**Thesis Project Portfolio**

# Improving the MadiDrop+ Tablet (Point of Use Water Technology) With the Application of Silver and Copper

(Technical Report)

# Societal and Cultural Influences on the Uptake of Water Disinfection Technologies; a Case Study of California, Australia, and South Africa

(STS Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science
University of Virginia • Charlottesville, Virginia

In Fulfillment of the Requirements for the Degree
Bachelor of Science, School of Engineering

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Spring, 2022
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## Sociotechnical Synthesis

The Capstone Report and the STS Research Paper both address the global threat of clean water insecurity. Within the technical project, the team worked with the MadiDrop+ tablet, which is a silver-embedded ceramic tablet that successfully disinfects water from bacterial pathogens. The goals of this project are to improve upon this point-of-use tablet by understanding the additional effects of adding copper on water disinfection. This was investigated within two subprojects: testing different configurations of the MadiDrop+ and copper mesh to release safe levels of copper and silver into water; and testing the effects of different silver and copper concentrations on mosquito larvae. The STS Research Paper examined the elements of societies around the world that effectively enabled or prohibited the successful implementation of viable water disinfection technologies. Conducting the Capstone Project and the STS Research Paper simultaneously was beneficial in motivating both efforts. My STS research has allowed me to weigh the societal factors of water disinfection technologies, such as the MadiDrop+, with great importance. The technical work the team has done was aimed at improving the ability to provide safe drinking water to people around the world, and my STS research has shown me that it is crucial to consider the factors of the MadiDrop+ that would make this tablet socially and culturally acceptable, beyond just technologically sound.

The focus of the Capstone Project surrounded the MadiDrop+ tablet, a point-of-use water treatment technology that treats drinking water by releasing silver nanoparticles into untreated water. The team conducted two projects related to using silver, and adding copper, to test the effectiveness of both elements on water disinfection. One of these projects included designing and sampling different configurations of the MadiDrop+ and copper mesh with the goal of releasing safe drinking levels of copper and silver that would disinfect contaminated drinking

water. Using Graphite Furnace Atomic Absorption Spectrometry technology, the samples of the configurations were measured to determine the copper and silver concentrations every 24 hours. By doing this, the team hoped to establish a configuration that would release levels of copper and silver that would be both safe to drink and effective in disinfecting water. The other project consisted of testing the effects of different silver and copper concentrations on mosquito larvae. The mosquitoes were monitored daily to record the emergence and survival rates of the larvae within the varying silver and copper concentrations. These experiments were run as an attempt to investigate whether the target copper and silver levels released from the MadiDrop+ experiments would also have an effect on the larvae.

Many technologies that have been developed to address the problem of a lack of consistent, clean water that millions face worldwide. This STS research aimed to study: how can societies influence the respective community's acceptance of water disinfection technologies? To better understand this predicament and analyze the impacts that established cultures have on the acceptance of some of these technologies, I have examined historical case studies of the "toilet-to-tap" water system in Orange County, California, the Water Futures Initiative referendum in Toowoomba, Australia, and silver-embedded ceramic pots point-of-use water treatment in Thohoyandou, South Africa, highlighting the social, political, and cultural systems in place and their influence over the acceptance, or lack thereof, of each respective technology. Hence, I have used the social construction of technology to research this question. This STS framework asserts that societies influence the trajectory of a technology, rather than vice versa. Through this research, I have been able to understand the factor(s) of society that hold the most power over people's acceptance of viable water disinfection technologies. This is crucial to understand because engineers must not only design technologies that scientifically work; they must also

develop a technology that consumers will understand and want to use. A technology can only be effective if people actually use it, so knowing how to make this possible with respect to water disinfection technologies will allow engineers to reach a wider audience and further mitigate the devastating problem of clean water insecurity.

By working on both projects simultaneously, I learned a tremendous amount about how to design and consider a technology from many different angles. Creating and improving a technology for its technological benefit is important, but it is not the only thing that matters; understanding the societal and cultural implications of the technology is necessary for complete, true success. Researching case studies of the acceptance or rejection of various water disinfection technologies across the world has shed light on the importance of designing technologies that will be suitable for the intended society. Without this consideration, viable solutions have not, are not, and will not be utilized to advance clean water access. Additionally, working with a water disinfection technology has allowed me to apply this reflection to the MadiDrop+ to ensure that, beyond just being technologically successful, it would also be successful when introduced into societies and cultures around the world.