

THE REDUCTION OF STORMWATER RUNOFF POLLUTION THROUGH  
COMMUNITY SERVICE EFFORTS

by

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## DEDICATION

To my family, friends, and colleagues for your continuous encouragement and support. Your guidance, patience, and unwavering support have provided a lasting impression on me during my lifelong educational journey. Specifically, I want to dedicate this capstone to two people who have supported my education and career more than anyone; Paula Damm and Scott Hart. I have learned a great deal from you and am blessed to have your support.

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## TABLE OF CONTENTS

### CHAPTER ONE: INTRODUCTION

Introduction.....	6
Personal Background.....	6
Educational Journey.....	7
Rationale and Context.....	9
Summary.....	10

### CHAPTER TWO: LITERATURE REVIEW

Introduction.....	12
Adopt A Drain .....	12
Watershed Dynamics.....	13
Introduction	
Lakes, Tributaries, Creeks and Rivers	
Storm Event Influxes	
City Utilities.....	20
Introduction	
Curb and Gutter History	
Alternative water Remediation Options	
Henning, Minnesota .....	28
Introduction	
Utilities	
Community Service Efforts	

Conclusion.....	31
CHAPTER THREE: CAPSTONE PROJECT	
Introduction.....	33
Project Overview and Rationale.....	34
Project Format and Timeline.....	34
Setting and Audience.....	41
Conclusion.....	42
CHAPTER FOUR: CONCLUSIONS	
Introduction.....	44
What I have learned.....	44
Revisiting the Literature Review .....	46
Project Implications.....	46
Project Limitations.....	47
Future Projects.....	48
Communicating Results.....	48
Project Benefits.....	49
Conclusion.....	49
BIBLIOGRAPHY.....	52

## CHAPTER ONE

### Introduction

My story begins in 1984. I find that to be a significant date for a few reasons. That birth year would classify me as a member of the Millennial Generation. While I admit that I have multiple characteristics fitting with members of that generation, I further identify with a microgeneration called the Xenials. This term encompasses the group of people that were born in the late 1970's and early 1980's . We are a group of Americans that were raised on the idea of playing outside as much as possible, being home by the time the street lights were on and the use of electronics was reserved for the poorest of weather days. We were raised to take care of our planet and surroundings. We were raised to be active and engaged citizens. This civic engagement trait within me has often made me wonder what we, as a generation, are capable of accomplishing. My capstone course has helped me funnel this curiosity and ask the question *“How can community service efforts be integrated into student learning to reduce river pollution caused by stormwater runoff?”* We experienced a childhood that emphasized imagination, sports, creativity and nature. Now, which generation I truly belong to really does not matter. The fact of the matter is that my journey, beginning in 1984 in rural Minnesota, included a substantial environmental component.

### Personal Background

I consider myself to be very fortunate in a few areas of life. I was raised in a traditional and loving Catholic household with two parents and 4 older siblings in north-central Minnesota around the community of Wadena. We are a middle to low

income family with two working parents that both are proud Veterans of the US Military during the Vietnam War. Dad worked heavy equipment, doing road construction, and Mom worked as a technician at a pharmacy. Although we were basically poor, I never realized it. I always had everything I needed which included love, food, clothing, a safe home and lots of friends and relatives to play with.

Wadena is a quaint county seat with approximately 4000 residents. The small municipality produces an intimate luxury based on its robust offerings that I never fully appreciated until my adult life. It is located on the boundary of Wadena and Otter Tail Counties in the heart of “Lakes Country.” My community is neat for multiple reasons, one of those being the environmental diversity within a short distance in any direction. From the heart of downtown, if you travel 15 minutes north, you will encounter the boreal forest pines of northern Minnesota. If you travel 15 minutes west, you will find yourself surrounded by any one of the 1000+ lakes surrounded by hardwood oak and maple forests of Otter Tail County. If you venture south 15 minutes you will see the boundaries of the tallgrass prairie and oak savannah. My community lends its name to the Wadena Drumlin Field, an area of rolling hills formed from the most recent glacial period. If you can imagine the environmental setting of my hometown, you can respect why I consider myself to be an “outdoors guy”.

### **Educational Journey**

My late-father was not a good student. In fact, his educational background is quite modest. He was raised in Bluegrass, MN, which is a community that sounds just like its name. He did not attend kindergarten because there was no such thing. He

walked 2 miles to a one room country school labeled as District 14 of Wadena. Here he attended class for grades 1 through 8. When he advanced into high school, he was bussed into Wadena. He struggled academically and ultimately ended up dropping out of high school to join the US Navy and serve his country in Vietnam. He obtained his GED in the Navy and that was the end of his formal education. My mother was academically gifted. She was the Salutatorian of Perham High School, the same district where her mother was Valedictorian many years prior. Mom attended St Catherine's University in the metro area for nursing but was unable to finish due to financial reasons. She ended up dropping out of college and joining the US Air Force to proudly serve her country in the Vietnam War. She received some medical training in the USAF and attended random night courses as an adult as she could. All 4 of my older siblings struggled in school. My oldest brother dropped out with substance abuse issues. My three older sisters did just enough work to get by and stay eligible for sports. I on the other hand, always loved school. I never got a grade lower than an A- in all my years of school at Wadena Deer Creek Public Schools. I graduated in 2003 as Salutatorian with academic distinction.

I went on to attend the University of Minnesota, Morris on academic scholarships. I majored in Biology with a minor in Geology prior to obtaining my secondary education licensure. After landing a teaching job at Henning Public Schools I began my career with Hamline University working to obtain a Master's Degree in Natural Science and Environmental Education. This capstone is the result of many years of academic effort and growth.

### **Rationale and Context**



As you may have gathered in my introduction, family and home is everything to me. Family needs and a terminally ill father prompted me to obtain a teaching job as close to Wadena as possible in 2008 when I was job searching. I was fortunate to land a job in Henning, which is a small rural farming community of 800 people located just 20 minutes West of Wadena. It is a proud and vibrant community supporting a K-12 school with an enrollment of almost 400 students. I am thankful for the opportunity to work within this district and help the students and families to the best of my ability. I am attempting to obtain this degree in order to better serve the students and families of Henning by improving my teaching, educational background and course offerings.

The Master's degree required me to complete a course offered by Tracey Fredin titled "Environment and Society". This course illustrated the positive and negative impacts of mankind on nature. While on the campus of Hamline University this summer for that course, we learned of a metro based program called *Adopt a Drain*. The guest speaker shared with the class about the successes and struggles of this program. To briefly summarize the program, I will say that they are encouraging citizens to take ownership of a storm drain on the street and keep it clear of trash and debris to protect the Mississippi River. The Mississippi is the ultimate end location of runoff that goes down storm drains. Therefore, anything that goes down the drain goes into the river, including pollution, fertilizer runoff, grass clippings, oil, and so on. The program coordinator shared that the project is struggling because of the sheer number of drains in the metro and large amount of resident turnover. As I sat in on this lecture, my country boy mind questioned if this program could be implemented into rural Minnesota. Would

this program work better in Henning compared to Burnsville? That curiosity has led me to the question: *“How can community service efforts be integrated into student learning to reduce river pollution caused by stormwater runoff?”*

### **Summary**

My childhood upbringing and family situation planted me into the outdoors and guided me to my educational journey to the science field. My continuing education at Hamline University through the NSEE Master’s Degree sparked my curiosity. Research shows that the health of a river is adversely impacted by the input of autochthonous organic material and chemical based pollutants by means of stormwater runoff. If you think of a country setting, when it rains the precipitation percolates into the ground and is absorbed by plant roots or integrated into the groundwater aquifers. In an urban setting, all the water that would normally percolate into the soil is prevented by doing so because of developed surfaces such as asphalt, concrete and other hard impermeable surfaces. Therefore, all of the water that lands on hard surfaces has to go somewhere. It travels downhill to a gutter system where it flows towards a drain. Those drains are connected with a utility system and it is drained into a nearby creek or river. In an ideal situation, it is pure rainwater that is collected in the gutter system and drained into the river. Even in this ideal setting, the massive influx of rainwater can increase river flooding and cause problems. My capstone will not address those issues. I will work to address a more realistic situation where the water that collects in the gutter system and drains is filled with pollutants. Material such as grass clippings, leaves, oil, chemicals, fertilizer and other material goes into the drain and therefore river unfiltered and freely. In Henning,

all of our drains dump out into Brandborg Creek, which flows to East Battle Lake and ultimately, the Mississippi River.

It is my intention to develop a project in Henning, MN where I mobilize the citizens of the community to adopt a storm drain on their street. This would include them keeping the drain free and clear of any debris that would have a negative impact on the Willow Creek. With that goal in mind I ask *“How can community service efforts be integrated into student learning to reduce river pollution caused by stormwater runoff?”*

## Chapter Two: Literature Review

### Introduction

Throughout this chapter, I will work to share content, facts and information found in the scientific literature to provide a robust understanding of how municipal storm systems manage stormwater and how that runoff can adversely impact local lakes, streams and watersheds. The discussion will further explain possible ways that community service and civic engagement can be effectively employed to reduce those adverse impacts on rivers by managing and protecting storm drains throughout the city. Through the research of these items, I have asked *“How can community service efforts be integrated into student learning to reduce river pollution caused by stormwater runoff?”*

### Adopt A Drain

There are many programs available to protect nature and our environment. Many of those programs are aimed at protecting waterways, watersheds, lakes and rivers. One program that will serve as a uniting theme for this literature review is the Adopt a Drain program(AaD). The AaD program has been in place informally for many years. The first formal program was launched in San Francisco, CA. within the last ten years. (Prosser, 2015) The idea behind the AaD program is that citizens choose to register themselves to take ownership of a storm drain. Usually that drain is located on their block or out in front of their home. The citizen pledges to monitor the storm drain and keep it clear of refuse, trash, leaves, debris and other items. By monitoring and maintaining the storm drain area, the citizen is preventing those items such as leaves, fertilizer, oil and trash from being flushed down the storm drain and into a river.

Since the inception of the AaD program, it has spread across the United States. It has become increasingly common in metropolitan areas including Minneapolis and St. Paul, Minnesota. Cities such as Roseville, Bloomington, Burnsville, Minneapolis, St. Paul and others included in the 7 county metro area.

## **Watershed Dynamics**

### **Introduction**

A watershed is defined as a geographical region or area that drains into a particular basin (McElroy, 2013). In Minnesota, the majority of the state falls into the Mississippi River Watershed. A small portion of our state drains into Lake Superior while another area is part of the Hudson Bay Watershed drained by the Red River of the North. The regional continental divide, which is an elevated region separating two distinct watersheds, is located just West of Henning near Inspiration Peak.

### **Lakes, Tributaries, Creeks and Rivers**

Freshwater features such as wetlands, streams, lakes, creeks and rivers serve as an intricate and efficient drainage system for local areas. In my earlier days, I worked as a landscaper and we frequently were designing and building projects to help drain water properly. It required a great deal of preparation, research and thought to “get it right”. I think it is pretty interesting to see that nature gets it right every time.

Wetland areas serve as a natural sponge for water. That influx of water can be sourced from snow melt, rain, irrigation and other mechanisms. (McElroy, 2013)

Unfortunately, wetland areas are for the most part seen as wasteland and undesirable. For that reason, among others, many wetlands are drained using culverts, ditches, drain tile

pipes and other means. The removal of wetlands has caused an increase in the frequency and severity of flooding events. Artificial or man made wetland areas have been built in areas however they have been shown to be far less effective in mitigating water.

(Redmond, 2013)

Wetlands themselves are mostly formed from the eutrophication of lakes. Over time, the lake bowl fills in with dead and decaying organisms and what once was a typical lake eventually becomes filled in. No matter what stage, a lake or pond is a large storage basin for freshwater. Many times these lakes are fed by rivers and/or springs. Henning is nestled in the heart of Otter Tail County. Otter Tail County is significant because we have more lakes in this one county than any other county in the entire United States. We were even featured in a 2013 article in the Minneapolis Star Tribune written by Doug Smith. In the article, Smith shares facts about our county, reports that 11 percent of our county is lake and he even encourage tourists to flock to Otter Tail County to take advantage of our beautiful recreational areas.

In addition to these freshwater features, the ground itself serves as a source of water mitigation. Percolation and infiltration are words commonly used to describe when freshwater is absorbed into the ground. This is important because it will replenish the underground aquifers that are used for private and public wells. (Redmond, 2013)

### **Storm Event Influxes**

The constant fluctuation of temperatures on our planet is the driving force that powers the water cycle to circulate freshwater around the globe. One important factor of the water cycle is precipitation and percolation. Precipitation is defined as moisture, in

any form, falling from the atmosphere. Percolation is when the water from that precipitation infiltrates the soil and replenishes groundwater acquirers. Human activities such as construction, urban development and farming can greatly impact percolation by reducing infiltration and increasing runoff. Runoff is when water flows over the surface of the land to a (temporary) storage location such as a pond, lake, stream or river. Urban development created nonporous surfaces such as paved roadways and parking lots. Stormwater must go somewhere so they engineer gutters and storm drains to remediate water runoff effectively. This design works well but it comes with side setbacks. Gutters and storm drains are also collection areas for pollution, leaves, fertilizers, oils and other debris. This material, carried by stormwater, runs through public utility drains and into neighboring watersheds. This influx of water and the accompanying pollutants has a devastating effect on the health and quality of watersheds. (Janke, 2017)

Climate is generally accepted as the prevailing pattern of weather and atmospheric conditions for a region. Many students, mine included, confuse weather and climate. They struggle to understand that weather is “right here, right now” and climate is “what is normal for right here, right now.” The statistical patterns presented by climate records are showing a dramatic shift from the expected pattern. This change in climate can be attributed to many factors, most notably is the increase in levels of carbon dioxide in our atmosphere caused by the increased combustion of fossil fuels. Evidence of climate change can be seen all over the world.

One prime example of climate change rearing its ugly head is the increased number of large rainfall events. These events, coupled with drought periods can make it

difficult to record statistics. Let me try to explain using the idea of monthly precipitation amounts. Let's say that the average month brings 6 inches of rain. In this example, we still receive 6 inches of rain but it is being delivered in 2 massive rain events that each brought 3 inches. In between those two rain events we had zero precipitation, which qualified as drought time. This shows that we received an average amount of rain in the month but it was in two large influxes as opposed to many smaller increments.

This model of precipitation is happening more frequently and it is a problem. Large influxes of rain increase the volume of runoff and provide little in replenishment to the underground aquifers and vegetation roots. The amount of runoff is increased after a drought because the surface of the land is hardened and dry, making it temporarily impervious. The best style of precipitation is a slow and gentle rain. That allows for maximum percolation. Drought-hardened turf and other impervious surfaces such as urbanized roads and parking lots greatly increase runoff. Urban stormwater is water running off an urban land surface after a rainfall or snowmelt event. (MPCA, 2016). Half of the Earth's population lives in urban areas and impervious surfaces associated with urban areas greatly decreases infiltration. (Blair, 2016) As our planet continues to see development, the ratio of pervious to impervious land will diminish and exacerbate this problem.

Stormwater runoff is an issue because it increases the damage due to localized flooding and is the primary cause of nonpoint source pollution. Non-point source pollution (NPSP) is pollution that is created in one area and impacts another. A great example of this would be a factory in St Paul, MN dumping waste into the Mississippi



River and that is causing environmental harm in Wabasha, MN, which is located about an hour south of the metro. This problem is increasing in severity and frequency as heavier rainfall storms become more common with climate change. One way that cities are making advances in this area is with a storm sewer flow monitoring site. These are solar powered control stations that open and close gates and mechanically control the flow of water into local waterways. (Hayhurst, 2017)

According to an educational module published by the Minnesota Pollution Control Agency in 2016 , urban areas have less infiltration and evaporation and more runoff compared to rural areas with more grassland and forested areas. Some important factors to consider are the overall amount of impervious (developed) land compared to natural land and the total distance traveled by runoff before encountering a porous area. To further explain, we need to consider whether or not there are buffer strips between hard surface areas. A great example would be in a parking lot. One needs to consider if the parking lot is one large impervious surface or are there “islands” or medians in the parking lot that allow for drainage. (MPCA, 2016)

Stormwater runoff is not isolated to rainwater. It also includes whatever is picked up by the draining water. This can include a variety of materials such as grass, leaves and organic material. It can include waste such as garbage, refuse, animal feces and cigarette butts. One primary concern is that runoff can, and often does, contain chemicals such as fertilizers, nitrates and oils. Sediments, bacteria, metals and other materials carried by stormwater are unwelcomed additions to water bodies. All of these materials get washed across impervious surfaces and eventually run down a storm drain. In almost all city

storm sewer systems, the drains dump directly into a body of water or a natural drainage ditch area. In some sensitive areas, legislation has been passed that mandates stormwater to be routed through a septic treatment plant prior to discharge into local waterways.

This is a great remedy to a serious problem however it is very costly. The immediate cost is associated with the utility upgrades and reconstruction needed to reroute storm drains into a treatment facility rather than a culvert that dumps into a waterway. The long-term cost associated with this model include a massive increase in the amount of water treated at a facility. This could even require a municipal treatment plant to upgrade its facilities or build new to accommodate the massive increase in volume. (Selbig, 2017)

Stormwater runoff of nutrients from developed landscapes is recognized as a major threat to water quality degradation through eutrophication and pollution. (Yang and Lusk, 2018). Eutrophication is the enrichment of a lake or body of water that leads to increased growth of algae and vegetation. This decreases the quality of the water and makes it a less ideal aquatic area for both humans and wildlife.

Beach areas are huge drivers of economic stimulus in a region. They provide for larger amounts of tourism than any other natural feature. (Liebesman, 2016). Enclosed beaches are very popular recreation areas. Enclosed beaches are beaches along coastlines and shorelines in a somewhat protected area. It could include shoreline on an inland lagoon area or a bay sheltered from the wind. These areas are prime recreation swimming zones because of the calm and frequently shallow waters. The unfortunate fact is that these areas are highly susceptible to stormwater pollution due to the low circulation of water. In a recent study of more than 600 beaches in the Western US, it

was determined that enclosed beach areas are 50% more polluted than open beach areas. (Rippy, et. al., 2014)

In addition to eutrophication of lakes and wetlands, another risk is water quality. Stormwater runoff is the single most devastating factor reducing water quality in lakes, rivers and wetland areas. Water quality is a highly-monitored and important role of various agencies such as the Department of Natural Resources (DNR), Environmental Protection Agency (EPA), Soil and Water Conservation Districts (SWCD), United States Geologic Survey (USGS), Lake associations and Pollution Control Agencies (PCA).

My home and the community of Henning, MN., is located within the boundaries of the East Otter Tail County Soil and Water Conservation District. They are one of the government agencies responsible for the monitoring of water quality in our region. They currently monitor levels of phosphorous, chlorophyll a, nitrates, nitrogen and other materials. They also keep strict records of secchi disk depth. A secchi disk is a round metal disc approximately one foot in diameter that has black and white stripes. This disk is lowered into the water and used to detect visibility levels.

There are three main lakes impacted by the stormwater runoff of the city of Henning. Those lakes are East Leaf Lake, West Leaf Lakes and East Battle Lake. East and West Leaf lakes are connected to the city of Henning by Willow Creek. These lakes are drained by the Leaf River which flows eastward out of the lakes towards Wadena, MN where it connects with the Red Eye River. It eventually meets up with the Crow Wing River north of Staples, MN. The Crow Wing river empties into the Mississippi eventually near the city of Motley, MN and Fort Ripley Military Base. (Henry, 2012)

The reference data for East and Middle Leaf Lakes is alarming. Just like any data, it shows certain peaks and troughs representing times of high water quality and times of low. The alarming trend is that the overall pattern shows a decrease in water quality and an increase in pollutants. (Henry, 2012). Based on these results, East Otter Tail SWCD has encouraged farmers and lakefront owners to change their habits. They have presented locals with information about buffer zones and crop reduction programs that work effectively to protect the lakes. The eastern edge of Henning has a storm drain system that drains into a natural ditch area. This area allows for a large amount of infiltration and inevitably, some of it flows over the land into Willow Creek.

The other body of water directly affected by stormwater from Henning is East Battle Lake. East Battle Lake is connected to the city of Henning via Brandborg Creek. Brandborg Creek is really nothing more than a babbling brook winding and weaving its way through lakes' country and agricultural fields in the 5 miles between the city of Henning and the lake. During storm events, Brandborg Creek swells to a small roaring river thanks to the large influx of stormwater from the city storm drain system.

## **City Utilities**

### **Introduction**

People say that two things in life are certain; death and taxes. I am not here to argue with that saying. I am here to share information about one important reason why we pay taxes. Government run utilities are present in every municipal area in the United States. Utilities include necessary basic services including electricity, water, sewage, gas and others. Infrastructure such as roads, bridges, culverts and curbing are similar tax

funded areas. These services allow for large scale urban development and often develop into impressive feats of engineering. Curb and gutter service with storm drains are common public utilities that people often take for granted. It is very important and when functioning properly it can prevent a fortune in flood damage. The dark side of curb and gutter with storm drains is that they do great harm to local watersheds during storm events by flushing pollutants into the river.

### **Curb and Gutter History**

The Minneapolis Public Works Department represents one of the oldest government agencies in the state of Minnesota. The first ever municipal septic systems were installed in Minneapolis in 1870. These rudimentary basins were made of brick and clay and they drained directly into the Mississippi River. The brick construction allowed for a lot of infiltration (leaking). The brick construction methods were replaced with solid concrete in 1938. These systems were more efficient and prevented groundwater pollution but increased the amount of influx into the river. These systems combined stormwater and sewage. In the early 1940s, construction began to engineer two separate systems where sewage was treated before entering the river. This system did not provide any treatment for stormwater. Stormwater can overwhelm a treatment plan and cause structural damage to backlogged pipe systems. It can even cause sewage backups into basements. This presents a health hazard and results in costly damages as well as upset citizens. Ultimately, the EPA has final jurisdiction over these matters in our modern days. The standards of the EPA tend to change with each presidential administration. Currently, the Trump Administration has directed the EPA to back down on regulations

controlling stormwater systems. This is a concern for environmentalists. This current administration is not the only to back down on EPA guidelines. There are still large cities in the US that have failed to take advantage of innovations to reduce their impact on downstream ecosystems and that is wrong. (Bernhardt, 2008)

A pattern exists with the quality of a stormwater and septic system and the level of urbanization. Typically, areas that are more rural tend to have less complicated systems. These are basically gravity-fed systems that do little to nothing to protect the local watersheds. The rudimentary systems of rural areas work because of the decreased amount of impervious surfaces and increased amount of infiltration. Highly urbanized areas must handle a far larger volume of water and sewage. They also have an incredibly high amount of impervious surfaces. The east coast of our country has some of the most highly engineered systems in the world. The Rhode Island DOT has committed more money per capita than any other state in the union to construct quality stormwater management systems. The state recently completed legislation providing 112 million dollars in funding to improve the 25,000 storm drains located on state highways. This is an aggressive commitment to improvement. (Wilson, 2015)

Efforts have been made across the country to restore stream channels, specifically those in proximity to urban areas. These streams are subject to frequent deluge flooding events caused by stormwater influxes. So many of these streams have been mechanically dug out by heavy equipment that they now resemble drainage ditches more than a natural stream. The re-engineering of these streams is a challenge in an urban setting due to the lack of available land for reclamation. Imagine a straight drainage ditch. This takes up a

fraction of land in a narrow strip. A natural stream would have had a more sinuous (s-shaped) pattern. The sinuous pattern would occupy a much wider swatch of land. This style of stream slows the flow of water but requires a great deal of acreage. To reconstruct these rivers requires time, money and lots of space. It requires the allocation of necessary lands and must provide for temporary drainage of the existing channel while the new channel is constructed. (Gregory and Chin, 2002) These efforts, although challenging and expensive, are becoming more common. I recently interviewed Theodore Rud, a civil engineer with Houston Engineering Firm of Fargo, ND. He shared with the story of the restoration of The Sand Hill River near Fertile, MN. This river restoration project was the product of 8 years of planning and 3 years of construction. (Personal Communication, 2018)

I have mentioned a great deal about stormwater management systems in Minnesota and the United States. An alarming fact is that the US accounts for just a fraction of the development in the world. For the most part, government agencies are monitoring and enforcing regulations that protect our watersheds. This is not the case in underdeveloped nations. The most pressing tasks for urban hydrology struggles exists in rapidly growing third world cities. These struggles are due to intense tropical rainfall events in combination with highly weathered soil that is riddled with unregulated pollution including trash, feces and refuse. (Douglas, 1976) This problem has been documented for almost 50 years however the US has little ability to provide pressure on developing nations. One could rationale that the US Government has enough struggles within its own boundaries.

## **Alternative Water Remediation Options**

The term urban stream syndrome can be used to describe the downfall and degradation of local waterways in proximity to urban areas. Studies have shown that the more impervious surfaces in a drainage basin, the less likely one is to encounter a watershed with acceptable water qualities. (Walsh, 2005) With advances in technology, awareness and advocacy comes improvements to stormwater management systems. Innovative designs have led to the construction of alternative structures designed to mitigate stormwater. One such structure is a rain garden. A rain garden is a depression area that has the ability to absorb and infiltrate a large volume of water during storm events. A typical location of a rain garden is adjacent to a hard surface such as a parking lot. These rain gardens are frequently adorned with native grasses, mulch and a variety of rocks. Rain gardens require thoughtful placement and design. They include a column of sediments assembled in layers. Highly engineered rain gardens, such as those found along the Green Line Light Rail Transit System of the Minneapolis-St. Paul metro area, even include overflow drains connecting them to a drainage system or holding pond. These rain gardens can range in price but the average cost is about \$40,000. (El-Samra, 2018)

A spillway is a less costly endeavor. A spillway is a drainage area made up of a variety of rocks and gravel connecting an impervious area such as a parking lot to a natural green space such as a field, forest or ditch. The purpose of the spillway is to divert, slow and filter water during storm events to manage the influx to the natural area.



Spillways are not as effective as rain gardens but they are a fraction of the cost, usually around \$5,000. (El-Samra, 2018)

Lagoons, ravines and artificial pond areas, sometimes called coulees and levees work to retard or hold back stormwater. These are man-made structures that flood and fill in, essentially trapping stormwater. They have a gate system that can be mechanically controlled to allow for the flow of water. These areas are effective at mitigating stormwater but they do little to protect the watershed. A rain garden and spillway can serve as natural filters while these do not. They simply trap the water and hold it to be released at a controlled rate at a later time. (Prosser, 2015)

These storm drain systems have to outlet somewhere. As mentioned earlier, they usually empty into a local waterway or a natural ditch. One common sense idea to protect the waterway from a majority of trash would be to filter the rainwater. This practice is in place in a variety of locations around the US. These filters, which are essentially screens or grates on the culvert emptying into a waterway, work to catch solids just as a colander is used in your kitchen. This requires an obvious amount of maintenance and comes with a certain risk in the event of the filter becoming plugged and thus causing backlogs. They also do little to nothing in terms of protecting waterways from chemical pollutants. New systems can employ a graduated system that filters the stormwater based on size so it pulls out larger items first and then in a size based system continues to filter out solids. The final stage can use a carbon filter to catch chemicals. These systems are costly to install and require a large commitment by

maintenance personnel. They do work though and should be considered to be an effective solution to stormwater runoff problems. (Pool, 1999)

An alternative method currently being explored to mitigate stormwater runoff is modeled after old practices seen in Europe for hundreds of years. These endeavors include grass or sod roof systems and porous parking lots. Sod roof systems are costly to build and require a large amount of maintenance. They have not been shown to save any money but do show data to support that they reduce runoff slightly. I recently saw an example of this at the Ramsey Washington Water Conservation District in St Paul. The sod roof system was placed on their office building in conjunction with a porous parking lot. There are two main designs being used for porous parking lots. The cheaper version uses cement blocks like a paver patio with large gaps of up to one inch wide. This allows for water to infiltrate a porous layer of rocks, sand and gravel underneath the bricks. A second version of the porous pavement includes a newly designed asphalt that allows for infiltration. Both of these options cost almost 10x that of a regular pavement option so you can understand why they are so rarely used. (Lampe, 2017)

Changing economic and social times brought forth a period of time known as “The Great Recession” in 2008. This economic disaster left thousands of properties in foreclosure and abandoned. As the economy has rebounded, a portion of these properties have been redeveloped but others remain dormant. Utilizing abandoned urban land for stormwater management is an effective solution being utilized by various metropolitan areas. This practice includes garnering the abandoned properties, demolishing any remnant developments and cleaning up any environmental hazards. Once the initial

phase is complete, the land is then developed into “green space”. These green spaces can come in a variety of looks. They can be as simple as a city park or grassy area or as involved as a communal farming / gardening plot. Either way, the land is permeable and works effectively to reduce runoff. The most effective design of these properties utilize native grasses and shrubs. There are negatives to this option. These negatives include being a magnet for homeless people and the various downfalls associated there. They also provide zero support to the local tax base. They typically become tax burdens and maintenance nightmares for city crews. They frequently get developed after being claimed as green space due to the controversy of losing green space. (Hoard, 2017)

One final alternative method to mitigate stormwater runoff is to plant trees and other forms of vegetation. Established trees and shrubs absorb an incredible amount of groundwater through their root systems. This in turn allows the ground to absorb more water through percolation or infiltration. Many cities in the Great Lakes region have ordinances requiring trees to be planted in the boulevard areas flanking city streets. Not only is this appealing visually, it has been shown to increase property values and encourage development. The down fall of this model is that the tree roots themselves can wreak havoc on underground utilities, curbs, sidewalks and other structures. The leaves from the trees that get rinsed down a drain can serve as NPSP. Shrubbery can be useful as well and can serve as an aesthetically pleasing improvement to an area as many shrubs sport beautiful flowers throughout the year. These also serve a serendipitous positive by supporting pollinators. The downfall is that shrubs can obstruct views, specifically at intersections, leading to hazards. They can also quickly become overgrown. Shrubs have

also been known to be a refuge for homeless individuals and can accumulate trash.

Studies show that the perception of public safety can be reduced in areas with shrubs.

This is because people could hide in the shrubs for various crime-related activities.

(Selbig, 2017)

## **Henning, Minnesota and its Utilities**

### **Introduction**

Henning, Minnesota is a small and quaint farming community nestled in the heart of Otter Tail County. The prideful community has roots that date back to the later 1800's with a formal incorporation date of 1887. The most recent census reported that Henning has a population of 802. This number reflects a steady population over the past 25 years. Henning is flanked by multiple beautiful lakes of Otter Tail County including the Leaf Lakes Chain, East Battle Lake and others. Brandborg and Willow Creeks flow near city limits. The community serves as a local hub for residents as it is found at the junction of MN State Hwy 210 and 108 in addition to a Northern Pacific Rail Line. (Otter Tail County Historical Society. (n.d.). Retrieved from <https://www.otchs.org/>)

### **Utilities**

The city of Henning is rather compact with a footprint of just over a mile in either direction. The 3.5 square miles of city limits is made up of a traditional mix of developments including industry, commercial, educational, government and residential structures. On the outskirts of town there is a municipal airport with one of the few remaining grass runways in the state. The average property parcel is between 0.5 and

0.75 acres. The city continues to make economic decisions to encourage and provide for growth and development in the future.

Municipal electricity service is provided to residents by the city of Henning in cooperation with Otter Tail Power Company based out of Fergus Falls, MN. Natural gas is provided through Minnegasco. The city infrastructure supports septic service that drains northeast of town to 3 holding ponds for treatment before being released into Willow Creek and runs into the Leaf Lakes chain.

The city maintains curb and gutter service on most of the city streets. 100 percent of the streets within city limits have bituminous asphalt pavement. Not all streets are outfitted with curb and gutter because some of them just drain into nearby ditches or turf areas. Of the various streets with curb and gutter, the storm drain system is connected into one drainage system. That system drains into a man-made ditch just west of our school grounds and empties into Brandborg Creek. Brandborg creek is a small stream that drains into East Battle Lake.

## **Community Service Efforts**

### **Introduction**

The inspiration for me to embark on an AaD quest in rural Minnesota began in the summer of 2018 on Hamline's campus during a NSEE course. We learned about the AaD program and were made aware of the various hurdles and struggles encountered when trying to implement the program in such a large metropolitan area. This forced me to think about the AaD program in rural Minnesota. One of the issues with AaD in the metro is that the region has hundreds of thousands of storm drains. It is overwhelming to

think we could maintain that many drains. I felt that this program would easily be implemented into a smaller community such as Henning, MN. The community of Henning has fewer than 80 drains. I visited with some folks and we all agreed it would be pretty impressive to advertise an entire community as having adopted a drain and committed to working together to protect local watersheds.

The water quality of Henning is strictly monitored. They test, record and report the quality of water used in city water as well as the water that is released into Willow Creek after being processed by the city sewage management system. According to a 2017 Drinking Water Report published by the Consumer Confidence Report on file at the city hall, the Henning drinking water comes from two wells ranging in depth from 120-138 feet deep. This report indicates an overall positive review of the quality of water in Henning. The city passed inspection levels testing for copper, lead, nitrates, chlorine, fluoride, haloacetic acids and methane. The municipal septic system in Henning collects sewage waste in a series of three ponds northeast of town. These holding ponds are the main feature in the adequate and legal septic treatment system of the city. The city report shows that the levels of various pollutants such as phosphorus and nitrates are within legal range. The water quality of Willow Creek and the subsequent Leaf Lakes Chain are classified as mesotrophic with a secchi disk depth of 10 feet. These are positive results for the city. The East Otter Tail Soil and Water Conservation District, in cooperation with the Minnesota DNR have commended the city for its due diligence in protecting the regional waters.

The city does not monitor, test, or record the quality of the stormwater that is released into various ditches and Brandborg Creek. Some areas of the community have gutter systems that drain into nearby ditches and grassy areas but the heart of the city, with storm drains, all collect and dump stormwater into Brandborg Creek on the West side of town. This influx of stormwater runoff is not monitored or tested by the city according to Scott Grabe, City Engineer and Utility Supervisor. When I interviewed Mr. Grabe, I shared with him that I was surprised the city did not monitor the runoff and he replied that it is very uncommon for a city to monitor such a thing. He went on the record to ask a very appropriate question. “Even if we detected pollutants in our runoff, how could we help? It isn’t like we can go without a drainage system in town.” I couldn’t have asked for a better transition to the AaD program. He was not aware that such programs existed and was very open and supportive of the idea to implement an AaD program in Henning. He happily exclaimed “ Count me in! “ (Personal Communication, 2018)

## **Conclusion**

This exhaustive literature review has outlined a framework for the research behind my intentions to implement an Adopt a Drain program within the city of Henning. This project will be implemented as a community service based curriculum to be used in our school and community. In order to successfully develop meaningful curriculum, I needed to conduct significant areas of research to better understand such topics as the the ADD program and its history, watershed dynamics, city utilities, runoff mitigation options and the city of Henning, MN. It is my hope that with a further understanding of

these related topics, I now can develop a useful and practical program to monitor storm drains. Through the successful launch of an AAD program within the community of Henning, MN., one can hope to improve awareness, reduce pollution in nearby watersheds and increase water quality. One lofty goal of this project could be the improvement of city utility systems through reconstruction projects or an increased monitoring by changing the practices of city employees.



## Chapter 3: Capstone Project

### Introduction

This chapter provides a full description of the capstone project, including its context and purpose. The project will be designed in an attempt to answer the question: “*How can community service efforts be integrated into student learning to reduce river pollution caused by stormwater runoff?*” This is an idea for a project I have had for several months now. The project idea came to me in a discussion with a classmate after a guest speaker in Tracy Fredin’s NSEE course titled “Environment and Society.” The project, in summary is a curriculum unit that includes instructional lesson plans that build towards a community service project. Students learn about standards-based concepts including the water cycle and human impact on nature. This develops into a community service project where students are adopting storm drains in their community, similar to the Adopt-A-Drain programs currently used in multiple US cities. They maintain and clean storm drains in a neighborhood and eventually pass the responsibility off to citizens that have been recruited to help by the students.

This project is important to me on multiple levels. It is important that I create a useful project that can enhance student learning while emphasizing community service. It is important for me to develop this project as part of my Master’s Degree in Natural Science and Environmental Education. The most important reason for the undertaking of this project is the passion and love for my home region. I am a lifelong resident of this area of Otter Tail County and I have the innate duty to do my part and then some to protect our local waterways.

The main component of my project includes an educational component, consisting of a unit of lesson plans, aimed to raise awareness. The students and citizens of Henning need to be made aware of how their actions, or sometimes inaction, can impact the environment in various ways. They need to learn how the city utility systems work and can be improved. They can be helpful in protecting our local ecosystems by understanding how watersheds function. Ultimately, they can lend a helping hand by becoming an active citizen taking responsibility within their community. This chapter will outline the rationale of my project and review the proposed format that I have developed in different phases.

### **Project Rationale**

This project truly is a capstone representing many hours of work and development. The project required a large-scale literature review in combination with planning and brainstorming. The project itself is a series of lesson plans culminating in a joint community service venture that unites a school district with its community. The final part is the maintenance and publication of the project. The assets working on my behalf include a supportive department, administration, and city government plus cooperative students and citizens.

### **Project format**

The project has multiple phases. The primary phase is the foundation work to be completed by the instructor. Phase II is the instructional phase. Phase III is the community service component and phase IV is the maintenance, publication and release of the project. The project submission for this capstone, phase II, includes the curriculum

to be taught to 8th grade Earth Science middle school students. The project is outlined having been designed for the city of Henning, MN and Henning Public Schools but it is important to realize that the project is suitable for any small community and district.

The initial phase of the project required foundational work setting up communication within the school district and community. It required the establishment of a professional working relationship with the local utility company. The unwritten foundation work is a respected reputation within the community and district. Small communities and districts thrive on relationships and as a teacher, I needed to earn the respect of my community, students and administration prior to attempting a project this substantial.

One suggestion is to work with the local newspaper to include a series of articles aimed at informing readers about aspects of the project and make it known that this is a long term project that may take a while to catch on. Inform citizens of some hazards such as sidewalk salt, grass fertilizer and leaking vehicles that can harm the ecosystem via runoff pollution.

After obtaining the city's cooperation, I worked with the utility department to learn about the specific storm drain system in town. It is important for the teacher to be knowledgeable and prepared prior to beginning this unit. The city was so cooperative, they were willing to provide me with a master map of every storm drain in the community. This is a valuable resource for later on in the project. The city utility director helped me locate the two outlets for stormwater runoff in our community. These locations will serve as valuable locations for the field trips outlined in the lesson plans.

Phase II of the plan would be the instruction of curriculum unit action plan. The lesson plans of the unit were created following the format outlined in Understanding By Design, written by Grant Wiggins. The Understanding By Design format used to build this unit began by outlining specific learning outcomes and overarching understandings. Specific activities were created to address those learning goals. Performance tasks, projects and other pieces of evidence were developed to provide the instructor with feedback as the unit progresses. Essential questions, learned skills and assessments provided a strong framework to drive the unit towards its overarching goals.(Wiggins, 2008)

Understanding By Design provided valuable implications for the creation of this unit. As an veteran educator with over a decade of classroom experience, I am confident that I know how to create quality lesson plans and produce valuable learning exercises for my students. If it were not for the guiding principles of this book, I believe that my unit plan would have lacked an overarching theme and uniting set of goals. I can freely create quality lesson plans but to pull them together, I needed guidance. (Wiggins, 2008)

In this instructional phase of the project, the initial content presented centers around the three states of matter, water and its physical properties. The project provides access to free, interactive, online curriculum via active links. The traditional instructional methods used in the initial part of the unit are intentionally used to establish a firm foundation for subsequent lessons. These lesson plans cover topics such as hydrology, public utilities, water quality and community service. Hydrology is studied using a combination of text reading, interactive online activities and ultimately, a hand-on lab

experience modeling the water cycle and its specific components. Students compose two separate lab reports given a skeleton outline following the scientific method. The unit plan turns to a more creative area with the student modeling project designed to educate students about the form and function of a city storm drain system. Students build a model city following specific guidelines on the provided project handout and rubric. They will visually witness the functionality of a drain system and observe how easy it is to cause damage to a watershed via storm drain pollution. As with any unit, evaluation is key. For this unit, I feel the best way to evaluate students would be for them to keep a journal throughout the project. Smaller quizzes to assess their knowledge of the scientific topics could be added or the online curriculum assessment would suffice.

Phase III of this project is the culmination community service project and its publication. The project allows students the opportunity to adopt a storm drain in town and maintain it for a specific amount of time. The project provides instructions for the students to pass on that responsibility to local citizens. Between the students and citizens, they are instructed to work together and conduct various jobs such as adopt a highway, litter pickup, drain sweeping, sidewalk chalk art by the drains and other acts of community service.

Throughout all the different phases of the project, it is important to work with the city of Henning, local newspapers and media, other educators and volunteers to develop our public information forums. These forums would include various methods of spreading awareness, information and news to citizens.

This project involves students finding various storm drains in high profile areas and using sidewalk chalk to decorate them. The sidewalk chalk art visually educates residents that whatever goes down the drain ends up in the river. These advertisements are temporary but they are fun for students, visually appealing to residents and serve as an effective method of spreading information.

The project allows the opportunity for students to develop small signs to be placed in the yard of those residents that choose to adopt a drain. The signs are like miniature versions of a campaign sign and it serves as a way for the homeowner to celebrate their commitment to public service. The small signs placed in the lawn of the different citizens that have chosen to adopt a drain can create a positive buzz around a neighborhood and encourage others to follow suit. These activities create a personal campaign to help with the AaD program. A combination of local artistry, signage, door hangers and flyers has been shown to be an effective and attractive way to spread the word about AaD. This procedure includes the use of sidewalk chalk art, drawn by students around the storm drains. Suggested themes include adding phrases such as “only rain down the drain” or “FYI this drains into the creek” and other similar messages coupled with pictures of fish, vegetation, pollution and others. This is a fun activity that is also effective at reaching younger community members. One obvious downfall of this method is that the longevity of the drawings are short-lived, disappearing after a rain event.

Local signage has been proven to be very effective in small towns. To accomplish this, make arrangements for numerous signs to be placed around the community, similar

to those seen during election season. Our community also utilizes crosswalk signs, placed strategically in the crosswalk out in the street. The community has various bulletin boards around town including at the post office, grocery store and bank lobby.

The project can be supplemented if needed. One suggestion for supplementing is to have students draft various informative brochures and newsletters. These would serve as inserts to be included with the city newsletter periodically. One of these publications could inform them of the threat to local watersheds, one could educate citizens on the city storm drain system, another could inform them about our project and a final one could provide instructions for claiming a drain.

Guidelines for those that adopt a drain are created within the project. These guidelines help keep the homeowner (and students) safe from hazards associated with adopting a drain. It encourages them to wear gloves when cleaning drains and other safety measures.

One of the many benefits of living in small-town Minnesota is that you truly get to know the various people and business owners in town. I have been teaching in Henning for 11 years now and lived in the region my entire life. I have an effective professional working relationship with the owner of the Henning Citizen's Advocate. The Advocate is our local newspaper which has been in business for over 100 years. The publisher and owner of the newspaper is aware of my intentions to foster the AAD program in Henning and he is excited to help publicize my program in the newspaper. He also owns the paper in a neighboring community so the opportunity to spread the word is possible.

The community of Henning has various social media websites that are free, popular, easy to use and portable. It would be an easy way to profile volunteers who have helped the program. The city administrative office sends out a monthly newsletter. I have been approved to insert a flyer into the newsletter or include a write up. The final method of communication through the city is their instant alert program via Honeywell Communications. The city of Henning employs Honeywell Communications to provide a phone based communication system that can relay automated messages via text or voicemail to all registered users. This was initially used only for emergency purposes however it has now been opened up for less critical matters. This mode of communication does not appeal to me because I think it is a bit too aggressive and invasive. I would rather that communication method be reserved for more important matters of public safety.

My project can only be successful if the student's buy into the idea and immerse themselves into my lesson plans. This unit will frequently require students to engage in community service and encourage others to get involved.

Phase IV of my project would be the maintenance and eventual release of the project. This is not a permanent release, it is just temporary until the next semester of students is ready to begin the unit. During this release, it is recommended that the instructor continue to support those citizens that have chosen to adopt a drain. I recommend that the instructor be prepared for citizens to need replacements or ultimately, drains could go unmaintained until the new semester. With each class of new students, it is my sincere hope that the program gets a burst of life.



It is not realistic for the instructor continue this program indefinitely without the proper support. This program, like all other AAD programs needs to be supported by the utility / public works departments of a city. In Phase IV of the project, the instructor should work with the city council, government officials and maintenance staff to design and implement a support process. This would also be helpful if the instructor's teaching assignment changed and could no longer foster the student-based help through the instruction of my unit plan.

Future planning out updates are a possibility with this project. Depending on circumstances, the instructor could add more lab experiments to the unit where students would measure secchi disk depth of the stream at various locations. Students could test for various chemical contaminants. One project I predict would be interesting to students is the inventory of macroinvertebrates such as caddis flies that can be used to indicate water quality in a stream. The project is complete and functional but the opportunity for an instructor to personalize it is a distinct possibility.

### **Setting And Audience**

I have the distinct pleasure of being a science teacher in rural Otter Tail County K-12 public school. The content created in this project is designed for 8th grade Earth Science students. The project was designed around the rural community of Henning, MN based on the local dynamics of the community and school district. One of the finer points of the project is that with very little adjustment, this content could also be implemented into any community of similar size. For this project to work on a larger scale in an urban area, the instructor would need to make accommodations.

One interesting factor with this project is that it could easily be implemented into a Social Studies course by highlighting the civic engagement component. It could be used by the Art department if they were to highlight the graphic design component. The larger writing parts of the project could certainly be used by an English Department. All in all, I designed this for 8th grade Science students but in reality, it is flexible enough to fit in multiple disciplines.

To effectively use this content in a classroom, I would recommend following a similar order of this capstone. I think the first topic worth exploring is the natural flow of water through rivers, percolation and watersheds. I would then move to discuss how city utilities manage stormwater. The next area of instruction would surround influx events and the risk it poses to watersheds. You could then encourage a community service component by encouraging the students to actually adopt a drain. Overall, I feel that this type of an education unit in your classroom would be well-received and appropriate for all Minnesota students.

## **Conclusion**

The capstone project, as designed by the NSEE program at Hamline University provides a process for a thorough and rigorous educational endeavour in which one explores all aspects of a topic that is important for one reason or another. For me, my capstone project combines a variety of passions in my life. This capstone uses aspects of community service, education, environmental stewardship and civic duty. These areas are pillars of passion for me as a student, teacher, environmental enthusiast, and citizen. It is my sincere hope that the rationale, educational foundation, literature review and

logic for my capstone are presented within these chapters. When I ask the question

*“How can community service efforts be integrated into student learning to reduce river pollution caused by stormwater runoff?”* I hope that this capstone provides instructions

and information to address this essential question.

## CHAPTER FOUR:

### **Introduction**

Throughout my educational journey through this Master's program and specifically this capstone, I have attempted to keep the big picture in mind. I understand that in the end of this quest I will have added significant credentials to my resume but the growth is so much more. This program represents a second wave of education, growth and learning for me as a student, teacher, and environmentalist.

I am the product of two very different families coming together. I emphasized my family in the introductory parts of this endeavor because my family is everything to me. My father's modest side of the family is represented by a variety of hard-working blue collar Americans including farmers, veterans, construction workers, masons, plumbers and small business owners. They valued and respected a quality education but to them, that education was developed on the job or in the military. My mother's side of the family is rather different. They believed that your education came from a book in a classroom or library. I am proud of myself because I feel that in my experiences, I have honed my craft in both the trade world learning valuable skills on the job and by excelling in academia, culminating in this Master's Degree in Natural Science and Environmental Education.

### **What I Have Learned**

My capstone project has focused on the ability and goals of local citizens and students to take ownership of their community impact on pollution by attempting to reduce stormwater runoff pollution entering the watershed via storm drains. I have asked

the question *“How can community service efforts be integrated into student learning to reduce river pollution caused by stormwater runoff?”*

Throughout this capstone project, I must say that I learned a great deal about the environment, municipalities, engineering, watersheds and ultimately, myself. I was thankful to have access to incredible resources such as the Bush Library at Hamline University as well as other research tools such as the SIRS Researcher, CERC Database, Viking Library System, and others. I was pleased to be able to use accumulated resources from my previous undergraduate and graduate level courses to aid in this project.

As a writer I learned that it is important to get to the point efficiently. All too often we come across references that include valuable data and information but it is buried deep within many pages of fluff. As a writer, I have grown to be able to translate complicated terminology and explanations into an easy to understand format. I have learned to be thankful for previous writing assignments that have developed my writing skills.

As a learner, I realized that I still have what it takes to set a goal and work towards meeting and exceeding those expectations. Sometimes I think that teachers can be the worst students because we get too comfortable at the front of the class and less energetic about being a student. As a learner, I also quickly realized that it is important to surround yourself with a network of professionals that can support your efforts.

### **Revisiting the Literature Review**

I conducted an extensive and rigorous literature review to develop this project. In doing so, I found that the most valuable research for this project came in the form of local conversations with Henning Utilities Supervisor Scott Grabe. Mr. Grabe served as a priceless resource throughout this project. He provided me with walking tours of Henning's Utilities and also shared maps and personal experiences with me to help me understand the storm drain setup for our community. Prior to our interview, I assumed the storm drains were interconnected with the sewage system. When I initially learned that there are two separate systems then I thought naturally that they flow into the Leaf Lakes. After communicating with Mr. Grabe, I was interested to learn that the systems splits into an East outlet into Willow Creek and a West outlet into Brandborg Creek. (Personal Communication, 2018)

I also found it helpful to read up on the various AAD programs being sponsored by other communities such as Minneapolis, St. Paul, San Francisco and many others. I liked reading about similarities between programs and looking for subtle adjustments from city to city. The local watershed districts in each of these case study cities provided me with a new connection to the literature review and opened up a whole new world of research resources. AAD programs that are already in place emphasize civic engagement, safety, stewardship and support to make the programs successful. (Megan, R. A. , 2014)

### **Project Implications**

I feel that my project has implications for the city of Henning as well as many other small communities. I believe that I have created a unit plan that will provide

guidance to teachers to begin an AAD program in their small towns. Throughout the project I have explained the various reasons why larger cities struggle with AAD programs and used those reasons to understand why smaller communities could be successful. By using the local school district, its students and teachers, I truly feel that the AAD program can be successfully and efficiently implemented into a small town. I would like to think of my capstone project as a “grass roots” campaign to help our local watersheds.

### **Project Limitations**

My project is far from perfect and probably even flawed but it is a start. My project was designed knowing the specifics of the classroom, district and community in which I teach. I know that my unit plan will struggle with various limitations from district to district but hopefully fellow educators see enough value in the unit to at least use it as a base or template and adjust it to meet their local needs.

One benefit of a small district like the one where I am employed is that I know for sure I am the only science teacher so I guarantee that I will be teaching the course. In other districts, teachers may be shuffled around and that mixup could present some challenges to the AAD service project unit plan. Another limitation of my project could be the lack of cooperation from your local city government or even your administration. The unit plan is aligned to standards and begins in a traditional manner however it quickly morphs into some cutting edge learning environments that may not be acceptable to some administrations or department leads.

### **Future Projects**

The beauty of teaching science is that we are never finished. There is always a next step. As I mentioned recently, my unit plan is far from perfect and therefore I think it could be modified and changed after getting more experience. I could see teachers omitting certain lessons or even adding others. Ideally, I would like to see my unit plan become an interdisciplinary unit that fosters collaboration between the science department, social studies department and english department. The science teacher could emphasize the environmental impact whereas the social studies teacher could utilize the civics component and our english colleagues could work with the journaling and writings. I see no reason why an art department couldn't get involved using the signage and chalk art pieces. One interesting approach would be for multiple grade levels to attack this project. Imagine the 8th graders doing the lesson plans and then employing the efforts of the 7th grade to help clean drains in teams while the 6th graders are in charge of the art pieces. This could all be profiled and become a writing project for 9th graders and so on. The options are endless and that, in itself, is one of the finer points of my project. By being flexible, it has the ability to evolve with the times.

### **Communicating Results**

The results of this endeavor would be communicated first and foremost by student learning. I could imagine this project would make for a great news story in the local media outlets. If a student were looking for a major research project, I would propose they take initial stream quality data as a baseline, implement this program for a period of time and track water quality results over that window. This would be an ultimate step in finding out if our community service efforts truly are making a difference.



## **Project Benefits**

This project reflects a benefit to the environment, community and schools. My project is a benefit the environment because it protects local creeks and rivers. As mentioned before, these waterways are polluted heavily when toxins and waste are rinsed down storm drains. Even if one creek isn't connected to a runoff outlet, chances are they are all interconnected at some point in the watershed.

My project is a benefit to the community because it connects, engages and motivates citizens to take ownership and responsibility within their community. Informed citizens are more likely to support local business, participate in government, vote, volunteer and benefit the community. One added benefit of this project is that by having clean drains, clean gutters and clean streets, it also helps improve the overall appearance of a city or neighborhood.

This project is a benefit to the education profession because it offers more than just lesson plans. It offers an opportunity for teachers and students to work together for a common goal. It offers a chance for students to see that they can be just as valuable as adults. It is a benefit to our profession because it would require little prep work on the teachers part as it is written but it could be so much more if a teacher chooses to augment or personalize it.

## **Conclusion**

As I conclude my capstone research project, it is important to realize that the end is nowhere near in sight. We still have a long way to go in protecting our watersheds and educating students and citizens. This version of AAD provides the basics to undertake a

project and answer the question “*How can community service efforts be integrated into student learning to reduce river pollution caused by stormwater runoff?*” Even though I expect my project will change from town to town, I am confident that the answer to my question is provided within this project and we, as a community of citizens, students, teachers and stewards can work together to learn, grow, protect and serve.



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