



**Amanda Costello**

MSCE Thesis Defense

## **Evaluation of Process Changes on Finished Water Quality for Gift of Water System**

Gift of Water (GOW, est. 1995) is an Indiana-based nonprofit organization dedicated to providing clean drinking water for communities in Haiti. Their system involves prechlorination, followed by a string filter, granular activated carbon (GAC), and then post-chlorination. The initial design of the GOW system included a polypropylene string filter with a nominal pore size opening of 5  $\mu\text{m}$ , which has been changed to one with a nominal pore size opening of 1  $\mu\text{m}$ . Experiments were conducted to compare the original system with the modified system and to quantify the effectiveness of the systems to produce clean drinking water, including measurements of volumetric flow rate, *E. coli* removal efficiency, turbidity, free, total and combined residual chlorine concentrations, volatile disinfection byproducts (DBPs), and UV absorbance at 254 nm. The clogging rates for the 1  $\mu\text{m}$  and the 5  $\mu\text{m}$  filters were measured to quantify the sustainability of the two filter types. Inactivation assays for human viruses were also performed on the GOW system with a pure and a natural water source. Finally, source water quality data, including turbidity and viable *E. coli* concentrations, from communities where GOW systems are used were collected during a trip to Haiti.

Little difference was noted in the volumetric flow rates between the two string filters throughout the course of the experiment. Bacterial inactivation was consistently effective; both filter types successfully removed the *E. coli* from the source water. Both filters were able to remove a large fraction of the colloidal particles from the water. The effluent turbidity values for both filter types fell below 5 NTU when the influent water was less than or equal to 12 NTU.

Free and total chlorine concentrations decreased from intermediate to final water samples for both filter types. The combined chlorine concentration measurements were substantially less than the free chlorine concentration measurements. Chloroform ( $\text{CHCl}_3$ ) was the only DBP observed to be present above the detection limit in the chlorinated water samples. The chloroform concentrations measured in the effluent water samples from the 1  $\mu\text{m}$  and the 5  $\mu\text{m}$  filters were all well below the Maximum Contaminant Level of 80  $\mu\text{g/L}$  for Total Trihalomethanes, as established by the US EPA. The absorbance generally decreased from intermediate to final water samples. The UV-absorbing compounds are successfully removed by the filtration or adsorption in the GAC, or by the reactions in the secondary chlorine dose.

The clogging rates between the two filters were nearly identical. The 1  $\mu\text{m}$  filter allowed an average of 4037 liters of water through the filter, and the 5  $\mu\text{m}$  filter allowed an average of 3828 liters of water through the filter before clogging occurred. This corresponds to approximately 202 runs for the 1  $\mu\text{m}$  filters and 191 runs for the 5  $\mu\text{m}$  filters.

The GOW system achieved over seven logs of inactivation for the  $\phi\text{S1}$  phage suspension and over four logs of inactivation for the T4 phage suspension when used with Milli-Q water. When used with Wabash River water, the GOW system achieved approximately three logs of inactivation for the  $\phi\text{S1}$  phage suspension and less than one log of inactivation for the T4 phage suspension. The GOW system was not effective at inactivating human viruses in a natural water source.

Water quality data from six water sources were collected in Haiti. The *E. coli* concentrations in the samples ranged from 1.5 most probable number (MPN) of *E. coli* per 100 mL of the sample to 48.3 MPN of *E. coli* per 100 mL of sample. The turbidity measurements ranged from 0.19 NTU to 6.64 NTU.

**Date:** Friday, July 19, 2013

**Time:** 10:00 AM

**Place:** HAMP B115D

Advisor: Professor Ernest R. Blatchley III

Faculty, students, and the general public are invited.