

PROCEDURE FOR DISINFECTING WATERMAINS

INDEX

TS 7.30.01	SCOPE	3
TS 7.30.02	REFERENCES.....	3
TS 7.30.03	(NOT USED).....	3
TS 7.30.04	(NOT USED).....	3
TS 7.30.05	MATERIALS	3
TS 7.30.05.01	Disinfectants	3
TS 7.30.05.02	De-chlorinating Agents.....	3
TS 7.30.06	(NOT USED).....	4
TS 7.30.07	GENERAL REQUIREMENTS.....	4
TS 7.30.07.01	During Watermain Construction and Rehabilitation	4
TS 7.30.07.01.01	Installation of Pipes.....	4
TS 7.30.07.01.02	Material Handling.....	4
TS 7.30.07.01.03	Precautions before Disinfection	4
TS 7.30.07.02	Supervision of Disinfection, Inspection, and Testing of Samples	4
TS 7.30.07.02.01	Submission of Disinfection Proposal	4
TS 7.30.07.02.02	Supervision, Testing and Records	5
TS 7.30.07.02.03	Valve Operation	5
TS 7.30.08	DISINFECTION PROCEDURES.....	5
TS 7.30.08.01	General.....	5
TS 7.30.08.01.01	Flushing and Swabbing	6
TS 7.30.08.01.02	Valve Operation Sequence	6
TS 7.30.08.01.03	Flush to Remove Turbidity	6
TS 7.30.08.02	Standard Chlorination	6
TS 7.30.08.02.01	Continuous Feed.....	6
TS 7.30.08.02.01.01	Free Chlorine Residual at the End of Contact Time	7
TS 7.30.08.02.02	Slug Method.....	7
TS 7.30.08.03	Flushing after Disinfection	8
TS 7.30.08.04	Short Filler Pieces and Appurtenances.....	8
TS 7.30.08.05	Disposal of Chlorinated Water	8

TS 7.30.09	BACTERIOLOGICAL AND WATER QUALITY SAMPLING	8
TS 7.30.09.01	Water Stand Time.....	8
TS 7.30.09.02	Water Sampling and Analytical Tests	9
TS 7.30.09.03	Re-disinfection.....	9
TS 7.30.09.04	Sampling for Short Filler Pieces and Appurtenances	9
TS 7.30.09.05	Water Quality Guidelines for Disinfection Approval.....	9
TS 7.30.09.06	Test Results.....	10
TS 7.30.09.07	Final Flushing.....	10
TS 7.30.10	DISINFECTION OF WATERMAINS IN EMERGENCY SITUATIONS.....	10

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 long period of time.

TS 7.30.02 REFERENCES

- “Disinfecting Water Mains”, AWWA Standard C651-99;
- Ontario Drinking Water Standards (revised January 2001);
- “Water Chlorination Principle & Practices”, AWWA M20;
- “Development of Disinfection Guidelines for the Installation and Replacement of Water Mains”, AWWA Research Foundation;
- “Hypochlorites”, AWWA Standard B300 (1992);
- “Drinking Water Protection”, Ontario Regulation 459-00;
- “Disinfection Standards – Sampling Protocols”, Metro/Region/Area Municipalities/MOEE Co-ordination November 1995 Meeting;
- “Procedures for Disinfecting City of Toronto (North York District) Watermains” (April 1998);
- “Disinfection of Newly Installed Water Mains Including Private Water Main Systems”, Scarborough PUC Procedures Manual, Policy Reference WW-20.

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.

TS 7.30.05.02 De-chlorinating Agents

See appendix C, AWWA Standard C651-99.

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, e.g., 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

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, using a filler piece as short as possible to the existing system.
- (b) Provide a 50mm diameter tap with sampling cock and pressure gauge on the dead side of the isolating valve and a 25mm diameter tap with sampling cock and pressure gauge on the live side of the isolating valve.
- (c) Provide a minimum 50mm 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

Prior to disinfection, the disinfection crew shall submit to the City's representative, a site map showing the following locations, together with dosage calculations for the affected sections of watermain and pressure test results.

- (a) Location and status of valves.
- (b) Chlorination application points.

-
- (c) Flushing points.
 - (d) Live side residual monitoring points.
 - (e) Pressure monitoring points.
 - (f) Sampling points.
 - (g) Discharge points.

TS 7.30.07.02.02 Supervision, Testing and Records

The City's representative shall witness all swabbing and disinfection activities. The workforce carrying out the disinfection is to take and record measurements on City approved forms. All such records shall be submitted to the City's representative.

Testing of all samples to be performed by a laboratory accredited by the Standards Council of Canada (SCC) as recommended by the Canadian Association for Environmental Analytical Laboratories (CAEAL).

TS 7.30.07.02.03 Valve Operation

During the disinfection, a Works and Emergency Services Department operator, certified under Ontario Regulation 435/93, will be on site to operate hydrants and valves on the active distribution system. The disinfection crew is to notify the Works and Emergency Services Water and Wastewater Operations Section at least 48 hours in advance to make arrangements for the crew.

TS 7.30.08 DISINFECTION PROCEDURES

TS 7.30.08.01 General

A standard disinfection procedure consists of 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 scouring velocity of 0.8 m/s. Keep the main isolated from the active distribution system by physical separation until satisfactory bacteriological testing has been completed. When specified, install a 50mm diameter back flow preventor between the source and the installed pipe to achieve this physical separation.

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.

TS 7.30.08.01.03 Flush to Remove Turbidity

Flush the watermain at all hydrants and blow-offs to eliminate all the air pockets and particulates, and to achieve and sustain a turbidity of less than 1 NTU or, at the City's discretion, no higher than that generally prevailing in the system. Do not proceed with chlorination until these turbidity levels are achieved. Verify that the watermain 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 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 (2) methods of chlorination are acceptable for standard disinfection of watermains including temporary bypass systems.

TS 7.30.08.02.01 Continuous Feed

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 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% of the original concentration at the end of the contact time. During the waiting period perform residual 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.

TS 7.30.08.02.02 Slug Method

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 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% 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 passes down the main all valves, hydrants and side branches shall be exposed to the disinfecting solution).

TABLE 1
Chlorine Concentration and Contact Time (Interim Levels)

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 Procedure	300 mg/L (PPM) –All pipe materials	3 hours
Slug Procedure	300 mg/L (PPM) –Transmission main	3 hours
Slug Procedure	300 mg/L (PPM) – Temporary bypass mains	3 hours
Slug Procedure	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% of the original level at all sample points, flush the heavily chlorinated water from the main, through hydrants and blow-offs, until the free chlorine residual is less than 1 mg/L and the turbidity is less than 1 NTU or no higher than that generally prevailing in the active distribution system. 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 mg/L. (Note: The total chlorine content of the potable water in the City's system is normally between 0.1 mg/L and 1.0 mg/L).

TS 7.30.08.04 Short Filler Pieces and Appurtenances

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

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 C651-99. All discharges must comply with the current City of Toronto Sewer Use By-Law.

TS 7.30.09 BACTERIOLOGICAL AND WATER QUALITY SAMPLING**TS 7.30.09.01 Water Stand Time**

After flushing the chlorinated water from the watermain, close the isolation valve and all other appurtenances. The watermain is to remain isolated for twenty-four hours prior to sampling. Under special circumstances (eg. surface by-pass mains), the stand time may be reduced to no less than 16 hours, at the discretion of the City's representative.

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 350m of the watermain and one set from each branch. In areas where the City’s representative suspects contamination, sampling shall be taken at intervals no greater than 60m.

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 *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

Table 2 below represents results deemed acceptable for placing the main back into service.

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

Parameter	Standard
Total Coliform	0/100 ml
Fecal Coliform / E. Coli	0/100 ml
Background Colony Counts	≤ 5/100 ml
Heterotrophic Plate Counts	≤10/ 1 ml
Total Chlorine Residual	0.25 to 1.0 mg/L
pH Level	7.0 – 8.5
Turbidity	≤ 1.0 NTU

TS 7.30.09.06 Test Results

FAX copies of all Laboratory water quality test results to the Commissioner of Works and Emergency Services or the City's representative where specified.

Upon receipt of the water quality test results, the City's representative will determine if the test results are satisfactory and the main may be placed into service.

TS 7.30.09.07 Final Flushing

Disinfected watermains shall be re-flushed prior to being placed back into service. The time interval between the final flush and restoring the main back into service shall not exceed 4 hours.

Prior to making the connection, 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 watermain develops a leak and repairs are carried out while the watermain 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 fresh 5% hypochlorite solution.

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 fresh 5 percent hypochlorite solution.
- (c) Apply liberal quantities of hypochlorite granules or place tablets to the open trench.
- (d) Flush system with potable water, preferably in both directions, until the turbidity level is 1 NTU or less, or is similar to that in the source water.
- (e) When there is suspicion of contamination in the watermain, a standard disinfection of the main shall be completed.

-
- (f) 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, the City's representative shall evaluate the situation, initiate appropriate corrective action, and continue with daily sampling until bacteriological samples have recorded two consecutive acceptable results.