

Good Practices for Preventing Microbial Contamination of Water Mains

FIELD POCKET GUIDE



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Preventing Microbial
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Mains**

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2014 Update

Purpose & Contents

This pocket handbook is intended to serve as a **general guide** for utility field personnel involved with both the **installation** and **emergency repair** of water mains. It outlines good practices for preventing microbiological contamination of piping, fittings, and appurtenances. This guide is not intended to provide specific, detailed field procedures, as these will vary for different utilities, site conditions, and job circumstances.

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PART 1 - COMMON SOURCES OF WATER MAIN CONTAMINATION

There are several pathways by which microbiological contamination of water mains can occur during installation and repair activities. The most common sources of distribution system contamination can be grouped into two categories: (1) introduction into the distribution system and (2) transport throughout the distribution system.

Introduction of Microbiological Contamination

- Accumulation of soil, sediment, and other foreign material on pipe interior and appurtenance surfaces during storage and installation.
- Contact with or entry of non-potable water during storage and installation activities. Examples of non-potable water include: trench water, stormwater, sewage, and other sources of environmental water (e.g. agricultural run-off).
- Unsanitary human contact with pipes and fittings.
- Animals and insects that enter pipe during storage or installation.
- Low or negative pressure changes that draw in contamination through faulty seals or broken pipe.

Harboring Microbiological Contamination

- Returning new or repaired water mains to service without sufficient flushing.
- Returning new or repaired water mains to service without sufficient disinfection.

PART 2 – GOOD PRACTICES FOR NEW INSTALLATIONS AND SCHEDULED REPAIRS

SITE CONDITIONS

Site Control

- Secure the site to create a safe work zone.
- Use signage to communicate with general public.
- Provide measures for protection against stormwater, agricultural, and industrial runoff (if applicable) such as the use of sand bags, portable pumps, etc.
- Provide measures for dust control.
- Provide site access routes that will minimize airborne contamination of materials and equipment.

Utility Lines

- Locate, mark, and protect all existing utility lines in the vicinity of excavations, including water, storm, sewer, phone, cable, gas, and power lines.
- Locate and mark nearby water grid isolation valves so that they can easily be found and used, as needed.
- For main replacement, completely isolate the section through valve isolation.
- For main repairs, maintain positive pressure by closing all valves except one, or partially closing multiple valves.

Public Notification

- Notify affected customers about planned work.

CONDITION AND STORAGE OF MATERIALS

- Inspect all new pipe, fittings, valves, and appurtenances before accepting their delivery.
- Store materials in designated storage areas until installation.
- Provide security barriers or fences around material and equipment storage areas.
- Elevate stored pipe on supports to prevent water entry.
- Provide a clean, intermediate barrier between fittings and ground surface.
- Provide for water drainage around designated material storage areas.
- Remove visible foreign matter from pipe and fittings.
- Use and maintain watertight end caps, plugs, or other protective devices to prevent foreign matter, soil, and animals from entering pipe during storage. Use lockable and inflatable caps when possible.
- Maintain protective coverings on fittings until installation
- Visually examine all internal surfaces prior to delivery for installation.
- In the event of contamination, scour internal surface or scrape clean, followed by disinfection.

GENERAL CONSTRUCTION PRACTICES

Excavation and Trench Work

- Install temporary diversion devices to prevent surface water runoff from entering trench.
- Provide for continuous dewatering of excavation to minimum one-foot below the level of pipe invert.
- Provide shoring when necessary.
- Keep pipe, fittings, and valves away from excavated soil or backfill materials.
- Clean interior of pipe materials which come into contact with soil or backfill.
- Postpone work during rainy periods if runoff, trench water, or groundwater cannot be adequately controlled.
- If hazardous soil conditions are discovered, isolate the soil and report to appropriate authorities for clean-up.

Installation Activities

- Do not deliver materials to the trench site that are not ready for installation.
- Do not string the pipe along the trench alignment prior to installation, if possible.
- Maintain pipe caps, plugs, or other protective coverings until pipes are joined.
- Keep fittings, valves, and appurtenances covered and protected until ready for installation.
- Cover or cap all open ends of new pipes and fittings in the trench at the end of each work period or when unattended. Use lockable caps with watertight seals.

Installation Activities (Continued)

- Clean visible debris from exposed areas of existing pipe.
- Spray disinfectant (minimum 1% bleach or equivalent) and swab interior joint surfaces just prior to making connections (unless in sub-freezing conditions).
- Minimize soil contamination of working equipment.
- Disinfect hand tools, saws, and tapping machines used for installing pipe and fittings. Use chlorine dips, sprays, and/or rinses (unless in sub-freezing conditions).
- Keep gaskets clean at all times.
- Clean and disinfect all reusable appurtenances.
- Rinse pipe and fittings prior to installation, if practical.
- Spray disinfectant (minimum 1% bleach or equivalent) and swab fittings, valves, clamps, and exposed areas of existing connections.
- Complete all joints in the trench before work is stopped, if possible.
- Ensure that all cables, pipes, and hoses drawn through mains are clean.
- Verify pressure conditions at the start of construction, periodically during construction, and at the end of construction.
- Report any observations indicating that pipe, pipe parts, or the trench may have become contaminated during installation such that the internal surfaces were affected.

Hydrostatic Testing

- Follow established hydrostatic testing procedures. Take appropriate actions to correct leaks prior to flushing, cleaning, and disinfecting.

Cleaning and Flushing

- Follow established main filling and flushing procedures.
- If internal contamination is suspected, provide end caps with blow-offs or large hoses to achieve a scouring flush (minimum 3 feet-per-second).
- Where an adequate flushing velocity is not achievable, pig the main(s) using pre-chlorinated, hydraulically propelled pigs or swabs.
- Conduct flushing from lower elevation to higher elevation hydrants to remove entrapped air.
- Document the actions taken to clean and flush the main.

Disinfection

- Follow established disinfection procedures, such as ANSI/AWWA C-651.
- Ensure proper field analytical methods are used to measure disinfectant residual.
- Provide for proper disposal of chlorinated water, such as the addition of a dechlorinating or neutralizing agent.
- Ensure accurate and timely reporting of results to appropriate authorities.

RETURN TO SERVICE

Water Quality Testing

- Chlorine residual testing can be performed in the field. Ensure that field analytical methods follow Standard Methods or other accepted procedures.
- Follow established water sampling, preservation, and shipping procedures.
- Review results of coliform bacteria and total/free chlorine residual tests to evaluate potential contamination. Other useful indicators include pH, turbidity, and odor.
- Ensure accurate and timely reporting of water quality testing results to the appropriate people so that a timely decision for return to service or the need for additional action can be made.

Restoration

- Properly backfill and compact trench per applicable specifications.
- In accordance with local requirements, temporary restoration of the roadway may be required.
- Upon successful completion of the repair and approval for release to service of the main, restore pavement with a permanent patch.

PROJECT CLOSEOUT

- Ensure that all inspection field notes are compiled, with documentation of significant activities and actions associated with contamination control.
- Have inspector provide feedback to utility engineers and management on the results of contamination control methods used on the job, with emphasis on items to improve.
- Document as-built location of new water system components.
- Have unit responsible for approving the final return to service provide feedback to inspectors and management.

PART 3 – GOOD PRACTICES FOR UNSCHEDULED AND EMERGENCY REPAIRS

CONDITION AND STORAGE OF MATERIALS

- Inspect all new pipe, fittings, valves, and appurtenances before accepting their delivery.
- Store materials in designated storage areas until installation.
- Provide security barriers or fences around material and equipment storage areas.
- Elevate stored pipe on supports to prevent water entry.
- Provide a clean, intermediate barrier between fittings and ground surface.
- Provide for water drainage around designated material storage areas.
- Remove visible foreign matter from pipe and fittings.
- Use and maintain watertight end caps, plugs, or other protective devices to prevent foreign matter, soil, and animals from entering pipe during storage. Use lockable and inflatable caps when possible.
- Maintain protective coverings on fittings until installation
- Visually examine all internal surfaces prior to delivery for installation.
- In the event of contamination, scour internal surface or scrape clean, followed by disinfection.

EMERGENCY RESPONSE

- Secure the site to protect workers, the public, and property.
- Determine the type of break and associated risk for microbiological contamination¹:

Low Risk (Type 1): No loss of pressure during break; repair can be completed under pressure; no evidence of contamination.

Medium Risk (Type 2): No loss of pressure during break; repair allows for a controlled shut-down to complete repair; no evidence of contamination.

High Risk (Type 3 or 4): Loss of pressure at break site and/or elsewhere in the system before shut-down; proximity to potential sources of contamination (e.g. sewer lines); observation of contamination during repair activity.

Note that a high risk emergency or unscheduled repair can become a new main installation, which often happens with larger transmission main breaks or a scheduled repair.

- Perform repair, disinfection, and related procedures commensurate with level of risk (see page 13).

¹ Main break types (1 through 4) are categorized based on the risk for microbial contamination based on the results of Water Research Foundation project #4307.

GENERAL REPAIR PRACTICES

Excavation and Trench Work

- Install temporary diversion devices to prevent surface water runoff from entering trench.
- Provide for continuous dewatering of excavation to minimum one-foot below the level of pipe invert.
- Provide shoring when necessary.
- Keep pipe, fittings, and valves away from excavated soil or backfill materials.
- Clean interior of pipe materials which contact soil or backfill.
- Postpone work during rainy periods if runoff, trench water, or groundwater cannot be adequately controlled.
- Maintain flow or positive pressure to prevent backflow into pipe.
- If hazardous soil conditions are discovered, isolate the soil and report to appropriate authorities for clean-up.

Typical Repair Activities

- Maintain protective coverings on equipment until ready for installation.
- Clean visible debris from exposed areas of existing pipes.
- Protect existing mains and service connections with caps or covers.
- Ensure that all cables, pipes, and hoses drawn through mains are clean.
- Keep fittings, valves, and appurtenances covered and protected until ready for installation.
- Minimize soil contamination of working equipment.
- Disinfect hand tools, saws, and tapping machines used for installing pipe and fittings. Use chlorine dips, sprays, and/or rinses (unless in sub-freezing conditions).
- Keep gaskets clean at all times.
- Clean and disinfect removed, reusable appurtenances.
- Disinfect (chlorinate) fittings, valves, and exposed areas of existing connections with swab or spray technique.
- Rinse pipes and fittings prior to installation, if practical.
- Spray disinfectant (minimum 1% bleach or equivalent) and swab interior joint surfaces just prior to making connections (unless in sub-freezing conditions).
- Minimize soil contamination of working equipment.
- Complete all joints in the trench before work is stopped, if possible.
- If repair is completed under pressure, verify pressure conditions at the start of repair, at least once during repair, and end of repair.

Risk-Based Procedures

Low Risk (Type 1) Repairs:

- Complete repair under pressure.
- Follow sanitary repair practices outlined above.
- Check disinfectant residual in distribution system prior to and after repair.

Medium Risk (Type 2) Repairs:

- Follow all procedures for Low Risk repairs.
- Conduct low velocity flush, turning over a minimum of three pipe volumes, when repair is completed.

High Risk (Type 3 or 4) Repairs:

- Follow all procedures for Low Risk and Medium Risk Repairs (except ability to repair under pressure).
- Document possible sources of contamination.
- Report to applicable local, State, and/or health officials with primacy.
- Conduct a scour flush at a minimum three feet-per-second (where possible).
- Perform slug chlorination for a minimum CT (contact time) of 100 mg/L-min or follow disinfection procedures for the installation of a new main such as ANSI/AWWA C-651.
- Control flush and rinse water and dechlorinate prior to discharge to the environment.
- Issue Boil Water Advisory as appropriate or if required by local regulatory authority.

Risk-Based Procedures (Continued)

High Risk (Type 3 or 4) Repairs (Continued):

- Perform bacteriological testing as appropriate or as required by local regulatory authority.
- When performing bacteriological testing, collect and analyze samples following established water sampling, preservation, and shipping procedures.
- Ensure that the results of water quality sampling reach the appropriate people so that a timely decision for return to service can be made.

RETURN TO SERVICE

Public Notification

- Notify affected customers about schedule, procedures, and concerns.
- Suggest customers flush their home plumbing after repairs are completed.
- For High Risk (Type 3 or 4) breaks, coordinate public notifications with the local health department or applicable agency.

Connection Start-Up

- Flush hydrants after repairs are completed according to the level of risk.
- Sequence operation of valve openings to avoid low (or negative) pressure transients.

JOB COMPLETION

- Compile job notes that outline the type of repair, particular field conditions and problems encountered, and suggestions/recommendations for avoiding problems on similar jobs.
- Report all findings to local regulatory authorities, as required.

FLUSHING QUICK REFERENCE

Flow in Pipe for a Flushing Velocity of 3.0 ft/sec

Pipe Diameter	Flushing Velocity	Flow in Pipe		
(Inch)	(ft/sec)	(ft ³ /sec)	(gpm)	Three Pipe Volume/Linear FT of Pipe Length (gal)
2	3.0	0.07	29	0.49
4	3.0	0.26	118	1.96
6	3.0	0.59	264	4.41
8	3.0	1.05	470	7.83
10	3.0	1.64	735	12.24
12	3.0	2.36	1058	17.62
16	3.0	4.19	1881	31.33

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