

APPENDIX I

DISINFECTION OF WATER MAINS

WATER QUALITY COMPLIANCE SPECIFICATION

I1 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.

I2 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.

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

The water quality from new mains must comply with Water Agency Licence requirements before the water is suitable for use. In the case of drinking water it must be safe, clear and free from objectionable taste and odour. In the case of non-drinking water it must be safe for its intended purpose and meet any required aesthetic requirements.

The Australian Drinking Water and Recycled Water Guidelines and applicable state and territory acts and regulations, e.g. the Victorian Safe Drinking Water Act 2003 and Regulations 2005, all 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.

I3 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 I5](#). 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 an independent approved water mains disinfection contractor to achieve a minimum chlorine contact time (C.t) value (Refer to [Clause I5](#)) 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.

I4 Preventative measures

I4.1 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 and non-drinking water mains, since it is a requirement of these specifications that these products comply with AS/NZS 4020.

I4.2 Keeping items clean and dry

I4.2.1 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.

I4.2.2 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.

I4.3 Cleaning methods

All new mains DN 100 and larger shall be swabbed to remove any deleterious material. Swabbing shall be carried out in accordance with Section 18.

All mains, including those that are swabbed and mains that are less than DN 100 (i.e. typically DN 40, DN 50 and DN 63) 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 ≥DN 200) 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 I5](#)).

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.

I5 Disinfection and neutralisation of disinfectant

I5.1 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 I1](#).

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 I1](#).

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 I1 – 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.

I5.2 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.

I6 Sampling

I6.1 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](#).

I6.2 Sample set A – Existing main

The Designer shall include a requirement in the Specification for the Constructor to have one sample taken from an external hose tap adjacent to the meter at a property already supplied from the existing main provided:

- (a) the sample location is located within 500 m of the connection point; and
- (b) permission from the property owner or tenant has been obtained.

An option shall be included in the Specification, where it is not practicable to take a sample from an external hose tap at a property on the existing main, for the Constructor to collect a sample from a fire hydrant on the existing main after it has been flushed at a minimum flow of 0.5 L/s for a minimum of 5 minutes.

Whichever sample point is chosen, it shall be flamed i.e. application of heat to the sample point in order to disinfect the sample point.

I6.3 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.

I7 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](#)).

I8 Acceptance of Test Results

I8.2 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](#).

I8.3 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.

I8.4 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 the new main/s shall be flushed or swabbed and flushed in accordance with [Clause I6.3](#), 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 I6.3](#), 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](#).

I9 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 19.2 (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

Parameter	Units See Notes 3 to 9	Sample set A Existing main Default limits	Sample set B New main Default limits	ADWG ¹ Recommended limits
PHYSICAL PARAMETERS				
pH		As measured and within ADWG limits >6.5 and <8.5 ²	Within ADWG limits & "A" ± 0.5 (Note 2)	> 6.5 and < 8.5 ²
Apparent Colour	PCU	As measured and within ADWG limits ≤15	Within ADWG limits & <("A" + 5)	≤15
Turbidity	NTU	As measured and within ADWG limits ≤5	Within ADWG limits & <("A" + 0.5)	5
EC	mS/cm	As measured and within ADWG limits ≤1250	Within ADWG limits & <("A" + 50)	~1250
CHEMICAL PARAMETERS				
Free chlorine residual health	mg/L	As measured and within ADWG limits <5	Within ADWG limits & "A" ± 0.2	<5
Free chlorine residual aesthetic	mg/L	As measured and within ADWG limits <0.6	Within ADWG limits & "A" ± 0.2	<0.6
Total chlorine residual	mg/L	As measured and within ADWG limits <5	Within ADWG limits & "A" ± 0.2	<5
MICROBIOLOGICAL PARAMETERS				
<i>E.coli</i>	orgs/100 mL	As measured and within ADWG limits <1	Within ADWG limits	<1
Total coliforms	cfu/100mL	No ADWG limits available recommend <1	Within recommended limits & <2 x "A"	Recommended limit <1 (Note 10)
Heterotrophic plate count	cfu/mL	As measured and within ADWG limits <100	Within ADWG limits & <2 x "A"	Recommended limit <100 (Note 10)

NOTES:

- 1 ADWG = Australian Drinking Water Guidelines 2004 (NHMRC)
- 2 9.2 allowed for pH only for extreme cases
- 3 "A" = the actual test result for the relevant parameter for Sample set A (existing main)
- 4 PCU = Platinum Cobalt Units
- 5 NTU = Nephelometric Turbidity Units
- 6 mS/cm = microsiemens per centimetre
- 7 mg/L = milligrams per litre
- 8 cfu/100 mL = organisms per 100 millilitres
- 9 cfu/mL = organisms per millilitre
- 10 This limit is advisory as there is no specific recommended limit in ADWG

Non-Drinking Water:

For non-drinking water quality parameter limits, use a risk-based approach as outlined in the “Australian Guidelines for Water Recycling (AGWR): Managing Health and Environmental Risks 2006”.

The Water Agency should develop and use parameter limits appropriate to the end use (i.e. fit for purpose) for the commissioning of new mains for uses such as dual reticulation, industrial and agricultural (irrigation). For example, non-drinking water supplied for residential purposes in dual reticulation requires a higher quality product and thus more stringent commissioning limits than recycled water supplied for irrigation or agricultural purposes.

As a guide, the following tolerance between the existing and new systems may be used:

NON-DRINKING WATER QUALITY PARAMETER SAMPLE TOLERANCE LIMITS

Parameter	Units See Notes 3 to 8	Sample set A Existing main Default limits	Sample set B New main Default limits	AGWR ¹ Recommended limits
PHYSICAL PARAMETERS				
pH		As measured and within AGWR limits >6.5 and <8.5 ²	Within AGWR limits & “A” ± 0.5 (Note 2)	> 6.5 and < 8.5 ²
Apparent Colour	PCU	As measured and within AGWR limits ≤25	Within AGWR limits & < (“A” + 5)	≤25
Turbidity	NTU	As measured and within AGWR limits ≤5	Within AGWR limits & < (“A” + 0.5)	5
EC	mS/cm	As measured and within AGWR limits ≤1250	Within AGWR limits & < (“A” + 50)	~1250
CHEMICAL PARAMETERS				
Free chlorine residual health	mg/L	As measured and within AGWR limits <5	Within AGWR limits & “A” ± 0.2	<5
Free chlorine residual aesthetic	mg/L	As measured and within AGWR limits <0.6	Within AGWR limits & “A” ± 0.2	<0.6
Total chlorine residual	mg/L	As measured and within AGWR limits <5	Within AGWR limits & “A” ± 0.2	<5
MICROBIOLOGICAL PARAMETERS				
<i>E.coli</i>	orgs/100 mL	As measured and within AGWR limits <10	Within AGWR limits ≤ “A”	<10 (Note 10)
Total coliforms	cfu/100mL	No AGWR limits available recommend <1	Within recommended limits & < 2 x “A”	<1 (Note 10)

NOTES:

- 1 AGWR = Australian Guidelines for Water Recycling: Managing Health and Environmental Risks 2006
- 2 9.2 allowed for pH only for extreme cases
- 3 "A" = the actual test result for the relevant parameter for Sample set A (existing main)
- 4 PCU = Platinum Cobalt Units
- 5 NTU = Nephelometric Turbidity Units
- 6 mS/cm = microsiemens per centimetre
- 7 mg/L = milligrams per litre
- 8 $\text{cfu}/100 \text{ mL}$ = organisms per 100 millilitres
- 9 cfu/mL = organisms per millilitre
- 10 This limit is advisory as there is no specific recommended limit in AGWR. Adopt a limit appropriate to the end use.

ANNEXURE 2

RECOGNISED TESTING LABORATORY AND ANALYSIS

A recognised testing laboratory is one that is:

1. accredited by the National Association of Testing Authorities (NATA) having a scope of accreditation 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 accreditation 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

