

An exploration on the impacts of warehouses on municipalities



WPI

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By:

Diana Binney

Axel Luca

Yicheng Si

Project Sponsor:

Nashua River Watershed Association
(Martha Morgan, Jessica Veysey Powell)

Project Advisor:
Professor Paul Mathisen

Additional Special Thanks to:
Anne Ogilvie

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Abstract

The goal of this project was to create a summary of potential impacts warehouses may have on municipalities and watersheds in Massachusetts and to use that summary to develop recommendations for communities. Information for this project was collected through visits to the case study location of Lancaster, Massachusetts, interviews, and thorough content analysis of warehouse documentation and permits. Through this research, we have found a variety of environmental, social, and economic impacts that warehouses can have that are both beneficial and detrimental in nature. We have also created recommendations for municipalities on matters such as mitigating unwanted impacts and reactions, increasing information availability and accessibility, and expanding communications.

Table of Contents:

Abstract	I
Table of Contents:	I I
List of tables	V
List of figures	V I
Executive Summary	V I I
Acknowledgement	I X
Authorship	X
1.0 Introduction	1
2.0 Background Chapter and Literature Review	3
2.1 Warehouses and Distribution Centers	3
2.2 Impacts of Warehouses and Distribution Centers	5
2.2.1 Environmental Impact	5
2.2.2 Economic and Social Impacts	6
2.3 Efforts to Mitigate Unwanted Impacts	6
2.3.1 Zoning and Land Use Laws	6
2.3.2 Media Pressure	7
2.4 Nashua River Watershed Association and Lancaster, Massachusetts.....	7
3.0 Methodology	9
3.1: Case Study of Potential Warehouse Siting in Lancaster, Massachusetts.....	9
3.2: Identify and Explore Other Warehouse Siting Situations.....	10
3.3: Develop Summary	11
3.4: Draw Conclusions and Recommendations from Summary	11
3.5: Run Recommendations by our Sponsor and Develop Brochures	11
3.6 Project Deliverables	12
4.0 Findings and Results	13
4.1 Data collected from case study in Lancaster, Massachusetts	13
4.1.1 Site Visits.....	13
4.1.2 Water Quality Tests	15

4.1.3 Overview of Interviews.....	16
4.1.4 Data Interpretation.....	18
Overall view on opinions regarding warehouse constructions.....	19
Potential positive and negative impacts of warehouse construction.....	20
Overview of Intra-community Relationships.....	21
4.1.5 MEPA Analysis.....	22
4.2 Research Conducted About Other Towns.....	24
Lunenburg.....	24
Shirley.....	24
Douglas and Gardner.....	24
Northborough and Devens.....	25
4.3 Discussion of Findings.....	25
5.0 Recommendations and Conclusion.....	27
5.1 Conclusion.....	27
5.2 Recommendations.....	27
5.2.1 Increase Information Availability/Accessibility.....	27
5.2.2 Expand Communications.....	28
5.2.3 Mitigate Unwanted Impacts and Reactions.....	29
5.3 Concluding Thoughts and Recommendations for Future Work.....	30
6.0 References:.....	32
7.0 Appendices.....	38
7.1 Picture of forest coverage.....	38
7.2 Picture of Bow Brook.....	38
7.3 Picture of the wooden bridge.....	39
7.4 Picture of the solar array.....	39
7.5 Picture showing planned warehouses.....	40
7.6 Picture showing the closeness between planned warehouses and residential buildings.	40
7.7: Site Walk Narrative and description.....	41
7.8 Picture of map of Lancaster.....	42
7.9 Map of the southern part of Lancaster (South Lancaster).....	43
7.10 Website of denied access.....	44
7.11 Draft Interview Questions.....	44
7.12 Interview Preamble.....	45

7.13: Project Timeline:.....	46
7.14 Summary of Potential Impacts and Recommendations.....	46
7.14.1 Potential Impacts.....	47
7.14.1.1 Environmental Impacts.....	47
7.14.1.2 Social Impacts.....	47
7.14.1.3 Economical Impacts.....	48
7.14.2 Recommendations.....	48
Increase Information Availability/Accessibility.....	49
Expand Communications.....	49
Mitigate Unwanted Impacts and Reactions.....	50
7.15: Brochures:.....	52

List of tables

Table 1: Information on different types of warehouses (Olimjonovich, 2022).....	4
Table 2, Key Findings During First Site Visit by Car	14
Table 3, Key Findings During First Site Visit On Foot.....	15
Table 4, Water Test Results	16
Table 5, Number of Mentions about Information People Wish Others Should Knew Better	19
Table 6, Number of Mentions of Positive Impacts by Warehouses	20
Table 7, Number of Mentions of Negative Impacts.....	20
Table 8, Number of each response when asked about ideas on how to ensure a positive intra-community relationship	22

List of figures

Fig 1 Major Sub-Basins of the Nashua River Watershed (Nashua River Watershed Association - Board and Staff, n.d.).....8
Figure 2, Lancaster Site Walk Route..... 14
Figure 3, Resident Time Lived in Lancaster 19

Executive Summary

The goal of this project was to create a summary of potential impacts warehouses may have on municipalities and watersheds in Massachusetts and to use that summary to develop recommendations for communities. Information for this project was collected through visits to the case study location of Lancaster, Massachusetts, interviews, and thorough content analysis of warehouse documentation and permits. We then summarized all the information and input collected from visual analysis, interviews, and the content analysis. This included the environmental, social, and economic impacts that warehouses may have found in these parts, as well as the reaction from the municipality on some of these impacts.

We began this project by conducting background research. We first explored the makeup and variety of warehouses and distribution centers. Then, we discussed the impacts that they had on municipalities in three different categories: environmental, economic, and social. After that, we shared what had already been done to combat negative impacts and highlighted good ones. Finally, we introduced our case study in Lancaster, Massachusetts. In order to accomplish our goal, we developed the following five objectives.

- Objective 1: Develop Case Study of Potential Warehouse Siting in Lancaster, Massachusetts
- Objective 2: Identify and Explore Other Warehouse Siting Situations
- Objective 3: Develop Summary
- Objective 4: Draw Conclusions and Recommendations from Summary
- Objective 5: Run Recommendations by our Sponsor

To achieve these objectives, we created a summary and two trifold brochures on the possible impacts warehouses may have on watersheds and municipalities. We collected the majority of our data through interviews and site visits about the impacts of warehouses on communities and watersheds, focusing largely on the area around Lancaster but also looking into other Massachusetts municipalities as well. Through content analysis and 11 interviews, we also obtained information about some environmental, social, and economic benefits and detriments that warehouses can bring.

We also visited a site proposed for warehouse development a number of times and conducted water quality testing on a local brook in Lancaster to learn more about the local natural features. Additionally, by interviewing nearly a dozen Lancaster residents, we were able to gain the citizens' perspectives regarding these municipalities' concerns, including how they feel and what ideas they have concerning the proposed developments. Following the site visits we also conducted a water test and learned that the streams are less polluted than other streams in the watershed. A secondary goal was to develop recommendations for municipalities to aid them in mitigating unwanted impacts and in creating positive community/company relationships.

The broad environmental impacts were found to be in the following areas: water pollution, air pollution, land pollution, noise pollution, and light pollution. The broad social impacts collected were increased traffic and safety issues. The broad economic impacts collected were as follows: Increased revenue, decreased taxes, increased jobs and decreased property value. To address these findings on environmental, economic, and social impacts, as well as intra-community relationships, we have developed recommendations. The

recommendations are listed in three main categories: mitigation of unwanted impacts and reactions, increasing information availability/accessibility, and expanding on communications. The categories are listed below.

- Keep information about the development as easily accessible as possible
- Maintain active communication with both proponents and opponents of the development in the community
- Discuss with developers their efforts to mitigate unwanted impacts

To strengthen these recommendations we recommend the town make them public by including them into the official town bylaws when possible. Doing so will give people more assurance that these measures will actually be followed through.

We have two primary recommendations on how to improve information availability and accessibility in municipalities in regards to warehouse development. These recommendations included:

- Create ease of access to notable documents
 - Provide easy electronic access to all permits, applications, reports, etc. regarding the construction project via the town website
 - Provide easy physical access to copies of all permits, applications, reports, etc. regarding the construction project through the town hall
- Provide an edited version of notable reports that state the main points and are easy to read by the average resident

In order to help towns or municipalities to better mitigate unwanted impacts and ensure a relatively positive relationship within the community, we have the following recommendations about setting up meetings if given time and resources to expand communications:

- All stakeholders are involved
- Give free time to let concerns be expressed
- Active participation from all sides
- Provide specific examples of tangible mitigation plans
- Provide a specific estimation of monetary values with all factors possible included

We have some recommendations on how to mitigate possible unwanted reactions such as rising tensions among the residents due to increased warehouse construction in town. These recommendations are:

- Provide a descriptive, thorough cost-benefit analysis or analyses of the construction
- Make the town agree on (a) time period(s) where there will be no/minimal traffic to and from the constructed warehouses
 - An example of such time periods would be typical peak commuting hours.

Overall, the construction of a warehouse in a municipality can have many impacts on the environment, society, and economy of the community. In this project, we encapsulated all of these effects into one of our three deliverables—a summary of all potential impacts warehouses may have on watersheds and municipalities. We then provided recommendations based on these impacts in our second deliverable, which is the recommendations we developed for the municipalities. Finally, we organized this data into a visual and simple format in our third deliverable, which took the form of two trifolds that can be created and distributed to residents of municipalities.

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Authorship

Content	Author(s)	Editor(s)
Table of Contents	Yicheng Si	Yicheng Si
Abstract	Diana Binney	Diana Binney
Executive Summary	All	All
Acknowledgement	Yicheng Si	Diana Binney
1.0 Introduction	All	All
2.0 Background Chapter and Literature review	Diana Binney	Axel Luca, Yicheng Si
2.1 Warehouse and Distribution Centers	Axel Luca	Diana Binney, Yicheng Si
2.2 Impacts of warehouses	Yicheng Si	Diana Binney, Axel Luca
2.3 Efforts to Mitigate Unwanted Impacts	Diana Binney	Axel Luca, Yicheng Si
2.4 Nashua River Watershed Association and Lancaster, Massachusetts	Yicheng Si	Diana Binney, Axel Luca
3.0 Methodology	Diana Binney	Axel Luca, Yicheng Si
3.1 Case Study of Potential Warehouse Siting in Lancaster, Massachusetts	Axel Luca	Diana Binney, Yicheng Si
3.2 Identify and Explore Other Warehouse Siting Situations	Diana Binney	Axel Luca, Yicheng Si
3.3 Develop Summary and Brochures	Yicheng Si	Diana Binney, Axel Luca
3.4 Draw Conclusions and Recommendations from Summary	Yicheng Si	Diana Binney, Axel Luca
3.5 Run Recommendations by our Sponsor and Develop Brochures	Diana Binney	Axel Luca, Yicheng Si
3.6 Project Deliverables	Diana Binney	Axel Luca, Yicheng Si
4.0 Findings and Results	Diana Binney	Axel Luca, Yicheng Si

4.1 Data collected from case study in Lancaster, Massachusetts	Axel Luca	Diana Binney, Yicheng Si
4.1.1 Site Visits	Yicheng Si	Axel Luca, Diana Binney
4.1.2 Water Quality Tests	Yicheng Si	Axel Luca, Diana Binney
4.1.3 Overview of Interviews	Axel Luca	Diana Binney, Yicheng Si
4.1.4 Data Interpretation	All	All
4.1.5 MEPA Analysis	Diana Binney	Axel Luca, Yicheng Si
4.2 Research Conducted About Other Towns	Axel Luca	Diana Binney, Yicheng Si
Lunenburg	Diana Binney	Axel Luca, Yicheng Si
Shirley	Axel Luca	Diana Binney, Yicheng Si
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4.3 Discussion of Findings	Diana Binney	Axel Luca, Yicheng Si
5.0 Recommendations and Conclusion	Yicheng Si	Diana Binney, Axel Luca
5.1 Conclusion	Diana Binney	Axel Luca, Yicheng Si
5.2 Recommendations	Yicheng Si	Diana Binney, Axel Luca
5.2.1 Increase Information Availability/Accessibility	Diana Binney	Axel Luca, Yicheng Si
5.2.2 Expand Communications	Yicheng Si	Axel Luca, Diana Binney
5.2.3 Mitigate Unwanted Impacts and Reactions	Axel Luca	Diana Binney, Yicheng Si
5.3 Concluding Thoughts and Recommendations for Future Work	Axel Luca, Yicheng Si	Diana Binney
6.0 Appendices	By Section	By Section
Site Pictures	Diana Binney, Yicheng Si	N/A
Site Walk Description	Yicheng Si	Diana Binney

Maps	Axel Luca	N/A
Northborough Website	Yicheng Si	N/A
Interview Preamble & Example Questions	Diana Binney	Axel Luca, Yicheng Si
Timeline	Diana Binney	Yicheng Si
Summary of Potential Impacts & Recommendations	All	All
Trifold Brochures	Yicheng Si	Diana Binney, Axel Luca
7.0 References	Axel Luca	Diana Binney, Yicheng Si

1.0 Introduction

Industrialization, the transition of previously simple operations and/or manual operations to complex, mechanical, automated operations, is everywhere you look. It is present in all aspects of our day-to-day lives: public transport, roads, jobs, schools, etc. Despite this, many impacts of industrialization are not given the attention they deserve. The smaller the community, the bigger impact a large industrialization project could have on it, especially in regards to warehouses. With enticing benefits of new jobs and tax dollars and scary issues ranging from an increase in pollution to loss of local businesses, these matters are dealt in terms of predictions, probabilities, and “potentials” (Fichtinger et al., 2015; see also Richards, 2018). Without reliable information available for small towns, and strategies to allow the benefits to outweigh the negatives, towns are at a disadvantage.

Warehouses and distribution centers can have significant impacts on a community. For example, the town of Lancaster, Massachusetts, a small community in Massachusetts, has a number of warehouses and distribution centers that are under construction or planned to be in the near future. The impacts of those warehouses and distribution centers on the environment, society, and economy of municipalities are currently unknown and need to be discovered. This is—especially the case for a small agriculture-centered community like Lancaster (*Lancaster MA* | n.d.; see also *Explore Census Data*, n.d.).

In Lancaster, Massachusetts there have been efforts to understand the warehouse development and its potential impacts on the municipality. Beyond Lancaster, Massachusetts as a whole has made progress in understanding the impacts of warehouses and on mitigating unwanted impacts. Local conservation groups look at the negative environmental impacts of warehouses on nature and have a wealth of information in that area. An example of such is a project called “Research on design and optimization of green warehouse systems based on case analysis”. The goal of this research was to provide a facility optimization technique that can both minimize warehouse carbon emissions and contribute positively to the overall environmental impact (Ren et al., 2023). Broad efforts to mitigate unwanted impacts can be found in zoning laws. Through zoning, everything gets its own space to exist with minimal negative effects on surrounding areas. Houses and conserved lands can be maintained without warehouses built right on top of them. Massachusetts have state-wide zoning laws, and towns have their own individual laws as well that are tailored to their area (*Business Improvement Districts (BID) | Mass.Gov*, n.d.).

While this does allow for case-by-case situations, it also leads to a major lack of communication about what is exactly effective at stopping unwanted impacts.

The goal of our project was to give municipalities information about the impacts of warehouses so that they can have more effective interactions with companies looking to develop in their area. We accomplished this by developing a summary containing the possible impacts of warehouses on watersheds and municipalities primarily in Massachusetts. By doing this, we gave communities the required knowledge in order to give them the best chance to have good interactions with companies looking to develop in the area. To do this, we collected and used information collected from the case study in Lancaster. In order to accomplish our goal, we developed five objectives. Our first objective was to focus on Lancaster, Massachusetts and the situation there. Next, our second objective was to look at other case studies outside of Lancaster to broaden our view. We accomplished these objectives through content analysis, site walks, and semi-structured interviews. Then, our third objective was to develop a summary based on all the information from the previous two objectives. We then

drew conclusions and developed strategies for positive company/community interaction and ran these strategies and the summary information by our sponsors. Based on our sponsors' thoughts and advice, we then developed two trifold brochures that are easy to read and understand.

The final deliverables of this project was a summary of potential impacts of warehouses and the recommendations for communities, which were developed in objectives three and four. The summary can be found in Appendix 7.14, the two trifold brochures can be found in Appendix 7.15 the method of formulating the summary can be found in section 3, and recommendations can be found in section 5.2.

2.0 Background Chapter and Literature Review

Industrialization, the transition of previously simple operations and/or manual operations to complex, mechanical, automated operations, is everywhere you look. Despite this, many impacts of industrialization are not given the attention they deserve. The smaller the community, the bigger impact a large industrialization project could have on it, especially in regards to warehouses. With enticing benefits of new jobs and tax dollars and scary issues ranging from an increase in pollution to loss of local businesses, these matters are dealt in terms of predictions, probabilities, and “potentials” (Fichtinger et al., 2015; see also Richards, 2018). Without reliable information available for small towns, and strategies to allow the benefits to outweigh the negatives, towns are at a disadvantage.

In this chapter we begin by exploring the makeup and variety of warehouses and distribution centers. After that, we discuss the impacts that they have on municipalities in three different categories: environmental, economic, and social. Then we will share what has already been done to combat negative impacts and highlight good ones. Finally, we will introduce our case study in Lancaster, Massachusetts.

2.1 Warehouses and Distribution Centers

Warehouses have proven to be very advantageous in the United States not only because they can be used to store and deliver a variety of materials such as food, medicine, wine, and furniture, but also because they can provide a variety of other types of impactful services (Bingqing & Liting, 2020). Statistics show that the number of warehouses in the U.S. grew consistently from about 14,000 in 2007 to 20,000 in 2021. Additionally, by the first quarter of 2021, the total industrial space in the U.S occupied by warehouses was about 10,000,000,000 square feet (Bureau of Labor Statistics, 2022; see also JLL, 2021). The U.S Department of Transportation’s Federal Highway Association defines a warehouse as a “storage place for products” and states that “principal warehouse activities include receipt of product, storage, shipment and order picking” (Freight Glossary and Acronyms - FHWA Freight Management and Operations, n.d.). On average, warehouses are built with a height of 31 feet (Logistics Management, 2021). Two known warehouse general frame structures are called steel frame and rack supported structures. Steel frame structures have three common structural options: simple beam, portal frame, and lattice structure. Portal frames are the most popular option for spans of 32 to 196 ft, while lattice structures are used for longer spans and heavy loads. Rack supported structures utilize steel storage racking as the basic support for the roof and walls of the building (Vujanac et al., 2017). The rack supported structure design concept aims to reduce construction costs while maintaining storage capacity (Vujanac et al., 2017). While the cost of construction of warehouses varies depending on the state, the costs range from \$75 up to \$200 per square foot (Statista Research Department, 2022). Of all the estimated 1,600,000 employees working for the warehousing industry in January 2021, the breakdown by job is about 310,000 employees were industrial truck and tractor operators; 330,000 of them were laborers and freight, stock, and material movers; 73,000 of them were shipping, receiving and traffic clerks; 340,000 of them were stock clerks and order fillers; 17,000 of them were transportation, storage, and distribution managers; and the remaining 550,000 of them were assigned to other various positions (Industries at a Glance, n.d.). By January 2022, there were about 1,900,000 total employees working for the warehousing industry, showing that there were about 300,000 people newly hired to work in the warehousing industry over the course of the year 2021 (Industries at a Glance, n.d.).

When selecting appropriate sites for warehouses, various factors such as the type of products, distribution costs, traffic conditions, and construction costs are taken into consideration. The location of a warehouse plays a crucial role in determining the efficiency of warehouse operations. To select appropriate warehouse locations, a couple known methods that companies often use are computer-based warehouse site location analysis and analytic hierarchy processes to select the best site. (Vlachopoulou et al., 2001; see also Bingqing & Liting, 2020).

When selecting appropriate sites for warehouses, various factors such as the type of products, distribution costs, traffic conditions, and construction costs are taken into consideration. The location of a warehouse plays a crucial role in determining the efficiency of warehouse operations. To select appropriate warehouse locations, a couple known methods that companies often use are computer-based warehouse site location analysis and analytic hierarchy processes to select the best site. (Vlachopoulou et al., 2001; see also Bingqing & Liting, 2020).

There are a variety of types and functions of warehouses (see Table 1) (Olimjonovich, 2022; see also Van den Berg, 1999). Distribution centers are important to consider because they can have significant impacts on communities and this type of warehouse has been proposed for small towns such as Lancaster, MA, and other communities in Massachusetts. Also known as fulfillment centers, distribution centers generally only store products with a high demand in the region where the company is located and are charged with guaranteeing that certain products remain in stock in a particular area. They receive goods from company production centers and store these items that are eventually sent to end customers. Their purpose is to minimize delivery time, prevent any disruptions to the supply process, and to provide end customers with good service. Accordingly, distribution centers typically accommodate many pallets of a single product with a high turnover that allows it to be tracked (Olimjonovich, 2022).

Table 1: Information on different types of warehouses (Olimjonovich, 2022).

Type of Warehouse	Description	Key Characteristics
Distribution Center	Strategic logistics facilities located close to end customers to minimize delivery times and ensure products remain in stock	Houses high demand products, high turnover, focused on providing good service to end customers
Production Warehouse	Stores goods required for manufacturing operations and feeds company production lines	Located near production centers, connected to plants, stores raw materials, production parts, components, and semi-finished products
Order Picking Warehouse	Ensures agile and error-free order preparation process	Equipped with storage solutions for direct access to goods, optimized for time and space efficiency, incorporates manual and/or automated storage systems
Consolidation Center	Helps businesses speed up shipping and prevent errors during shipping phase	Stores orders by SKU, shipping route, and end customer, implements automated systems to streamline logistics strategy and reduce transportation overcosts

2.2 Impacts of Warehouses and Distribution Centers

To understand the influences of warehouse and distribution centers, we explore the positive and negative environmental, social, and economic impacts.

2.2.1 Environmental Impact

Warehouses can significantly impact the environment. They contribute to greenhouse gas emissions, pollute surface waters, harm watersheds and soil, introduce heavy traffic loads and increase the total paved parking area, the latter of which can lead to stormwater runoffs and pollutant deposits, and can lead to deforestation and habitat destruction if not properly planned. Some of the more significant impacts are included in this section.

First warehouses are the second most impactful emitters of greenhouse gasses (Fichtinger et al., 2015). Most warehouse emissions occur in the supply chain process during transportation (McKinnon, 2010). According to research by Fichtinger in 2015, buildings account for 13% of emissions, and warehouses are a big part of the buildings. Heavy-duty trucks and forklifts are the most common consumers of fossil fuels in warehouses and contribute to greenhouse gas emissions (Nantee & Sureeyatanapas, 2021). Moreover, the electricity used by warehouses in the United States consists of 61% electricity generated from fossil fuels (U.S. Energy Information Administration, 2021).

Second, warehouses may cause harmful unwanted metals and other pollutants to be added to surface waters like rivers, ponds, lakes, or streams through a watershed. One way harmful metals are deposited is through the accumulation of sediment from polluted air onto paved parking lots, roadways, and warehouse roofs; rainwater runoff washes this pollution into the water system (Astatkie et al., 2021).

Activities within warehouses that generate harmful metals and other unwanted compounds as byproducts will eventually pollute the soil and earth around them. After a heavy storm, the pollutants from the soil and the roof's runoff will be washed into the water system (Graney & Eriksen, 2004). In a study in southern Ethiopia, researchers discovered that significantly higher concentrations of zinc, lead, nickel, copper, chromium, and cadmium were elevated in the area of a pond around a warehouse than in other parts of the pond. They also found that some of the elements were deposited a long time ago and have persisted ever since (Astatkie et al., 2021).

Third, warehouses with a lack of parking spaces for freight trucks create traffic jams on local roads, which often cannot endure heavy traffic loads (Gnap et al., 2017). It also can introduce a great amount of truck traffic to the local area due to normal warehouse operations. A study done on warehouses by KIA motors in Korea shows that a 2-hour wait is prevalent for all vehicles due to the lack of truck parking spots. In the United States, high waiting time and increased traffic load is also prevalent (Yuan, 2021). This will cause trucks to pile up on narrow country roads and introduce noise pollution and elevated traffic loads to the local area. In the long run, increased truck traffic will also introduce damage and destruction to pavements and roads too. With the incentive of more parking spots, more paved parking lots will be constructed, which may cause additional environmental impacts.

Finally, warehouse development can also impact the environment through deforestation and habitat destruction. When warehouses are planned and built in an area of environmental concern or areas of forest preservation, it may lead to deforestation and habitat destruction. In a study in the Amazon forest in Brazil, researchers found that with the considerable roof area of a warehouse in 2013, even if the warehouse was 1.25-1.56 miles away, it also polluted the

feeding areas, washed away the mudflats and removed bird nesting areas (Cardoso, 2013). Additionally, in the Amazon Forest, the construction of warehouses also leads to significant deforestation (A & Carvalho, 2022), causing further habitat loss. In Massachusetts, land developments—such as warehouses and distribution centers—introduce habitat fragmentation to the local pond and forest areas. Habitat fragmentation can lead to habitat destruction, which is the leading cause of decrease in wildlife. (Land Development in Massachusetts, n.d.). In a study about developments in Essex and Middlesex, research found that the land development also relates to reduction in forest and other protected open-space infringement which can lead to an increase of both air, and noise pollution in the area.

2.2.2 Economic and Social Impacts

Warehouse's impact on the local economy and society includes impacts on workers, tax revenue and local employment opportunities.

Local governments may also impose high property tax and corporate income taxes on the distribution centers in their area. In some cases, high tax rates may wipe out the company's income tax burden and most of the sales tax burden (Walczak, 2015); which in turn will cause companies to cut costs and hurt workers' salary and working conditions.

However, if the developers have outlined a specific business plan and stick with that, it may generate tax revenue to the local town and community, relieving the burden from residents' shoulder of paying taxes and help the town economically (Bartholdi & Hackman, 2008). Additionally, if the business plan is well laid out, it will also generate a great number of job openings that can increase the town and its neighboring communities' employment rate.

2.3 Efforts to Mitigate Unwanted Impacts

2.3.1 Zoning and Land Use Laws

Currently, the federal government has three groups that focus on land use in the United States: the U.S. Department of Housing and Urban Development, the United States Department of Agriculture, and the Bureau of Land Management. However, across these three departments, land usage laws surrounding warehouses in small communities are practically nonexistent (*Q and A about HUD*, 2017; Conservation, n.d.; About, n.d.). With communities themselves not being protected federally, the task primarily falls to each individual state. Massachusetts, at present, has very few state-wide rules regarding zoning and land usage (but the state does have laws around wetlands protection). Under current law, cities and towns are responsible for passing zoning ordinances and bylaws (Business Improvement Districts (BID) | Mass.Gov, n.d.). While this allows for case-by-case situations, it means there is no cohesive data about what works and what does not, as well as a lack of guidelines to aid municipalities in creating their zoning laws.

In Massachusetts, the town of Lancaster has bylaws to protect water resources in the town limits, including but not limited to prohibiting building on certain areas that may destroy or otherwise impede upon the water quality of said area (Town of Lancaster, MA, n.d.). However, Lancaster's wetlands protection bylaws were put into action in 2007, which was over a decade ago (Town of Lancaster, MA, n.d.). While the bylaws have not changed, the towns have had significant changes in terms of development and population. This uneven rate of development means that the protections in place are likely ineffective or perhaps even completely useless.

2.3.2 Media Pressure

Media is a way of bringing attention to an issue. Due to the fact that it is up to the municipality what is allowable, some construction of warehouses can be controversial to the residents of the municipality, and, in most cases, local residents seek media attention to raise the profile of the warehouse construction. These criticisms can focus on the societal and environmental impacts that the warehouses may have, such as loss of local businesses or increase in pollution. Negative public opinion in Needham, Massachusetts led to potentially positive changes, as the large outcry convinced developers to change their plans to try and make most people happy (Ballantyne, 2020). Not all negative reactions cause positive changes or are even loud enough to be acknowledged. In Chicago's Little Village community, racism and environmental neglect by companies have quieted the voices of the residents who are protesting harsh pollution that has led to nearly 50 deaths (Isaacs, 2020). While media outcry can lead to positive changes, it is not a tool that always works. Additionally, the media does not always disavow these developments, as they are not wholly without benefits to the community.

Positive reactions to warehouse development do occur, and these reactions are typically due to the economic opportunity that the warehouses can offer. Warehouse jobs are seen as beneficial entry-level jobs, allowing workers not only to receive pay but also to pad their resume for the future. With the "relatively healthy effect" that these warehouses have, there are a multitude of people who see warehouse construction as a positive advancement of their community. These warehouses are not without their own controversy, of course. Despite this many still see the positives outweigh the negatives on a larger scale (AP Technology Writer, 2017). In 2022, FedEx suggested the prospect of opening up a distribution facility in Taunton (Schemer, 2022). This was received with excitement from the community, as it was proposed in an area where there would be no disruption of public roads and would create around 150 new jobs. Positive media reactions may not always be reflective of the will of the citizens of the municipality. A study conducted at Harvard found that the vast majority of media is either owned by the federal government or by private owners, typically families (Shleifer et al.). This means that a good portion of the media is not controlled by these locals or even the states they are living in, resulting in a high possibility for miscommunication, ignorance, or even purposeful incorrect statements being made. While the media is a strong tool, it is not necessarily an accurate one.

With all of this in mind, it is important to make sure that the voices one is hearing through the media are authentic stories from real people affected by the developments. Additionally, it is crucial to look at a variety of perspectives—to not just focus on all positives and all negatives, but to have a holistic approach. By doing this, the media is a powerful tool that can allow one to bear witness to situations beyond their own town.

2.4 Nashua River Watershed Association and Lancaster, Massachusetts

The above-mentioned impacts are currently being experienced in Lancaster, Massachusetts. The town is within the Nashua River watershed, and there are a number of warehouse locations being planned and executed around the area. Because of that, we consider Lancaster, Massachusetts for this project as a case study, as it is a town located in the central-northern part of the state. It has an area of 73 with 1.3 of water and 71.8 of land, which is 28.18 with 0.5 of water and 27.72 of land (Lancaster MA |, n.d.). Lancaster has a total population of 8,441 and an unemployment rate of 4.9% as of 2021 (Explore Census Data, n.d.).

The unemployment rate in the state of Massachusetts is 3.7%, which puts Lancaster in a category of slightly higher unemployment rate.

The Nashua River Watershed Association, or NRWA, is a non-profit organization located in Groton, Massachusetts. The organization was founded in 1969 by Marion Stoddard and has become the regional leader focusing on the protection for 32 watershed communities in north central Massachusetts and southern New Hampshire, where the Nashua River and its neighboring watersheds are located.

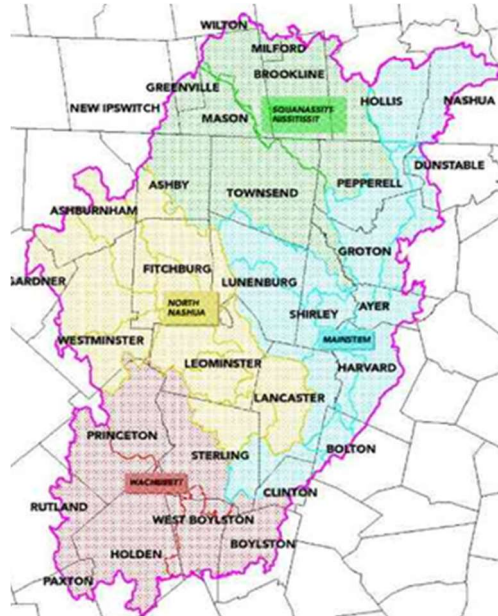


Fig 1 Major Sub-Basins of the Nashua River Watershed (Nashua River Watershed Association - Board and Staff, n.d.).

The NRWA would like to help communities have more agency in the placement of distribution centers, and they wish to help local communities to better understand the development of the warehouses and how to mitigate some of the impacts through this project.

3.0 Methodology

The goal of this project is to develop a summary containing the possible impacts of warehouses on watersheds and municipalities in Massachusetts and strategies to help communities plan and coordinate construction. To do this, we collected information and used the proposed warehouses in Lancaster, Massachusetts on the Nashua River Watershed as a case study for this data. In order to accomplish our goal, we developed the following five objectives.

- Objective 1: Develop Case Study of Potential Warehouse Siting in Lancaster, Massachusetts
- Objective 2: Identify and Explore Other Warehouse Siting Situations
- Objective 3: Develop Summary
- Objective 4: Draw Conclusions and Recommendations from Summary
- Objective 5: Run Recommendations by our Sponsor

3.1: Case Study of Potential Warehouse Siting in Lancaster, Massachusetts

The first step of this project was to better understand the impact of warehouses in Lancaster. To achieve this objective, we planned on conducting semi-structured interviews with a diverse group of community members and conducted content analysis on relevant Lancaster planning documents. The use of semi-structured interviews offered multiple benefits. The first benefit was that the use of semi-structured interviews allowed for the ability to formulate questions that directly related to the project's goals. On top of that, it also allowed for an analysis appropriate to the technique of open questioning and enabled the development of analytical categories and instruments in response to the demands of the material collected rather than being restricted to a list of topics that were predetermined in advance (Wolff, 2004). We planned to begin our interviews with people and organizations that were concerned about the impacts of warehouses. However, only interviewing those concerned about the impacts of warehouses would have given us a narrow view of the situation and biased data. Therefore, in order to gain more diverse perspectives, we also planned on interviewing some of Lancaster's residents, and people who were concerned about the development of warehouses as well as people who supported most warehouse development projects. Example questions that we may have asked during the interviews we conducted were "What changes have you noticed over the past few years in Lancaster?" and "What fears do you have about warehouse construction in Lancaster?"

In addition to avoiding bias, we also planned on interviewing both proponents and opponents of warehouse development in Lancaster because by doing so, we would have been able to not only see opinions from both proponents and opponents of warehouse development in Lancaster, but also see what terminology people use and how they define it. This information would have helped us discover if there are any misconceptions between groups of people that may not typically directly communicate—for example, if a certain word has a certain connotation with one group that it lacks with an opposing group (Wolff, 2004). The discovery of these misconceptions along with the data from the interviews would have been able to help us overall understand the general feelings on the matter and showcase what gaps in knowledge needed to be filled so that everyone would be working on the same information. One of the main concerns for this project was the fact that statements made by various stakeholders may, if out of context, cause issues for the stakeholder in question. To address this concern, we have taken steps to mitigate risk to any participants by drafting an informed consent preamble that we will share with

all interviewees. Moreover, to ensure that we were conducting our project in an ethical and responsible manner, we sought approval from WPI's Institutional Review Board (IRB) before commencing any interviews, or site visits and informed all participants of potential risks that could possibly occur with participating in the study before asking them to give their consent for each one of those interviews, and site visits that we conduct. In addition to this, we also stated that all the interviews are inherently confidential at the beginning of each interview so that the interviewees would know that their information would not be released without their consent.

In addition to planning to conduct all these interviews, we also conducted content analysis of planning laws and documents from the town of Lancaster and reviewed a map of the Nashua River Watershed to identify the relevant physical areas involved. An example of an additional document we looked at is the Massachusetts Environmental Policy Act (MEPA)'s Certificate of the Secretary of Energy and Environmental Affairs on the Draft Environmental Impact Report. Through this research, we aimed to gain a comprehensive understanding of the situation, stakeholder opinions and its potential effects on the community in this specific case study.

3.2: Identify and Explore Other Warehouse Siting Situations

While we are doing an in-depth case study of warehouse siting in Lancaster, MA, we want data about warehouse impacts and successful methods to facilitate positive community/company relationships in general. The situation in Lancaster, MA is not unique—industrialization is happening all over the United States. By looking at other cases, we can get a sense of the impacts of warehouses on bodies of water and on small communities and successful mitigation efforts. Additionally, the situation in Lancaster is at an early stage. By broadening our research, we will be able to analyze situations and impacts that may not be apparent until later without having to wait for it to happen to Lancaster itself. While this data might not perfectly apply to Lancaster, it nonetheless is worth looking into—either as a cautionary tale or as an illustration of success.

To accomplish this objective, we conducted online research of warehouse development in towns throughout the state. We found these areas by entering the following search strings into online search engines: “warehouse impacts” and “distribution center effect”. Once we identified several examples, we will then dove deeper into these communities by reviewing all relevant articles and statistics we could find. We searched newspaper databases and any studies that may have been conducted in the area. We analyzed the information we collected to identify similarities or differences. Further we reviewed town board, town planning, and other relevant committee meeting minutes to see how the matters were handled during each step of the warehouse development. By looking at both the development of the warehouse and the community's respective reactions to it in each stage, we expanded our knowledge of what the impacts are. While these cases may have already concluded, observing past situations can help us understand the warehouse siting process and community reactions. Furthermore, by reviewing a full situation that has already happened, we will be eliminating any bias we may have by unconsciously drawing conclusions of what will happen later (Wolff, 2004). We also visited any areas we could to observe matters firsthand. Regardless of if the warehouse is built or not, we wanted to look through the thought processes of proponents and opponents of the development to try to find similar threads of logic between different communities. These places that we looked at include Northborough, Lunenburg, and Devens.

For data analysis in regards to this objective, we had collected data from online research. We used tools such as coding, categorization, and qualitative decision matrices for this objective, and this helped us categorize and select qualitative data into a format suitable for a summary.

3.3: Develop Summary

After researching and collecting data and information from objectives one and two, we developed a summary to help communities understand the impacts of warehouses, and the strategies to manage and address these impacts.

During this process, we organized all data and information into different set groups and divided them into quantitative data and qualitative information. We structured our guidance such that it includes organized data and information groups. We reviewed and assessed the data we have collected and information we have gathered through interviews and selected the data and information that we deem most relevant to our project goal and required research. Within the two organized data groups, we separated our data into environmental-impact-related, economic-impact-related, and possibly social-impact--related. We then identified the necessary data and information for the summary and structured the summary based on the identified data and information. We also used comparative analysis for all the qualitative information with comparative tables and key words coding. By using this method, it helped us to identify common concerns and most frequently mentioned worries during our interviews. In addition to that, we used simple decision matrices for our qualitative data. These tools helped us better formulate our summary and draw conclusions based on the data we have collected.

We then used the data collected to form the summary for municipalities. After separating our data into groups, we started putting the data and information into the sections of the summary that matched the organized groups.

3.4: Draw Conclusions and Recommendations from Summary

After having input data into the summary, we started analyzing the data and information within the summary and started looking for potential patterns and trends that can indicate a warehouse's impact on watersheds and small municipalities. We also formulated trends and similarities from the information contained in the summary and drew conclusions based on the similarities and differences in both environmental and economic situations.

After we analyzed the data, we created recommendations that the surrounding municipalities can use so that they can make informed decisions on planning and construction; also, they can use the recommendations to have a better knowledge on how to mitigate impacts that they deem unwanted while they do their current and future planning and zoning of new warehouses.

As zoning and planning the development of warehouses was a sensitive topic around our focused area, there were obstacles and hardships that could stop us from gathering data from all stakeholders. We were mostly able to reach out in our capacity as students from Worcester Polytechnic Institute rather than advocates of one side to help reduce assumptions towards us and help us be viewed as objective. We were not fully successful due to the lack of input from interviews with proponents of warehouse developments. The majority of the proponent contacts either did not respond or replied with no comment. Because of that, our conclusions and recommendations may have limitations.

3.5: Run Recommendations by our Sponsor and Develop Brochures

Once we developed the summary with all the information and developed findings and recommendations, we shared them with our sponsors and project stakeholders. We shared our findings and recommendations in a meeting using a PowerPoint presentation and sought their feedback via facilitated discussion. We were not fully successful due to the lack of input from interviews with proponents of warehouse developments. The majority of the proponent contacts

either did not respond or replied with no comment. Because of that, our conclusions and recommendations may have limitations.

3.6 Project Deliverables

We developed a summary of information that municipalities, such as Lancaster, and residents can utilize when considering permitting warehouse construction in their community. This summary compiled important variables that individual towns must consider. Such variables include possible social, environmental, and economic impacts. We strove to find out why residents did or did not support warehouse construction and to take their thoughts into consideration. In short, this summary will be used as a repository of information collected during the project. We used all the information in the summary to develop recommendations for the municipalities for them to reduce the negative environmental and social impacts and improve planning quality. We then took these recommendations and fashioned them into two trifold brochures that are easy to read.

4.0 Findings and Results

For this project, a primary goal was to create a summary on the possible impacts warehouses may have on watersheds and municipalities. We collected a lot of data about the impacts of warehouses on communities and watersheds, focusing largely on the area around Lancaster but also looking into other Massachusetts municipalities as well. Through content analysis and interviews, we obtained information about some environmental, social, and economic benefits and detriments that warehouses can bring. We also visited a site proposed for warehouse development a number of times and conducted water quality testing on a local brook in Lancaster to learn more about the local natural features. Additionally, by interviewing nearly a dozen Lancaster residents, we were able to gain the citizens' perspectives regarding these municipalities' concerns, including how they feel and what ideas they have concerning the proposed developments. In this chapter, we will display the visual analysis, interview results, and content inspections we found that are relevant to this project. A secondary goal was to develop recommendations for municipalities to aid them in mitigating unwanted impacts and in creating positive community/company relationships. In this chapter, we utilize all of our findings into a conclusion with these recommendations.

4.1 Data collected from case study in Lancaster, Massachusetts

In this section we outlined all the data we have collected during our case study focusing on Lancaster, MA. The data we collected are from interviews, site visits and water tests. This section also analyzes the data and provides a brief conclusion of all findings in the case study. In this section, we present the data that was collected from visual analysis, interview results, and content inspections.

4.1.1 Site Visits

For the case study in Lancaster, MA, we conducted two site walks in Lancaster, MA around the Bow Brook area, next to Fort Pond Road. We primarily focused our site walk around Bow Brook near Fort Pond Road. We focused on analyzing this area mainly because the stream is located close to some of the planned warehouses in the Lancaster area and the stream flows out of Fort Pond itself. We also chose this stream because it is easily accessible for visual analysis and water testing. A detailed location can be seen in Figure 2.

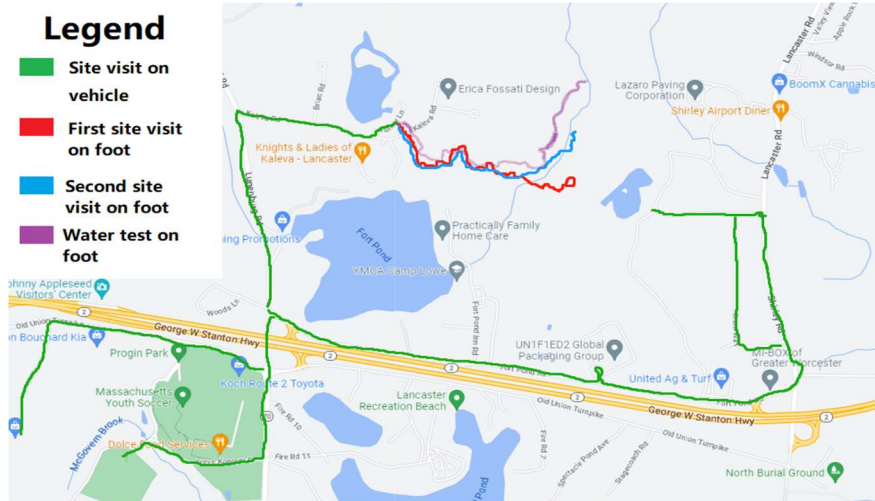


Figure 2, Lancaster Site Walk Route

In the first site walk, we spent an estimated three hours on site, visually analyzing the presence of nature in the area. We have noticed a number of things that are deemed important to the locals. Concerns and locations of interest include roadways, increased traffic, environmental concerns, and industrial approximation.

This visit included travel by car and walking routes. The key points we have learned during our first site visit by car are marked in green on the map and are summarized in table 2. A brief description of the entire process of all site visits can be found in Appendix 7.7:

Table 2, Key Findings During First Site Visit by Car

Key Findings	Occurrence	Comments
Poorly maintained road	Prevalent	The roadways are old and poorly maintained.
Short entry and exit ramp	4 Occurrences	The entry and exit ramps are very short and almost non-existent. Trucks using the ramps may experience hardships of joining the highway.
Narrow roadway	Prevalent	The roads are narrow and without traffic lights. An increased traffic due to warehouse operations will cause trucks to back up.
Tiny roundabout	1 Occurrence	The one roundabout in the town is not suitable for large trucks and trucks will take a long time to navigate through them.
Distance between warehouse and residential buildings.	1 Occurrence	The planned warehouse gate is right next to a residential house (see Appendix 7.6)

During our first site visit on foot, we walked around the area of Bow Brook, which is marked on the map in red. The key findings are listed in the table 3:

Table 3, Key Findings During First Site Visit On Foot

Key Findings	Occurrence	Comments
Forest coverage	Prevalent	Parts of the area are covered with forest and a lot of wild animals' droppings. (See Appendix 7.1)
Clear stream of Bow Brook	Prevalent	The stream is very clear and suitable for coldwater fishery according to locals and experts.
Wooden Bridge	1 Occurrence	There is a wooden bridge as shown in Appendix 7.3
Huge solar panels array	1 Occurrence	Over the hill behind the wooden bridge there is a huge solar array farm as shown in Appendix 7.4
Huge number of planned warehouse with significant footprint	1 Occurrence	There is a wetland surrounded by planned warehouses and eventually will be cut off from the water system as shown in Appendix 7.5.
Diesel sent around	Prevalent	There is a faint diesel smell in the forest.

During the second site visit, which is marked on map in blue, we mainly focused on deciding the location for our water sample testing. In general all of the planned warehouses are overly close to the residence neighborhood, as well as to the forest and stream shown in the map. which will cause concerns both socially and environmentally in the future.

4.1.2 Water Quality Tests

We conducted one set of water tests during our case study. The location of the water test is marked on the map as the end tip of the purple line. For the water test the main parameters that we were focusing on were bacteria (as indicated by Escherichia coliform, or E. coli), temperature and conductivity. An attempt was made to test for the dissolved oxygen, but the results were inconclusive.

With information provided by our sponsor NRWA, we've learned that during this water sample all the sampled streams have lower-than-normal units of E. coli, and the sample of Bow Brook sits as the lowest among the samples. The water test shows that the stream is in a relatively good shape, with lower-than-average E. coli units of 7.45 colony-forming units / 100 ml of water suggesting that the water is less polluted than other main streams by bacteria that indicate pollution from animal or human fecal matters. For reference, results across our sites ranged from: 1.0 - 99.0. Last year, with the drought, we had values that were > 2420 cfu / 100 ml in several places. The results of the tests are presented in Table 4.

Table 4, Water Test Results

Attempts Results	Attempt 1	Attempt 2	Attempt 3
Temperature	14.3°C	13.9 °C	13.8°C
Conductivity	484 µs	497 µs	498 µs
E.coli	7.45 colony-forming units / 100 ml of water		

From our collected water sample data, we can conclude that Bow Brook right now is less polluted in terms of E. coli, which indicates that the water is less polluted by sewage and human or animal fecal matters than other sample locations in the area.

On top of that, after reviewing zoning and regulations, we can conclude that even though the developers are in compliance with state standards, there is still some work to be done in regards to noting areas of concern and sharing mitigation efforts.

4.1.3 Overview of Interviews

In this section, we present a general overview of all the information obtained throughout all of our conducted interviews. A large subset of the questions we asked our interviewees can be found in Appendix 7.11. For the purposes of this case study, we sent out interview invitations to both proponents and opponents of warehouse development primarily in Lancaster. In addition to this, we also sent out interview invitations to people who oversee regulations regarding commercial development and environmental policy. Out of all of the people whom we sent out interview invites to, seven of them did not reply back to us at all, four of them stopped replying, three of them declined our interview invites, and twelve of them were successfully interviewed. Out of those twelve people, one of them was a town official from the Massachusetts Department of Environmental Protection while the remaining eleven were residents who lived close to actual proposed warehouse constructions such as the one on 696 Fort Pond Rd in Lancaster. However, what all twelve of our interviewees had in common was that they had concerns regarding potential impacts warehouse construction could bring to a town. Now, out of the fourteen people who either declined our invites, stopped responding, or didn't respond to our invites at all, nine of them were town officials, four were people worked for organizations similar to the Nashua River Water Association such as the Ipswich River Watershed Association and the Connecticut River Conservancy, and the remaining individual was a resident who lived close to actual proposed warehouse constructions such as the one on 696 Fort Pond Rd in Lancaster. While not certain, some possible reasons people either declined our invites, stopped replying, did not respond to our invites at all could be because they did not have time to respond, did not have any specific comments they wished to share, or maybe believed that we held opposing views and did not want to engage. Some of our interviewees have lived in Lancaster for as little as 3 years while others have lived there for as long as over 35 years.

In addition to this, some of our interviewees' favorite parts of the town included things like the town's culture, the fact that it is easy to get around, and specific areas of the town such

as Spec Pond and White Pond. However, more than half of our interviewees mentioned the fact that they particularly like the town for its rural atmosphere and the fact that the town is generally peaceful and quiet. Over the past few years, all of our interviewees noticed at least some kind of changes in the town of Lancaster, but most of the changes seen seem to relate mostly to the town's development. Examples of such developments include large warehouses with solar fields, room to add in more commercial, residential development, and car dealerships.

Our interviewees had a variety of thoughts on and experiences with the proposed warehouse construction. Some interviewees were not in favor because they believed it would bring an influx of activity that could change the character of their neighborhood. An example of such activity would be a significant increase in traffic, thus making it harder to navigate around the town. Other people from our interviewees thought that having warehouses with some of the massive sizes proposed would ruin the quality of life in the town and make the town lose its rural atmosphere due to their close proximity to neighborhoods and the amount of light and noise pollution they might bring. An example of such is how constructing massive warehouses could lead to pollution and habitat destruction. In addition to this, our interviewees each had a set of hopes and fears related to this kind of proposed warehouse construction. A specific hope that most of our interviewees had was that the proposed warehouses would not be built in the town. This is due to reasons like them being skeptical that developers will find tenants and that traffic will be moderate and condensed to typical business hours. Another key hope mentioned from our interviewees was to have more collaboration between local neighbors and developers in terms of planning these kinds of developments.

They also hoped that, if these kinds of developments were to happen, mitigation efforts would be added to reduce unwanted effects. Examples of these would be high retaining walls, reasonable fencing, landscape buffers to drown out sound, and restrictions on the type of lighting used. Some of the interviewees' fears in regards to warehouse construction in the town include traffic congestion, truck noise, and diesel smells, and the possibility of the warehouse operating 24/7, which would be unpleasant for residents who live nearby. Most of the other fears mentioned were mostly related to traffic. Examples of such include the fact that increased traffic may make getting anywhere in the town more difficult, and cause multiple accidents. After getting information about our interviewees' hopes and fears in regards to warehouse construction in the town, we asked them to tell us about their ideas about the potential environmental, social, and economic impacts that warehouse construction in the town could have as well. Although most of our interviewees were not necessarily experts on all these fields, the majority of them are still stakeholders as they are residents who will be impacted by the warehouses. Because of this, it is crucial to take all of their concerns into consideration. One of the main environmental impacts mentioned is the use of diesel trucks, the resulting diesel particulate emissions, and increased air pollution. Additionally, our interviewees thought that warehouse construction would increase air pollution, and stormwater runoff into the Nashua River. Our interviewees were also worried about the impact on local wildlife and that the air pollution caused by increased trucks would drive off local animal species.

We also asked the interviewees about their perspectives on the social impacts of warehouses, including both the effects on the society and the reactions from residents on those and other various outcomes. To begin, many of our interviewees indicated that they would expect the construction of the warehouse to lead to further conflict among residents and companies. Moreover, some of the buildings' sizes raise concerns about the potential necessity to increase the usage of police and fire services. This may lead to a need to hire more police and fire personnel and purchase more vehicles for the town, which may cause tax increases. Our interviewees also expect traffic to increase exponentially, leading to concerns about emergency services' ability to access the neighborhood due to increased traffic. Furthermore, it would make it more difficult for residents to access everyday activities and work. In addition, some of our interviewees are concerned that the construction of the warehouse may lead to a

decrease in house evaluations for local neighbors.

While most of our interviewees reported that most of the economic impacts of warehouse construction would be rather positive—examples of such being the idea that it will bring money into the town, help balance the budget through economic development, and lead to an increase in job opportunities and tax revenue—there are also concerns that these benefits may not be worth the problems that the warehouse construction may cause. After telling us about all those potential impacts of warehouse construction in Lancaster, a number of our interviewees informed us that this kind of construction was also happening in neighboring towns such as Lunenburg and Shirley.

After this, some of our interviewees informed us that they were able to personally interact with organizations like the town's planning board and the Massachusetts Department of Environmental Protection (MassDEP) in order to express their opinions and concerns about warehouse construction. They indicated that, for all of those meetings, the companies and local boards alike were not able to address our interviewees' concerns to their satisfaction. Another important point brought up by most of our interviewees is that most citizens of the southern part of Lancaster do not seem to realize that if the warehouses are built, they will be affected by them in many ways as well. The southern part of Lancaster is considered to be the part of Lancaster that is below Deershorn Road (see Appendices 7.8 and 7.9 for visual comparison). Therefore, they concluded that the citizens in the southern part of town need to empathize more so that they can work with warehouse corporations better. Due to how divided the people in the town are, our interviewees reported that this itself is a very difficult goal to achieve, if not impossible. Despite this, some of our interviewees did propose some ideas to help make this happen such as starting by limiting truck traffic to certain hours of the day.

4.1.4 Data Interpretation

In this section, we are going to analyze the aforementioned data and visualize it in terms of graphs and charts.

During the interviews, we took detailed notes of each interviewee's responses and analyzed them accordingly. We have utilized word frequency charts to represent the most mentioned keywords to some of the most important questions asked across all interviewees. The frequency chart can be found below.

While primarily an ice-breaker question, "How long have you lived in Lancaster?" allowed us to fully realize how much experience the resident may have with the town. The spread of information collected can be found in Table 1. Overall, the average years the interviewees had lived in Lancaster came out to be about 17.5 years, indicating that they have had spent quite some time in the town and are qualified to speak on how it has changed over the years.

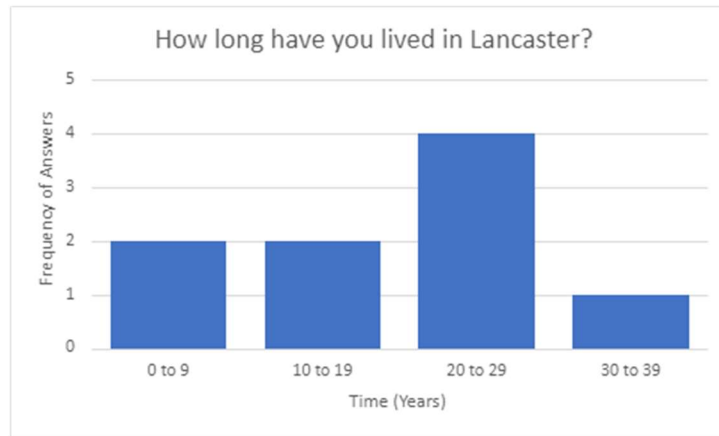


Figure 3, Resident Time Lived in Lancaster

Overall view on opinions regarding warehouse constructions

We asked our interviewees about what they wish the other people in the town who are not as concerned as them to know better about the warehouses being planned. The background information is that the town is quite divided between people who support warehouse constructions and people who oppose it. The two sides usually do not listen to the opinions from the other side. We have received ten responses from all of our ten interviewees, and their responses are mostly similar. The ten responses are categorized and put into a table below, showing the most mentioned and concerned aspects that the 10 interviewees wish that other people in the town should know better. The responses are summarized in Table 5.

Table 5, Number of Mentions about Information People Wish Others Should Knew Better

Information People Wish Others Knew Better	Number of Mentions
Traffic impacts beyond the immediate area	5
True economic impact and costs	3
Complicated nature of the project	2
Power and agency of individuals	1
Other Environmental impacts	1
Impact on water aquifers	1

From Table 5, we can conclude that the most mentioned part that people primarily in Lancaster wish others should know better is the fact that the increased traffic may not only just impact the north part of the town, but the southern part of the town too. This reveals that the increased traffic and all the impact coming with it is really a concern for the locals, Since the increased traffic is mostly trucks, it is very unlikely for them to use Route 2, as the entrance ramp is too short for the trucks to accelerate and the traffic on the road is relatively heavy.

In addition, the number of times that the true economic impact and the complicated nature of the project makes it clear that there are divisions about opinions within the town. From

interviews with Lancaster residents, we have concluded that they have been informed that the developments of the new warehouses will bring tax revenues and economic benefits to the town. However, as mentioned with some of our interviewees, all of the planned warehouses are being built on spec, which means that there are no existing tenants to use those warehouses, making it uncertain how the new warehouses will definitely bring the economy up. On top of that, some of our interviewees have mentioned that the town has lost its reputation as it has made several bad financial decisions before, so the nature of this project and its economic benefits are questioned by some people. The other three points are always brought up during our previous interviews, which means that they are a constant concern for the local residents, mainly about environmental concerns.

Potential positive and negative impacts of warehouse construction

Following all of that up, Tables 6 and 7 show the different potential environmental, social, and economic impacts mentioned by our interviewees and the number of interviewees that mentioned each one of those potential impacts. This was in response to us asking them about their thoughts in terms of what they thought those would be. The potential economic impacts mentioned by our interviewees were typically positive while the potential environmental and social impacts mentioned were all negative. Because of this, it made more sense to create two tables— one for the positive potential impacts mentioned by our interviewees and another one for the negative potential impacts mentioned—than it did to create one table for each of the three types of potential impacts mentioned.

Table 6, Number of Mentions of Positive Impacts by Warehouses

Positive potential impact	Number of mentions
Increase in job opportunities	6
Bring money to the town	6
Tax revenue	5

Table 7, Number of Mentions of Negative Impacts

Negative potential impact	Number of mentions
Increased traffic	8
Water pollution	8
Air pollution	7
Light pollution	6
Noise pollution	6
Habitat destruction	6
Change to the town's aesthetic	4
Roadway congestion	3
Increase tensions between people	3
Emergency response delays	3
Increase in taxes	2

After analyzing the results obtained from Tables 6 and 7, it is clear that our interviewees primarily in Lancaster said that warehouse construction may bring in several positive potential economic impacts such as money to the town and an increase in job opportunities—both of which play a key role in increasing tax revenue. In addition to this, our interviewees also mentioned that warehouse construction may cause a considerable amount of negative impacts such as roadway congestion from increased traffic as well as various sources of pollution and natural habitat destruction

Although our interviewees mostly mentioned positive economic impacts, that does not mean that there are not also negative ones. Based on their responses, there may be a possibility that our interviewees think of the nuisance caused by increased traffic as this is immediately visible and directly affects people's everyday lives. Even so, pollution and the general aesthetics of warehouse constructions are also factors that negatively impact the living standards of a community. With a perceived degraded quality of life, neighborhoods become less attractive, real estate prices and associated tax revenues drop and the town could fail to attract other businesses with less of a negative impact on the environment and the same or higher potential for wealth creation.

Therefore, even though not as immediately perceived by our interviewees, a degraded environment could work against certain short term anticipated economic benefits in the long term. This does not consider the cost of long term health effects from higher pollution, the need for water treatment facilities, and other infrastructure investments required to deal with the impacts listed in Table 7.

Overview of Intra-community Relationships

We asked our interviewees about their suggestions on creating and maintaining a positive intra-community relationship, if it is possible. The responses we received are shown in Table 8. All ten interviewees responded to this question and from their responses we have concluded the following table.

Table 8, Number of each response when asked about ideas on how to ensure a positive intra-community relationship

Response	Number of People Mentioned
Increase the communication and transparency	6
Mitigation and address the community's concerns	5
Compromise and find a middle ground	2
Hiring a mediator or neutral third party	2
Enforcing the laws and hold developers accountable	1
Addressing traffic concerns	1
Encouraging community involvement in decision-making like more effective meetings etc.	1
Understand that the zoning was established a long time ago	1
Total number of people who thought it was impossible	2
Total number of people who had mixed feelings	8
Total number of people who had positive attitude	0

From the table above we can tell that none of the interviewees held an optimistic view towards being able to fix the intra-community relationship. This shows the level of division within the community just because of this warehouse development. Among those people who do not hold a positive attitude, two of them think that it is impossible to mend the relationship within the town, and eight of them gave us some of their suggestions. The most mentioned response that has been provided is that the town needs to increase communication and transparency. Throughout our interviews we have discovered that most of the residents felt that the towns are having "closed door meetings", which they feel left out and not being listened to. From the number of mentions about this suggestion we can tell that the town may really have ignored the locals and put them uninformed during this process.

Additionally, the town needs to address the community's concerns, whether it is about environmental impacts or about taxation benefits. This also falls under the part where the town needs to be more transparent and listen more about the community. After that the interviewees also mentioned that the town also needs to find a middle ground, whether it be through a mediator or by community negotiation. This shows how divided the town is, yet it also shows

how most of the people are still willing to accept some compromise if they feel like they are being listened to.

4.1.5 MEPA Analysis

Part of our content analysis consisted of reviewing the Massachusetts Environmental Policy Act (MEPA)'s Certificate of the Secretary of Energy and Environmental Affairs on the Draft Environmental Impact Report in regards to the proposed construction on McGovern Boulevard in Lancaster. This certificate was published on February 14, 2020 and consists of both the MEPA findings as well as letters from concerned constituents. Key finds related to the warehouse development in Lancaster involve mitigation efforts and reported impacts by the developers, with comments from MEPA.

Ultimately, the Secretary of Energy and Environmental Affairs found that the Draft Environmental Impact Report (DEIR) submitted by the developers to be lacking in several ways, including missing a "comprehensive alternatives analysis nor addressed the potential impacts of the project on a designated Area of Critical Environmental Concern (ACEC), wetland resource areas, and water quality as required in the Scope for the DEIR" (Executive Office of Energy and Environmental Affairs, 2020). In other words, the developers did not submit their own research or mitigation efforts on the impacts the development may have on several parts of Lancaster in a way that was sufficient for MEPA. Major topics addressed by the MEPA certification included traffic, environmental impacts, and mitigation efforts. These are reviewed in the following paragraphs

The MEPA certification also explains specific facts about how traffic will be affected by warehouse construction. Due to projected impacts on Route 2 and I-190, the Massachusetts Department of Transportation (MassDOT) requires this project to get a Vehicular Access Permit and the developers had to conduct a Traffic Impact Analysis (TIA) in accordance with MassDOT's regulations. Additionally, an annual Traffic Monitoring Program (TMP) must be conducted to monitor "traffic operations, parking occupancy, and public transportation/pedestrian/bicycle use" after the project is completed with specific steps that must be taken according to the documentation (Executive Office of Energy and Environmental Affairs, 2020). The TMP will not just focus on the highways, but also on roads inside the town such as Lunenburg Road and McGovern Boulevard. The developers also included a Transportation Demand Management (TDM) program in the DEIR, which commits them to several measures focused at reducing traffic issues. While the TIA submitted does reveal that "all intersections and approaches under state jurisdiction are anticipated to operate at an acceptable [Level of Service] during the weekday morning and evening peak periods, except the northbound Route 2 Westbound (WB) Off-Ramp left-turn approach at the Fort Pond Road/Route WB Ramps intersection", it does also state later that the developers have mitigation efforts in mind that the MASSDOT has reviewed and agreed (Executive Office of Energy and Environmental Affairs, 2020). All of these showcase that the developers are acting in compliance with MEPA and MassDOT and are putting forth mitigations to reduce traffic issues.

This certificate also discloses potential environmental impacts of the construction project. While the certificate found the DEIR lacking in terms of environmental mitigation and required the submission of a Supplemental Draft Environmental Impact Report (or SDEIR) as a result, that does not mean that there is nothing present. A portion of the development takes place in proximity to wetlands, so the document notes that they are required to mitigate stormwater and pollutant runoff from entering the wetlands. Additionally, the DEIR states that the project will be designed with water conservation in mind, where measures such as minimizing irrigation and installing low-flow plumbing fixtures will be put into place.

Furthermore, the Secretary notes that the town of Lancaster is the recipient of a planning grant from the Municipality Vulnerability Preparedness Program, and the funding is to be used

to have the town be “assess the Town’s vulnerability to natural and climate-related hazards and to develop and prioritize specific actions to reduce vulnerability to the effects of climate change and improve resilience” and encourages the proponent to discuss with the town how this will tie into the project area (Executive Office of Energy and Environmental Affairs, 2020). We were unable to find out if these discussions ever occurred. However, it is able to be noted that the project is subject to review under the GHG Policy and that “the DEIR includes an analysis of GHG emissions and mitigation measures for the proposed project in accordance with the standard requirements of this Policy which requires projects to quantify carbon dioxide (CO) emissions and identify measures to avoid, minimize or mitigate such emissions” (Executive Office of Energy and Environmental Affairs, 2020). There are also further references to commitments the project developers have made, such as one to “minimiz[e] tree removal in all work zones” (Executive Office of Energy and Environmental Affairs, 2020).

4.2 Research Conducted About Other Towns

To provide a broader review of potential implications and strategies to manage impacts of warehouse development, case studies from other towns were also considered. Information was found on towns including: Lunenburg, Shirley, Douglas, Gardner, Northborough, and Devens.

Lunenburg

Within the last few years in Lunenburg, there was a proposed warehouse construction on Leominster-Shirley Road. This similar situation was not much different from Lancaster in terms of worry regarding traffic impacts. However, a notable difference was that part of the TDM for the development in Lunenburg contained a commitment for the “Provision of Employee Transportation Coordinator (ETC) to disseminate TDM information to tenants” (*Transportation Demand Management (TDM)*). Another distinctive change between the TDM for the Lancaster development and the Lunenburg development is that in the Lunenburg development there was also a commitment regarding the shift hours of the warehouse employees, stating that there will be “encourag[ment] to include scheduling times for truck drivers and warehouse staff that result in primary trip patterns to/from the Site that occur outside of traditional commuter periods” (*Transportation Demand Management (TDM)*).

Shirley

In Shirley, there was a proposed project about adding 21,000 square feet to an existing warehouse located at 3 Patterson Road. While it is much smaller than what is proposed in Lancaster, this construction project raised major concerns about habitat destruction, the town’s aesthetic, and increased traffic. However, while researching about the town, it became clear that Shirley already has mitigations in place to address these kinds of concerns. This is evidenced by the fact that Shirley makes sure that proposed warehouse constructions in their town follow a set of bylaws that relate to things like zoning regulations such as the requirement for a Site Plan Review process, building codes, and regulations related to construction, design, safety, accessibility, energy usage, and environmental performance. An example of such bylaws is one from the Protective Zoning Bylaws which states that “wherever possible, existing natural vegetation and landforms are protected and incorporated into the buffer area” (*Shirley MA* |, n.d.).

Douglas and Gardner

Towns such as Douglas and Gardner have had similar proposed warehouse construction projects of their own in the past such as the approximately 5,100 square foot proposed warehouse construction on 188 Sherman St. in Gardner in 2013. Even though some of the information regarding warehouse construction obtained from researching both of these towns was similar to information obtained from investigating Lancaster—such as that increased warehouse construction could cause increased traffic, roadway congestion, and pollution—new information regarding mitigations that may be taken to address the concerns that they raise was also obtained. The first example of these mitigations would be that the people who are in charge of these constructions may be required to follow rules such as not working at all past certain hours, on weekends, and/or on holidays; having all applicable permits before beginning any construction work; and making sure that all waste materials resulted from any necessary demolition do not end up in places they should not be. Following that up would be the fact that some of those constructions may require legal documents such as the one called the “Developer Agreement”, which highlights certain regulations that the construction manager must follow regarding different aspects such as traffic mitigation, public infrastructure, and roadways (Important Documents | Douglas, MA, n.d.; see also Gardner MA | Official Website, n.d.). This additional information is significant because it may or may not apply in Lancaster. This uncertainty is due to the fact that no evidence indicating one way or another was found.

Northborough and Devens

Towns like Northborough, MA have experienced a greater amount of development than that of Lancaster. In the meeting with developers and town planners, the residents in Northborough also expressed their concerns and thoughts related to environmental destruction, habitat loss, air pollution, increased demographic and traffic as well as snow removal. However, the town seems to be more transparent about mitigations and have developed effective ways to talk to its residents and share their mitigation plans. However, some of the documents are still not publicly available on the governments’ website as shown in Appendix 7.10. Similar things can also be applied to Devens, MA, as the town’s website is not informative enough with mitigating all the concerns that the locals have brought up.

4.3 Discussion of Findings

In this section, we summarize all the information and input collected from visual analysis, interviews, and the content analysis. This will include the environmental, social, and economic impacts that warehouses may have found in these parts, as well as the reaction from the municipality on some of these impacts.

The broad environmental impacts were found to be in the following areas:

- Water pollution
- Air pollution
- Land pollution
- Noise pollution
- Light pollution

Each of these types of pollution also lends itself to additional impacts, such as habitat destruction. This can be of great note, especially if the warehouse is built on or near an Area of

Critical Environmental Concern (ACEC). Furthermore, each of these types of pollution can not just create negative health effects on the flora and fauna of the municipality, but also the residents.

The broad social impacts collected were as follows:

- Increased traffic
- Safety issues

With increased traffic, some further impacts are roadway congestion and emergency service delays. If the infrastructure of the municipality is unequipped to handle both the increase in cars (due to warehouse employees commuting to work) and the increase in trucks, then roadway congestion can become a big issue. This may lead to delays in not only the average resident getting to school, work, or home, but can also hinder emergency services such as ambulances or firefighters from reaching their destination in a timely manner. An additional safety issue is if the town's emergency response force is not equipped to handle what inherent dangers may come with the warehouse construction itself. An increase of people in an area increases crime, which the municipality's police force may not be equipped to handle. Also, in the case of large warehouse construction, the fire department may not have the correct equipment and gear to handle a large fire at one of those warehouses—or even have enough personnel to actively respond.

The broad economic impacts collected were as follows:

- Increased revenue
- Decreased taxes
- Increased jobs
- Decreased property value

With increased jobs and town revenue, warehouses can potentially bring a good amount of money to a financially struggling municipality. The demographic of the town and types of new jobs being offered are two important factors to consider when weighing what percentage of local residents will likely be filling these positions. If the people in the municipality are not the majority of the workers of the warehouse, then revenue may increase in other ways. Due to the resulting increase in commute through town, these new individuals are likely to make purchases for things such as food or gas. With more revenue to the town, taxes may decrease. Decreased taxes can also help residents, allowing goods and services in town to potentially become more affordable and may even aid in drawing in more people to the town. On the other side, potential decrease in property value for areas near the warehouses may also occur, and may lead residents away from these areas.

As one can see, warehouses can lead to a wide variety of impacts in a municipality. All of these impacts should be considered and researched in order for the positive impacts to be taken advantage of, potential detriments to be mitigated to the best that they can be, and all impacts visible to residents and community leaders to create communication and productive discussion.

5.0 Recommendations and Conclusion

5.1 Conclusion

Overall, the construction of a warehouse in a municipality can have many impacts on the environment, society, and economy of the community. For the communities we studied, we found that the negative impacts are largely in terms of pollution and traffic growth. There are mitigation strategies that already exist to combat these concerns. These mitigation efforts are typically legal requirements for the developers to conduct under statewide authorities or laws such as the Massachusetts Environmental Policy Act (MEPA) or the Massachusetts Department of Transportation (MassDOT). Under MEPA, issues such as water pollution due to stormwater runoff must be mitigated with the usage of basins to collect and slow rainwater. With these mitigation techniques not just being recommended but rather legally required, this ensures that all developers across Massachusetts have clear commitments to adhere to. This is the same case with mitigation efforts under MassDOT. Additionally, these statewide organizations also have some permit processes and specific requirements that can cause several negative potential impacts to not happen or are greatly lessened.

We have also found that positive impacts are largely considered to be in terms of societal and economic growth. With warehouses having the potential to lower taxes, increase job opportunities, and bring significant revenue to the town, struggling municipalities are able to utilize the earnings and tax revenue from warehouses to financially aid them. Typically these areas already have land zoned for industrial use, in which case warehouse construction may have a minimal effect on the property value of nearby houses. This is not always the case, however, as there are many places that are zoned for industrial usage and not used for some time or experience enough traffic and noise to still devalue the home.

In this project, we encapsulated all of these effects into one of our three deliverables—a summary of all potential impacts warehouses may have on watersheds and municipalities. This can be found in appendix 7.14. Our second deliverable is our recommendations to the municipalities in order to create positive intra-community relationships as well as successful relationships between the town and the developers. We also created two trifold brochures as our third deliverable that includes our recommendations and advice to be sent out to municipalities.

5.2 Recommendations

To address these findings on environmental, economic, and social impacts, as well as intra-community relationships, we have developed recommendations in three areas: increase information availability/accessibility, expand communications, and mitigate unwanted impacts

5.2.1 Increase Information Availability/Accessibility

Our recommendations on how to increase information availability and accessibility are the following:

- The town could endeavor to make the numerous documents that exist regarding the warehouse construction project accessible for each warehouse on their town website, perhaps under the Planning Board or the Town Clerk.

- Create versions of important documentation that are as easily accessible that have been edited for readability and understanding by the average resident

A large theme that we found throughout our project was lack of information. Throughout our interviews with them, residents of Lancaster repeatedly noted that they felt like they did not have enough information on the new developments; These same interviewees also noted that they felt that their town did not have enough information regarding the construction project either. Additionally, the Massachusetts Environmental Policy Act (MEPA) documentation on Lancaster's McGovern Boulevard project's Draft Environmental Report (DEIR) stated that there was a lack of information about the development details. Even in our project itself, there is a lack of information on warehouse proponents due to being unable to meet with them.

However, for the projects in Lancaster and in other areas, there often is actually a good deal of information available if one is persistent and has the right contacts. For example, in the DEIR report referenced in the MEPA documentation, the warehouse developers clearly put a lot of thought into the potential negative impacts the project may have and how to mitigate them. This level of planning and analysis is legally required of them, along with all of the certification, permitting, and review that is required of it up to this point. However, only a few of our interviewees were able to reference this documentation, despite several claiming to have dedicated a significant amount of time into researching the development. This implies that a good amount of data analysis exists in regards to this project that is difficult to access or entirely inaccessible by the residents of the town. Those who did mention it also mentioned how it is of significant length and has many terms and initialisms that one has to research to fully understand. This is logical, as the primary purpose of these forms are for governmental use, not educational. However, easy access to these reports along with a version that has edits for readability and understanding by the average resident, would definitely help to aid in the understanding of this project by residents. It would also serve to reassure residents that their concerns have been addressed in some capacity, allowing them to feel listened to and acknowledged.

Additionally, the MEPA certification is not the only part of the warehouse construction permitting process that exists, nor does it apply to all warehouse constructions. MEPA only is in effect when certain thresholds are met, and these can be avoided in many places. There are many other documents that exist that all had to be written, reviewed, corrected, and submitted in order for a warehouse to be constructed legally. In an additional way to increase information accessibility, the town could endeavor to make all of these easily accessible for each warehouse on their town website, perhaps under the Planning Board or the Town Clerk. A good example of this suggested format can be found on the town of Northborough's website, where under the Planning Board there is a section about all projects currently under review. These projects are listed by address, and by clicking on the address one is brought to a new page where all documentation on that project can be found. It is not perfect, of course—especially due to the fact that some documents cannot be accessed—but the general formatting is a great showing in information availability, and one that we encourage other towns to replicate.

5.2.2 Expand Communications

In addition with more accessible information, expanding communication is also important. According to the responses we gathered from the interviews with local residents, the concerns related to impacts by warehouse developments leads to a significant division within the community, and it needs to be dealt with immediately with a good strategy. From the analyzed interview responses, we have concluded that the most helpful solution to this problem is to increase the transparency and communication from the town side to make the locals feel

that their concerns are being listened to. Additionally, finding a middle ground between sides can also help the town to mend its internal relationship.

In order to find a middle ground, the concerned citizens in Lancaster suggested that some of the things mentioned in the previous section's table 8 about what information people wish others should know better should be brought up to the proponents of this development. The most concerning parts are traffic impacts to the whole town and the true economic benefit that this project brings. During our interviews some of the interviewees who are Lancaster residents have expressed that they have tried to talk about their concerns but feel being not listened to.

From the research we did about other towns like Northborough, their community relations seems to be much more cohesive than Lancaster's and the main difference between the two towns is the difference in meeting frequencies and meeting productivity. From the meeting minutes from Northborough residents can get information about how mitigation efforts are made to address the concerns brought up in a tangible way by them while in Lancaster, most of the mitigations are not presented tangibly.

In this case, we recommend the municipalities to conduct, if given the time and resources, more frequent and productive meetings that covers the following major points:

- All stakeholders are involved
- Give free time to let concerns be expressed
- Active participation from all sides
- Provide specific examples of tangible mitigation plans
- Provide a specific estimation of monetary values with all factors possible included

However, some example factors that may affect the estimation of monetary values that may not be able to be included are:

- Increase of emergency vehicles and equipment
- Increase of emergency service personnel
- Possibility that the warehouses may be vacant for an unknown amount of time
- Possibility that the current infrastructure may need to be repaired or updated

In addition to that, we also recommend that both sides should come together and try to find a middle ground. Trying to listen to the other side may help to ease the tension and let the other side understand that a conversation is happening, not an argument.

In this case, we suggest the following:

- Find a reputable person in the town as a mediator
- Find someone outside this situation as a mediator
- Make a definitive list of matters that are important to either side
- Try to listen to the point that the other side is making, and try to understand them from their perspective.
- Hosting more meetings to allow for more people to be able to have a chance to say their piece

By following the above recommendations towns should be able to make the residents feel involved and being listened to instead of feeling being ignored. This would help tremendously with the feeling on both sides of the town once the division of opinions is present. Also, finding a mediator would help the town to ease the tension and actually make progress on finding a place that both sides are feeling acceptable. However, since during our research we

did not see any other towns with a mediator, we are unsure about the effectiveness of this method.

For example, as the meeting minutes in Northborough mentioned, since the local residents are expressing concerns relatively similar to the concerns brought up by Lancaster residents. However, the town has hosted meetings that actually have people addressing the concerns in a tangible way so the participants feel like they are being listened to and developing mitigation plans like snow removal storage places. In that way the locals would feel being listened to and can accept a middle ground more easily.

5.2.3 Mitigate Unwanted Impacts and Reactions

Based on all of the responses we obtained from our interviews, it is clear that there exists a wide variety of both positive and negative possible impacts of warehouse development in municipalities. It is in reviewing all of these impacts and weighing them against each other that one can make an informed decision. After reviewing all of the information collected from our conducted interviews, we noticed that most of our Lancaster interviewees thought that the town boards were not listening to the residents and not properly analyzing all of the impacts that the proposed warehouse constructions would bring to the town. The combination of this lack of communication with the town and how divided peoples' opinions were in regards to the impacts of warehouse construction, led to soaring tensions among the people. All Lancaster interviewees stated that they believe warehouse development will bring positive impacts to the town if it is successful. Despite this, the same interviewees mentioned multiple ways that the town would be negatively affected as well. With all of this, the debate about warehouse construction between the people lies within how large those positive impacts will be and if it is worth the resulting environmental and social detriments.

A possible way to mitigate increased tensions among the people is to provide a descriptive, thorough cost-benefit analysis or analyses to not only be conducted, but widely shared amongst the residents of the municipality. This way people can see what factors were considered, how each one was weighed, and also what the project net outcome will be. A second recommendation to address this issue we obtained when conducting our interviews is to make the town agree on a time period during the day where there will be no warehouse operations in order to decrease traffic impact on neighborhoods. This would be beneficial as it would allow residents to have time where there is minimal change from before the warehouse was built. In addition to the increased tensions among the people, other examples of key concerns brought up by most of our interviewees in terms of impacts caused by warehouse construction were the potential environmental impacts and the risk of traffic increase. Some example measures to mitigate environmental impacts such as pollution caused by warehouse construction that can also be found in the Massachusetts Environmental Policy Act Office (MassDEP) documentation include traffic improvements; pedestrian and bicycle accommodations; construction and maintenance of a stormwater management system; restoration and/or replication for impacts to wetland resource areas; using energy management systems; providing solar-ready roof space on the building roofs; and the implementation of construction-period best management practices (BMPs). Typical BMPs on a construction site are silt fences, inlet protection, and site-stabilization techniques (U.S. Environmental Protection Agency | US EPA, 2023). A potential way to mitigate the issue with traffic that again can be found in the MEPA documentation is to install traffic lights at road intersections if needed. Some other ways to address this issue would be to widen roadways and add entry/exit ramps on them.

While these mitigations may have a few flaws—such as potentially being costly—they provide some insights on how people in their town could come together in terms of being able to implement warehouse construction while making sure to minimize its negative impacts along the

way. In order to give them more strength, these mitigating measures could be made public by being included into the official town bylaws. Doing so will give people more assurance that these measures will actually be followed through.

5.3 Concluding Thoughts and Recommendations for Future Work

During this project we have gained knowledge about how a variety of both positive and negative potential impacts that warehouse construction can affect a town. This is to the point where we were able to come up with and recommend mitigation approaches to address these issues. Even so, these mitigation approaches are not perfect and may have flaws such as being costly. This means that it is up to the town planning boards and warehouse construction companies to actually come together in order to implement and create effective mitigations. This must be done in order to minimize the negative impacts of warehouses while preserving the positive ones and protecting the environment.

We have also discovered that opinions can be widely split on due to warehouse construction, and the severity of this split was something that surprised all of us. Through means of more communication and better understanding, the community can better prepare themselves for warehouse developments. It is also through listening to different opinions that the municipalities may be able to ease the tension that otherwise would build inside the community.

In addition to the existing recommendations and the trifold brochures that we have developed, we also developed ideas for how to realistically implement our advice. These are:

- Making the summary, recommendations and brochures publicly available
 - Make a virtual version available freely and without sign-in or proof of identity
 - Make a hardcopy version available and freely distributed
- Encourage residents to be involved with development projects and not be afraid to talk to their town board, the developers, or other organizations
- Ensure town boards are aware of their own financial power and change the mitigation efforts accordingly.

This project is the initial phase to further help the communities and municipalities. If future steps could be taken, then municipalities could better mitigate some of the unwanted impacts by warehouse constructions.

6.0 References:

A, B. M., & Carvalho, C. A. de. (2022). *Territorial relations between deforestation and Rural Environmental Registry (CAR) in the Amazon biome using free software QGIS/PostgreSQL/PostGIS and Data Warehouse Structure*.

<http://www.alice.cnptia.embrapa.br/handle/doc/1150829>

About: Our Mission | Bureau of Land Management. (n.d.). Retrieved February 1, 2023, from <https://www.blm.gov/about/our-mission>

About the U.S. Department of Agriculture. (n.d.). Retrieved February 1, 2023, from <https://www.usda.gov/our-agency/about-usda>

Acronyms Used in Procurement. (n.d.). Office of General Services. Retrieved March 3, 2023, from <https://ogs.ny.gov/procurement/acronyms-used-procurement>

AP Technology Writer, M. O. (2017a, August 2). Amazon, in sign of growth, holds job fair for US warehouses. *Associated Press State Wire: Massachusetts (MA)*. Access World News. https://infoweb.newsbank.com/apps/news/openurl?ctx_ver=z39.88-2004&rft_id=info%3Asid/infoweb.newsbank.com&svc_dat=AWNB&req_dat=0EE19A61357F6E6B&rft_val_format=info%3Aofi/fmt%3Akev%3Amtx%3Actx&rft_dat=document_id%3Anews%252F166068B5D9E4BD08

AP Technology Writer, M. O. (2017b, August 3). Thousands show up for jobs at Amazon warehouses in US cities. *Associated Press State Wire: Massachusetts (MA)*. Access World News. https://infoweb.newsbank.com/apps/news/openurl?ctx_ver=z39.88-2004&rft_id=info%3Asid/infoweb.newsbank.com&svc_dat=AWNB&req_dat=0EE19A61357F6E6B&rft_val_format=info%3Aofi/fmt%3Akev%3Amtx%3Actx&rft_dat=document_id%3Anews%252F1660AB805B5544C8

Astatkie, H., Ambelu, A., & Beyene, E. M. (2021). Sources and level of heavy metal contamination in the water of Awetu watershed streams, southwestern Ethiopia. *Heliyon*, 7(3), e06385. <https://doi.org/10.1016/j.heliyon.2021.e06385>

Ator, S. W., Blomquist, J. D., Webber, J. S., & Chanat, J. G. (2020). Factors driving nutrient trends in streams of the Chesapeake Bay watershed. *Journal of Environmental Quality*, 49(4), 812–834. <https://doi.org/10.1002/jeq2.20101>

Ballantyne, T. (2020, December 17). Board aims to revive zoning proposal Planning officials eye 2021 annual town meeting. *Needham Times (MA)*, A1. Access World News. https://infoweb.newsbank.com/apps/news/openurl?ctx_ver=z39.88-2004&rft_id=info%3Asid/infoweb.newsbank.com&svc_dat=AWNB&req_dat=0EE19A61357F6E6B&rft_val_format=info%3Aofi/fmt%3Akev%3Amtx%3Actx&rft_dat=document_id%3Anews%252F17F6F7924A3649D0

Bartholdi, J., J., & Hackman, S. T. (2008). *Warehouse & Distribution Science: Release 0.89*. Atlanta: Supply Chain and Logistics Institute.

Bingqing, F., & Liting, C. (2020). Study on Warehouse Site Selection based on AHP. 2020 5th International Conference on Information Science, *Computer Technology and Transportation (ISCTT)*, 276–280. <https://doi.org/10.1109/ISCTT51595.2020.00055>

Bureau of Labor Statistics. (November 14, 2022). Total number of warehousing and storage enterprises in the United States from 2007 to 2021 [Graph]. In *Statista*. Retrieved March 24, 2023, from <https://www.statista.com/statistics/873492/total-number-of-warehouses-united-states/>

Business Improvement Districts (BID) | Mass.gov. (n.d.). Retrieved January 13, 2023, from <https://www.mass.gov/service-details/business-improvement-districts-bid>

Cardoso, T. A., & Zeppelini, D. (2013). Migratory shorebirds roosting on a roof in Paraíba, Brazil: Response to a new habitat or loss of the natural ones?. *Ornitologia Neotropical*, 24(2), 225-229.

Conservation. (n.d.). Retrieved February 1, 2023, from <https://www.usda.gov/topics/conservation>

Dan, D., Tanasa, C., Stoian, V., Brata, S., Stoian, D., Nagy Gyorgy, T., & Florut, S. C. (2016). Passive house design—An efficient solution for residential buildings in Romania. *Energy for Sustainable Development*, 32, 99–109. <https://doi.org/10.1016/j.esd.2016.03.007>

Dörflinger, N., Pulignano, V., & Vallas, S. P. (2021). Production Regimes and Class Compromise Among European Warehouse Workers. *Work and Occupations*, 48(2), 111–145. <https://doi.org/10.1177/0730888420941556>

Executive Office of Energy and Environmental Affairs, 2020. (2020). *Certificate of the Secretary of Energy and Environmental Affairs on the Draft Environmental Impact Report*.

Explore Census Data. (n.d.). Retrieved February 10, 2023, from <https://data.census.gov/profile?q=06000000US2502734165>

Fichtinger, J., Ries, J. M., Grosse, E. H., & Baker, P. (2015). Assessing the environmental impact of integrated inventory and warehouse management. *International Journal of Production Economics*, 170, 717–729. <https://doi.org/10.1016/j.ijpe.2015.06.025>

Freight Glossary and Acronyms - FHWA Freight Management and Operations. (n.d.). Retrieved February 23, 2023, from <https://ops.fhwa.dot.gov/freight/fpd/glossary/index.htm#w>

Gardner MA | Official Website. (n.d.). Retrieved April 19, 2023, from <https://www.gardner-ma.gov/ArchiveCenter/ViewFile/Item/327>

Google Maps. (n.d.). [Map of Lancaster]. Retrieved May 1, 2023, from <https://www.google.com/maps/place/Lancaster,+MA/@42.4838139,->

[71.7507119,12z/data=!4m6!3m5!1s0x89e3ee72a5aa8649:0xc814ba06f0215f48!8m2!3d42.4556452!4d-71.6731242!16zL20vMHYwM3o?hl=en](https://www.google.com/maps/place/South+Lancaster,+Lancaster,+MA+01523/@42.4357889,-71.7507119,12z/data=!4m6!3m5!1s0x89e3ee72a5aa8649:0xc814ba06f0215f48!8m2!3d42.4556452!4d-71.6731242!16zL20vMHYwM3o?hl=en)

Google Maps. (n.d.). [Map of South Lancaster]. Retrieved May 1, 2023, from <https://www.google.com/maps/place/South+Lancaster,+Lancaster,+MA+01523/@42.4357889,-71.7507119,14.07z/data=!4m6!3m5!1s0x89e3f1be64f2018d:0xc9f4b095a5babf6c!8m2!3d42.4445363!4d-71.6870138!16zL20vMHYwOXq?hl=en>

Gnap, J., Varjan, P., & Semanová, Š. (2017). Logistics of Entry and Parking of Vehicles at Large Production Companies. *MATEC Web of Conferences*, 134, 00016. <https://doi.org/10.1051/mateconf/201713400016>

Graney, J. R., & Eriksen, T. M. (2004). Metals in pond sediments as archives of anthropogenic activities: a study in response to health concerns. *Applied Geochemistry*, 19(7), 1177–1188. <https://doi.org/10.1016/j.apgeochem.2004.01.014>

Hare, J. A., Borggaard, D. L., Alexander, M. A., Bailey, M. M., Bowden, A. A., Damon-Randall, K., Didden, J. T., Hasselman, D. J., Kerns, T., McCrary, R., McDermott, S., Nye, J. A., Pierce, J., Schultz, E. T., Scott, J. D., Starks, C., Sullivan, K., & Beth Tooley, M. (2021). A Review of River Herring Science in Support of Species Conservation and Ecosystem Restoration. *Marine and Coastal Fisheries*, 13(6), 627–664. <https://doi.org/10.1002/mcf2.10174>

Hills, R. M., & Schleicher, D. (2010). The Steep Costs of Using Noncumulative Zoning to Preserve Land for Urban Manufacturing. *The University of Chicago Law Review*, 77(1), 249–273. <https://www.proquest.com/docview/664784303/abstract/89D806BA8A3C4B66PQ/1>

Isaacs, C. (2020). Environmental Justice in Little Village: A Case for Reforming Chicago's Zoning Law. *Northwestern Journal of Law & Social Policy*, 15(3), 357. <https://scholarlycommons.law.northwestern.edu/njlsp/vol15/iss3/4>

Important Documents | Douglas, MA. (n.d.). Retrieved April 19, 2023, from <https://douglas-ma.gov/DocumentCenter/View/3187/Douglas-Development-Agreement-with-CRG-Executed-7-20-2022>

Industries at a Glance: Warehousing and Storage: NAICS 493: U.S. Bureau of Labor Statistics. (n.d.). Retrieved March 23, 2023, from <https://www.bls.gov/iaq/tgs/iaq493.htm>

JLL. (April 23, 2021). Total industrial space in the United States in the first quarter of 2021, by type (in million square feet) [Graph]. In *Statista*. Retrieved March 24, 2023, from <https://www.statista.com/statistics/873554/industrial-space-by-type-united-states/>

Lancaster · Clinton, MA. (n.d.). Lancaster · Clinton, MA. Retrieved May 1, 2023, from <https://www.google.com/maps/place/Lancaster,+MA/@42.4721661,-71.759295,12z/data=!3m1!4b1!4m6!3m5!1s0x89e3ee72a5aa8649:0xc814ba06f0215f48!8m2!3d42.4556452!4d-71.6731242!16zL20vMHYwM3o?hl=en>

Lancaster MA |. (n.d.). Retrieved February 10, 2023, from <https://www.ci.lancaster.ma.us/>

Land development in Massachusetts: Its effect on the environment within Essex and Middlesex counties from 1990 to 2007 - ProQuest. (n.d.). Retrieved April 11, 2023, from <https://www.proquest.com/docview/742597069?pq-origsite=gscholar&fromopenview=true>

Logistics Management. (November 2, 2021). Average height of buildings in distribution center networks of logistics and warehouse providers in the United States from 2016 to 2021 (in feet) [Graph]. In *Statista*. Retrieved March 24, 2023, from <https://www.statista.com/statistics/947267/logistics-distribution-center-network-average-height-united-states/>

Low Impact Development | Mass.gov. (n.d.). Retrieved April 24, 2023, from <https://www.mass.gov/low-impact-development>

Maro Vlachopoulou, George Silleos, Vassiliki Manthou (2001). *Geographic information systems in warehouse site selection decisions, International Journal of Production Economics, Volume 71, Issues 1–3, Pages 205-212, ISSN 0925-5273.* <https://www.sciencedirect.com/science/article/pii/S0925527300001195>

Nashua River Watershed Association - Overview. (n.d.). Retrieved February 1, 2023, from <https://www.nashuariverwatershed.org/who-we-are/mission-and-history/overview.html>

Olimjonovich, I. O. (2022). MODERN AND TRADITIONAL WAREHOUSES AND THEIR TYPES. *British Journal of Global Ecology and Sustainable Development*, 9, 92-94

Persad, J., & Rocke, S. (2022). Multi-material 3D printed electronic assemblies: A review. *Results in Engineering*, 16, 100730. <https://doi.org/10.1016/j.rineng.2022.100730>

Piekutin, J. (2015). ASSESSMENT OF GROUND WATER POLLUTION IN PARKING AREAS. *Journal of Ecological Engineering*, 16, 153–168. <https://doi.org/10.12911/22998993/601>

Planning Board | Lancaster MA. (n.d.). Retrieved February 15, 2023, from <https://www.ci.lancaster.ma.us/planning-board>

Preventing Warehouse & Distribution Center Impacts To Neighborhoods. (n.d.). Community & Environmental Defense Services. Retrieved April 24, 2023, from <https://ceds.org/>

Q and A about HUD. (2017, September 20). HUD.Gov / U.S. *Department of Housing and Urban Development (HUD)*. <https://www.hud.gov/about/qaintro>

Ren, Q., Ku, Y., Wang, Y., & Wu, P. (2023). Research on design and optimization of green warehouse system based on case analysis. *Journal of Cleaner Production*, 388, 135998. <https://doi.org/10.1016/j.jclepro.2023.135998>

Richards, G. (2018). *Warehouse management: a complete guide to improving efficiency and minimizing costs in the modern warehouse (3rd Edition)*. Kogan Page Ltd.

Schemer, D. (2022, August 22). Excitement grows for planned FedEx facility - What you need to know about project in Taunton. *Taunton Daily Gazette (MA)*, A1. Access World News. https://infoweb.newsbank.com/apps/news/openurl?ctx_ver=z39.88-2004&rft_id=info%3Aid/infoweb.newsbank.com&svc_dat=AWNB&req_dat=0EE19A61357F6E6B&rft_val_format=info%3Aofi/fmt%3Akev%3Amtx%3Actx&rft_dat=document_id%3Anews%252F18C0D27092F61C58

Shirley MA |. (n.d.). Retrieved April 19, 2023, from https://www.shirley-ma.gov/sites/g/files/vyhlf5001/f/minutes/pb_minutes_9-8-2021_final.pdf

Statista. (October 6, 2022). Average construction costs of industrial warehouses in the United States from 4th quarter 2021 to 3rd quarter of 2022, by city (in U.S. dollars per square foot) [Graph]. In *Statista*. Retrieved March 24, 2023, from <https://www.statista.com/statistics/830417/construction-costs-of-industrial-warehouses-in-us-cities/>

Town of Lancaster, MA: Wetlands Protection. (n.d.). Town of Lancaster, MA Code. Retrieved January 27, 2023, from <https://ecode360.com/11813507>

Unfulfilled promises: Amazon fulfillment centers do not generate broad-based employment growth. (n.d.). Economic Policy Institute. Retrieved February 1, 2023, from <https://www.epi.org/publication/unfulfilled-promises-amazon-warehouses-do-not-generate-broad-based-employment-growth/>

U.S. Energy Information Administration. (2021). U.S. utility-scale electricity generation by source, amount, and share of total in 2021. <https://www.eia.gov/tools/faqs/faq.php?id=427&t=3>

U.S. Environmental Protection Agency | US EPA. (2023, April 18). https://www3.epa.gov/npdes/pubs/cu_swposter-final-fullsize.pdf

Van den Berg, J. P., & Zijm, W. H. (1999). Models for warehouse management: Classification and examples. *International journal of production economics*, 59(1-3), 519-528.

Veysey Powell, J. (n.d.). *Linkedin, Jessica (Jessica Veysey) Veysey Powell*. <https://www.linkedin.com/in/jessicaveyseypowell/>

Vlachopoulou, M., Silleos, G., & Manthou, V. (2001). Geographic information systems in warehouse site selection decisions. *International journal of production economics*, 71(1-3), 205-212.

Vujanac, R., Zivkovic, M., Slavkovic, R., & Vulovic, S. (2017). Steel frame versus rack supported warehouse structures/Celicne okvirne konstrukcije na suprot samonosivim regalnim Skladistima. *Tehnicki Vjesnik - Technical Gazette*, 24(4), 1269–1277. <https://doi.org/10.17559/TV-20140226220936>

Walczak, J. (2015, September 4). Location Matters: Effective Tax Rates on Distribution Centers by State. *Tax Foundation*. <https://taxfoundation.org/location-matters-effective-tax-rates-distribution-centers-state/>

Watershed Protection Act | *Mass.gov*. (n.d.). Retrieved January 13, 2023, from <https://www.mass.gov/info-details/watershed-protection-act>

Wigand, C., Brennan, P., Stolt, M., Holt, M., & Ryba, S. (2009). Soil respiration rates in coastal marshes subject to increasing watershed nitrogen loads in southern New England, USA. *Wetlands*, 29(3), 952–963. <https://doi.org/10.1672/08-147.1>

Wolff, S. (2004). *Wolff in Flick et a.* (pp. 153-154, 254).

7.0 Appendices

7.1 Picture of forest coverage



7.2 Picture of Bow Brook



7.3 Picture of the wooden bridge



7.4 Picture of the solar array



7.5 Picture showing planned warehouses



7.6 Picture showing the closeness between planned warehouses and residential buildings.



7.7: Site Walk Narrative and description

On our way to the site, we noticed a number of concerns related to the local roadways. First being the age of the road. The warehouses are being planned next to Route 2, with hope that the traffic can join this ancient highway straightaway. However, we have noticed that because this part of Route 2 is poorly maintained and aged, the exit ramps are short and covered with potholes. The entrance ramp is almost non-existent and joining the road is very dangerous for vehicles like diesel trucks which accelerate very slowly. Additionally, all the roads are very narrow with all roadways being two-lane roadways. The town does not have traffic lights and nor does it have noise proof and insufficient safety features, lots of stop signs as well as roundabouts. The roundabout is also too small for the truck to go through. According to local residents it takes a truck roughly 8-10 seconds to get through. All of these elements may cause the traffic to slow down and trucks to back up, according to the research done by Yuan in 2021, and consequently damage the roads and pollute the area.

In addition to the poorly designed and maintained roadways, the traffic pattern may also impact the town. Because truck drivers may take an easier road than shorter road due to the lack of entrance ramp, this will cause the large number of trucks to join I-90, I-190 and I-495 instead of Route 2. This will lead the trucks across town and take up the single-laned road connecting north and south sections of the town, increasing the potential of slowing the connection between the two parts of the town. The local residents are also concerned about emergency service response time when the warehouses are established. Due to the poorly maintained and narrow roadways, an increased truck traffic may cut the north part of the town from the emergency services.

In addition to the things we discovered related to traffic and roadways, we also experienced the local environment and noticed a few concerns during our walk in the local natural area. Firstly the area consists of a lot of forest coverage, as shown in the picture in Appendix 7.1. In the time we spent walking in the area, we needed to navigate through the thick forest coverage from time to time. During the site walk, we also encountered the Bow Brook that runs through the forest, as shown in the picture in Appendix 7.2. Bow Brook, according to the local residents and experts, is a stream suitable for coldwater fishery. There is a wooden bridge that goes across the stream that leads to a small hill as shown in the picture in Appendix 7.3.

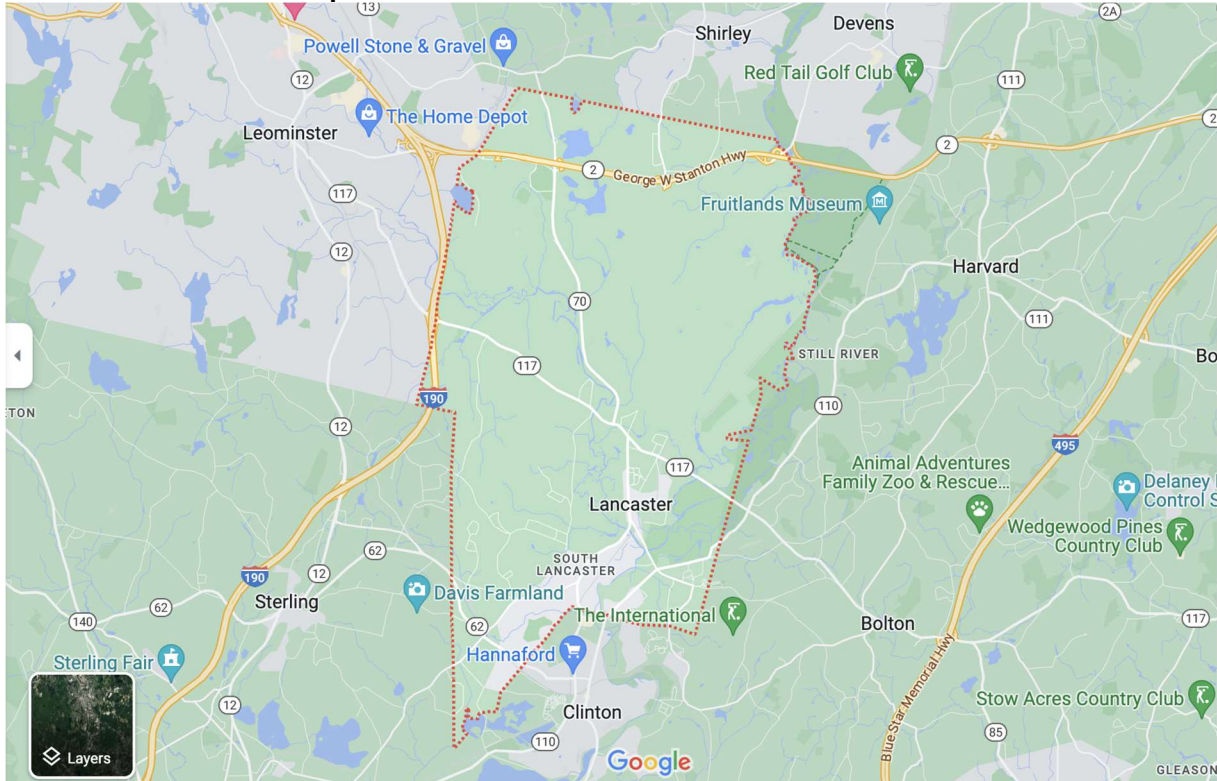
During the site walk we went up the hill, and encountered a solar panel array with a significant footprint, as well as a sand and gravel pit which are shown in pictures in Appendix 7.4. The solar array and gravel pit, at least to us, seems very out of place and disrupt the natural beauty of the local area. Next to the hill there is a medium sized wetland area that is considered as a Massachusetts Area of Critical Environmental Concern (ACEC). It shows that the planned warehouse will surround the wetland and the area of ACEC as shown in the picture in Appendix 7.5.

Besides this site walk we also went for a drive around the neighborhood, and drove to places where large warehouses are being planned. During the drive we also noticed a few concerns. In the neighborhood next to the solar array we encountered in the site walk, we came across a gate that leads to the warehouse with a significant footprint as mentioned above. The gate is shown in the picture in Appendix 7.6, and the picture shows how close the gate is to the neighborhood and when the warehouse is fully established, this will cause a lot more truck traffic to the narrow community road. While in the forest area, we also noticed a faint scent of diesel exhaust and a relatively bearable but noticeable noise from Route 2 and trucks going by on that.

During our second site walk, which is marked in blue on the map above, we spent roughly one and half hours in the forest covered area around Bow Brook, in order to find the

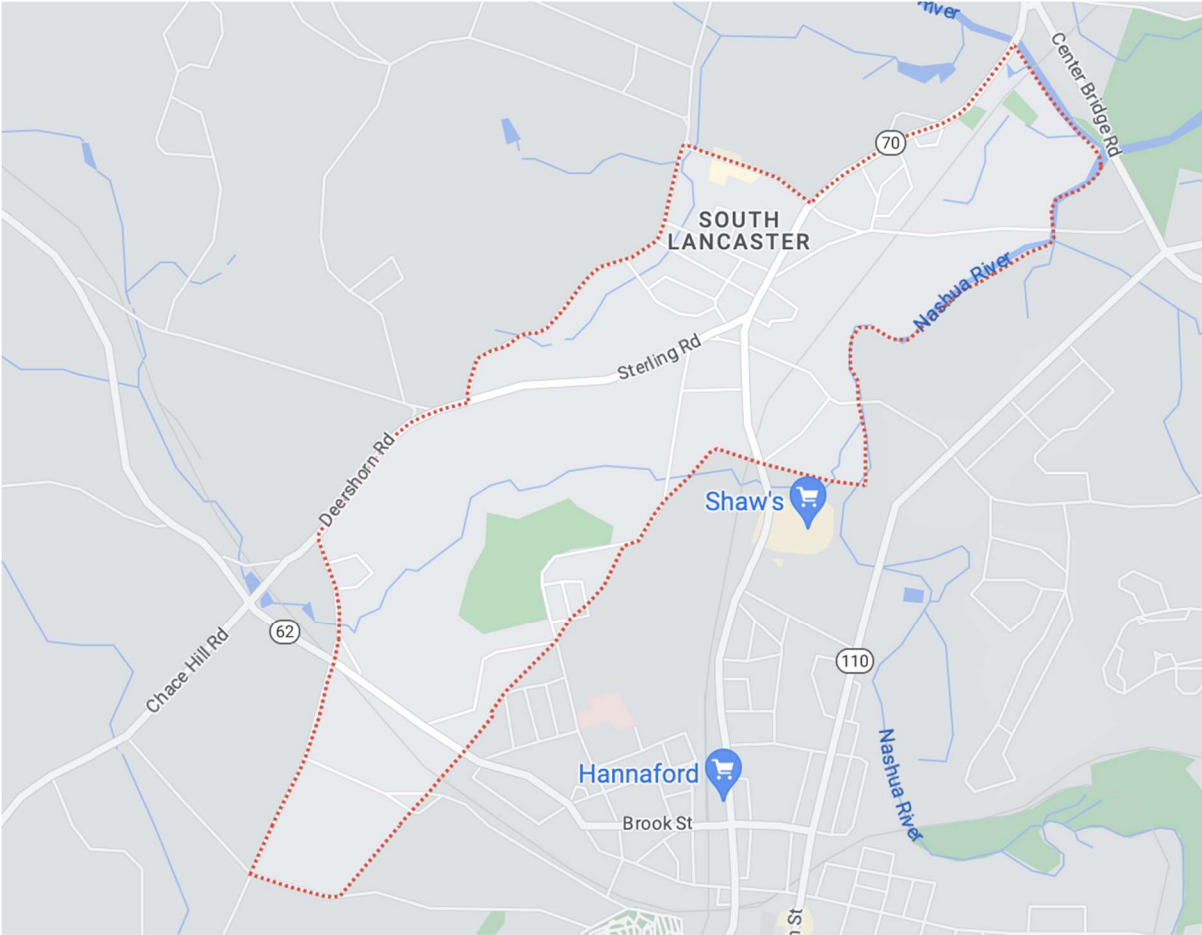
location for our water test. During this site walk, we crossed the stream and encountered some relatively thick branches. When we tried to navigate along the stream the road led us to a location where two streams meet and we decided that location to be the position to do water sample tests. During this site walk we also noticed a number of deer and other animals' droppings which is an indication that the area is housing a great number of wild animals.

7.8 Picture of map of Lancaster



(Google Maps. (n.d.). [Map of Lancaster], Retrieved May 1, 2023)

7.9 Map of the southern part of Lancaster (South Lancaster)



(Google Maps. (n.d.). [Map of Lancaster], Retrieved May 1, 2023)

The screenshot shows the Northborough Massachusetts website. The header includes the town name and logo, a search bar, and navigation links for 'About', 'Departments', 'Boards & Committees', 'Residents', 'Business Info', 'How Do I?', 'Be Well Northborough', and 'COVID-19-Information'. There are also links for 'REPORT AN ISSUE' and 'CONTACT US'. Below the header, there are 'LOG IN' and 'REQUEST NEW PASSWORD' buttons. A red error message states: 'Access denied. You must log in to view this page.' The main content area is titled 'User account' and contains two input fields: 'Username *' with the instruction 'Enter your Northborough MA username.' and 'Password *' with the instruction 'Enter the password that accompanies your username.' A 'Log in' button is located below the password field.

7.11 Draft Interview Questions

1. How are you doing today?
 2. How long have you lived in Lancaster?
 3. What is your favorite part of the town?
 4. What changes have you noticed over the past few years in Lancaster?
 5. Can you tell us your thoughts on and experiences with the proposed warehouse construction?
 6. What hopes do you have for this warehouse construction?
 7. What fears do you have about this warehouse construction?
 8. What do you believe the environmental impacts of this construction project will be?
 9. What do you believe the social impacts of this construction project will be?
 10. What do you believe the economic impacts of this construction project will be?
 11. Have you been seeing this type of industrialization that is happening in Lancaster in other towns?
 12. Have you had personal interactions with the proposed warehouse developers?
 13. What do you wish other Lancaster residents knew about these warehouses?
 14. Do you have any ideas about ensuring a positive intra-community relationship?
 15. Do you have any questions for us?
 16. Is there anything else you would like to say?
- We modified the interview question to fit individual interviews better.

7.12 Interview Preamble

Hello.

We are a group of students with Worcester Polytechnic Institute (WPI) and are working with the Nashua River Watershed Association.

We are conducting interviews about warehouses in order to learn more about warehouse-municipality interactions. We aim to ultimately create a summary of data with objective analyses for municipalities that inform them in an unbiased manner about the positive and negative effects of a warehouse in their municipality.

This interview is scheduled to take one hour.

Participation in this interview is completely voluntary and you may stop the interview at any time. Your identity will remain confidential if you request so and anything that you want stricken from the record will be removed.

If you have questions, you may reach out to our faculty advisor (mathisen@wpi.edu). Additionally, any information provided will be sent back for final consent before publication of the study. If you would like, we are happy to share a full copy of our results at the conclusion of the study.

Thank you.

7.13: Project Timeline:

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7
Send out invitations for interviews*							
Site Walk**							
Review Northborough Case							
Research other cases							
Research Lancaster Case							
Develop the Summary							
Draw conclusions							
Create recommendations							
Present recommendations and conclusions							

Updated timeline

*Interviews will be conducted at any points from weeks 2-6 as interviewees become available

**Additional site walks may occur as necessary from weeks 2-5

7.14 Summary of Potential Impacts and Recommendations

In this section we present our final findings in a deliverable that contains two parts. The first part contains potential impacts we have learned from our case study about Lancaster as well as studies about other towns in Massachusetts. The second part contains our recommendations for towns or small municipalities on how to mitigate some unwanted impacts brought by warehouse construction plans.

7.14.1 Potential Impacts

The potential impacts by warehouse construction plans include several categories, we have divided them into environmental impacts, social impacts and economic impacts. The three categories are listed below in our deliverable.

7.14.1.1 Environmental Impacts

The broad environmental impacts collected were as follows:

- Water pollution
- Air pollution
- Land pollution
- Noise pollution
- Light pollution

Each of these types of pollution also lends itself to additional impacts, such as habitat destruction. This can be of great note, especially if the warehouse is built on or near an Area of Critical Environmental Concern (ACEC). Furthermore, each of these types of pollution can not just create negative health effects on the flora and fauna of the municipality, but also the residents.

The listed environmental impacts can be expanded to include the following specific impacts:

- Water pollution related
 - Surface and groundwater hydrology and quality
 - Water-based animal species and habitat destructions
 - Scenic qualities
- Air pollution related
 - Air quality
 - Greenhouse gas emissions
 - Warehouse pollutants
- Other pollution related
 - Scenic quality disturbance
 - Pedestrian risk increase
 - Topography, geology, and soils
 - Infrastructures

7.14.1.2 Social Impacts

The broad social impacts collected were as follows:

- Roadway congestion
- Increased Traffic
- Emergency response delays

Increased warehouse construction may lead to vehicles being required to go at slower speeds whenever traveling on roadways. This itself leads to additional issues such as increased traffic on roadways due to vehicular queuing, and that it may take longer for emergency services like the police, ambulance, or fire department to reach their telecommunicators who may need serious attention.

7.14.1.3 Economical Impacts

The broad economic impacts collected were as follows:

- Increased revenue
- Decreased taxes
- Increased jobs
- Decreased property value

With increased jobs and town revenue, warehouses can potentially bring a good amount of money to a financially struggling municipality. The demographic of the town and types of new jobs being offered are two important factors to consider when weighing what percentage of local residents will likely be filling these positions. If the people in the municipality are not the majority of the workers of the warehouse, then revenue may increase in other ways. Due to the resulting increase in commute through town, these new individuals are likely to make purchases for things such as food or gas. With more revenue to the town, taxes may decrease. Decreased taxes can also help residents, allowing goods and services in town to potentially become more affordable and may even aid in drawing in more people to the town. On the other side, potential decrease in property value for areas near the warehouses may also occur, and may lead residents away from these areas.

7.14.2 Recommendations

Our project led to a number of recommendations that we have identified to help towns or municipalities to mitigate unwanted impacts by warehouses or warehouse construction plans. The recommendations are listed in three main categories: mitigation of unwanted impacts and reactions, increasing information availability/accessibility, and expanding on communications. The categories are listed below.

- Keep information about the development as easily accessible as possible
- Maintain active communication with both proponents and opponents of the development in the community
- Discuss with developers their efforts to mitigate unwanted impacts

To strengthen these recommendations we recommend the town make them public by including them into the official town bylaws when possible. Doing so will give people more assurance that these measures will actually be followed through.

Increase Information Availability/Accessibility

We have two primary recommendations on how to improve information availability and accessibility in municipalities in regards to warehouse development.

- Create ease of access to notable documents
 - Provide easy electronic access to all permits, applications, reports, etc. regarding the construction project via the town website
 - This can be done under the Planning Board or under the Town Clerk
 - All of these should be accessible without the requirement of any sort of town account or proof of residency
 - Provide easy physical access to copies of all permits, applications, reports, etc. regarding the construction project through the town hall
- Provide an edited version of notable reports that state the main points and are easy to read by the average resident
 - All acronyms/initialisms used should be clearly defined
 - This should not take the place of the original report, and the original report should be linked at the top of the edited report
 - These should be available both electronically and physically

Expand Communications

In order to help towns or municipalities to better mitigate unwanted impacts and ensure a relatively positive relationship within the community, we have the following recommendations about setting up meetings if given time and resources to expand communications:

- All stakeholders are involved
- Give free time to let concerns be expressed
- Active participation from all sides
- Provide specific examples of tangible mitigation plans
- Provide a specific estimation of monetary values with all factors possible included

In addition to that, we also recommend finding a middle ground between two groups of people with different opinions. The recommendations of how to find a middle ground is listed below:

- Find a reputable person in the town as a mediator
- Find someone outside this situation as a mediator
- Make a definitive list of matters that are important to either side
- Try to listen to the point that the other side is making, and try to understand them from their perspective.

- Hosting more meetings to allow for more people to be able to have a chance to say their piece

We also have some recommendations related to increasing the transparency of the developers, it would help the residents if brought up in one of the meetings mentioned above. The recommendations are as follows:

- Even in situations where a Environmental Impact Report (EIR) is not required by MEPA, the town can require the developers to do one for clarity and transparency
 - This would include MEPA requirements for an EIR, of which the following are a few examples of:
 - The status of the project
 - Details about the size and nature of the project
 - The availability and plans for mitigation efforts

With these recommendations the town or the municipality should be able to mitigate some of the unwanted division between different groups of people holding different opinions about warehouse constructions or even with other matters.

Mitigate Unwanted Impacts and Reactions

We have some recommendations on how to mitigate possible unwanted reactions such as rising tensions among the residents due to increased warehouse construction in town.

- Provide a descriptive, thorough cost-benefit analysis or analyses of the construction
 - Make sure that it is widely shared amongst the residents of the municipality
 - Make sure that people can clearly see what factors were considered in the analysis or analyses, how each one was weighed, and also what the project net outcome will be
- Make the town agree on (a) time period(s) where there will be no/minimal traffic to and from the constructed warehouses
 - An example of such time periods would be typical peak commuting hours.

We also have some recommendations on how to mitigate some unwanted impacts of warehouse construction such as potential environmental impacts like pollution and social impacts such an increase in traffic.

- Possible features that warehouses could be built with to mitigate environmental impacts:
 - Construction and maintenance of a stormwater management system
 - Restoration and/or replication for impacts to wetland resource areas energy management systems
 - Solar-ready roof space on the building roofs
 - Stream crossings
 - Drought tolerant plantings
 - Techniques to reduce irrigation losses due to evaporation
 - Water conservation equipment on irrigation infrastructure

- Low-flow plumbing fixtures
 - Implementing maintenance and employee education programs
 - Passive House design
 - To achieve the passive house standard, a building must have an annual heating/cooling energy demand of at most 15kWh/(m²year) and a total primary energy demand of less than 120kWh/(m²year) (Dan et al., 2016).
 - Incorporation of renewables and inclusion of LID in site design
 - Low Impact Development (LID) is an approach to environmentally friendly land use development.
 - It includes landscaping and design techniques that attempt to maintain the natural, pre-developed ability of a site to manage rainfall.
 - LID techniques capture water on site, filter it through vegetation, and let it soak into the ground (Low Impact Development | Mass.Gov, n.d.).
 - The implementation of construction-period best management practices (BMPs)
 - Typical BMPs on a construction site are silt fences, inlet protection, and site-stabilization techniques.
- Possible mitigations developers can do to minimize social impacts of warehouse construction:
 - Pedestrian and bicycle accommodations
 - Install traffic lights at road intersections if needed
 - Widening roadways
 - Improving and/or adding entry/exit ramps
 - Conduct traffic evaluations beyond what is required
 - Make warehouse construction sites more than a thousand feet from the nearest residential areas (*Preventing Warehouse & Distribution Center Impacts To Neighborhoods*, n.d.)

7.15 Brochures:

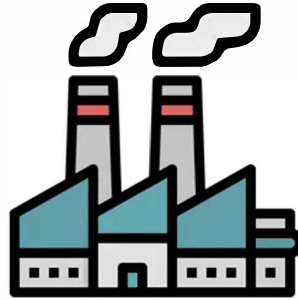
Increase Information Availability/Accessibility

1. The town could endeavor to make the numerous documents that exist regarding the warehouse construction project accessible for each warehouse on their town website, perhaps under the Planning Board or the Town Clerk.
2. Create versions of important documentation that are as easily accessible that have been edited for readability and understanding by the average resident.



Want to get Involved?

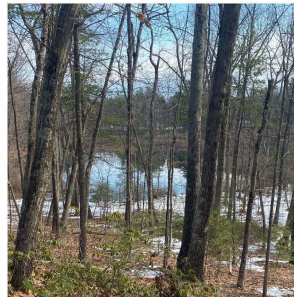
- Reach out to your town and see if they have documents online available.
- If not, ask them to update the most recent documents under each development.
- Attend town meetings.



Mitigate Unwanted Impacts of Warehouses

Minimizing Impacts of Warehouses on the community

WPI NRWA IQP Group
Diana Binney, Axel Luca,
Yicheng Si



Let's protect these beautiful water systems!

Mitigate Environmental Impacts

1. Provide stormwater management.
2. Control Evaporation.
3. Put solar panels on the roof.
4. Reduce energy consumption.

Mitigate Economic Impacts

Complete cost-benefit analysis to address all economy related concerns.

Mitigate Social/Traffic Impacts

1. Protect pedestrians.
2. Improve road conditions.
3. Manage the traffic flow.
4. Non-operation period during the night.

Expand Communications

We recommend the following points:

1. Involve all stakeholders.
2. Give free time to let concerns be expressed.
3. Promote participation from all.
4. Provide specific examples of tangible mitigation plans.
5. Provide a specific estimation of monetary values with all factors.

We also recommend the town to find a middle ground through these ways:

1. Make a definitive list of matters that are important to either side.
2. Try to listen to the point that the other side is making and try to understand them from their perspective.
3. Hosting more meetings to allow for more people to be able to have a chance to say their piece.
4. Find a reputable person in the town or someone outside the town as a mediator.

WAREHOUSE IMPACTS

Warehouses are an important part of our lives, from online shopping to storage. However, when a warehouse is planned in a small municipality, the town and its residents may not be able to fully understand the benefits and impacts of the planned warehouse.



WHY IS IT IMPORTANT

It is related to all of us, and warehouse may come to a town. Getting a better idea on the impacts and mitigation efforts can help the town better prepared for these large developments.

HOW CAN I LEARN MORE?

Find your local planning board.
Find Mass Dep Office.
Look for other activists.

RECOMMENDATION BROCHURE

IMPACTS OF WAREHOUSES AND MITIGATION STRATEGIES

WPI IQP Project – NRW Group

Diana Binney, Axel Luca, Yicheng Si

Key Impacts

ENVIRONMENTAL



- Water pollution
- Air pollution
- Land pollution
- Noise pollution
- Light pollution



SOCIAL

- Increased traffic
- Safety issues

ECONOMICAL



- Increased revenue
- Decreased taxes
- Increased jobs
- Decreased property value

COMMUNITY RECOMMENDATIONS

• INCREASE INFORMATION AVAILABILITY/ACCESSIBILITY

- Put public documents online.
- Make public documents more readable.

• EXPAND COMMUNICATIONS

- Host more frequent and productive meetings.
- Consider finding a mediator.

• MITIGATE UNWANTED IMPACTS AND REACTIONS

- Communicate and address concerns by developing detailed steps.

