Reducing Disinfection Byproducts through Optimization

Webinar #4: Implementing DBP Control Strategies: Approach and Case Studies

May 13, 2019

Webinar Series

- Primary Learning Objective: Introduce participants to disinfection byproduct (DBP) optimization tools that can be used to reduce DBPs in public water systems. These tools have been developed in partnership with state drinking water programs through the Area Wide Optimization Program (AWOP).
- Four successive webinars:
  - ~~April 8th – DBP Optimization Process and Priority Setting~~
  - ~~April 22nd – Approaches to Prioritize Plant Optimization Efforts~~
  - ~~May 6th – Approaches to Prioritize Distribution System Optimization Efforts~~
  - **May 13th – Implementing DBP Control Strategies: Approach and Case Studies**

Webinar Series Logistics

- All webinars will be scheduled for 1:30 pm ET, will take about 2 hours (including Q&A), and will be recorded.
- Viewers can submit questions via the Questions Panel at any time during the broadcast, *but we encourage you to do so as soon as the question comes to mind.* A Q&A session will be held at the end of all the presentations.

Webinar #4: Learning Objectives

- Understand overall approach for the webinar series, including a brief review of information covered in the previous webinars
- Understand optimization-based DBP control strategies available to water systems and how they can be implemented.
  - Overview of controls strategies (Presentation 2).
  - Water System Case Studies (Presentations 3 and 4).

Disclaimer

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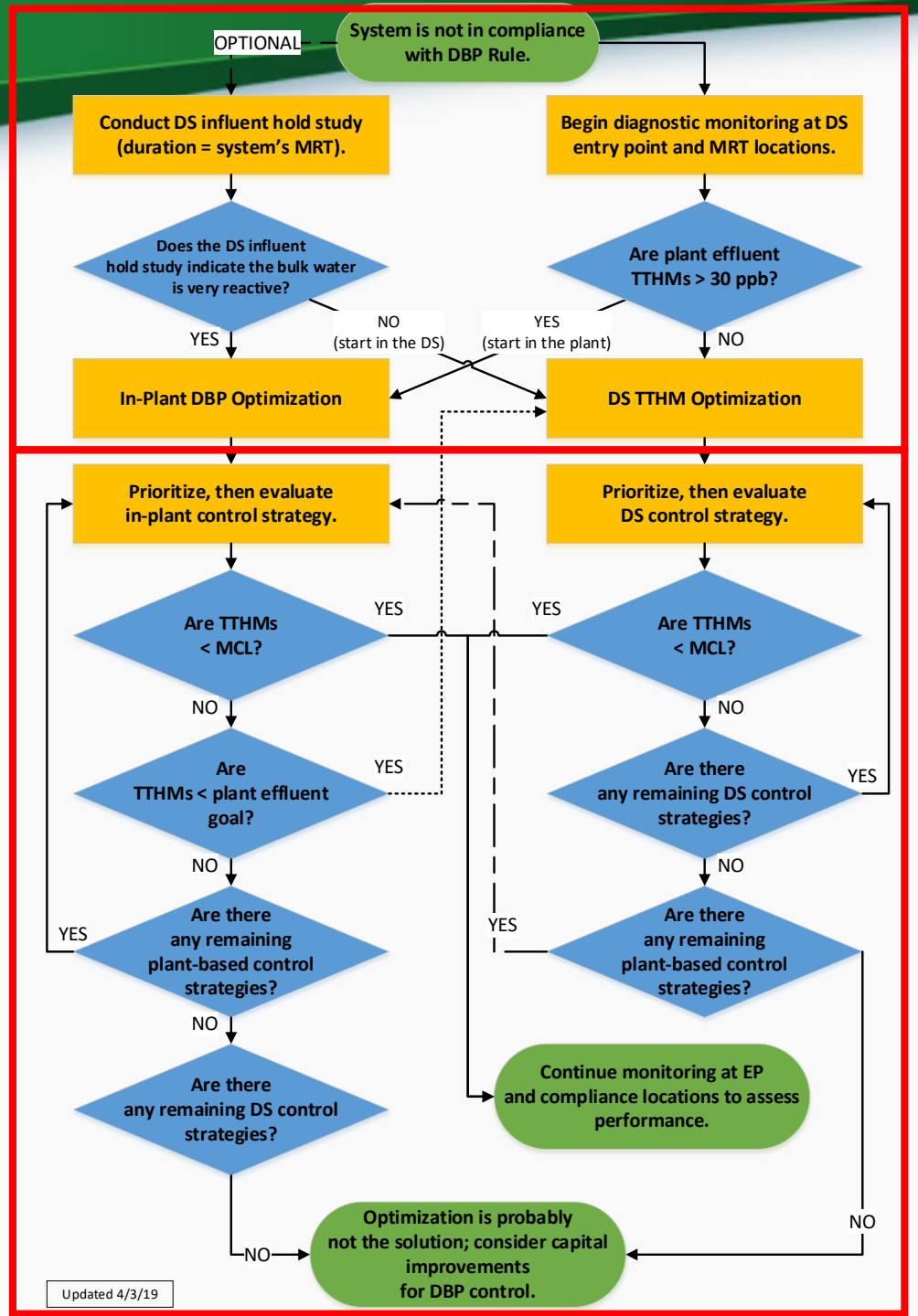
Process to Reduce DBPs through Optimization: Review

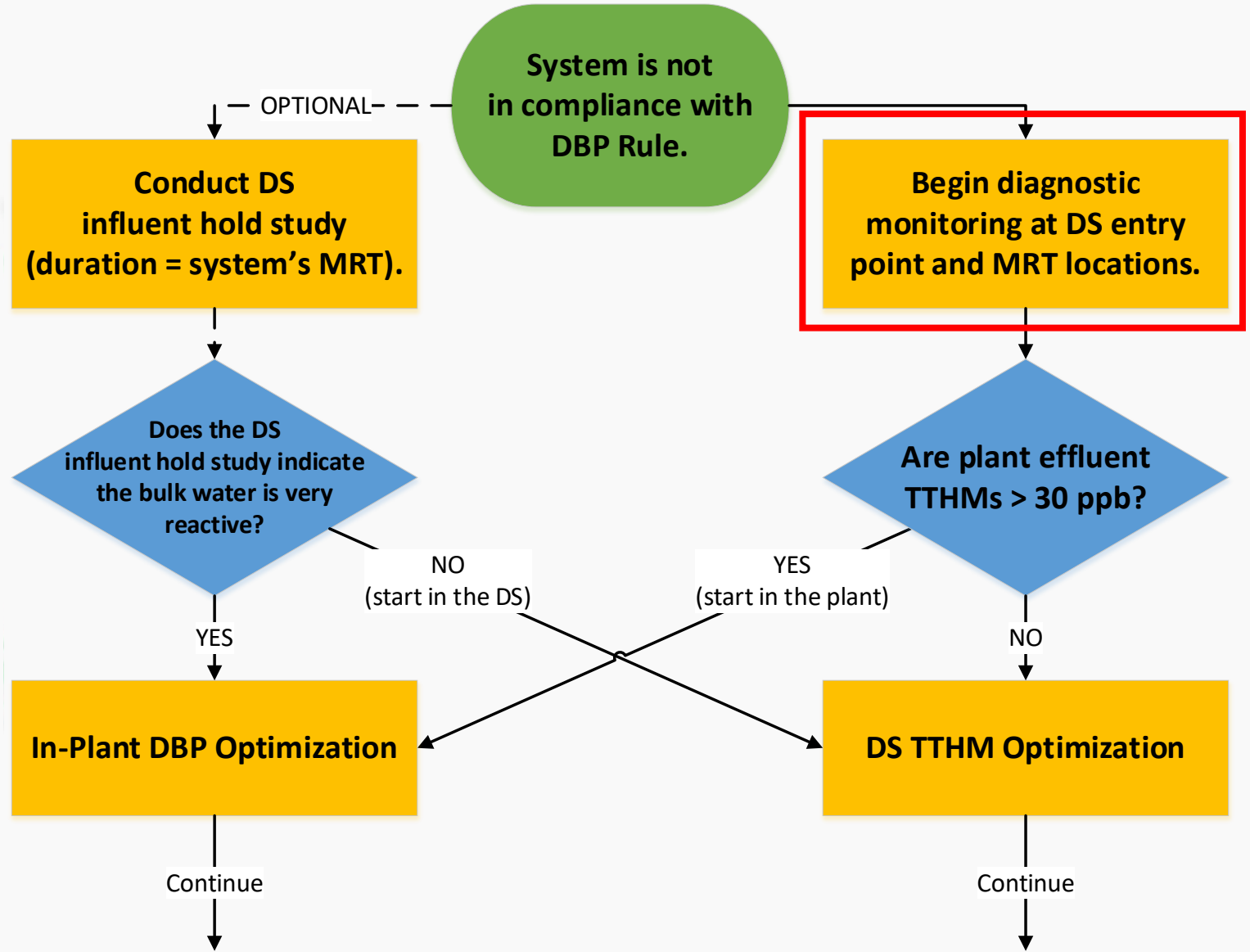
Process to Reduce DBPs through Optimization

Note: in-plant optimization efforts can be effective for both HAA5 and TTHM reduction, while distribution system (DS) optimization efforts will generally only reduce TTHM levels.



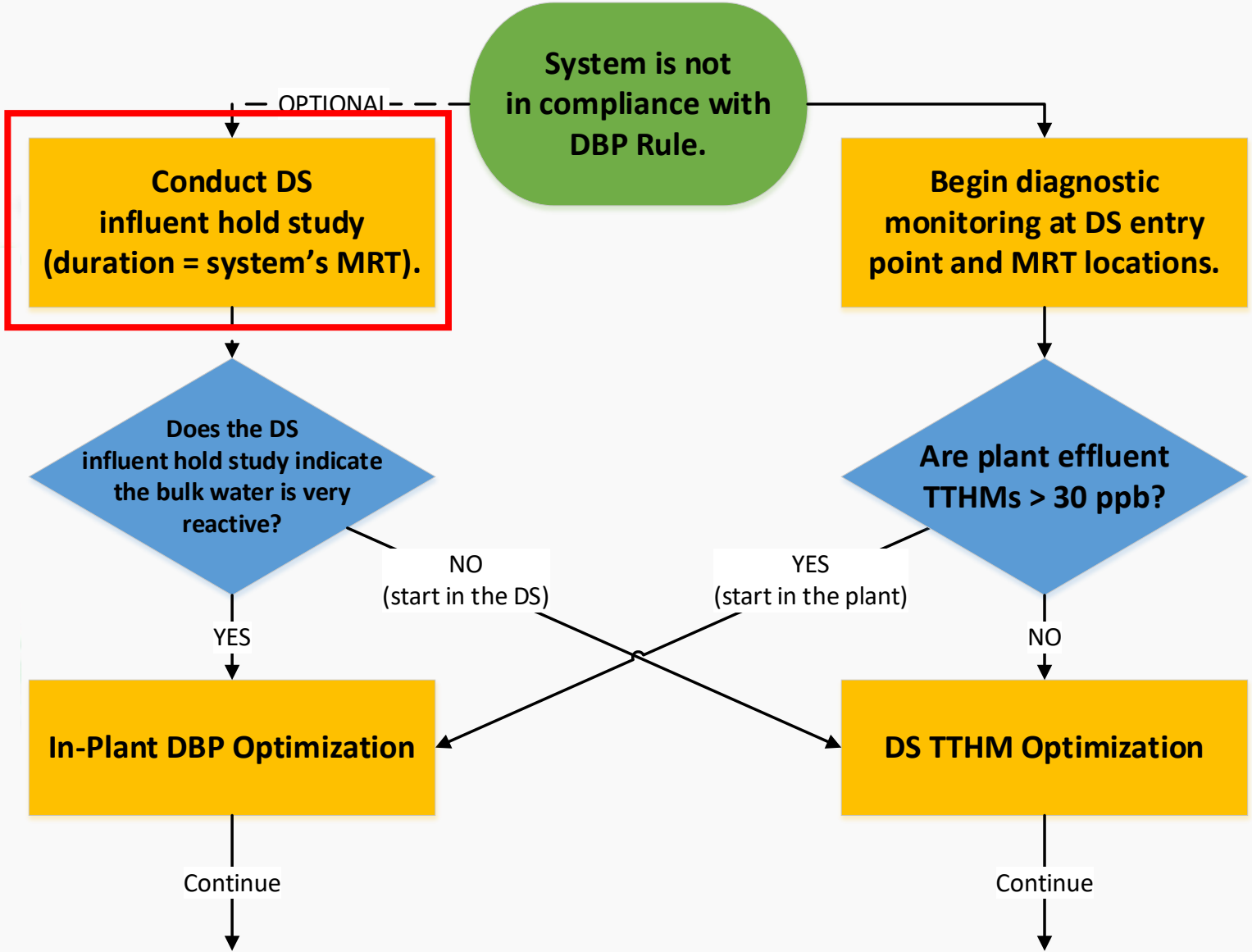
Diagnosing DBP Formation

First step is to conduct diagnostic monitoring



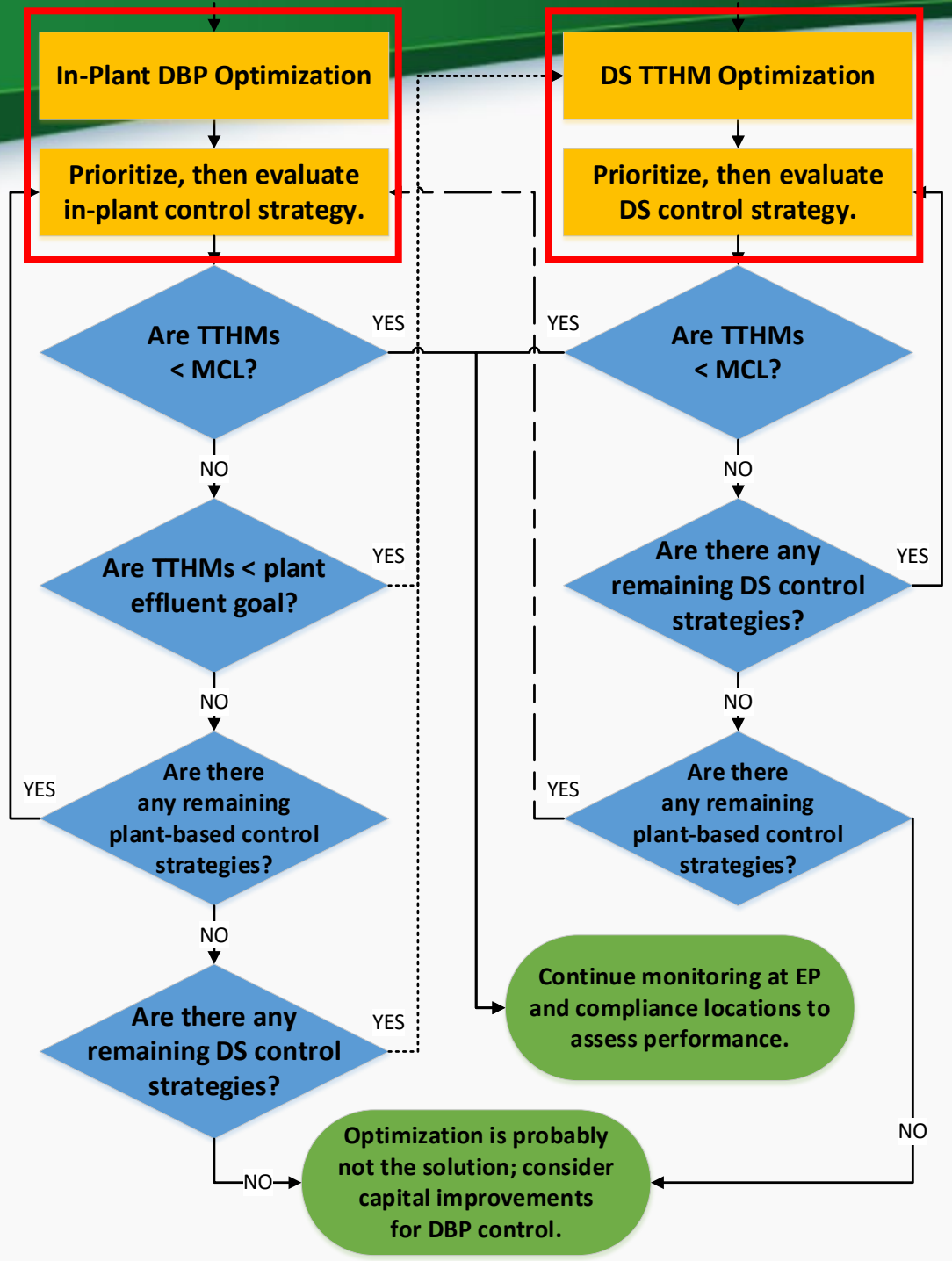
Diagnosing DBP Formation

Optional step to conduct a DS influent hold study



Evaluating Control Strategies

- During Webinars 2 and 3, discussed how to prioritize the strategies
- This webinar focuses on how to implement the strategies



Evaluating DBP Control Strategies

Alison G. Dugan, P.E.

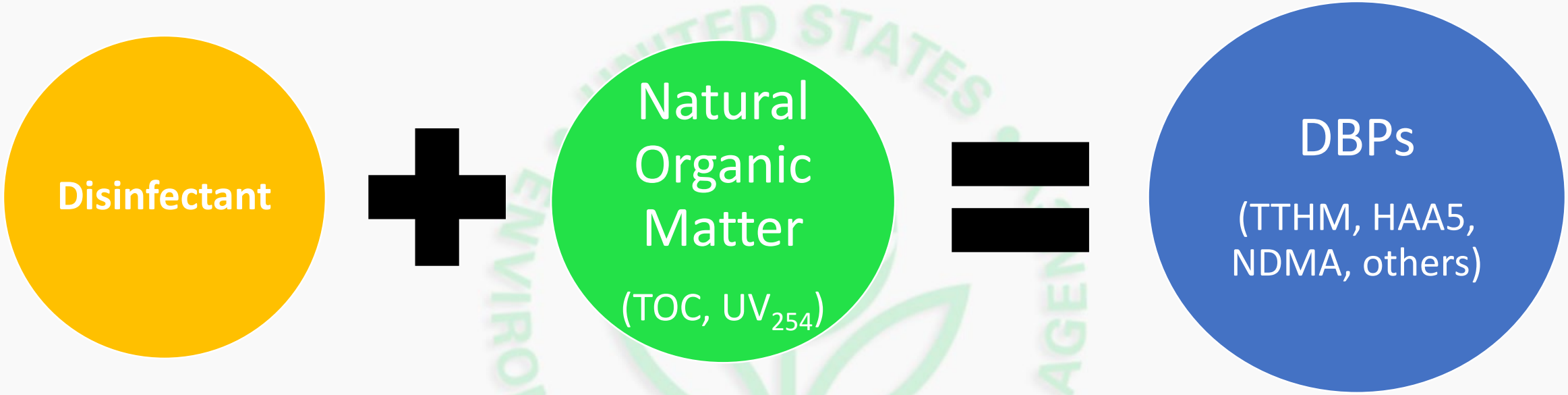
United States Environmental Protection Agency; Office of Ground Water and Drinking Water

Standards and Risk Management Division; Technical Support Center

Overview

- Overview of DBP Control Strategies
- Process for Evaluating DBP Control Strategies

Disinfection Byproduct (DBP) Formation



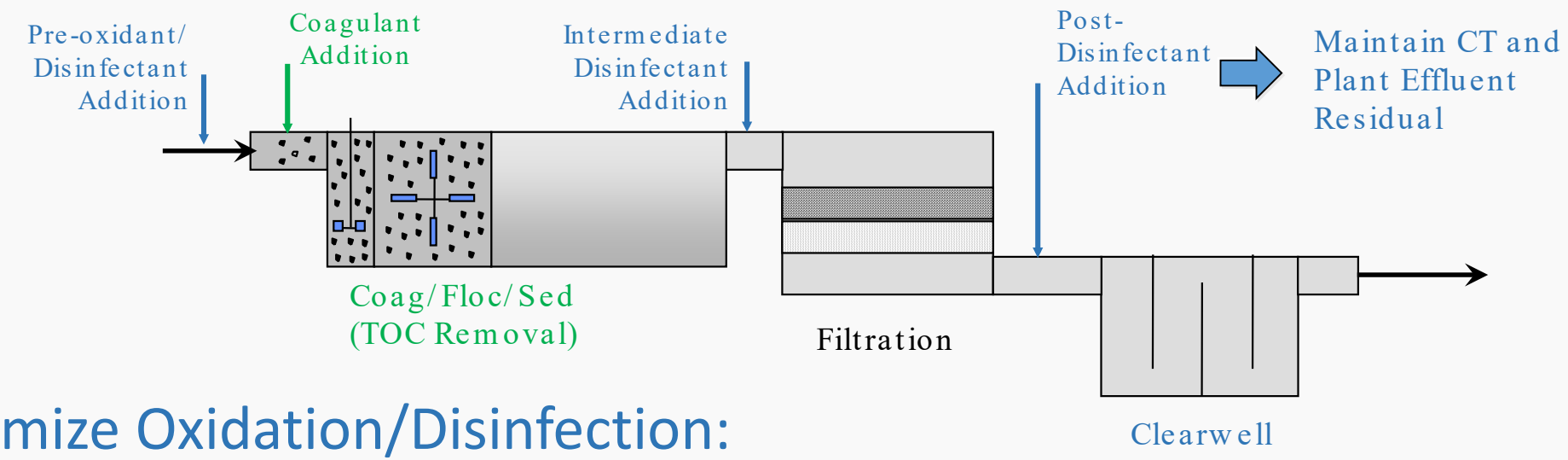
DBP formation is a function of temperature, water age, Cl_2 & NOM concentration, NOM composition, and pH

Optimization Control Strategies for DBPs

Definition and Implementation Considerations

- Definition: An operations-based change in a water system which results in lower DBP formation
- Implementation considerations:
  - May require minor system modifications
  - May be implemented on a seasonal or year-round basis
  - May have unintended consequences that negatively impact water quality and system operations
  - Will be most effective in systems that have not optimized to reduce DBPs

Potential Plant-Based Strategies



- Optimize Oxidation/Disinfection:
  - Preoxidation/prechlorination, if applicable (i.e., prior to TOC removal)
  - Intermediate (i.e., post-sed or top-of-filter location)
  - Post disinfection
- Optimize Coagulation for TOC Removal
- Optimize Process pH
- Others??

Example Unintended Consequences of Plant-Based Control Strategies

Unintended Consequence	Optimize Oxidation/ Disinfection	Optimize TOC Removal
↓ Disinfection (CT) and/or DS residual	x	
↑ In-plant bio-growth	x	
Change in quantity/quality of sludge		x
Impact inorganic oxidation and removal (e.g., Fe, Mn)	x	x
↑ Settled and filtered water turbidity	x	x
Impact treatment strategy for harmful algal blooms	x	x
Impact corrosion control treatment	x	x
Others??	x	x

Resource Considerations Related to Plant-Based Strategies

- Costs associated with
  - Optimizing disinfection
  - Optimizing coagulation
  - Conducting bench or pilot-scale evaluations of alternate oxidants, coagulants, etc.
  - Enhanced monitoring
- Staffing
- Others?

Distribution System Strategies

- Primarily focused on reducing water age
  - Managing tanks
  - Flushing
  - Modifying hydraulics
- Treatment/design changes

Example Unintended Consequences of DS Control Strategies

- Impacts related to modifying system hydraulics:
  - Reduced capacity for peak demands
  - Release of poor water quality into the system due reduced tank levels
  - Low water pressure due to reduced tank levels
  - Concerns with removing tanks from service
  - Additional wear on pumps due to fill cycle changes
  - Potential hydraulic challenges associated with rerouting water

Example Unintended Consequences of DS Control Strategies

- Customer complaints, such as:
  - Discolored water may result from flushing or changing flow patterns
  - Anti-conservation perceptions (e.g., flushing)
- Others?

Resource Considerations Related to DS Control Strategies

- Costs associated with:
  - Installing and operating treatment and/or design changes
  - Tank maintenance services
  - Development and implementation of unidirectional flushing program
- Staffing
- Revenue lost due to unbillable water (e.g., flushing)
- Others?

Evaluating Potential DBP Control Strategies

For each DBP control strategy, identify:

- Data needed to assess the strategy
- Basis for considering the strategy
  - → Does the strategy apply?
- Potential unintended consequences (cautions)
  - → Some may be major obstacles for the system
- Flexibility to implement given the resources needed

Evaluating Oxidation/Disinfection Optimization: Data Needed

Data Needed	Purpose/ To Assess	Pre-Oxidation/ Disinfection	Intermediate/ Post-Disinfection
Chlorine dose & residual from each disinfection segment	Chlorine levels through the plant	x	x
Other oxidant dose information	Status of current oxidants	x	
Inactivation (CT) calculations from each segment	CT contribution from each disinfection segment	x	x
Raw and finished water TOC data	TOC concentration relative to chlorine dose	x	
Data to support the evaluation of any potential unintended consequences			

Oxidation/Disinfection Optimization: Basis for Considering Strategy

- Does the strategy apply?
  - Does the water system pre-chlorinate? *(if not, this strategy may not apply)* Yes
  - Does the system achieve CT through their clearwell (i.e., as opposed to needing the pre-disinfection segment to achieve adequate CT)? Yes
  - Are high chlorine residuals maintained through the plant? Yes
  - Is the total chlorine dose high relative to the raw water TOC concentration? Yes

Oxidation/Disinfection Optimization: Considerations Related to Potential Unintended Consequences for Disinfection/CT

- Has a tracer study been done to assess contact time through the plant?
- Is the clearwell baffled? If not, this could potentially be considered as a minor modification to improve contact time.
- Could this strategy be implemented seasonally, considering warm water CT > cold water CT?
- Is the state regulatory agency aware of this potential change?
- Others?

➔ Any major obstacles for the system? No!

Oxidation/Disinfection Optimization: Considerations Related to Potential Unintended Consequences for Pre/Intermediate Oxidation

- What are the treatment objectives (e.g., Mn/Fe, algal toxin control, minimizing bio-growth, turbidity control, others?)
- Could the chlorine application point be moved downstream?
- Would additional chemical feed equipment be needed?
- Status of pre-oxidant demand studies (i.e., completed, needed)?
- What are considerations for corrosion control treatment?
- Others?

➔ Any major obstacles for the system? No!

Oxidation/Disinfection Optimization: Potential Unintended Consequences for Intermediate/Post-disinfection

- Where does the system achieve CT?
- What residual disinfectant (e.g., chlorine) level is needed to maintain an acceptable residual in the distribution system?

  Note: reducing intermediate/post disinfectant dose may not have a measurable impact on DBP formation in the distribution system…

➔ Any major obstacles for the system?

➔ Can the strategy be implemented?

Evaluating Optimized Coagulation for TOC Removal: Data Needed

Data Needed	Purpose/ To Assess
Raw and finished water TOC data, coagulant dose and pH data	TOC trends, coagulation changes in response to changing water quality
TOC Performance Ratio information	Is this met through TOC removal or through an alternate compliance criterion?
Any jar test or other applicable study results	May provide insights into potential for additional TOC removal
Data to support the evaluation of any potential unintended consequences	

Optimized Coagulation for TOC Removal: Basis for Considering Strategy

→ Does the strategy apply?

- Do jar test data show that the system has the potential to achieve additional TOC removal?

Yes

- Is the historical TOC performance ratio (actual removal/required removal) running annual average < 1.1?

Yes

- Do some of the TOC removal data-sets show actual removal > required removal?

Yes

Optimized Coagulation for TOC Removal: Basis for Considering Strategy (con't)

→ Does the strategy apply?

- Did the system operate at a relatively constant coagulant dose with little/no consideration of raw water TOC? Yes
- Is the system using a coagulant that may not be effective for TOC removal (e.g., polymer)? Yes
- Can process pH be optimized further for TOC removal? Yes
- (If available), is the majority of raw or treated water SUVA > 2.0 L/mg-m? Yes

Optimized Coagulation for TOC Removal: Considerations Related to Potential Unintended Consequences

- Concerns about increased settled and finished water turbidity?
- How might this strategy impact corrosion control treatment?
- Concerns about changing the quality and/or quantity of sludge?
- Might treatment of inorganics (e.g., Mn) may be impacted?
- Harmful algal bloom treatment strategy considerations?
- Others??

➔ Any major obstacles for the system?

➔ Can the strategy be implemented?

Evaluating Distribution System Control Strategies: Data Needed

Data Needed	Purpose/ To Assess	Managing Tanks	Modifying Hydraulics	Flushing
DS chlorine residual – historic data and investigative sampling	Areas of poor water quality/ high water age in the system	x	x	x
Tank characteristics and level data	Turnover time and mixing characteristics (calculated using the tank spreadsheet)	x	x	
DS map	Pipe size, valve locations, etc	x	x	x
Data to support the evaluation of any potential unintended consequences				

Distribution System Control Strategies: Basis for Considering Strategy

→ Does the strategy apply?

- Are plant effluent TTHMs < 30 ppb?

Yes

- Does the hold study indicate that the bulk water is not very reactive?

Yes

- Has the system <u>not</u> fully implemented distribution system optimization, related to tank operations, a flushing program, system hydraulics, etc.?

Yes

Evaluating Distribution System Control Strategies : Potential Unintended Consequences and Resource Considerations

- Customer complaints
- Hydraulic concerns
- Others?

❖ See slides 9-11 for more information

➔ Any major obstacles for the system?

➔ Can the strategy be implemented?

Summary

- Assessing DBP control strategies might seem overwhelming, but really it comes down to:
  - Pulling together the system information, water quality and operations data that you need
  - Determining whether the strategy would apply
  - Considering the potential unintended consequences and resource needs.
- If the system has the flexibility to implement the strategy, we encourage you to develop an implementation approach!

DBP Optimization: Parent-Consecutive System Case Study

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Kentucky
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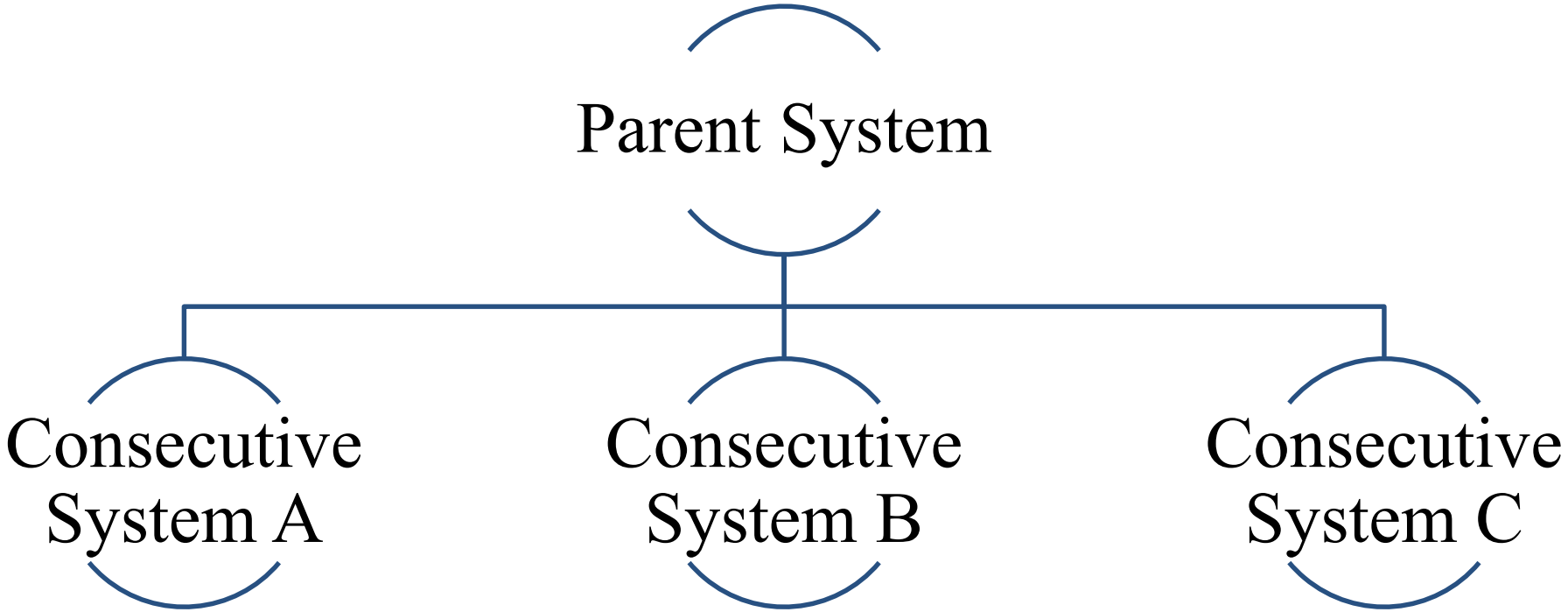
System Family



Parent System (PS)

- 8.0 MGD water treatment plant with membrane filtration
  - Average daily demand ~2.6 MGD
  - Four distribution storage tanks with combined capacity of 7.5 MG
  - Many oversized and parallel lines
- Provides 100% coverage to three consecutive systems and a small portion to a fourth consecutive system
  - Serves a system population of ~28,000 and combined population of ~38,000
- First TTHM MCL violation issued for 3rd quarter 2016
- Returned to compliance 3rd quarter 2017

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Consecutive System A (CS-A)

- Purchase all water through one master meter served via a 16" line
  - Two distribution system tanks with combined capacity of 0.6 MG
  - Serves a population of ~1400
- First TTHM MCL violation issued for 3rd quarter 2014
- Returned to compliance 4th quarter 2017

Consecutive System B (CS-B)

- Purchase all water through one master meter served via a 10" line
  - Three distribution tanks with a combined capacity of 0.5 MG
  - Serves a population of ~4700
- First TTHM MCL violation issued for 4th quarter 2014
- Returned to compliance 4th quarter 2017

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Consecutive System C (CS-C)

- Purchase all water through one master meter served via a 12" line
  - Four distribution tanks with a combined capacity of 0.4 MG
  - Serves a population of ~3700
- Several DBP MCL violations issued
  - First TTHM issued for 3rd quarter 2014
  - HAA5 for 4th quarter 2015 and 1st quarter 2016
- Returned to compliance for both parameters by 4th quarter 2017

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First Steps for System Family

- Distribution System Optimization Training conducted in August 2015
  - Regional training open to all systems
  - Parent and all three consecutive system from System Family attended
    - Parent system was in compliance, consecutive systems were in violation
    - Training attendance included in Enforcement Corrective Action Plans
  - Training was well-received, but System Family needed some additional encouragement ☺

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Next Steps for System Family

- First group meeting was held in Mid-October 2015
  - Goal was to get all parties in the same room to encourage communication and collaborative efforts—holistic approach
  - Parent system did not feel responsible for CS violations, despite having "optimization potential"
  - Identified action items for each system
- Group continues to meet annually

First Steps for PS

- WTP superintendent and DS superintendent met (late October 2015)
  - Initial Findings
    - Operated as two separate entities with little communication, under separate budgets
  - Through this effort, changes were implemented:
    - Regular meetings improved communication—key to success!
    - Collaborative efforts and budget sharing

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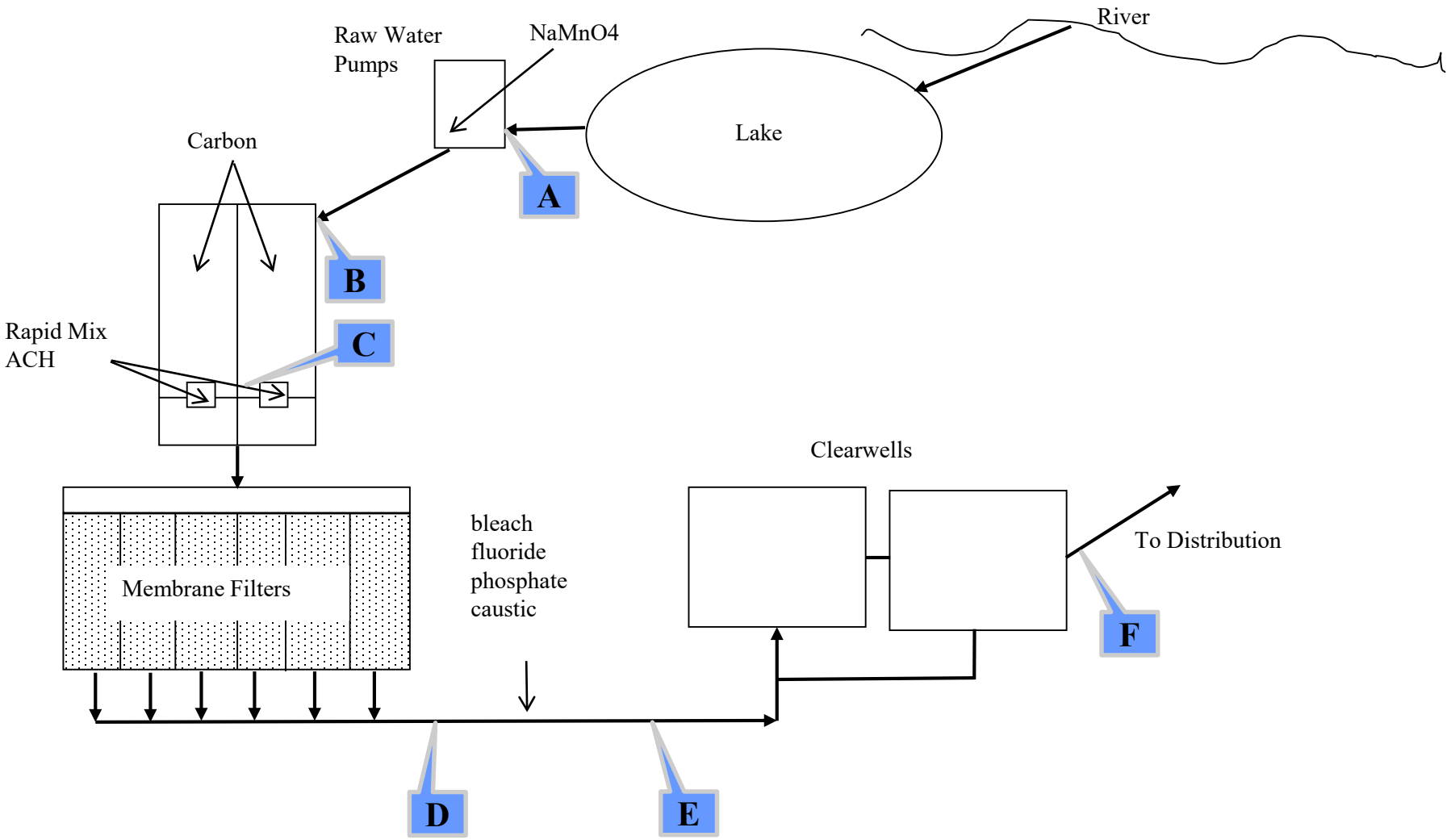
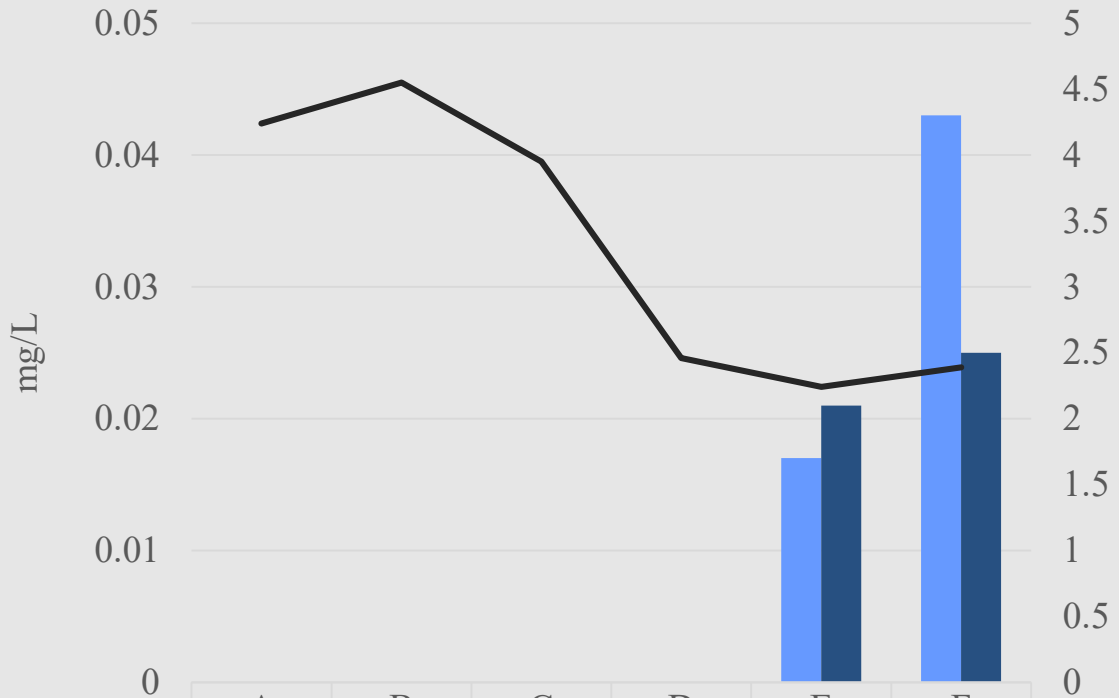
Parent System WTP DBP Optimization



WTP DBP Optimization: Before

- Plant profile to establish baseline



	A	B	C	D	E	F
TTHM					0.017	0.043
HAA5					0.021	0.025
TOC	4.24	4.55	3.95	2.46	2.24	2.39

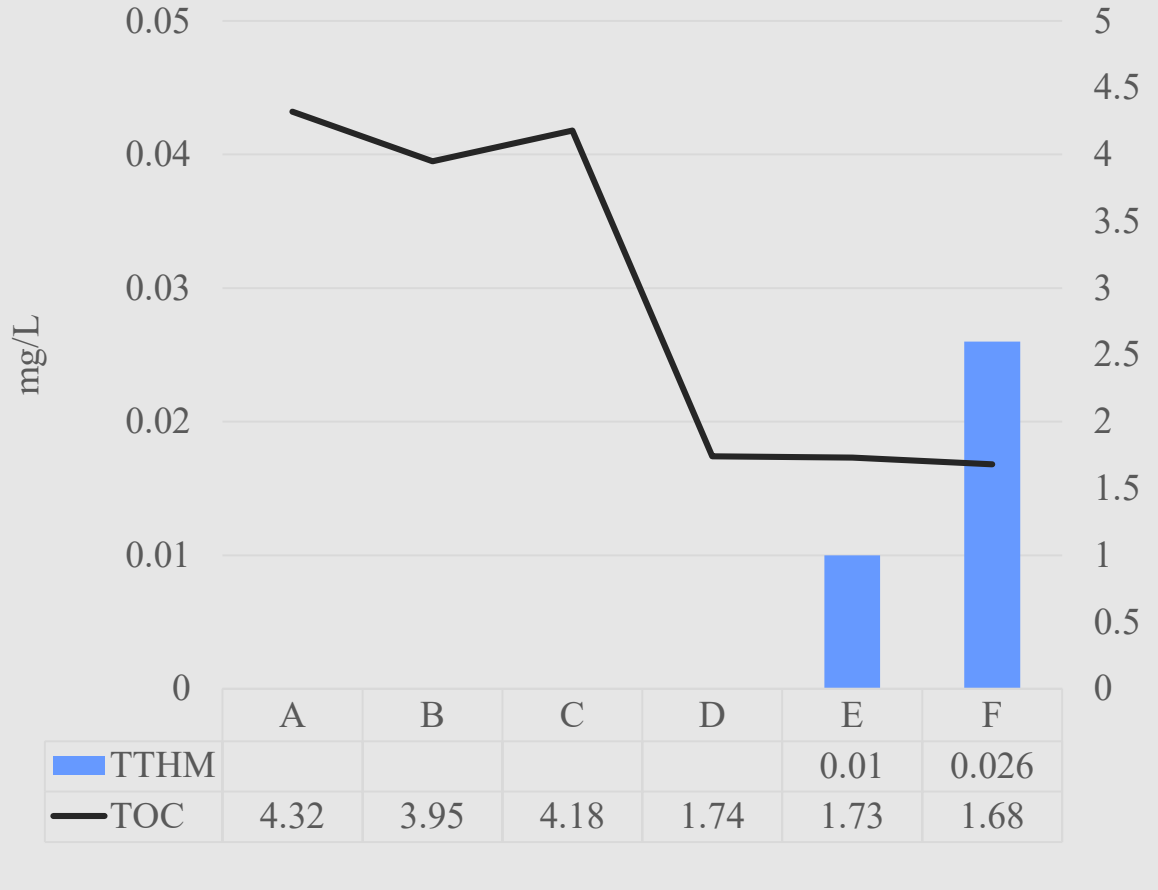
- Treated TOC was ~2.5 mg/L
- Plant tap TTHMs were 0.043 mg/L
- Plant tap HAAs were 0.025 mg/L

WTP DBP Optimization

- Potential strategies: improve TOC removal and optimize pre-oxidation
  - Jar testing
    - Limited on coagulant options due to membrane filtration
    - Optimized pre-oxidant
      - Sodium permanganate
    - Optimized carbon feed
      - Limited on carbon options due to membrane filtration (gold number)
      - Several trials to identify the best type, feed rate, and application point

WTP DBP Optimization: After

- Post in-house plant profile



- Treated TOC dropped from 2.4 to 1.7 mg/L
- Plant tap TTHMs dropped from 0.043 to 0.026 mg/L
- Relatively small decreases, but a big impact out in the system!

PS DS DBP Optimization

- Implemented control strategies presented in the Distribution System Optimization training
  - Increased monitoring in DS
    - Critical locations
      - Dead ends, large mains, parallel lines, low flow, tank effluent, low chlorine areas
      - Chlorine and TTHM (in-house THM analyzer)
    - Installed monitoring panel at the main 3 MG tank
      - Chlorine, pH, turbidity, conductivity, and pressure
      - In the process of installing more units

PS DS DBP Optimization

- Optimized tank operations
  - Lowered tank levels to reduce water age
  - Changed fill and draw levels for better turnover
  - Cleaned storage tanks
  - Made improvements to the main 3MG storage tank
    - Recoated interior
    - Installed mixing system (duckbill valves)
      - » Improves mixing but not water age

PS DS DBP Optimization

- Optimized flushing program
  - System-wide flushing twice a year
    - Combination of unidirectional and conventional flushing techniques
  - Low velocity flushing (“soft” flush) in critical areas quarterly
    - Purpose is to turn the water over rather than scour the lines
    - Fine-tuned water turnover using the THM analyzer
  - Systematically installed automatic flushing devices
    - Used THM analyzer to determine the best locations
  - Coordinated flushing efforts with consecutive systems

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PS DS DBP Optimization

- Rerouted water
  - Parallel lines
  - Eliminated hydraulic dead-ends
- Began feeding a bio-penetrant
  - Chlorine residual monitoring used to measure effectiveness

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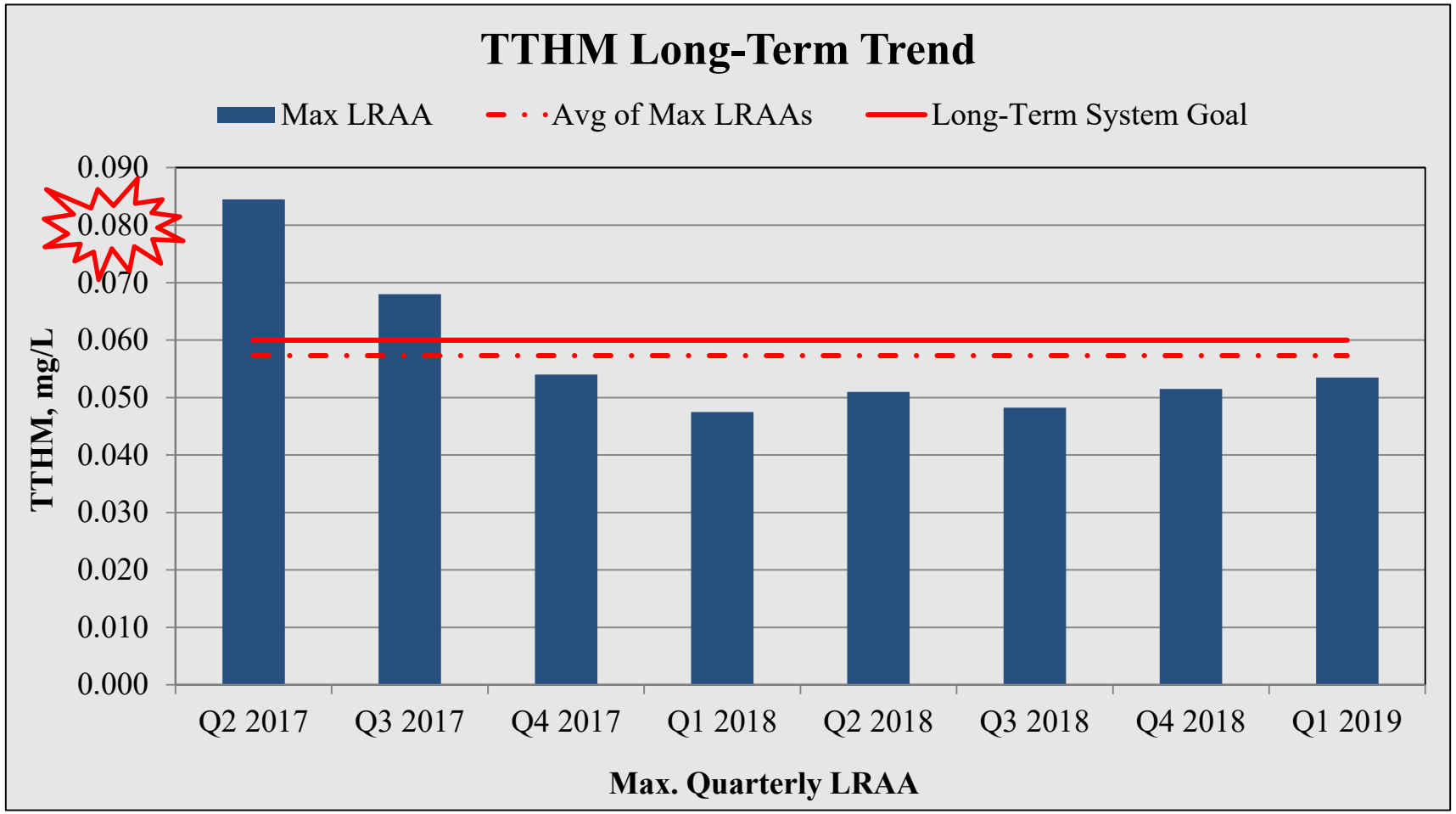
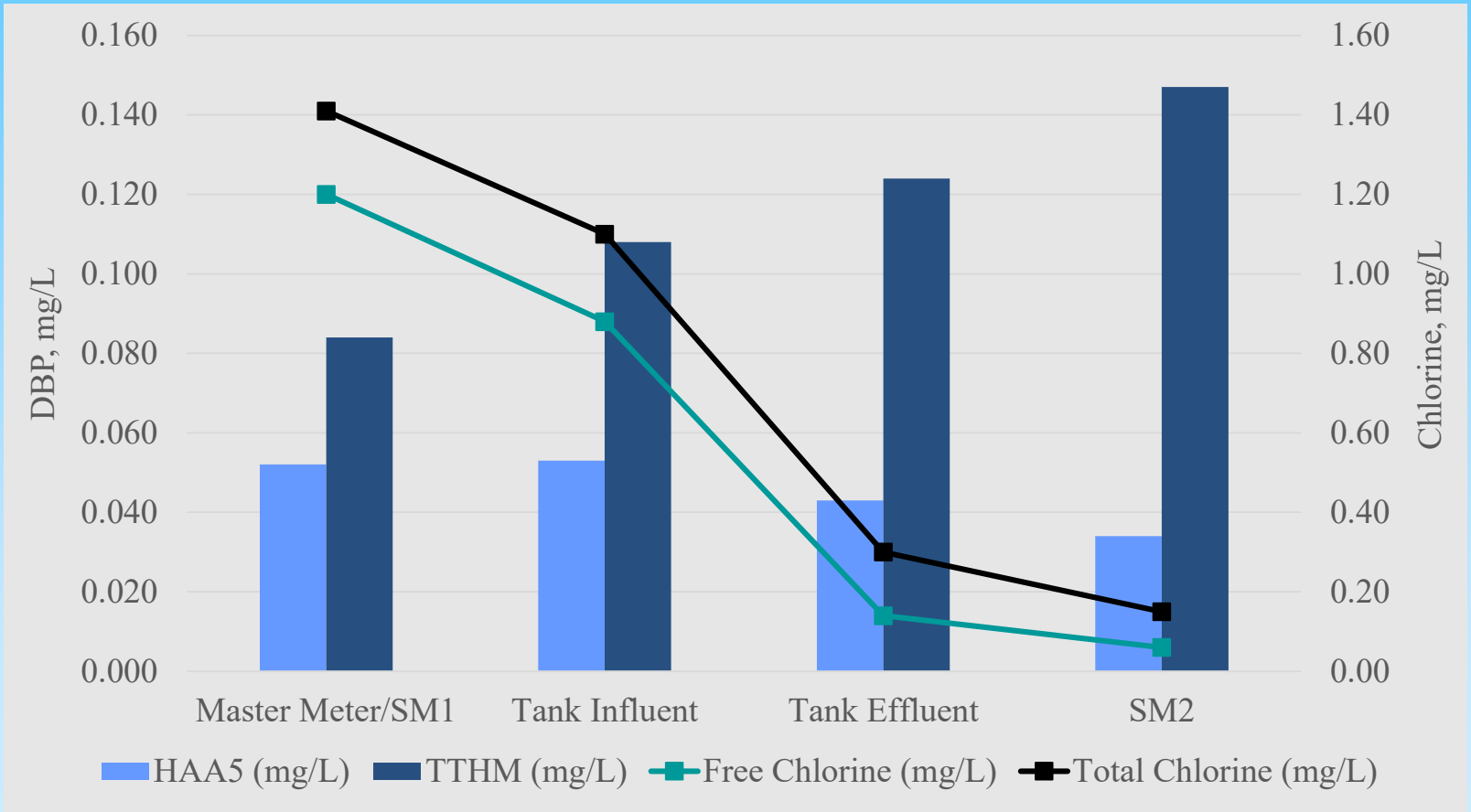
PS TTHM Trends



CS-A DS Optimization: Before

- Conducted diagnostic monitoring of the DS



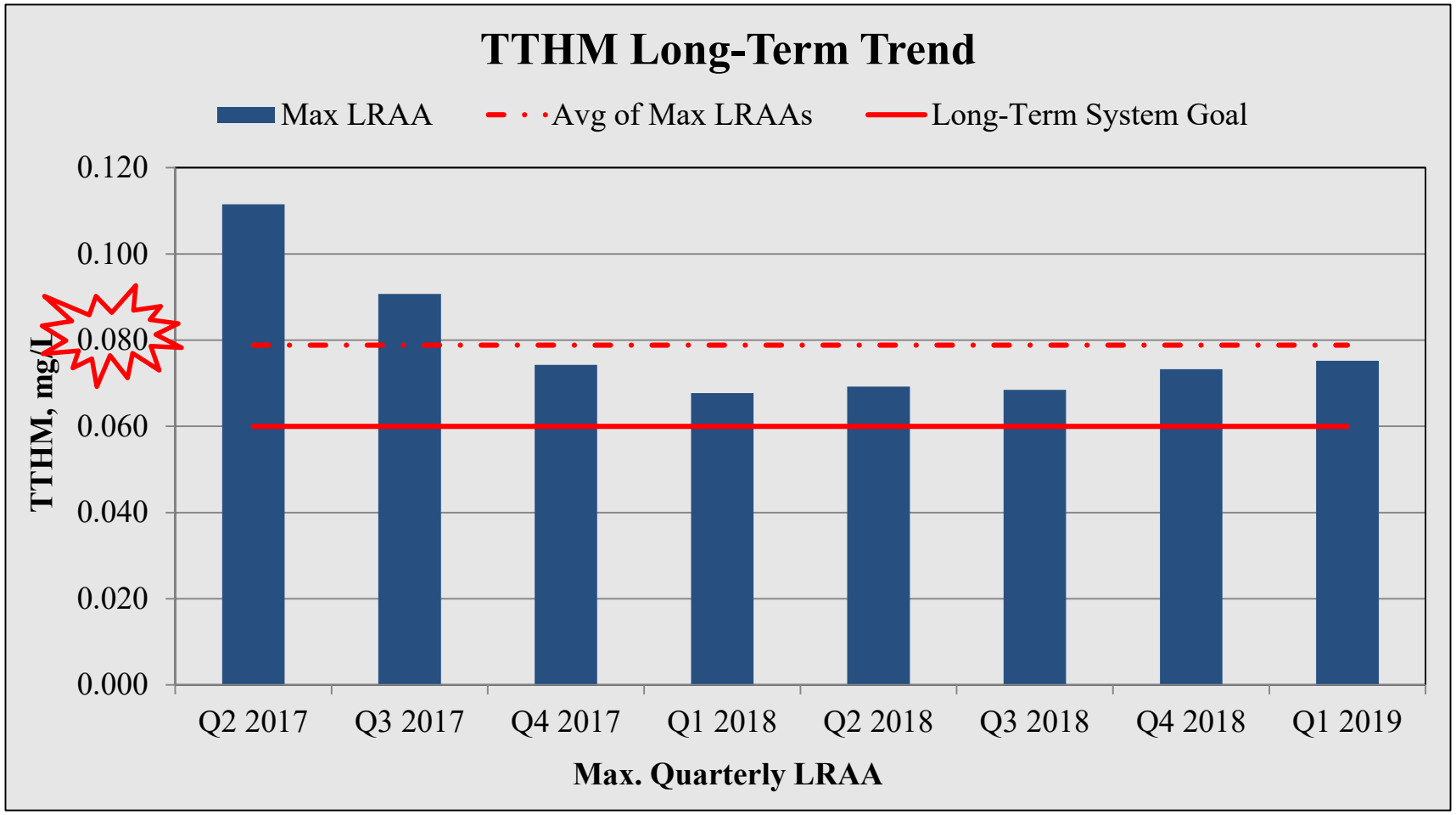
CS-A DS Optimization

- Implemented control strategies presented in the Distribution System Optimization training
  - Optimized tank operations
    - Increased turnover while maintaining adequate fire protection
      - » Hydraulic challenges
        - » Operating off of parent system pressure
        - » Tanks not same elevation
        - » One tank used for industry fire protection so low level limitations
    - Installed mixing system (duckbill valves) and recoated interior of tank sampled during DS profile

CS-A DS Optimization

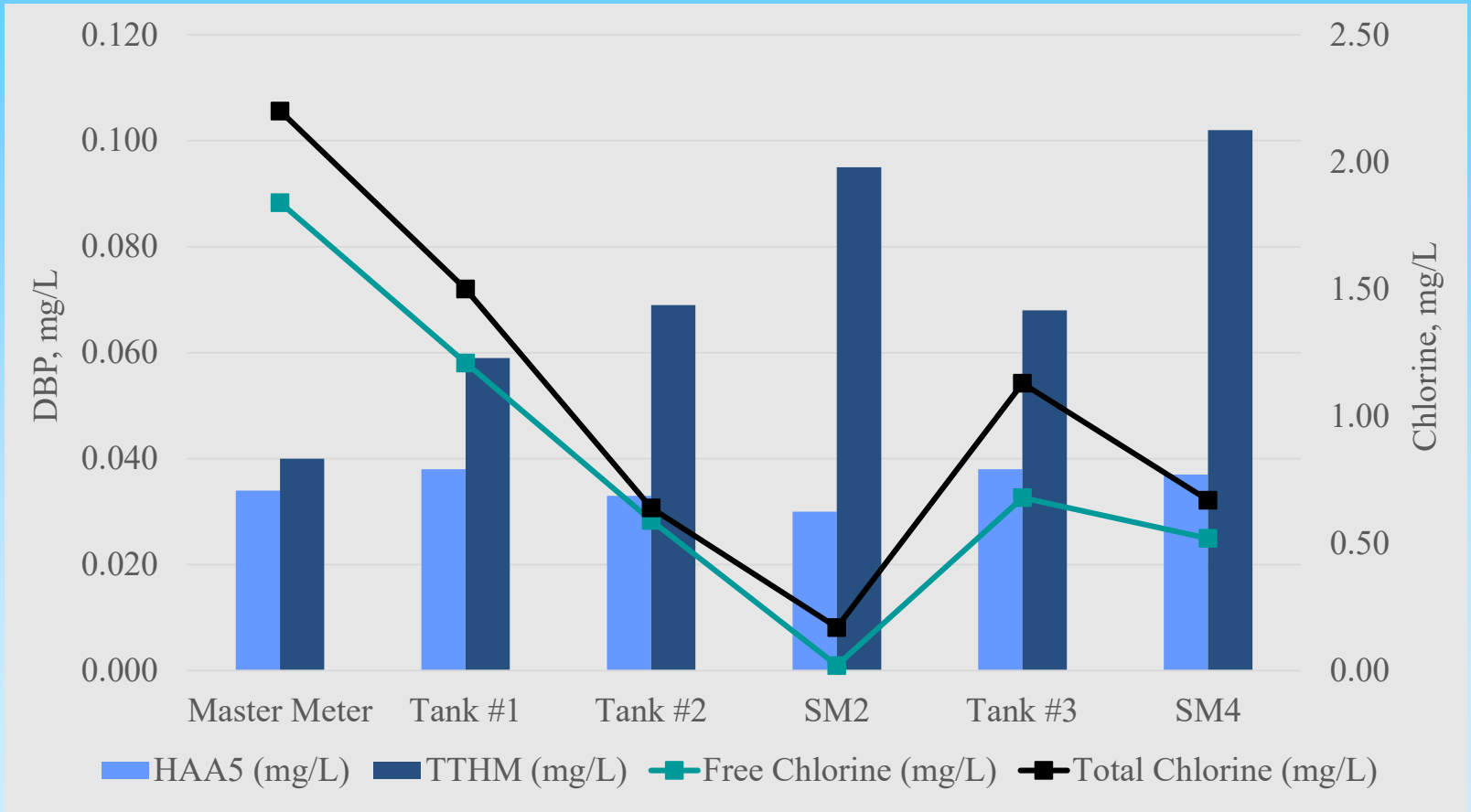
- Optimized flushing program
  - System-wide conventional flushing twice a year
  - Low velocity flushing (“soft” flush) in critical areas quarterly
  - Limited number of automatic flushing devices
  - Coordinated flushing with parent system

CS-A: After


TTHM Long-Term Trend
Max LRAA
Avg of Max LRAAs
Long-Term System Goal
0.120
0.100
0.080
0.060
0.040
0.020
0.000
TTHM, mg/L
Q2 2017
Q3 2017
Q4 2017
Q1 2018
Q2 2018
Q3 2018
Q4 2018
Q1 2019
Max. Quarterly LRAA

CS-B DS Optimization: Before

- Conducted diagnostic monitoring of the DS



CS-B DS Optimization

- BART (biological activity reaction test) monitoring
  - Iron reducing bacteria presence determined at some locations
  - Installed bio-penetrant feed just downstream of the master meter
  - Installed phosphate feed to boost level measured at the master meter

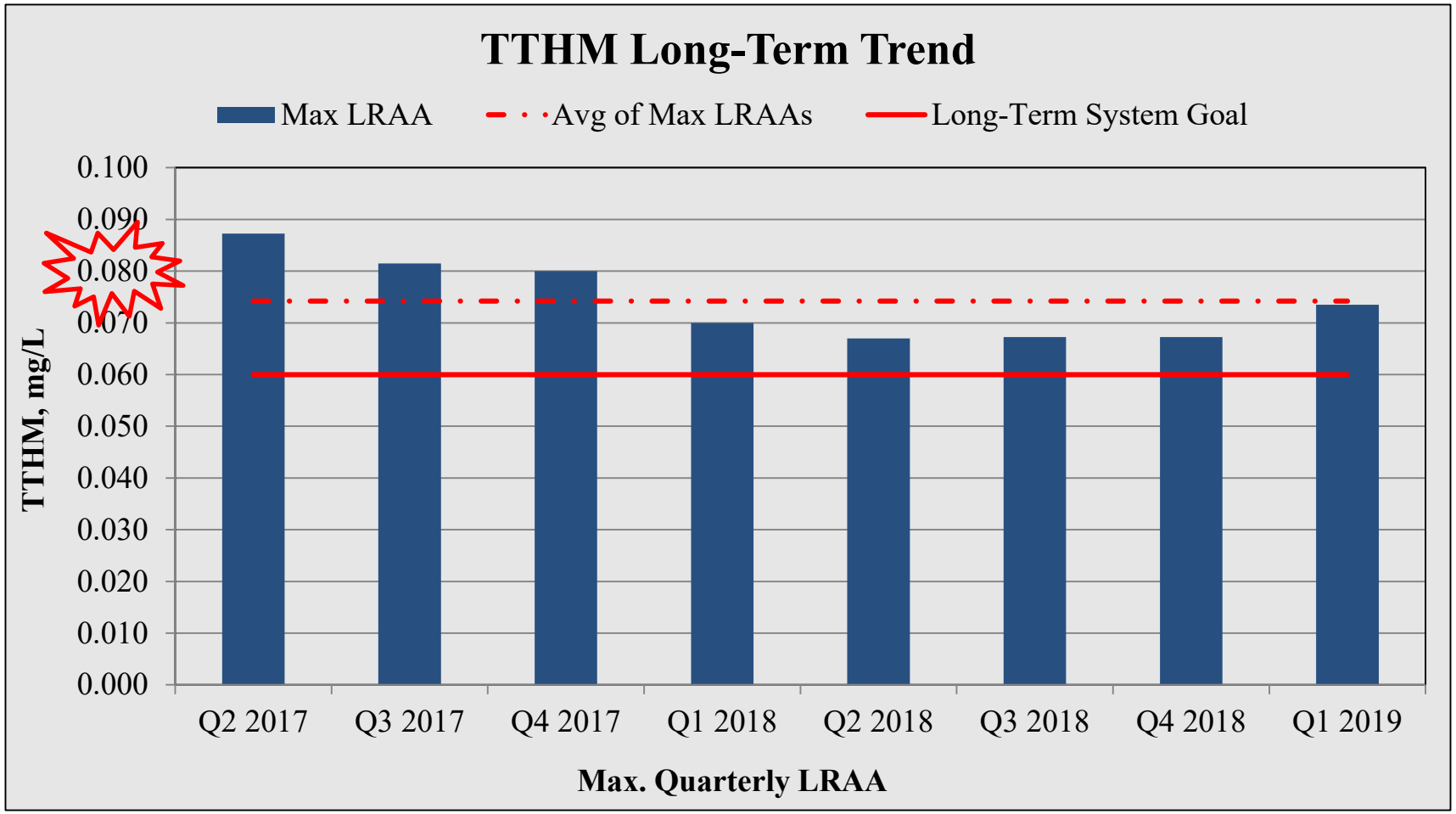
CS-B DS Optimization

- Implemented control strategies presented in the Distribution System Optimization training
  - Optimized flushing program
    - System-wide conventional flushing twice a year
    - Low velocity flushing (“soft” flush) in critical areas quarterly
    - Limited number of automatic flushing devices
    - Coordinated flushing with parent system

CS-B DS Optimization

- Optimized tank operations
  - Made some adjustments to the fill and draw levels to increase turnover
  - Mixing system (duckbill valves) installed in tanks
  - Cleaned storage tanks

CS-B: After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0.080
0.070
0.060
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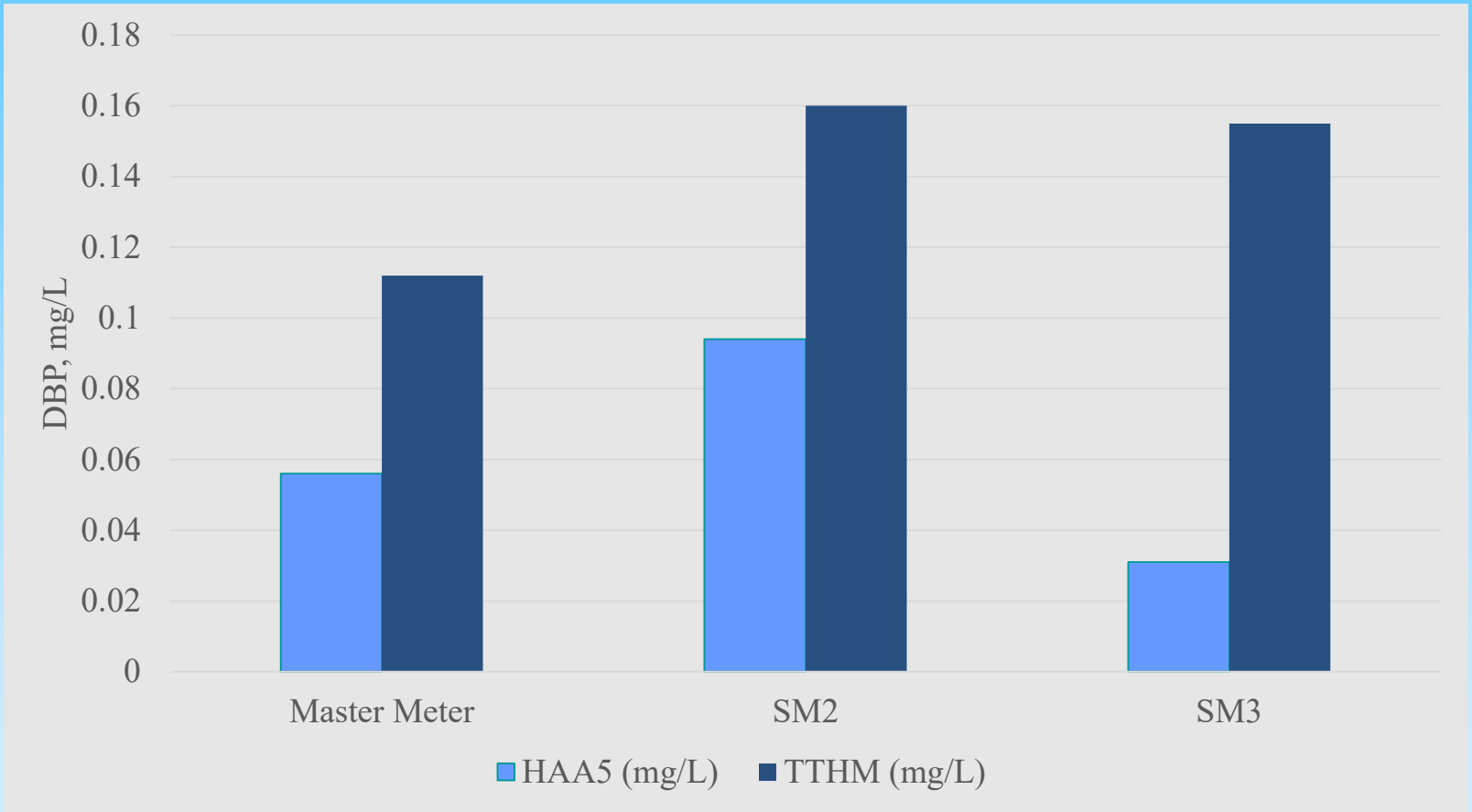
0.040
0.030
0.020
0.010
0.000
TTHM, mg/L
Q2 2017
Q3 2017
Q4 2017
Q1 2018
Q2 2018
Q3 2018
Q4 2018
Q1 2019
Max. Quarterly LRAA

CS-C: Before

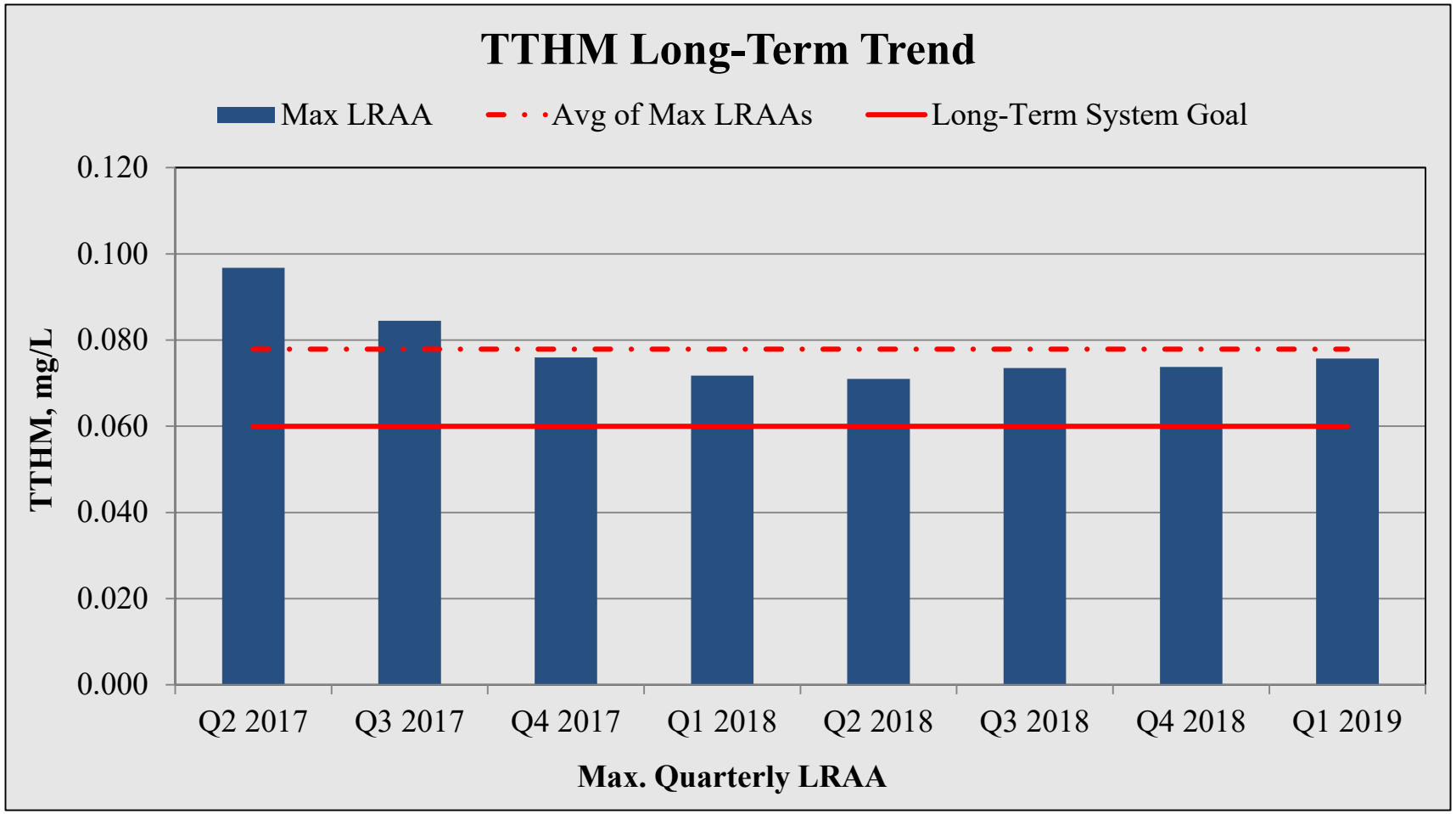
- Initial DS monitoring



CS-C DS Optimization

- Implemented control strategies presented in the Distribution System Optimization training
  - Flushing program
    - Challenges with flushing due to the limited number flush points
    - Limited low velocity flushing (“soft” flush) in critical areas quarterly
    - Coordinated flushing with parent system
  - Optimized tank operations
    - Made some adjustments to the fill and draw levels to increase turnover

CS-C: After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0.020
0.000
TTHM, mg/L
Q2 2017
Q3 2017
Q4 2017
Q1 2018
Q2 2018
Q3 2018
Q4 2018
Q1 2019
Max. Quarterly LRAA

Final Thoughts

- Success required a holistic approach
- All systems have maintained compliance since 3rd and 4th quarters of 2017 and some are achieving optimization goals
- Continued meetings on an annual basis
  - Topics of discussion include: compliance, coordinated efforts, projects, sampling, etc.
- Great example of the benefit gained by communicating and working together!

Thank You!

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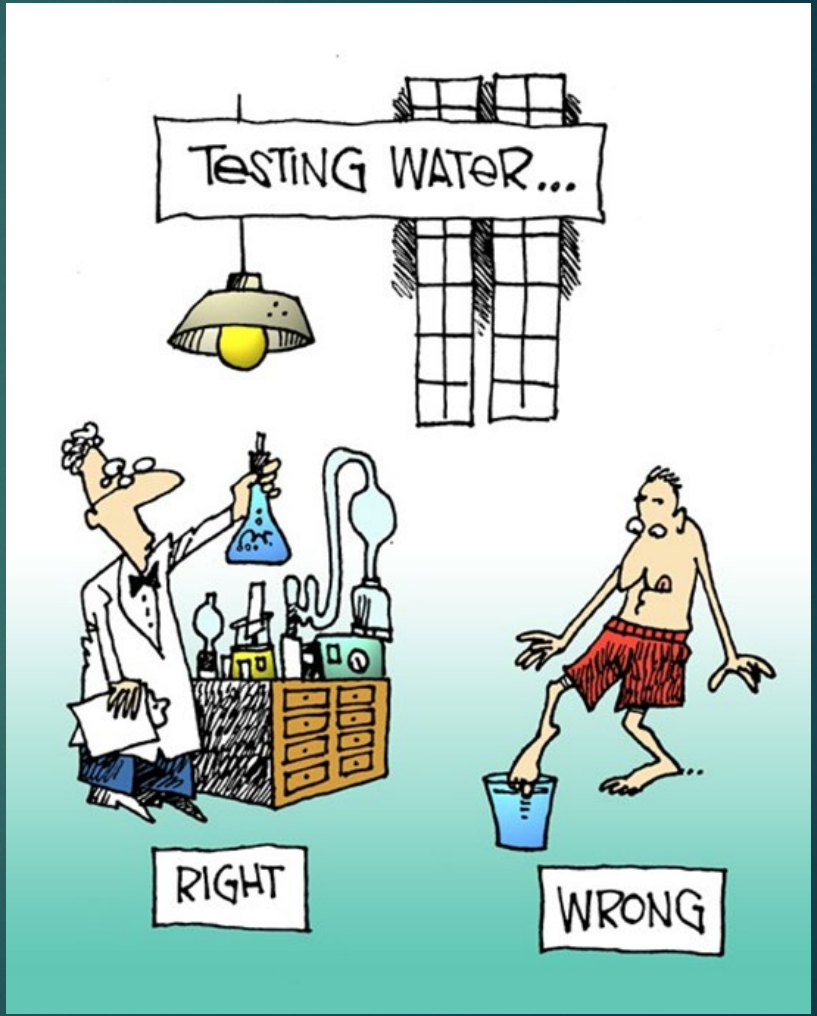
Alabama's Approach to DBPs

WILLIAM MCCLIMANS
SURFACE SOURCE SECTION
DRINKING WATER BRANCH
ALABAMA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

- Alabama's Information
- Stage 1 DBPR
- Predicting the Future
- Finished TOC Goal
- Master Meter Monitoring
- Operational Evaluation Levels (OELs)
- Distribution System Evaluations (DSEs)
- AWOP



Alabama's Information

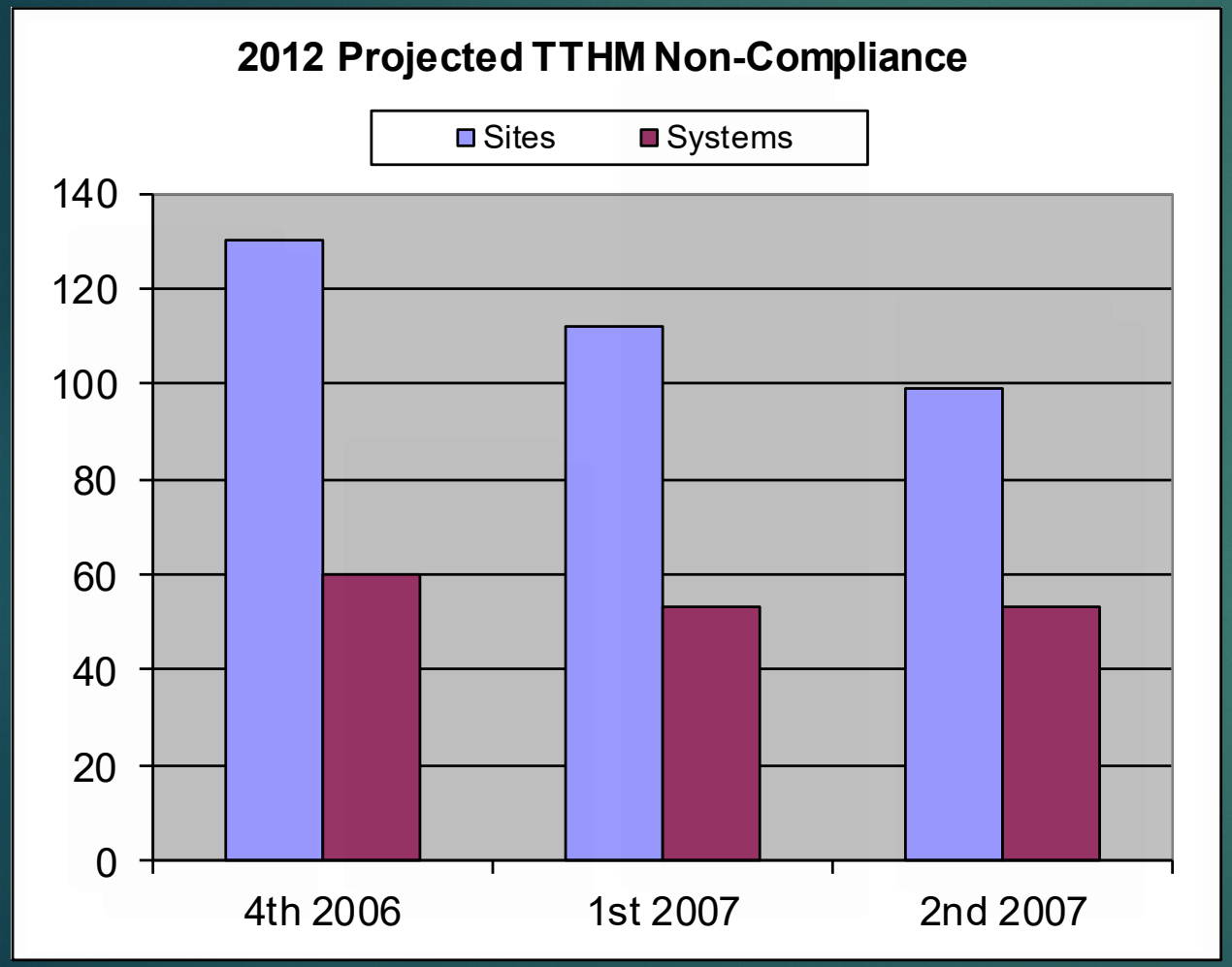
- 510 Community Water Systems
  - 77 Surface Water Systems (98 Surface Water Treatment Plants)
  - 244 Ground Water Systems
  - 150 Surface Purchase Systems
  - 39 Ground Water Purchase Systems

- 240 Systems on quarterly DBP monitoring
- High level of interconnection between water systems
- All on **FREE CHLORINE**

Stage 1 DBPR

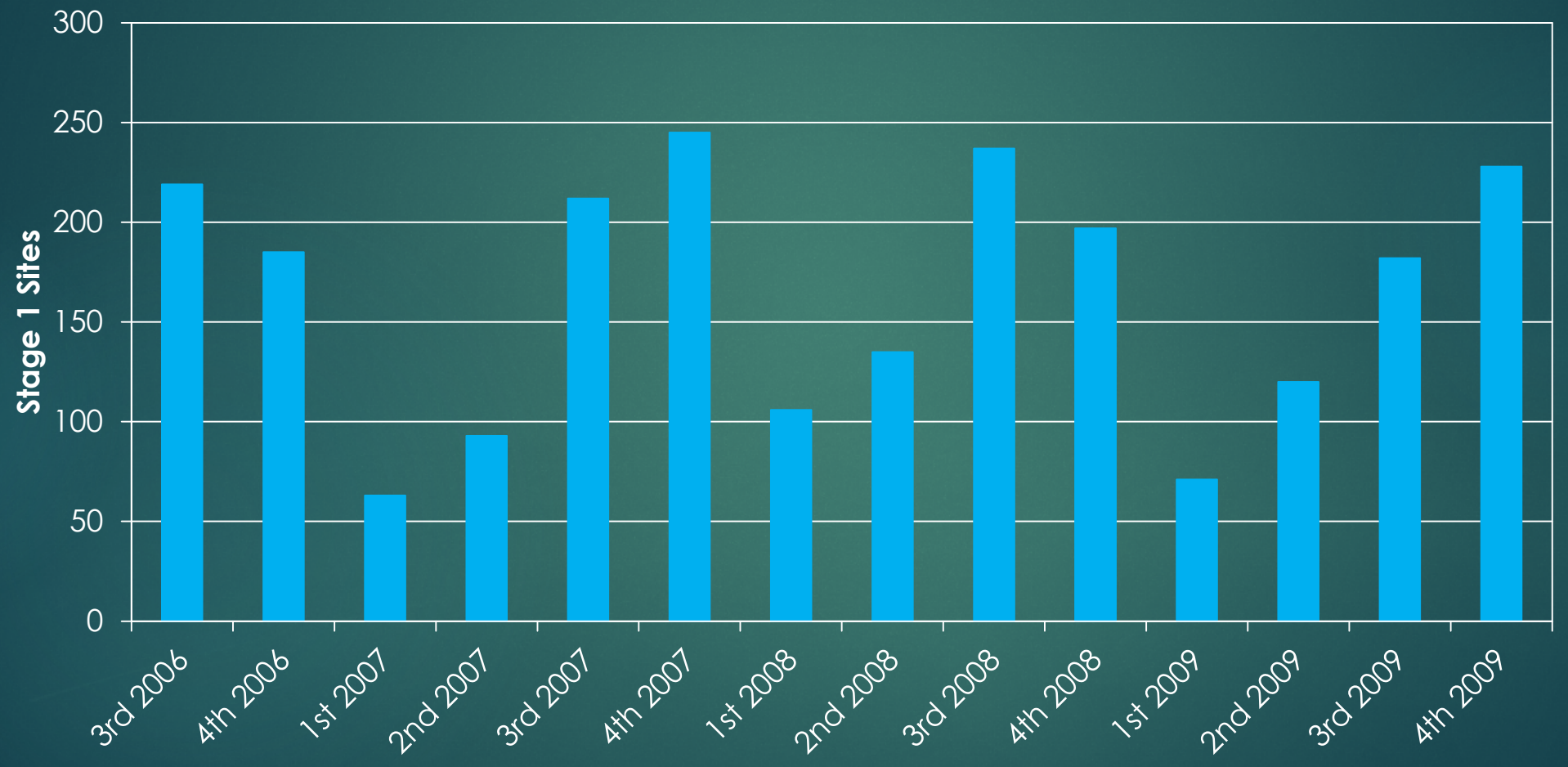
- In 2005 ADEM altered the drinking water regulations to require:
  - Water treatment plant effluent monitoring
  - Consecutive system monitoring
    - 2006 all systems had to monitor
    - 2007 parent systems were no longer responsible for consecutive systems
- Cause for change was complaints and estimating the effect of Stage 2 on the State.

Stage 2 Predictions From Stage 1 Data

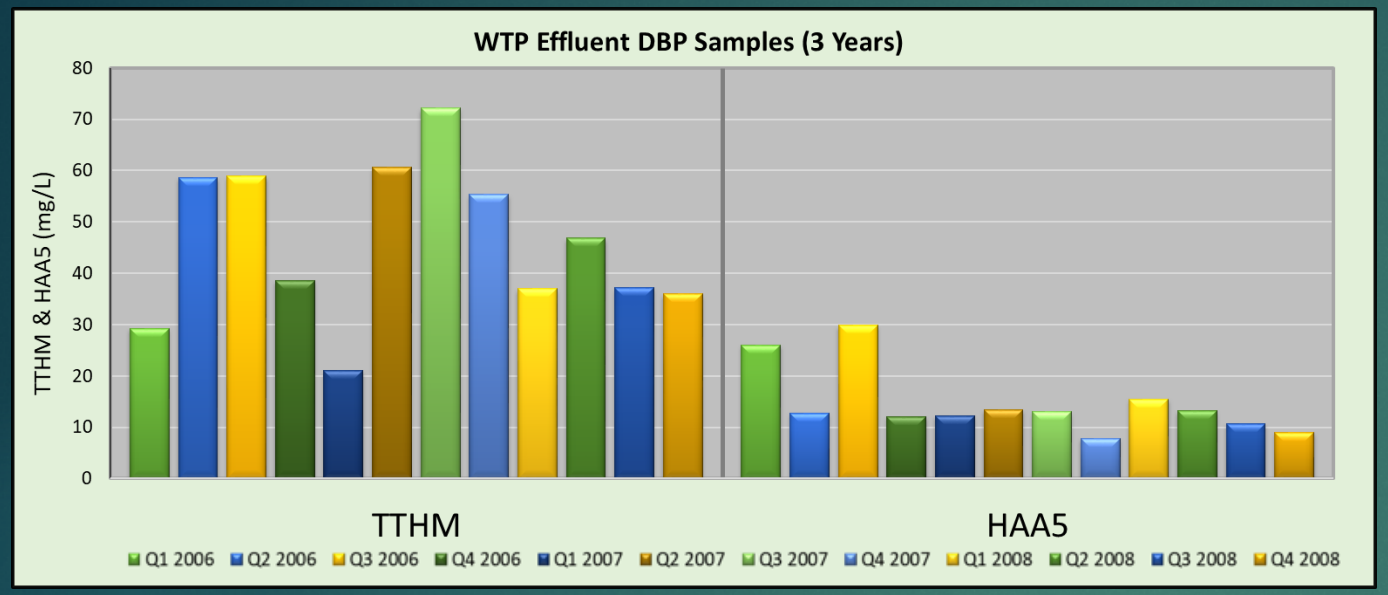


- 4th QTR 2006
  - 60 Systems
  - 130 Sites
- 1st QTR 2007
  - 53 Systems
  - 112 Sites
- 2nd QTR 2007
  - 53 Systems
  - 99 Sites

TTHM OEL Predictions



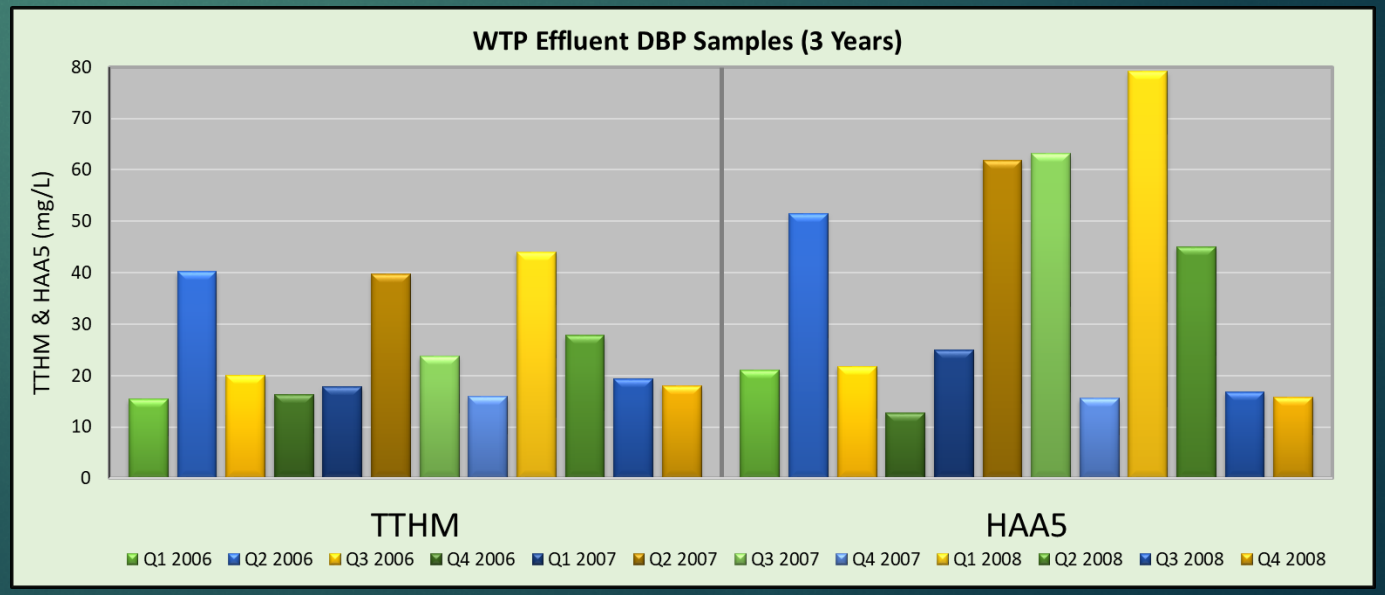
Water Treatment Plants' Effluent DBPs



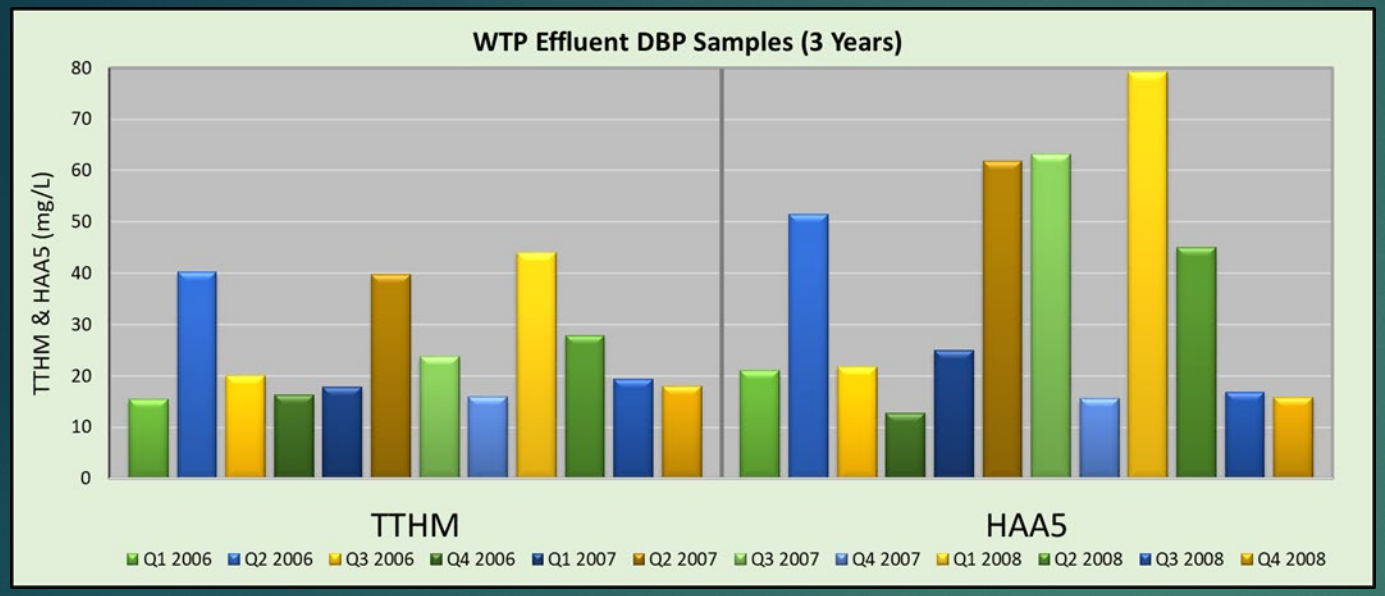
TTHM Problem

HAA5 Problem

The Ugly Truth

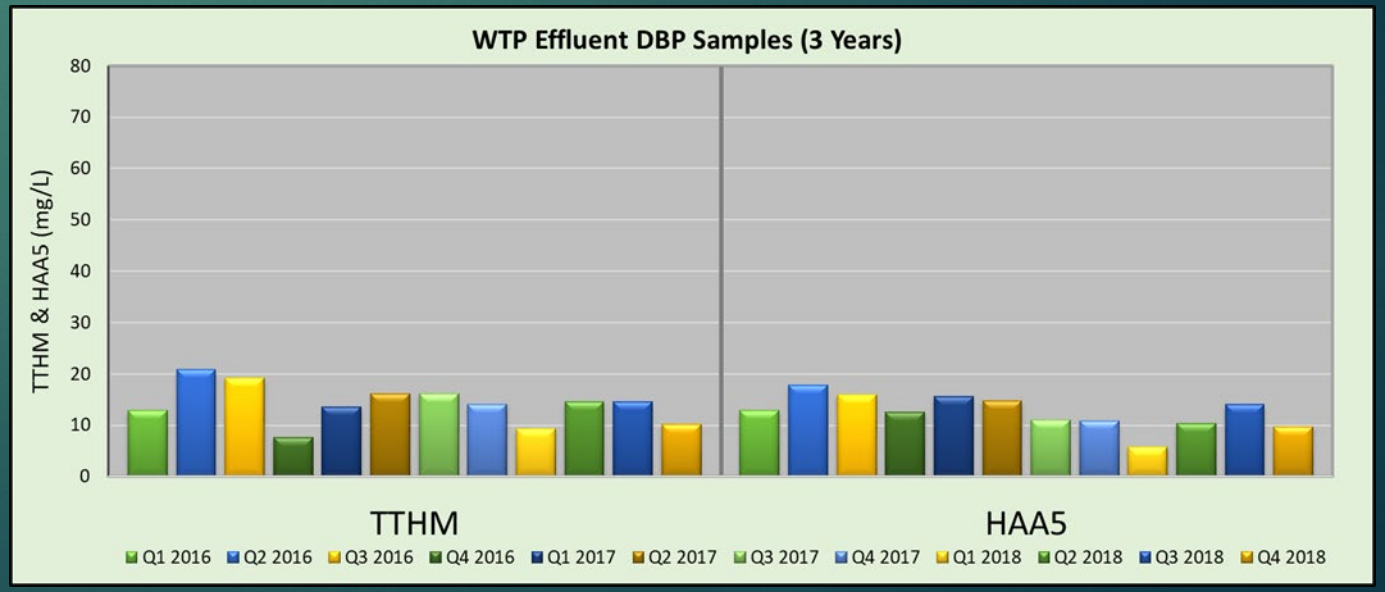


WTP Effluent Improvement



2006 - 2008

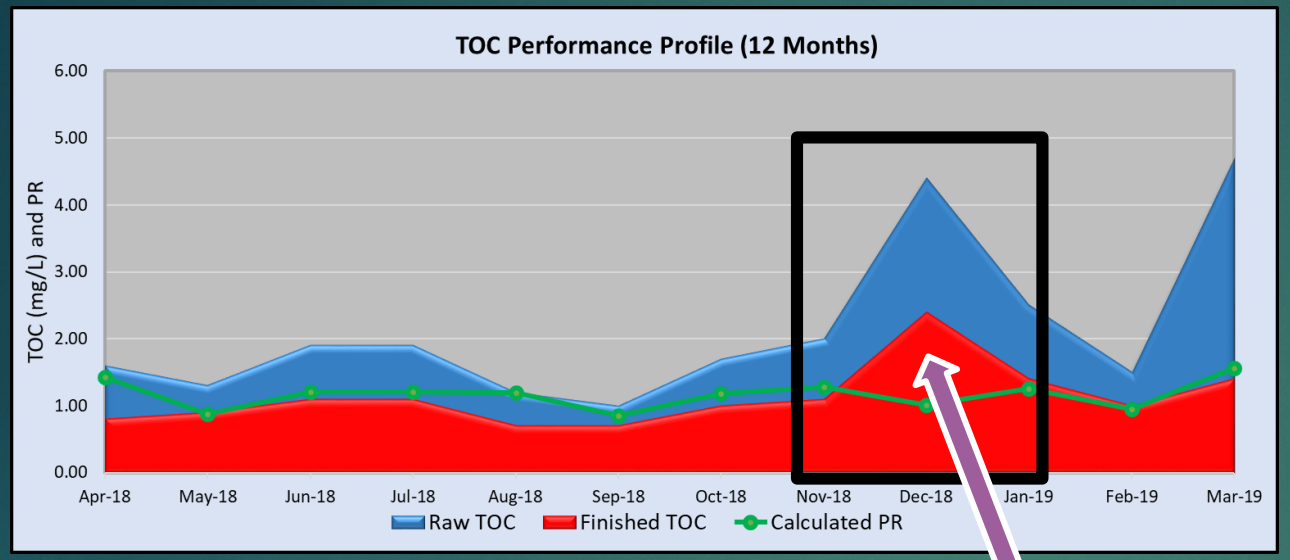
2016 - 2018

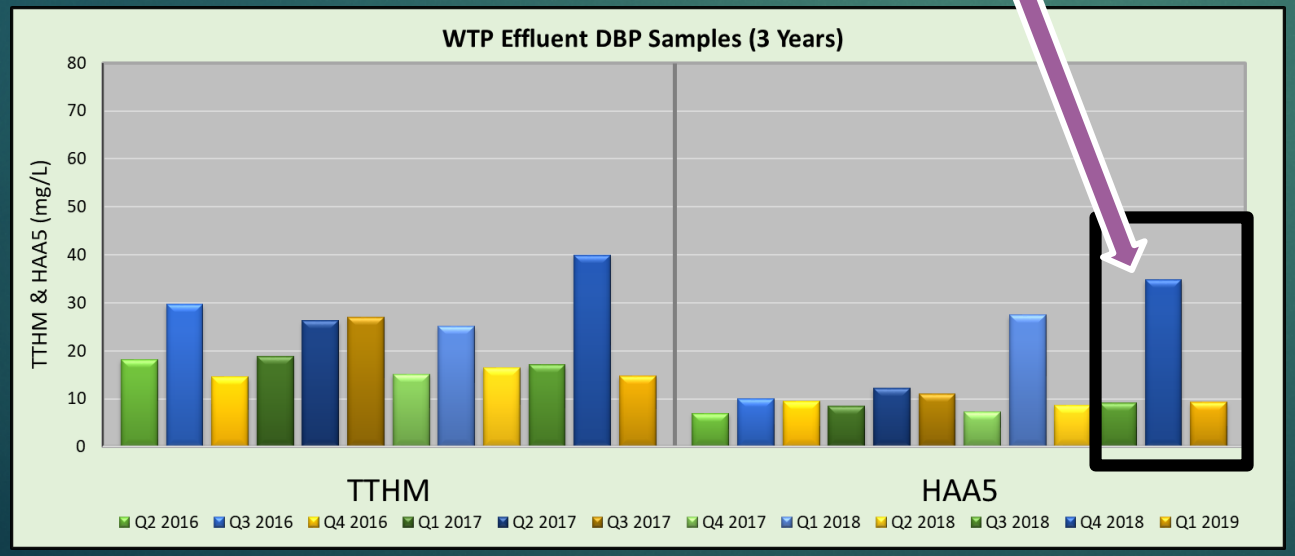


Finished TOC Goal

- Determined that the performance ratio is not a good indicator of optimized TOC removal for DBP control
  - > 50% TOC removal still had major DBP issues
  - Systems with finished water < 2.0 mg/L tended to have lower DBPs
- Analyzed WTP TOC and effluent DBP data.
- Optimization Goal set to 1.7 mg/L as a RAA.
- Acknowledged some WTPs will have to be lower.

Finished TOC – DBP Connection



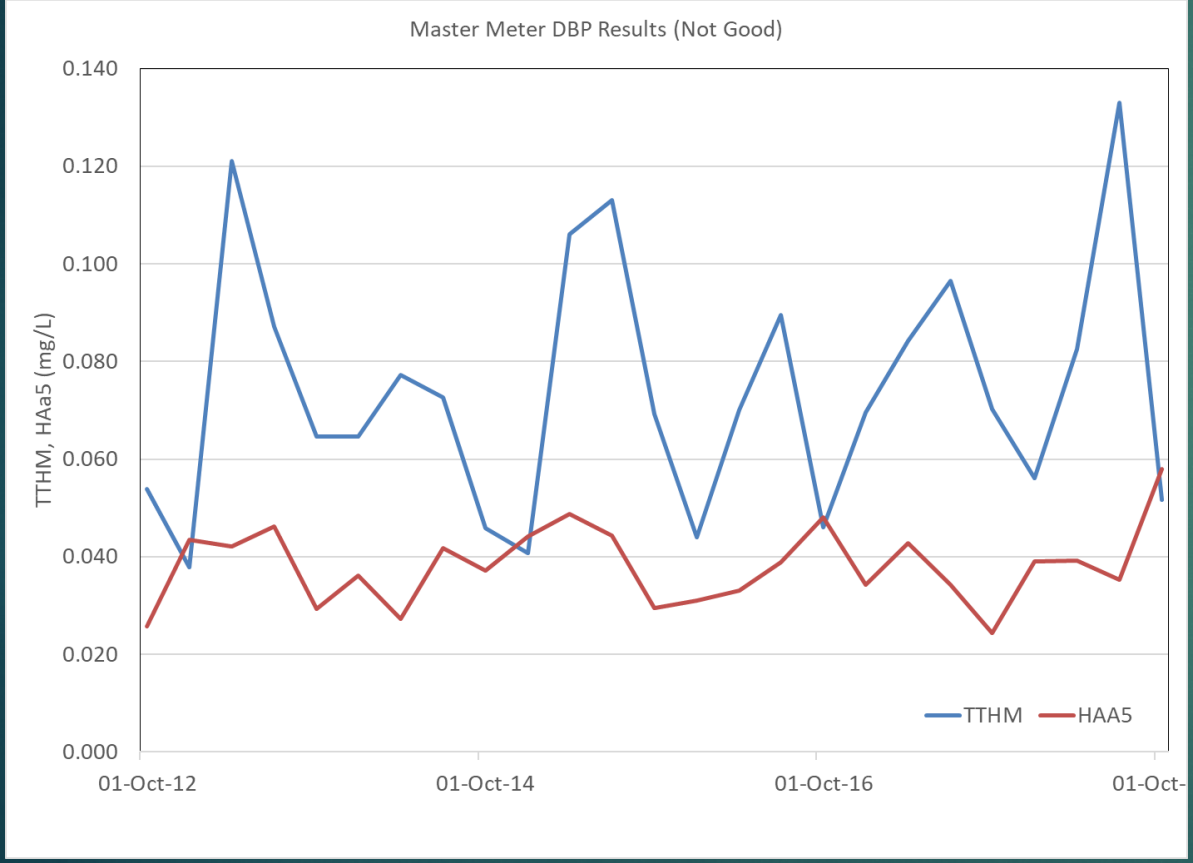


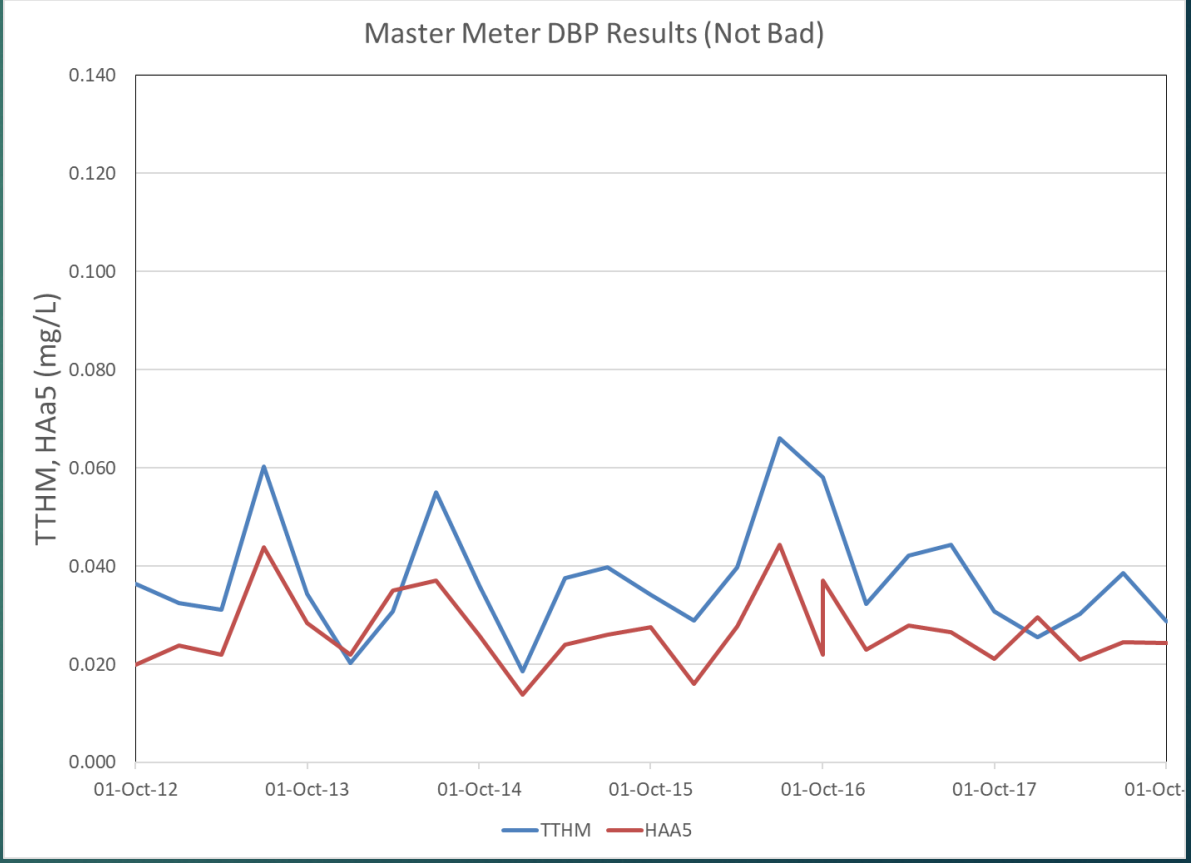
In analyzing finished water TOC with WTP effluent DBPs, a connection has been observed. This information is now being shared with operators during inspections.

Master Meter Monitoring

- Parent and consecutive systems have fought over water quality since consecutive system monitoring began in 2006; some even longer!
- Water systems were told to work it out or ADEM would.
- Master meter monitoring started 3rd QTR 2012
  - Ground water only systems were exempted unless issues arise
  - Parent system responsible for cost (part of doing business)
  - Must provide results to consecutive systems
  - Allows for reduction in monitoring

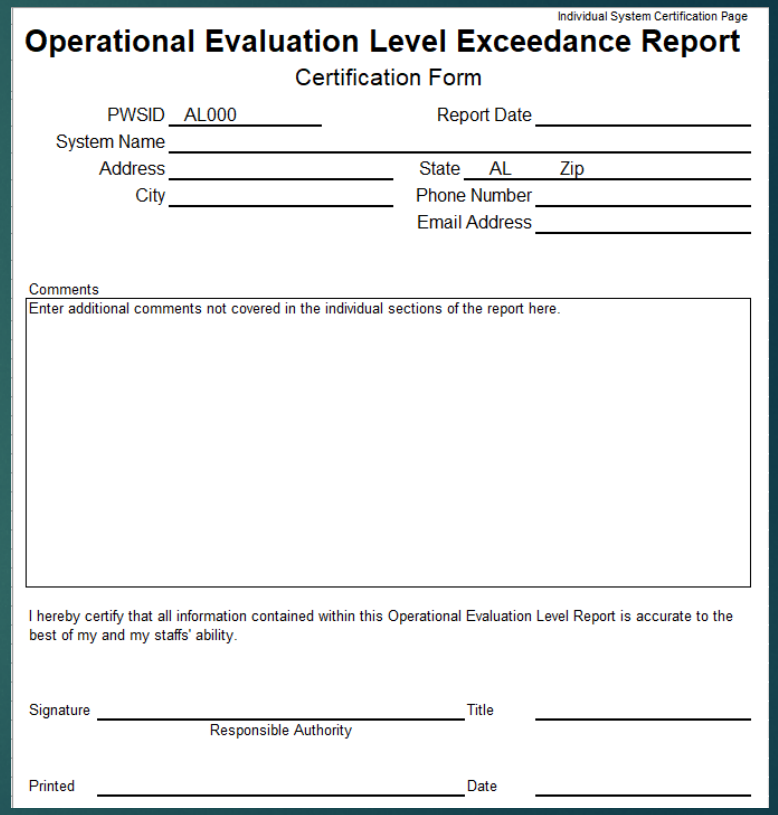
Master Meter DBP Results





OEL Report

- Designed to find root cause of violation
  - Does a good job at determining if the source or WTP is the culprit and why it occurred.
  - Does not help very well with distribution due to lack of data
- Designed to make operators not want to fill it out a second time.
  - A producing system report is a minimum of 23 pages
  - A purchase system report is 9 pages



Individual System Certification Page

Operational Evaluation Level Exceedance Report

Certification Form

PWSID AL000 Report Date

System Name

Address State AL Zip

City Phone Number

Email Address

Comments

Enter additional comments not covered in the individual sections of the report here.

I hereby certify that all information contained within this Operational Evaluation Level Report is accurate to the best of my and my staffs' ability.

Signature Title

Responsible Authority

Printed Date

Joint OEL & Mandatory Meeting

If a consecutive system exceeds the TTHM and/or the HAA5 MCLs … then the following applies:

- A joint operational evaluation must be completed which includes
  - the wholesale system that supplies water to the site where the exceedance occurred, and
  - any consecutive system that conveys the water where the exceedance occurred.
- Representatives from all systems involved shall
  - meet quarterly to evaluate the effectiveness of the measures implemented based on the operational evaluation.
  - Submit an attendance list and meeting minutes ~~shall be submitted~~ to the Department within 30 days of each meeting.

Distribution System Evaluations (DSE)

- ADEM's regulations require systems to redo their DSE every 9 years or earlier if one of the following conditions is met:
  - Addition of a new surface water treatment plant
  - New ground water source not in same aquifer as other sources
  - New purchase connection
  - System consolidation
  - Or required by the Department
- The second DSE started in 2016 and Schedule 4 system reports are due by July 1

Second DSE

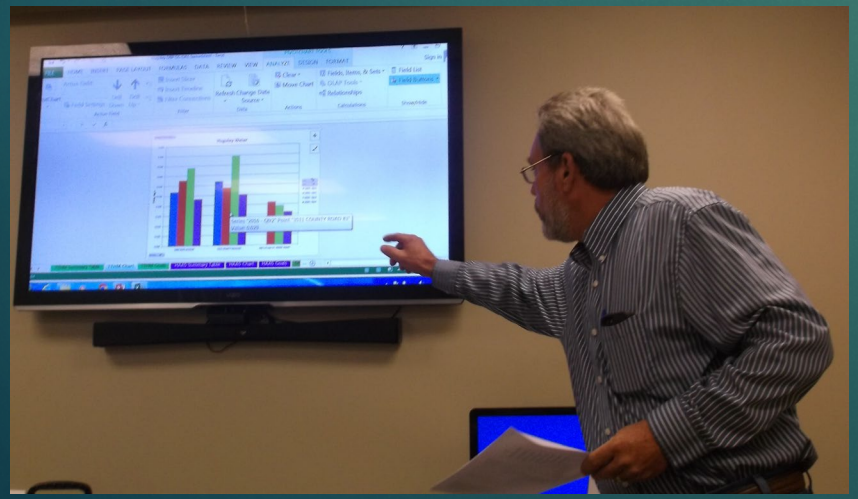
- Most systems moved at least one of their max sites
- Several systems had all new sites
- Results from new sites were 20 – 80% higher than previous year.
- Water systems have to reduce DBPs throughout the entire system instead of individual sites
- Next DSE round scheduled to start in 2024

Area Wide Optimization Program

- Alabama joined the Region 4 AWOP in 1997
- Initial focus was on turbidity removal
- Expanded scope in 2004 to include DBPs
  - Session added to microbial Performance Based Training (PBT) to address WTP DBPs
    - TOC Removal (UV254)
    - THM+ (no longer taught in Alabama)
    - Very limited distribution work

Distribution Optimization

- AWOP expanded in 2006 to include distribution systems
- Started DS-PBT in 2011 with Cullman Project
- Adopted distribution goals
- Developed ranking system to help prioritize systems
- Currently conducting 7th Series
- 8th series starting in next couple months



Distribution Goals

- Distribution DBPs
  - TTHM LRAA ≤ 70 ppb at all sites
  - HAA5 LRAA ≤ 50 ppb at all sites
  - TTHM Long Term Goal ≤ 60 ppb
  - HAA5 Long Term Goal ≤ 40 ppb
- WTP Effluent
  - TTHM RAA ≤ 20 ppb
  - HAA5 RAA ≤ 15 ppb
  - TOC RAA < 1.7 mg/L
  - Maintain CT
- Chlorine
  - 0.20 mg/L everywhere
- Storage Tanks
  - Turnover ≤ 4.0 days
  - Mixing ratio > 1.0
- Distribution pH
  - ± 0.3 pH units from WTP effluent or master meter pH
- Temperature
  - Consistent throughout distribution system (< 5° C)

Distribution Prioritization System

		TTHM LRAA				TTHM OEL				HAA5 LRAA				
System Name	SCORE	Apr-18	Jul-18	Oct-18	Jan-19	Apr-18	Jul-18	Oct-18	Jan-19	Apr-18	Jul-18	Oct-18	Jan-19	Apr-18
	12,531	0.098	0.100	0.110	0.103	0.116	0.114	0.111	0.091	0.057	0.051	0.055	0.055	0.056
	12,053		0.104	0.116	0.111	0.066	0.115	0.139	0.095		0.034	0.042	0.040	0.024
	9,808	0.064	0.083	0.098	0.096	0.062	0.096	0.122	0.088	0.032	0.038	0.047	0.045	0.032
	8,747	0.059	0.069	0.090	0.071	0.061	0.078	0.090	0.058	0.040	0.050	0.060	0.050	0.040
	8,403	0.095	0.090	0.082	0.063	0.097	0.081	0.082	0.038	0.013	0.012	0.012	0.009	0.015
	8,028	0.049		0.104	0.089		0.093	0.099	0.082	0.044		0.048	0.042	
	7,630	0.079	0.082	0.086	0.098	0.082	0.085	0.098		0.033	0.033	0.030	0.030	0.036
	7,168	0.080	0.074	0.077	0.069	0.066	0.082	0.081	0.061	0.054	0.045	0.045	0.046	0.044
	6,920	0.076	0.086	0.081	0.078	0.076	0.101	0.080	0.073	0.045	0.042	0.045	0.045	0.045
	6,812	0.066	0.068	0.077	0.072	0.069	0.077	0.083	0.058	0.054	0.052	0.055	0.057	0.050

	2nd QTR 2017	3rd QTR 2017	4th QTR 2017	1st QTR 2018	2nd QTR 2018	3rd QTR 2018	4th QTR 2018	1st QTR 2019
Systems Optimized	**182**	**181**	**183**	**188**	**187**	**175**	**177**	**184**
Met TTHM LRAA Goal	234	235	230	231	224	213	216	225
Met TTHM Long Term Goal	216	216	214	219	214	212	203	205
Met TTHM Short and Long Term Goals	214	215	211	214	208	198	200	204
Met HAA5 LRAA Goal	225	225	222	229	229	225	224	233
Met HAA5 Long Term Goal	197	200	198	199	200	200	199	201
Met HAA5 Short and Long Term Goals	195	197	195	196	197	191	191	199
Met Both Short Term Goals	219	221	214	220	218	207	207	221
Met Both Long Term Goals	188	190	189	194	193	190	185	189
Not Meeting Any Goals	2	2	3	3	5	3	5	2
Systems Tracked	243	243	243	243	243	241	240	240

Increased Compliance Achieved by:

- Being aware of problem
  - Quarterly status component (20 minutes to complete due to automation)
  - Prioritizes systems based upon DBP levels
- Taking a proactive approach at the State level
  - WTP Effluent Monitoring
  - Master Meter Monitoring
  - Joint OELs
  - Discussing performance and optimization during inspections (Annual and Sanitary)

Increased Compliance Achieved by:

- Educating Operators
  - Annual Surface Water Meeting
  - ARWA and AWPCA Annual Conference presentations
  - Other classes
  - Giving out spreadsheets
- **Performance Based Training**
  - **Targeting parent & consecutive systems**
  - **Teaches operators to diagnose problems**
  - **Teaches State staff to help with issues**

Summary

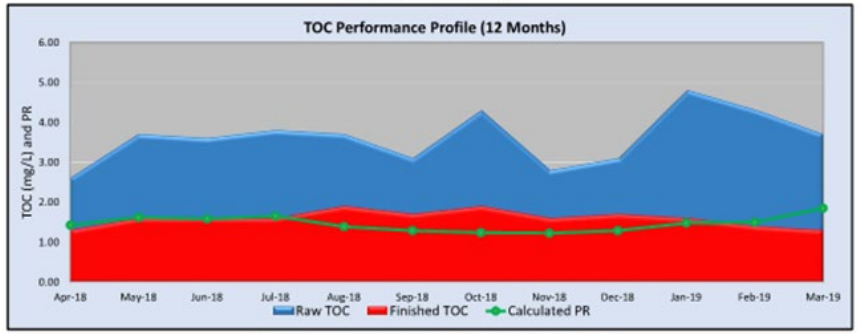
- Be a part of your EPA's Regional AWOP.
- Develop a way to track your water systems/water plants
- **Be proactive, not reactive**

Water System Information Here

TOC Results Past 12 Months

	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19	Feb-19	Mar-19
Raw Alkalinity	12	13	11	16	14	14	14	17	16	10	11	10
Raw TOC	2.60	3.70	3.60	3.80	3.70	3.10	4.30	2.80	3.10	4.80	4.30	3.70
Finished TOC	1.30	1.60	1.60	1.60	1.90	1.70	1.90	1.60	1.70	1.60	1.40	1.30
Removal Percentage	50%	57%	56%	58%	49%	45%	56%	43%	45%	67%	67%	65%
Required Removal	35%	35%	35%	35%	35%	35%	45%	35%	35%	45%	45%	35%
Calculated PR	1.43	1.62	1.59	1.65	1.39	1.29	1.24	1.22	1.29	1.48	1.50	1.85
Alternate PR	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Selected PR	1.43	1.62	1.59	1.65	1.39	1.29	1.24	1.22	1.29	1.48	1.50	1.85
Compliance PR	The Compliance PR must be greater than or equal to 1.00 or finished TOC average < 2.0 mg/L											1.46

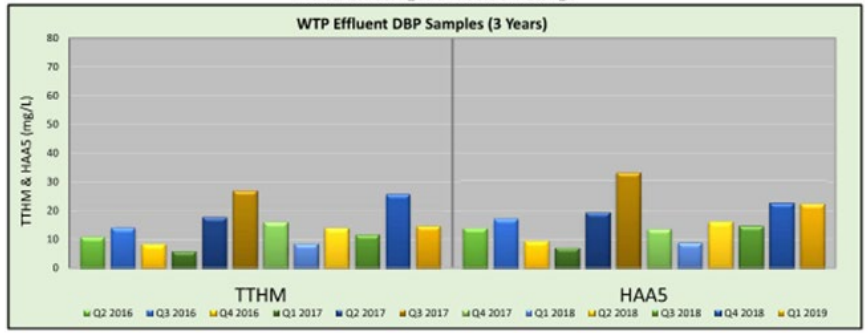
Finished TOC RAA Goal ≤ 1.7 mg/L



WTP Effluent Individual DBP Sample Results (Past 3 Years)

WTP Effluent	Q2 2016	Q3 2016	Q4 2016	Q1 2017	Q2 2017	Q3 2017	Q4 2017	Q1 2018	Q2 2018	Q3 2018	Q4 2018	Q1 2019
TTHM	11.0	14.1	8.6	6.2	17.7	26.6	16.0	8.7	14.0	11.8	25.4	14.7
HAA5	14.0	17.2	9.7	7.4	19.3	32.8	13.8	9.1	16.2	14.7	22.5	22.2

TTHM Goal LRRA ≤ 20 mg/L and HAA5 Goal LRAA ≤ 15 mg/L



Thank You!

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Reducing Disinfection Byproducts through Optimization

Webinar #4: Implementing DBP Control Strategies: Approach and Case Studies

May 13, 2019

Webinar #4: Learning Objectives

- Understand overall approach for the webinar series, including a brief review of information covered in the previous webinars
- Understand optimization-based DBP control strategies available to water systems and how they can be implemented.
  - Overview of controls strategies (Presentation 2).
  - Water System Case Studies (Presentations 3 and 4).

Question and Answer Session

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