

Transformative Technologies Group Research Project

2023 Transportation Technology Tournament

Submitted by:

Team Greenway

May 2023

The Herff College of Engineering

The University of Memphis

Memphis, Tennessee

CONTENTS

1.	Team description	1
1.1	Team Members	1
2.	Abstract	1
2.1	Summary of Problem	1
2.2	Background	1
3.	Team Dynamics and Methodologies	2
3.1	Team Meeting Schedule	2
3.2	Team Member Roles	2
3.3	Tentative Project Deadlines	3
4.	Description of Problem	3
4.1	Dynamics of Problem	3
4.2	Requirements for Solution	4
4.3	Stakeholders	4
5.	Description of Solution	4
5.1	Approach to Address Problem	4
6.	Solution Estimates	6
6.1	Work	6
6.2	Estimated Costs	6
6.3	Timeline	6

7.	Anticipated Impacts	7
7.1	Health Benefits	7
7.2	Operational Benefits.....	7
7.3	Safety Benefits	7
7.4	Environmental Benefits.....	8

1. TEAM DESCRIPTION

1.1 Team Members

James Tyler Hardin – University of Memphis – Electrical Engineering

Anthony Dontoh – University of Memphis – Civil Engineering

Allan Abraham – University of Memphis – Electrical Engineering

Trey Justice – University of Memphis – Electrical Engineering

Lan Ca – California State University Long Beach – Civil Engineering

2. ABSTRACT

2.1 Summary of Problem

The Nashville DOT is looking for solutions to deal with issues that occur on Culbertson Road along Mill Creek in Nashville, Tennessee. This is a narrow local road that deals with three main issues which are seasonal flooding, speeding, and illegal dumping. They are also looking for a possible solution to converting this route into a greenway connection that connects to the existing Mill Creek greenway. Nashville DOT is looking for innovative traffic calming strategies as well as technology-based solutions to improve the overall safety of the residents that live along this route.

2.2 Background

Culbertson Road is a narrow local road that is as narrow as 18 feet at some points. This area is constantly used for cut-through traffic since it connects the main roads in that area. The area already has some cameras placed along the route, but they do not seem to be too effective

against speeding traffic. They do not have anything to prevent illegal dumping and nothing to prevent the nearby creek from flooding the road.

3. TEAM DYNAMICS AND METHODOLOGIES

3.1 Team Meeting Schedule

Our team decided to have team meetings during our set class times at the University of Memphis which was Monday and Wednesdays from 4-5:30 pm. We also had extra meetings on the weekends and Mondays right after class from 6-7:00 pm if we needed to catch up or meet certain deadlines. Since we have a member that is from Cal State University, we also had zoom meetings to catch them up on anything we discussed in class.

3.2 Team Member Roles

Anthony Dontoh - Leader: Focused on research for implementing traffic calming strategies.

Allan Abraham - Secretary: Focused on research for implementing methods that mitigate illegal dumping and speeding.

Lan Ca - Coordinator: Focused on research to address the flooding problem and possible solutions.

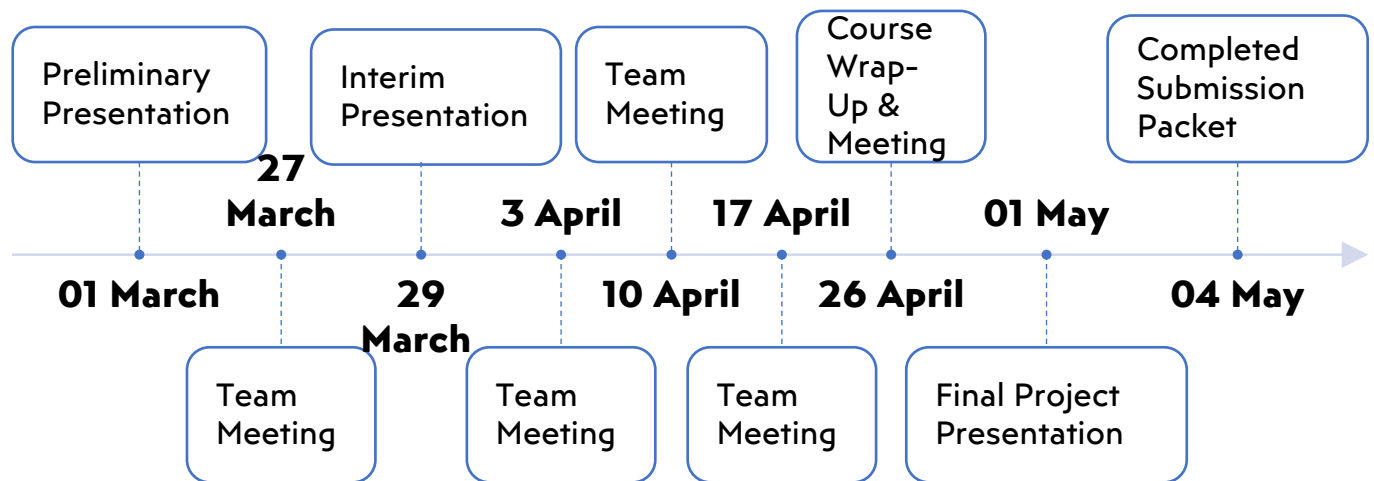
James Tyler Hardin - Arbitrator: Focused on research for innovative ways to implement electrical based components to road design.

Trey Justice - Arbitrator: Focused on research for improved planning and design methods for greenway implementation.

3.3 Tentative Project Deadlines

Since our team is participating in this tournament for a transformative technology class our deadlines are based on the time, we had to submit everything in the semester. Our timeline and deadlines are based on the end of our semester. Figure 1 shows the tentative deadlines.

Figure 1: Tentative Project Deadlines



4. DESCRIPTION OF PROBLEM

4.1 Dynamics of Problem

This area faces three major problems that negatively affect the residents living along the route. The main issue is seasonal flooding because Mill Creek runs along the route and is around the same elevation as the road. When any rain occurs, it does not take much for the creek to flood the road and make it undriveable. Illegal dumping is another issue that has yet had any solutions to prevent this behavior. This illegal dumping causes the flood drains to be clogged which does not help the flooding problem. It also can negatively affect the wildlife that live in this environment. Speeding is another issue along this route because it is used as a cut-through road to access the main highways. This is very unsafe for the families that live in the area and the

drivers since it is such a narrow road. There are a few cameras along the route, but they do not seem to be too effective in preventing speeding and illegal dumping.

4.2 Requirements for Solution

The Nashville DOT is looking for innovative traffic calming strategies to help prevent the speeding issue. They are also looking for technology-based solutions that could possibly deter speeding and illegal dumping in this area. Transformative technology needs to be applied to address each one of these issues and create a better environment overall. They are also looking for a long-term plan to convert this route into a greenway connection and connect it to the existing Mill Creek greenway.

4.3 Stakeholders

The stakeholders of this problem are mainly the residents that live along Culbertson Road. They are affected the most and looking for solutions to convert this route into a safer area to ensure the safety of their families. The Nashville DOT could also be considered a stakeholder since they strive for safety of their roads and transportation in the city.

5. DESCRIPTION OF SOLUTION

5.1 Approach to Address Problem

Flooding:

- Wetlands - to store flood waters that overflow riverbanks or surface water that collects in isolated depressions and restore habitat.
- Floating wetlands - to remove excess nutrients and pollutants from the water, improve water quality, reduce erosion.

Growing water absorbent plants and trees along the creek to absorb water and beautify the landscape. These solutions can help address the flooding problem and create a green pathway to attract more pedestrians.

Speeding Traffic: In view of the extant literature available on various traffic calming measures, speed humps are proposed to handle the issue of speeding traffic on Culbertson Road. For optimum benefits, speed humps will be combined with artificial intelligence which is handled by other professionals in the project. The justification for using speed humps is that the length of the road is 1.5 miles and having two installed just at the start and end of the road respectively will be good. Speed humps are also quite easy to install and cost effective and are effective in reducing mean speed of drivers.

Illegal Dumping: To prevent illegal dumping, we plan to implement a visual recognition and classification model using machine learning. We will first sample the videos and extract frames. Then it will identify and classify bulky waste in each area using visual recognition. The model will be trained with many similar images with different values of brightness and contrast, taken from different angles and in varied light conditions. Based on the used training set, the classifier will estimate the model's confidence between 0 and 1 based on its classification. From this we collect data on where people are most likely to dump trash the most and what trash is usually thrown. Then we can plan and decide where to place garbage bins and how big it must be for residents to use.

6. SOLUTION ESTIMATES

6.1 Work

It usually does not take much work to get a speed hump installed. The road surface needs to be cleared of any debris or obstacle that could prevent its installation. After that, it just needs to be leveled and anchored to the road surface. For the visual recognition and classification machine learning model, most of the work will be done to train, implement the model, and collect data. It takes quite a lot of work to get wetlands functioning properly and will be the only proposed solution that could take months to establish.

6.2 Estimated Costs

Rubber speed humps costs about a few hundred dollars. The cost of installation and maintenance will depend on the agency contracted. Ranging from a few hundred dollars to a thousand dollars would be ideal to install a single speed hump. The overall cost to install two speed humps on Culbertson Road is two thousand dollars. The cost of implementing wetlands is not known yet.

6.3 Timeline

Based on several consultations done, the physical installation of a rubber speed hump normally takes several hours. However, in cases of adverse conditions, it can take up to a day before a speed hump can be installed. Rubber speed humps are cost effective and easy to install. For the visual recognition and classification machine learning model, it will usually take around one or two weeks to create the model. However, it might take a month to collect data and plan

where to place the garbage bins. Similarly, Wetlands normally take several months to years to implement.

7. ANTICIPATED IMPACTS

7.1 Health Benefits

Wetlands are significant ecosystems that offer many advantages to both people and wildlife. Firstly, wetlands serve as natural filters that capture and remove contaminants from water, thus improving water quality. More importantly, wetlands mitigate natural disasters by absorbing extra water and slowing the flow of water, which lessens the effects of natural disasters like floods and hurricanes. Lastly, wetlands give access to recreational opportunities like birdwatching, hiking, and fishing, which can promote physical activities and mental well-being.

7.2 Operational Benefits

Since wetlands can effectively control flooding long-term, they can be used in replacement of expensive flood control infrastructure. Wetlands can also be used to generate electricity by utilizing plant microbial fuel cells (PMFC).

7.3 Safety Benefits

By effectively controlling the flood, wetlands can reduce the flood risk and protect nearby communities. They also prevent erosion, protecting roads, bridges, and nearby houses. Furthermore, wetlands can act as natural fire barriers that prevent the spread of wildfires.

7.4 Environmental Benefits

Wetlands play a critical role in maintaining a healthy environment by regulating water flow, filtering pollutants, storing carbon, supporting biodiversity, and maintaining soil health. As mentioned in the Health Benefits' section, wetlands help to regulate the flow of water, which can help prevent flooding and erosion downstream. They also help to maintain water levels during dry periods, which is important for supporting aquatic life. Wetlands also act as natural filters, removing pollutants such as nutrients, sediments, and toxins from water. Another benefit includes the ability to store large amounts of carbon, which helps to mitigate climate change by reducing greenhouse gas emissions in the atmosphere. In addition, wetlands are home to a diverse range of plant and animal species, many of which are rare or endangered, so they provide important habitat for migratory birds and other wildlife. Lastly, wetlands help maintain soil health by preventing erosion and promoting nutrient cycling, supporting agricultural productivity, and maintaining healthy ecosystems.