

MEADOW CREEK WATER MANAGEMENT PLAN

**CONFRONTING THE WATER ETHICS OF A DOMINANT SOCIETY: ENGINEERING
SOCIAL JUSTICE FOR THE NAVAJO NATION**

An Undergraduate Thesis Portfolio
Presented to the Faculty of the
School of Engineering and Applied Science
In Partial Fulfillment of the Requirements for the Degree
Bachelor of Science in Civil Engineering

By

Caroline M. Marquis

May 6, 2021

SOCIOTECHNICAL SYNTHESIS

Engineering innovation that brought the United States nuclear weaponry and expanded its cities has had harmful environmental repercussions. This technical research report focuses on the impact of urbanization on the hydrologic landscape of the Meadow Creek watershed, including increases in stormwater runoff and stream degradation, and develops an informed plan for the city of Charlottesville to capture and treat this stormwater runoff. This will help the city to meet Virginia's Total Maximum Daily Load (TMDL) requirements and preserve the ecological functions of Meadow Creek. The STS research examines the Navajo Nation water crisis. Development of nuclear weaponry in the American Southwest during World War II contaminated groundwater within the Navajo Nation, and an effective engineering solution to this contamination has not yet been achieved. The objectives of this technical research and loosely coupled STS research are to address these two water quality and quantity issues with well-informed sociotechnical solutions.

Prior to 2012, Meadow Creek was listed as an impaired waterway due to high levels of sediment, the direct result of streambank erosion. While a 2012 restoration project reinforced the stream channel, little has been done to address the increased development that is the source of this stormwater runoff. Watershed land use data obtained from Geographic Information System Mapping (GIS) was used to develop both a Stormwater Management Model (SWMM) and the Virginia Runoff Reduction Method spreadsheet to provide runoff data for Meadow Creek.

The watershed runoff data provided by SWMM and VRRM informed a green infrastructure proposal to help capture and treat the stormwater runoff of a priority subbasin within the watershed. The selection of this priority subbasin was based upon social factors like race and income level as well as stormwater runoff data, to ensure that historically disadvantaged

communities receive the benefits of this design. The proposed green infrastructure decreases the subbasin's total phosphorus load by 73% and total nitrogen load by 73.8%, bringing it closer to meeting the state's TMDL requirement. Furthermore, this analysis displays the need for better stormwater management practices to maintain the ecological functions of Meadow Creek.

Concerning the STS portion of this research, developing a framework for better water resource practices within the Navajo Nation required a greater understanding of the history behind this water crisis, tribal water rights, and fundamental differences between Western and indigenous water ontologies. In response, the main research question posed by this project is: how can we combine the traditional ecological knowledge of the Indigenous Peoples with more modern water treatment technology? While current projects like the Navajo Water Project have been successful in helping people within these vulnerable communities get clean water, long-term sustainable change will only be brought on by changes to the way the U.S. government regulates water and interacts with the Navajo government. This analysis drew from academic journals and case studies that focused on various aspects of the Navajo Nation, as well as news articles that provided insight into the knowledge and views of the Navajo people.

As the threat of water scarcity continues to grow in the American Southwest due to climate change, the traditional ecological conservation knowledge of the Navajo people becomes even more important. Navajo communities have long standing, personal connections with the land on which they live, and can therefore provide key insights into what specific sites need. Technological innovation within this water crisis must place the Navajo people at the forefront of water resource decision-making and allow for more communication between all of the relevant stakeholders. By incorporating indigenous values into current water resource practices, engineers can better address past, present, and future considerations.

Urbanization and industrialization have led to many environmental and socioeconomic problems around water quality and quantity both in the Meadow Creek Watershed and the Navajo Nation. This technical research paired with the STS research yielded insights which informed effective design solutions. In the cases of both these projects, social and technical factors were considered for the final design to avoid repeating engineering mistakes of the past.

TABLE OF CONTENTS

SOCIOTECHNICAL SYNTHESIS

MEADOW CREEK WATER MANAGEMENT PLAN

with Xavier Richards, Lindsey Stegenga, and Emma Stephens

Technical advisor: Teresa B. Culver, Department of Engineering Systems and Environment

CONFRONTING THE WATER ETHICS OF A DOMINANT SOCIETY: ENGINEERING SOCIAL JUSTICE FOR THE NAVAJO NATION

STS advisor: Catherine D. Baritaud, Department of Engineering and Society

PROSPECTUS

Technical advisor: Teresa B. Culver, Department of Engineering Systems and Environment;

STS advisor: Catherine D. Baritaud, Department of Engineering and Society