

Thesis Project Portfolio

The Design of a Desalination Plant in New Orleans, Louisiana

(Technical Report)

Health, Environmental, and Regulatory Concerns of Water Treatment

(STS Research 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, 2024

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Executive Summary

In recent years, saltwater from the Gulf of Mexico has crept into the Mississippi River. Not only does this intrusion endanger marine life and local ecosystems located close to the river, but also threatens Louisiana's source of clean water, posing a significant challenge to the city's water supply security. Recognizing the pressing need for an alternative water source, the plan is to build a desalination plant 60 miles south of New Orleans, in Port Fourchon, to take in water from the Gulf and turn it into usable tap water. The proposed idea plans to generate enough water for the neighborhood of Algiers in New Orleans. A neighborhood representing a seventh of the city's total population. This work also addresses the issue of brine disposal, a by-product that can pose environmental concerns if not managed appropriately, by introducing an integrated process that not only resolves the brine disposal dilemma but also transforms it into valuable by-products. Specifically, this work proposes the utilization of the brine to produce fertilizer and rock salt, thereby minimizing waste and creating additional resources with tangible benefits. The technical work relates to the STS research because it involves the water treatment processes, specifically desalination, and their challenges and threats that are posed on health, the environment, and regulations set in the United States. As the process of desalination is detailed heavily in the technical work with equipment, calculations, and economical analyses, the STS research highlights the implications of this process and is treated as a post-analysis of such a design. Ultimately, both works are directly related to each other as they cover all aspects of water treatment that would be beneficial for the public to be aware of.

For the technical work, the aim was to design a desalination plant in New Orleans, Louisiana, that supplies drinkable, tap water from seawater from the Gulf of Mexico to the neighborhood of Algiers. Daily, 10 million gallons of water are produced from the plant and

transported to the neighborhood via underground pipes. On top of that, brine disposal is the most common issue this type of water treatment faces. So, as a part of the process, brine is treated to produce fertilizer and rock salt instead of disposing it back into the ocean and harming the environment. This design includes multiple necessary unit operations implemented in three different phases of the process. Starting with the pre-treatment phase, multiple filtration systems including strainers, microfiltration, ultrafiltration, and Reverse Osmosis (RO) systems are responsible for separating impurities and salt from the seawater stream. The next phase is post-treatment, which involves remineralizing, recarbonating, and rechlorinating the water stream exiting the RO system. This is done to add essential minerals back into the water since most of it was separated in the previous phase, as well as protecting the water when travelling in pipes to households. Finally, the brine post-treatment phase includes the process of vaporizing water from the brine solution in massive evaporation units to crystallize, as well as adding and mixing chemicals, such as ammonia and phosphoric acid, to produce fertilizers and rock salt. The plant design includes detailed equipment designs, hand calculations, and economic analyses to decide if the plant design is a go or a no go.

For the STS research, this paper investigates the effects of water treatment plants, such as desalination, on the society surrounding them regarding human health, the environment, and government regulations. The health concerns include salmonella and norovirus, where salmonella causes salmonellosis disease. Both have similar symptoms, but salmonella is a bacteria, while norovirus is a virus. For the environment, brine waste is the main by-product of water treatment processes. High salinity and toxic chemical exposure are consequences of such treatment, as it causes the marine life and ecosystem to deteriorate. Regulations enforced on water treatment plants are plenty; however, this issue is still pertinent in the water industry.

Inspections and improvements on current regulations are required to eliminate the root cause of this dilemma. This research paper utilizes sources from scholarly work such as similar research papers obtained from the library and internet, as well as university faculties with expertise in related fields, including chemical and civil/environmental engineering from the University of Virginia. Water treatment concerns are common in the US as many areas suffer from poor tap water distributed to their homes. It is an issue that affects society by using technology to apply scientific concepts, hence the abundance of research and regulation updates. Numerous solutions were found to help alleviate this problem, but implementation remains preventing the progression of successfully overcoming this dilemma.

Working on the technical work and STS research simultaneously has provided a deeper understanding on how water treatment processes work, especially desalination. Designing all the equipment and the processes that go into treating seawater showcased the intricacies and challenges that occur during such tasks. Knowing the fine details of the whole process eased the understanding of the research question discussed in the STS research. Since the STS research topic is directly related to the technical work, it was essential to understand the relationships and harms of such processes on the society in a broader aspect.