

PROCEDURE FOR DISINFECTING WATERMAINS

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TS 7.30.01 SCOPE

This procedure covers the disinfection of watermain systems. Unless specified otherwise, 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

“Disinfecting Water Mains”, AWWA Standard C651 (latest edition)

Ontario Drinking Water Quality Standards (latest edition)

“Water Chlorination Principle & Practices”, AWWA M20 (latest edition)

“Development of Disinfection Guidelines for the Installation and Replacement of Water Mains”, AWWA Research Foundation;

“Hypochlorites”, AWWA Standard B300 (latest edition)

Drinking Water Systems, Ontario Regulation 170/03 (latest edition)

“Practice No. 8 – Watermain, Reservoir and Elevated Tank Disinfection”, Toronto Water Practices (latest edition)

TS 7.30.03 (NOT USED)

TS 7.30.04 (NOT USED)

TS 7.30.05 MATERIALS

TS 7.30.05.01 Disinfectants

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

TS 7.30.05.02 De-chlorinating Agents

See Appendix C, AWWA Standard C651 (latest edition).

TS 7.30.06 (NOT USED)

TS 7.30.07 GENERAL REQUIREMENTS

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

Contractor shall adhere to the following requirements to ensure proper disinfection:

- (a) Complete testing for leakage and allow only one feed to the section to be disinfected. Always feed through an isolating valve or bypass of an isolating valve.
- (b) Provide a 50 mm diameter tap with sampling cock and pressure gauge on the dead side of the isolating valve and a 25 mm diameter tap with sampling cock and pressure gauge on the live side of the isolating valve.
- (c) Provide a minimum 50 mm diameter blow-off at the end of all pipe sections to be disinfected.
- (d) Flush the source water as near the shut-off as possible.

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

TS 7.30.07.02.01 Submission of Disinfection Proposal

1. Contractor performing the disinfection shall submit disinfection proposal to the contract administrator.
2. The contract administrator shall review the proposal prepared by the contractor prior to any work commencing. The proposal is to include the following:
 - Disinfection criteria, including; watermain dimensions, watermain material, disinfection method, contact time, concentration, receiving location and source of supply water.

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- Disinfection site map and key map, including; location of mainline valves, sodium hypo-chlorite application, dechlorination agent application, flushing, receiving, live side residual and pressure monitoring and sampling.
 - Calculation sheets including; chemical volumes, watermain volume, flushing discharge rate and chemical application rates.
 - Emergency response for spills and exfiltration to the distribution or transmission systems.
 - Traffic protection plan – in accordance with the Occupational Health & Safety Act (OHSA).
 - Confined space entry procedure – in accordance with the OHSA.
3. If the site is determined to be unsuitable by the contract administrator, the “Disinfection Proposal” will be returned to the requestor for corrective work to be performed.

If the site is determined to be suitable by contract administrator, the “Disinfection Proposal” will be distributed to the applicable Toronto Water supervisor(s) 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 City’s representative shall witness all swabbing and disinfection activities. The contractor carrying out the disinfection is to take and record the readings on City approved forms. All such records shall be submitted to the City’s representative.

All microbiological samples will be tested by an accredited laboratory that is licensed by the Ministry of the Environment (MOE) to test drinking water.

1. The City’s representative shall witness, confirm and record all disinfection activities including:
 - a) flushing discharge rate;
 - b) sodium hypo-chlorite application rate;
 - c) turbidity checked;
 - d) chlorination application time and residual;
 - e) live side residual monitoring;
 - f) 24-hour residual confirmation;
 - g) flushing, to sanitary sewer, time and discharge residual;

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- h) dechlorination, to storm sewer, dechlorination application rate, time and discharge residual;
 - i) flushing residual confirmation;
 - j) sampling time and locations; and
 - k) approvals and notifications.
2. Forms are to be submitted to Toronto Water staff for entry into the Toronto Water's work management system.

TS 7.30.07.02.03 Valve Operation

During the disinfection, a licensed Toronto Water operator, certified under Ontario Regulation 128/04, will be on site to operate hydrants and valves on the active distribution system. The disinfection crew is to notify the Toronto Water operations section at least 48 hours in advance to make arrangements for the crew.

TS 7.30.08 DISINFECTION PROCEDURES

Refer to AWWA Disinfection Standard C651- (latest edition).

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 any residual contamination that may remain, and flushing the chlorinated water from the main.
- (e) Following disinfection, determining the bacteriological quality of the water in the main by laboratory testing.
- (f) Connecting the approved, disinfected watermain to the active distribution system.

TS 7.30.08.01.01 Flushing and Swabbing

Flush and where specified, swab new, replaced, or relined watermains prior to the start of disinfection. Where achievable, flushing shall attain a scouring velocity of 0.8 metre/second. Maintain physical separation of the main from the active distribution system using an isolating valve until bacteriological testing has been satisfactorily completed. When specified, install a 50 mm diameter back flow preventor between the source and the installed pipe to achieve this physical separation.

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.

TS 7.30.08.01.02 Valve Operation Sequence

During flushing and disinfection, sequence the valve operation so as not to pressurize the main to be disinfected to a level equal to or greater than that of any connected in-service watermains.

A licensed Toronto Water 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 (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.

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. During the chlorination procedure, perform ongoing residual chlorine checks on the live side of the watermain to ensure there is no leakage or contamination of super chlorinated water entering the active distribution system.

The following two methods of chlorination are acceptable for standard disinfection of watermains including temporary bypass systems.

TS 7.30.08.02.01 Continuous Feed

Refer to AWWA Standard C651 (latest edition).

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. 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. Chlorine application is to continue until the entire main is filled with heavily chlorinated water.

TS 7.30.08.02.01.01 Free Chlorine Residual at the End of Contact Time

Successful disinfection is achieved only when the free chlorine residual in the watermain is greater than 50 percent of the original concentration at the end of the contact time. Perform residual checks on the live side of the watermain during the waiting period to ensure there is no leakage or contamination of super chlorinated water entering the active distribution system.

TS 7.30.08.02.02 Slug Method

Refer to AWWA Standard C651- latest edition.

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 intact along the watermain so that all interior surfaces have a minimum contact time as specified in Table 1.

The free chlorine residual must be monitored as the slug progresses along the main. If the free chlorine residual falls below 50 percent of the original concentration, the flow is to be stopped, the chlorination equipment relocated to the head of the slug, and additional chlorine must be added at the head of the slug to re-establish the predefined concentration. As the slug advances along the main, all valves, hydrants and side branches will be exposed to the disinfecting solution.

TABLE 1
Chlorine Concentration and Contact Time

Chlorination Method	Concentration for Main Type	Contact Time
Continuous Feed	25 mg/L (PPM) – temporary by-pass service connections	24 hours
Continuous Feed	100 mg/L (PPM) – mortar lined and concrete pipes	24 hours
Continuous Feed	250 mg/L (PPM) – PVC	24 hours
Continuous Feed	250 mg/L (PPM) – cast iron and ductile iron	48 hours
Slug Method	300 mg/L (PPM) – all pipe materials	3 hours
Slug Method	300 mg/L (PPM) – transmission main	3 hours
Slug Method	300 mg/L (PPM) – temporary bypass mains	3 hours
Slug Method	temporary bypass service connections	not permitted

TS 7.30.08.03 Flushing after Disinfection

Measure the free chlorine residual before beginning the process for final flushing. If after the prescribed contact time the free chlorine residual is greater than 50 percent of the original level at all sample points, flush the heavily chlorinated water from the main through hydrants and blow-offs until the chlorine residual does not exceed 1.5 milligrams/litre or is the same as the chlorine residual level of the incoming water in the active water distribution system and the turbidity is less than one NTU or no higher than incoming water. Once these parameters are achieved, flushing should continue for at least an extra 30 minutes during which the total chlorine residual should consistently be less than 1.5 milligrams/litre. The maximum chlorine residual level in the watermain after final flushing shall be less than 1.5 milligrams/litre or the same as the chlorine residual level of the incoming water at the time of disinfection. Testing of the incoming water for chlorine residual level may be required if the residual chlorine level of the watermain after final flushing exceeds 1.5 milligrams/litre.

If the chlorine residual level is greater than 1.5 milligrams/litre or higher than the chlorinated mains, continue to flush for 30 minutes beyond the achievement of the correct levels.

TS 7.30.08.04 Short Filler Pieces and Appurtenances

Where normal disinfection methods are not possible or work is accomplished in manner that precludes the possibility of contamination of the main, clean short filler pieces—less than one pipe length—and appurtenances, remove dirt and debris and disinfect the entire interior surface area by spraying or swabbing the filler pieces, fittings and couplings with a minimum 5 percent solution of fresh sodium hypochlorite, and flush the affected section of main until the total chlorine residual is equal to the source water. Prior to tapping, clean and wipe the exterior of the main with a 5 percent solution of fresh sodium hypochlorite.

TS 7.30.08.05 Disposal of Chlorinated Water

To minimize the risk of backflow into the active distribution system, ensure all hydrants and blow-offs within the newly chlorinated main are open prior to opening the isolation valve connecting the active system to the newly chlorinated main.

After the retention period, discharge 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 may be found in Appendix C of AWWA standard C651. All discharges must comply with the latest edition of the City of Toronto sewer use bylaw.

TS 7.30.09 BACTERIOLOGICAL AND WATER QUALITY SAMPLING

TS 7.30.09.01 (NOT USED)

TS 7.30.09.02 Water Sampling and Analytical Tests

Collect samples from points along the main, including both ends. At least one set of samples shall be collected from every 350 metres of the main and one set from each branch. In areas where the City's representative suspects possible contamination, sampling shall be taken at intervals no greater than 60 metres.

After de-chlorination and flushing of the watermain and if the turbidity count is less than or equal to one NTU and the chlorine residual is less than 1.5 ppm (milligrams/litre), the first set of samples at all sampling points shall be collected as per AWWA standard C651. No less than 24 hours after the first set of samples are collected; a second set of samples shall be collected at the same sampling points.

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 as required by handbook *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 initial disinfection fails to produce satisfactory results, re-flush and re-sample, or re-disinfect the main as required by the City’s representative. If check samples also fail to produce acceptable results, disinfect the main again until satisfactory results are obtained.

To confirm the source water parameter levels, take samples representative of the water in an unaffected part of the distribution system, upstream of the newly disinfected main (upstream samples).

TS 7.30.09.04 Sampling for Short Filler Pieces and Appurtenances

For short filler pieces and appurtenances, where standard disinfection methods are not applied, take samples immediately after flushing. Process the samples immediately and analyze the results to confirm that there is no deterioration of water quality based on acceptance standards.

TS 7.30.09.05 Water Quality Guidelines for Disinfection Approval

The total chlorine residual standard in Table 2 Water Quality Guidelines for Disinfection Approval is amended as follow.

**TABLE 2
Water Quality Guidelines for Disinfection Approval**

Parameter	Standard
Total Coliform	0/100 ml
E. Coli	0/100 ml
Background Colony Counts	≤ 20/100 ml
Heterotrophic Plate Counts	≤ 50/1 ml
Total Chlorine Residual	0.5 to 1.5 mg/L
pH Level	7.0 – 8.5
Turbidity	≤ 1.0 NTU

Match the chlorine residual levels of the incoming water of the water distribution system at the time of disinfection. If a chlorine residual level of 0.50 milligram/litre cannot be reached, continue to flush the main until the chlorine residual level is equal to the chlorine residual level in the existing water distribution system at the time of disinfection.

While samples meeting the above criteria are indicative of a satisfactory disinfection, the City may apply discretion and approve disinfections where certain non health related criteria are not met due to incoming water quality.

TS 7.30.09.06 Test Results

Fax copies of all laboratory water quality test results to the City's contract administrator.

Upon receipt of the water quality test results, the City's contract administrator will determine if the test results are satisfactory. The City's contract administrator will provide a copy of the test results to Toronto Water. On receipt of confirmation of satisfactory results from the City's, contract administrator, Toronto Water staff will put the new main into service.

TS 7.30.09.07 Final Flushing

Disinfected watermains shall be re-flushed by Toronto Water prior to being placed back into service. The time interval between the final flush and restoring the main back into service and a final residual check of the system shall be recorded into the City's computerized maintenance management system.

Prior to making the connection, the contractor is to provide each affected customer with a copy of the City's standard "Notification to Customer", advising the customer to flush all their taps prior to using the water.

TS 7.30.10 DISINFECTION OF WATERMAINS IN EMERGENCY SITUATIONS

When an existing main develops a leak and repairs are carried out while the main remains under positive pressure, no disinfection is required. However, as a precautionary measure, dewater the excavation, and if necessary, apply fresh hypochlorite granules to the open trench. Spray the exterior of the watermain and all materials used in the repairs with 5 percent solution of fresh sodium hypochlorite.

Where pipe sections are removed to facilitate repairs, the following action shall be taken:

- (a) Dewater open trench areas.
- (b) Spray and swab all portions of all pipes, fittings, and materials used in repairs that will be in contact with the water supply, with a 5 percent solution of fresh sodium hypochlorite.
- (c) Apply liberal quantities of hypochlorite to the open trench. In the event that the trench water cannot be pumped to a sanitary sewer, the trench waters must be de-chlorinated before entering a storm sewer or catch basin with the use of a de-chlorination device.
- (d) Using unidirectional flushing on the section of the system that contains the repaired watermain, flush out the system from all connection points with the system until the water is clear and returns an acceptable chlorine residual result.
- (e) The isolation valve at one end of the repaired section of main shall be opened to charge the main and place the main it into partial service.

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- (f) When there is suspicion of contamination in the main, a standard disinfection of the main shall be completed.
 - (g) Take bacteriological samples after completion of repairs to provide a record for determining the procedure's effectiveness. If the direction of flow is unknown, take bacteriological samples on each side of the main break. If water sample results do not meet the guidelines specified in Table 2, Toronto Water staff shall evaluate the situation, initiate appropriate corrective action, and continue with daily sampling until bacteriological samples have recorded two consecutive acceptable results.