Information Collection and Research Needs for Cross-Connection, Backflow Prevention and Pressure/Intrusion

Melinda Friedman
TWG Representative
TCRDS Federal Advisory Committee
January 16, 2008

This Meeting's Presentations

Objectives

Provisions

System compliance

Improvement

Research

CCC/BF and Intrusion research and information collection needs

Presentation Objectives

- Define the topic
- Explain why this topic is of concern and may warrant additional research / information collection
- Review the current state of research
- Describe decision-relevant research and information needs
- Identify linkages to related topics and cross-cutting issues

Definition of Topic – CCC/BF

- “Cross-connection” – Definition provided in previous presentation
- “Backflow” – Definition provided in previous presentation

Magnitude of Public Health Concern - Backflow

- Hundreds of cases of documented backflow incidents over past three decades
  - Many incidents may go undetected or unreported
  - Programmatic improvements over last three decades
- Is not quantified on a national level and will vary from system to system
- A wide variety of microbial, chemical, and physical substances can be introduced into the distribution system and/or premise piping
  - Once introduced, many chemical and physical variables will influence potential for public health impact
- Cross connections often occur beyond the service connection
  - May or may not impact distribution system

Mitigation Strategies - Backflow

- Preventative
  - System Design and Operation - Water distribution systems are designed and operated to maintain a positive pressure under most flow conditions
    - State review and approval of major system mains
    - Portion of ISO Fire Suppression Ratings based on water supply capacity
  - Cross connection control and backflow prevention programs
    - Industry, state, and federal guidance manuals are available for establishing cross connection control programs
  - Plumbing code enforcement
- Responsive
  - Multiple system responses associated with identifying cause, contaminant, impact area, notification, isolation, and removing contaminated water from system

Implications for Different Systems - Backflow

- Community water systems may be impacted by cross connections that occur within the distribution system and/or beyond the service line
  - Do not have jurisdiction over premise plumbing
    - Local building/plumbing department review, approval, and inspection of premise plumbing
  - Typically, CCC/BFP programs specify installation of backflow prevention devices at the service connection of high hazard facilities
- Non-community water systems own and control both their internal plumbing system and any associated distribution system
  - Local building/plumbing department review, approval, and inspection of premise plumbing

State of Current Research - Backflow

- On-going research and data collection on the degree to which cross-connections exist and pressure differentials occur
- Contaminants from documented incidences have been compiled
- General understanding of the maintenance and management aspects of a CCC/BP program
- History of designing, manufacturing and installing backflow prevention devices
- At this time, only limited understanding of:
  - Magnitude of the public health risk
  - Information needed to quantify risk reduction or effectively monitor public health benefit
  - Political dimensions of local implementation
    - CWS separate from local building/plumbing department
    - Active implementation and enforcement may be resource-limited

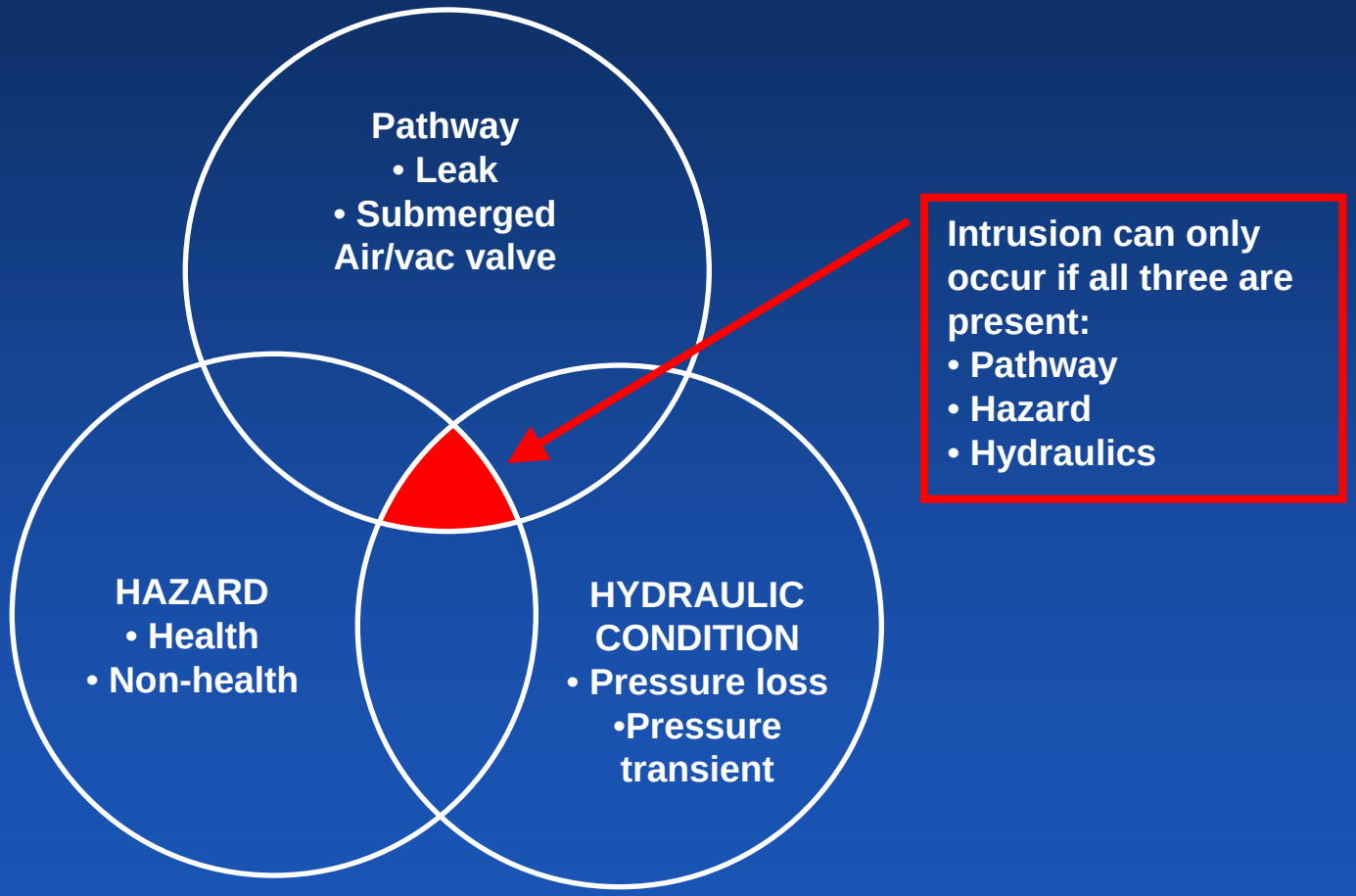
CCC/Backflow Research/Information Gaps

Gap	Exposure / Vulnerability	Health Effect / Risk	Mitigation Strategy
Analytical framework for assessing backflow occurrence and exposure	++ (1-5 y)		
Occurrence of cross connections and backflow risk factors in a range of water systems (backpressure, backsiphonage, hazards, cross connections)	++++ (1-5 y)		
Fate and transport of contaminants introduced during backflow (delivered concentration to the consumer)	+++++ (5-10 y)	+++++ (>10 y)	
Epidemiologic evidence of illness associated with backflow events (linkage of public health data with backflow events)		+++++ (>10 y)	
Define critical elements of an effective CCC/BP programs			+ (1-5 y)
National characterization of CCC/BP program implementation and limitations			++ (1-5 y)
Health effects from contaminants associated with documented backflow events		+ (1-5 y)	

Definition of Topic – Pressure Transient/Intrusion

- “Pressure transient” – a wave of energy traveling through a pipe in the form of a pressure differential caused by an abrupt change in water velocity
- “Intrusion” – entry of non-potable water through a leak or other orifice into the distribution system as a result of *low or negative* pressure

Intrusion Incident Requirements



Magnitude of Public Health Concern - Intrusion

- Is not quantified on a national level and will vary from system to system
- Intrusion may introduce a wide variety of microbial, chemical, and physical substances into the distribution system
  - Once introduced, many chemical and physical variables will influence potential for public health impact
- A few epidemiological studies have suggested that distribution systems may have been responsible for increased levels of gastrointestinal illnesses
  - There is some data linking pressure loss to illness
  - There is limited data linking intrusion to illness
  - There is no data linking intrusion to toxic chemical exposure

Mitigation Strategies - Intrusion

- Engineering standards and practices
  - System design to maintain positive pressure under most flow conditions (e.g. elevated storage)
  - Separation distances between water and sewer pipes
  - Valve sizing and design of air/vacuum relief valves
  - Surge control devices
  - Network analysis to minimize transients
- Valve and pump operation to avoid sudden changes in velocity
- Leak detection and repair
- Maintenance of residual
  - May afford some inactivation of certain microbes if adequate CT provided?

Implications for Different Systems - Intrusion

- Intrusion is primarily viewed as a potential exposure pathway associated with *buried or submerged* infrastructure (pipes and appurtenances)
  - The amount of buried infrastructure is significantly higher in CWSs than NCWSs
- Activities that can cause pressure loss events occur more frequently in CWS
  - Main breaks, power loss to pump stations, etc.
- Quantity of intruded water reaching consumer is unknown for CWSs and NCWSs, and will vary significantly

State of Current Research - Intrusion

- History of designing, manufacturing, and installing buried infrastructure to minimize intrusion
  - Limited understanding of the actual “porosity” of existing infrastructure
  - Porosity expected to increase as infrastructure degrades
- General understanding of the maintenance and management of water systems to maintain positive pressure
  - Causes of transient pressure events are largely known
  - Limited understanding of frequency and magnitude of transient pressure events
- At this time, research is needed to quantify risk reduction and effectively monitor public health benefit of additional steps to prevent intrusion

Pressure Transient/Intrusion Research/Info Gaps

Gap	Exposure / Vulnerability	Health Effect / Risk	Mitigation Strategy
Analytical framework for assessing pressure loss/intrusion occurrence and exposure	++ (1-5 y)		
Pathogen and contaminant occurrence in vicinity of intrusion pathways	++++ (1-5 y)		
Occurrence of pressure loss and intrusion risk factors in a range of water systems (leakage, submerged infrastructure, etc.)	++++ (5-10 y)		
Assessment of intrusion volumes under various physical and hydraulic regimes	+++++ (5-10 y)	+++++ (>10 y)	
Fate and transport of intruded contaminants with distribution system (delivered concentration to the consumer)	+++++ (5-10 y)	+++++ (>10 y)	
Epidemiologic evidence of illness associated with intrusion events (linkage of public health data with events)		+++++ (>10 y)	
National characterization of pressure management strategies, degree of implementation			+++ (1 - 5 y)

Cross-Cutting Issues

- Implications of Pressure Loss
  - Cross connections and intrusion - In which situations is pressure loss (or backpressure) sufficiently severe as to lead to an exposure that threatens public health?
- Sudden Changes in Velocity
  - May scour or entrain pipe scales, sediments, biofilms
  - May damage infrastructure
- Linkage to Over-arching Issues
  - Infrastructure deterioration will lead over time to more opportunities for the distribution system's hydraulic integrity to be breached