANAGEMENT PLAN

1 INTRODUCTION

1.1 PURPOSE

This is the DWQMP Improvement Plan for the Mount Isa City Council (MICC). It is a supporting document of the Drinking Water Quality Management Plan (DWQMP).

The purpose of this improvement plan is continual improvement in drinking water risk management. In addition, it will address identified needs for full implementation of the DWQMP and compliance with the Queensland Drinking Water Quality Management Plan Guideline (the Guideline).

This Improvement Plan demonstrates how the MICC will address the risks identified in the DWQMP and risk assessment. The plan outlines the interim, short-term to long-term management measures and actions and the implementation of timeframes and funding requirements (the Guideline).

1.2 SCOPE

This Drinking Water Quality Improvement Plan covers the drinking water services operated by MICC. The improvements that are in this plan have either been identified through the water quality risk assessment undertaken throught the DWQMP, or to improve compliance with the Guideline.

1.3 OBJECTIVES

The Australian Drinking Water Guidelines 2011 (ADWG) specifies a risk management approach to managing drinking water quality. Guiding Principle Six states ***ensuring drinking water safety and quality requires the application of a considered risk management approach***. *Risk management is about taking a carefully considered course of action. As the obligation is to ensure safe water and protect public health, the balancing process must be tipped in favour of taking a precautionary approach.*

This improvement plan prioritises resources on high risks, ensuring the safest possible drinking water. It also sets out a framework for continual improvement in water quality.

2 REGULATORY FRAMEWORK

Section 95(1) of the *Water (Safety and Reliability) Act 2008* (the Act) states that each provider must prepare a DWQMP for the service and apply to the regulator for approval of the plan (this includes providers that supply bulk water, manufactured water and distributor- retailer services). While a service may comprise of one or more discrete drinking water scheme(s), all the schemes must be covered by the plan.

Section 95(3)(b) of the Act states the plan must demonstrate how the drinking water service provider intends to manage the risks posed by the hazards and hazardous events. The Guideline specifies how a drinking water service provider's DWQMP is to address this requirement of the Act. The Guideline states that a *Risk Management Improvement Program (the Program) is a mechanism for the provider to demonstrate to the regulator how it will address these identified risks in the plan*.

The Program must describe the management measures proposed for each unacceptable residual risk, including:

- Measures, actions, strategies or processes
- Priority for implementation
- Timeframe
- Other factors, for example, responsibilities between the provider and third parties and/or other stakeholders.

3 IMPROVEMENT ACTIONS

3.1 IDENTIFICATION

Appendix A lists those management measures that were identified as a result of a review or risk assessment for both the Mount Isa and Camooweal schemes. The source of information that determined the need for action is listed. Appendix A also details required improvements to the management of the system. Comparing existing MICC documents to the requirements in the Guideline identified these improvements.

3.2 PRIORITISATION

The priority of each action was determined using level of risk, as follows:

- Level 1 priority was assigned to hazardous events with a risk of High or Extreme and must be actioned within 12 months of acceptance of this plan. If an action was linked to the CCP or could be done earlier to optimise system management/performance then it was also given Level 1 priority.
- Level 2 priority was assigned to hazardous events with a Medium (9) or Medium (8) risk and must be actioned within 24 months of acceptance of this plan.
- Level 3 priority was assigned to hazardous events with a risk of less than Medium (8) and must be actioned within 48 months.

It is intended that all deficiencies identified in the plan are addressed prior to the first external audit and, as such, have been assigned a Level 2 priority. All other improvements, which have been identified from other sources, have been assigned a Level 3 priority.

3.3 IMPROVEMENTS

The following improvements are listed as Level 1 priority and require action within the next 12 months:

- Mixing in reservoirs
- THMs monitoring
- Staff recruitment and retainment
- Chlorinator installation
- Chlorine contact time investigation
- Cave awareness
- Online reservoir monitoring
- ERP revision
- Bore inspection and maintenance
- Raw water turbidity testing
- Mains hygiene procedure

3.4 FUNDING

All projects will be internally funded through the Operations Funds due to the nature of the project being a continuous living document.

4 REVIEW

It is the responsibility of the MICC Chief Executive Officer to ensure that this document is up-to-date and is communicated to employees. The support, commitment and ongoing involvement of the Chief Executive Officer is essential for the continual improvement of the organisation's activities related to drinking water.

This plan is to be reviewed as appropriate and, at least, annually.

Details of the improvement actions in Appendix A are to be updated in the spreadsheet as and when required, and this spreadsheet is to be treated as a live document.

APPENDIX A – WATER QUALITY IMPROVEMENT PROGRAM

Water Quality Improvements

Ref	Source	Scheme	Project Title	Project Description	Residual Risk	Responsibility	Priority	Timeframe	Status	Outcome
WQ1	Risk Assessment 2012	Mount Isa	Mixing in reservoirs	Mixing of water in reservoirs will help maintain a consistent water quality. Mixing to be trialed to determine its effectiveness in maintaining a stable disinfection residual. This should be rolled out if successful	Medium (8)	MICC - Deputy Executive Officer/ Manager Engineering	1^	12 months	To start	
WQ2	Risk Assessment 2012	Mount Isa	Additional chlorine	If mixing fails to improve Cl levels install additional Cl dosing.	Medium (8)	MICC - Deputy Executive Officer/ Manager Engineering	2	24 months	To start	
WQ3	Risk Assessment 2012	Mount Isa	THM monitoring	Add THM monitoring to the monitoring program.	High (12)	MICC - Technical Services Engineer	1	12 months	To start	
WQ4	Risk Assessment 2012	Mount Isa and Camooweal	Staff Recruitment and Retainment	Join Qwater at an individual operator level and roll out training as appropriate.	High (12)	MICC - Deputy Executive Officer/ Manager Engineering	1	12 months	To start	
WQ5	Risk Assessment 2012	Camooweal	Chlorinator installation	Undertake maintenance on the chlorinator to improve reliability.	Medium (8)	MICC - Foreman	1^	12 months	Underway	
WQ6	Risk Assessment 2012	Camooweal	Alarm system	Undertake a feasibility study for a telemetry system that can send alarms. Camooweal is a remote, unstaffed site and alarms that initiate action on a failure of the system are essential. This should include online chlorine monitoring.	Medium (8)	MICC - Deputy Executive Officer/ Manager Engineering	2	24 months	Underway	
WQ7	Risk Assessment 2012	Mount Isa	Online reservoir monitoring	Chlorine residual monitoring in the reservoirs was identified as a CCP. The MICC will undertake a feasibility study to install online monitoring of chlorine at a minimum of one reservoir in each zone to be representive of low and high zone water.	Medium (8)	MICC - Deputy Executive Officer/ Manager Engineering	1^	12 months	To start	
WQ8	Risk Assessment 2012	Camooweal	Investigate Ct	Calculate Ct to first customer and implement changes as appropriate to ensure a Ct of at least 15. Change may require redirection of water through reservoirs before being supplied to customers.	Medium (8)	MICC - Technical Services Engineer	1^	12 months	To start	
WQ9	Risk Assessment 2012	Camooweal	Cave Awareness	Educate public about the connection between caves and groundwater. Erect signs warning penalties for illegal dumping in caves. Encourage use of Camooweal garbage tip to ensure no illegal dumping occurs.	Medium (5)	MICC - Manager Utility Services	1*	48 months	To start	
WQ10	DWQMP	Mount Isa and Camooweal	WQ Incident and Emergency Response Plan	Develop a water quality incident and emergency response plan in line with the existing framework (Tables 28-29 DWQMP).	n/a	MICC - Technical Services Engineer	1r	6 months	To start	
WQ11	DWQMP	Mount Isa and Camooweal	O & M Manual	MICC needs to prepare Operation and Maintenance Manuals for both Mount Isa and Camooweal that clearly detail day to day operations. A good O & M Manual is especially important for MICC with such high staff turnover. Some operational procedures exist.	n/a	MICC - All staff	2	24 months	To start	
WQ12	Risk Assessment 2012	Camooweal	Bore inspection and maintenance	Inspect and conduct required maintenance of the bore casing and borehead security to prevent ingress from stormwater runoff	Medium (5)	MICC - Foreman	1*	12 months	To start	
WQ13	Risk Assessment 2012	Camooweal	Turbidity testing	Monitor turbidity to see if there is a correlation between changes in turbidity and rainwater.	Medium (8)	MICC - Foreman	1^	12 months	To start	
WQ14	Risk Assessment 2012 and DWQMP	Mount Isa and Camooweal	Documented procedures	Procedures that need to be developed include Management of Reservoir Levels Procedure, Reservoir Cleaning Program, Inspection Program, Flushing and Repairing Mains Procedure	Medium (8)	MICC - All staff	2	24 months	To start	
WQ15	Risk Assessment 2012	Mount Isa and Camooweal	Documented procedures	Procedures that need to be developed include Mains Hygiene Procedure	High (12)	MICC - All staff	1	12 months	To start	
WQ16	DWQMP	Service wide	Document currency and record retention	Review existing process for water quality related document currency and record retention	n/a	MICC - All staff	2	24 months	To start	

Ref	Source	Scheme	Project Title	Project Description	Residual Risk	Responsibility	Priority	Timeframe	Status	Outcome
WQ17	DWQMP	Mount Isa and Camooweal	Procedure revision	The water quality monitoring procedures need to be revised.	n/a	MICC - Technical Services Engineer	2	24 months	To start	

Lengend:
^ linked to CCP or key barrier hence assigned priority 1
* early action will ensure risk level remains low hence assigned priority 1
r requirement by Regulator

Drinking Water Quality Incident and Emergency Response Plan

Mount Isa City Council

July 2013

Drinking Water Quality Incident and Emergency Response Plan

Mount Isa City Council

Viridis Consultants Pty Ltd
GPO Box 135
Brisbane Qld 4001
Australia
www.viridis.net.au
ABN: 49 129 185 271

Telephone: 1300 799 310
Facsimile: 1300 799 350

Date: 29 July 2013
Reference: REC-13-010
Status: Final

Citation: Tasleem Hasan and Mena Reyes 2013, Drinking Water Quality Incident and Emergency Response Plan – Mount Isa City Council, prepared for Mount Isa City Council by Viridis Consultants Pty Ltd.

Contents

Figures

Tables

Document History and Status

Revision	Date issued	Approved by	Date approved	Revision type
0.1	30/05/13	James Howey	03/06/13	Initial Draft
1.0	07/06/13	James Howey	07/06/13	Final

Author:	Tasleem Hasan and Mena Reyes
Project manager:	Tasleem Hasan
Name of client:	Mount Isa City Council
Name of project:	DWQMP Procedures
Name of document:	Drinking Water Quality Incident and Emergency Response Plan
Document number	REC-13-010
Document version:	1.0
Project number	13QU04

1. Introduction

Mount Isa City Council (MICC) have developed a Drinking Water Quality Management Plan (DWQMP) with the goal of protecting public health. Incident and emergency response planning is an essential part of the DWQMP.

Considered and controlled responses to incidents and emergencies that can compromise the safety of water quality are essential for protecting public health, as well as maintaining consumer confidence and the organisation's reputation.

Although preventive strategies are intended to prevent incidents and emergency situations from occurring, some events cannot be anticipated or controlled, or have such a low probability of occurring that providing preventive measures would be too costly. For such incidents, there must be an adaptive capability to respond constructively and efficiently.

This document is the Drinking Water Quality Incident and Emergency Response Plan (IERP) for MICC. The benefits of establishing and implementing an IERP include:

- timely response to drinking water incidents and emergencies
- reduced health risks by preventing or reducing the exposure of customers to contamination
- clearly defined roles and responsibilities of employees and stakeholders
- consistency in response
- improved audit trail.

The key elements of the MICC IERP are shown in Figure 1 and explained in detail in this plan.

Figure 1 IERP Key Elements

1.1. Scope

This plan applies to MICC's responses to drinking water quality incidents and emergency situations in relation to public health. It does not include management of water quantity, nor does it include specific details of disaster management which could impact water quality.

Appropriate reference to the Drought Management Plan / Significant Service Failure Plan (2009) and the Local Disaster Management Plan (2011) has been made to link response actions and avoid duplication of efforts.

1.2. Objectives

This Plan aims to assist MICC to:

- outline timely and consistent response to drinking water quality incidents and emergency situations
- define roles and responsibilities, including reporting and communication
- make reference to clearly defined and documented remedial actions.

2. Drinking Water Schemes

The MICC is responsible for providing drinking water distribution service for Mount Isa and the entire supply scheme for Camooweal. It is a customer of the Mount Isa Water Board (MIWB) who supplies bulk potable water to a number of customers in the Mount Isa area.

The Mount Isa scheme distributes treated water to the population of Mount Isa while the Camooweal scheme involves both distribution and treatment services for the remote township of Camooweal. Table 1 summarises the description of the two drinking water schemes.

Table 1 MICC Drinking Water Schemes

Description	Mount Isa Scheme	Camooweal Scheme
Location	Mount Isa City	190 km North-West of Mount Isa on the Barkly Hwy
System description	The Mount Isa scheme receives treated water from the MIWB and distributes it to its customers. MIWB obtain water from two dammed storages – Lake Julius and Lake Moondarra. Raw water is treated via a natural filtration system, disinfected through chlorination, pumped to the Mount Isa Terminal Reservoir (MITR) and re-chlorinated before being supplied to MICC.	Camooweal scheme uses three sub-artesian bores as sources. The bore pumps deliver water which gets injected with chlorine for disinfection prior to being supplied to Camooweal town.
Population served	21,994	300
Number of connections	6,335 (residential) 569 (commercial)	100
Person responsible for maintaining and implementing the IERP	Manager Utility Services	

3. Incident and Emergency Levels

Incidents and emergencies within MICC's drinking water schemes are grouped in four levels, with Level 1 being the least severe and complex in relation to response coordination. Figure 2 shows the levels and escalations of drinking water incidents and emergency, and linkages between the levels.

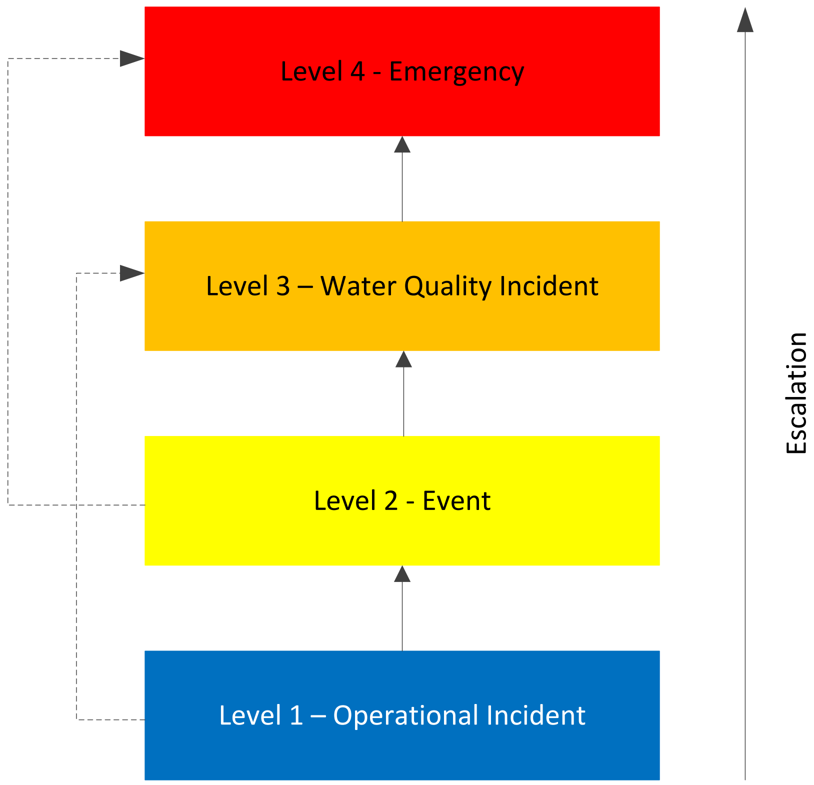


Figure 2 Incident and Emergency Level and Escalation

Table 2 provides the detailed descriptions of the constituents of each level of incident and emergency.

Table 2 Incident and Emergency Levels and Descriptors

Incident/Emergency Level	Description of Levels
Level 1 (Operational incident)	Exceedence of operational limits as per the DWQMP, including alert level for the chlorination CCP. Includes customer complaints. There is no non-compliance against the water quality criteria to impact public health. Incident is managed within the operations team. The incident is managed in line with the DWQMP without any additional assistance.
Level 2 (Event)	Anything that has happened or is likely to happen, in relation to a drinking water service that may have an adverse effect on public health. Examples include flood, bushfire, contamination of source water, contamination of treated water, major mains breaks, terrorism, natural disaster, and treatment failure. Incident may require coordination across the Council departments and external resources and support, such as from the Queensland Water Supply Regulator (QWSR), Queensland Health. It has the potential to create secondary issues more damaging than the actual incident.
Level 3 (Water quality incident)	There is a non-compliance against the water quality criteria (ADWG health guideline values). Includes upper critical limit exceedence for chlorination CCP. May result from escalation of a Level 1 or Level 2 event. Incident is managed within the team responsible for drinking water operations and management in line with the DWQMP. In some cases, it may require coordination across the Council departments and external resources and support, such as from the QWSR or Queensland Health.
Level 4 (Emergency)	There is an outbreak of waterborne disease or declared disaster situation by the Council or state/national government. May result from escalation of Level 2 or Level 3. Requires coordination across the Council departments and is likely to require external resourcing and support from agencies, such as the QWSR, Queensland Health, local disaster management groups, emergency responders QFRS and Police.

4. Actions and Responsibility

A summary of the key actions to be taken according to the level of the incident or emergency and the person responsible for each action is provided in Table 3.

Table 3 Lists of Actions to be Taken for Each Levels

Level	Actions to be Taken	Person/s Responsible
1 (Operational Incident)	• Implement relevant standard operating procedure or the CCP procedure • Undertake follow up sampling, as required • Review operations and maintenance records for anomalies • Commence investigation to determine cause and instigate immediate remediation actions • In case of customer complaints, coordinate investigation and resolution, including obtaining water samples where required • Ensure all preventive measures identified in the DWQMP are functioning effectively • Increase operational monitoring frequency where required • Fill in the appropriate form or the CCP reporting form, as required • Notify Manager Utility Services • Manager Utility Services to conduct de-brief meeting for CCP alert exceedence	Team Leader Water and Sewer
2 (Event)	• Report incident to QWSR within the required timeframe • For Mount Isa scheme - contact MIWB to inform them of the event • Ensure all control measures identified in the DWQMP are functioning effectively • Consider need to revise water restriction level, as necessary • Follow any directives from QWSR or Queensland Health • Drought Management Plan / Significant Service Failure Plan and Disaster Management Plan are on standby if the need arises • Conduct de-brief meeting	Manager Utility Services
3 (Water Quality Incident)	• Report incident to QWSR within the required timeframe • For Mount Isa scheme - contact MIWB to investigate possible problem with bulk supply • For non-compliance of bulk water supplied by MIWB at point of receipt, immediately notify MIWB and isolate supply if required • Initiate follow up sampling • Review associated laboratory reports and operational records • Ensure all control measures identified in the DWQM Plan are functioning effectively • Commence investigation to determine cause and instigate immediate remediation actions, including isolation of affected area where possible • Follow any directives from QWSR or Queensland Health regarding risk to public health, need for public warning and corrective actions • Consider what community notification or messaging is needed (e.g. do not drink alert, boil water alert or water distribution) in consultation with QWSR • Disaster Management Plan is on standby if the need arises • Conduct de-brief meeting	Manager Utility Services
4 (Emergency)	• Activate Council's Disaster Management Plan as required • Assemble team of appropriate professionals, as per the Disaster Management Plan • Notify QWSR as soon as practicable • Follow any directives from relevant government department regarding risk to public health, need for public warning and corrective actions • Consider what community notification or messaging is needed (e.g. do not drink, boil water notice or water distribution) • Conduct de-brief meeting	Chief Executive Officer

5. Communication

5.1. Communication Lines

Effective communication is vital in managing incidents and emergencies. It is important to have clear lines of communication with employees, customers, stakeholders, media and government departments.

The communication lines from the person responsible for each respective incident or emergency level, and the summary of the actions are detailed in Figures 3 to 6.

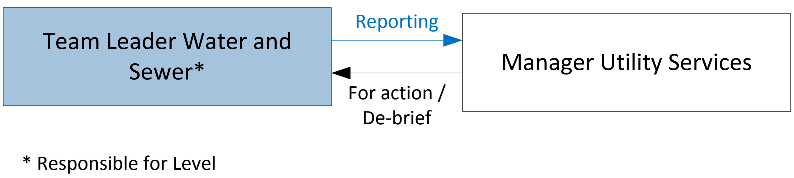


Figure 3 Communication Lines - Level 1 Operational Incident

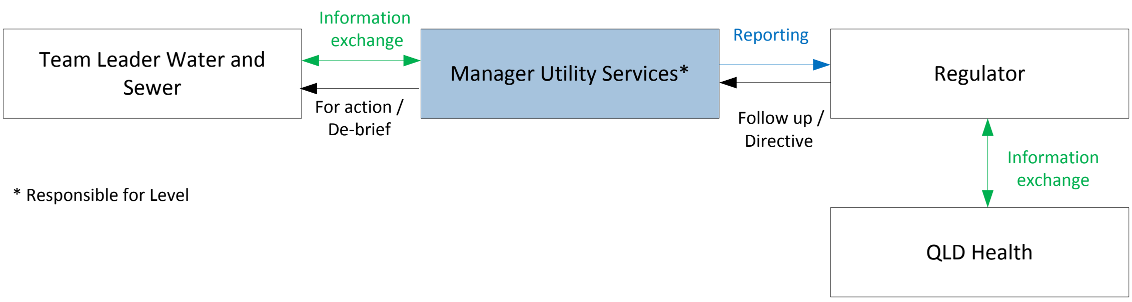


Figure 4 Communication Lines - Level 2 Event

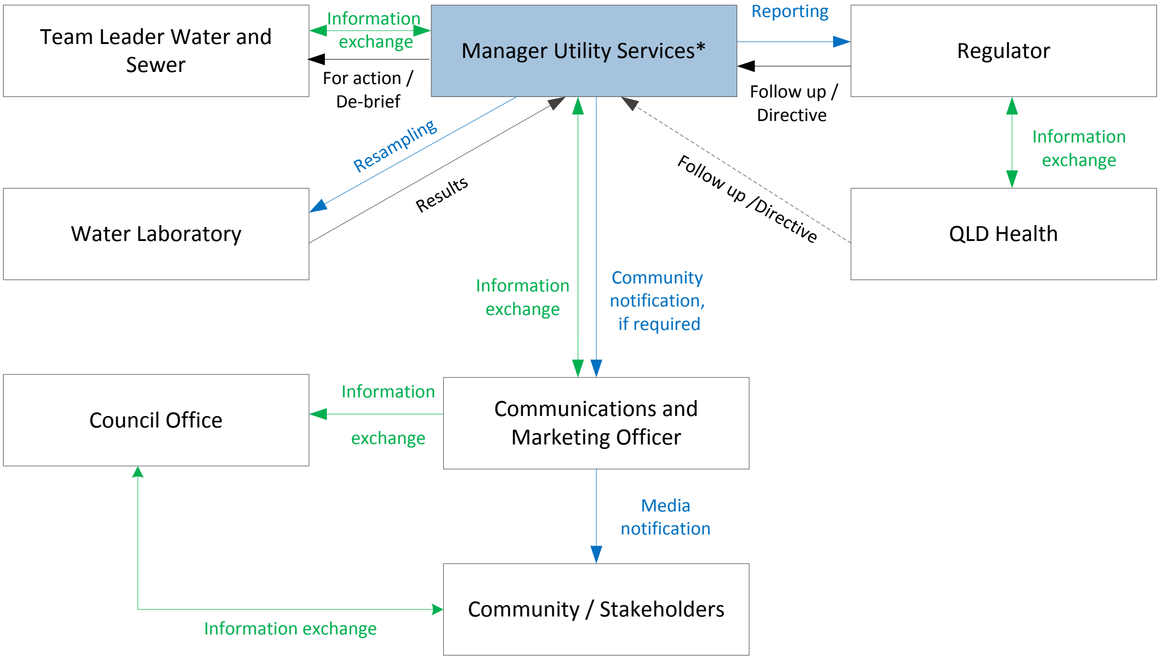


Figure 5 Communication Lines – Level 3 Water Quality Incident

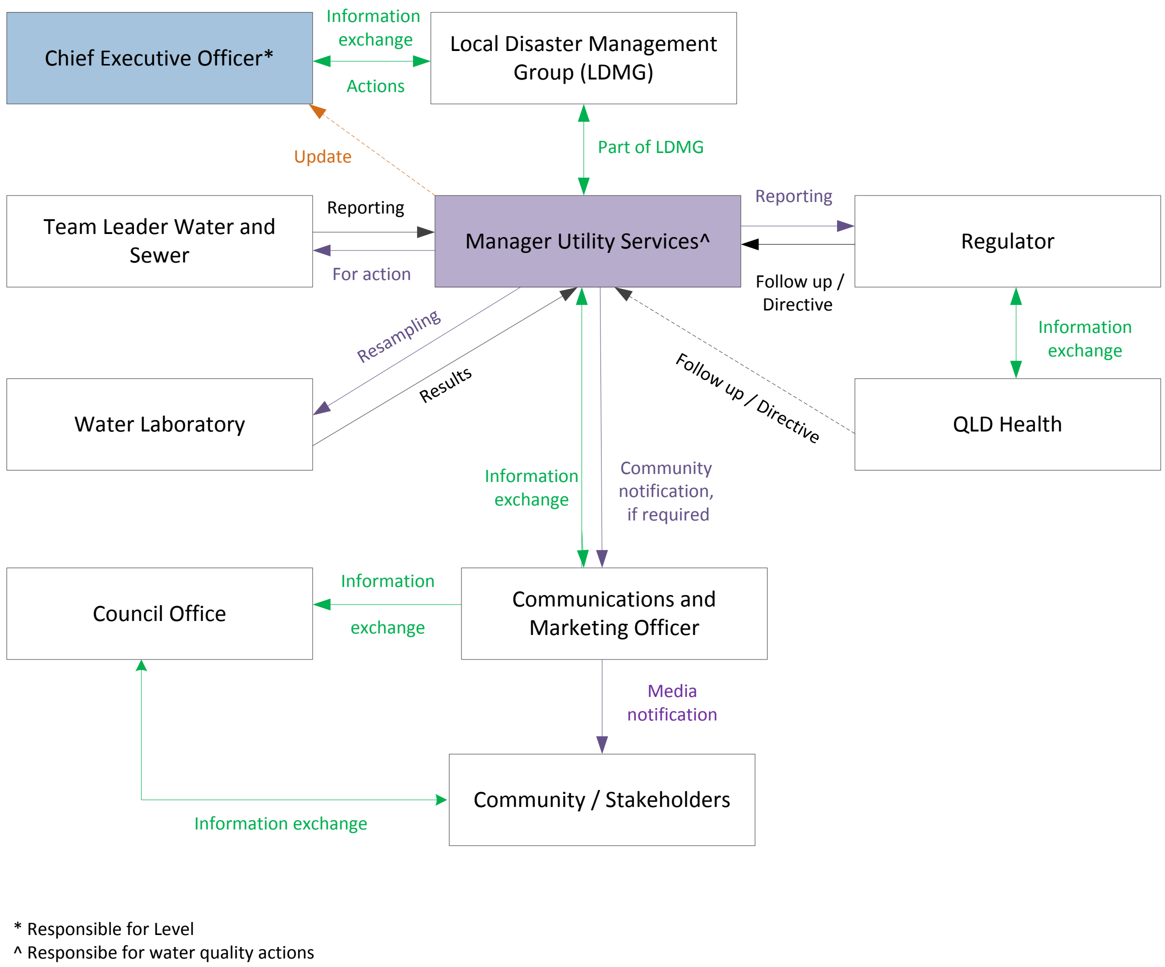


Figure 6 Communication Lines – Level 4

5.2. Internal and External Contacts

A contact list of key people, agencies and businesses should be kept to ensure the communication process is effective and efficient. Table 4 and Table 5 provide internal and external contacts for a drinking water incident or emergency.

The Manager Utility Services and the Team Leader Water and Sewer remain on call to attend to incident and emergency situations as required.

The Manager Utility Services is responsible for keeping the contacts list updated.

Table 4 Internal Emergency Contacts

Internal	Details
Emilio Cianetti	Chief Executive Officer (CEO) Mount Isa City Council 07 47474 3281
Ricardo Marino	Acting Director of Engineering Services Mount Isa City Council 0427 379 260
Mike Jones	Manager Utility Services Mount Isa City Council 0417 607 531
Ash Cooke	Team Leader Mount Isa City Council 0407 565 350
Greg Hovi	Plumbing Inspector Mount Isa City Council 0417 745 720
Ellie Johnson	Acting Manager Technical Services Mount Isa City Council 07 4747 3274
Leoni Harrop	Administration Support Officer Utility Services Mount Isa City Council 0439 854 646
Sandy Hansen	Engineering Services Executive Assistant Mount Isa City Council 07 4747 3251
Priviledge Mapiye	Environmental Health Officer Mount Isa City Council 0439 662 766
Ella Warszczynski	Laboratory Technician Mount Isa City Council 07 4743 6085
Alisha Dean	Communications and Marketing Officer Mount Isa City Council 0409 197 900

Table 5 External Emergency Contacts

External Contact	Details
Department of Energy and Water Supply	Queensland Water Supply Regulator 1300 596 709
Queensland Health	Environmental Health Branch 07 3234 0111
Mount Isa Water Board	Glenn de Vera Water Quality and Environmental Services Engineer 0428 451 691
Cairns Regional Council	Mark Wuth Laboratory Services 07 4044 8344
Mount Isa Police	Officer in charge 07 4744 1111

External Contact	Details
Mount Isa Hospital	Deputy Director of Nursing 07 4744 4444
Happy Valley State School	Principal 07 4645 0333
Central State School	Principal 07 4743 2096
Camooweal Health Centre	Director of Nursing 07 4748 2159
State Emergency Service	Local Controller 07 4643 2601
Mount Isa Fire and Ambulance Service	Mount Isa SES Officer in charge 07 4743 2601
Local radio	ABC News Radio 13 99 94
Local Newspaper	The North West Star Chief of Staff 07 4743 3355
Telecoms service provider	Telstra 13 22 03
Electricity Provider	Ergon Power Station Operator 13 22 96

5.3. Community Notification

During an incident or emergency, MICC's Communications and Marketing Officer will be the designated person to communicate to the community and media, if the need arises.

Community notification or key messages such as 'boil water notice', 'do not drink water' etc (if required), will be channelled through the Communications and Marketing Officer. The Manager Utility Services will consult with the QWSR to determine need for community notification such as boil water notice.

The boil water notice which MICC will distribute to its customers and post on notice boards and its website is attached in Appendix A.

All employees should be kept informed of any incident / emergency that requires community notification, as they provide informal points of contact for the community.

6. Reporting to Regulator

The reporting of Levels 2 to 4 to the QWSR is a regulatory requirement. Table 6 outlines the details of the incidents that need to be reported and the reporting timeframe. The incident reporting forms Part A and B are attached in Appendices B and C respectively.

Table 6: Incidents that Must be Reported to the Regulator

Incident	Detail	Timeframe for reporting to the regulator
Detection of *E. coli*	In reticulation system for the drinking water service	• reported by telephone within three hours of receipt of the test result • written confirmation by fax or email within 24 hours (incident reporting form Part A) • written confirmation by fax or email upon resolution of the incident (incident reporting form Part B)
Detection of pathogen	In treatment component of the drinking water service	
Failure to meet chemical health-related guideline values as specified in the ADWG	In transmission component of the drinking water service	
Fluoride: greater than 1.5 mg/L	In raw water or source water if parameter cannot be removed or reduced and will impact on final drinking water quality.	
Radiological: Greater than 0.5 Becquerel per litre for gross alpha activity Greater than 0.5 Becquerel per litre (after subtraction of potassium – 40 activity) for gross beta activity.	In raw water or source water or drinking water	• reported by telephone within three hours of receipt of the test result • written confirmation by fax or email within 24 hours (incident reporting form Part A) • written confirmation by fax or email upon resolution of the incident (incident reporting form Part B)
Parameter for which there is no guideline value in the ADWG.	Any parameter for which a guideline value is not available under the ADWG.	• written confirmation by fax or email within 24 hours of receipt of test result (incident reporting form Part A) • written confirmation by fax or email upon resolution of the incident (incident reporting form Part B)
An event or series of events likely to affect drinking water quality or will cause difficulty in ability to adequately treat or provide drinking water	Examples: Flood Bushfire Equipment failure Deviation from an operational critical limit for a critical control point Contamination of source water Mains break Terrorism Natural disaster	• reported by telephone as soon as practicable after the drinking water service provider becomes aware that the situation has escalated to the level where usual mitigation actions will not control the situation and the ability to provide safe drinking water is compromised • written confirmation by fax or email within 24 hours as soon as practicable (incident reporting form Part A) • written confirmation by fax or email upon resolution of the incident (incident reporting form Part B)

The following flowcharts, Figures 7 to 9, summarise the actions taken and reporting requirement for key routine incidents which MICC may experience, considering their monitoring program.

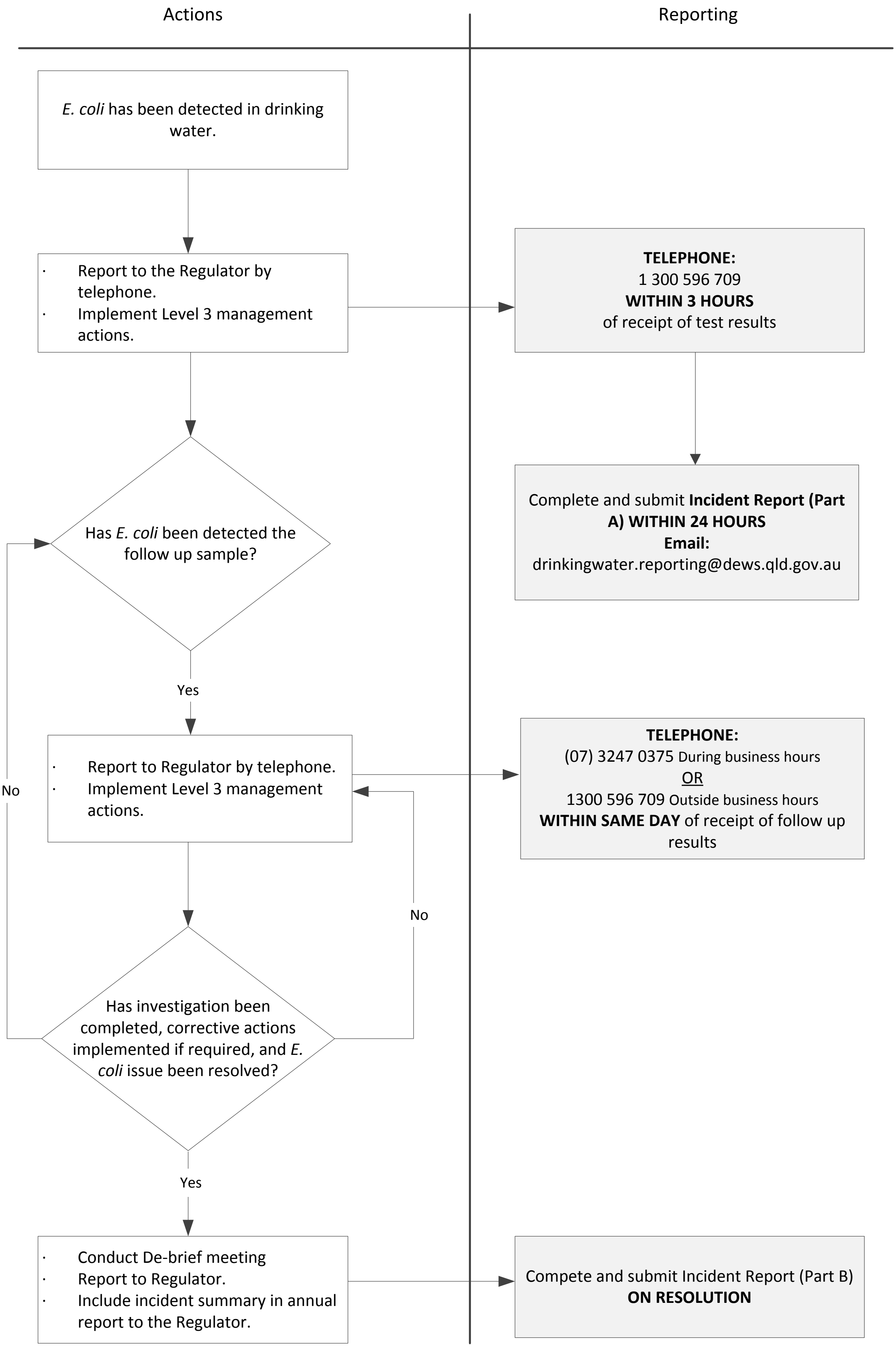


Figure 7 Actions and Reporting for Detection of *E. coli*

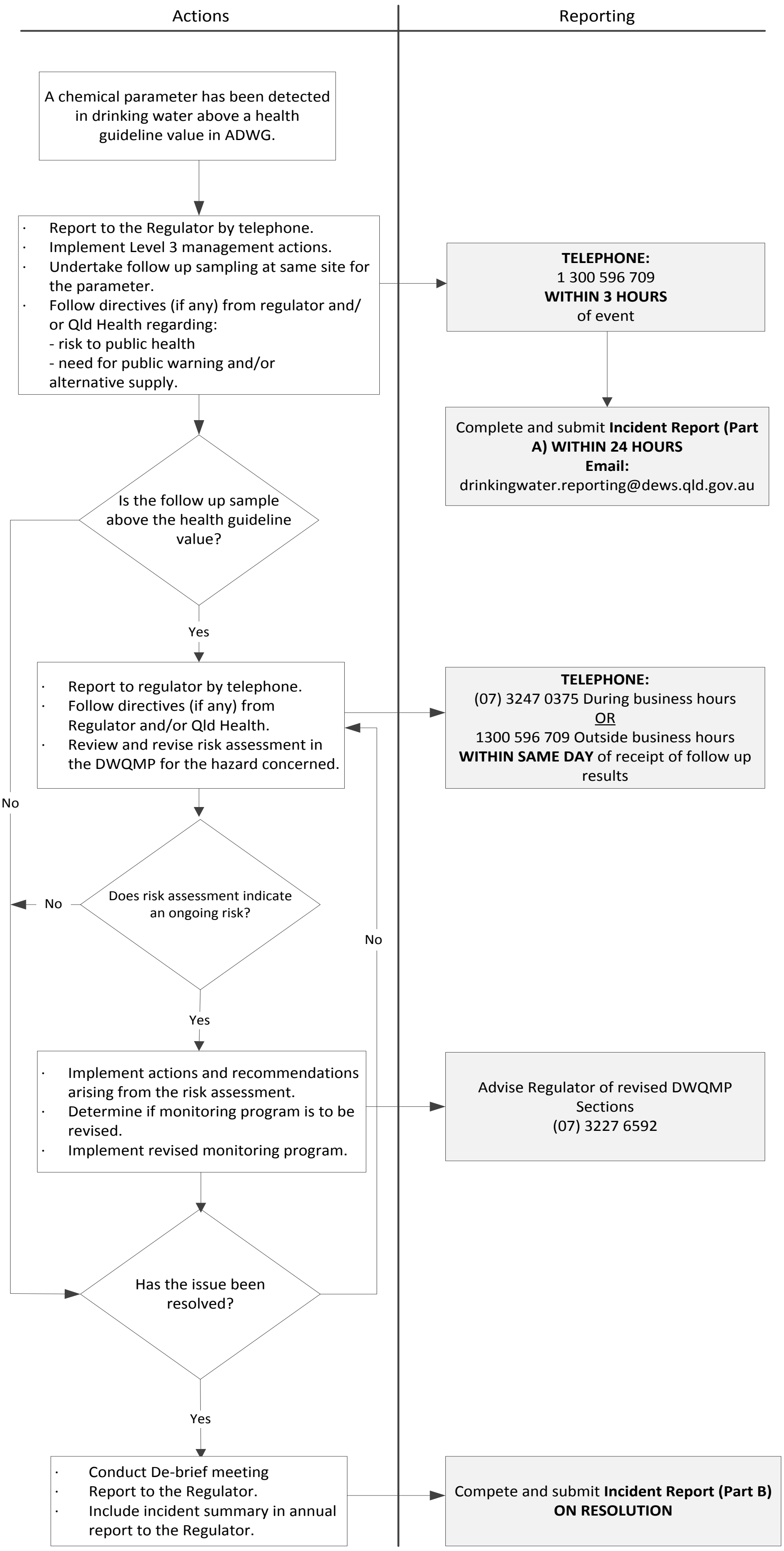


Figure 8 Actions and Reporting for Detection of Chemical Parameters above ADWG Health Guideline Values

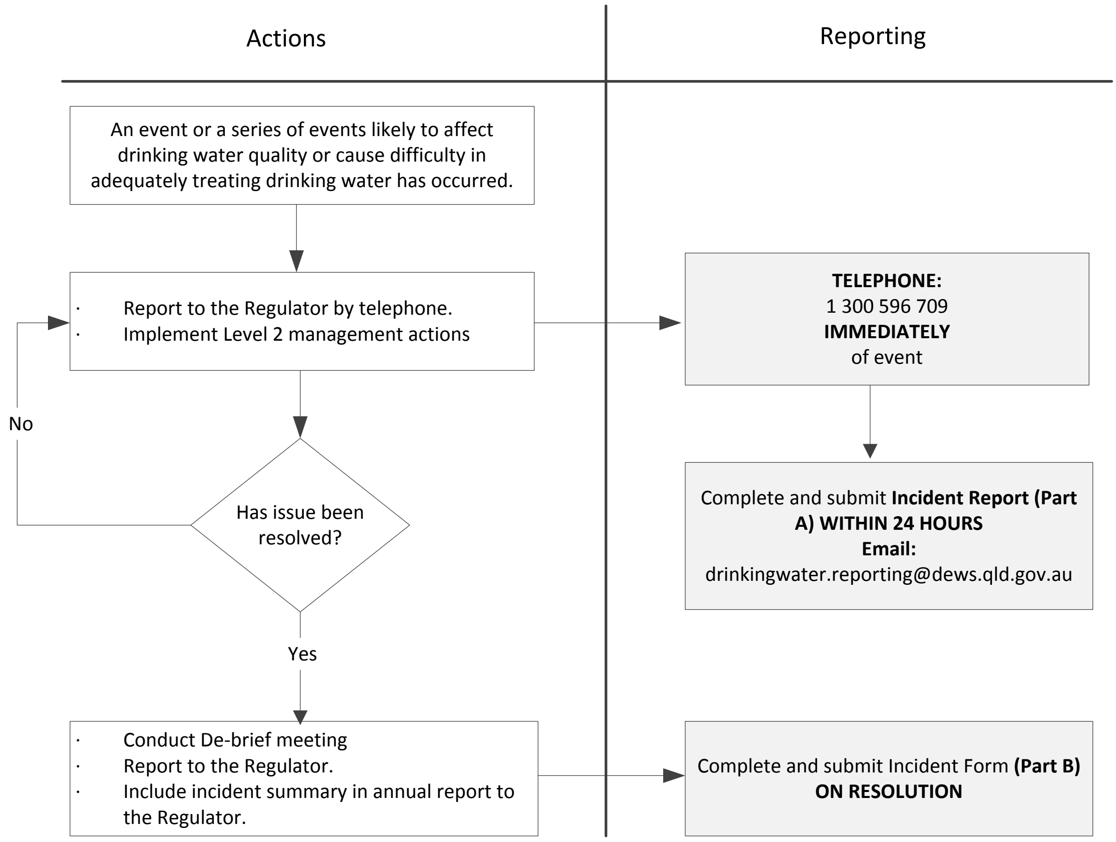


Figure 9 Actions and Reporting for an Event Likely to Affect Drinking Water Quality

7. Staff Training

Incident and emergency response training is essential for the effective implementation of the IERP. Training educates and familiarises staff about incident and emergency situations, resulting effects on water systems and response protocols. Its also provides an opportunity to practice responses.

Training should be conducted at least annually as refresher or when:

- new employees join (part of induction)
- DWQMP is updated or revised, including procedures.

Training should include instructions and explanation of the IERP, including response actions and documenting and reporting requirements.

The staff training records should be kept up-to-date, as required, to reflect the training history, including refreshers.

8. Improvements

A de-brief meeting should be conducted to ensure lessons from an incident or emergency are documented and actions that will prevent a recurrence or improve the response for similar situations are completed.

The meeting may be formal or informal, with outcomes documented in relevant forms for future references:

- Level 1 – CCP Reporting Form (Appendix D, reproduced from the DWQMP)
- Levels 2 to 4 – Part B of the incident reporting form (Appendix C).

The Manager Utility Services is responsible for initiating the de-brief meeting, ensuring the outcomes are documented and implementing actions in order to improve the IERP. The outcomes of the de-brief meeting may include a review of the IERP (discussed in section 9).

9. Review

This IERP should be reviewed annually. Other triggers for review include:

- de-brief meeting outcome following an incident or emergency recommends review of the IERP
- update or revision of the DWQMP, including any key procedures
- immediately upon change in contact information.

The Manager Utility Services is responsible for undertaking the annual review of the IERP.

10. References

Department of Health. (2003). *Emergency Response Planning Guide for Public Drinking Water Systems*. Division of Drinking Water, Washington State Department of Health.

DERM. (2010). *Water Quality and Reporting Guideline for a Drinking Water Service*. Department of Energy and Water Supply, Brisbane.

DERM. (no date). *Drinking Water Quality: Incident Reporting*. Form WSR503 Version 2.

DERM. (no date). *Incident Reporting Protocol Flowcharts*. http://www.nrm.qld.gov.au/water/regulation/pdfs/incident_flowcharts.pdf (Accessed on 15 April 2013).

Mount Isa City Council. (2012). *Drinking Water Quality Management Plan*. Council Office, Mount Isa City Council.

Mount Isa City Council. (2009). *Drought Management Plan / Significant Services Failure Plan*. Appendix O, Total Management Plan for Water Supply and Sewerage Services, Council Officer, Mount Isa City Council.

Mount Isa City Council. (2011). *Local Disaster Management Plan*. Council Office, Mount Isa City Council.

NHMRC & NRMMC 2011, National Water Quality Management Strategy: *Australian Drinking Water Guidelines.* 6th Ed., National Health and Medical Research Council and Natural Resource Management Ministerial Council, Australian Government, Canberra.

NSW Health. (no date). *Example Boil Water Alert E. coli Contamination*. http://www0.health.nsw.gov.au/resources/publichealth/environment/water/pdf/bwa08.pdf (Accessed on 10 April 2013).

Seqwater. (2010). *Incident and Emergency Response Plan*. Brisbane, Australia.

Appendix A

Appendix A Boil Water Notice

Boil Water Notice
E. coli Bacteria Contamination

MOUNT ISA CITY COUNCIL

Regular monitoring for *E. coli* bacteria in the water supply system is conducted by Council. *E. coli* itself is generally not harmful but its presence in drinking water is associated with sewage and animal wastes. The presence of these bacteria indicates that the water may be contaminated with organisms that may cause disease.

Recent monitoring has shown *E. coli* to be present in the water supply system. As a precaution you are advised that water for consumption should be brought to a rolling boil. Water should then be allowed to cool and stored in a clean container with a lid and refrigerated.

Cooled boiled or bottled water should be used for:

- drinking, cooking, washing raw foods (such as seafood or salads), making ice, pet's drinking water and cleaning teeth
- dishes should be washed in hot soapy water or in a dishwasher. Children should take bottled or cooled boiled water to school.

Mount Isa City Council is working to alleviate the problem.

Precautions should be taken until further notice.

Please share this information with other people who drink this water, especially anyone who may not get this notice directly. For further information, contact Mount Isa City Council on (07) 4747 3200.

Appendix B

Appendix B Incident Reporting Form Part A

Drinking Water Quality:
Incident Reporting

Part A (***To be completed and submitted within 24 hours of becoming aware of the incident)***

Tick ***one box only*** to describe the type of incident:
(For Level 3 incidents, please complete all sections)

- ☐ **Detection of Escherichia coli *(E. coli)***
- ☐ **Detection of a pathogen**
- ☐ **Detection of chemical parameter that does not meet a health guideline value in the *Australian Drinking Water Guidelines (ADWG)***
- ☐ **Detection of radioactivity exceeding gross alpha and gross beta screening values in the ADWG**
- ☐ **Detection of parameter for which there is no guideline value in the ADWG**

(For incident Level 2, please complete all sections, except 3)

- ☐ **An event or series of events likely to affect drinking water quality or will cause difficulty in ability to adequately treat drinking water**

1. Drinking water service provider details

Drinking water service provider	SPID
Mount Isa City Council (MICC)	91

Drinking water scheme *(Mt Isa or Camooweal)*

2. Contact Details

Contact person		Position
		Manager Utility Services
Phone number	**Fax number**	**Mobile number**
(07) 4747 3200	(07) 4747 3209	

Postal address

P.O. Box 815 Mt. Isa QLD 4825

Email address

Details of telephone report to the Regulator (Telephone No: 1300 596 709)
Person reported to:

Date reported: / /	Time reported: AM / PM
Regulator assigned incident number:	

MOUNT ISA CITY COUNCIL

For Mt Isa scheme, has Mount Isa Water Board been contacted?
☐*Yes* ☐*No*

Person spoken to:	
Date:	
Time:	
Details *(any issues with bulk supply, actions taken)*	

Have you informed any other organisation/agency about this incident?
If **Yes,** other organization/agency contact details

Organisation/agency name			
Contact name		Date	
Phone number		Email address	
Organisation/agency name			
Contact name		Date	
Phone number		Email address	

3. Sample information

Initial sample

System location	☐ Raw/source water ☐ Transmission ☐ Treated water from water treatment plant ☐ Reticulation
Date sample taken:	Time taken: AM / PM

Parameter (e.g. *E. coli,* Fluoride)

Sample location

Results (e.g. 5 cfu/100mL, 1.7 mL)	Date results received:

Laboratory name where analysis was undertaken

Follow up sample(s)

Have follow up samples taken? *(This must include a sample from the initial location)*
If **Yes,** expected timeframe for receipt of results

Date:	Time: AM / PM

If **No,** expected timeframe for follow up sample(s) to be taken

Date:	Time: AM / PM

4. Incident Information

Describe incident *(e.g. events that led to the incident and the immediate impact. Additional information may be attached).*

5. Immediate corrective actions

Have immediate corrective actions been taken? ☐*Yes* ☐*No*

If **Yes,** please describe action taken (*e.g. what and when corrective action took place and if any public health notification has already taken place, or will be required? Additional information may be attached).*

If **No,** please explain reasons why immediate corrective actions have not been taken (*Additional information may be attached).*

6. Signature

Name:	
Signature:	**Date:**

7. Submission

Please complete and sign the form and **send** to Queensland Water Supply Regulator **Facsimile:** (07) 3224 7999 **or** **Email:** drinkingwater.reporting@dews.qld.gov.au

Appendix C

Appendix C Incident Reporting Form Part B

Part B ***(To be completed during de-brief meeting when incident has been resolved and no further action required)***

Regulator assigned incident number (from Part A):

De-brief Meeting

Date: / / /	Time: AM / PM
Attendees:	

1. What did you do to investigate the incident? *(Additional information may be attached).*

2. What did you find? *(Additional information may be attached).*

3. What actions did you take to correct the problem? *(Additional information may be attached).*

4. What actions did you take to prevent the incident occurring again?

(Additional information may be attached)

5. Provide evidence that demonstrates that the incident has been resolved *(E.g. results of follow up sampling. Additional information may be attached).*

6. Signature

Name:	
Signature:	**Date:**

7. Submission

Please complete and sign the form and **send** to Queensland Water Supply Regulator

Facsimile: (07) 3224 7999 **or** **Email:** drinkingwater.reporting@dews.qld.gov.au

Appendix D

Appendix D CCP Reporting Form

CCP Reporting Form

Section A – Limit Exceedence (Operator to Complete this Section)

1. Which CCP has been exceeded?			
	CCP 1 Chlorine residual		

2. Sample information			
Date taken: / /		Time taken: AM/PM	
Chlorine alert / critical	Limit:	Result:	

3. Describe the issue.

4. What corrective action did you take?

5. Have additional samples been taken and did they verify the exceedence?

Section B – Critical Limit Exceedence (Manager Utility Services to Complete this Section)

1. What investigations have been undertaken?

2. What is the reason for this exceedence?

3. Were the corrective actions taken successful? (provide details)

4. Were the preventive measures in place effective? (provide details)

5. Are any improvements required to prevent future exceedences?

www.viridis.net.au

Mount Isa City Council

Standard Operating Procedures

July 2013

Mount Isa City Council

Standard Operating Procedures

Viridis Consultants Pty Ltd
GPO Box 135
Brisbane Qld 4001
Australia
www.viridis.net.au
ABN: 49 129 185 271

Telephone: 1300 799 310
Facsimile: 1300 799 350

Date: 29 July 2013
Reference: 13QU04
Status: Final

Citation: Tasleem Hasan and Mena Reyes 2013, Mount Isa City Council - Standard Operating Procedures, prepared for Mount Isa City Council by Viridis Consultants Pty Ltd.

Contents

Appendices

Document History and Status

Revision	Date issued	Approved by	Date approved	Revision type
0.1	03/07/13	James Howey	08/07/13	Draft
1.0	09/07/13	James Howey	09/07/13	Final

Author:	Tasleem Hasan and Mena Reyes
Project manager:	Tasleem Hasan
Name of client:	Mount Isa City Council
Name of project:	DWQMP Procedures
Name of document:	Standard Operating Procedures
Document number	Rec-13-039
Document version:	1.0
Project number	13QU04

1. Introduction

The importance of a consistently safe water supply to the community cannot be overstated. It is essential for a drinking water service provider to take adequate management actions to prevent any source of contamination. The management actions are usually documented as Standard Operating Procedures (SOPs).

The SOPs attached to this document have been prepared in response to the Improvement Plan for the Mount Isa City Council (MICC) Drinking Water Management Plan (DWQMP). The MICC DWQMP was approved by the Regulator in May 2013.

SOPs ensure that the risks to the water service are minimised through staff implementing established procedures. It also ensures minimal disruption to the operations in case of staff turnover.

1.1. Purpose

The purpose of this document is to present the SOPs developed for MICC, as per their Improvement Plan, refer to Appendices A-E.

1.2. Scope

The SOPs attached to this document entail the procedures for the following:

- Mains Hygiene
- Mains Flushing
- Reservoir Cleaning
- Reservoir and Bore Inspections
- Management of Reservoirs

2. Actions and Responsibility

All personnel operating and maintaining the water supply are expected to be fully aware of the SOPs provided in Appendices A-E.

The Manager Utility Services is to ensure that the SOP are current and updated and must provide these SOPs to the Team Leader (Water and Sewer), water staff and contractors for implementation.

3. Recordkeeping

Records associated with each SOP must be maintained appropriately for review, future reference, audits and protection against legal consequence in the future.

Employee training records should be kept up-to-date as required to ensure and reflect that all relevant employees are aware of and understand the SOPs.

Log sheets and checklist should be filed appropriately and must be kept as records.

4. Key Performance Indicator

The SOPs include key performance indicators (KPIs) to reflect the effectiveness of each SOP.

If the KPI is not achieved, the Manager Utility Services must be contacted. The relevant KPIs are included in the respective SOPs.

Appendix A

Standard Operating Procedure – Mains Hygiene

1. Introduction

Works undertaken in drinking water mains associated with either maintenance or repairs requires appropriate hygiene practices in order to prevent cross contamination, which might endanger public health. Therefore, it is vital that all personnel working within Mount Isa City Council (MICC) water supply system take the strictest possible precautions to avoid any contamination when working with drinking water mains.

1.1 Purpose

The purpose of this Standard Operating Procedure (SOP) is to ensure adequate mains hygiene is achieved for the safety of the drinking water quality. It outlines the recommended methodology and responsibilities of water utility staff and contractors to eliminate contamination of potable water during the operation or repair of water mains, or during storage and handling of pipes, fittings, pumps, etc. prior to installation.

1.2 Scope

This SOP applies to the hygienic practices used by water personnel or contractors operating and maintaining water mains in MICC schemes. It is also covers maintaining the hygiene of tools which may come into contact with treated water in the mains.

It does not contain the specific disinfection procedure to follow when repairing mains.

2. Responsibilities

All water staff and contractors undertaking work within the MICC water supply system are responsible for understanding and carrying out the duties outlined in this SOP. Table 1 summarises the key responsibilities for mains hygiene procedure.

Table 1 Mains Hygiene Responsibility

Role / Position	Responsibilities
Manager Utility Services	• Ensure this SOP is current and up-to-date • Ensure staff are trained and competent to implement this SOP • Authorise work in mains • Approve changes to this SOP • Provide contractor a copy of this SOP to use when working on MICC water mains
Team Leader – Water and Sewer	• Implement this SOP • Ensure the water staff undertake the required training and understanding of this SOP • Advice Manager Utility Services on any changes required to the SOP • Ensure contractors follow this SOP
Water Staff	• Understand and implement the procedures • Discuss challenges / issues in implementing this SOP with the Team Leader – Water and Sewer
Contractors	• Apply this SOP when working on MICC mains

3. Procedure

3.1 Hygiene Practice for Tools and Equipment

The following practices are required to reduce the potential for tools and equipment to introduce sources of contamination when water distribution systems are being constructed or have been opened for repairs:

All equipment is to be cleaned of dirt and debris and disinfected using 200 mg/L chlorine solution through spraying or swabbing (refer to section 3.5).

Disinfected tools must not be placed on the ground prior to use.

Where possible, vehicles, tools and equipment and clothing for water supply and sewage operations shall be kept separate.

All materials must be stored and handled in a way that minimises the introduction of foreign materials (e.g. all fitting stored in boxes with lids, all pipes capped).

All vehicles are to have hand-cleaning agents (potable water, antibacterial soap and or wipes; preferably antiseptic) available for staff to use.

3.2 Hygiene Practice for Personnel

The following steps are required to minimise the potential for contamination from personnel when water distribution systems are being constructed or have been opened for repairs:

Staff or contractors should avoid working between water and sewage systems (finish one work at a time), wherever possible. If possible, work on the water system first.

Wash, clean or change working gears when working from wastewater to drinking water.

Where staff are required to work between water and sewage systems, they should ensure their working gear (shoes, clothes) do not come in direct contact with wastewater.

All personnel should wash hands using soap and water or antiseptic hand cream.

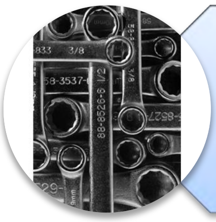
Temporary or permanent toilet facilities must be maintained in a clean and hygienic condition and arrangements must be made for regular and safe disposal of toilet wastes.

Satisfactory toilet arrangements must be made for all personnel working on water supply system and hands must be washed thoroughly after using any toilet facilities.

If personnel have suffered diarrhoea or any notifiable disease or gastrointestinal illness, they should inform the Team Leader (Water and Sewer) and not undertake works that involve direct contact with water supplies until a medical clearance certificate has been obtained stating that they are clear of the disease.

3.3 Hygiene for New Mains

The interiors of pipes, fittings and valves must be kept free from contamination using the following hygiene procedures.

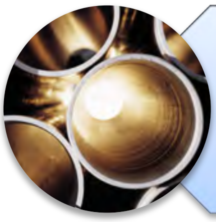


All materials used for the construction of a main must remain in the sealed condition as provided by the manufacturer and not uncovered until immediately before use.

Disinfect with minimum 15 mg/L of chlorine solution (refer to section 3.5). Wash interior and exterior ends using a clean cloth and chlorine solution. A cloth swab soaked in chlorine solution is needed to clean and disinfect the interior of the pipe.

If a main is flooded by storm event during construction, standing water must be drained and the main flushed in accordance with *Mains Flushing SOP.*

If dirt enters a pipe, it must be removed and the pipe swabbed with minimum 15 mg/L of chlorine solution.



All openings in the pipeline must be closed with watertight plugs at the end of the day's work.

A bactericidal lubricant must be used on all rings and gaskets that will be in contact with potable water. Lubricants must be complaint with ASNZS 4020:2005.

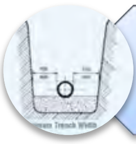
3.4 Hygiene for Mains Repairs

Repairs and maintenance arising during normal operation of existing mains require appropriate hygiene procedures. During a main fracture or repair, extreme care is required to prevent contamination.

Ensure sections 3.1 and 3.2 are followed.

Implement section 3.3 as necessary.

If digging is required, the trench must be dug on both sides of main. Trench water and soil may be contaminated with bacteria.



Ensure trench is deep enough to keep the water adequately below the pipe.

As necessary, ensure safety requirements when working on a confined space is followed.

Use pumps to adequately control the trench water.

Repair the main / pipe break.

During the repair, foreign material shall be prevented from entering the main. The inside of the pipe-work shall always be examined for debris at the completion of the works.

If possible, all temporary connections of reticulated water mains under repair shall incorporate testable double check backflow devices to prevent contamination of the existing reticulation.

After completion of work, follow Mains Flushing SOP.

3.5 Chlorine Solution Calculation and Safety Handling

3.5.1 Chlorine Calculation

- To achieve 200 mg/L of chlorine solution, mix 20 mL of 10% chlorine solution in 10 litres of water.
- To achieve 15 mg/L of chlorine solution, mix 1.5 mL of 10% chlorine solution in 10 litres of water.

3.5.2 Chlorine Safety Handling

Chlorine is a hazardous substance. In solution, it is highly corrosive and splashes can cause burns and damage the eyes. It is mandatory to follow the safety steps when handling chlorine:

- Gloves should be worn and protective eyes glasses are essential.
- In the event of splashes and especially splashes to the eyes, immediately rinse affected areas thoroughly with water.
- All containers in which chlorine is stored should be labelled, identifying the contents and with a hazard warning in a form that is readily understood.
- Storage sites for chlorine in any form should be secured against unauthorized access and especially against children.

4. Recordkeeping

Employee training records should be kept up-to-date as required to reflect that all relevant employees are aware of and understand this SOP.

5. Key Performance Indicator

Signed training record to ensure that employees are aware of this SOP.

In addition, measuring the free chlorine following any mains related work is an indicator that this SOP is being followed in conjunction with other relevant SOPs. The free chlorine reading should be 0.7 – 1.5 mg/L in the reticulation.

If KPI is not achieved, contact Manager Utility Services for further instructions.

6. References

ANSI/AWWA C651-05. (2005). *Disinfecting Water Mains.* American Water Works Association (AWWA). USA.

ASNZS 4020:(2005). *Testing of products for use in contact with drinking water.* Standards Australia. Australia and New Zealand.

Ministry of Health. (2007) *Optimisation of Small Drinking Water Treatment Systems: Resource for the Drinking Water Assistance Programme.* Ministry of Health. Wellington.

Mount Isa City Council. (2012). *Drinking Water Management Plan.* Mount Isa City Council Office.

NHMRC, NRMMC. (2011). *Australian Drinking Water Guidelines Paper 6 National Water Quality Management Strategy*. National Health and Medical Research Council, Natural Resource Management Ministerial Council, Commonwealth of Australian, Canberra.

Queensland Urban Utilities Water Supply Standards. (2010). *QUU Disinfection Procedure Summary – Supplementary Manual to WSA 03.2.* Available online at http://www.brisbane.qld.gov.au/2010%20Library/2009%20PDF%20and%20Docs/2.%20Planning%20and%20Building/2.4%20Common%20building%20projects/appendix_wf_disinfection_procedure_summary.pdf. Accessed on: 04/06/2013.

Water Care. (2013). *Code of Practice for Water Reticulation Disinfection.* Water Care Service Ltd.

Washington State Department of Health. (2011) *Guide for small public water systems using groundwater.* Office of Drinking Water Publications. Available online at: https://fortress.wa.gov/doh/eh/dw/publications/publications.cfm. Accessed on: 03/06/2013.

World Health Organisation. (2013). *Dosing for chlorine – Fact Sheet 2.23.* Available on: www.who.int/water_sanitation_health//hygiene/emergencies/fs2_23.pdf. Accessed on: 01/06/2013.

Glossary

Term	**Definition**
Disinfection	The process designed to kill most microorganisms in water, including essentially all pathogenic (disease-causing) bacteria. There are several ways to disinfect, with chlorine being the most frequently used in water treatment.
Free Chlorine	Generated from combination of chlorine and water and is intended to kill or inactivate pathogenic (disease-causing) microorganisms.
Hygiene	Conditions or practices conductive to maintaining health and preventing disease, especially through cleanliness.
Tools	Tools and equipment can be any instrument required to perform maintenance, which has the potential to enter the potable network asset (directly or indirectly). This includes but is not limited to: • Diving equipment, wetsuits and masks • Ladder • Scaffolding • Measuring equipment • Submersible cameras • Boats • Personnel shoes • Hand-tools

Appendix B

Standard Operating Procedure – Mains Flushing

1. Introduction

Flushing is a necessary water utility task that ensures that water in areas of low flow is turned over and that chlorine residual is maintained in the water. Flushing also removes dirty water in the mains that may be contaminated with iron, manganese, biofilm or other aesthetic related contaminates.

Main breaks or fractures require urgent repairs using approved repairing methods. After repairs or installing new mains, flushing is necessary to ensure there is no contamination introduced that may pose risk to public health.

1.1. Purpose

This Standard Operation Procedure (SOP) describes the procedures for flushing of newly installed mains, repaired mains and dead ends to remove dirty or contaminated water.

The SOP aims to ensure that Mount Isa City Council (MICC) meets the water quality criteria as per their Drinking Water Quality Management Plan (DWQMP).

1.2. Scope

This SOP applies to the flushing of mains following repair, replacement or installation works carried out within the distribution network, as well as general flushing of mains to manage dead ends and respond to customer complaints. This procedure applies to the drinking water schemes managed by MICC.

2. Responsibilities

All water staff and contractors undertaking work within the MICC water supply system are responsible for understanding and carrying out the duties outlined in this SOP. Table 1 summarises the responsibilities of water utility staff for flushing and repairing mains.

Table 1 Mains Flushing Responsibility

Role / Position	**Responsibilities**
Manager Utility Services	• Ensure this SOP is current and up-to-date • Ensure staff are trained and competent to implement this SOP • Authorise work in mains • Approve changes to this SOP • Provide contractor a copy of this SOP to use when flushing or repairing on MICC water mains
Team Leader – Water and Sewer	• Implement this SOP • Ensure the water staff undertake the required training and understand this SOP • Advice Manager Utility Services on any changes required to the SOP • Ensure contractors follow this SOP
Water Staff	• Understand and implement the procedure • Discuss challenges / issues in implementing this SOP with the Team Leader – Water and Sewer
Contractors	• Apply this SOP when flushing or repairing on MICC mains

3. Procedure

3.1 Preparation for Flushing

Ensure the following steps are to be undertaken prior to flushing of mains.

- Determine which sections of the mains are to be flushed at one time, the valves to be used and the order, which the pipelines will be flushed.
- Notify all customers who will be affected of the dates and times of the flushing.
- Traffic control and warning devices are to be used where traffic is being affected.
- Ensure that reservoirs are full to provide adequate amount of flushing water.

3.2 New and Repaired Mains Flushing

Flushing of the water mains is done initially to ensure that there are no debris, dirt and other contaminants left in the pipe. *Mains Hygiene SOP* should be used in conjunction with this SOP.

- Ensure the new or repaired pipe is appropriately disinfected using chlorine (refer to *Mains Hygiene SOP*).
- Where practical, isolate the section to be flushed from the rest of the system. Close the valves slowly to prevent water hammer.
- Flushing velocity should be sufficient to remove foreign matter, use fire hydrants where possible.
- Open hydrant fully for a period long enough (5-10 minutes) to stir up the deposits inside the water main.
- Flush until discoloured water flows clear and odour is eliminated.
- Assure that the system pressures in nearby areas do not drop.
- Record all pertinent data regarding the flushing operation.
- After the flushing, test the free chlorine residuals to ensure they are at 0.7 – 1.5 mg/L.
- Slowly close the hydrant or blow-off valves.
- Air scouring and swabbing the main may be used in replacement of flushing if the pipe diameter cannot develop sufficient velocity.

3.3 General Mains Flushing

General mains flushing are undertaken as part of the flushing program for dead ends or in response to a customer complaint.

- Commence flushing from a hydrant at the downstream end of the section of main to be flushed.
- Open the hydrant slowly. Once it is fully open, allow sufficient flow to provide the desired flushing and achieve a cleansing velocity.
- A minimum flushing velocity should be maintained until a clear, non-turbid flow is achieved.
- System pressure should not drop.
- After flushing, sampling should confirm a minimum chlorine residual of 0.7 – 1.5 mg/L to provide evidence of the effectiveness of the flush.
- Hydrant must be closed slowly to prevent water hammer.
- Flush Mount Isa dead end zones and areas of long detention every week.
- Flush Camooweal scheme every month.

3.4 Watermain Swabbing

In some cases, flushing a water distribution system may not effectively improve water quality or hydraulic capacity. If there is evidence of severe pipe tuberculation or corrosion (e.g. on old cast iron pipes), water treatment chemical build-up or silt/sand build-up, watermain swabbing using a soft foam swab may be required. Qualified professionals should conduct swabbing. Swabbing is normally done in phases working from the source into the distribution system.

4. Recordkeeping

The mains flushing log sheet is provided with this SOP and should be used to record every flushing undertaken within mains and dead ends. The log sheet is maintained by the Manager Utility Services.

5. Key Performance Indicators

After flushing, the water should be:

- not discoloured (visual)
- has no foul odour (sensory)
- free chlorine level between 0.7 – 1.5 mg/L.

If KPI is not achieved, contact Manager Utility Services for further instructions.

6. References

ANSI/AWWA C651-05. (2005). *Disinfecting Water Mains.* American Water Works Association (AWWA). USA.

Mount Isa City Council. (2012). *Drinking Water Management Plan.* Mount Isa City Council Office.

Ministry of Health. (2007). *Optimisation of Small Drinking Water Treatment Systems: Resource for the Drinking Water Assistance Programme.* Wellington: Ministry of Health.

NHMRC, NRMMC. (2011). *Australian Drinking Water Guidelines Paper 6 National Water Quality Management Strategy*. National Health and Medical Research Council, Natural Resource Management Ministerial Council, Commonwealth of Australian, Canberra.

Washington State Department of Health. (2011). *Guide for small public water systems using groundwater.* Office of Drinking Water Publications. Available online at: https://fortress.wa.gov/doh/eh/dw/publications/publications.cfm. Accessed on: 03/06/2013.

MOUNT ISA
CITY COUNCIL

Mains Flushing Log Sheet

Scheme Name	Mains Location	Date & Time	Reason for Flushing	Length of Flushing (min)	After Flushing			Person(s) Flushing	Other Comments
					Colour	Odour	FAC (mg/L)		

Appendix C

Standard Operating Procedure – Reservoir and Bore Inspections

1. Introduction

Regular inspections of reservoirs and bores are essential to monitor and manage potential hazards which may impact on water quality and endanger public health.

Inspections play a key role in operational monitoring and proactive preventive management to reduce risks to water quality.

1.1. Purpose

The purpose of this Standard Operating Procedure (SOP) is to define the inspection programs for Mount Isa City Council (MICC) reservoirs and bores.

1.2. Scope

This SOP covers the inspection methodology and frequency for inspecting bores and reservoirs for MICC drinking water systems. It includes the responsibilities and inspection checklists.

2. Responsibilities

Contractors and approved personnel are responsible for undertaking inspections for bores and reservoirs. Table 1 summarises the key responsibilities for inspections.

Table 1 Inspections Responsibility

Role / Position	Responsibilities
Manager Utility Services	• Ensure this SOP is up-to-date • Ensure staff are trained and competent to implement this SOP • Authorise inspection programs • Approve changes to this SOP • Provide contractor a copy of this SOP to use when inspecting MICC reservoirs and bore
Team Leader – Water and Sewer	• Implement this SOP • Ensure the water staff undertake the required training and understand this SOP • Advice Manager Utility Services of any changes required to the SOP • Ensure contractors follow this SOP
Water Staff	• Understand and implement the procedure • Discuss challenges / issues in implementing this SOP with the Team Leader – Water and Sewer
Contractors	• Apply this SOP when undertaking inspection program for MICC reservoirs and bore

3. Procedure

3.1 Inspection of Reservoirs

- Reservoir inspections are to be undertaken every 6 months by the Team Leader (Water and Sewer) or designated staff.
- The reservoir inspection checklist is to be filled on-site during the inspection (attached to this SOP).
- Any urgent issues / problems which need to be resolved are to be reported to the Manager Utility Services within 24 hours of completing the inspection.

- The inspection checklist should be appropriately filed and maintained for future reference.

3.2 Inspection of Bore

- Bore inspections are to be undertaken every 6 months by the Team Leader (Waste and Sewer) or designated staff.
- The bore inspection checklist is to be filled onsite during inspections (attached to this SOP).
- Any urgent issues / problems which need to be resolved are to be reported to the Manager Utility Services within 24 hours of completing the inspection.
- The inspection checklist should be appropriately filed and maintained for future reference.

4. Recordkeeping

Bore and reservoir checklists (attached to this SOP) should be used for thoroughness and consistency in data and record collection. The records should be filed appropriately.

5. Key Performance Indicator

Any improvement noted in the relevant checklist is attended to in a timely manner and resolved prior to the next scheduled inspection.

6. References

Environmental Protection Agency. (2011). *Service Reservoir Inspection, Cleaning and Maintenance.* Office of Environmental Enforcement. USA.

Federal of Canadian Municipalities and National Research Council. (2003). *Deterioration and Inspection of Water Distribution Systems.* Issue No. 1.1. Canada.

Mount Isa City Council. (2012). *Drinking Water Management Plan.* Mount Isa City Council Office.

Ministry of Health. (2007). *Optimisation of Small Drinking Water Treatment Systems: Resource for the Drinking Water Assistance Programme.* Wellington: Ministry of Health.

National Water Commission. (2010). *Groundwater bore deterioration: schemes to alleviate rehabilitation costs.* Waterlines. Australian Government Canberra.

NHMRC, NRMMC. (2011). *Australian Drinking Water Guidelines Paper 6 National Water Quality Management Strategy*. National Health and Medical Research Council, Natural Resource Management Ministerial Council, Commonwealth of Australian, Canberra.

US Environmental Protection Agency (EPA). (1999). *Uncovered Finished Water Reservoirs Guidance Manual*. Office of Water. United States.

Victorian Government Department of Health. (2009). *Guidelines for private drinking water supplies at commercial and community facilities.* Food and Safety and Regulatory Activities. Melbourne, Australia.

Washington State Department of Health. (2011). *Guide for small public water systems using groundwater.* Office of Drinking Water Publications. Available online at: https://fortress.wa.gov/doh/eh/dw/publications/publications.cfm. Accessed on: 03/06/2013.

Reservoir Inspection Checklist

If any item below is checked "No" it means improvements need to be made, the Manager Utility Services should to be contacted within 24 hours following the inspection.

Drinking water scheme: ____________________ Inspection Date: ________________________

Reservoir Name: _________________________ Inspected by: __________________________

Questions	☐Yes *(Please tick)*	☐No *(Please tick)*	Comments
1. Has the inside of the tank been cleaned within the last five years?			
2. Is the tank overflow pipe and vent screened and is the screen intact?			
3. Is the access hatch locked and properly sealed to prevent roof run-off entering the reservoir?			
4. Are the reservoir roofs or walls free from growing vegetation that could penetrate or compromise the structure?			
5. Is the tank vermin proof (i.e. no possible access point for animals)?			
6. Is the bottom of the tank free from sediment build–up?			
7. Are the storage tank roof, walls, foundation structurally intact without holes and cracks?			
8. Are the water level controls functioning properly?			
9. Is the coating on the inside / outside of the tank in good condition?			

Points to report to Manager Utility services:

____

____

Other comments:

____

____

Bore Inspection Checklist

MOUNT ISA
CITY COUNCIL

If any item below is checked "No" it means improvements need to be made, the Manager Utility Services should to be contacted within 24 hours following the inspection.

Drinking water scheme: ____________________ Inspection Date: ________________________

Bore Name: ______________________________ Inspected by: __________________________

Questions	☐Yes *(Please tick)*	☐No *(Please tick)*	Comments
1. Is the bore head sealed and secured (i.e. no openings or cracks)?			
2. Are the bore fences secured and locked?			
3. Is the bore casing intact?			
4. Is the rising main within the bore free of corrosion?			
5. Is area around the bore free of blockage (i.e. provides good drainage so water does not pool)?			
6. Is the bore site free of foreign materials such as garbage or faecal matter?			
7. Is the bore area free from signs of vandalisms?			

Points to report to Manager Utility Services:

____

____

____

Other comments:

____

____

____

Appendix D

Standard Operating Procedure – Reservoir Cleaning

1. Introduction

A regular cleaning program for reservoirs is essential in a drinking water supply system in order to reduce the potential for microbial, chemical or physical problems. Overtime, reservoirs can become a source of contamination through sediment accumulation, biofilm formation, and introduction of hazards from vermin and roof run-off.

The sediment or sludge at the bottom of the reservoir can serve as breeding ground for bacteria and other microorganisms, which can result in increase of chlorine demand for the system. Hence, reservoirs should be periodically inspected and cleaned.

1.1. Purpose

To ensure appropriate reservoir cleaning is undertaken to maintain the safety of the water. This Standard Operating Procedure (SOP) outlines appropriate reservoir cleaning practices and the responsibilities of Mount Isa City Council (MICC) water staff to carry out the cleaning program.

1.2. Scope

This SOP applies to all reservoirs for the MICC drinking water schemes. It provides a cleaning program, including frequency of cleaning and best practices to consider. This SOP does not detail the cleaning steps.

2. Responsibilities

The Manager Utility Services shall ensure that reservoirs are cleaned and records are maintained. Table 1 summarises the responsibilities for reservoir cleaning.

Table 1 Reservoir Cleaning Procedure Responsibility

Role / Position	Responsibilities
Manager Utility Services	• Ensure this SOP is current and up-to-date • Ensure staff are trained and competent to implement this SOP • Authorise cleaning program • Approve changes to this SOP • Provide contractor a copy of this SOP to use when undertaking cleaning of reservoirs
Team Leader – Water and Sewer	• Implement this SOP • Ensure the water staff undertake the required training and understanding of this SOP • Advice Manager Utility Services on any changes required to the SOP • Ensure contractors follow this SOP
Water Staff	• Understand and implement the procedure • Discuss challenges / issues in implementing this SOP with the Team Leader – Water and Sewer
Contractors	• Apply this SOP when cleaning reservoirs

3. Procedure

3.1 Reservoir Cleaning

- Periodic inspection of reservoirs should be conducted in accordance with the *Bore and Reservoir Inspection SOP*.
- Cleaning should be undertaken following favourable wet season when there are no water restrictions in place.
- Notify all customers who will be affected on the date, time and duration of cleaning, as necessary.
- Inform Mount Isa Water Board and GlencoreXstrate operators to change maximum water level setting for reservoir filling, as per *Management of Reservoirs SOP*.
- Isolate only one tank at a time to maintain supply of water. MICC's reservoirs are configured to allow water to the reticulation (or zone) to come from two reservoirs simultaneously (e.g. reservoir 1 and reservoir 2 both supply water to the low zone.
- All inlet and outlet pipes of the reservoir should be closed off before any cleaning of the internal structure of the reservoir takes place to prevent sediment from entering the distribution network.
- Ensure that the reservoir is drained before starting cleaning procedures.
- All internal surfaces shall be pressure washed to remove all contaminants, loose concrete, chemicals and foreign matter using high-pressured hose.
- The floor should be cleaned off into the scour sump and all solids removed by wet vacuum and disposed of appropriately. Dispose sediment / sludge to wastewater treatment plant.
- Disinfect reservoirs with reference to section 3.2 of this SOP.
- Undertake reservoir cleaning at least once every five years or as required based on findings of the *Reservoir Inspection Checklist.*

3.2 Disinfection of Reservoirs

- If possible use qualified professionals.
- Safety requirements on handling of chlorine and working in a confined space should be followed.
- Method 2 C652-86 (ANSI/AWWA) will be used as it does not require disposal or neutralisation of large amounts of heavily chlorinated water which can be hazardous to the environment. This is explained in the following steps.
- A solution of 200 mg/L chlorine solution (refer to section 3.3) shall be applied directly to the surfaces of all parts of the storage facility which would be in contact with water when the storage facility is full to the overflow elevation.
- The chlorine solution may be applied with suitable brushes or spray equipment.
- The solution shall thoroughly coat all surfaces to be treated, including the inlet and outlet piping, and shall be applied to any separate drain piping.
- Overflow piping need not be disinfected.
- The surfaces disinfected shall remain in contact with the strong chlorine solution for at least 30 minutes
- Wash down the surfaces with potable water and drain off. The drain piping shall be purged of the chlorinated water.
- Open inlet valve to allow treated water into the reservoir, and fill to its overflow level.
- Subject to satisfactory water quality test results (refer to section 5) water may be served to the distribution system.

3.3 Chlorine Calculation

To achieve 200 mg/L of chlorine solution, mix 20 mL of 10% chlorine in 10 litres of water.

4. Recordkeeping

The reservoir cleaning program log sheet is attached to this SOP and should be used to record all cleaning undertaken. The log sheet should be filed appropriately.

5. Key Performance Indicator

The reservoir is returned to service when the free chlorine result is between 0.7 – 2.0 mg/L, 6 hours after the reservoir has been filled with water.

If KPI is not achieved, contact Manager Utility Services for further instructions.

6. References

ANSI/AWWA C652. (2005). *Disinfection of Water-Storage Facilities*. AWWA Publications. USA.

Environmental Protection Agency. (2011). *Service Reservoir Inspection, Cleaning and Maintenance.* Office of Environmental Enforcement. USA.

Ministry of Health. (2007). *Optimisation of Small Drinking Water Treatment Systems: Resource for the Drinking Water Assistance Programme.* Wellington: Ministry of Health.

Mount Isa City Council. (2012). *Drinking Water Management Plan.* Mount Isa City Council Office

NHMRC, NRMMC. (2011). *Australian Drinking Water Guidelines Paper 6 National Water Quality Management Strategy*. National Health and Medical Research Council, Natural Resource Management Ministerial Council, Commonwealth of Australian, Canberra.

US Environmental Protection Agency. (1999). *Uncovered Finished Water Reservoirs Guidance Manual.* Office of Water. USA.

Victorian Government Department of Health. (2009). *Guidelines for private drinking water supplies at commercial and community facilities.* Food and Safety and Regulatory Activities. Melbourne, Australia.

Washington State Department of Health. (2011) *Guide for small public water systems using groundwater.* Office of Drinking Water Publications. Available online at: https://fortress.wa.gov/doh/eh/dw/publications/publications.cfm. Accessed on: 03/06/2013.

Reservoir Cleaning Log Sheet

MOUNT ISA CITY COUNCIL

Scheme Name	Reservoir Location	Date & Time	Reason for Cleaning	Duration of Cleaning	After Cleaning FAC (mg/L)	Person(s) Cleaning	Other comments

Date approved:	Approved by: Mike Jones, Manager Utility Services	Version: 1.0

Appendix E

Standard Operating Procedure – Management of Reservoirs

1. Introduction

Water storage tanks and reservoirs are critical components of distribution systems, yet they can pose a significant challenge for water utilities in terms of management to maintain good quality water. Water quality problems such as loss of residual disinfectant, increase in disinfection by-products (DBPs) and regrowth of bacteria can occur in reservoirs as a result of poor mixing, poor turnover and short-circuiting.

Mount Isa scheme reservoirs 1, 2, 3 and 4 have a common inlet/outlet pipe at the bottom, whereas reservoirs 5 and 6 have separate inlet and outlet pipes on opposite ends at the bottom of the reservoirs. With a common inlet and outlet, the reservoirs can either be filling or emptying. Reservoirs with a common inlet/outlet are liable to turn over water only in the vicinity of the inlet/outlet leaving a large dead zone, which causes increase in water age and loss of chlorine residual.

Due to current reservoir design limitations (inlet and outlet configuration), passive tank mixing approaches are used by MICC. Passive approaches may not promote the proper degree of mixing under some operating conditions, but are simple, reliable and require less maintenance. Active tank mixing approaches are being investigated by MICC.

1.1 Purpose

This SOP describes key actions for management of reservoirs to maintain good water quality whilst in storage.

1.2 Scope

This SOP discusses the method for improving the mixing and turnover of water in MICC's Mount Isa scheme reservoirs. It also makes reference to the *Bore and Reservoir Inspection SOP* and the *Reservoir Cleaning SOP*.

2. Responsibilities

The Manager Utility Services allocates the work to the Team Leader (Water and Sewer), water staff and contractors for the management of reservoir. Table 1 shows the key responsibilities.

Table 1 Responsibility for Managing of Reservoir

Role / Position	Responsibilities
Manager Utility Services	• Ensure this SOP is current and up-to-date • Ensure staff are trained and competent to implement this SOP • Authorise work in reservoirs • Approve changes to this SOP • Provide contractor a copy of this SOP to use when working on Mount Isa reservoirs
Team Leader – Water and Sewer	• Implement this SOP • Ensure the water staff undertake the required training and understanding of this SOP • Advice Manager Utility Services on any changes required to the SOP • Ensure contractors follow this SOP
Water Staff	• Understand and implement the procedures • Discuss challenges / issues in implementing this SOP with the Team Leader – Water and Sewer
Contractors	• Apply this SOP when working on Mount Isa reservoirs

3. Procedure

3.1 Turnover / Mixing

Generally, water usage during winter, May to August, is low (8-10 ML/day) and high (up to 25 ML/day) in summer, September to April.

The procedure implemented by MICC for reservoir turnover and mixing is as follows:

3.1.2 Default Reservoir Levels for Pump Operation

- Winter – low level 40% and high level 60%.
- The Manager Utility Services or designated staff should call the Mount Isa Water Board (MIWB) and GlencoreXstrata operators towards the end of April with the winter reservoir operation levels.
- Summer – low level 60% and high level 80%.
- The Manager Utility Services or designated staff should call MIWB and GlencoreXstrata operators towards the end of August with the summer reservoir operation levels.
- In case of flushing or cleaning of Mount Isa scheme reservoirs, inform MIWB and GlencoreXstrata operators to change maximum water level to 95%. Change back to default level afterwards.

3.1.2 Facts to Consider

When changing the reservoir operation water level, the Manager Utility Services and Team Leader (Water and Sewer) should consider the following facts:

- water demand
- water restriction levels during drought periods
- minimum level to maintain system pressure
- minimum level for contingency in terms of lost supply and fire fighting
- need to decrease water age by reducing maximum water level
- impact on chlorine levels
- pumping cycle, time between start and stop
- ensure that pumps run everyday

3.2 Residual Chlorine

Maintaining adequate chlorine residual in the reservoirs is an important control against re-contamination of treated water. MICC ensures this through implementing the critical control point (CCP) procedure for free chlorine as per their Drinking Water Quality Management Plan.

3.3 Reservoir Cleaning and Inspection

Cleaning and inspection are important actions for the management of reservoirs. MICC ensures this through implementing:

- *Reservoir Cleaning SOP*
- *Bore and Reservoir Inspection SOP.*

4. Recordkeeping

The CCP reporting form is used to record actions undertaken to maintain adequate chlorine levels. Record keeping for reservoir cleaning and inspection is described in the relevant SOP.

5. Key Performance Indicator

Effective management of reservoirs should ensure that the residual chlorine level is maintained between 0.7 mg/L to 1.5 mg/L.

6. References

Ministry of Health. (2007). *Optimisation of Small Drinking Water Treatment Systems: Resource for the Drinking Water Assistance Programme.* Wellington: Ministry of Health.

Mount Isa City Council. (2012). *Drinking Water Management Plan*. Mount Isa City Council Office.

New Zealand Ministry Health. (2005). *Guidelines for Drinking Water Quality Management for New Zealand.* New Zealand Ministry of Health. New Zealand.

NHMRC, NRMMC. (2011). *Australian Drinking Water Guidelines Paper 6 National Water Quality Management Strategy*. National Health and Medical Research Council, Natural Resource Management Ministerial Council, Commonwealth of Australian, Canberra.

US Environmental Protection Agency. (1999). *Uncovered Finished Water Reservoirs Guidance Manual.* Office of Water. USA.

Victorian Government Department of Health. (2009). *Guidelines for private drinking water supplies at commercial and community facilities*. Food and Safety and Regulatory Activities. Melbourne, Australia.

Washington State Department of Health. (2011). *Guide for small public water systems using groundwater*. Office of Drinking Water Publications. Available online at: https://fortress.wa.gov/doh/eh/dw/publications/publications.cfm. Accessed on: 03/06/2013.

VIRIDIS CONSULTANTS

www.viridis.net.au