Expert Workshops/Panels on Distribution System Issues: Summary of Outputs

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This Meeting's Presentations

Objectives

Provisions

System compliance

Improvement

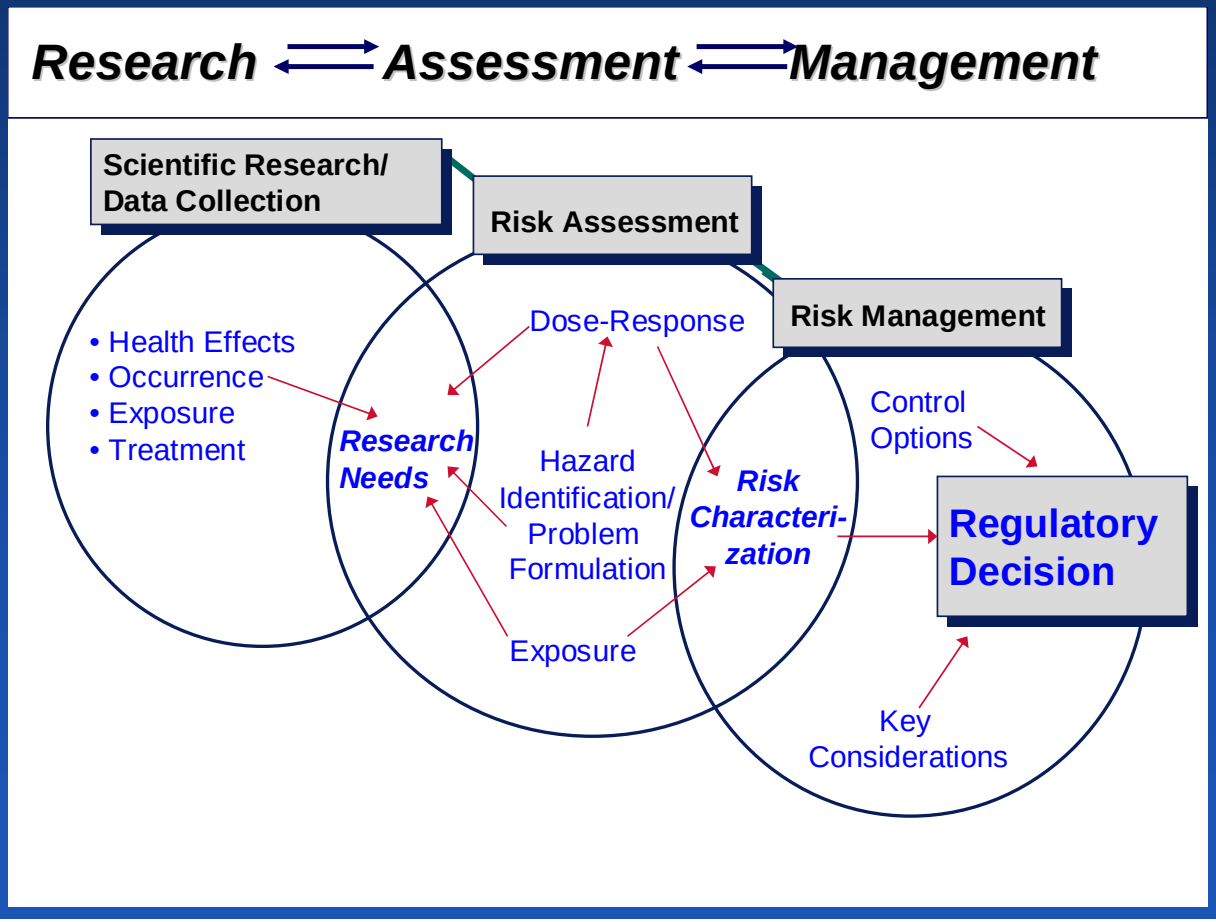
Research

Expert Workshops/Panels on Distribution System Issues

6 Expert Panels/Workshops: Summary of Outputs

- This is a summary of outputs from six expert panels or workshops on distribution system issues associated with water contamination or loss in water quality
- This does not include
  - Evaluation or summary of solutions to problems (such as operator training) or regulatory options
  - Any cost-benefit analyses, risk assessments, or evaluations of impacts on various public water systems

Workshops/Panels Provide a Starting Point for Risk Assessment & Management



6 Workshops/Panels to be Discussed

Sponsoring Organization	Code	Workshop/Panel
NRC	NRC	Committee on Public Water Supply Distribution Systems: Assessing and Reducing Risks
EPA	EPA WP	Distribution System White Papers Meeting
EPA	EPA PS	Public Stakeholder Meeting on Distribution System Issues of Potential Concern
EPA	EPA EA	Exposure Assessment Workshop, Pathogens and Toxic Chemicals in Drinking Water Distribution Systems
AwwaRF	AwwaRF PI	Pathogen Intrusion into the Distribution System Expert Panel Workshop
AwwaRF	AwwaRF SIRP	Distribution System Water Quality Strategic Initiative Research Plan Workshop

Workshop Elements and Prioritization

- The following table shows prioritized output from participants in the workshops/panels.
- This is *NOT* the prioritization from the Technical Working Group
- The information in the table is being shown to help the FAC consider distribution system elements and prioritization criteria

Summary of Workshop/Panel Output: Priority Issues

(H= high, M= medium, L= low)

Distribution System Issue	Expert Panel/Workshop					
	NRC	EPA WP	EPA PS	EPA EA	AwwaRF PI	AwwaRF SIRP
Cross connection & backflow	H	H	H	H	H	---
Biofilm and microbial ecology	M	H	M	H	L	H/M
New and repaired mains & breaks	H	H	M	L	H	---
Storage facility integrity	H	M	L	H	M	---
Pressure transients & intrusion	---	H	M	H	H	---
Nitrification	L	M	M	M	---	M
Internal pipe corrosion	L	---	L	H	---	M

National Research Council (NRC) / NAS Committee

- 2004 - 2006
- 15 industry experts invited by the National Research Council of the National Academies in consultation with EPA (water utilities, academia, consultants, States)
- Conduct a review of water quality issues associated with public water supply distribution systems and their potential risks to consumers.

Output:

1) *Public Water Supply Distribution Systems: Assessing and Reducing Risks -First Report* (2005), The National Academies Press, Washington, D.C.

2) *Drinking Water Distribution Systems- Assessing and Reducing Risks* (2006), National Academy of Sciences.

EPA Distribution System White Paper Meeting

- March 7-8, 2002
- 32 industry experts invited by EPA (utilities, academia, consultants, EPA, States, NRDC, AWWA)
- Review nine distribution system white papers drafted by/for USEPA to determine what data are missing in the papers, and what research is needed

Output:

1. Recommendations for revising the white papers.
2. Identification of areas where more information is needed.
3. Relative ranking of distribution system issues.

EPA Public Stakeholder Meeting

- November 14, 2002
- 69 attendees (water utilities, EPA, Health Canada, States, AWWA, consultants, manufacturers, US PHS)
- Presentation and discussion of EPA's nine White Papers

Output:

Four breakout groups each developed answers to four questions regarding each white paper:

1. Do we have all of the relevant information?
2. Is the issue a public health issue worth following up on?
3. Are we focusing on the right issues and are they correctly combined?
4. What needs to be done to address the problem?

Stakeholders also ranked (by voting) the nine issues according to public health relevance

EPA Exposure Assessment Workshop

- March 29-31, 2004
- 36 experts invited by EPA (academia, States, AwwaRF, utilities, EPA, consultants, AWWA, NRDC, UK DWI, KIWA)
- **Primary goals:**
  - Evaluate exposure assessment concepts
  - Recommend factors for additional consideration related to an exposure assessment due to contamination of distribution systems
  - Recommend specific data sets to support such analysis
  - Recommend next steps for how EPA could continue development of an exposure assessment

EPA Exposure Assessment Workshop (Continued)

Output:

Questions were posed, and answers provided, for pathways included in the nine EPA White Papers.

The workshop experts also discussed:

- What pathways should we be most concerned about?
- What indicators may be relevant for multiple exposure pathways?
- Areas where research and exploration are required to develop a better understanding of issues.

AwwaRF Pathogen Intrusion Workshop

- April 30-May 1, 1998
- 15 experts identified by AwwaRF and its research project team (utilities, academia, consultants, AwwaRF, EPA, KIWA)
- To rank the intrusion pathways identified in the project's literature review to help focus subsequent project and research activities

Output:

- Criteria and definitions were developed for ranking waterborne pathogens.
- Waterborne pathogens were ranked based on severity of health effects.
- Waterborne pathogen routes of entry were compiled and simplified into nine major routes.
- The nine routes of entry were then ranked into categories of high, medium, and low.

AwwaRF Strategic Initiative Research Plan Workshop

- May 30 - 31, 2007
- 29 experts invited by AwwaRF and CH2M Hill (EPA, States, consultants, academia, utilities, AwwaRF, Singapore
- To support the development of a draft research plan for the AwwaRF Distribution System Water Quality Strategic Initiative (a commitment to research projects worth $1 million per year, for an expected duration of at least five years)

Output:

- An overview on the state of science of distribution system water quality in a summary paper.
- Potential research project descriptions.
- Ranking of potential research projects.

Comparison of Distribution System Elements that were Identified in Workshops/Panels

Notes on Comparison

- Each workshop/panel addressed issues a little differently
- Not every issue/element was addressed by every workshop/panel.
- For example, biofilm could include nitrification and regrowth, or these could have been separated into three different elements.
- Some “elements” are routes of entry for contamination (intrusion, backflow)
- Others are conditions found in the distribution system.(water age, loss of disinfectant residual, corrosion)

Common Elements among Workshops/Panels

Distribution System Element	Expert Panel/Workshop					
	NRC	EPA WP	EPA PS	EPA EA	AwwaRF PI	AwwaRF SIRP
Biofilm and bacterial regrowth	X	X	X	X	X	X
Backflow / cross connections	X	X	X	X	X	
Storage facility maintenance	X	X	X	X	X	
Pressure transients & intrusion	X	X	X	X	X	
Nitrification	X	X	X	X		X
Leaching	X	X	X	X		X
New & repaired mains	X	X	X		X	
Permeation	X	X	X	X		

Other Elements or Related Topics

Distribution System Element	Expert Panel/Workshop					
	NRC	EPA WP	EPA PS	EPA EA	AwwaRF PI	AwwaRF SIRP
Water age	X	X	X			
Scale and corrosion layers	X			X		X
Leaks and breaks in mains	X				X	
Inadequate treatment	X				X	
Chlorine loss	X			X		
Biological stability	X					X
DBP formation	X					X
Premise plumbing	X					X
Aging buried infrastructure		X	X			

Other Elements or Related Topics

Distribution System Element	Expert Panel/Workshop					
	NRC	EPA WP	EPA PS	EPA EA	AwwaRF PI	AwwaRF SIRP
Service lines	X					
Loss of pressure	X					
Low water flow	X					
System design	X					
Pathogen transport and retention						X
Disinfectant residual effectiveness						X
Sediment deposition / inorganics accumulation		X				

Ranking / Prioritization Criteria for Distribution System Issues

- Criteria used (depending on the panel/workshop):
  - Literature review
  - Expert opinion/experience
  - EPA White Papers
  - Stakeholder opinion (EPA PS only)

Summary of Prioritization/Ranking

(H= high, M= medium, L= low)

Distribution System Issue	Expert Panel/Workshop Ranking					
	NRC	EPA WP	EPA PS	EPA EA	AwwaRF PI*	AwwaRF SIRP*
Cross connection & backflow	H	H	H	H	H	---
Biofilm and microbial ecology	M	H	M	H	L	H/M
Pressure transients & intrusion	M	H	M	H	H	---
New and repaired mains & breaks	H	H	M	L	H	---
Storage facility integrity	H	M	L	H	M	---
Nitrification	L	M	M	M	---	M
Internal pipe corrosion	L	---	L	H	---	M

*Note: AwwaRF PI and SIRP were focused on research needs

Summary of Prioritization/Ranking

(H= high, M= medium, L= low)

Distribution System Issue	Expert Panel/Workshop Ranking					
	NRC	EPA WP	EPA PS	EPA EA	AwwaRF PI*	AwwaRF SIRP*
Permeation	L	M	L	M	---	---
Leaching	L	H	L	L	---	---
Water age	L	M	M	---	---	---
Aging infrastructure	---	H	L	---	---	---
Premise plumbing	H	---	---	---	---	L
Disinfectant residual & its loss	M	---	---	---	---	H

*Note: AwwaRF PI and SIRP were focused on research needs

Low Priority or Research Only

(H= high, M= medium, L= low)

Distribution System Issue	Expert Panel/Workshop Ranking					
	NRC	EPA WP	EPA PS	EPA EA	AwwaRF PI	AwwaRF SIRP
DBP formation and fate	L	---	---	---	---	L
Treatment breakthrough	---	---	---	---	H	---
Pathogen retention and transport	---	---	---	---	---	H
Lead and copper	---	---	---	---	---	H
Organochloramines	---	---	---	---	---	H
Sediment deposition/ inorganics	L	---	---	---	---	---
Biological stability of treated water	---	---	---	---	---	L

*Note: AwwaRF PI and SIRP were focused on research needs

What information does the FAC need from the TWG to help you evaluate elements and priority?

APPENDIX

Additional Panel / Workshop Information

6 Workshops/Panels

NRC	**National Research Council's** Committee on Public Water Supply Distribution Systems: Assessing and Reducing Risks
EPA WP	EPA Distribution System **White Paper** Meeting
EPA PS	**EPA Public Stakeholder** Meeting on Distribution System Issues of Potential Concern
EPA EA	**EPA Exposure Assessment** of Pathogens and Toxic Chemicals in Drinking Water Distribution Systems
AwwaRF PI	**Pathogen Intrusion** into the Distribution System-Expert Panel Workshop
AwwaRF SIRP	Distribution System Water Quality **Strategic Initiative Research Plan** Workshop

(NRC) National Research Council / NAS Committee

Recommendations Pertaining to a Possible Distribution Rule

- Cross-connection control should be in place for all water utilities.
- EPA should work closely with representatives from states, water systems, and local jurisdictions to establish the elements that constitute an acceptable cross-connection control program.
- Residual disinfectant choices should be balanced to meet the overall goal of protecting public health.

(NRC) National Research Council / NAS Committee

Recommendations – Research Needs :

- Epidemiological studies that specifically target the distribution system component of waterborne disease are needed.
- Distribution system ecology is poorly understood, making risk assessment via pathogen occurrence measurements difficult.
- Current microbial monitoring is limited in its ability to indicate distribution system contamination events, such that new methods and strategies are needed.
- Distribution system integrity is best evaluated using on-line, real-time methods to provide warning against any potential breaches in sufficient time to effectively respond and minimize public exposure.
- Research is needed to better understand how to analyze data from on-line, real-time monitors in a distribution system.
- Communities should squarely address the problem of *Legionella*, both via changes to the plumbing code and new technologies.

(NRC) National Research Council / NAS Committee

Recommendations - Information Collection Needs

- More attention should be paid to having adequate facilities, instructors, and apprentice programs to train utility operators, inspectors, foremen, and managers.
- There is inadequate investigation of waterborne disease outbreaks associated with distribution systems, especially in premise plumbing.

Other General Recommendations:

- EPA should create a homeowner's guide and website that highlight the nature of the health threat associated with premise plumbing and mitigation strategies that can be implemented to reduce the magnitude of the risk.
- Research projects are needed that specifically address potential problems arising from premise plumbing.

(NRC) National Research Council / NAS Committee

Elements Identified for the Distribution System:

<u>Physical Integrity</u>

- Backflow and cross connections
- New or repaired mains and components
- Covered storage facility maintenance
- External corrosion
- Internal corrosion
- Leaks and breaks
- Permeation
- Service line issues

(NRC) National Research Council / NAS Committee

Elements Identified for the Distribution System:

<u>Hydraulic Integrity</u>

- Pressure transients
- Loss of pressure
- Water age
- Low flows
- Mixing and turnover, or operation of storage facilities
- Reduced hydraulic capacity due to scales/corrosion
- System design (dead ends, over-sized mains, etc.)

(NRC) National Research Council / NAS Committee

Water Quality Integrity

- Intrusion of contaminants
- Inadequate treatment
- Biofilm and regrowth
- Nitrification
- Permeation
- Scale formation and dissolution
- Chlorine residual loss
- Sediment deposition
- Leaching
- Internal corrosion and byproducts
- Biological stability of water
- DBP ongoing formation
- Premise plumbing

(NRC) National Research Council / NAS Committee

Criteria for Prioritization: Independent literature review, EPA's White Papers, and expert opinion/experience.

Highest Priority Issues to Address (based on associated potential health risks)

- Cross connection control and backflow
- New or repaired water mains
- Finished water storage facilities
- Premise plumbing
- Distribution system operator training

(NRC) National Research Council / NAS Committee

Medium Priority Issues to Address (based on having some potential to impact public health)

- Uncontrolled biofilm growth
- Loss of disinfectant residual via water age and nitrification
- Low pressure transients and intrusion

Low Priority Issues to Address (based on maintaining a well-managed system)

- Other effects of water age (DBP formation, corrosion, sediment deposition, etc.)
- Other effects of nitrification (nitrite and nitrate formation, changes in pH and alkalinity)
- Permeation
- Leaching

Additional Issue - Control of post precipitation

(EPA WP) EPA Distribution System White Paper Meeting and **(EPA EA)** EPA Exposure Assessment Workshop

Elements identified:

1. Intrusion from pressure transients
2. Cross connections and backflow
3. Aging buried infrastructure
4. Permeation
5. Leaching
6. Nitrification
7. Biofilm
8. Storage facilities
9. Water age
10. New and repaired mains
11. Internal corrosion

(EPA WP) EPA Distribution System White Paper Meeting

Criteria for Prioritization: Literature review (used to form the EPA White Papers) and expert opinion/experience.

High Priority

- Cross connection and aging infrastructure
- Biofilm
- Leaching
- Pipe repair/replacement
- Intrusion

Maybes:

- Nitrification
- Covered storage
- Water age
- Permeation

(EPA EA) EPA Exposure Assessment Workshop

Regarding the ranking of the importance of pathways, workshop experts noted that:

- All pathways are important.
- Water systems might rank the pathways in a different order in different circumstances, so ranking may not be appropriate for setting national priorities.
- Ranking the importance of the pathways and priorities is most helpful and applicable when specific source waters and specific system characteristics are considered in conjunction with the pathways.
- The frequency of various risk factors across systems might be a logical way to choose which issues take immediate priority.
- Pathways that are not as well characterized (e.g. permeation and leaching) should be re-evaluated when more complete data are obtained and interpreted.

(EPA EA) EPA Exposure Assessment Workshop

Criteria for Prioritization: EPA White Papers and expert opinion/experience

Rankings / priorities - contamination from <u>outside</u> the distribution system:

- <u>Backflow</u> and <u>intrusion</u> were identified as <u>high priorities</u>; they were considered of equal concern due to the significant overlap of contributing factors (loss of pressure, presence of potential contamination).
- External contamination of <u>storage facilities</u> was also related to backflow and intrusion
- <u>Permeation</u> was identified as a somewhat <u>lower priority</u>.

(EPA EA) EPA Exposure Assessment Workshop

Rankings / priorities - contamination from <u>within</u> the distribution system:

- <u>Corrosion</u> was identified as a <u>high priority</u> because toxic metals have known negative health impacts.
- <u>Biofilm</u> was identified as an <u>important issue</u> because *Legionella* and *Mycobacteria* are significant microbial contaminants associated with biofilms.
- <u>Nitrification</u> was identified as a somewhat <u>lower priority</u> because the consequences of nitrification, such as loss of chlorine residual, biofilm growth, and release of toxic metals from corrosion, are of greater concern than nitrification itself.
- <u>Leaching</u> was identified as a relatively <u>lower priority</u> because widespread health risks have not been documented. However, leaching may be a health risk consideration for systems with susceptible pipe material and <u>should be further investigated</u>.

(EPA PS) EPA Public Stakeholder Meeting

Criteria: EPA White Papers and participant opinion.

	Votes
Cross-Connections	42
Main Repair and Replacement	19
Intrusion	13
Nitrification	11
Biofilm	8
Water Age	7
Permeation and Leaching	6
Aging Infrastructure/ Corrosion	4
Covered Storage	2

(AwwaRF PI) AwwaRF Pathogen Intrusion Workshop

Routes Of Entry

- Water Treatment Breakthrough
- Transitory Contamination
- Cross Connection
- Water Main Repair/Break
- Uncovered Storage Facilities
- New Main Installation
- Covered Storage
- Biological Growth/Resuspension
- Purposeful Contamination

Criteria for Prioritization: Independent literature review and expert opinion/experience.

(AwwaRF PI) AwwaRF Pathogen Intrusion Workshop

ENTRY ROUTES	NUMBER of VOTES	Research Need
Treatment Breakthrough	8	High
Transitory Contamination	8	High
Cross Connection	8	High
Water Main Repair/Break	7	High
Uncovered Storage	4	Medium
New Main Installation	2	Low
Covered Storage	2	Low
Growth/Resuspension	1	Low
Purposeful Contamination	0	Low

(AwwaRF SIRP) AwwaRF Strategic Initiative Research Plan Workshop

Distribution System Elements Identified:

- Biofilm
- Pathogen transport and retention
- Efficacy of disinfectant residuals
- Lead and copper leaching
- Organochloro (halo) amines
- Nitrification
- Internal corrosion
- Stability of pipe scales
- DBP formation and fate
- Premise plumbing (including service lines)
- Biological stability of treated water

Criteria for Prioritization: Independent literature review, EPA White Papers, and expert opinion/experience.

(AwwaRF SIRP) AwwaRF Strategic Initiative Research Plan Workshop

15 Recommended Research Projects in Order of Ranking:

1. Role of Biofilm on the Fate and Transport of Waterborne Pathogens in Distribution System and Premise Plumbing
2. Efficacy of Secondary Disinfection for Pathogen Control
3. Lead and Copper Corrosion Control in New Construction
4. Formation, Activity and Significance of Organochloramines
5. Microbial Ecology of Piped Water with Respect to Health Risks

(AwwaRF SIRP) AwwaRF Strategic Initiative Research Plan Workshop

15 Recommended Research Projects in Order of Ranking (cont'd.):

6. Evaluate Alternatives to the Total Coliform Indicator

7. Characterizing the Components of the Microbial Community Responsible for Nitrification

8. Screening of Methods for Determining the Microbial Ecology of Distribution Systems

9. Water Industry Contribution to Epidemiological Studies Involving Distribution System Water Quality

10. Effects of Disinfectants, Natural Organic Matter and Other Water Quality Parameters on the Internal Corrosion of Iron Pipe and Stability of Surface Scales

(AwwaRF SIRP) AwwaRF Strategic Initiative Research Plan Workshop

15 Recommended Research Projects in Order of Ranking (cont'd.):

11. Development of Predictive Models for the Formation and Fate of DBPs in Distribution Systems
12. Occurrence Study of Water Quality Changes in Premise Plumbing
13. Developing Exposure Estimates of the Contribution on Drinking Water to Blood Lead Levels using Realistic Integrated Water Levels
14. Identification of Research Gaps in Defining Biological Stability in North American Distribution Systems
15. Real-Time Data Fusion to Support Distribution System Operation and Management