Air Force SBIR/STTR

# Innovation

Air Force SBIR/STTR Innovation Story

**SBIR Topic Number:**
AF073-139

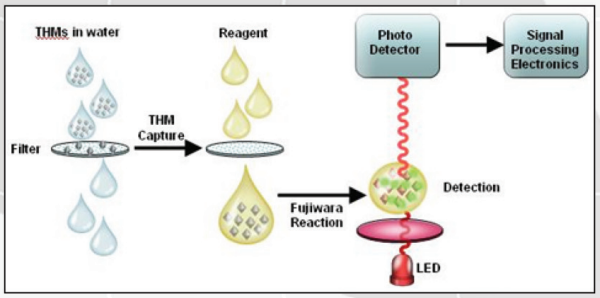
**SBIR Title:**
Field Sensor for Measuring Total Trihalomethanes Concentrations in Drinking Water

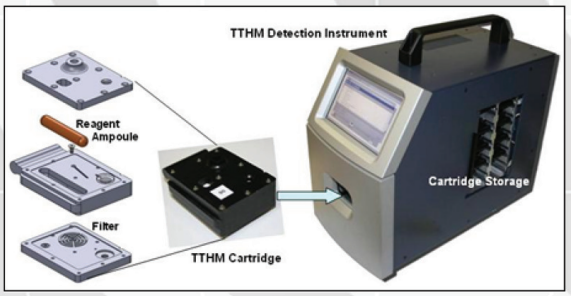
**Contract Number:**
FA9302-09-C-0019

**SBIR Company Name:**
Agave BioSystems, Inc., Ithaca, NY

**Technical Project Office:**
Air Force Flight Test Center, Edwards AFB, CA

This Air Force SBIR/STTR Innovation Story is an example of Air Force supported SBIR/STTR technology that met topic requirements and has outstanding potential for Air Force and DoD.




**Left – Figure 1. Trihalomethanes (THMs – represented by ♦) are filtered from water samples. Upon extraction with the Agave reagent, they undergo a modified Fujiwara reaction and yield a unique spectral signal detectable by the Agave BioSystems TTHM Detection Instrument. Right – Figure 2. Agave BioSystems designed the system to allow all reaction fluids to be maintained within a sophisticated cartridge. The instrument performs the complex fluid control necessary to conduct the assay in an automated fashion. Operation is, therefore, simplified such that the operator only needs to insert a cartridge and connect the water supply to be tested to the instrument. The instrument automatically filters 1 L of water, then performs the assay and displays results.**

## Water Contamination Detection System Integrated into a Portable Field Instrument

- High trihalomethanes (THM) concentrations are associated with a number of health threats, including toxicological, carcinogenic, and mutagenic effects
- Agave BioSystems has developed a colorimetric total trihalomethanes (TTHM) detection system, using a modified Fujiwara reaction, which has been successfully integrated into a portable field instrument
- This assay system elutes THMs filtered from a water sample and, through application of the modified Fujiwara reaction, yields a detectable spectral output that correlates directly to the TTHM levels of the water sample
- The Agave BioSystems TTHM Detection system is highly marketable; the sensor has applications at numerous Department of Defense sites and at over 6,200 various public or private drinking water distribution systems nationwide, which disinfect potable water and monitor TTHM concentrations

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## Air Force Requirement

Trihalomethanes (THM) are the byproducts of drinking water disinfection formed as a result of interaction between chlorine and bromine disinfectants and organic compounds present in the treated water. High THM concentrations are associated with a number of health threats, including toxicological, carcinogenic, and mutagenic effects.

The THMs of greatest interest include chloroform, bromodichloromethane, dibromochloromethane, and bromoform. Rapid detection of the total trihalomethanes (TTHM) in treated drinking water is essential for compliance with the Environmental Protection Agency's (EPA) Stage 2 Disinfectants and Disinfection Byproducts (DBP) Rule, which limits the maximum contaminant level of TTHM in drinking water to 80 parts per billion. The current detection method for TTHM determination involves sending samples to EPA-certified laboratories for gas chromatography analysis, a method that is both expensive and time consuming. The ideal TTHM water monitoring system would be a portable, rapid response device that would detect TTHM levels and aid in the identification of contamination sites before they develop into larger problems.

## SBIR Technology

Agave BioSystems has developed a colorimetric TTHM detection system, using a modified Fujiwara reaction, which has been successfully integrated into a portable field instrument. This assay system elutes THMs filtered from a water sample and, through application of the modified Fujiwara reaction, yields a detectable spectral output that correlates directly to the TTHM levels of the water sample (Figure 1). A variety of reaction conditions and parameters were evaluated, including the use of various reagents and solvents, to optimize accuracy and sensitivity.

After successful development of this assay, it was integrated into a highly sophisticated portable detection instrument capable of sensitive, quantitative evaluation of TTHM concentrations in water (Figure 2).

## Potential Application

The Agave BioSystems TTHM Detection system is highly marketable as an easy to use and fast alternative to EPA methods 502.2 and 551.1. The sensor has applications at numerous Department of Defense sites and at over 6,200 various public or private drinking water distribution systems nationwide, which disinfect potable water and monitor TTHM concentrations. Due to rapid detection, the device will provide a means to test locations more frequently, enabling water service workers to work proactively to lower TTHM spikes before they pose a heath concern. The ease of use of the device will also save water distribution facilities the cost of lab testing fees and training dollars.

TTHM has repeatedly been linked to increased rates of bladder and colorectal cancers, and several studies link TTHM to heart, liver, and central nervous system damage. The EPA estimates that lowering TTHM levels in as few as 1,200 small drinking water systems could prevent up to 20 cases of bladder cancer per year, resulting in economic benefits of up to $110 million per year. One of the most studied and documented health risks associated with TTHM is the increased rate of miscarriage and congenital birth defects in areas with high TTHM levels. A cost-effective and easy- to-use field portable sensor, such as the one proposed by Agave BioSystems, would enable drinking water delivery systems of any size to effectively monitor the levels of TTHM in their water supply on a more frequent basis. This would allow proactive treating of TTHM levels before they are a health threat, possibly saving treatment facilities and the government billions of dollars in healthcare costs and lawsuits.

Prototype construction was recently completed and the instrument was delivered to Edwards Air Force Base where further testing and validation will proceed.

## Company Impact

"This SBIR contract has allowed Agave BioSystems to advance its water monitoring technology capabilities and opens a significant market opportunity," states Noe Salazar, company president. "In 2010, a spin-off company was formed to commercialize water monitoring technologies developed by Agave BioSystems. This technology will be an important addition to that company product line. The platform that has been developed can be adapted to a variety of settings where monitoring of TTHMs is important."

"The technology advancement resulting from this SBIR contract has also provided a significant measure of experience and expertise in device development both for optical systems, fluid control systems, and chemical detection assays. This will enhance our ability to obtain future R&D contracts in these fields."

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