

Procedure for Disinfecting Watermains

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TS 7.30.01 SCOPE

This procedure covers the disinfection of watermain systems. This procedure applies to new mains, cleaned mains, cleaned and relined mains, repaired mains, temporary mains and mains that have been out of service for a significant period of time.

TS 7.30.02 REFERENCES

Contractors shall comply with all applicable parts of the following Acts, Standards, Specifications or Publications:

Provincial Statute

Ontario Drinking Water Quality Standards

Ontario Regulation 128/04 Certification of Drinking Water System Operators and Water Quality Analysts

Ontario Regulation 170/03 Drinking Water Systems

Ontario Regulation 248/03 Drinking Water Testing Services

Safe Drinking Water Act, 2002

Ontario Ministry of the Environment and Climate Change

Watermain Disinfection Procedure November 2015

City of Toronto Standard Drawings

T-1104.03-3 DCVA Connection Detail for Below Grade Installation During Disinfection

T-1104.03-4 DCVA or RP Connection Detail for Above Grade Installation During Disinfection

City of Toronto Form

TS 115 Disinfection Proposal Plan

Toronto Water

Practice No. 8 Watermain, Reservoir and Elevated Tank Disinfection

Municipal Drinking Water Licence Number 010-101

Drinking Water Works Permit #010-201

American Water Works Association

B300 Hypochlorites

B301 Liquid Chlorine

C651 Disinfecting Water Mains

C655 Field Dechlorination

M20 Water Chlorination Principle and Practice

AWWA RF Development of Disinfection Guidelines for the Installation and Replacement of Water Mains

NSF International Standards

NSF/ANSI Standard 60 Drinking Water Treatment Chemicals – Health Effects

Canadian Standards Association

CSA B64.10 Selection and Installation of Backflow Preventers

TS 7.30.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Certified Operator means a person who holds a Class I or higher certificate or license issued under the requirement of O. Reg. 128/04 and who conducts operational checks of or who adjusts, tests, or evaluates a process that controls the effectiveness or efficiency of a subsystem and includes a person who adjusts or directs the flow, pressure or quality of water within the subsystem, if that person works in a 'distribution subsystem' or a 'distribution and supply subsystem'.

Water Quality Analyst means a person who holds a water quality analyst's certificate issued under section 16 of O. Reg. 128/04 or who holds a conditional water quality analyst's certificate issued under section 17 of O. Reg. 128/04.

Backflow Prevention means the prevention of a reversal of normal flow that could introduce contamination to the potable water supply; accomplished by an air gap or a CSA approved backflow preventer selected, inserted and tested according to CSA B64.10, Selection and Installation of Backflow Preventers.

Wet Taps means an operational task where a tapping device is used to connect a new watermain or service connection to a watermain that is full or under pressure and part of the operating system.

TS 7.30.04 DESIGN AND SUBMISSION REQUIREMENTS – Not Used

TS 7.30.05 MATERIALS

TS 7.30.05.01 Disinfectants

Use sodium hypochlorite that meets or exceeds AWWA B300 and is certified against standard ANSI/NSF 60.

Liquid chlorine (gas) according to AWWA B301 and packaged in steel containers.

Calcium hypochlorite according to AWWA B300 in 5 gram tablets or granular form with approximately 65 per cent available chlorine by weight.

TS 7.30.05.02 De-chlorinating Agents

For more information on de-chlorinating agents, see AWWA C655.

TS 7.30.06 EQUIPMENT

TS 7.30.06.01 Chlorine Residual Testing

All chlorine residual field testing shall be performed by using the DPD Drop Dilution Method or High-Range Chlorine Test Kit according to AWWA C651 Appendix A. All test kits shall be calibrated and maintained according to manufacturer's recommendations.

TS 7.30.06.02 Selection, Installation and Testing Backflow Preventer

All backflow preventers shall be a Reduced Pressure Principle (RP) or Double Check Valve (DCVA) according to CSA B64.10 and AWWA C651. The backflow prevention valve assembly shall be installed according to T-1104.03-3 or T-1104.03-4. The following CSA B64.10 installation conditions shall be followed:

- Minimum clearance between bottom of RP relief valve and the floor: 300 mm
- RP backflow preventers shall not be installed in a below-grade pit or vault
- DCVA backflow preventers shall not be installed in a below-grade pit or vault unless the vault can be maintained in a dry condition (i.e. installation of a sump pump)
- When a DCVA backflow preventer is installed in a below-grade pit or vault, all test cocks on the device shall be plugged using a means that is watertight.

The backflow preventer shall be field tested, upon installation and when relocated, in accordance with the applicable requirements specified for each type of device in CSA B64.10. Field tests shall be performed only by a certified tester that has completed and received a valid Cross-Connection Control Specialist (CCCS) certificate by an accredited organization. Test results shall be reported on the designated forms and submitted to the Contract Administrator for recordkeeping and eventually submission to the City along with other contract records.

TS 7.30.07 CONSTRUCTION

TS 7.30.07.01 During Watermain Construction and Rehabilitation

TS 7.30.07.01.01 *Installation of Pipes*

Keep pipes clean and dry. Take precautions to protect the interiors of pipes, fittings, and valves against contamination. Cap all openings with watertight plugs/seals. Remove plugs only when making connections. Complete joints of all pipes in trenches before any stoppage of work, such as at the end of the workday. Pipes shall not be laid in water.

TS 7.30.07.01.02 *Material Handling*

Handle all materials including sealing gaskets and lubricants in a manner to avoid damage and contamination.

TS 7.30.07.01.03 *Precautions before Disinfection*

Contractors shall comply with the following prior to disinfection:

- a) All water used for pressure testing and disinfection shall be supplied from a temporary backflow-protected connection to the existing distribution system. The backflow protection device shall be selected, installed and tested according to TS 7.30.06.02, herein.
- b) Provide a minimum 50 mm diameter blow-off at the end of all pipe sections to be disinfected.

TS 7.30.07.01.04 *Pressure Testing and Disinfection*

The Contractor shall pressure test and disinfect all newly installed water mains, hydrant leads and water services connections 100 mm in diameter and larger.

The large diameter water services 100 mm in diameter and greater shall be pressure tested and chlorinated at the same time as the pressure testing and disinfection of the new mainline water main.

TS 7.30.07.02 Supervision of Disinfection, Inspection, and Testing of Samples

TS 7.30.07.02.01 *Submission of Disinfection Proposal Plan*

Contractor performing the disinfection shall submit *Disinfection Proposal Plan* to the Contract Administrator. The Contract Administrator shall review and sign the proposal plan prepared by the Contractor prior to any work commencing. The proposal plan is to include the following:

- 1) Disinfection criteria, including; watermain dimensions, watermain material, disinfection method, contact time, concentration, receiving location and source of supply water. Record this information on form *TS 115 – Disinfection Form* page 1.
- 2) Disinfection site map and key map, including; location of mainline valves, sodium hypo-chlorite application, de-chlorination agent application, flushing, receiving. Record this information on form *TS 115 – Disinfection Form* page 1.
- 3) Calculation sheets including; chemical volumes, watermain volume, flushing discharge rate and chemical application rates.
- 4) Emergency response for spills and exfiltration to the distribution or transmission systems.
- 5) Traffic protection plan—in accordance with the *Occupational Health and Safety Act* (OHSA).
- 6) Confined space entry procedure—in accordance with the OHSA.

If the *Disinfection Proposal Plan* is determined to be unsuitable by the Contract Administrator, it shall be returned to the Contractor for corrective work to be performed.

If the *Disinfection Proposal Plan* is determined to be suitable by Contract Administrator, it shall be submitted to the applicable Toronto Water supervisor(s) via DisinfectionResults@toronto.ca to notify them of the scheduled disinfection before proceeding with the disinfection.

All valve or flushing operations on the distribution or transmission systems adjacent to the section of watermain to be disinfected will be suspended until the disinfection activity is completed.

TS 7.30.07.02.02 *Supervision, Testing and Records*

The Contract Administrator shall verify and confirm that the Contractor accurately performed the disinfection activities, including any sampling and testing, in accordance to the latest published version of TS 7.30 and the approved Disinfection Proposal Plan. The Contract Administrator shall ensure that the latest version of the Disinfection Record (TS 115) is wholly completed by the Contractor performing the activities and that no bacteriological samples are taken unless the turbidity and total chlorine residual levels have first been tested and confirmed to be within the limits set out in Table 2.

All records specified in TS 7.30 herein shall be submitted to the City and retained in the contract files for a period of seven years. The Contract Administrator shall be responsible for ensuring that any information submitted in these records do not constitute as false or misleading information which is an offense under Part XI of the Ontario Safe Drinking Water Act.

TS 7.30.07.02.03 *Valve Operation*

Any operation of valves and hydrants on the active distribution system shall be performed by a Toronto Water Certified Operator. The Contract Administrator shall notify Toronto Water operational units at least 2 Working Days in advance to make arrangements for the valve operation.

TS 7.30.07.03 *Connection of New Watermain to Watermain in Service*

TS 7.30.07.03.01 *Tapping*

All Wet Taps shall be performed by, or under the direct supervision of, a Certified Operator. Certified Operators shall be validated according to TS 7.30.09.01 herein.

TS 7.30.07.03.02 *Tapping Sleeves*

For new watermain replacement projects, the Contractor shall use a tapping sleeve and valve to connect to the existing water distribution system along with a bypass before starting to construct the new watermain.

The pipe surface at the location of the tap shall be cleaned and disinfected using a minimum 5 per cent sodium hypochlorite solution. Where applicable, the drilling, cutting or tapping bits and all surfaces of main stops, service saddles, tapping sleeves and valves which will come into contact with drinking water shall likewise be cleaned and disinfected using a 5 per cent sodium hypochlorite solution immediately prior to installation. If any of the disinfected surfaces come into contact with the soil or water or both in the excavation prior to use, the cleaning and disinfection procedure shall be repeated.

Upon completion of the wet tapping, a coupon for connections 100 mm in diameter and larger shall be provided to the Contract Administrator.

TS 7.30.07.03.03 *Water Service Lines*

Prior to making the connection, the Contractor shall provide each affected customer with a copy of the City's standard *Important Notice* special notice, advising the customer to flush all their taps prior to using the water. The special notice can be found on the City's intranet at <http://insideto.toronto.ca/ppfa/pcu-notification-guide.htm>.

Water services less than 100 mm in diameter shall be installed by wet tapping. The Contractor shall only operate the water service main stop and curb stop. All other valve operations shall be completed by a Toronto Water Certified Operator. The Contract Administrator or inspector shall confirm all wet tapping activities according to this specification herein.

The pipe surface at the location of the tap shall be cleaned and disinfected using a 5 per cent sodium hypochlorite solution. Where applicable, the drilling, cutting or tapping bits and all surfaces of main stops, service saddles, tapping sleeves and valves which will come into contact with drinking water shall likewise be cleaned and disinfected using a 5 per cent sodium hypochlorite solution immediately prior to installation. If any of the disinfected surfaces come into contact with the soil or water or both in the excavation prior to use, the cleaning and disinfection procedure shall be repeated.

TS 7.30.08 DISINFECTION PROCEDURE

All disinfection activities shall be performed according to the MOECC Watermain Disinfection Procedure and AWWA C651 Standard.

TS 7.30.08.01 General

A standard disinfection procedure shall ensure the following:

- a) Preventing contaminating material from entering the watermain during storage, construction, or repair.
- b) Removing, by flushing or other means, those materials that may have entered the watermain.
- c) Protecting the existing distribution system from backflow due to hydrostatic pressure and disinfection procedures.
- d) Chlorinating and documenting the process used for disinfection, and then flushing the chlorinated water from the main and disposal of the chlorinated water.
- e) Following disinfection, determining the quality of the water samples collected from the pipe by laboratory testing and ensuring the results meet the requirements of TS 7.30.09.05 herein.
- f) Connecting the disinfected and approved watermain to the active distribution system.

TS 7.30.08.01.01 *Flushing and Swabbing*

Flush and swab new, replaced or relined watermain prior to the start of disinfection. Where achievable, flushing shall attain a scouring velocity of 0.9 m/s. A physical separation shall be maintained at all times between the active (potable) distribution system and the new (installed) watermain.

The physical separation shall consist of two 50 mm ball valves and a Backflow Preventer selected, installed and tested according to TS 7.30.06.02 herein.

When a section of a new watermain is satisfactorily disinfected and the connection(s) to the active (potable) distribution system is completed, it is then considered part of the active (potable) distribution system.

The Contractor shall:

- 1) Confirm watermain is isolated. Blow-off pressure at highpoint of watermain.
- 2) Confirm isolating valve(s) are properly tagged or locked out on site.

Prior to disinfection, all new watermain, service connections, and side street connections 100 mm in diameter and greater shall be swabbed.

Swabbing outlets will connect to the new mains and connections using a 45 degree vertical bend and riser pipe that extends above the surrounding ground surface. Swabbing outlets shall be the same diameter as the pipe to which they are connected.

Swabbing outlets will be mechanically capped prior to and after swabbing to prevent entry of debris into watermains and service connections. During swabbing, discharge water shall be directed to a sanitary sewer inlet or storm sewer inlet, if not chlorinated. Contractor is to take all necessary measures to avoid flooding and erosion of adjacent properties, and build-up of ice during cold weather.

Swabs shall have a diameter 50 mm larger than the pipe that is going to be swabbed. The new watermain and service connections shall be filled with water a minimum of 24 hours in advance of the swabbing operation. Swabs shall be propelled using potable water with sufficient velocity to remove debris from the watermain. The swabbing operation should continue until the discharge water runs clear and the last swab is clean. The Contractor shall demonstrate to the Contract Administrator that all swabs or parts thereof have been retrieved from the new watermain.

TS 7.30.08.01.02 *Valve Operation Sequence*

During flushing and disinfection, the new watermain shall be in isolation from the existing water distribution system with a backflow preventer.

A Toronto Water Certified Operator, certified under Ontario Regulation 128/04 will operate all distribution and transmission hydrants and valves.

TS 7.30.08.01.03 *Flush to Reduce Turbidity*

Flush the main at all hydrants and blow-offs to eliminate all air pockets and particulates, and to achieve and sustain a turbidity of less than one nephelometric turbidity units (< 1 NTU) or, at the City's discretion, no higher than that of the incoming water. Do not proceed with chlorination until these turbidity levels are achieved. Verify that the main to be disinfected is isolated from the system and not pressurized. Record the turbidity readings in Table 1 on page 2 of form TS 115.

TS 7.30.08.02 *Standard Chlorination*

Before beginning chlorination, establish the proper flow rate in the main and adjust the flushing rate and dosage rate as required to achieve the proper chlorine dosage. Document the disinfection process in Table 1 on page 2 of form TS 115 by recording the time and initial chlorine concentrations at each sampling point. Record the chlorine concentrations again after satisfactory contact time has been achieved depending on the disinfection method chosen.

The following two methods of chlorination are acceptable for standard disinfection of watermains including temporary bypass systems, and service pipes of 100 mm or greater in diameter and greater than 6.0 m in length.

TS 7.30.08.02.01 *Continuous Feed*

Refer to MOECC, Watermain Disinfection Procedure and AWWA C651 for details.

The flow is adjusted to a constant known rate and sufficient chlorine is added to completely fill the main with chlorinated potable water to produce a homogeneous chlorine solution as specified in Table 1 of this specification. Once this steady state is achieved the chlorinated water is left standing for a specified minimum contact time. For concentration and contact time see Table 1.

To assure that the desired concentration is achieved, the disinfection crew shall measure the chlorine concentration at regular intervals using the appropriate chlorine test kits according to TS 7.30.06.01 herein. Chlorine application is to continue until the entire main is filled with heavily chlorinated water. Document the disinfection process onto form TS 115 – Table 1.

TS 7.30.08.02.01.01 *Total Chlorine Residual at the End of Contact Time*

Successful disinfection is achieved only when the total chlorine residual in the watermain has not decreased by more than 40 per cent of the initial chlorine concentration – to a maximum of 50 mg/L – at the end of the contact time.

TS 7.30.08.02.02 *Slug Method*

Refer to MOECC, Watermain Disinfection Procedure and AWWA C651 for details.

Chlorine and water are applied to the main at a constant measured rate so that a solid column of highly chlorinated water is achieved and moved slowly intact along the watermain so that all interior surfaces have a minimum contact time as specified in Table 1.

The total chlorine residual must be measured at regular intervals as the slug progresses along the pipe. If at any time the total chlorine residual has decreased by more than 25 mg/L, the flow shall be stopped, the chlorination equipment shall be relocated at the head of the slug, and as flow resumes, additional chlorine shall be applied to restore the chlorine concentration in the slug to not less than 100 mg/L. As the slug advances along the pipe, all valves, hydrants and side branches on the isolated side of the system shall be exposed to the disinfection solution.

Table 1: Chlorine concentration and contact time for new watermain¹

Disinfection method	Minimum contact time	Initial chlorine concentration	Maximum allowable decrease in chlorine concentration
tablet or continuous feed	24 hours	≥ 25 mg/L	40% of the initial chlorine concentration to a maximum of 50 mg/L
slug	3 hours	≥ 100 mg/L	25 mg/L
spray	30 minutes	≥ 200 mg/L	Measurement not required

¹ At levels over 10 milligrams per litre, a measurement of total chlorine shall be deemed to be equivalent to a measurement of free chlorine.

TS 7.30.08.03 *Flushing after Disinfection*

Begin final flushing of the heavily chlorinated main only if after the specified minimum contact time has elapsed, the measured chlorine concentration at each sampling point has not decreased more than the "maximum allowable decreases" from Table 1. The heavily chlorinated water shall be completely dechlorinated prior to being discharged into the environment according to TS 7.30.08.05 herein. Flush the main via hydrants and blow-offs until the following water quality parameters are consistently met: turbidity is less than 1 NTU, and total chlorine residual is between 0.50 mg/L and 2.5 mg/L. Once these parameters are achieved, flushing shall continue for an extra 30 minutes as a precaution. After satisfactory water quality has been restored, proceed with TS 7.30.09 to determine the bacteriological quality of water samples collected from the pipe.

TS 7.30.08.04 Final Filler Piece Connections and Appurtenances

All installed filler pieces 6 metres or less in length and appurtenances must be clean from dirt and debris, then sprayed or swabbed with a minimum of 5 per cent solution of freshly prepared sodium hypochlorite solution with a minimum contact time of 30 minutes prior to use. Final connections – filler pieces – longer than 6 metres must be disinfected and tested as a new watermain according to Table 1, with two sets of satisfactory bacteriological samples received prior to use.

TS 7.30.08.05 Disposal of Chlorinated Water

After disinfection, discharge the chlorinated water into a sanitary sewer. If a sanitary sewer is not available, do not discharge to a storm sewer, open ditch or watercourse unless the chlorinated water has been de-chlorinated. A list of de-chlorinating (neutralizing) agents can be found in AWWA C655. All discharges must comply with Toronto Municipal Code, Chapter 681 Sewers.

TS 7.30.09 BACTERIOLOGICAL AND WATER QUALITY SAMPLING AND TESTING

TS 7.30.09.01 Qualified Persons

All testing prescribed by the Safe Drinking Water Act, including field-testing of drinking water shall be performed by a Certified Operator or Water Quality Analyst. Certification must be validated on www.OWWCO.ca . If an instance occurs when the name of a person claiming to be a Certified Operator cannot be verified, then the local MOECC Water Compliance Supervisor must be notified immediately.

TS 7.30.09.02 Water Sampling and Bacteriological Testing

After disinfection and final flushing such that normal water quality parameters are met according to TS 7.30.08.03, bacteriological samples shall be collected from sampling points along the main, including both ends, to verify the quality of the disinfection. Before approving a main for release, an initial set of samples must be taken, then after a minimum of 16 hours have elapsed since the initial set, another set of samples taken from the same locations. Both sets of samples must pass bacteriological testing for the main to be approved for release. For more information, see AWWA C651 Section. 5.10.

No bacteriological samples shall be taken unless the turbidity and total chlorine residuals levels have first been tested and confirmed to be within the limits set out in Table 2. Turbidity and chlorine residuals test results shall be recorded on the Disinfection Record (TS115 – Table 1). Record the ID of the corresponding Chain of Custody / Sample Submission document used during submission of the samples to an accredited laboratory for testing on the Disinfection Record (TS115 – Table 2). All bacteriological samples shall be tested by a laboratory that is licensed by the Ministry of the Environment and Climate Change (MOECC) to test drinking water.

Samples shall be collected from every 350 metres of the main and one set from each branch. Branch connections include large diameter water services, hydrant leads and side street connections. In areas where the Contract Administrator suspects possible contamination, sampling shall be taken at intervals no greater than 60 metres.

All samples shall be collected in a manner as to avoid contamination from the environment surrounding the main. Collect samples for bacteriological analysis in sterile bottles treated with sodium thiosulfate according to Section 9060 *Standard Methods for the Examination of Water and Wastewater*. Do not obtain samples from a hose or fire hydrant unless there are no alternative sampling points available.

TS 7.30.09.03 Re-disinfection

If the bacteriological sample sets fail, the Contract Administrator can request for additional flushing prior to attempting another cycle of two consecutive sets of bacteriological samples. If the results continue to fail even after two additional cycles of sampling, the disinfection steps may be repeated.

TS 7.30.09.04 Sampling for Short Filler Pieces and Appurtenances

After the Contractor has installed the final connection – filler piece – and appurtenances or both according to TS 7.30.08.04, a Toronto Water Certified Operator shall obtain one water sample from the filler piece for bacteriological testing according to AWWA C651, Section 5.10. The valve separating the disinfected main from the existing distribution system will not be opened until this bacteriological sample has passed.

If the filler piece continues to fail the bacteriological testing, consult with Toronto Water, Customer & Technical Support Services section to develop a site specific plan to resolve the water sample failures.

TS 7.30.09.05 Water Quality Parameters for Disinfection Approval

A watermain shall not be approved for release unless the standards in Table 2 below have been met for each verification sample taken:

Table 2: Water quality parameters for disinfection approval

Parameter	Standard
Total Coliform	0 CFU/100 mL
E. Coli	0 CFU/100 mL
Background Colony Counts	< 100 CFU/100 mL
Heterotrophic Plate Counts	< 500 CFU/1 mL
Turbidity ^a	< 1.0 NTU
Total Chlorine Residual ^a	0.50 to 2.5 mg/L

Note ^a: These must be field-tested at the same time and from the same location as the bacteriological samples. Test results shall be recorded on the Disinfection Record (TS115) next to the associated bacteriological sample. Failure to do so constitutes as a failure of the standard.

In certain circumstances, Toronto Water operations unit may exercise discretion and approve disinfections where a parameter not related to health such as turbidity, fails to be met due to the quality of supply water.

TS 7.30.09.06 Test Results

E-mail scanned copies of all laboratory water quality test results, along with the completed *Disinfection Record (TS115 Page 2)* to the Contract Administrator. Upon receipt of these documents, the Contract Administrator shall determine if the test results and completeness of records are satisfactory. If satisfactory, the Contract Administrator shall provide a copy of these documents to Toronto Water and schedule for Toronto Water sampling of the final connection.

TS 7.30.10 DISINFECTION OF WATERMAINS IN EMERGENCY SITUATIONS

When an existing watermain develops a leak and repairs are required, a Toronto Water Operator-In-Charge (OIC) normally visits the site to categorize the type of break into one of two categories described below by visual inspection. However, if the OIC cannot visit the watermain break to be repaired by a Contractor, the type of break shall be classified as a Category 2 by default regardless of actual contamination, so that a visual inspection by an OIC will not be required.

TS 7.30.10.01 Category 1

Watermain breaks with no evident or suspected contamination are classified as Category 1. Follow the steps described in section 3.2 and 3.3 according to MOECC Watermain Disinfection Procedure.

Contamination is typically not suspected for circumferential breaks or small leaks where flow is maintained from the break until an air gap is established and where the air gap is maintained during the repair procedure. If, at any time, contamination is evident or suspected, the break shall be reclassified as Category 2.

TS 7.30.10.02 Category 2

Watermain breaks with evident or suspected contamination are classified as Category 2. Watermain repairs involving more than six metres of replaced pipe are also classified as Category 2. Follow the steps described in section 3.2 and 3.4 according to MOECC Watermain Disinfection Procedure. Microbiological testing after the repair is mandatory and will be performed by a Toronto Water Certified Operator.

TS 7.30.10.03 Sewage or Chemical Contamination

If there is evident or suspected sewage or chemical—for example petroleum products, liquids of abnormal colour and so on—contamination of a watermain, the Contractor shall immediately notify the Contract Administrator, who will then immediately notify Toronto Water Operations. Under no circumstances is the return to normal service of the watermain permitted until further notice by Toronto Water.