WEST VIRGINIA
WATER RESEARCH INSTITUTE

Targeted Study

Monongahela: Trihalomethane (THM)

Project Description :

Trihalomethanes, a family of halogenated disinfection byproducts is ubiquitously present in finished drinking water. This is a great concern for the public health since daily intake of those compounds can create toxicity and cancer in humans. According to USEPA's Disinfectants/Disinfection Byproducts Rule (D/DBPR), the regulatory standard of the total Trihalomethanes (TTHMs) is 80 µg/L, and water treatment plant operators are required to closely monitor TTHMs in the finished water on quarterly basis.

Although the relationship between intake bromide levels and TTHM in finished water is not clear, high bromide levels at the water authority's intake increase the risk of exceeding TTHM limits. Our 3RQ data have shown increasing bromide levels in the Monongahela River downstream of Masontown PA, reaching maximum levels at Brownsville and decreasing slightly downstream of the Youghiogheny River.

3RQ 2016 Study :

In 2016, WRI began studying THMs in Charleroi PA and has continued using cost-share Colcom funds for a United States Geological Survey (USGS) 104b project.

Sampling took place at the following locations: Charleroi, East Dunkard, PA American Brownsville, Southwest and TriCounty, along with 3RQ monitoring stations M61 and M82 (Figure 1). Samples were collected over a four week period during February 2016. Permission to sample at the schools prior to February was not possible due to school closures.

The February sampling did not find any exceedances for TTHM at any of the sample locations over the four week study period (Figure 2). In addition to TTHM, we also analyzed for bromide. Concentrations were low at all stations (non-detect shown as 1⁄2 the minimum detection limit (e.g. 0.010 mg/l)). Our data showed no correlation between either bromide or chloride levels at the River intakes and total THM.

In both the November and February samples, about 90% of the total THMs were either purely or dominantly chlorinated forms. This suggests that chlorination alone might be the dominant factor in raising THM levels during low River flow periods.

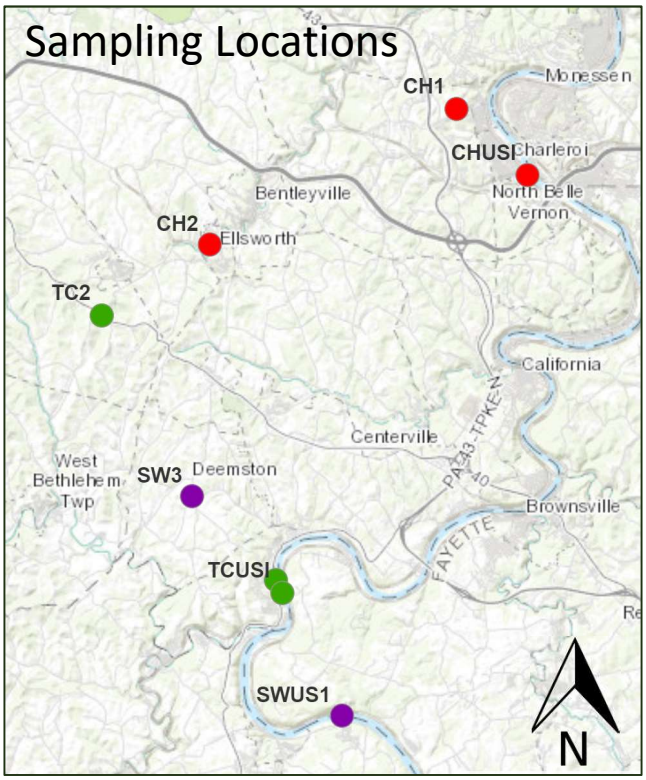

Figure 1. Map of southwestern Pennsylvania showing the sites for sample location

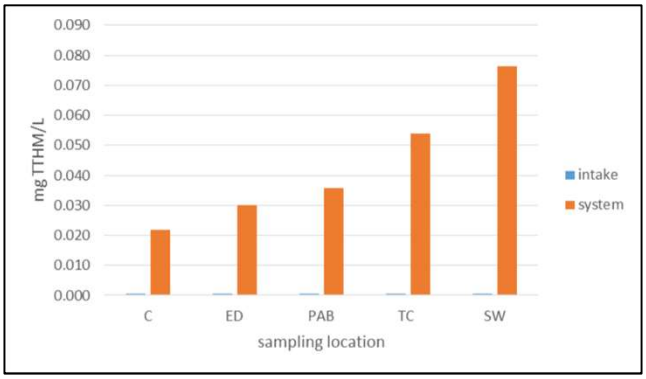

Figure 2. TTHM concentrations at sampling locations in the Charleroi (C), East Dunkard (ED), PA American Brownsville (PAB), Tri County (TC) and Southwest (SW) systems (upstream of the intake and within the distribution system).

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Project Extension USGS :

The USGS provided 3RQ with additional funding to continue sampling at this targeted study. Samples were taken September 2018 till May 2019 in Southwestern Pennsylvania. Samples were taken at the same locations from the 2016 study.

In addition to the water samples, treatment related data was collected from the Borough of Charleroi Water Authority. This data included the daily chlorine dose added for the water treatment, quarterly organic carbon test in raw water, and quarterly THM check according to Disinfectants/Disinfection Byproducts Rule (D/DBPR) in the finished water. Additional analyses were conducted to investigate the controlling factors and remedies for TTHM formation in this water authority.

The objectives of this study are to

1) Develop a statistical model for predicting TTHM levels using source water quality data,
2) Examine the effects of water treatment and distribution on TTHMs formation.

Findings from 2018 Study :

1) TOC concentration in the intake water positively correlated with the TTHM formed in the finished water of distribution system. The correlation improved when plotted for individual treatment facility indicating that THM formation potential varies with the treatment practices of the individual facility.

2) The concentration of TOC was higher during the months of September and May when the temperature was also higher than other months. There was slight increase in TOC …with increase in temperature during March and April, but the TOC levels were still lower than the level in September. As a result, TTHM levels were found to be highest in each distribution point and reached above 80 µg/L.

3) Our sampling showed that the bromide levels in the intake water were mostly below the reporting limit (0.01 mg/L). Thus, among the trihalomethanes, chloroform was the most dominant species in all the finished water samples.

Results :

There was a positive correlation of TTHM formation with the intake water total organic carbon (TOC) levels. Chloroform was the most dominant species in all the finished water samples, which can be seen in the figure below.

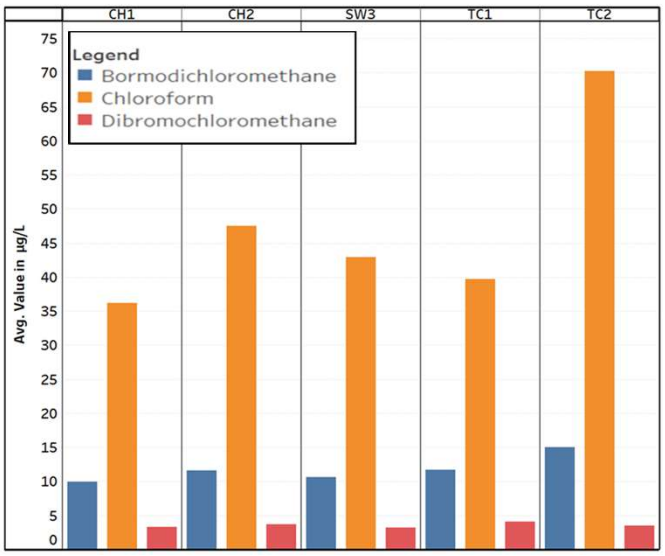

Figure 3. Distribution of trihalomethane species in the finished water samples.

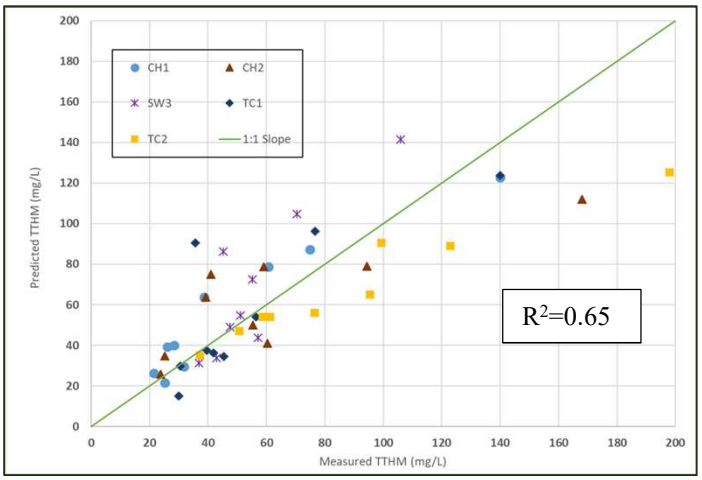

Figure 4. Comparison of measured TTHM vs the predicted TTHM Concentration from the model

Based on the model the TTHM can be calculated from the following equation:

TTHM (µg/L): -2.95*chloride (mg/L) +16.15*TOC (mg/L) +4.65*Temp (in C) -10.52

The analysis showed that the developed model tends to under-estimate the TTHM concentration when TTHM concentration are above 100 µg/L. The inclusion of actual chlorine dose (other than chloride) and retention time may yield a better model to predict the TTHM in the finished water.