

APPENDIX I

DISINFECTION OF WATER MAINS

WATER QUALITY COMPLIANCE SPECIFICATION

11. Scope

This Appendix addresses the construction, disinfection, testing and acceptance and notification of results for new water mains, as well as neutralisation measures for disinfectant water before reuse or discharge to the environment.

12. Purpose

This Appendix has been established as a typical specification for water quality compliance testing for new drinking water and non-drinking water supply systems. Water Agencies may adopt as defined or with modification to reflect Water Agency water quality requirements.

Where the SEQ water service provider has procedures or technical specifications that are linked to mandatory Drinking Water Quality Management Plans these procedures and technical specifications are to be read in conjunction with this Appendix and must be complied with in full. In the event that the said procedures and guidelines conflict with the requirements of this Appendix, the procedures and guidelines shall prevail.

Many new water mains are constructed each year for developments or as part of the replacement/renewal of existing mains.

The Australian Drinking Water Guidelines and applicable Queensland acts and regulations, e.g. [Water Supply \(Reliability and Safety\) Act 2008](#), focus on the Water Agency maintaining risk management plans for the water supply system from the catchment to the customer's tap.

A water quality compliance specification for new mains is typically adopted as part of the Water Agency's risk management plan. It embraces the Hazard Analysis and Critical Control Point (HACCP) principles by reducing risks to hazards/contamination and verifying that the water quality is compliant with the Water Agency requirements before a new main is accepted into service and the water is made available for use.

It is the responsibility of the Designer to include a water quality compliance specification for new mains complying with this Appendix in the Project Specification for the Constructor.

13. Summary of requirements

New water mains shall be constructed to minimise the risk of contamination of the water. The measures for prevention of contamination and requirements for mains cleaning are provided in [Clause 15](#). Any contaminating materials shall be removed by swabbing and flushing.

The water from new mains shall be tested by a recognised test laboratory for compliance with water quality requirements nominated by the Water Agency before the main can be accepted for service. The Water Agency requirements for water quality test results are provided in [Annexure 1](#). Requirements of a recognised test laboratory are provided in [Annexure 2](#).

Water quality test results shall be submitted to the Water Agency as evidence that the water quality complies with the requirements. Where test results do not comply, further mains cleaning works shall be undertaken before re-sampling and retesting until all test results comply.

Water mains shall be disinfected by the Water Agency or by an approved water mains disinfection contractor to achieve a minimum chlorine contact time (C.t) value (Refer to [Clause 15](#)) prior to sampling and testing at locations identified on the Design Drawings and approved by the Water Agency.

NOTE: Some Water Agencies may exempt particular mains diameters from disinfection. Where exemption is granted, compliance with water quality testing is still required.

The water from all disinfected mains shall be treated (e.g. pH corrected, filtered and de-chlorinated, as required, to meet the relevant discharge quality requirements) before reuse or discharge to the environment.

14. Preventative Measures

14.1 General

Preventing contamination of drinking and non-drinking water in all parts of the water supply system from catchment to customer's tap is the focus of the risk management plans/HACCP plans maintained by the Water Agency. It is essential that the requirements of this Clause be followed to reduce the risks of contamination. Preventing contamination at this early stage of a system's life is relatively easy and low cost because it is the last time the asset is readily accessible.

Only products that comply with WSAA or Water Agency Product Specifications shall be used in the construction of drinking water mains, since it is a requirement of these specifications that these products comply with AS/NZS 4020.

14.2 Keeping items clean and dry

14.2.1 Storage

Items such as pipes, fittings, valves, gaskets, seals etc. and materials such as jointing lubricants delivered for construction shall be stored and handled so as to minimise contamination by foreign materials. Delay in placement of delivered items invites contamination. The more closely the rate of delivery is related to the rate of pipelaying, the less likelihood of contamination.

Pipes shall be capped during storage where there is a specific risk of contamination.

Where specified, fittings, valves, gaskets, seals and other appurtenances shall be boxed, capped or sealed with plastics wrapping during storage. Jointing lubricants shall be stored in sealed containers kept in a clean condition at all times.

14.2.2 Temporary capping during construction

During and after pipelaying operations, the contractor shall supply and use exclusion caps, plugs or blank flanges of approved design to seal all open ends of pipes, fittings and valves at all times.

14.3 Cleaning Methods

All mains, including those that are swabbed and mains that are less than DN100 (i.e. typically DN40, DN50 and DN63) shall be flushed at flow > 7.5 L/s for at least 5 minutes for every 100 m of main or part thereof. For larger diameter (typically \geq DN200) mains it is necessary to open several standpipes to achieve sufficient flow to achieve the necessary scouring velocity. A flow velocity of >1 m/sec is recommended.

NOTE: A fully open hydrant with average system hydraulic pressure (30 – 50 m) will typically flow at 10 L/s or more. A high flow is required to generate a water velocity that will re-suspend, carry and discharge small particulate material. Recommended velocity is > 1 m/sec.

All mains shall be disinfected after swabbing (Refer to [Clause 15](#)).

Mains larger than DN 750 may be manually cleaned in stages by sweeping and hosing and sealing after completion of all internal works and prior to disinfection.

15. Disinfection and neutralisation of disinfectant

15.1 General

Disinfection of new water mains shall be carried out by the Water Agency or an independent approved contractor.

All water mains shall be disinfected using chlorine as the disinfectant in the form of sodium hypochlorite solution. Alternatively, other disinfectants, acceptable to the Water Agency, e.g. ozone may be used.

The disinfectant shall be added to the water main via a suitable injection point just downstream (within 3 m) of the connection of the new main to the existing main – a hydrant is a suitable injection point.

The disinfectant shall be discharged from the end of the water main via a suitable discharge point with a portable flow meter to measure discharge flow – a hydrant or other suitable control valve is a suitable discharge point.

The disinfectant shall be injected into the main when there is a known water flow measured using the discharge flow meter, which shall be adjusted to match the disinfectant dose.

The flow of disinfectant into the new main shall be calculated to achieve a minimum continuous residual of at least 5 mg/L of chlorine.

The injection of the disinfectant shall be terminated when the free chlorine residual (FCR) in the discharge water is 5 mg/L or greater.

The disinfected new main shall be isolated from the existing supply to prevent backflow during the contact period by closing the control valve.

The disinfectant must stay in the new main for a minimum contact time of at least 1 hour to achieve a minimum C.t value of 5 mg.h/L i.e. 5 mg/L of chlorine for a 1 h period, or 2.5 mg/L of chlorine for 2 h. See [Table II](#).

The FCR shall then be measured at 15 minute intervals.

NOTE: The measured FCR in the discharge water will decrease with time. The contact time should therefore continue until the minimum C.t value is achieved – refer to **Table II**.

If the FCR has dropped below 3 mg/L within 15-30 minutes, repeat the chlorine dosing procedure. If the rate of chlorine decay is still unacceptable, repeat the mains cleaning procedure.

At the end of the contact time, the chlorine in the water in the new main shall be dechlorinated before the water is reused or discharged to the environment.

Dechlorination can be achieved using various agents such as sodium thiosulphate, sodium ascorbate or hydrogen peroxide. FCR measurements of the discharge water must be taken to confirm at least < 0.1 mg/L residual chlorine levels to verify dechlorination.

An alternative dechlorination method is to capture the disinfected water and contain it on site to allow the chlorine to dissipate. A minimum of 2 days containment period, including exposure to sunlight, is recommended before the water can be discharged to the environment but not before FCR measurements of the discharge water have been taken to confirm at least < 0.1 mg/L residual chlorine.

The following parameters shall be recorded:

- (a) volume of water in the main to be disinfected, kL;
- (b) volume of disinfectant, L;
- (c) FCR at end of dosing, mg/L;
- (d) FCR at 15 minute intervals during the required contact time, mg/L;
- (e) contact time, h;
- (f) dechlorination method used;
- (g) three FCR measures during discharge using the specified dechlorination method; mg/L;
- (h) containment period (if applicable), h;
- (i) one FCR measure before reuse or discharge at the end of the on-site containment dechlorination method, mg/L.

TABLE II – C.t VALUES
MINIMUM CHLORINE RESIDUAL/CONTACT TIME (C.t) FOR THE DISINFECTANT
(BASED ON THE LOWEST MEASURED FCR)

Chlorine Residual (C) mg/L during time t	Minimum Contact Time (t) hours
5.0 or greater	1 hour
4.0	1.25 hours
3.0	1.7 hours
2.5	2 hours
2.0	2.5 hours

NOTE: Experience has shown that a free chlorine residual less than 2 mg/L, especially when the feed water is chloraminated, is not stable and may undergo a backward reaction into combined chlorine.

15.2 Safety

Chlorine disinfectants and chlorine neutralising agents are harmful substances. Manufacturer's specification and Material Safety Data Sheets must be followed when using, storing, handling, etc.

16. Sampling

16.1 General

As per Clause 19.7.2, water samples shall be collected from the identified locations by a recognised test laboratory (Refer to [Annexure 2](#)) after final swabbing / flushing / hydrostatic pressure testing and disinfection/ removal of disinfectant.

Satisfactory completion of all water quality testing is required prior to completion of connection of the new mains to the existing system and final system commissioning.

The Designer shall include a requirement in the Specification for the Constructor to:

(a) record the exact location of each sample site for appropriate referencing by the laboratory and for the Water Agency; and

(b) arrange for collection of at least one sample for each Sample Set. Refer to the flowchart of the sampling/testing process shown in [Annexure 3](#).

16.2 Sample set A – Existing main

The Designer shall include a requirement in the Specification for the Constructor to have one sample taken from a verification sample point located in the reservoir supply zone. The Designer shall contact the Water Agency for this information. The sample shall be collected by a NATA accredited sampling personnel.

UW:

Contractors are not permitted to access verification sample points. Instead, existing main samples must be collected from a hydrant or a customer tap (provided they are connected to the existing main and permission is granted). If a hydrant is used, the hydrant and standpipe should be appropriately disinfected through thorough application of a 1000mg/L or greater chlorine spray solution (visible dirt will need to be removed first). Additionally, E. coli is not to be analysed on any hydrant sample due to the risk of obtaining a false positive.

16.3 Sample set B – New main

The Designer shall include a requirement in the Specification for the Constructor to have at least one sample taken at the mid-point of the feeder section of the new mains system, located centrally within system as well as additional samples if the system has more than five (5) branch mains and/or dead-ends.

The Designer shall identify on the Design Drawings the location for the samples to be taken and provide the appropriate sample location reference(s) for the laboratory and the Water Agency.

The Water Agency may direct more and/or alternative sample locations.

17. Tests

The collected water samples shall be tested by an independent approved NATA certified laboratory (Refer to [Annexure 2](#)) for the physical, chemical and microbiological parameters specified in [Annexure 1](#) (Refer to the flowchart of the sampling/testing process shown in [Annexure 3](#)).

18. Acceptance of Test Results

18.2 All results – Sample set A (existing) and set B (new mains)

The water quality results shall be deemed satisfactory if they are within the limits for all parameters specified in [Annexure 1](#).

18.3 Non-compliant results for sample set A – existing main

For test results outside the limits specified in Annexure 1, the Water Agency shall be advised.

The Water Agency may take appropriate action carrying out rectification works on the existing main to ensure that the water quality complies with the limits before the new main is accepted into service.

In situations where the existing main fails to meet the water quality tolerance limits detailed in Annexure 1 the SEQ water service providers may, if appropriate, accept the new main however leave it isolated until the overarching water quality issue is resolved.

18.4 Non-compliant results for sample set B – New main

For test results outside the limits specified in [Annexure 1](#), the Designer shall include a requirement in the Specification for the Constructor to carry out rectification works on the new main to ensure that the water quality complies with the limits before the new main is accepted into service. Rectification works shall be specified as follows:

- (a) For microbiological quality parameters, the new main/s shall be flushed or swabbed and flushed in accordance with [Clause I4.3](#), and, if required, disinfected in accordance with [Clause I5](#), until the follow up samples comply with all parameters.
- (b) For the chemical and physical quality parameters, retest for the parameter(s) that failed. If the follow up sample(s) comply with the limits then no further works are required. If the follow up sample(s) fail again, the new main(s) shall be flushed or swabbed and flushed in accordance with [Clause I4.3](#), and, if required, disinfected in accordance with [Clause I5](#), until the follow up samples comply with all parameters.

A summary flowchart of the sampling/testing process is shown in [Annexure 3](#).

19. Notification

The Designer shall include a requirement in the Specification for the Constructor to:

- (a) notify the Water Agency:
 - (i) if any sample is reported to contain *E.coli*, immediately after the result is available;
 - (ii) if any non-compliant results for the other parameters are reported within 24 hours of results being available; and
- (b) provide a copy of:
 - (i) test results with sample site references within 48 hours of results becoming available; and
 - (ii) records for disinfection and neutralisation (refer to [Clause I5.1](#)).

ANNEXURE 1

Drinking Water:

Sample test results for the existing and new systems need to demonstrate compliance with the drinking water quality parameter limits defined with Table below (and/or specified by Water Agency).

The following tolerance between the existing and new systems parameter limits shall be achieved prior connection and commissioning of the new system with the existing systems.

DRINKING WATER QUALITY PARAMETER SAMPLE TOLERANCE LIMITS

For both drinking and non-drinking water pipe acceptance tests

Parameter	Units See Notes 3 to 8	Sample set A Existing main Default limits	Sample set B New main Default limits
PHYSICAL PARAMETERS			
pH		>6.5 and <8.5 ²	>6.5 and <9.2 (Note 2)
Colour	PCU	<15	<15
Turbidity	NTU	<5	< 5 (Note 9)
EC	µS/cm	≤1250	≤1250
CHEMICAL PARAMETERS			
Free chlorine residual health	mg/L		<3
Total chlorine residual	mg/L		<3
MICROBIOLOGICAL PARAMETERS			
<i>E.coli</i>	cfu/100 mL	<1 (Note 10)	<1
Total coliforms	cfu/100 mL	<1	<1 (Note 1)
Heterotrophic plate count	cfu/mL	<100	<100

NOTES:

1. A result of <10 cfu/100 mL may be accepted by the Water Agency if total chlorine is greater than 0.5 mg/L and chlorination documentation verifies that the minimum testing, free chlorine residual and Ct criteria specified in I5.1 were achieved.
2. 9.2 allowed for pH for new cement lined mains
3. PCU = Platinum Cobalt Units
4. NTU = Nephelometric Turbidity Units
5. µS/cm = microsiemens per centimetre
6. mg/L = milligrams per litre
7. cfu/100 mL = colony forming units per 100 millilitres
8. cfu/mL = colony forming units per millilitre
9. The Water Agency may require investigation and further action if the turbidity of sample B exceeds the turbidity of sample A by more than 2 NTU.
10. **UW:** This criterion is not relevant for hydrant samples.

ANNEXURE 2

RECOGNISED TESTING LABORATORY AND ANALYSIS

A recognised testing laboratory is one that is:

1. **certified** by the National Association of Testing Authorities (NATA) having a scope of **certification** covering the testing for all parameters listed in **Annexure 1**.
or
2. accredited by an International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Arrangement (MRA) signatory and having a scope of **certification** covering the testing for all parameters listed in **Annexure 1**.

Additionally the testing laboratory shall employ drinking water analysts approved by the Water Agency except for Victoria where drinking water analysts are approved and listed by the Victorian Department of Human Services for analysing *E.coli* and turbidity parameters pursuant to the Safe Drinking Water Regulations (SDWR) 2005. For a list of approved Drinking Water Analysts and Laboratories for Victoria refer to the Department of Human Services (DHS) Victoria website <http://www.health.vic.gov.au/environment/water/d-guidelines.htm>.

It is recommended that Water Agencies adopt the list of approved drinking water analysts published by the Victorian Department of Human Services unless their relevant Health Departments have established a similar listing scheme.

ANNEXURE 3

FLOWCHART – WATER QUALITY COMPLIANCE FOR NEW MAINS

