American Water Works Association

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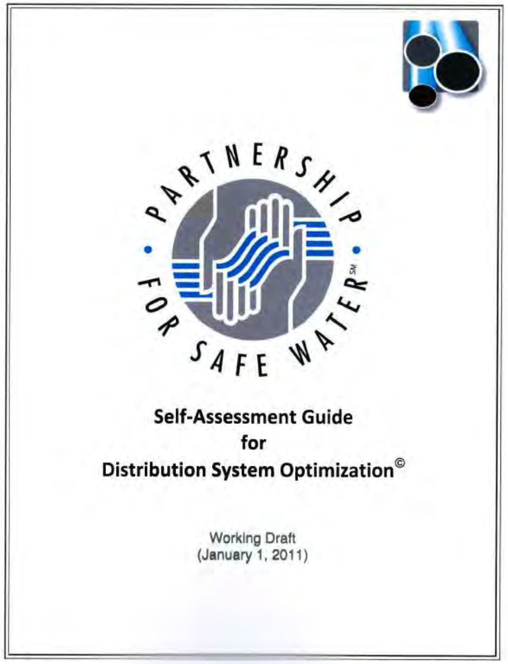
Partnership for Safe Water Distribution System Optimization Program:

Case Studies from Utility Subscribers

Barbara Martin, AWWA

Outline

- Partnership for Safe Water Distribution System Optimization Program Overview
- Self-Assessment Case Studies
  – Philadelphia Water Department (PA)
  – Aurora Water (CO)



Acknowledgements

- Charles Zitomer - Assistant General Manager – Field Operations, Philadelphia Water Department
- Tom Ries – Manager – Water Operations and Maintenance, Aurora Water
- Partnership for Safe Water subscribers and volunteers

Partnership for Safe Water

- Established in 1995 to address *Cryptosporidium* concerns
- Partner organizations:

American Water Works Association

EPA

Water Research Foundation

ASDWA Association of State Drinking Water Administrators

NAWC National Association of Water Companies

Association of Metropolitan Water Agencies

Partnership for Safe Water

- Partnership for Safe Water mission:
  - *To improve the quality of drinking water delivered to customers of community water systems by optimizing operations.*
- Two programs
  - Treatment plant optimization
  - **Distribution system optimization (DSOP)**

Partnership Optimization Philosophy

The Partnership for Safe Water achieves ***continuous improvement by optimizing operational performance****. Optimization, as defined by the Partnership, means that all the system processes are being performed at the highest level (all the optimization goals of the Partnership are being continuously achieved).*

Self-assessment is a tool used to determine optimization status and to identify areas for improvement over time. Systems should ***engage in the self-assessment process to identify opportunities for improvement*** *and to advance their optimization status. Participating utilities embrace the opportunity to discover areas for improvement. Only when these are known can they be improved. This is the outcome of the self-assessment.*

It is ***difficult to achieve fully optimized status*** *as defined by the performance goals of the Partnership for Safe Water. These goals reflect operational superiority. Optimization efforts are used to advance system operation to attain performance nearer the Partnership goals.* ***Continuous improvement is a process****. Partnership utilities* ***tirelessly strive for higher levels of performance****. Even the elite systems that achieve fully optimized status are never satisfied, so they continue to tenaciously search for ways to improve. The Partnership for Safe Water is a philosophy that* ***embraces the quest for excellence in water system operation*** *to improve the quality of water and reliability of service provided to all users.*

Assessment & Optimization Benefits

- Assessment benefits:
  - Know your system
  - Prepare for future regs (RTCR)
- Improving performance has the potential to:
  - Improve water quality
  - Provide improved public health protection
  - Reduce water loss rates
  - Reduce operating costs
- Positive recognition through Partnership program (Directors Award)

Representatives from Long Beach Water Department (CA) receive the Directors Award at ACE13

Self-Assessment Objectives

- Identify performance limiting factors (PLFs)
- Create action plans to address these factors
- Work towards achieving optimization
- Document and track ongoing performance

Self-Assessment Team

- Team is formed that incorporates utility personnel at all levels of the organization
  - Management
  - Operations – field staff participation vital
  - Involve as many staff as possible

Many utilities cite improved communications and teamwork as significant benefits of completing the Self-Assessment process.

Self-Assessment Areas

- Self-Assessment of:
  - Performance against optimization goals**:
    - Performance criteria (disinfection, pressure, breaks)
    - Performance improvement variables
  - System design
  - System operation
  - Administration
- No time limit – self-paced

Guidance documentation steps utilities through the Self-Assessment process

Key Monitoring Parameters

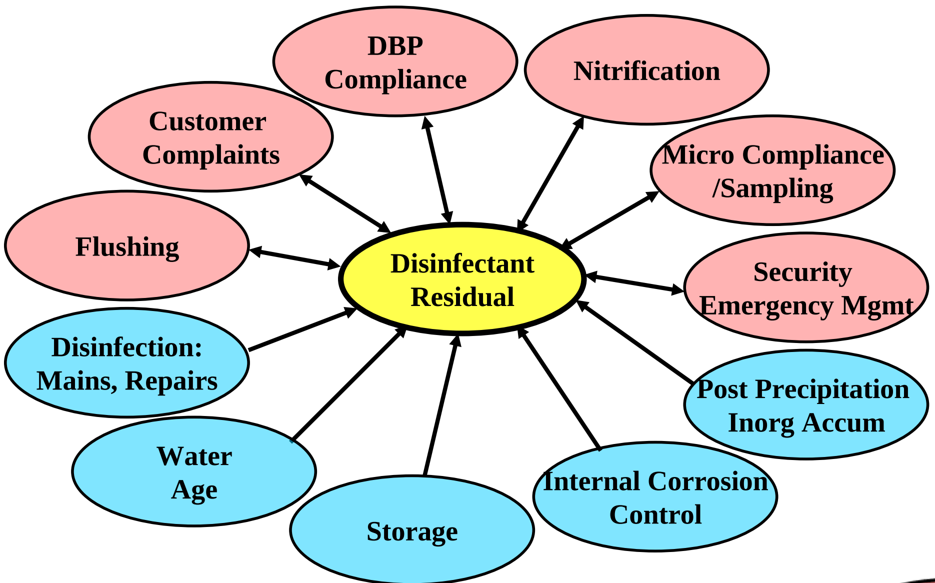
- Disinfectant residual
  - *Water quality integrity*
- Main break frequency
  - *Physical integrity*
- Pressure management
  - *Hydraulic integrity*

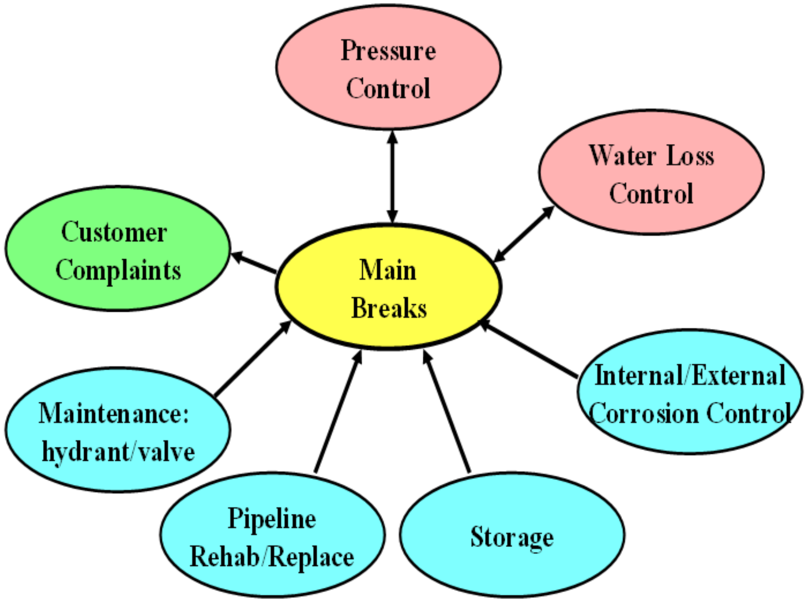
2006 National Academy of Sciences report on Drinking Water Distribution Systems – Assessing and Reducing Risks

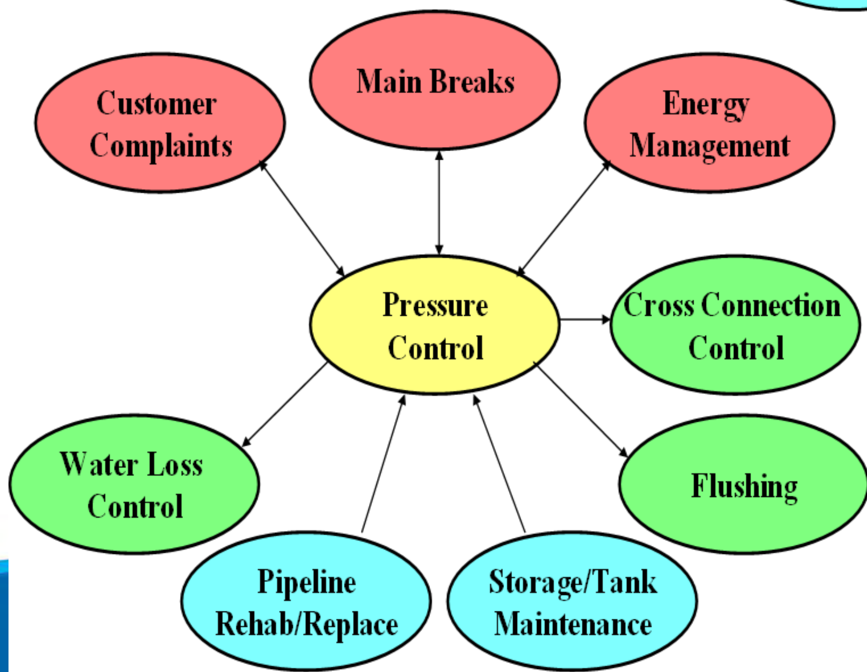
Performance Improvement Variables

- Disinfectant Residual
- Cross-Connection Control
- Customer Complaints
- DBP Control
- Energy Management
- External Corrosion Control
- Flushing
- Hydrant and Valve Maintenance
- Internal Corrosion Control
- Main Breaks
- Nitrification
- Pipe Rehabilitation and Replacement
- Inorganic Accumulation Control
- Pressure Management
- Security and Online Monitoring
- Storage Tank O&M
- Water Age Management
- Water Loss Control
- Water Sampling and Response

Parameters


DBP Compliance
Nitrification
Customer Complaints
Micro Compliance /Sampling
Flushing
Disinfectant Residual
Security Emergency Mgmt
Disinfection: Mains, Repairs
Post Precipitation Inorg Accum
Water Age
Internal Corrosion Control
Storage


Pressure Control
Water Loss Control
Customer Complaints
Main Breaks
Internal/External Corrosion Control
Maintenance: hydrant/valve
Pipeline Rehab/Replace
Storage


Customer Complaints
Main Breaks
Energy Management
Pressure Control
Cross Connection Control
Water Loss Control
Flushing
Pipeline Rehab/Replace
Storage/Tank Maintenance

Optimization Goals: Disinfectant Residual

- Disinfectant Residual (>95% of meas.)
  - Free Chlorine: ≥ 0.20 and ≤ 4.0 mg/L
  - Total Chlorine: ≥ 0.50 and ≤ 4.0 mg/L
  - Chlorine Dioxide: ≥ 0.20 and ≤ 0.80 mg/L
- No *consecutive* residual measurements outside target concentrations at *optimized* routine sample locations
- DBPs within regulatory requirements

Optimization Goals: Pressure

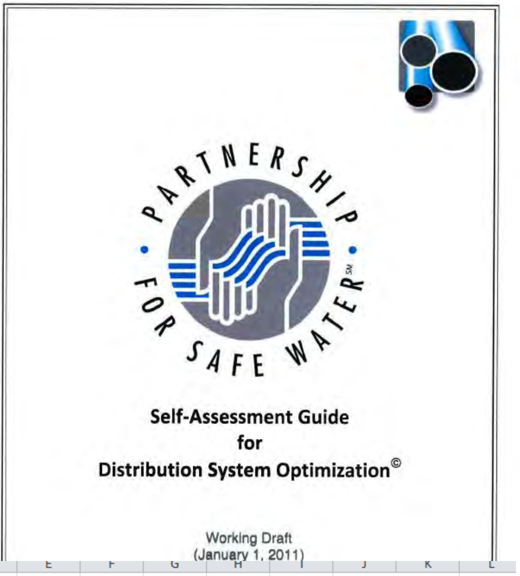
- Minimum Pressure (≥ 99.5% of meas.)
  - Pressure: ≥20 psi for daily minimum
- Maximum pressure (≥ 95% of meas.)
  - Does not exceed utility specified maximum
- Pressure fluctuations (≥ 95% of meas.)
  - Does not exceed range specified by utility

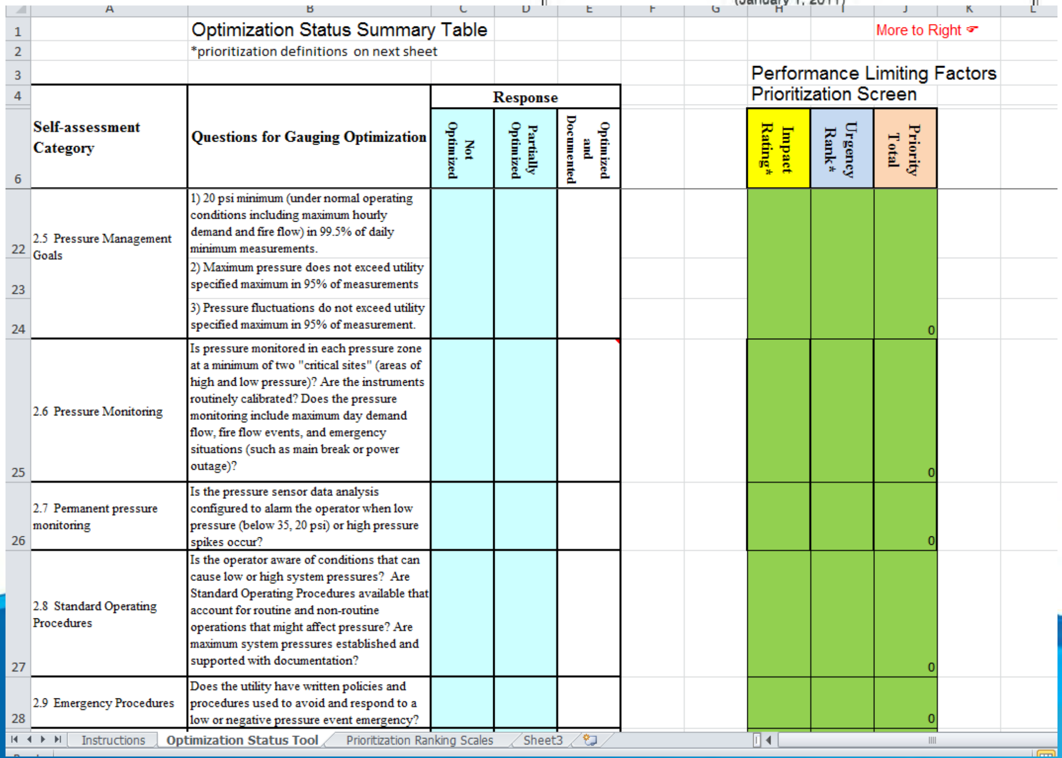
Optimization Goal: Main Breaks

- Main Breaks and Leaks
  - ≤ 15/100 miles of pipe/year - for reported leaks and breaks in utility-controlled distribution and transmission piping
- Or – declining main break frequency trend demonstrating progress towards optimization

Partnership Tools: Self-Assessment

- Self-assessment guide
- Tracking and prioritization software tools
- Report and action plan templates
- Assistance and mentorship
- Example report





Optimization Status Summary Table
*prioritization definitions on next sheet

More to Right

Performance Limiting Factors Prioritization Screen

Self-assessment Category	Questions for Gauging Optimization	Response: Not Optimized	Response: Partially Optimized	Response: Optimized and Documented	Impact Rating*	Urgency Rank*	Priority Total
2.5 Pressure Management Goals	1) 20 psi minimum (under normal operating conditions including maximum hourly demand and fire flow) in 99.5% of daily minimum measurements.						
	2) Maximum pressure does not exceed utility specified maximum in 95% of measurements						
	3) Pressure fluctuations do not exceed utility specified maximum in 95% of measurement.						0
2.6 Pressure Monitoring	Is pressure monitored in each pressure zone at a minimum of two "critical sites" (areas of high and low pressure)? Are the instruments routinely calibrated? Does the pressure monitoring include maximum day demand flow, fire flow events, and emergency situations (such as main break or power outage)?						0
2.7 Permanent pressure monitoring	Is the pressure sensor data analysis configured to alarm the operator when low pressure (below 35, 20 psi) or high pressure spikes occur?						0
2.8 Standard Operating Procedures	Is the operator aware of conditions that can cause low or high system pressures? Are Standard Operating Procedures available that account for routine and non-routine operations that might affect pressure? Are maximum system pressures established and supported with documentation?						0
2.9 Emergency Procedures	Does the utility have written policies and procedures used to avoid and respond to a low or negative pressure event emergency?						0

Instructions | Optimization Status Tool | Prioritization Ranking Scales | Sheet3

Assessment Questions

- Primary performance monitoring parameter:
  - Disinfectant residual assessment questions
- How to address questions?

Self-assessment Category	Questions for Gauging Optimization	Response: Not Optimized	Response: Partially Optimized	Response: Optimized and Documented	Comments
Disinfectant Residual	Do the disinfectant residual data meet the performance goals? These are: -Disinfectant residual in 95% of monthly routine measurements. -Free Chlorine ≥ 0.20 mg/L and ≤ 4.0 mg/L; -Total Chlorine ≥ 0.50 mg/L and ≤ 4.0 mg/L -Chlorine Dioxide ≥ 0.20 mg/L and ≤ 0.80 mg/L The Annual Data Collection spreadsheet is used for this evaluation.				Submit data collection spreadsheet.
Individual Site Testing	Does the utility have a system sampling map? Are sample collection sites representative of the overall distribution system? Does the utility track sites that repeatedly have low disinfectant residuals? Are performance improvement variables (chapter 3) used to reduce low residual reoccurrence? Are non-routine low residual sites added to the next year's routine sample location schedule? Are there any consecutive disinfectant residual measurements at optimized routine sample locations below the residual goals?				
Residual Test Methods and Procedures	Is disinfectant residual testing performed using approved methods and digital testing equipment? Are values recorded to two decimal places? Are there on-line continuous chlorine monitors in use throughout the distribution system? Is data collected and continuously displayed for operators by the SCADA system?				
Chlorine and Chloramine Interaction	Does the system monitor and operate to minimize odors and other interaction by-products? Is free ammonia monitored where interaction may cause breakpoint issues?				Report test results near booster stations.

Action Plan Development

- Action plans developed for high priority areas that are not optimized/partially optimized
- Utilities should not hesitate to act!

Self-Assessment Category	Issue	Short Term Solution	Person(s) Responsible	Target Date	Long Term Solution	Person(s) Responsible	Target Date
On-line Chlorine Monitor and SCADA Display	Additional online chlorine residual analyzers would provide valuable data	Finalize identification of key areas of distribution system for analyzer placement	Full Team, Consensus Decision Needed	Apr 2013	Install analyzers and connect with SCADA	Dist System Maintenance Supervisor	April 2014
		Budget for and purchase 3 analyzers	Distribution System Ops. Super-Intendent	Jan 2014	Review analyzer data trends for optimization opportunities	Treatment Plant and Distribution System Lead Operators	Ongoing, incorp. Into SOPs

Case Study: Philadelphia Water Department

- **Topic:**
  - Getting Started with the Distribution System Optimization Program
- **Overview:**
  - A large utility involves staff throughout the organization, forms teams, and approaches the self-assessment process.
  - (Approach may be applied to smaller utilities)
- **Acknowledgement:**
  - Thank you, Charles Zitomer, Assistant General Manager, Field Operations

Case Study: Philadelphia Water Department

- Distribution system overview:
  - Joined PfSW Distribution Program in 2011, currently Phase II and working through self-assessment process
    - Treatment program subscriber since 1996
  - 130 square mile service area
  - Two wholesale customers
    - Bucks County Water and Sewer Authority
    - Aqua Pennsylvania
  - Approximately 1.67 million population served

Case Study:
Philadelphia Water Department

- Distribution system overview:
  - Baxter, Belmont, and Queen Lane SWTPs provide water
  - Total storage capacity WTP/DS = 1065.5 MG
  - 3133 miles of mains
  - 25,200 fire hydrants
  - 238.8 MGD water delivery in FY 2013

Case Study: Philadelphia Water Department

- Approach:
  - Partnership acceptance by Commissioner
  - Team approach to get the correct information and involve the right parties
    - **Project Manager**
    - Steering Committee
    - Assessment Team
    - Subject Matter Experts

Philadelphia Water Department

Steering Committee

Led by project manager, consists of leaders within utility whose organization would be impacted by SA process, monthly meetings to develop framework for and oversee project

Assessment Team

Composed of younger professionals, 3 groups based on Performance Improvement Variables, managed and directed details of SA process and summary document

Subject Matter Experts

Participated in interviews with Assessment Team, reviewed findings and recommendations, Steering Committee members participated as SMEs

Communication

Case Study:
Philadelphia Water Department

- Lessons Learned:
  - Differing perspectives
    - SME interviews revealed differences in opinions
    - Discuss to be sure that all perspectives are understood and heard
  - Beyond Partnership
    - Actions suggested by SMEs were not limited to PfSW topics – they are being addressed
    - Self-assessment is not limited to PfSW topics/questions and can be utility specific – it is a resource for you

Case Study:
Philadelphia Water Department

- Most Valuable Lesson/Experience:
  - Role of Younger Professionals
    - Brought a lot of talent, enthusiasm, and tools (SharePoint) to the project
    - Give them the leeway to manage the project as self-assessment team members
    - Beneficial opportunity for learning, information transfer, and networking within organization
    - Career development potential

Case Study:
Philadelphia Water Department

- **Take-Home Messages:**
  - Identify the optimal team structure and approach for your utility
  - Ensure participants understand how they fit into the process and how distribution system optimization will impact them
  - Communication is key
  - Self-assessment is a tool for your utility – don't limit the possible outcomes
  - Career development and learning opportunity

Case Study: Aurora Water

- **Topic:**
  – Disinfectant residual assessment
- **Overview:**
  – Analysis of distribution system disinfectant residual data leads to water quality improvement
- **Acknowledgement:**
  – Thank you, Tom Ries, Manager – Water Operations and Maintenance

Case Study: Aurora Water

- **Partnership Overview:**
  - Joined PfSW in 2011, currently Phase II and working towards completion of self-assessment
    - Participant in treatment program since 1997, with 2 Excellence in Water Treatment Award facilities and 1 Directors Award facility

maps.google.com

Case Study:
Aurora Water

- **Distribution System Overview:**
  - 150 square mile service area
  - Serve approximately 340,000 population
    - Third largest utility in Colorado
  - 3 surface water treatment facilities
    - Binney, Griswold, Wemlinger WTPs
    - Water from plants blended to meet demand
  - 1600 miles of distribution system piping
  - Chloramine used as distribution system disinfectant to maintain residual

Case Study: Aurora Water

- **Approach:**
  - Self-assessment team formed, representing
    - Water treatment
    - Water quality
    - Engineering
    - Transmission
    - Distribution
    - Management

Case Study: Aurora Water

- **Approach:**
  - Disinfectant residual assessment began with
    - Review of existing data
    - PfSW reporting requirements and goals
  - PfSW optimization target for chloramine systems is <u>0.50 – 4.0 mg/L</u>
    - All distribution system sampling locations, 95% or more of the time

Case Study:
Aurora Water

- **Findings:**
  - Review of historical data
    - Met all state regulatory requirements
    - Patterns of chlorine residuals lower than the utility's internal goal and PfSW goal in areas where flushing commonly performed
    - Observed to be independent of flow or season
    - What is the cause?

Case Study:
Aurora Water

- **A Deeper Look – team examined:**
  - Maps to understand piping sizes and configurations
  - Historical water quality complaints
  - Historical chlorine residual data
  - Previous and ongoing flushing activity
  - Valve status
  - Hydraulic modeling and flow patterns
  - Small pipe segments to assess internal pipe conditions

Case Study: Aurora Water

- **Additional Findings:**
  - Lower chlorine residuals caused by a combination of practices and conditions
  - Key driver – nitrification
    - Follow up testing identified higher levels of free ammonia in the system
  - Communication with treatment plants revealed free ammonia was kept higher leaving the plants to allow for booster chlorination in the system

Case Study:
Aurora Water

- **Action Plan:**
  - Work with plants to adjust and optimize chlorine to ammonia ratio fed at the treatment plants
  - Closely monitor residuals and free ammonia
  - "Superflush" using highly chlorinated water in a section of dead-end pipe
- **Results:**
  - Reduction of free ammonia concentration 0.35 mg/L NH_3-N to 0.10 mg/L NH_3-N and more stable residuals
  - Reduced overall flushing volumes required to maintain residual

Case Study: Aurora Water

- **Lessons Learned:**
  - Evaluate all pertinent data
    - ID and fill gaps if necessary
  - Teamwork is key
    - Establish a team that brings together expertise from all levels of the organization
    - Ability to evaluate data from multiple areas to reach conclusions and develop an action plan
  - Communicate
    - Working closely with the treatment plant enabled resolution of the issue within 6 weeks

Case Study:
Aurora Water

- **Most Valuable Lesson/Experience:**
  - If you identify an opportunity for improvement, don't wait!
    - Develop action plan for improvement
    - Address issues now, while team is motivated and engaged
      - Disinfectant residual
      - Data completeness (pressure)
    - Allow short term successes to support future activities
    - Report progress and longer-term goals in the self-assessment report provided to the PfSW

Case Study:
Aurora Water

- **Take Home Messages:**
  - Take action now when opportunities for improvement are identified
  - Establish a team that draws representatives and varied expertise from across the organization
  - Communicate, communicate, communicate
  - Special study/deeper dive beneficial when initial data review may be inconclusive

Conclusions

- Distribution system self-assessment presents a unique and system-specific learning opportunity
- Conduct the self-assessment in the manner that provides your utility with the most benefit
- Team involvement and buy-in is key
- Having the right data is essential
- Communication is critical
- Don't wait to take action

Questions & More Information

www.awwa.org/partnership

Barbara Martin – Program Manager

(303) 347-6220

bmartin@awwa.org