

# Impacts of Bromide Concentration on Brominated THMs Formation in Southwestern Pennsylvania

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Presented by:

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# Background

- Usage of chlorine to annihilate pathogens give rise to disinfection byproducts
- Chlorine reacts with natural organic matter (NOM) in water and forms Trihalomethanes (THMs)
- Bromide, if is present, gets oxidized by chlorine to hypobromous acid which forms brominated THM

# Disinfectants and Disinfection By –products Rule (USEPA):

Regulated Contaminants	MCLG (mg/L)	MCL (mg/L)
Total Trihalomethanes (TTHM)		0.080 LRAA
Chloroform	0.07	
Bromodichloromethane	zero	
Dibromochloromethane	0.06	
Bromoform	zero	

# Objective

- Identify THM precursors in source water of treatment plant at southwestern Pennsylvania.
- Assess relationship between factors contributing to THM and Brominated THM formation.
- Outreach water authority and exchange knowledge on THM reduction implications.

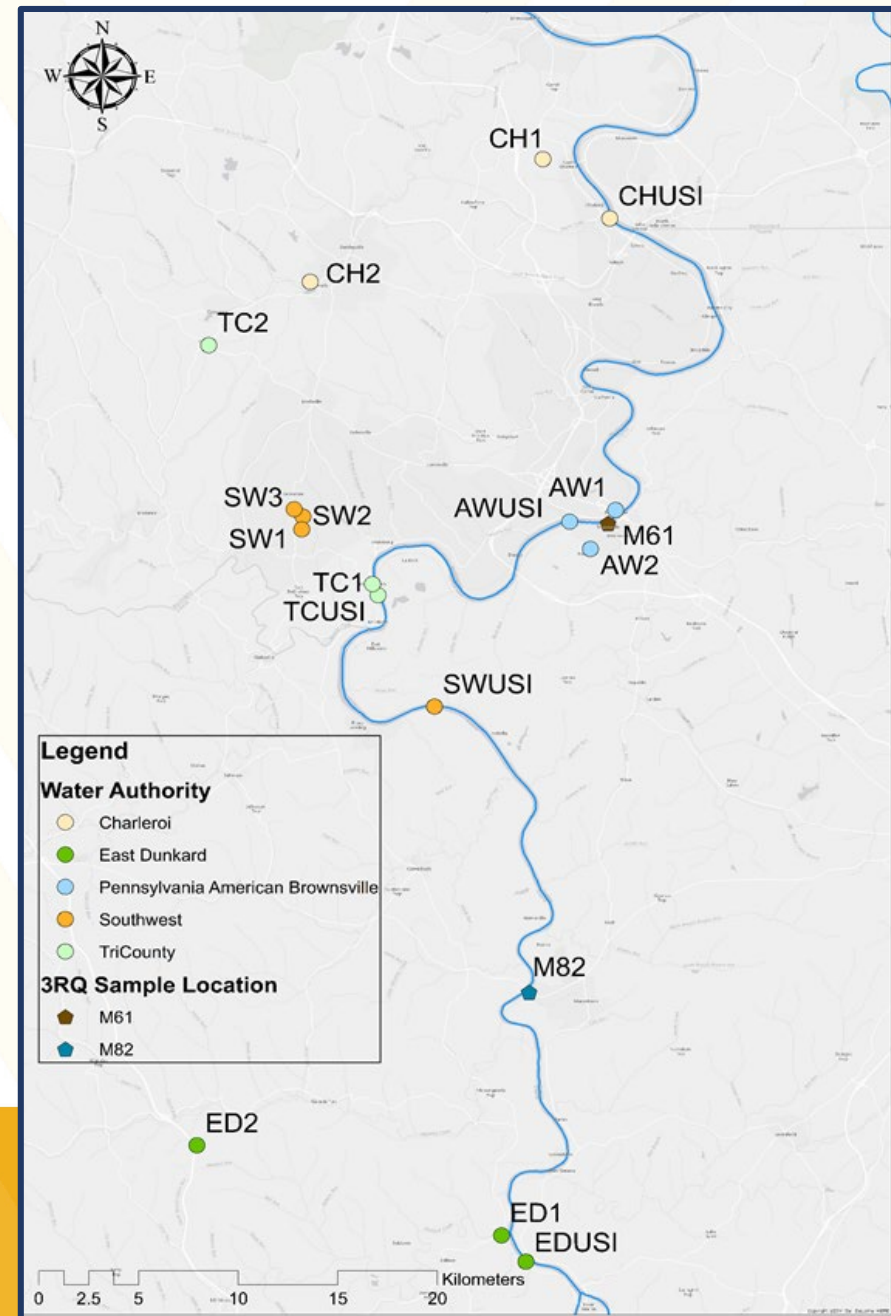
# Sampling locations

## Five Water Authority:

- Charleroi Water Authority
- East Dunkard Water Authority
- PA American Brownsville Water Authority
- Southwest Water Authority
- Tri-County Water Authority

And

11 locations within distribution network



# Factors influencing THM formation (Singer, 1994):

- pH
- Temperature and Season
- Nature and Concentration of NOM
- Chlorine dose and residual
- Contact time
- Bromide concentration

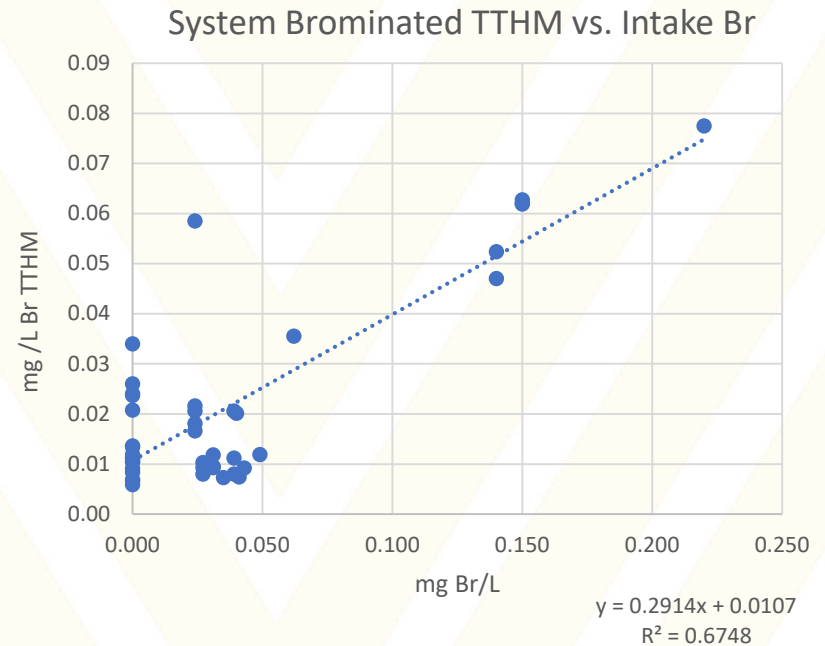
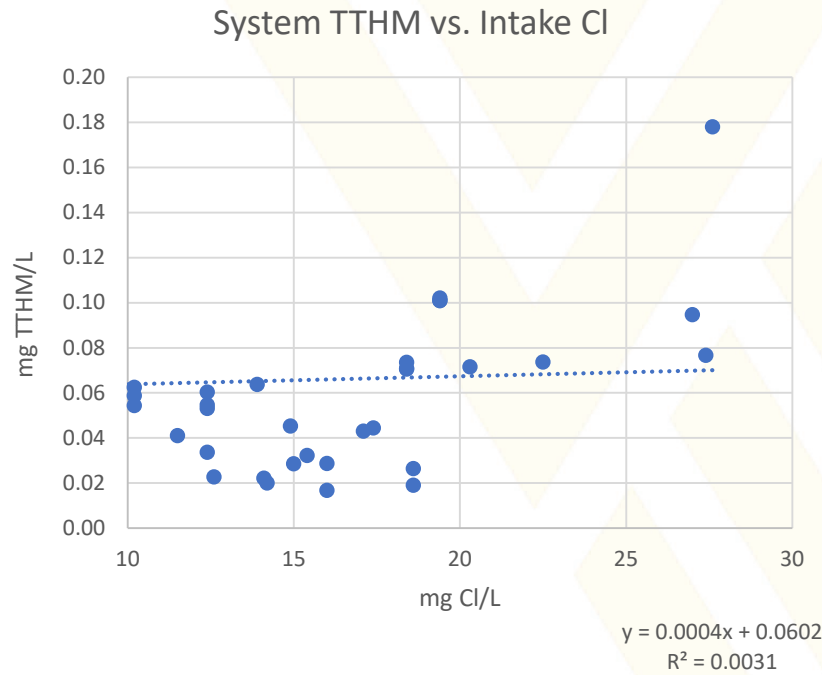
- THM is unfavored at acidic condition.
- **Reduction in pH** reduces THM formation (Stevens et al., 1976; Chowdhury and Champagne, 2008).
- THMs during the summer time are **higher** (Golfinopoulos et al., 1998; Golfinopoulos and Arhonditsis, 2002; Elshorbagy et al.,2000).
- **Higher chlorine dose** are added in summer.

- **NOM** is prime precursor for THM (Singer, 1994).
- Hydrophobic and hydrophilic fractions of NOM determine the composition.(Chowdhury *et al.*, 2009)
- **Extended reaction time** increase levels of THMs (Kim *et al.*, 2002)
- HOBr is more **reactive** ( $\approx 20$  times) than HOCl. (Uyak and Toroz, 2007)

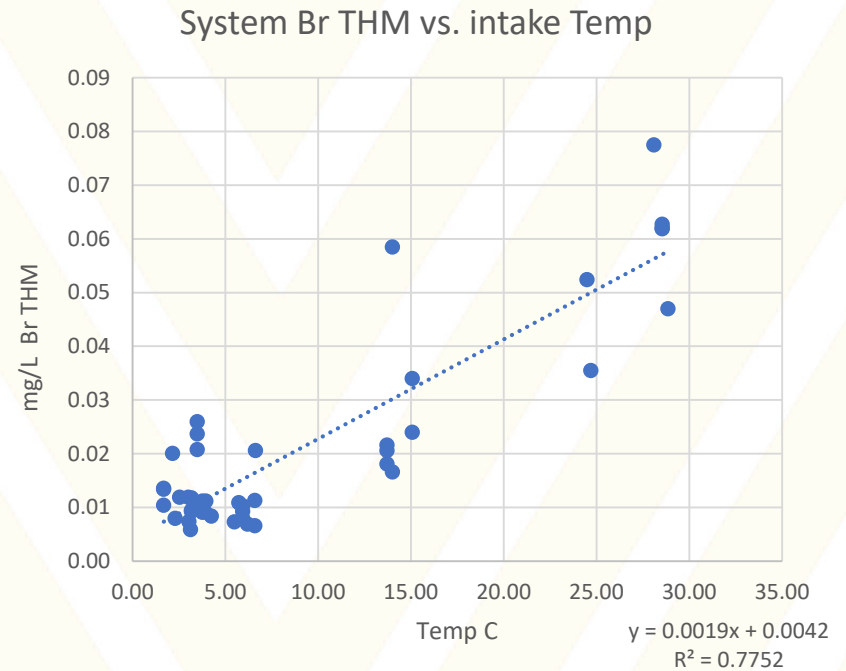
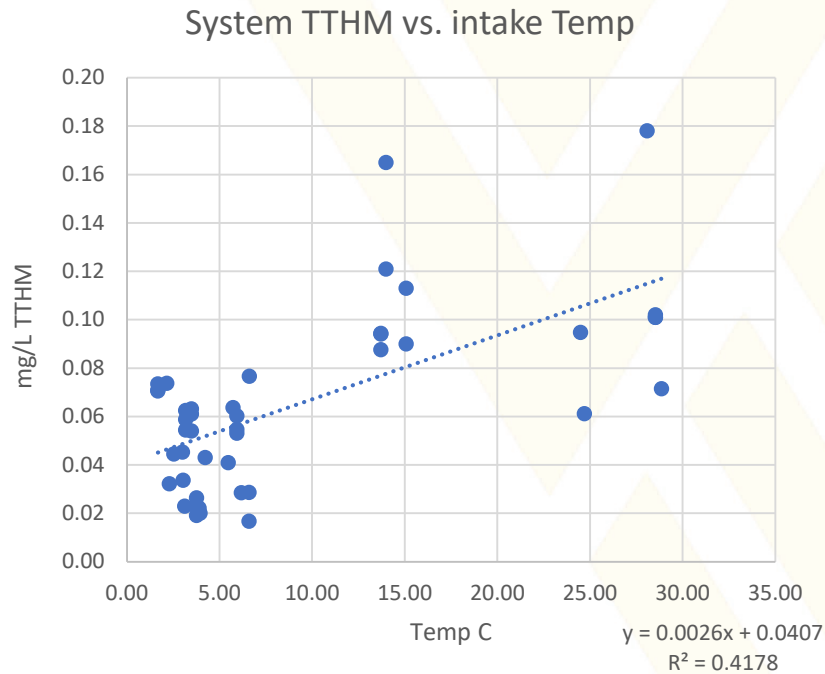


# Findings To-date

# Brominated TTHM positively correlated with the intake Bromine concentration.

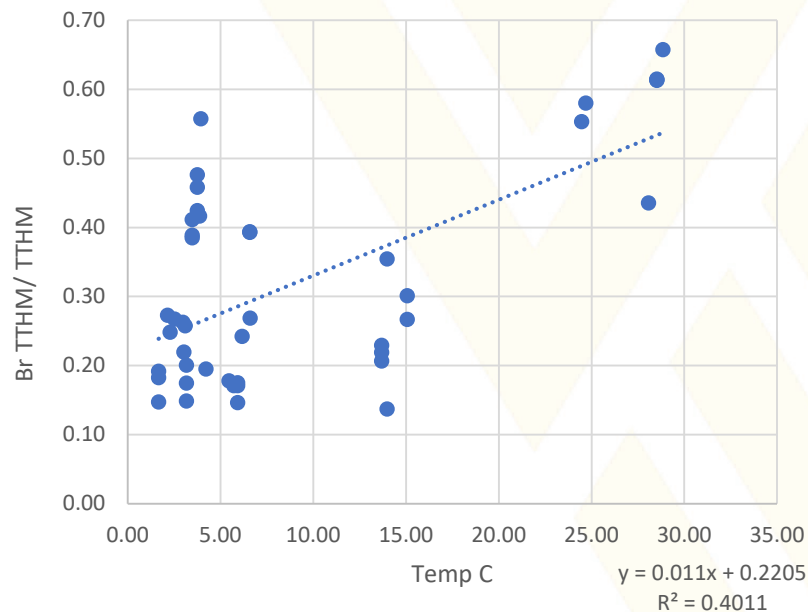


Both TTHM and Brominated TTHM correlated positively with intake temperature.

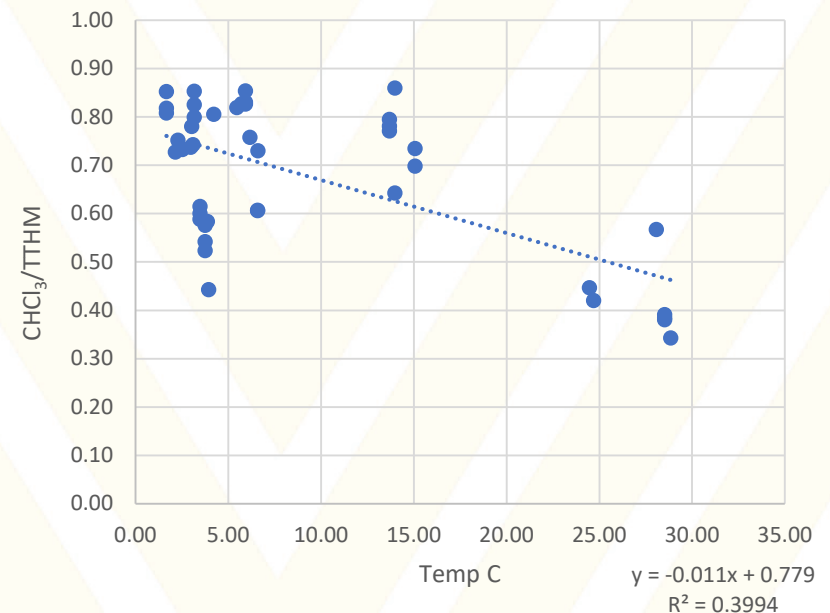


Temperature increases proportion of Brominated THM while the chloroform proportion decreases.

System Br TTHM/TTHM vs. intake Temp

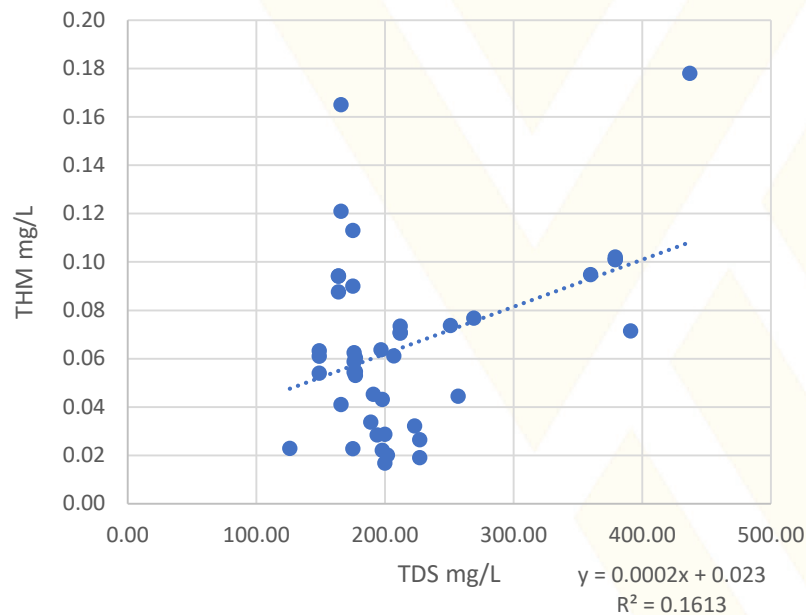


System CHCl<sub>3</sub>/TTHM vs. intake Temp

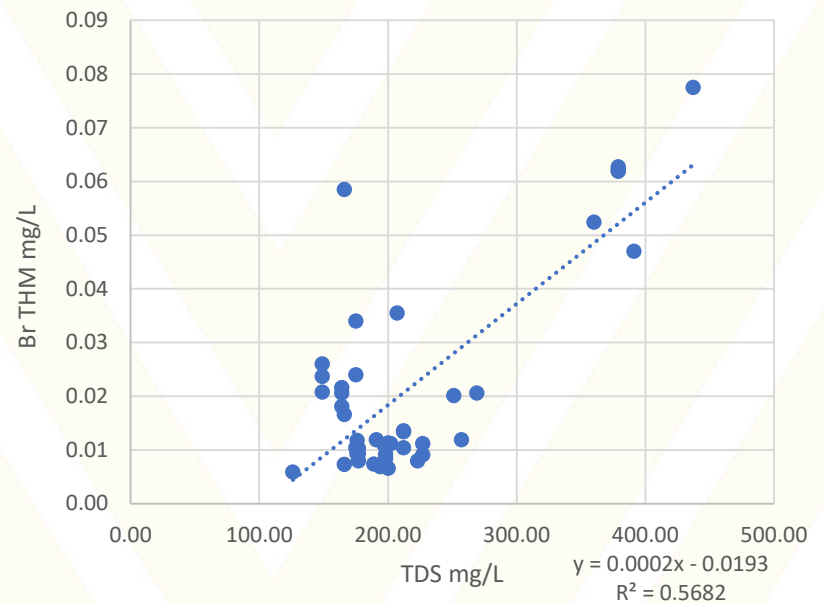


Brominated TTHM showed a positive correlation with TDS in intake water.

System TTHM vs. Intake TDS



System Br TTHM vs. Intake TDS



# Charleroi Water Authority



# Observations

- Less River flow more TDS
- Log removal rate (LRV) of membrane filter (MF) negatively related with temperature
- Temperature increases pressure in MF and permeability drops
- Violation of TTHM violation at far end of supply

- During autumn ( low flow condition), diluting the water by flushing.
- In the extremities with higher contact time, introduction of intermediate pumping stations.
- Bromide increases brominated THM by 60%. Being carcinogenic than chloroform, bromide in source water needs attention.



Thank You.

Any Questions?