Showcase

Title: **Online THM Analyzer Helps Utility Optimize Operation and Validate Laboratory Results**

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Challenge: (multiple options possible):

- ☐ minimise water loss
- ☐ protect water resources
- ☒ boost treatment efficiency/effectivity (process control & optimisation)
- ☐ recycle water (reuse; recovery of resources)
- ☐ combat climate change
- ☐ value water (awareness raising; participatory monitoring)
- ☐ attract talent (counter effects of an aging work force)
- ☐ other: ….

Location: The Brunswick & Topsham Water District (BTWD) in Maine, United States

Date: November 2019

Introduction & background information

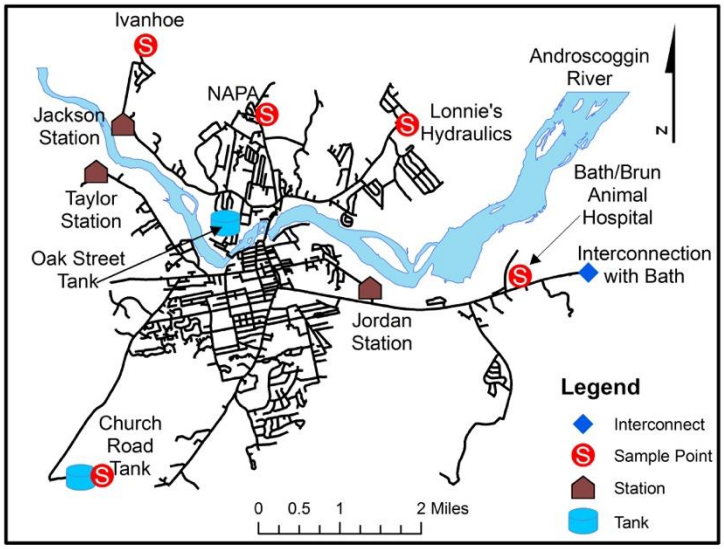
Serving the communities of Brunswick and Topsham in Maine since 1903, the Brunswick & Topsham Water District (BTWD) operates three facilities — Jackson Station, Taylor Station and Jordan Station — to meet the needs of approximately 30,000 residents. All three facilities treat groundwater, but each station has a different treatment technology to treat the source water.

In May 2016, BTWD installed an online THM analyser to help monitor trihalomethanes (THMs) due to concerns over decreasing demands and increasing THM annual running averages in its distribution system.

From 2016 through 2017, the district conducted two years of daily online samples from the primary treatment facility — Jackson Station, a 3.5 million gallon per day intermittently regenerated greensand treatment facility — and weekly grab samples from representative points in the distribution system. The study provided insightful data of the district's operational changes and its effect on THM mitigation. The use of an online THM analyser proved to be a valuable tool enabling the district to optimize operations, better understand treatment processes, resolve THM compliance concerns, and validate laboratory performance and results.

Water quality challenge

BTWD manages close to 120 miles of water mains. One-third of the system is north of the Androscoggin River in Topsham and two-thirds is south of the river in Brunswick.



Water demand is distributed evenly across the system and BTWD maintains two river crossings between the communities. Because Jackson Station accounts for more than 50% of the district's production, water typically flows from the Oak Street Tank to Topsham and limited portions of Brunswick.

In 2015 into 2016, BTWD experienced a THM event threatening regulatory exceedance of total trihalomethanes (TTHM) levels in the State 2 Disinfectants and Disinfection Byproducts Rule (Stage 2 DBPR) at the Jackson Station. While the event was ultimately identified as a laboratory analysis error, in response to the event and before the cause of the exceedance was identified, the district began conducting weekly grab sampling at four distribution sites (Ivanhoe, NAPA Auto Parts, Lonnie's Hydraulics and Church Road Tank) to monitor THM levels from May 2016 through December 2017.

Daily online samples also were taken at the treatment facility and provided several daily snapshots of THM levels entering the distribution system. BTWD installed an online THM analyser, the THM-100™ manufactured by Aqua Metrology Systems, at the Jackson Station facility in May 2016 to assist with the ongoing investigation.

Approach and implementation

The THM-100 is an automated system using a "purge-and-trap" method for TTHM extraction of the sample, followed by desorption into a chemical mixture that generates a coloured product and time-resolved spectrophotometric analysis for detection and determination THM levels. In addition to the online samples, manually collected grab samples from other locations in the network were collected and analysed alongside samples taken automatically by the monitor in its online mode. This allowed for both analysis at Jackson Station and throughout the distribution system.

Costs and maintenance

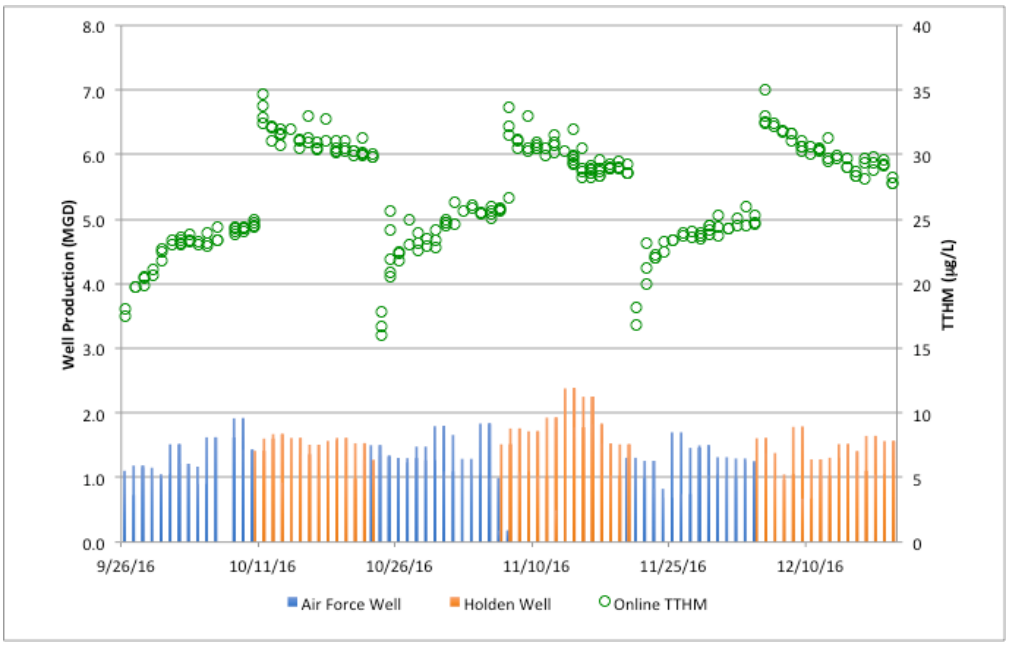
For an online THM analyser to maintain its long-term ability to provide accurate measurements and results, a built-in automatic self-calibration method is a necessity. In the case of the THM-100 using three reagents and two on-board standards, the system runs a daily validation and can be configured to run a full calibration more frequently than once a week if required. Onboard reagents and THM calibration standards compensate for variations in the colorimetric reaction, ambient temperature

fluctuations and aging of the trap. Automated calibrations coupled with quarterly maintenance and servicing, result in minimal instrument drift over extended periods. Software continually monitors the performance of internal run-time parameters and alerts the user to the need for more frequent calibration if needed.

On average, the THM-100 analysed six online samples daily and five grab samples per week. The THM data was provided at a fraction of the cost and time compared to traditional methods, the THM-100 analyser ranged from $7-14 per sample and provided results in 90 minutes. Traditional laboratory analysis can take 1-2 weeks to complete, when not expedited.

Data handling

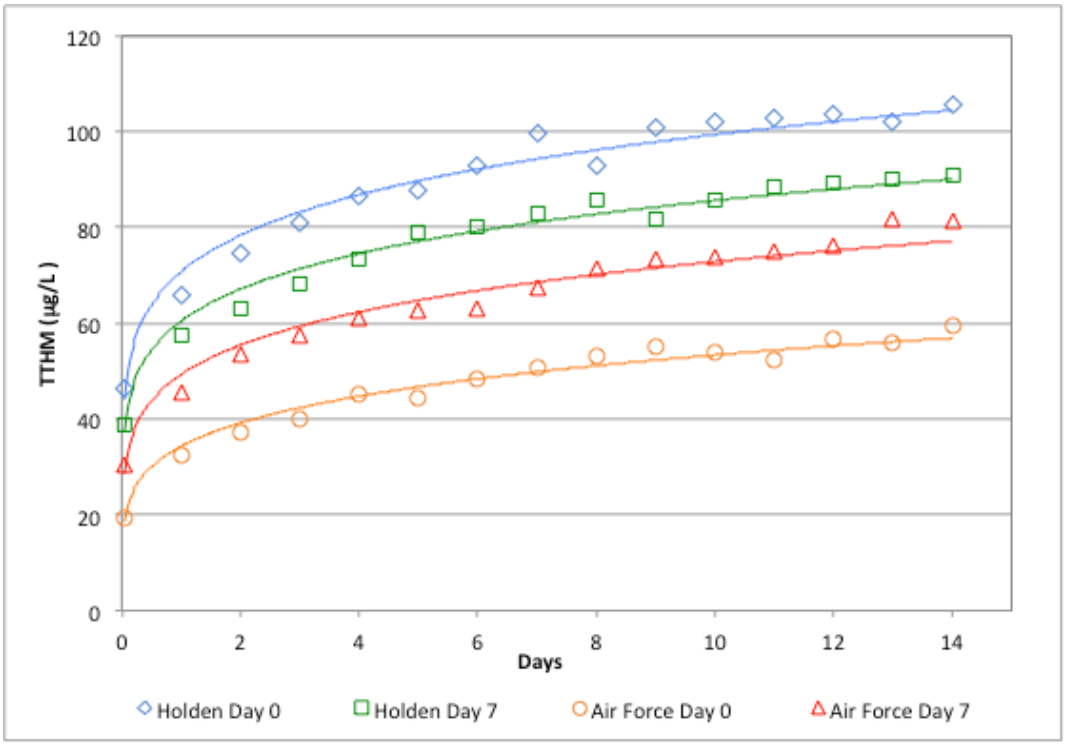
BTWD reviewed data points collected when the treatment plant was in operation. This data was then overlaid with well pumping data from the Air Force and Holden wells, which supply Jackson Station and are swapped on a biweekly basis.



The data clearly depicted that the biweekly well switch had a significant impact on THM levels leaving the facility.

The wells are in a semi-confined aquifer and the recharge mechanisms for the confined portions are slower and likely correlate to older groundwater, where the younger groundwater is likely recharged by surface waters.

Using the online THM analyser, BTWD created THM system distribution simulation (THM-SDS) curves using production water. The THM-SDS curves were produced for each well source at day zero and day seven after the biweekly well change.



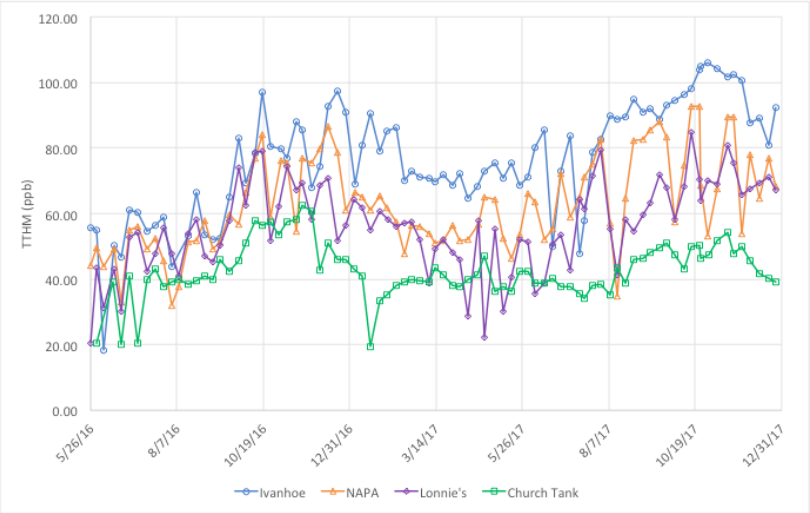
These results helped build the idea that the Air Force and Holden wells influence each other by shifting the zones of influence and subsequently the zones of contribution.

This data aided the District to develop a groundwater model that had contributions from a region that was rich in water susceptible to forming THMs and contributions from another portion of the aquifer that supplied water with a smaller capacity to form THMs.

Based on the collection of data it is theorised that the wells influence each other in the following manner. When the Air Force (AF) well is running water forming more THMs and is pulled by the Holden (Ho) well, the zones of contribution in the aquifer seek to reach equilibrium around the Air Force well. When the wells are swapped all of the water around the Holden well is high in water that forms THMs until the zones of contribution can re-establish equalisation around the Holden Well. This creates water from the Holden well that markedly decreases in THM formation. When the time comes to swap back to the Air Force well, the water around the Air Force well is low in precursors and the THMs formed from the water withdrawn from the well and will continue to rise until the equilibrium is re-established around the Air Force well. This process repeats for each well swap.

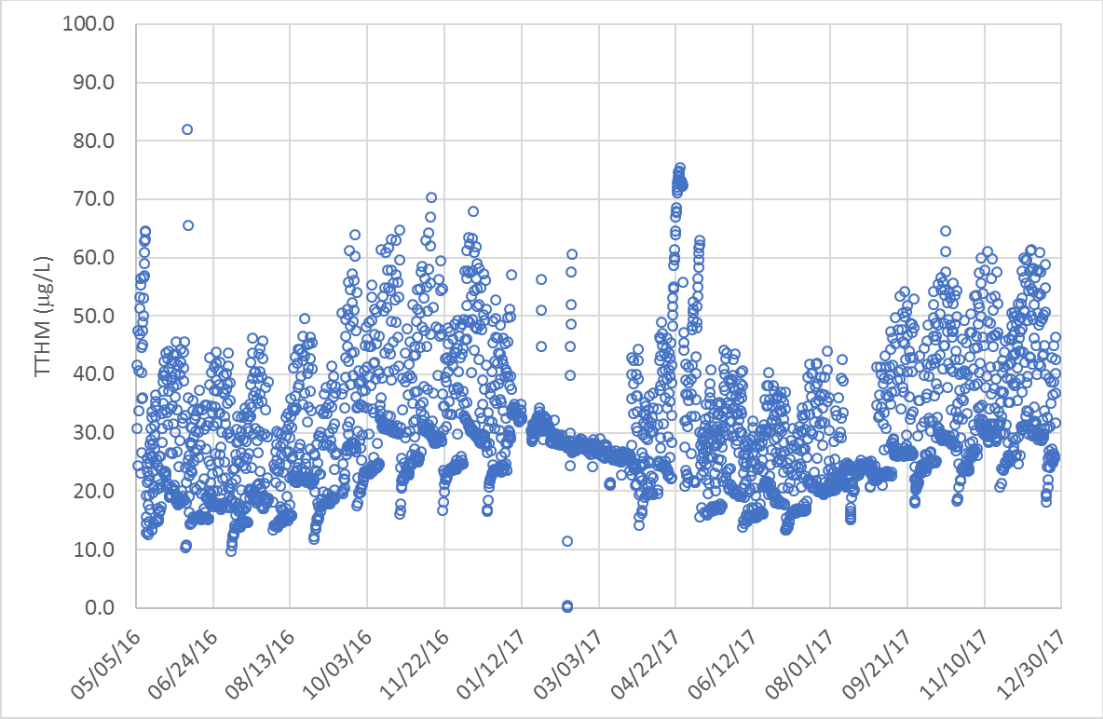
Showcase

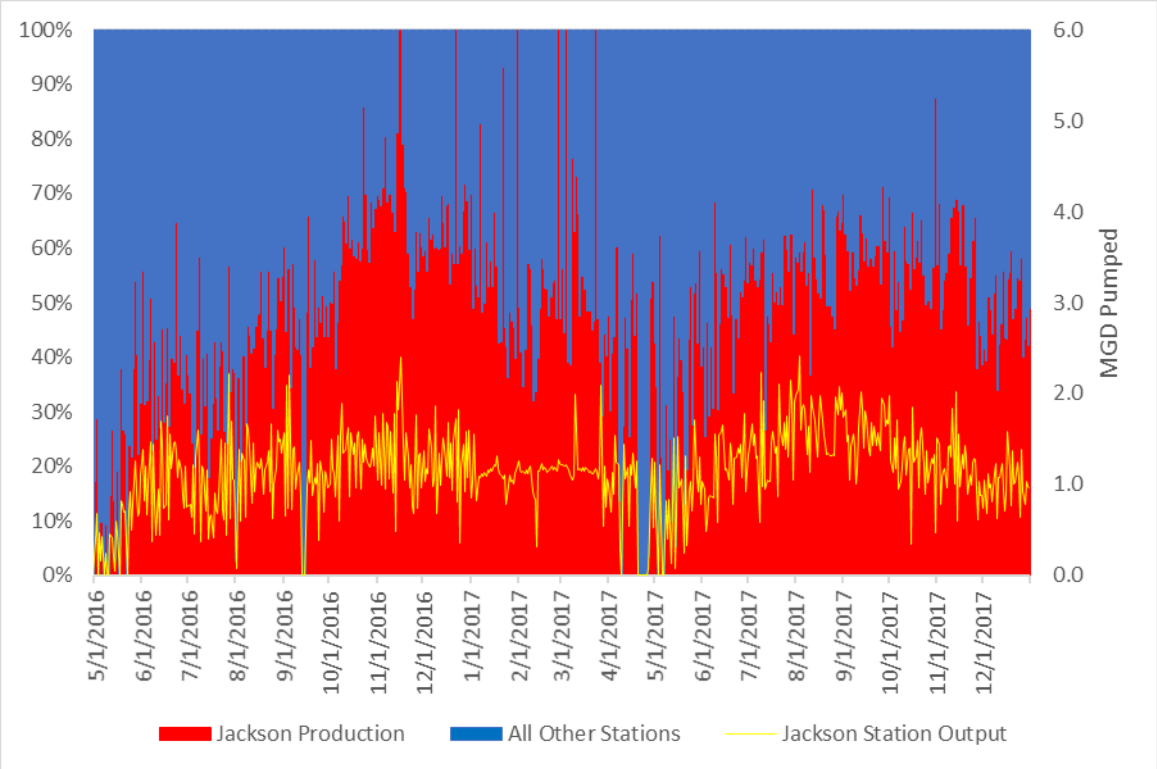
In early 2017, BTWD undertook a six-month pilot project to investigate new treatment techniques for the supplies at Jackson Station. The district ran the Holden well for two months, 24 hours a day. The online THM data from online and grab samples collected during this period (January and March 2017), indicated far more stable THM formation relative to the biweekly swapping of wells.



Evaluation of successes and limitations

BTWD collected weekly distribution THM's from 26 May 2016 through 26 December 2017 totalling 85 sample dates. The THM-100 online analyser also collected another 3,400 samples during this time. Of BTWD's three treatment facilities, Jackson Station is documented to have 2-3 times the formation of the two other stations in the system. Subsequently, it is expected that as the ratio of plant production goes up from Jackson Station there will be a greater impact on THMs in the Topsham and throughout the system.





During the period between 21 January 2017 to 22 March 2017 the District observed relatively stable THM levels from online and grab samples collected. This is comparable to distribution data collected from other facilities that run their treatment facility full-time. Treatment facilities operating in a continuous mode are in a better position to identify and correlate the small alterations that lead to variation in distribution TTHM. Nevertheless BTWD was able to make some operational decisions based on the data being collected in the field.

In 2016, BTWD was able to loosely correlate multiple operational events to the weekly distribution THMs. The water quality experienced in the Distribution system appeared to loosely mirror some of these events. The weekly data suggests there are events in the distribution system impacting delivered TTHMs. When this data is combined with the production ratio data and the trending data leaving the facility a clearer picture begins to emerge.

The wells supplying Jackson Station are in a semi-confined aquifer. The recharge mechanisms for the confined portions are slower and likely correlate to older groundwater. Where the younger groundwater is likely recharged by surface waters, the fluctuations of water withdrawn to match system demands becomes even more of an influence. This is observed in the online THM-100 analyser data showing late summer and fall as periods of higher initial THMs leaving the Jackson Station, whether the source is the Holden or Air Force well.

Lessons learnt

Until the online THM analyser was installed, the data available were insufficient and the district was unaware of the significant fluctuations in THMs leaving Jackson Station. In this instance, the source of

the fluctuation appeared to be the movement of the zone of contribution between the two production wells, which resulted in initial periods of high or low TTHMs.

While BTWD's research into the effects of well swapping and the creation of the THM-SDS curves left the district with a healthy questioning of what it can forecast within the distribution system, especially given the intermittent operation of the Jackson Station treatment facility; nevertheless, BTWD was able to make some operational decisions based on the data collected in the field.

The district learned a significant amount of information from the samples processed by the online THM-100 analyser. The data collected over the two-year THM monitoring study with the use of the THM analyser not only revealed a laboratory analysis error, but it helped BTWD study and better understand supply and distribution management impacts on THMs, evaluate its analytical results and build the district's confidence in the data collected. It also helped address the BTWD's THM compliance concerns and optimize operations.