Hydraulic Modeling Assisting in Water Quality

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WHO WE ARE

We are the largest and most geographically diverse publicly traded water and wastewater service provider in the United States.

✈️ We serve a broad national footprint and a strong local presence.

✈️ We provide services to approximately 15 million people in 46 states and Ontario, Canada.

✈️ We employ 6,900 dedicated and active employees and support ongoing community support and corporate responsibility.

✈️ We treat and deliver more than one billion gallons of water daily.
OUR SERVICE AREA

WE SERVE

• Approx. 2.4 million people in 36 counties (19% of the population)
• 658,000 water customers
• 65,000 wastewater customers

TRANSMISSION & STORAGE

• 11,054 miles of water and sewer pipe
• 256 water storage facilities
• 359 water and wastewater pumping stations
Uses of Hydraulic Modeling

• Capital Planning
• Design
• Assist Operation
• Assist Water Quality
  • Water age
  • Chlorine residual
  • Disinfection byproduct
  • Flushing (unidirectional flushing plan, flushing location)
  • Trace study (multiple sources)
Case 1 - Water Age Simulation

- Remote gradient with low demands and relatively large storage in tank and pipe
Case 1 - Water Age Simulation

- Tk 10-29 ft
- Minimize flushing

- 240 hrs
- 140 hrs
- 0.5 gpm
- 3 gpm

Color Coding Legend
Junction: WaterAge1 (hours)

- <= 80
- <= 120
- <= 200
- <= 300
- Other
Water Age – Will Tank Mixer Help?

• It depends on tank fluctuation
Water Age – How Short is Good

• It depends on the specific system and the purpose of using this term
• DBP, disinfectant residual, corrosion control, taste and odor
• Variables
  • Pipe condition (wall reaction), flow condition (bulk reaction)
  • Water characteristics: pH, temperature, NOM, inorganics, biostability, competitors
  • Type of disinfectant
  • Biological activities
Water Age – How Short is Good

• Water Age Management Solution Cycle

Managing Distribution Retention Time to Improve Water Quality—Phase I
Case 1 Summary

Reduce Water Age

• DO NOT over size
• Operate storage tanks in a good range
• Achieve mixing energy in tanks
• Flush effectively when needed
• Understand your system by monitoring water quality parameters and correlating results with water age
Case 2 – Trace Study and DBP Simulation

- Two Sources for the study zone
  - Purchase Water 1 – Surface Water with High DBP, minimal purchase, high flow
  - Purchase water 2 – Ground water with low DBP but limited flow of 260 gpm
- May 2017 – HAA OEL > 60 ug/L at Tank 1
- Compliance samples scheduled early July
Case 2 – Trace Study and DBP Simulation

• April 2017 Control
  • S1: ON T2 < 10.5 ft OFF T2 > 14 ft
  • T2 flow to T1: ON T1 < 30.5 ft OFF T1 > 32 ft
  • S2: ON T1 < 33.5 ft OFF T1 > 34.5 ft
  • Well blending controlled by the tank in another zone

• April 2017 Demand vs Supply
  • Customer Demand = 135 gpm
  • Well Blending = 215 gpm
  • S2 = 240 gpm S1= 110 gpm
  • S2/(S1+S2) ~ 70%

• Trace Study
  • 2-8% of S2 in Tank 1
Case 2 – Trace Study and DBP Simulation

- Proposed control should:
  - Max S2 & Min S1
  - Reduce water age of S1
  - Lower rechlorination dose
  - Max S2/S1 Ratio in T1, S2 to Tk1 instead of being consumed in system
  - T2 flow: ON T1 < 30.5 ft OFF T1 > 22 ft
  - S1: ON T2 < 310.5 ft OFF T2 > 414 ft
  - S2: ON T1 < 33.5 ft OFF T1 > 34.5 ft

- Well blending at max speed during Peak 8 hours and 4 hours at midnight
Case 2 – Trace Study and DBP Simulation

- Trace simulation: S2 60-70% in Tank #1
- HAA simulation: <40 ug/L in Tank #1
  - Assumptions: first order bulk reaction
  - Reaction rate estimated from testing results
  - Conservative HAA in S1
Case 2 Summary

• % of a source withdrawal \(\equiv\) % of the source in the tank
• Trace study to optimize operation (variables)
• DBP simulation = water age + user defined reaction formula + trace study
  • Challenges to define reaction and calibrate model
Challenges of Cl2 and DBP Modeling

• Too many factors that impact Cl2 decay and DBP reaction rate
  • Field testing → Reaction Rate
  • Rate changes constantly due to temperature, pH, pipe condition, constituents in water, mixing with other sources
  • Chloramines vs. Cl2
  • Nitrification?

• Purpose of WQ Modeling is to make better operational decisions, NOT to create a perfect model