Main Breaks and Cross Connections

Learning Objectives

• Be able to preserve water quality when responding to a water main break

• Describe the difference between proactive and reactive responses

Learning Objectives – Contd.

• Be able to describe what a cross connection is and recognize a cross connection

• Be able to describe the seriousness of cross-connections, and importance of cross-connection control

• Describe requirements for cross-connection control

• Be able to outline the emergency response in the event of a backflow
Main Break – how does it happen?

- Aging infrastructure
  - “a significant water line bursts on average every two minutes somewhere in the country”
  - “$334.8 billion will be needed for pipe, treatment, storage, source, and other infrastructure over the 20 year period 2007-26”
- Frost load
- Pressure surge
- Mechanical damage
- Sabotage

Main Break – how does it happen?

“The rupture was caused by an emergency pump shutoff that increased pressure from 180 psi to 300 psi.”

Main Break - Consequences

- Potentially a safety hazard
- Flooding of surrounding area
- Property damage
- Traffic interruptions
Main Break - Consequences

- Water service interruption
- Loss of pressure
  - Contaminant intrusion
  - May require bottled water or boil water order
- Loss of finished water
- High velocity scouring of pipes may dislodge sediments and increase turbidity

Corrective Measures

- Reactive
  - Flushing (after break)
  - Disinfection
- Make sure **ALL** valves are opened after disinfection
  - It usually takes 3 or more valves to shut off a break, but only 1 to put the line back into service.
- Long-term - Asset Management
  - Buried pipes are the most costly assets of most water utilities
  - The rate of pipe failure is greater than the pipe renewal rate in most utilities

Main Break Prevention

1. Develop a program to anticipate main breaks
2. Prioritize mains that need replacement and get them included in the Capital Improvement Plan
3. Develop a protocol for response to main breaks to limit adverse water quality effects

**Being proactive can reduce costs and protect water quality**
Recommended Response in Case of Main Break

- Notify State
  - State will assist with proper public notification
- Repair pipe
- Disinfect pipe
- Take Coliform sample
  - If possible pipe should remain out of service until Coliform results confirm there is no contamination
- Return to service
- Notify State

Disinfecting New Pipes and Returning New Pipes to Service

- New water mains and those taken out of service should be disinfected before returning to service
- For the detailed procedures and requirements, go to: AWWA Standard C651-05 – Disinfecting Water Mains

Disinfecting Pipe

4-step program can ensure the lines have been properly disinfected prior to being placed into service

1. Flush the line
2. Chlorinate
3. Flush to remove chlorinated water
4. Refill the line
4-Step Process

1. **Flush the line** to remove any particulates
   - More effective than burning with chlorine
   - Velocity > 2.5 fps
   - Flush at least 2x the volume of the pipe

2. **Chlorinate**
   - Should target a dose of 50 mg/L
   - A 5 mg/L residual should remain after 24 hrs
   - A higher chlorine dose can be used in exchange for a shorter contact time
   - Do not use dry chlorine (HTH) as granules may not fully dissolve

3. **Flush to remove chlorinated water** (minimum two full pipe volumes)
   - Chlorinated water must be dechlorinated prior to discharge in some areas

4. **Refill the line** and perform coliform sampling
   - If results are negative the line is ready to be returned to service
   - If results are positive, repeat from step 2
   - If positive results continue, pigging or additional flushing may be necessary

Disinfecting Pipe

- **What should you do if a pipe cannot remain out of service?**
  - Maintain a minimal distribution system residual of 0.5 to 1.0 mg/L
  - Increase frequency of coliform sampling
  - Consider a limited area Boil Water Notice (door hangers)
Cross Connections

- Any point in a water distribution system where chemical, biological, or other contaminants may come into contact with potable water
- Contaminants can be drawn or pushed back into the water distribution system during a backflow event
- A dynamic problem since plumbing systems are constantly being installed, altered, and extended

"over 100,000 new cross-connections are formed each day" (AWWARF, 2000)

"the greatest contributing factor to waterborne disease outbreaks in the U.S." (AWWARF, 2000)

Cross Connections

- Contaminants can enter the distribution system through two mechanisms
  - Backsiphonage
    - Negative or reduced pressure in the supply piping, sucking non-potable fluids into the distribution system
    - Low pressure can be caused by line break or fire flow and others
  - Backpressure:
    - When a potable system is connected to a non-potable system working under a higher pressure, forcing non-potable water into the potable system
Cross Connections: Backsiphonage

- Maryland
- Paraquat, an herbicide, entered the distribution system
- Cross connection between an herbicide holding tank and the potable water supply line

Cross Connections

- Pennsylvania
- Low pressure in the supply line due to a line break
- Chlordane and heptachlor entered the distribution system through a cross connection (a hose immersed in a chemical tank) and backsiphonage
Cross Connection Control Devices

• Air Gap: Twice the pipe diameter

Cross Connection Control Devices

• Atmospheric Vacuum Breaker
  – Not designed to protect against back pressure conditions

Cross Connection Control Devices

• Pressure Vacuum Breaker
  – Not designed to protect against back pressure conditions
Cross Connection Control Devices

• Double check valve

Cross Connection Control Devices

• Reduced pressure zone backflow preventer

What is wrong with this picture?
What is wrong with this picture?

What to do in case of a backflow event?

1. Stop the pressure differential that caused backflow of contamination, if possible
2. Identify and remove the cross connections
3. Contact state/primacy regulatory agency
4. If harmful contaminants are suspected, provide immediate notice to the affected customers
5. Develop and carry out a plan for systematic flushing of the system
6. Continue to sample within and outside the suspected contaminated area

Online Resources

• USEPA Cross-Connection Control Manual

• USEPA Cross-Connection Control: A Best Practices Guide

• ASSE Series 5000, USC’s FCCC & HR’s “Manual of Cross-Connection Control”, or UFL’s TREET’s “Backflow Prevention – Theory and Practice”