

Emerging Distribution System Research Topics and Regulatory Trends

**PNWS AWWA
Vancouver, WA
May 1, 2008**



Melinda Friedman, P.E.
President
Confluence Engineering Group, LLC
Seattle, WA
(206) 527-6832
melinda@confluence-engineering.com

Presentation Objectives:

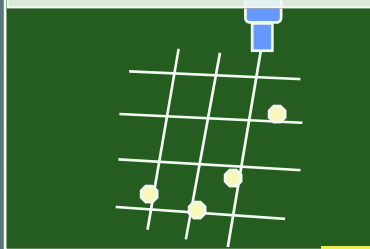
- To review the current status of several regulations that impact distribution system water quality
- To review some newer research trends
- To discuss impacts on all drinking water systems and what utilities can expect over the next few years

Why the Focus on Distribution Systems??

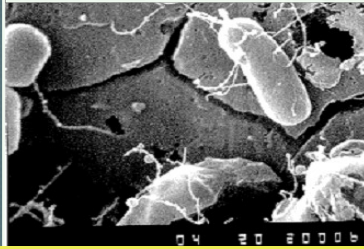
- Every public water system has one
- Numerous complex reactions occur between the source and the tap
 - Microbial
 - Chemical
 - Physical
- If the water looks or smells funny, the customer will not drink it, even if it is safe
- Distribution systems are the largest assets owned and operated by utilities
- Distribution systems are the final barrier in the SDWA Multiple Barrier Approach to protecting water quality

Water Quality in The Distribution System is the Past, Present, and Future

**Stage 1
DBP Rule**



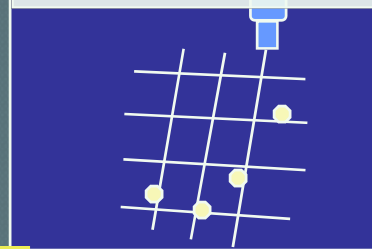
**Total Coliform
Rule**



**Ground Water
Rule**



**IDSE/Stage 2
DBP Rule**



**Lead and
Copper Rule**



**Revised Total
Coliform Rule**



**Distribution
System Rule**



**Lead and
Copper Rule
Revisions**

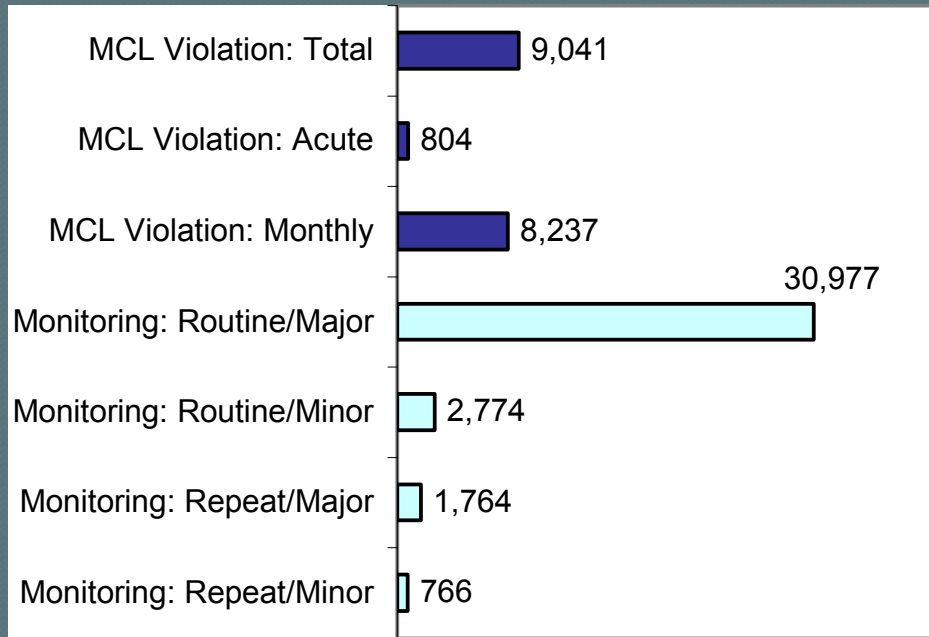


Objectives of the Total Coliform Rule

- Indicate adequacy of treatment
- Indicate presence of fecal contamination
- Indicate integrity of the distribution system

2003: Number of TCR Violations

(out 161,000 Public Water Systems)



- 9,041 MCL violations
- Approximately 36,000 monitoring violations

This is a real headache for many systems and for regulators!!!

Revisions to the TCR are Needed

- Are the violations actual indications of threats to public health?
- Is this rule, as currently written, adequately protecting public health?
- EPA and stakeholders believe that opportunities for reducing implementation burden, without compromising public health protection, exist if TCR is revised



TCR/DS Federal Advisory Committee

- Total Coliform Rule/Distribution System Federal Advisory Committee Convened (TCRDS FAC) (2007/2008)
 - Evaluating possible revision of the TCR
 - TCR monitoring framework
 - Sanitary survey provision
 - Definition of MCL violations and potential follow-up corrective actions, and
 - Communication of public health significance of violations
 - Evaluating the potential for requirements to address finished water quality in the distribution system
 - Information/research needs
 - Risk management strategies
 - Public health impacts

Information
Collection Rule???

- EPA believes that addressing TCR revision and distribution system issues together may result in more holistic approach
- Thus, we ended up with....

The Total Coliform Rule/Distribution System Rule!!!

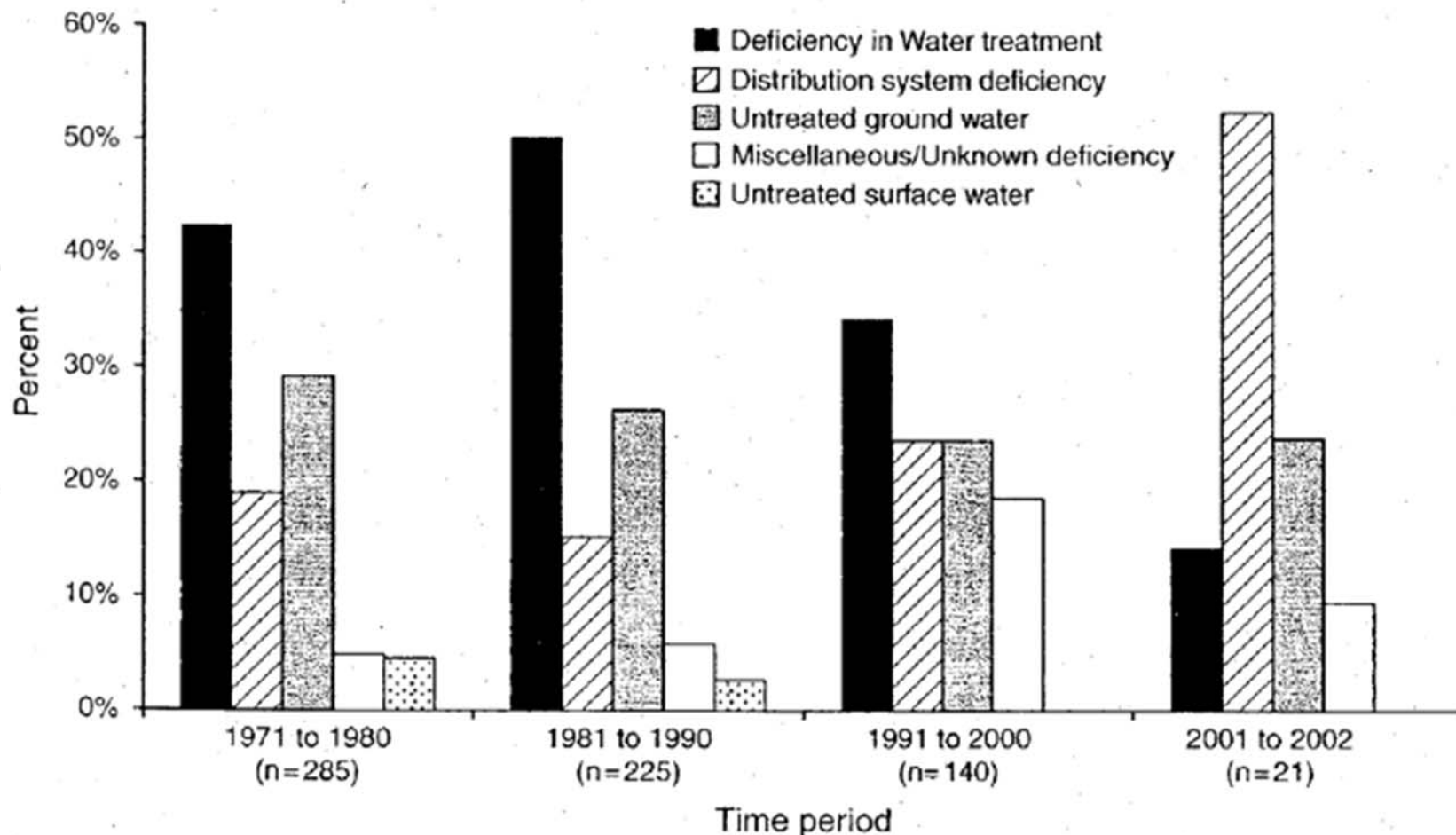
The Skinny on How Contaminants are Regulated

1996 SDWA Amendments

- “the Administrator shall...promulgate a national primary drinking water regulation for a contaminant...if...:
 - the contaminant may have an adverse effect on the health of persons;
 - the contaminant is known to occur or there is a substantial likelihood that the contaminant will occur in public water systems with a frequency and at levels of public health concern; and
 - in the sole judgment of the Administrator, regulation of such contaminant presents a meaningful opportunity for health risk reduction for persons served by public water systems...”
- When it is not economically or technologically feasible to determine the level of a contaminant, EPA can develop a treatment technique requirement

.....read....implementation and documentation of distribution system best management practices through distribution system optimization.....

Trends in System Deficiencies in Public Water Systems



OF OUTBREAKS ≠ # CASES OF ILLNESS

Craun, M.F. *et al.* 2006. *Journal of Water and Health. Waterborne outbreaks reported in the United States.* 04 Suppl 2: pp 19-30. Does not include Legionella.

Burden of Gastrointestinal Illness in the United States

(Source: Calderon, AWWA Distribution System Research Symposium, 2007)

- **CDC estimates**
 - 211 million episodes of acute gastrointestinal (GI) per year in the US
 - Includes food, waterborne, person to person transmission
 - Over 900,000 hospitalizations and 6000 deaths (Mead 1999)
- **1/3 of GI illness cases are related to drinking water**
 - Up to 70 million cases of GI illness may be caused by waterborne pathogens (Payment 1991& 1997)
- **The cost of infectious gastroenteritis in the US, including medical costs and lost productivity, are estimated to exceed \$20 billion annually (Peterson 2003)**
 - ~ \$7 billion annually due to drinking water

Limitations of Waterborne Outbreak Data

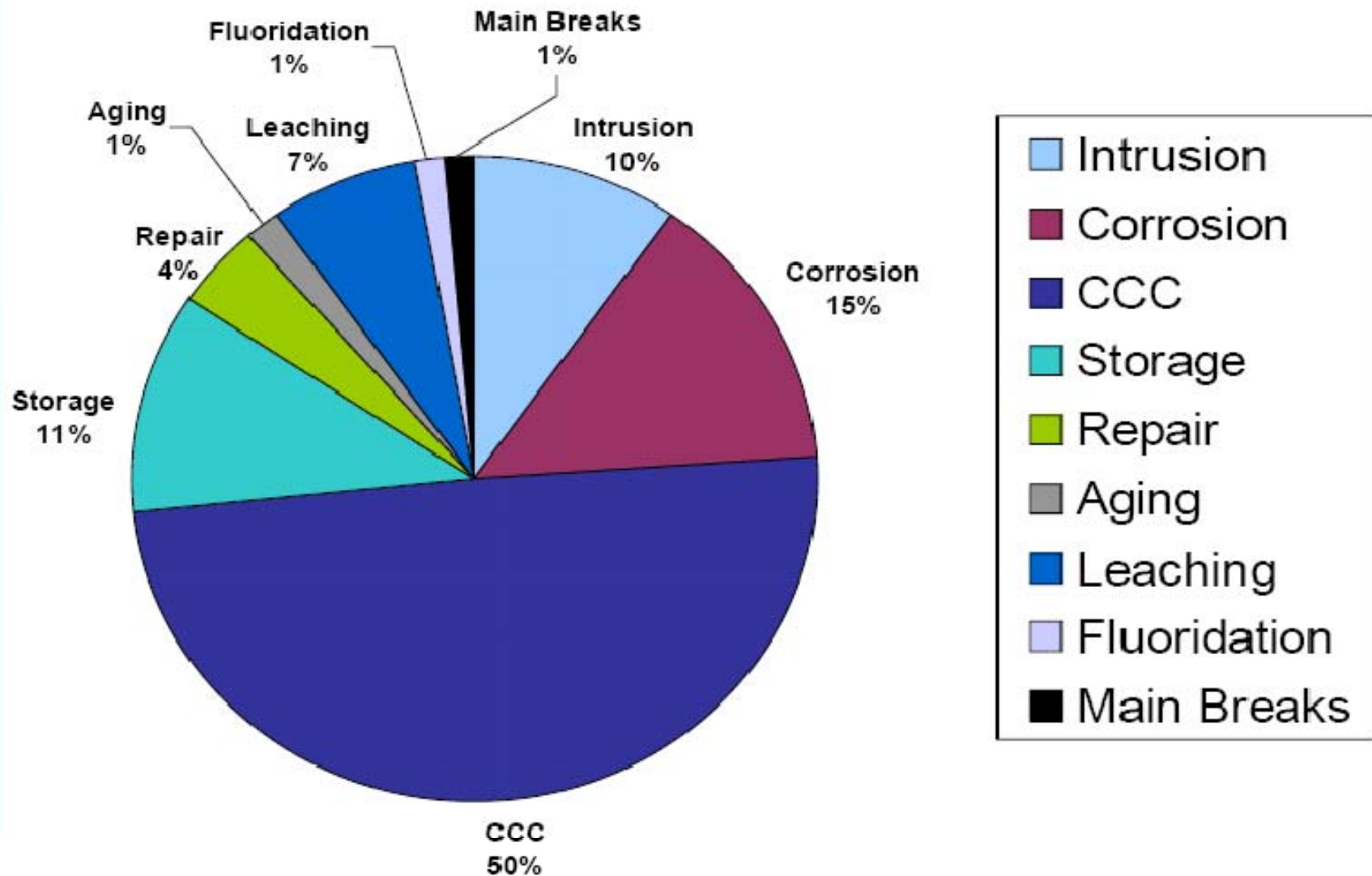
(Source: Calderon, AWWA Distribution System Research Symposium, 2007)

At least two persons must experience a similar illness after ingesting or using water intended for drinking

Epidemiological evidence must implicate the water as the source of illness

- **Detection and Investigation of Outbreaks Varies Among States**
- **Recognition of Outbreaks Depends Primarily on Passive Surveillance**
- **Voluntary Reporting of Waterborne Outbreaks**
- **Number of Cases May be Confirmed or Estimated**

WBOBs Caused by Chemical and Biological Contamination, 1981 - 2002



Emerging Research Related to Total Coliforms and Distribution System Contamination

AwwaRF 3116 - Strategy to Manage and Respond to Total Coliforms and *E. coli* in the Distribution System

Objective

To assess various strategies and build a toolbox for understanding and responding to coliform occurrences in the distribution system

AwwaRF 3116 - Strategy to Manage and Respond to Total Coliforms and *E. coli* in the Distribution System

○ Acknowledgements

- HDR Engineering, Inc. & Confluence Engineering Group, LLC
 - Melinda Friedman, Kylee Dewis, Amie Hanson
- American Water
 - Mark LeChevallier (Co-PI)
- Dalhousie University
 - Graham Gagnon, Lisbeth Truelstrup Hansen
- Ecole Polytechnique
 - Marie-Claude Besner
- Clancy Environmental Consultants
 - Jeff Rosen, Tom Hargy

Types of Tools under Consideration

- ◉ Use of existing data
- ◉ Sample site investigations
- ◉ Large volume sampling
- ◉ Data mining and Data visualization
- ◉ Microbial Source Tracking (MST) tools

Microbial Source Tracking

- Used for surface water/beach/watershed contamination
- Widely used in the food industry
- Many published methods but none have been EPA approved for detection of coliforms in drinking water
- Can MST tools can be used to identify and characterize coliforms in the water distribution system, and establish a connection between pathogen occurrence and point of infiltration?

Common Sources of Coliforms

- Treatment (or source water) breakthrough
- Contamination of distribution system
 - Cross connections
 - Intrusion
 - Main breaks
 - Storage facilities
- Regrowth
- Sample contamination

The Coliform Analysis Spectrum...

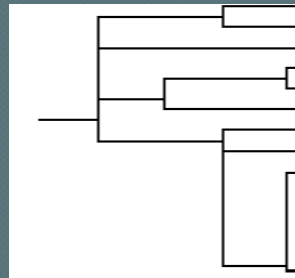
- Detection (and Quantification)

- Colilert, Colisure, Colitag
- Membrane Filtration



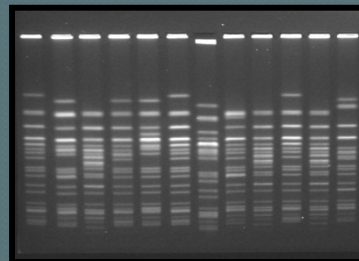
- Identification

- API 20E
- BIOLOG
- Vitek



- Characterization

- Pulsed Field Gel Electrophoresis (PFGE)
- Ribotyping



We got 2 hits
this month!!!

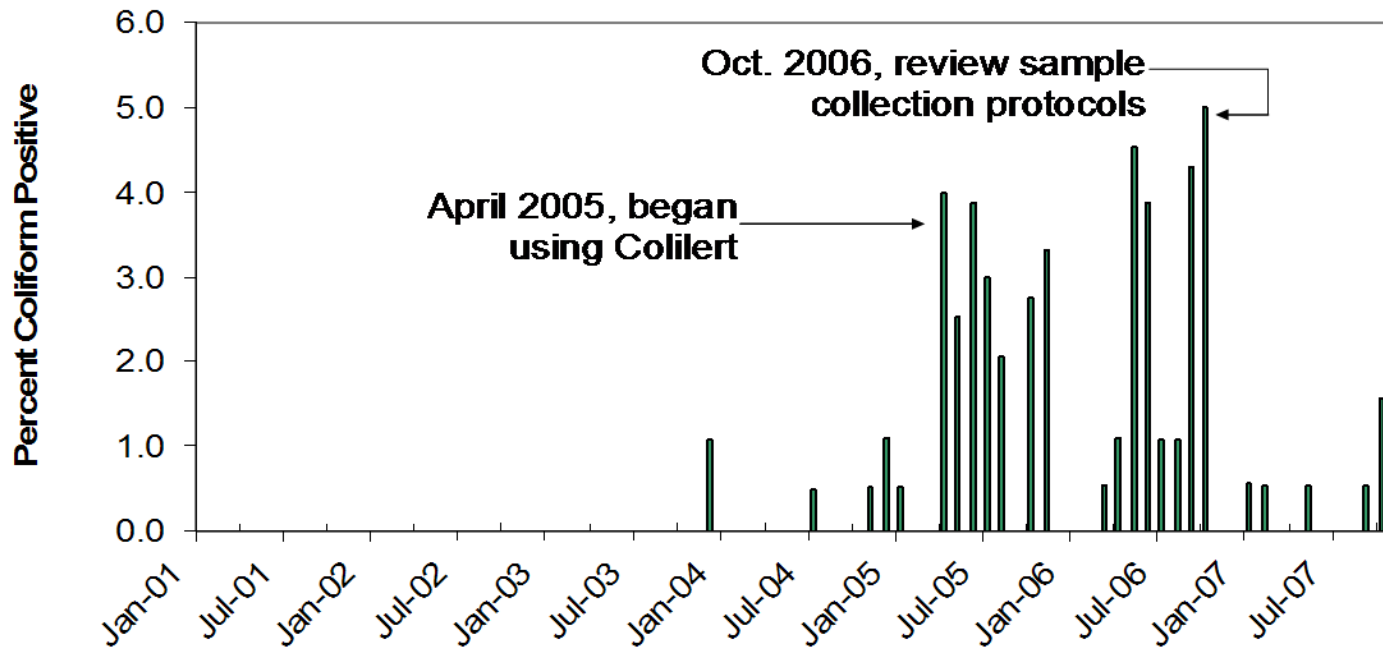


Interesting, they
are/are not the same
species...
pathogenic....



They are/are
not
genetically
related –
one-way
argument

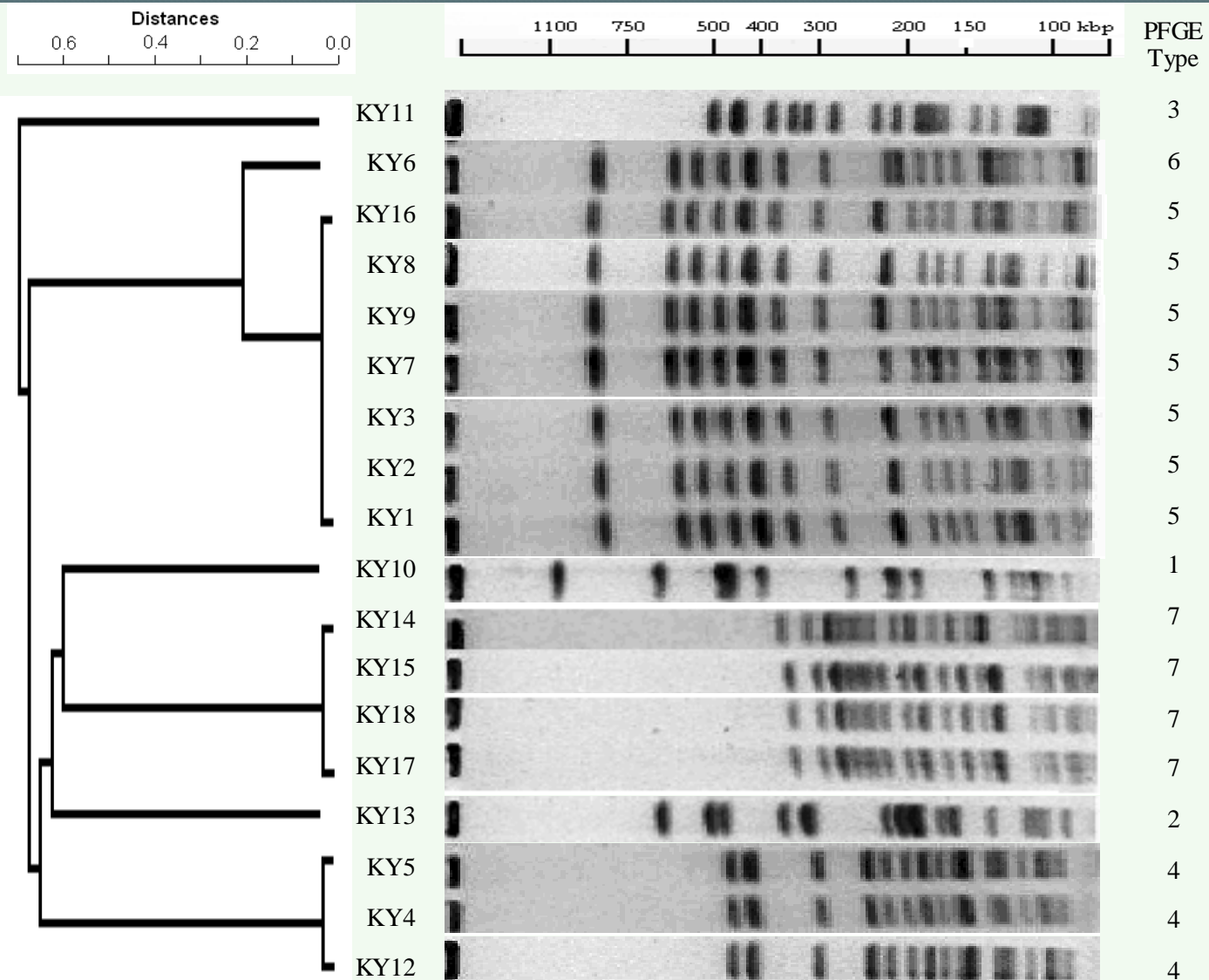
Case Study-Total Coliform History



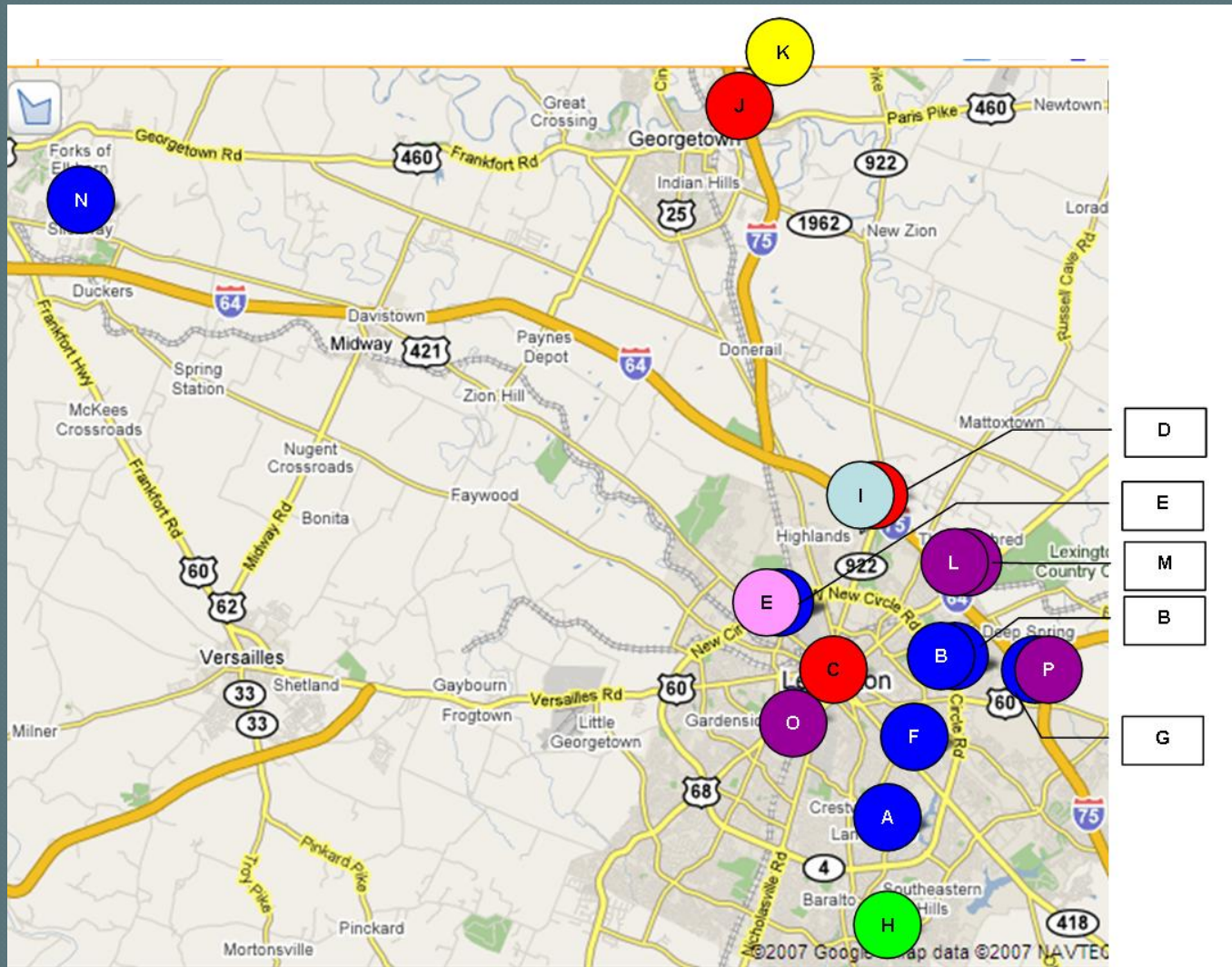
Isolate	Site^a	City	Sample Date	Sample Time	Total chlorine concentration (mg/L)
KY 1	A		10/10/2006	10:35	3.2
KY 2	B		9/20/2006	08:50	3.1
KY 3	B		9/21/2006	09:50	3.1
KY 4	C		9/14/2006	09:55	2.6
KY 5	D		9/8/2006	09:00	2.4
KY 6	E		10/11/2006	13:55	2.8
KY 7	E		10/12/2006	13:25	2.9
KY 8	F		10/11/2006	09:10	3.6
KY 9	G		10/12/2006	13:15	3.2
KY 10	H		9/6/2006	11:10	2.7
KY 11	I		8/8/2006	13:40	3.4
KY 12	J		9/19/2006	11:15	2.7
KY 13	K		9/5/2006	10:10	2.0
KY 14	L		10/17/2006	09:45	3.0
KY 15	M		10/17/2006	09:50	2.9
KY 16	N		10/10/2006	08:55	2.6
KY 17	O		10/17/2006	13:00	3.1
KY 18	P		10/12/2006	13:10	3.2

Isolate	API Identification^a	API 20E profile number^b	Sample Date
KY 1	<i>E. cloacae</i>	3205663	10/10/2006
KY 2	<i>E. cloacae</i>	3205663	9/20/2006
KY 3	<i>E. cloacae</i>	3205663	9/21/2006
KY 4	<i>E. asburiae</i>	3305523	9/14/2006
KY 5	<i>E. asburiae</i>	3305523	9/8/2006
KY 6	<i>E. cloacae</i>	3205463	10/11/2006
KY 7	<i>E. cloacae</i>	3205663	10/12/2006
KY 8	<i>E. cloacae</i>	3205663	10/11/2006
KY 9	<i>E. cloacae</i>	3205663	10/12/2006
KY 10	<i>E. cloacae</i>	2005573	9/6/2006
KY 11	<i>E. cloacae</i>	2305133	8/8/2006
KY 12	<i>E. asburiae</i>	2304523	9/19/2006
KY 13	<i>E. cloacae</i>	2105572	9/5/2006
KY 14	<i>C. freundii</i>	1404572	10/17/2006
KY 15	<i>C. freundii</i>	1404572	10/17/2006
KY 16	<i>C. freundii</i>	3204463	10/10/2006
KY 17	<i>C. freundii</i>	3604572	10/17/2006
KY 18	<i>C. freundii</i>	1404572	10/12/2006

PFGE Results of Kentucky Isolates



Geographical Distribution Of Coliform Clones in KY



How This May be Applied in the Future

- More rapid identification and characterization of coliforms will allow utilities to better determine sources/causes of occurrence
 - Treatment breakthrough
 - Contamination event
 - Regrowth
- Utilities will begin to build libraries of isolates associated with different events in their systems
- Will help focus and tailor responses to coliform events
- Will provide more confidence regarding integrity of distribution system and potential threats to public health
- Can assess adequacy of existing O&M practices

Relevance of Research and Regulatory Trends to Industry

- Still many unknowns with regard to water quality in the distribution system
 - May never be able to link sources of contamination with public health outcomes
 - EPA may need to rely on “occurrence of risk factors” to determine potential risk to public health
- Risk-based regulatory constructs favor utilities that can document optimized distribution system practices

How Can Utilities Stay Ahead of the Regulatory Curve?

- Follow developments with TCR/DS Rulemaking Process
- Implement AWWA Standard G-200-04 – Operation and Maintenance of Distribution Systems
- Develop Distribution System Optimization Plan (DSOP)

What is a DSOP?

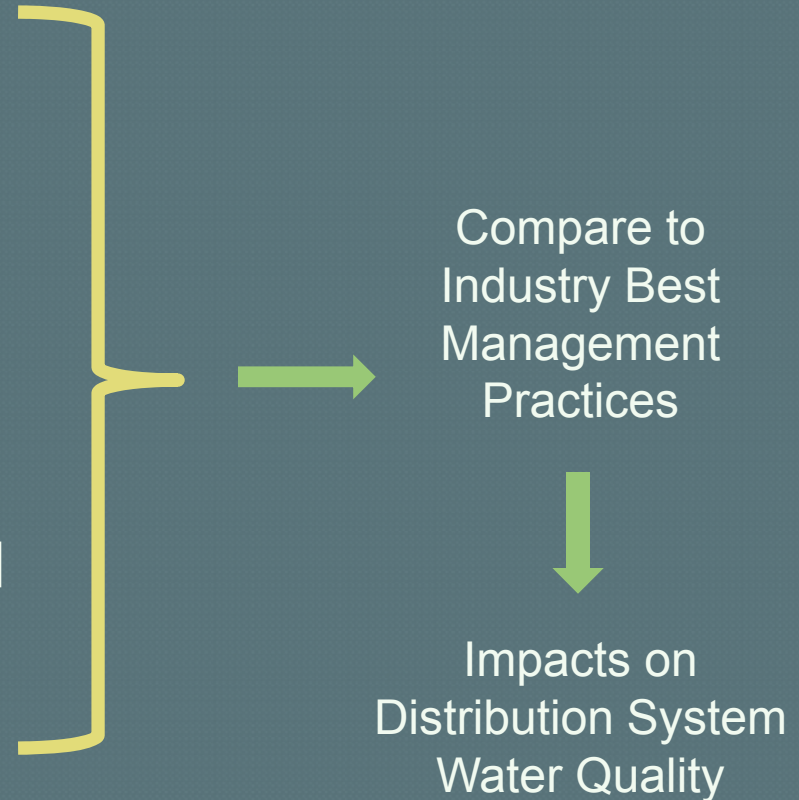
Distribution System **Water Quality** Optimization Plan

A plan/process for maintaining water quality throughout the distribution system.

A working document that organizes and integrates all policies and programs affecting water quality in the distribution system.

Distribution System Management Areas Covered by DSOP

- Management and training
- Water quality goals and monitoring
- Engineering and facilities planning
- Operations
- Maintenance
- Construction practices and inspections
- Cross-Connection control



Review can be conducted internally or through Third Party

Develop DSOP Work Plan

Act on the highest priorities with greatest potential for improving water quality:

- **Develop or improve programs:** flushing, monitoring
- **Develop or improve resources:** modeling, development standards
- **Investigate and resolve unknowns:** water age, biofilm formation, impact of dead-ends on water quality, pressure transients/hammer
- **Design and field-test solutions:** flushing, reservoir turnover, on-line monitoring, impact of pipe materials

You can start now, voluntarily....

- Or wait for a regulation to require it!
- It is possible that systems may be able to obtain waivers if they can demonstrate low risk to contamination and implementation of BMPs
- Similar to IDSE and LT2 monitoring requirements
 - *Low risk systems do not need to change treatment or operations*
 - *Very low risk DBP systems did not even need to do an IDSE*
 - *However, need to do the monitoring or self evaluations to demonstrate that you are low risk*

The “Risk-Based” regulatory environment favors those utilities that can demonstrate *actual* water quality conditions throughout their distribution systems and *use* of industry BMPs.

Our aging distribution systems are the next regulatory frontier.



confluence
ENGINEERING GROUP LLC

Melinda Friedman, P.E.

President

Confluence Engineering Group, LLC

Seattle, WA

(206) 527-6832

melinda@confluence-engineering.com