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Bicycle and Pedestrian Counting for Worcester

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Abstract

In an effort to determine locations in Worcester for walking and biking infrastructure improvements, our project, in collaboration with WalkBike Worcester, recommends the adaptation of the Local Access Score tool to establish a sustainable bicycle and pedestrian counting program for the City of Worcester. Using interviews with decision makers, street-side observations, and research on cities with current counting programs, we developed methodologies and protocols for Worcester to use to carry out its own counting program of walkers and bikers.

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- Zach Dyer, Deputy Director of the Department of Public Health,
- Dan Daniska, Associate Planner at the Central Massachusetts Regional Planning Commission,
- Rob Raymond, Assistant Planner at the Central Massachusetts Regional Planning Commission,
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Executive Summary

With the rapid growth of cities, transportation has become an important feature of modern life. Many people use personal vehicles and public transportation, but the popularity of other means of travel is starting to rise. Biking and walking recreationally or to commute is becoming more prevalent, especially in urban settings. However, some urban environments do not support safe and accessible biking and walking. Because of this, cities need more and better planning for pedestrian and bicycle friendly streets, including obtaining better information on where biking and walking infrastructure is most needed.

Counting programs, which either use volunteers or automated devices to track pedestrians and cyclists passing by a certain area during a specified time, have been successfully used to provide information on the paths and roadways traveled by non-motorized vehicles in many cities around the world. Utilization of such counting programs has led to the planning and building of infrastructure that has made walking and biking accessible and safe for a city's people. Worcester has minimal walking and biking infrastructure; therefore, it is evident that improvements should be made. A bicycle and pedestrian counting program implemented in Worcester would provide data on where and what improvements need to be made to the walking and biking infrastructure. Introducing a sustainable counting program to the City of Worcester would require the strong support of the city government and a majority of the population.

WalkBike Worcester, this project's sponsor, has recognized the City of Worcester's limited support for pedestrians and cyclists. The goal of this project was to develop a recommendation for the adaptation of the Local Access Score tool to establish a sustainable bicycle and pedestrian counting program. If implemented, a well-done counting program will help Worcester prioritize locations throughout the city where walking and biking infrastructure needs to be improved. We achieved this goal through accomplishing four objectives:

- We determined Worcester's current capacity and obstacles faced in establishing a sustainable counting program;
- We determined how optimal counting locations can be selected using the Local Access Score;
- We determined the procedures for completing bicycle and pedestrian counts;

- We verified the devised procedures' effectiveness and replicability by a third party.

We conducted interviews, researched counting programs in other cities, and performed a walk audit to gather information about walking and biking in Worcester. We also verified and tested the procedures for performing a manual count and using the Local Access Score to ensure that they can be completed successfully by a third party.

Bicycle and pedestrian counts have not been done in Worcester because of limited funding and resources to purchase counting devices and to perform counts. However, Worcester's departments have the capacity to implement a counting program by collaborating with one another and performing manual counts using volunteers.

Human counters equipped with an appropriate counting form can do manual counts. We determined manual counting is the best starting option for a counting program in Worcester since it is inexpensive and can use volunteers who do not take away from any of the city's limited resources. We have produced counting forms with a protocol for any organization to manage and perform the counts.

Selecting the locations that are most trafficked by bicycles and pedestrians is necessary to gather the most appropriate data. Since locating these busy locations can be difficult, we have provided a manual that uses the MAPC Local Access Score to assist with selecting counting locations. We found the counting form and the location selection manual we developed were simple and straightforward to use based on feedback from volunteer users.

We recommend that the City of Worcester adopt a manual bicycle and pedestrian counting program. Completing non-motorized traffic counts manually allows for sustainability since limited funding is required and data can be collected as desired. Per our recommendation, volume should be the sole focus of the counting program initially. This will avoid any confusion for the count coordinators and counters. Manual counts require a workforce of people, so an organization or city department must take on the task of managing the program and complying with the protocols and guidelines. Volunteers are the best source of manpower to carry out the counts and require minimal training; WalkBike Worcester is an excellent source of volunteers. We also recommend selecting locations for the manual counts using the Location Selection Manual, seeing as it adds a level of robustness to the program.

Although we recommend Worcester to pilot a manual counting program, automatic counters should be considered as a feasible option for the City of Worcester. The most effective automatic counter for Worcester by far is the video camera technology that has the ability to distinguish between vehicles, bicycles, and pedestrians. If the city chooses to invest in automatic counting devices, we recommend that the City of Worcester purchase those video cameras that can make distinctions among the things that are passing its range-of-view.

Since we were unable to determine the desire to bike in the city because of time constraints, we recommend conducting future research on the population's desire for biking in Worcester. Such research can show the city the population's demand, or a lack thereof, for making accommodations for cyclists.

1 Introduction

Walking and biking can be enjoyable means of recreation and efficient transportation options in an urban environment. These modes of travel are encouraged due to their health, environmental, economic, and safety benefits for the users and their cities (America Walks, 2016). Although motorized vehicles have brought speed and efficiency on a global scale, walking and biking can bring other benefits to urban areas everywhere. However, crowded urban areas face challenges when trying to improve their walkability and bikeability, including limited accessibility, funding, and public support.

Worcester is currently not a very accessible city for pedestrians and cyclists. One organization devoted to changing this is WalkBike Worcester (2016). Their goal is to make Worcester safer and more accessible for pedestrians and cyclists, partly through the "complete streets" initiative. The complete streets transportation policy and design approach requires streets to be planned and maintained to accommodate comfortable and safe travel by people of all ages and abilities, regardless of their mode of transportation. By making the city safer for cyclists and pedestrians, more people would use these travel options. The increased non-motorized transportation would cause a decrease in both traffic levels and carbon emissions (Bonnell, 2009). This goal is difficult to achieve in part due to the lack of information on people's actual and potential use of walking and biking in Worcester. Because there are no data on the number of pedestrians and bikers in the city or on the amount of interest in using alternative transportation methods, making convincing proposals for changes is difficult to justify.

Cities across the globe have been making improvements to their walkability and bikeability (America Walks, 2016; Litman, 2016; McLeod & Murphy, 2014). Due to raised awareness of the benefits of increased non-motorized transportation, cities are becoming eager to accommodate more cyclists and pedestrians. This is especially important when considering how Worcester could make improvements to its walkability and bikeability. Research regarding these improvements has tended to focus on wealthier communities in the United States like Cambridge, MA, and Berkeley, CA. Accessibility and safety are the main things to consider when improving walking and biking. Cities like these and others including Washington, DC, London, and Melbourne have infrastructure in place for higher pedestrian and bicycle accessibility (Dominic

Golding, personal communication, November 22, 2016). Additionally, these cities are safer to walk and bike in due in part to drivers' awareness and respect for non-motorized traffic. Information retrieved on these other cities illustrates examples of improved walkability and bikeability and the steps necessary to achieve them.

Previous research conducted on cities across the globe has detailed projects to improve their walkability and bikeability, but research about this topic for the City of Worcester has not been done. Worcester lacks such data to help plan any future improvements related to improving walkability and bikeability. WalkBike Worcester believes that a sustainable bicycle and pedestrian counting program for the City of Worcester could provide useful and up-to-date data on the amount of pedestrian and cycling traffic. This information could be used to prioritize locations throughout the city regarding where people could and should be going on foot or bicycle, and where infrastructure needs to be improved.

The goal of this project was to develop a recommendation for adaptation of the Local Access Score tool to establish a sustainable bicycle and pedestrian counting program for the City of Worcester. In order to assist our sponsor in achieving this goal, we identified four objectives. We determined Worcester's current capacity and obstacles faced in establishing a sustainable counting program. Additionally, we determined the procedure for completing bicycle and pedestrian counts. We also determined how optimal counting locations can be selected using the Local Access Score. Finally, we verified the devised procedures' effectiveness and its ability to be successfully replicated by a third party. We achieved these objectives through interviews, observations, and conducting a pilot counting program. The research and recommendations that this project produced are crucial in aiding WalkBike Worcester to increase Worcester's non-motorized means of transportation and improve the city as a whole.

2 Background

WalkBike Worcester is working to make the City of Worcester more aware of the problems encountered by bikers and walkers and believes that they can learn from the successes and failures of other cities. This chapter reviews the challenges faced by cyclists and pedestrians in a variety of cities around the world along with how the challenges have been addressed. We also provide detailed information about biking and walking including reasons why one might or might not bike/walk and ways biking and walking can be improved in urban environments.

2.1 Biking and Walking Around the World

Walking and biking are popular forms of travel in various locations around the world. The number of people who use these methods of travel varies based on location and challenges faced by the commuter.

2.1.1 Prevalence of Biking and Walking

As of 2014, around 900,000 people commute via bicycle in the US (McLeod & Murphy, 2014). While this is only 0.2% of the total population, this number has increased 62% nationwide since 2000, and by as much as 278% in some states since 2005. Some reasons for choosing to commute via bike include shorter travel times and health benefits (Heinen, van Wee, and Maat, 2010). The two cities with the greatest number of cyclists are New York, NY, with 42,806 cyclists and Los Angeles, CA, with 24,334 cyclists. The two cities with the greatest percentage of cyclists in the 70 largest cities in the US are Portland, OR, with 7.2% and Minneapolis, MN, with 4.6%. In cities of similar population to Worcester, the most cyclists were found in Berkeley, CA, with 5,572 bicycle commuters, or 9.7% of the population. As far as pedestrians go, the number in the US is much higher than cyclists, with 4 million in 2014. In cities of similar size to Worcester, the highest percentage of walking commuters was 24.9% in Cambridge, MA, or 26,715 people.

In most European countries, a high percentage of people own bicycles, with the number of bicycles per 1000 inhabitants ranging from 52 in the Czech Republic to 1000 in the Netherlands (European Commission, 2016). Survey data from seven different European countries show that between 3% and 28% of all trips are made via bicycle, the highest percent being in the Netherlands. A similar survey shows that 12-30% of all trips taken are made with walking as the main mode of transportation. The highest rate out of the surveyed countries is found in Great

Britain. The percentages of these trips trend higher for trips under 5 km, reaching a maximum of 45% in Great Britain.

2.1.2 Issues Faced When Biking and Walking

Cyclists face a multitude of issues when they travel. One of these challenges faced is harassment from motorists. A study done in Queensland, Australia, showed that out of 1830 respondents, 76% of men and 72% of women reported harassment when biking during the previous 12 months (Heesch, Sahlqvist, & Garrard, 2011). The most common form of harassment reported was cars driving too close, followed closely by shouting abuse and obscene gestures. This information was corroborated in an interview with Professor Dominic Golding of WPI (personal communication, November 22, 2016). He described the above forms of harassment as well as some other issues such as a lack of bike lanes, bicycle parking areas, and other infrastructure. Pedestrians also face many issues when traveling, and one of the major issues faced by both cyclists and pedestrians is traffic crashes. Traffic crashes are one of the major causes of death and injuries around the world (Peden et al., 2004). As of 2015, pedestrian and biker deaths average almost 50% of the total number of road traffic deaths worldwide (WHO, 2016).

2.2 Reasons People Avoid Biking and Walking

There are a number of benefits to walking and biking around a city, but there are also reasons why one should not, or simply why one cannot, walk and bike around a city. They include accessibility, safety, public transportation and parking.

2.2.1 Safety

Hills and traffic can make walking and biking in a city dangerous. Hills, especially steep ones, can make it difficult for cyclists to brake or turn at the bottom of the hill (Buehler & Pucher, 2012). Also, cyclists simply try to avoid hills for the difficulty that they pose. Another level of danger to walking and biking around a city is added by traffic. Traffic can inhibit a cyclist's ability to ride around vehicles, even pinning the cyclist to the side of the road or forcing him or her to use the sidewalk, which adds a new level of danger to pedestrians. Also, with an added number of vehicles on the road, the ability of some drivers to see bikers may become impaired, making it difficult or impossible to see oncoming cyclists either turning or passing. This can also make it dangerous for pedestrians to cross a street, even at a crosswalk, if there is too much vehicular traffic that drivers cannot see a person crossing the street. Another factor in the safety equation is the effect of weather conditions. Rain or snow can make the roads and sidewalks slicker or even impassible, and thus increase the probability that crashes will happen. Fog can inhibit both the cyclist's and the driver's ability to see greater distances, making the margin for error of stopping much smaller than on a clear day where there is greater visibility. Los Angeles may not seem like a city with many hills or that is topographically-diverse, but 4 of the 10 steepest roads in America are located in Los Angeles (Rogers, 2008). These steep streets can pose a danger when descending them and can pose an annoyance whilst climbing them, for either a cyclist or a pedestrian. When it comes to traffic, Los Angeles has proven to be a dangerous place to cycle. Inconsiderate drivers and few bike lanes still plague much of Los Angeles, causing an average of 22 cyclists to be badly hurt or killed annually.

2.2.2 Accessibility

The importance for people to be able to walk or bike to work or to do errands (such as shopping or other non-work related activities) has been increasing for the past 20 years (Nelson, Meakins, Weber, Kannan, & Ewing, 2013). However, the accessibility to these places, such as stores and restaurants, through the use of bike lanes, bike paths, or sidewalks for walkers and bikers has been limited. The total absence of bike lanes in some places and the overall slowdown in bike lane installation in Los Angeles has made accessibility decline, which in turn has caused a downturn in ridership in the city (Rogers, 2008).

2.2.3 Public Transportation

The prevalence of an efficient and cheap public transportation system, whether it is buses, subway systems, trams, taxis, or ride-sharing, would make walking and biking around a city a waste of time (Buehler & Pucher, 2012). London is an example of a city with great public transportation. London's taxis and subway system allow people to travel around the city without the need to bike around a busy and traffic-laden environment avoiding injury (Dominic Golding, personal communication, November 22, 2016). Also, if you need to travel around a big city, say Boston, New York, or even Worcester, then walking is certainly out of the question if you are under a time constraint, and resorting to biking could result in a crash. Your best course of action when moving about a big city is to utilize the public transportation available to you.

2.2.4 Parking

The ability to bike around a city only matters if there is a safe and convenient place to park your bike without fear of it being stolen (Dominic Golding, personal communication, November 22, 2016). Public transportation and parking your bike go together, because unless there is a safe place to park and lock your bike up at a train station, or a place to put your bike on a bus or a taxi, you are not going to want to ride your bike to catch a taxi, a bus, or even a train. Biking to work, for example, would only be feasible if there is a shower, a locker for your clothes and bike gear, and a place to park your bike to keep it safe.

2.3 Benefits of Biking and Walking

Walking or biking to work, school, or other locations frequently visited in an urban environment has numerous benefits. This activity is known as active commuting (Bopp, Hastmann, & Norton, 2013). Active commuting rates in the U.S. are relatively low in comparison to other first world countries. However, awareness and support for this activity is thought to be improved by advertising the benefits of increased biking and walking. The benefits of active commuting are safety, improved health and environment, and economic benefits. These positive effects work towards bettering one's self as well as society.

2.3.1 Safety Benefits

Unsafe conditions can be detrimental to the frequency of biking and walking in an urban environment; however, several safety benefits of walking and biking in the city are typically overlooked. With increased pedestrian and bicycle traffic in the city, the risk of crashes decreases as fewer people are driving (America Walks, 2016b). If there are more walkers and bikers on the streets, there will, in turn, be fewer drivers to collide with them. Because of this, policies that aim to increase the numbers of pedestrians and cyclists are also remarkably effective in improving their safety simultaneously (Jacobsen, 2003). Not only can this provide safer roads for pedestrians and cyclists, but it can provide safer roads for everyone. Of course, the speed limit must be decreased on the streets where walking and biking improvements are going to be put in place. The decreased speeds result in greater safety for everyone. A study was done in London to see the effects of reduced speed zones (Grundy et al., 2009). The results of this study show that zones reduced to 20 MPH correspond to a 42% decrease in all crashes. Based on this research, with increased biking and walking comes increased safety for all, if done correctly.

2.3.2 Health Benefits

Active commuting generates several advantages to people's health. Walking and biking to work or school and for errands adds exercise into people's daily lives (US Department of Health and Human Services, 2009). This fact is so beneficial because one of the main reasons for people not exercising is not having enough time in the day. Since this strategy turns commuting into exercising, there is no longer a need to build time into your day for exercising. In addition to active commuting, walking and biking has positive health impacts for elderly, disabled, and lower-income people since they have fewer opportunities to participate in sports or exercise programs (Litman, 2003). Another benefit of active commuting applies to children walking and biking to school. This physical activity is good for their cognitive health and learning ability (Jackson & Sinclair, 2012). Active commuting will improve concentration as well as boost the children's moods and alertness. It also can enhance memory and creativity.

Walking and biking can reverse poor health trends. Countries where walking and biking are most common tend to have the lowest obesity rates (Litman, 2016). To coincide with this trend, countries with high automobile transportation rates tend to have the highest obesity rates. These data are illustrated in Figure 1 were the countries with the higher obesity percentages (shown in red) have lower percentages of walking and biking transit trips (shown in green) and vice versa. Walking and cycling for everyday travel can be as effective as structured daily workouts for improving one's health (America Walks, 2016b).

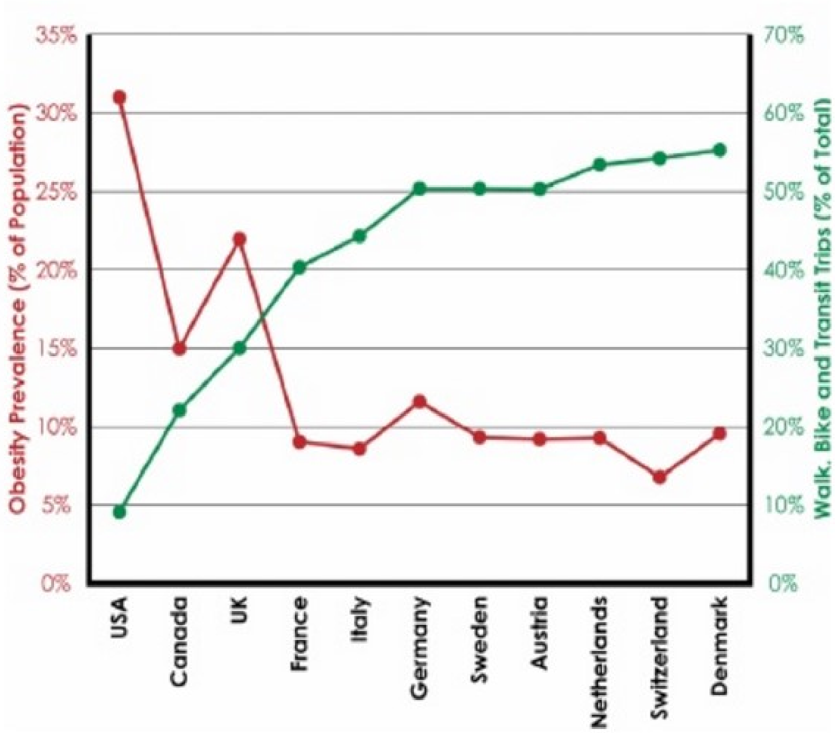

Figure 1: Relation of Obesity and Active Commuting (America Walks, 2016b)

2.3.3 Environmental Benefits

Active commuting also helps to conserve energy that typically would be expended by cars and other motorized transportation. The energy savings are relatively large because active commuting tends to replace short urban trips that produce high emissions per mile travelled because of cold engines and congestion in the city (Litman, 2016). The engine has the worst efficiency when it is cold and produces the most emissions at this time. A one percent shift to active commuting correlates to a two to four percent decrease in fuel consumption, according to Komanoff and Roelofs (1993). Likewise, increased walking and cycling over driving leads to a reduction in air pollution. Vehicles produce noise, carbon monoxide and particulate pollution, while walking and cycling produce no pollution.

2.3.4 Economic Benefits

Reduced driving and more walking and cycling saves money for the average person. A reduction in driving will save fuel, which will save money for the consumer-- $0.10-0.15 per vehicle-mile (Litman, 2003). Vehicles are usually most costly in a walkable environment because they are used over shorter distances. Short distances equate to shorter trips, meaning engines will be cold and inefficient. Also, more frequent car use leads to greater depreciation and increased risk of crashes, traffic, and parking citations. The $0.10-0.15 per vehicle-mile savings gets nearly doubled when considering all these factors. Over time the savings can build up when switching from driving to cycling or walking.

There are additional economic benefits for the public as well. The aforementioned benefits of safety and health have hidden economic benefits included with them. With improved safety, the likelihood of a fatality decreases (Ernst, 2012). The cost of a pedestrian fatality is estimated at $4.3 million, whereas the cost of a sidewalk curb extension is only $50,000, and the cost of a high visibility crosswalk is only $1200 (America Walks, 2016b). Adding infrastructure to increase the walkability and bikeability of an area is only a fraction of the cost of a traffic related death. Furthermore, in 2005 the cost of building and maintaining multi-use trails was $209 per person, while the direct medical benefit due to using these trails was estimated at $564 per person (CDC, 2005).

2.4 Ways of Improving a City's Walkability and Bikeability

Communities across the world are looking for ways to make walking and biking a safer, healthier, and more convenient way to get around. For example, the greater Cleveland area and cities such as Akron, Ohio, have bike lanes already implemented that allow cyclists to visit attractions that attract national tourists (Purdum & Fishel, 2011). Finland also has accessible bike paths and a rich history of biking (Mannisto-Funk, 2012). With a long history of biking and available infrastructure, Finnish people have adapted biking as part of their culture. Figure 2 shows that Finnish people have the ability to use their bicycles in harsh weather along with available parking.

Figure 2: Bicycles Parked in Snow in Finland (Source Chickery Kasouf, December 2016).

2.4.1 Bicycle and Pedestrian Counting

Bicycle and pedestrian counting is an important way to gather data that can be used to promote improvements to Worcester's walkability and bikeability (Karin Goins, personal communication, November 14, 2016). There are two kinds of bicycle and pedestrian counting programs used to measure the amount of bicycle and pedestrian traffic. The measurements can assist a city in determining how often people walk and bike in locations throughout the city as well as how the traffic varies based on time of day and weather conditions (Portland State University, 2016). One program type is a permanent counting program that has permanently installed, automated devices designed to collect data 24 hours a day, every day of the year. The other program type is a short duration counting program that can last a few days to several months. The counting for this method is typically completed using volunteers and portable equipment. Both methods can provide bicycle and pedestrian data to a city. Permanent counting programs provide the highest level of accuracy, but they can be relatively expensive. Ideally, a counting program should monitor all routes within a city at all times, but funding is always a limitation. The short duration program is designed to have less accuracy, but be more affordable to implement. Because of this, short duration programs tend to be more common.

An example of an automatic counter is the single camera technology for tracking and counting bicycles and pedestrians in real-time that has been developed (Qi, Chun-fu, & Yi, 2014). The camera works by removing shadows around the objects for identification. Such counting tools can be used in Worcester's most traveled streets to gather data with 85% accuracy. The estimated amount of non-motorized traffic in a full day can be manually counted for bicycle and pedestrian traffic for one specified hour per day and then scaled up for 12 hours of the day with 89% to 93% accuracy (Hankey et al, 2012). This method of counting can be used in Worcester for less traveled streets as it costs less compared to an automatic system. These and other counting methods are explained in the next section.

Types of Counts

As mentioned, the two types of counting programs are manual counts and automatic counts. Manual counts involve the use of volunteers and counting forms (Ryus et al, 2014). Automatic counts involve the use of automated counting devices. Each type of counting has its own strengths and limitations. We now discuss the two ways to conduct manual counts and some common examples of automatic counters.

Manual counting programs are done with human data collectors who can count both bicycles and pedestrians and their attributes such as age, gender, and helmet use (Ryus et al, 2014). Counters can make notes of behaviors and infrastructure integrity such as width of sidewalks, comments on bike lanes, conditions of crosswalks, number of jaywalkers and other examples. Besides capturing the volume and individuals' attributes, human counters can also capture turning movements and crossing volumes. Manual counts are the best way to start new counting programs because of the near zero cost of preparation and hiring counters, if done by volunteers.

Manual counting programs can be either done by going in-field to count or by counting using a sped-up video recorded using a camera mounted at the counting location (Ryus et al, 2014). Manual counts can be the most accurate, easily attained, and least expensive among all the different counting types. Manual counting programs that make use of volunteers and counting forms are cheaper still than ones that rely on the use of a camera. One of the best strengths of having video cameras set up is that counters are not constrained by time or distractions as much as when they must go in-field so they can be more accurate. Some of the limitations of the cameras are that they are susceptible to theft and could have poor vantage points. Also, corrupted data can require videos to be retaken.

Pneumatic tubes are a technology available mainly for bicycle counts. This technology is also being used to do automotive traffic counts. Rubber tubes are laid across the counting area, and the bursts of air produced when a vehicle passes over them can be detected (Ryus et al, 2014). This technology, costing between $1000-$3000, can count vehicles as well as their direction and speed (Baas, Galton, & Biton, 2016). Some advantages are this technology's portability, its capacity to upload data to a cloud-based system, and its ability to detect axle length-- meaning it can discern between bicycles and other vehicles. If a device with high durability or an ability to detect pedestrians is desired, other technologies should be considered.

Passive infrared (IR) devices are another technology available for pedestrian and bicycle counts. These devices detect pedestrians and cyclists by using a comparison of the temperature of the background to the infrared radiation emitted by people passing the sensor (Ryus et al, 2014). This technology is useful for counts where the mode of transportation is unimportant, as the sensor cannot distinguish between cyclists and pedestrians. However, this can be remedied through the simultaneous use of a bicycle-only counting method and some data comparison. Passive IR devices have the advantage of being portable, but they can encounter errors with groups of pedestrians or in extreme temperatures. These devices cost between $1000-3000 but are useable in both short-term counts and permanent installations.

Although video cameras are used for manual counts, there are different technologies that allow a permanently installed camera to automatically decipher and count pedestrians and cyclists (Ryus et al, 2014). These $1000-3000 camera systems can do this through computer algorithms to identify when the changes in the background image are either pedestrians or cyclists. An example of one of these pictures is shown in Figure 3.

Figure 3: Perspective from camera showing detection zones (Baas, Galton, & Biton, 2016).

These cameras are also able to count pedestrian and cyclist volumes and turning volumes at an intersection. Installation and training for use of this technology takes less than 30 minutes each. This technology is rather expensive, costing upwards of a few thousand dollars to buy and then install and operate, but it is highly accurate, mobile, and can provide data continuously without human assistance.

These are just a few of the automatic counters that are available to buy and use for an automatic counting program. There are many others, and the NCHRP Report 797 can provide more information on some of the other types of automatic counters (Ryus et al, 2014).

Cities with Counting Programs

Cities throughout the U.S. have implemented bicycle and pedestrian counting programs using these various counting methods. Often, these counting programs follow the guidebook provided by the National Cooperative Highway Research Program (NCHRP) for bicycle and pedestrian volume data collection (Ryus et al, 2014). Minnesota and Washington states are two locations in the United States that have adopted bicycle and pedestrian counting programs along with some of the recommendations made by the NCHRP. Each state has defined its own set of guidelines detailing how to select counting locations. Since manual counts have been completed in these states, instructions about when to do the data collection and how to complete the data collection have also been defined. Locations with many destinations such as retail stores, restaurants, schools and transit hubs are ideal locations for counting because of the likelihood they will have more pedestrian and bicycle traffic. The best months to conduct bicycle and pedestrian counts are in late September and early October since traffic would be at its peak due to desirable weather and people having returned from summer vacations. The best hours to count are in the morning and evening commutes from 7-9 AM and 4-6 PM, respectively. Similar guidelines could be adopted by the City of Worcester.

When gathering the bicycle and pedestrian volume data manually, each of the analyzed cities needed to obtain counters to collect the data as well as provide them with a form to record the data. Washington State required one counter at each location, but ideally there should two counters for both accuracy and safety purposes (Aken, 2016). Counters were provided with a background information sheet in addition to the counting form. Things such as weather, setting, and infrastructure conditions were recorded on this background sheet. The forms provided in Minnesota included a table to be filled out before the count, guidelines for completing the count, and a table to record the non-motorized traffic data (Lindsey, Hankey, Wang, & Chen, 2013). The data required before the count included location, date and time, duration, contact information of counters, and weather conditions. The guidelines assisted the counters with filling out the tables and counting the non-motorized traffic. The counting data table was divided into 15-minute time segments for a two-hour counting period, and bicycles and pedestrians counted within each 15-minute segments would be recorded in the appropriate cell.

2.4.2 MAPC Local Access

As previously mentioned, the ideal counting program will monitor all locations in a city, but this is nearly impossible to accomplish. Therefore, cities must prioritize locations where bicycle and pedestrian counting programs will be most beneficial in making municipal decisions. The Metropolitan Area Planning Council (MAPC) has developed the Local Access Score which is a tool to assist Massachusetts cities in prioritizing walking and biking locations (MAPC, 2016b). The Local Access Score rates streets on a scale from 0-100 based on how many trips have been taken on that street and how many could be taken on that street, based on the 2012 Massachusetts Travel Survey (MTS). Factors that are considered when calculating walking and biking scores are the size of the households in the surrounding area, how many school-age children live in the surrounding area of a school, the size of the destination (school, store), the most direct route to a desired destination, and the distance a pedestrian or cyclist would have to travel to arrive at the desired destination (Kate Ito, personal communication, Jan. 24, 2017). The destinations are categorized into four separate categories: schools, stores and restaurants, parks, and transit. Each of the four destination categories have two scores each: for walking and biking. These eight utility scores can be used to categorize specific locations that are representative of other locations throughout a city, thereby providing estimates of active transportation traffic volumes for different locations. The scores are put together and weighted to generate separate walking and biking scores as well as an overall score. The scores are mapped to an interactive online map that shows the destination types and scores for all routes within a city. All of these data can be used for planning and prioritization.

Furthermore, the Local Access Score can be used to identify groupings of locations that are representative of an entire study area for bicycle and pedestrian counting. With this, our project could benefit greatly from the data provided. The data could be used to generate recommendations for a sustainable bicycle and pedestrian counting program.

2.5 Summary

Biking and walking are inexpensive, healthy, and green forms of transportation when they are accessible and safe in an urban area. To increase the prevalence of biking and walking, cities need to implement and promote developments that provide accessibility and safety to cyclists and pedestrians. The City of Worcester has not significantly pursued any developments or the gathering of data to decide on the magnitude and the best locations for walking and biking in the city. Bicycle and pedestrian traffic counting can provide Worcester with data to assist in making improvements to the city. The methodology required to make the necessary recommendations to WalkBike Worcester are detailed in the following chapter.

3 Methodology

The goal of this project was to develop a recommendation for adaptation of the Local Access Score tool to establish a sustainable bicycle and pedestrian counting program for the City of Worcester. A counting program is needed to gather enough data about pedestrian and bicycle traffic so the city can make better planning decisions. The four objectives to achieve this goal were:

- Determine Worcester's current capacity and obstacles faced in establishing a sustainable counting program;
- Determine how optimal counting locations can be selected using the Local Access Score;
- Determine the procedure for completing bicycle and pedestrian counts;
- Verify devised procedures' effectiveness and replicability by a third party.

This chapter explains the research methods that we have used to achieve these four objectives.

3.1 Determining Worcester's Current Capacity & Obstacles

Before we determined the procedure to develop and conduct a sustainable counting program, we analyzed the need for improvement as well as how Worcester could adopt such a program. We assessed the current walking and biking conditions in the city. In addition, we were able to gather information on both Worcester's capacity to implement a counting program, and the obstacles Worcester as a city could face when establishing a counting program.

3.1.1 Obstacle Assessment

We gathered information on the obstacles that bicyclists and pedestrians face in Worcester through an interview with WalkBike Worcester co-chair, Gerald Powers, and also a group discussion with the leadership group for WalkBike Worcester. We selected Mr. Powers and the WalkBike Worcester leadership group because they are knowledgeable on the current bicycle and pedestrian obstacles and advocate for improvements. The protocols for each of these are located in Appendices C and D.

Additionally, we completed a walk audit along Main Street with WalkBike Worcester to determine the current issues facing Worcester's walkability and bikeability. A walk audit is an assessment of the walkability of the city infrastructure from the pedestrian's point of view. It allows for consideration and understanding of the needs for pedestrians by experiencing them first hand. We chose Main Street because of its high collision rate, meaning we would see many problematic locations throughout the audit.

3.1.2 Capacity Assessment

Our team gathered information on Worcester's current capacity to establish a sustainable counting program through three interviews with city officials and planners. We decided to interview transportation planners and city officials because of their knowledge on the topic. We chose to interview the following four people:

- Dan Daniska, Transportation Planner for the Central Massachusetts Regional Planning Commission;
- Zach Dyer, Deputy Director of the City of Worcester Division of Public Health;
- Stephen Rolle, Director of Planning for the City of Worcester;
- Paul Moosey, Commissioner for the Department of Public Works of the City of Worcester.

Dan Daniska and Stephen Rolle were selected because of their views as planners for the City of Worcester. They knew about the obstacles that Worcester would face in implementing a bicycle and pedestrian counting program, the resources available, and what data the city would need for this program to be successful. Zach Dyer was chosen because he knew how increased walking and biking would benefit the public's health and explained how our project could have dramatic importance. Paul Moosey was selected based on his experience and knowledge on the capacity Worcester has on planning and conducting counting programs. The protocols we followed for these interviews are located in Appendix D. These interviews provided valuable insight into how Worcester could develop its own counting program. They also helped us determine what kind of counting program would be most beneficial to the city, as well as the resources available for implementing such a program.

3.2 Determining How to Select Counting Locations

We determined the methods a city should use to develop a pedestrian and bicycle counting program based on the Local Access Score by interviewing Kate Ito, a Regional Planner at the Metropolitan Area Planning Council (MAPC) who had insights on the Local Access Score. Cities developing their counting programs could use this program to assist in the process, and Ms. Ito was able to provide us with information on how to accomplish this. The protocol for this interview is located in Appendix D. We then researched and analyzed the Local Access Score using GIS software. ArcGIS Desktop Explorer was the software recommended for use with the Local Access Score data. This free software for Microsoft Windows supports the file type in which the Local Access score data are stored. We installed this software and developed a methodology for how to use it and how to determine counting locations with it. We did this by downloading the Local Access score data and finding how streets were categorized in Worcester based on the walkability and bikeability scores provided. The methodology we developed was in the form of a how-to manual for utilizing the Local Access Score to determine optimal counting locations using the information Kate Ito provided and our exploration of the Local Access Score.

3.3 Determining the Procedure for Counting

We completed manual counting observations of busy intersections over one week to gather information and get an immersive understanding on how a manual counting program should be done. We also researched cities similar to Worcester in size and income that have already implemented a bicycle and pedestrian counting program to gain understanding on how Worcester could adopt a similar program. Participating in our own count and researching how other cities have implemented their own counting programs has allowed us to move forward in our recommendation for a counting program in Worcester.

3.3.1 Manual Counting Observations

We went to five locations in Worcester with regularly heavy traffic on selected days and times to observe the traffic patterns of pedestrians and cyclists. We did this in one-hour sessions. We selected the observation times to match typical weekday commuting times of arriving at work and going on lunch break. We also chose some weekend times in the afternoon because people are typically more likely to go out in the afternoon on the weekend than in the morning. We chose five locations based on how heavily trafficked those intersections are during the selected times. We decided to observe and manually count at locations around offices, retail businesses, transit hubs, and major traffic arteries, deeming these locations to be some of the most heavily trafficked locations for both pedestrians and cyclists. The selection of these locations was not based on any randomization or previous counting locations, but only on our previous knowledge of how busy each of the intersections can be. We believed that if we went to known busy locations, we would encounter more pedestrians and cyclists. For each location, we counted on one weekday, once in the morning and once in the afternoon. For weekend counts, we decided on one of the weekday locations to count during a mid-afternoon time. Our morning time for the weekdays was 8-9 AM, our weekday afternoon time was 12-1 PM, and our weekend afternoon times were 12-1 PM and 2-3 PM. We wanted to go to these locations at times with a higher volume of traffic so we can could get as much data as possible. These observations assisted us with determined how bicycle and pedestrian counts should be completed and how the data can be used to achieve our overall goal. The locations and times for these observations is given in Appendix B.

3.3.2 Researching Cities with Counting Programs

In order to determine how other cities have developed counting programs, we conducted research through library websites and databases regarding the selected cities' procedures for counting. We searched for counting procedures in cities that had done bicycle and pedestrian counts before and were similar to Worcester in population size, demographics, and median household income. We also researched the methods used to collect bicycle and pedestrian counting data. We selected two cities to examine and to adopt their non-motorized counting procedures. Insights about how they developed the program and how it is being used and cared for currently assisted us in meeting this objective.

3.3.3 Interviews with City Officials and Planners

Our team gathered information on how to do manual counts and the level of detail of the data desired from counting programs. We decided to interview transportation planners and city officials because of their knowledge on the topic. We chose to interview the following two people:

- Dan Daniska, Transportation Planner for the Central Massachusetts Regional Planning Commission;
- Stephen Rolle, Director of Planning for the City of Worcester.

We selected Stephen Rolle because of his knowledge on how detailed a manual bicycle and pedestrian counting pilot should be to become a sustainable and permanent counting program in Worcester. We selected Dan Daniska because of his experience using counting data for planning and what needs to be including in the program for it to be successful. The protocols for these interviews are located in Appendix D. These interviews provided us with the needed information on how to pilot a bicycle and pedestrian counting program in the City of Worcester.

3.4 Verifying Procedures' Effectiveness & Replicability

We verified and tested the procedures for performing a counting program and using the Local Access Score to select counting locations. Volunteers from WalkBike and the CMRPC tested the counting procedures to determine if a third party could duplicate the procedures. Karin Goins from WalkBike tested the location selection manual. If their feedback called for necessary improvements, we improved the procedures accordingly. If the testers also responded that using the protocols were difficult, we repeated the tests after making improvements. This allowed us to verify that we ironed out all the weaknesses and a third party could complete the procedures.

3.5 Summary

In summary, we determined the procedure for completing bicycle and pedestrian counts through our own counting observations and interviews with Worcester regional planners. We also determined how optimal counting locations can be selected using the Local Access Score through an interview with an MAPC planner. Additionally, we determined Worcester's current capacity and obstacles faced in establishing a sustainable counting program through interviews with Worcester city officials. Finally, we verified the devised procedures' effectiveness and ability to be successfully replicated by a third party through a pilot counting program. The next chapter contains the results of using these methods.

4 Results & Analysis

The goal of our project was to recommend how Worcester could adapt the Local Access Score to establish a sustainable bicycle and pedestrian counting program. In this chapter, we are presenting our data collected by performing each method discussed in the previous chapter. These results and their analyses include:

- Worcester's current obstacles and capacity in establishing a counting program;
- A procedure and a counting form for bicycle and pedestrian counting;
- A manual for selecting optimal counting locations using the Local Access Score;
- Verification of both the counting form and the location selection manual.

The full data and summaries from all the supporting interviews are provided in Appendix D. The summary of the WalkBike leadership group discussion is provided in Appendix C. Data collected from our observations is provided in Appendix B. The following sections explain the results and analysis from the data we collected.

4.1 Worcester's Current Obstacles & Capacity

In the opinion of Gerald Powers of WalkBike Worcester, Worcester's walkability and bikeability can undeniably be improved. A bicycle and pedestrian counting program would be helpful for Worcester to pinpoint locations where improvements would be most beneficial. With limited resources and many obstacles facing the city, implementing a counting program must be done in a sustainable and efficient manner, according to Stephen Rolle, the Director of Planning for the City of Worcester. We identified Worcester's capacity for implementing a counting program and the resulting improvements. To go along with this, we determined the obstacles inhibiting Worcester from making these improvements.

4.1.1 Obstacles & Capacity for Cyclists & Pedestrians

According to Gerald Powers, cyclists and pedestrians face hazards when travelling around Worcester; however, pedestrians face far fewer than cyclists do. The major limitation to cycling in Worcester is the low number of bike lanes and bike routes that would allow for safe travel alongside vehicular traffic. Some of these bike routes are depicted in Figure 4. Clearly, there are only three streets, shown in red, with shared road bike routes in this picture so more could be added in the city. Furthermore, none of these bike routes has separated bike lanes.

Figure 4: Map of shared bike routes in Worcester

Due to this limited infrastructure, people riding their bikes around Worcester must be very wary of dangerous surroundings. Added elements of danger occur when cyclists are forced to ride on the sidewalk in lieu of using the road, possibly due to a combination of street parking and heavy vehicular traffic. In addition, the city does not provide cyclists with safe parking spaces for their bikes in many areas, which is a deterrent for many to use their bikes to reach stores, school, or work.

There are definitely more upsides to walking around Worcester than there are for cycling, but based on information provided to us by the WalkBike leadership group, pedestrians still face challenges throughout the city on a daily basis. We chose to analyze these pros and cons further by walking along Main Street to audit Worcester's walkability. We saw some attractive features shown in Figure 5 including:

- Beautiful murals painted on the sides of buildings,
- Clearly marked and safe crosswalks at some intersections,
- Wide sidewalks,
- Some street trees.

Figure 5: Walking attractions on Main Street

However, some parts of Main Street need improvement, shown in Figure 6, because of problems such as:

- Sections of sidewalks with chunks of pavement missing,
- Intersections' crossing signals not concurrent with vehicular traffic,
- Empty potted plant receptacles used for trash disposal,
- Removed street trees filled-in with tar,
- Unremoved snow blocking sidewalks and crosswalks during the winter.

Figure 6: Walking deterrents on Main Street

Although these points might steer people away from walking in the city, it tells us that there are improvements that need to be made. Determining the priority locations for improvements in order to optimize resources can be made easily with data collected through a counting program, for these data can show where cyclists and pedestrians travel most frequently. The city can use these data to understand where make improvements will be most beneficial to cyclists and pedestrians.

4.1.2 Counting Program Obstacles & Capacity

Before recommending how to implement a counting program for this city, we needed to determine the current obstacles to implementing a pedestrian and bicycle counting program. One of the greatest obstacles to the implementation of a sustainable counting program in the City of Worcester is the limited resources. Funding and manpower that the various departments of the City of Worcester have at their disposal are few. Therefore, a counting program should not take away from these limited resources. As stated by Zach Dyer, the Deputy Director of the Department of Public Health (DPH), the departments that are interested in implementing a counting program, specifically a manual counting program, lack the necessary manpower to do so. The Department of Public Health of Worcester and the Central Massachusetts Regional Planning Commission (CMRPC) have conducted their own counts of both traffic and pedestrians during the summer months with the help of interns, but on the authority of Dan Daniska, an Associate Planner at the CMRPC, those counts were limited and not done on a regular basis. According to Paul Moosey and Mark Elbag of the Department of Public Works (DPW), the DPW performs pedestrian counts jointly with vehicular counts, but conducting pedestrian and bicycle counts separately would mean that money would be taken away from another project, such as road resurfacing, which is a top priority project and much more important to complete in their opinion.

As mentioned in Section 2.4.1, the use of automatic counters is also an option, but many automatic counters cost upwards of $3,000 per installation. Paul Moosey reported that the Department of Public Works would be interested in having automatic counters installed if the costs were low. Since more than one location is most essential for performing valid and useful counts, installing automatic counters may not be a viable option for the City of Worcester due to financial constraints. Based on these facts, we have determined the best way for the city to implement a bicycle and pedestrian counting program is by using volunteers and with assistance from the departments currently interested in the program. However, Paul Moosey and Mark Elbag stated that recommending automatic counters usable by the city in the future would be effective and conducive to achieving the same goal, should adequate budget be allocated for them.

Worcester does have the capacity to implement a sustainable counting program if various departments and organizations are willing to work together to accomplish this goal, in the opinion of Stephen Rolle. One of the ways to accomplish this would be for departments or organizations to coordinate and to collaborate using volunteers. According to Zach Dyer and Dan Daniska, the DPH and the CMRPC can both make use of interns, volunteers, and even employees to perform counts. Volunteers from WalkBike Worcester would also be available to gather counting data. Whoever coordinates the counting program can assist in determining the counting locations using the methodology defined in Section 4.3. A single department or organization trying to implement the counting program would be difficult, but with collaboration and use of volunteers, implementation would be simple.

4.2 The Procedure for Counting

We developed a manual counting program procedure for performing bicycle and pedestrian counts. We created this procedure based on our research, observations, and interviews. We produced a bicycle and pedestrian manual counting form that can be filled out during a count as well as a step-by-step protocol for conducting a counting program. In this section, we present the results that led us to the counting form and counting program protocol we developed.

4.2.1 Manual Counting Form

The manual counting form that we devised for use by volunteers who will be performing the counts is separated into three sections: pre-counting information, counting guidelines, and a table to be completed during the count. This form is located in Appendix F. The pre-counting information that we deemed to be important for consideration includes categories such as date, time, weather conditions, location, and contact information of the person completing the count. Counting programs like the Minnesota Pilot mentioned in Section 2.4.1, asked volunteers to supply similar information; therefore, we modeled the counting form after the one used in

Minnesota. Additionally, the city planners we interviewed verified that the pre-counting information our form requires is appropriate.

We also set up a list of counting guidelines to clear up any misunderstandings that may present themselves to the volunteers performing the manual count. Since the counting program pilot in Minnesota mentioned in Section 2.4.1 provided their counters with some guidelines, we decided to adopt something similar. We designed the guidelines presented with the form to meet what we deemed as necessary based on our own counting observations. One of the challenges we found during our observations was counting repeat pedestrians and cyclists that pass by a location. Stephen Rolle and Dan Daniska informed us that the volumes of bicycles and pedestrians are more important than counting unique users. Based on this advice our guidelines make it clear what to do when this occurs. For example, the counter must re-count previously counted pedestrians if they pass by the count location again.

Lastly, to produce the counting table, we adapted what was used during the Minnesota Pilot counting program detailed in Section 2.4.1. However, the table we created differed since we included what the Worcester city planners deemed as necessary data to collect during the count. The table is divided into 15-minute time segments for a two-hour counting period. Bicycles and pedestrians counted within each 15-minute segment would be recorded in the appropriate cell. During our observations, we collected data in one-hour increments. We determined that we needed to record the counting data in smaller time increments to gain a better understanding of the volumes of cyclists and pedestrians. The smaller time increments allow for a more accurate estimation of when the non-motorized traffic is highest and lowest. In addition, counting for two hours would provide more data than the one-hour session we used thus making the data more representative. Through our observations, we determined that guessing people's age accurately is difficult, so we have organized the table to distinguish between adults and children. For pedestrians, we have considered both assisted and unassisted pedestrians. Assisted pedestrians are defined as all people using wheelchairs, walkers, canes, skateboards, scooters, rollerblades, or strollers.

The provided table does not consider further details such as cyclists' helmet use, cyclists using sidewalks, or number of jaywalkers. Turn counts, counts that make note of the turning patterns of pedestrians and cyclists, are also not included in the provided table. The initial counting program for Worcester should start small and be simple, in the opinion of Stephen Rolle. Specifying gender would not be useful data for future planning, according to Dan Daniska. After establishing a counting program, Worcester could add turn counts to the data collection since they would provide another level of useful data to the city. The major focus in the initial stages is simply on the volumes of bicycles and pedestrians passing through specific observation points.

4.2.2 Counting Program Protocol

In addition to the manual counting form, we produced a step-by-step counting program protocol to direct the person or organization in charge of the counting program from start to finish. This protocol is located in Appendix E. The first step in this protocol is the selection of a specific location for the count. Locations should be selected such that bicycle and pedestrian volumes will be higher as mentioned in Section 2.4.1. As stated by Zach Dyer, schools are always a good location to count because many students walk and bike to schools. Transit locations also attract cyclists and pedestrians since those using public transit typically do not have cars. We designed a systematic methodology for completing this step, which is explained in Section 4.3.

The next step in our protocol was selecting the time of year to do counts. Defined in Section 2.4.1, the best months to conduct bicycle and pedestrian counts is in late September and early October. Early May is the next best time to see peak non-motorized traffic for the same reasons as stated by Dan Daniska. We recommend that any pedestrian and bicycle counts be completed in late September or early October as well as early May. It is often the case that the day of week and time of day for counting is dependent upon the location. The morning and evening commutes from 7-9 AM and 4-6 PM are the best times of day to count. For schools, the students' morning and afternoon commutes are the best times to count, which are dependent on the school. During our observations, we determined that lunch break, between 12 and 2 PM, is also a good time to count around workspaces. In certain locations such as shops and parks, weekend counts may be desired, and the peak bicycle and pedestrian traffic time is between 12-3 PM. We recommend that pedestrian and bicycle counts be done over a two-hour period during the morning and evening commutes. However, counting times should be appropriately selected based on the above criteria.

After determining the locations and times, the department or organization conducting the count will select volunteers. Getting volunteers is essential since, according to Stephen Rolle, employing people to complete the counts would require additional funding. On the authority of Zach Dyer, interns would also make good counters, but they are not typically available during the peak counting months. We have adapted a similar protocol to the one used by Washington State's program, covered in the Section 2.4.1. We recommend obtaining two volunteers for each counting location and providing them with the counting forms. They will perform the count, and they will submit the data collected to the person or organization conducting the program. Some ways of submitting the data include hand delivering the forms, mailing the forms, or scanning and emailing the forms. It is up to the person or organization in charge of the program to determine how the volunteers would submit the data.

4.3 Selecting Counting Locations

Location selection is the first step in the procedure for conducting bicycle and pedestrian counts. According to Zach Dyer, selecting the locations that will produce valid and plentiful data is essential. The Local Access Score (LAS) is a tool that can assist with selecting counting locations. This tool indicates where foot and bike traffic are expected to occur at locations throughout Massachusetts. The Local Access Scores can be further investigated using Geographic Information System (GIS) software. We created a methodology for using a GIS software to analyze the Local Access Score data.

Before designing this methodology, we determined what makes a good counting location and how the Local Access Scores could assist with selecting counting locations. Strong bicycle and pedestrian counting locations do not depend on the volume of traffic at that particular location. We discovered this during our observations. For our observations, we selected locations we believed were busiest in regards to traffic. However, the volume of bicycles and pedestrians was low at some of these locations. Based on these findings and our interview with Kate Ito, we determined the best bicycle and pedestrian counting locations are dependent on the nearby destinations and number of local residents. Nearby destinations such as transit stations, parks, schools, shops, and restaurants should be considered when selecting bicycle and pedestrian counting locations. Additionally, if there are all these destinations nearby, but there is nobody residing nearby, the volumes of bicycles and pedestrians will most likely be low. If both of these factors are considered, the volumes will be indicative of the amount of non-motorized traffic since the local residents will be funneled to these destinations.

Assessing locations in the city based on these criteria can be cumbersome, but can be made simple with assistance from the Local Access Score. This tool assesses the streets and provides a score based on the same criteria. The scores are provided on a scale from 0-100, with the highest scoring locations being the locations at which bicycle and pedestrian counts would generate the most indicative data. These high scoring locations are the locations where counting should take place since the Local Access Score signifies where bicycles and pedestrians should be traveling. This adds a level of robustness to the counting program because the locations will be selected using a scientifically calculated tool, not just intuition.

Since each street in the City of Worcester is scored in the dataset, a systematic way of finding the highest scoring locations was needed. We developed a step-by-step how-to manual for completing this process. The detailed manual is located in Appendix G. Included in this manual are steps on how to download and install ArcGIS Explorer and the LAS data. Furthermore, our manual guides one through the entire process of selecting the desired number of counting locations. Our previous technical experiences with various software provided us with the knowledge for all the installation steps. These experiences also made using ArcGIS straightforward; therefore, explaining exactly what to do within the software was clear-cut. Within ArcGIS, we were able to filter the Local Access data by municipality and clip it only to represent the City of Worcester. We filtered the Worcester Local Access data further by the specific score given to each street segment to find the highest scoring locations. This was an iterative process starting with the highest scoring location, decreasing the filtered score, and repeating. Knowing the scores to filter by was not obvious using ArcGIS so we needed another way to analyze the data. Since the Local Access data can be represented in a table, we determined the highest score for each category using an Excel spreadsheet. The last step for selecting counting locations is to determine whether the count should be completed at an intersection or midblock. Doing this requires checking the adjacent street segments for score similarity, which is a simple operation within ArcGIS.

Using the processes defined in the manual, we selected five counting locations in the City of Worcester. We selected these locations using the composite utility Score that considers both walking and biking. Figure 7 identifies these locations on an ArcGIS map.

Figure 7: Top 5 Composite bicycle and pedestrian counting locations in Worcester

We ranked the counting locations in this example as shown and color-coded them. The highest-ranking segment is on Shrewsbury Street shown in red. This count would be completed midblock. The second highest segment is on Main Street shown in purple and the count would be completed at the intersection with Oread Street. The third highest segment is at the intersection of Front and Foster Streets shown in green. Since some of the highest scoring segments were on Main Street as well, we had to look for the next highest scoring segment that was on a different street. We determined that the fourth highest scoring location, shown in black, is on Grafton Street where the count would be completed midblock. The fifth location we ranked is shown in yellow on Myrtle Street where the count would be completed at the intersection with Main Street. We determined that these are the five highest scoring bicycle and pedestrian counting locations identified by using the Local Access Score and ArcGIS.

4.4 Verification of Procedures

After developing the procedures for selecting a counting location and performing a count, we thoroughly tested the replicability and usage of these procedures. Below are the results from our tests and the changes we made to the original designs based on the results of these tests.

4.4.1 Location Selection Procedure Verification

The co-chair from WalkBike Worcester, Karin Goins, has familiarity with the municipality and counting programs. Because of this, we had her test the location selection manual without any other assistance and provided us with feedback. She successfully followed the manual and commented that it was well constructed. This allowed us to have confidence that the manual was simple and thorough because a person with the same familiarities is desired to coordinate the program. However, she suggested edits to the language to make it easier to read. She also recommended further explanations and clarifications in various places in the manual. We added to the first step by asking the user to check for system requirements of ArcGIS. We recognized any messages that pop up when opening ArcGIS and added additional guidelines for managing them. We inserted a note to warn the user of the prolonged time needed to open the data table. We also added explanations at the beginning of every step to make the purpose of the step clear to the user. By using her feedback on the manual, we edited the steps accordingly and made the necessary changes.

4.4.2 Counting Procedure Verification

Two groups of two volunteers each tested out the counting form without any external help. Two employees volunteered from the CMRPC and two members volunteered from WalkBike Worcester. Both groups provided us with feedback on the counting forms and guidelines.

The two volunteers from CMRPC found that providing the pre-count information was necessary and filled out the table with ease. They understood the guidelines of counting and filled the count table accordingly. The only difficulty they faced with the count tables were the sizes of some table cells. Some count categories would fill up faster than others would; therefore, they recommended adjusting the box sizes according to the amount of data that is expected.

The two WalkBike volunteers responded that filling out the pre-count information was effortless. They noted the simplicity of following the guidelines. However, they commented that more detail should be added about whether people obey traffic laws or not. They suggested noting people's specific interactions with infrastructure such as whether pedestrians wait for crossing signals and if they cause conflicts with motorists. Although they found filling the counting table and categorizing cyclists and pedestrians intuitive, their comments were that some table cells fill up quickly. Since both sets of volunteers made mention of this, we determined that an additional column at the end of the table for the overflow data is the best solution. This allows the counter to write in the category with the high volume in the extra column to allow for more space on the table. We added supporting guidelines to guide the counter on how to use the extra column on the counting table.

CMRPC volunteers suggested collecting additional data using count location diagrams. Drawing and labeling crosswalks at an intersection or a straight street would allow documentation of turn counts and provide behavioral data. Turn counts would provide the direction cyclists and pedestrians travel. Labeling crosswalks and segments of the street can enable counters to document where pedestrians are crossing and where cyclists are riding. An example of a diagram that could be used is shown in Figure 8.

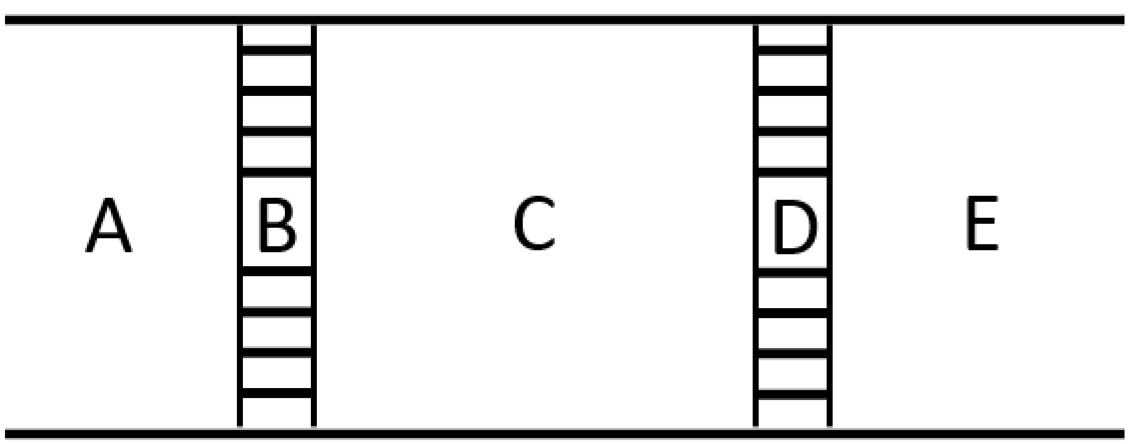

Figure 8: Street diagram example for more detailed counting

A supporting table with all the labels as columns can allow the counter to document how many pedestrians either used a crosswalk or jaywalked through a segment of the street. Counters can count how many pedestrians and cyclists follow traffic laws by using these diagrams. Our recommendation does not include this level of detail because the pilot program should start simple in Worcester to avoid any discouragement to its implementation. However, this could be added in the future.

4.5 Summary

Based on our research, we have determined the current limitations for cyclists and pedestrians and the need for improvements. Additionally, we have discovered and outlined the capacity and the obstacles the City of Worcester faces for implementing a counting program. We created a manual bicycle and pedestrian counting protocol for completing a counting program along with a supporting counting form. We provided a thorough methodology for selecting counting locations that uses the Local Access Score. Lastly, we verified the replicability of the counting program procedure and the location prioritization procedure by receiving feedback from third party users. All gathered results helped us reach our project goal of recommending a sustainable bicycle and pedestrian counting program through the use and adaptation of the Local Access Score. Our recommendations and conclusions are presented in the next chapter.

5 Conclusions & Recommendations

We analyzed our results and have assembled the conclusions and recommendations based on our research. The purpose of these recommendations is to establish a sustainable bicycle and pedestrian counting program for the City of Worcester, using the Local Access Score as an asset to the program.

5.1 Introduce a Manual Counting Program

We recommend that the City of Worcester adopt a manual bicycle and pedestrian counting program. Manually completing non-motorized traffic counts allows for sustainability since minimal funding is required. Completing counts manually requires manpower which could come from city departments and volunteers from organizations. With manual counts, more detailed data can be collected as desired. We formulated a protocol that should be followed when introducing this program. Additionally, we have created a form to be completed during the bicycle and pedestrian counts.

An organization or a city department must take on the task of managing the program and complying with the protocols and guidelines because manual counts require a workforce of people. Thus, we also recommend that city departments and organizations to collaborate to coordinate and complete these counts. By collaboration, city departments can each take part of the responsibility of implementing this counting program. This would minimize needed human resources and funding.

Selecting counting locations using the Local Access Score is another recommendation that we have along with the adoption of a manual bicycle and pedestrian counting program. Selecting the locations systematically adds a level of robustness to the program. We provided a manual for using the Local Access Score to select counting locations. Using the manual as guidance, anyone will be able to follow all the steps, from downloading ArcGIS to selecting locations for counting in Worcester. Since ArcGIS Explorer Desktop and the Local Access Score data are both free to download and use, the only requirement for completing this process is a Windows-based computer.

We also recommend that the City of Worcester initiate a manual bicycle and pedestrian counting program as simply as possible to leave out any confusion for the coordinators or counters. The volume of pedestrians and cyclists should be the initial focus of this program. Once this data is understood from numerous locations, data collection can shift to:

- Recording bicycle and pedestrian turning data,
- Recording pedestrian and bicycle behavioral patterns.

Intersection and street diagrams would be a straightforward way of collecting this data. This would require developing diagrams of each location counted; therefore, this should not be included in the initial stages of the program. It should be added once more detailed non-motorized traffic data is desired for planning. Information gathered from these more detailed observations can be helpful in determining things such as the best locations for crosswalks and bike lanes. We conclude that introducing a manual bicycle and pedestrian counting program would be the simplest implementation and can be completed using the provided protocols and procedures.

5.2 Gather Volunteers

We recommend the use of volunteers for performing the manual counts. Volunteers make counting pedestrians and cyclists inexpensive compared to buying automatic counters, which cost upwards of $3000 per unit. A workforce of volunteers can perform the counts at no cost to the city. Volunteers need minimal training while using our recommended counting forms. The recommended sustainable bicycle and pedestrian counting program only needs to be performed twice a year in early fall (September or October) and May to provide peak traffic data. Since volunteers do not need to be available all year, gathering people to perform counts will be easier.

We recommend WalkBike Worcester as an excellent source of volunteers. This non-profit, advocacy organization promotes the benefits of biking and walking and encourages people to volunteer and be involved in making improvements to biking and walking around Worcester. If the city promotes volunteering to complete the bicycle and pedestrian counts as community service, the program will become more attractive for people to get involved. High school students and college students often have a community service requirement for clubs and organizations; therefore, completing manual counts could be an attractive option for fulfilling their requirements. The Boy Scouts of America or other similar organizations could also get involved in the same way. If people know they will be benefiting their community, they will likely want to volunteer for the program.

5.3 Use Automated Devices in the Future

Although we recommend Worcester to pilot a manual counting program, automatic counters should be considered as a feasible option for the City of Worcester. Volunteers for a manual pedestrian and bicycle counting program can only count for 1-2 hours per session, per day. This limitation can be overcome with the use of automatic counters that can count continuously. Automatic counters could also be used at busy locations where volunteers might lose count. Although automatic counters are expensive, costing upwards of $3000 per unit, they could be cost-effective over a long period of time. Automatic counters can be uninstalled and reinstalled at different locations easily, making it a viable option to count more than just the location where they are installed first. Therefore, the City of Worcester would not need to buy an automatic counter for every counting location, adding to the fact that not every counting location in Worcester would be busy enough to need an automatic counter.

The most effective automatic counter by far is the video camera technology, mentioned in Section 2.4.1, that can distinguish between vehicles, bicycles, and pedestrians. These cameras can also record for a 24-hour period, far surpassing the amount of time that two counters can cover, for up to a week at a time. The DPW can also make use of this device for doing traffic counts, for this technology not only counts pedestrians and cyclists, but vehicles as well. This means purchasing these video cameras would be advantageous to the city. We recommend that if Worcester so chooses to invest in automatic counting devices, the City of Worcester make use of video cameras that can make distinctions of what is passing its range of view.

5.4 Future Research & Impacts

Due to our own limitations, we recommend that further research should be conducted into the desire for biking in Worcester. By adding the turn counting into the counting program we have recommended, future researchers can determine where people are walking and biking from and going to in the city. Residents of Worcester can be interviewed or surveyed to gather information on how many people currently bike, and how many people would bike if it were safer and more accessible to do so. Such research can show Worcester planners the city population's demand for making accommodations for cyclists.

We foresee our project having a positive impact on WalkBike Worcester as well as the City of Worcester. We see the results of our project as stepping stones towards making Worcester a more walkable and bikeable city. The city government will be able to start the counting program out small, and with the help of other organizations, such as WalkBike Worcester and volunteers, the program will be able to grow into something that can positively affect the entire city. With the help of this counting program, the city will be able to pinpoint and improve those areas throughout Worcester that should already be bustling with pedestrian and bicycle traffic.

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Step-by-step protocol for completing a bicycle and pedestrian counting program

Alliance for Biking and Walking. (2016). Alliance for Biking and Walking: About. Retrieved from http://www.bikewalkalliance.org/

The Alliance for Biking and Walking is a coalition of advocacy groups across North America working to transform communities into safe places to bike and walk.

America Walks. (2016a). America walks: About us. Retrieved from http://americawalks.org/about-us/

This webpage talks about the mission of the America Walks organization and can be used to talk about how it relates to WalkBike Worcester's mission statement

America Walks. (2016b). Benefits of walking. Retrieved from http://americawalks.org/learning-center/benefits-of-walking-2/

The webpage outlines the main benefits that come as a result of increased walking and biking. Benefits include safety, health, environmental, and economic. This site also provides information to reports with studies done assessing each of these issues.

Andersen, M., & Hall, M. L. (2014). Protected bike lanes mean business: How 21st century transportation networks help new urban economies boom. *Alliance for Biking & Walking*, 2-11. Retrieved from http://www.peoplepoweredmovement.org/

This report outlined the importance of adding bike lanes from an economical perspective and the benefits it brings the bikers. Could be a good resource to help persuade city officials toward complete streets.

Baas, J., Galton, R., & Biton, A. (2016). FHWA bicycle-pedestrian count technology pilot project - summary report. Washington, D.C.U.S. DoT.

This report talks about how counting programs can be done and gives some examples of pilot programs that have been done around the US. It also details the types of counting technologies that are out there.

Bonnell, I. (2009). Biking to work good for health, environment: Celebrate bike to work and school day on May 15. *Bellingham Business Journal,* 32.

Bopp, M., Hastmann, T. J., & Norton, A. N. (2013). Active Commuting Among K-12 Educators: A Study Examining Walking and Biking to Work. *Journal of Environmental and Public Health*, 2013, 1-8.

This article explains the benefits behind walking and biking as a means of getting to work and school. This activity is known as "active commuting".

Buehler, R., & Pucher, J. (2012). Cycling to work in 90 large American cities: New evidence on the role of bike paths and lanes. *Transportation, 39*(2), 409-432.

Dragun, C. M., Lent, D. W., Rombola, J. L., & Shollo, L. (2013). *Implementing Bike Paths in the City of Worcester* (undergraduate interactive qualifying project no. E-project-050313-085547). Retrieved from Worcester Polytechnic Institute Electronic Projects Collection: https://web.wpi.edu/Pubs/E-project/Available/E-project-050313-085547/

Ernst, M. (2012). *Dangerous by design 2011: Solving the epidemic of preventable pedestrian deaths.* Washington D.C.: Transportation for America.

Talks about all stats behind pedestrian fatalities and the positives that can come as a result of improving these issues.

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This website reports some survey data on the prevalence of walking and cycling in European Countries.

Hankey, S., Lindsey, G., Wang, X., Borah, J., Hoff, K., Utecht, B., & Xu, Z. (2012). Estimating use of non-motorized infrastructure: Models of bicycle and pedestrian traffic in Minneapolis, MN. *Landscape and Urban Planning, 107*(3), 307-316.

Recommends counting bicycle and pedestrian traffic in one hour and two hour intervals to estimate the traffic of the whole day.

Heesch, K. C., Sahlqvist, S., & Garrard, J. (2011). Cyclists' experiences of harassment from motorists: Findings from a survey of cyclists in Queensland, Australia. *Preventive Medicine, 53*(6), 417-420.

This article describes harassment experienced by cyclists when traveling in Queensland, Australia.

Heinen, E., van Wee, B., & Maat, K. (2010). Commuting by bicycle: An overview of the literature. *Transport Reviews, 30*(1), 59-96.

Grundy, C., Steinbach, R., Edwards, P., Green, J., Armstrong, B., & Wilkinson, P. (2009). Effect of 20 mph Traffic Speed Zones on Road Injuries in London, 1986-2006: Controlled interrupted time series analysis. *BMJ (Clinical Research Ed.), 339*, 44-69.

This article details a study done on the effects of decreased speed zones and how it results in fewer accident rates.

Jackson, D. R., & Sinclair, S. (2012). Designing Healthy Communities. San Francisco, California: Jossey-Bass.

This source talks about more health benefits to walk and cycling. A specific example is of children commuting to school by walking or biking and it takes about the positive effects it has on their learning.

Jacobsen, P. L. (2003). Safety in numbers: More walkers and bicyclists, safer walking and bicycling. *Injury Prevention: Journal of the International Society for Child and Adolescent Injury Prevention, 9*(3), 205-209.

This article talks about how increased biking and walking has led to safer streets in urban environments. This can be used as a benefit in the background chapter.

Komanoff, C., & Roelofs, C. (1993). *The environmental impacts of bicycling and walking.* Washington, DC: USDOT.

This report talks about the environmental positives of switching from driving to biking/walking. It gives good examples of the numbers behind it although it may be an older source.

Lindsey, G., Hankey, S., Wang, X., & Chen, J. (2013). The Minnesota bicycle and pedestrian counting initiative: Methodologies for non-motorized traffic monitoring. St. Paul, MN: Minnesota Department of Transportation.

This report details how Minnesota developed and conducted their pilot bicycle and pedestrian counting program with manual and automatic counts.

Litman, T. (2003). Economic value of walkability. *Transportation Research Record: Journal of the Transportation Research Board, 1828*, 3-11.

This source talks about the values walkable cities have for individuals. The benefits talked about are economical and health related.

Litman, T. (2011). America needs complete streets. *Institute of Transportation Engineers. ITE Journal, 81*(4), 36.

Describes benefits and ways to achieve bike roads and walk sideways in all streets.

Litman, T. (2016). *Evaluating active transport benefits and costs*. Victoria, Canada: Victoria Transport Policy Institute.

This report talks about the environmental and economic benefits provided by walking and biking. To be used in the background chapter in the section on benefits.

Lowry, M., McGrath, R., Scruggs, P., & Paul, D. (2016). Practitioner survey and measurement error in manual bicycle and pedestrian count programs. *International Journal of Sustainable Transportation, 10*(8), 720-729.

This article details a study done on the reasons why communities are using manual bicycle and pedestrian counting programs. The study also examined the estimated measurement error from manual counts.

Mannisto-Funk, T. (2012). The Prime, Decline, and Recalling of Rural Cycling: Bicycle Practices in 1920s' and 1930s' Finland Remembered in 1971-1972. *Transfers, 2*(1), 49-52.

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This webpage defines the Metropolitan Area Planning Council and its mission.

MAPC. (2016b). Local access score. Retrieved from http://localaccess.mapc.org/

This webpage explains how the MAPC Local Access program works and defines the ways a city can use it to benefit city planning with respect to bicycle and pedestrians. Has good details about how it works and links to data and guides.

McCann, B. (2013). *Completing our streets: The transition to safe and inclusive transportation networks.* Washington, DC: Island Press.

This book details the complex political process through which transportation projects are selected, planned, and implemented. It also goes in depth on the history of the "Complete Streets" movement and its importance in changing the way transportation decisions are made by cities.

McLeod, K., & Murphy, E. (2014). Where we ride: An analysis of bicycle commuting in American cities. *The League of American Bicyclists,* 1-41. Retrieved from http://bikeleague.org/sites/default/files/Where_We_Ride_2014_data_web.pdf

This report details the prevalence of bicycling and walking in various cities across the USA, sorted by population, percentage of cyclists, and number of cyclists.

Minge, E., Falero, C., Lindsey, G., & Petesch, M. (2015). *Bicycle and pedestrian data collection manual.* Minneapolis, Minnesota: Department of Transportation.

This manual from the Minnesota Department of Transportation provides information on the types of data to collect in a counting program as well as the best methods for collecting and analyzing the data.

Nelson, A. C., Meakins, G., Weber, D., Kannan, S., & Ewing, R. (2013). The tragedy of the unmet demand for walking and biking. *The Urban Lawyer, 45*(3), 615.

In the 2003 and 2005 surveys, Porter Novelli gauged market preferences for a variety of "smart growth" attributes including, for our purposes, the extent to which people believe it is important or very important to be able to walk or bike to work and shopping. The surveys are quite large, with 5,873 respondents in 2003 and 4,943 respondents in 2005. By contrast, other surveys we use range in sample size from about 1,000 to about 2,000. Because Porter Novelli asked the same questions in those years, our total sample size is 10,816. Given this large sample size, we are able to parse respondents based on a number of key demographic indicators such as age, income, and household composition. Because the future demographic makeup of the U.S. will be different from 2005, we need to decompose the Porter Novelli survey into demographic subgroups.

Nordback, K., Tufte, K. A., Harvey, M., McNeil, N., Stolz, E., & Liu, J. (2015). Creating a national non-motorized traffic count archive: Process and progress. *Transportation Research Record: Journal of the Transportation Research Board, 2527*, 90–98.

Offers methods of bicycle and pedestrian counting and making archives of the data.

Peden, M., Scurfield, R., Sleet, D., Mohan, D., Hyder, A. A., Jarawan, E., & Mathers, C. (2004). *World Report on Road Traffic Injury Prevention*. Geneva: World Health Organization.

Portland State University. (2016). Guide to Bicycle and Pedestrian Count Programs. Retrieved from https://www.pdx.edu/ibpi/count

This webpage talks about the purpose of having a bicycle and pedestrian counting program in your city as well as what a counting program is and does. It talks about the types of counting programs, when to use them, and how they can be implemented.

Proulx, F., Schneider, R., & Miranda-Moreno, L. (2016). Performance evaluation and correction functions for automated pedestrian and bicycle counting technologies. *Journal of Transportation Engineering, 142*(3), 1-10.

This paper examines the performance of various automatic bicycle and pedestrian counting tools, and the functions that are used to correct the counts for each tool.

Purdum, S., & Fisher, M. (2011). *Pedaling along the north coast*. Akron, Ohio: The University of Akron Press.

Qi, L., Chun-fu, S., & Yi, Z. (2014). A robust system for real-time pedestrian detection and tracking. *Journal of Central South University, 21*(4), 1643-1653.

A camera system was developed to count bicycle and pedestrian traffic in real-time.

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Ryus, P., Ferguson, E., Laustsen, K. M., Schneider, R. J., Proulx, F. R., Hull, T., & Miranda-Moreno, L. (2014). Methods and technologies for pedestrian and bicycle volume data collection. *NCHRP Project 07-19.* Retrieved from https://www.nap.edu/catalog/23429/methods-and-technologies-for-pedestrian-and-bicycle-volume-data-collection

Evaluates six automatic bicycle and pedestrian technologies.

Steins, C. (2016). Bicycling and walking in the United States 2016 benchmarking report. *Alliance for Biking & Walking,* 30-118. Retrieved from http://www.bikewalkalliance.org/

This is a benchmarking report that analyzed all the US states as well as the cities in them to get data about walking and biking. Illustrates what is already in place to support walking and biking as well as the impact of project that are geared toward this goal.

Terzano, K., & Gross, A. (2016). Do wealthier neighborhoods have better conditions for walking? A comparison study in Springfield, Massachusetts, USA. *Transportation Research Part F: Traffic Psychology and Behavior, 42*, 227-231.

This source has research that supports a link between neighborhood characteristics and levels of physical activity. There is evidence that crime and vacant housing negatively affect walkability.

US Department of Health and Human Services. (2009). Developing Healthy People 2020: Physical Activity and Fitness. Retrieved from https://www.healthypeople.gov/2020/topics-objectives/topic/physical-activity

This report talks about the benefits of regular physical activity and fitness. One topic covered is active commuting and how exercise can be built into your daily routine with it.

U.S. Government Accountability Office. (2015). Pedestrians and cyclists: Cities, states, and DOT are implementing actions to improve safety, 3-25. Retrieved from http://www.gao.gov/assets/

As walking and biking are becoming increasingly more used modes of transportation, safety is becoming a greater factor for cities. This report talks about what factors are contributing to accidents with bikers and walkers. It also explains what cities are implementing safety measures and what these safety measures include.

WalkBike Worcester. (2013). WalkBike Worcester: About. Retrieved from https://walkbikeworcester.org/about/

WalkBike Worcester (WBW) works to make walking and bicycling in Worcester more safe, pleasant and convenient. WBW was founded in 2011 as a work group of the Worcester Food and Active Living Policy.

City of Worcester, MA. (2016). Colleges and universities. Retrieved from http://www.worcesterma.gov/living-working/sites-sounds/colleges-universities/

World Health Organization. (2016). Reported distribution of road traffic deaths by type of road user. Retrieved from http://apps.who.int/gho/data/node.main.A998

Appendix A: Sponsor Description – WalkBike Worcester

WalkBike Worcester (2016) is a non-profit, citizen advocacy group that was founded in 2011 as a working group of the Worcester Food and Active Living Policy Council. They are now an independent organization with two co-chairs: Karin Valentine Goins and Gerald Powers. WalkBike Worcester has no budget or funds, but most of their time and effort goes into advocating ideas and plans to the public and city officials of Worcester that could make it safer and more accessible for people to walk or bike in the city. They have an email distribution list of 200 volunteers, and 630 likes on Facebook. Along with the volunteers, people in the public sector who support the goals of making Worcester safer and more accessible for pedestrians and cyclists are equally important and relevant to WalkBike Worcester's cause.

The mission of WalkBike Worcester is to make the City of Worcester safer and more accessible for pedestrians and cyclists (WalkBike Worcester, 2016). They work to educate city officials and the public on greater pedestrian and cyclist safety. They stage community events, comment on engineering designs, and participate in Road Safety Audits. The group attempts to carry forward the active transportation priorities outlined in the Mass in Motion grant gifted to Worcester, which includes a "complete streets" initiative to integrate pedestrians and cyclists into the pre-existing transportation networks. WalkBike Worcester (2016) has several other important goals. They aim to reduce the environmental and climate impacts of transportation and encourage physical activity to combat obesity and other health problems. Lastly, WalkBike Worcester would like to increase transportation opportunities for low-income families and individuals, college students, and youth.

There are several organizations across the United States including some in Massachusetts that are working toward the same goal as WalkBike Worcester. Some of these organizations are the Metropolitan Area Planning Council (MAPC) (2016a), America Walks (2016a), and Alliance for Biking and Walking (2016). The MAPC (2016a) is a planning agency serving over 100 cities and towns near Metropolitan Boston that takes part in projects dedicated to increasing access for modes of bicycle and pedestrian transportation. America Walks (2016a) and Alliance for Biking and Walking (2016) are both national organizations. America Walks (2016a) is a non-profit organization that provides support to statewide, regional, and local groups with the mission to increase walking and the walkability of communities across America. Alliance for Biking and Walking (2015) is a coalition of over 200 groups across North America that works to transform communities into safe places to bike and walk. These three organizations have the potential to support WalkBike Worcester in making Worcester a more walkable, bikeable city.

Appendix B: Observation Results

Location 1: Lake and Belmont Intersection

Attractions Nearby:

- Retail store fronts at intersection
- White City Plaza across the bridge
- UMass Hospital nearby

Infrastructure Conditions:

- Sidewalks that lead into crosswalks in all locations
- Crosswalks in all directions with signals
- Bike lane on Lake Ave and going across Route 9 bridge
- Takes several minutes for crossing signal to change
- Walk signal beeps to notify when to walk
- ~30sec to cross with the signal
- Stopping islands halfway through crossing for pedestrians to wait at

➔ **Time 1:** Thursday, Jan. 19, 8-9AM
  - **Weather:** Clear, 32°F
  - **Additional Comments:**
    - Crosswalk signals are integrated into the traffic light cycle during this time

➔ **Time 2:** Thursday, Jan. 19, 12-1PM
  - **Weather:** Partly Cloudy, windy, 42°F
  - **Additional Comments:**
    - Construction nearby causing limited sidewalk use on one side of Lake Ave
    - Might want to consider the side of street people are on during counts
    - Might want to consider the path to get through the intersection
    - A car stopped in the middle of the crosswalk blocking pedestrians
    - Not everyone would wait for the signal because it took too long
    - Occasionally jay-walking

➔ **Time 3:** Sunday, Jan. 22, 2-3PM
  - **Weather:** Very light shower, windy, 43°F
  - **Additional Comments:**
    - Cars taking right turns usually blocked the crosswalk
    - People did not even press the crossing signal button to cross about half the time, takes too long

Location 2: WRTA and Union Station Intersection

Attractions Nearby:

- WRTA Hub

- Union Station
- Saint Vincent Hospital
- Parking Garage
- Memorials at corner

Infrastructure Conditions:

1. Construction blocks the sidewalk entirely on one corner
2. Large sidewalk areas
3. Crosswalks with signals in all directions
4. Bike racks located at the WRTA Hub
5. Benches for sitting
6. ~20sec to cross with signal

- **Time 1:** Friday, Jan. 20, 10-11AM
  - **Weather:** Cloudy, 34°F
  - **Additional Comments:**
    - Some people press the button and wait, others go without pressing the button at all
    - Lots of jay-walking due to the construction most likely
    - People would cross the intersection diagonally
    - People disregarded cars completed at times
    - People don't want to wait for signals
    - Intersection not easily accessible for wheelchairs
- **Time 2:** Friday, Jan. 20, 2-3PM
  - **Weather:** Cloudy, 38°F
  - **Additional Comments:**
    - Peds cut through Union Station to get to WRTA
    - Most people were heading toward the Bus Hub

Location 3: Park and Chandler Intersection

Attractions Nearby:

- ➔ Restaurants nearby
- ➔ Walgreens at corner
- ➔ Gas station at corner

Infrastructure Conditions:

1. Fast moving traffic in all directions
2. Crosswalks with signals in all directions
3. Crossing signal take a long time to activate
4. ~20sec to cross with signal

- **Time 1:** Saturday, Jan. 21, 12:30-1:30PM
  - **Weather:** Sunny, 47°F

- **Additional Comments:**
    - Kids on bikes cutting through the intersection with no regards to traffic
        - Caused drivers to get angry
    - Wheelchair going down Park Ave in the street, extremely dangerous, couldn't get on the sidewalk because too bumpy
- **Time 2:** Tuesday, Jan. 24, 8-9AM
  - **Weather:** Snow/rain, 32°F
  - **Additional Comments:**
    - Sidewalks not clear of snow
    - Roads in poor condition
    - People were bundled up so hard to tell gender
- **Time 3:** Tuesday, Jan. 24, 12-1PM
  - **Weather:** Light drizzle, 33°F
  - **Additional Comments:**
    - People walking in road because sidewalks in poor condition
    - Snow blocking connection between sidewalk and crosswalk, big snowbanks

Location 4: Lincoln Square

Attractions Nearby:

- ➔ MCPHS
- ➔ Police Headquarters
- ➔ Bus stops nearby
- ➔ MCPHS dorms on other side of intersection from classrooms

Infrastructure Conditions:

- Crosswalks and signals in all directions
- Cameras on traffic lights
- Crossing signal also built into light cycle
- Islands in the middle of crosswalks
- Ambulance has control of lights
- ~30sec to cross with signal
  1. **Time 1:** Monday, Jan. 23, 8-9AM
     a. **Weather:** Snowing/Cloudy, 31°F
     b. **Additional Comments:**
        i. Lots of traffic
        ii. Bikers riding on sidewalks
        iii. Mostly college kids
  2. **Time 2:** Monday, Jan. 23, 12-1PM
     a. **Weather:** Snow flurries, 33°F

b. **Additional Comments:**
   i. Motorized wheelchairs
   ii. Bus stop by police station was busy

Location 5: Main and Pleasant Intersection

Attractions Nearby:

- ➔ Worcester Common
- ➔ Coffee shops
- ➔ Restaurants
- ➔ Santander Bank
- ➔ Bus Stops
- ➔ City Hall

Infrastructure Conditions:

- Good Sidewalk infrastructure
- Large sidewalk space by City Hall
- Snow narrowing the sidewalks
- Crosswalks and sidewalks in all directions
- Corners on intersection not lined up making it hard to cross at times
- ~20sec to cross with signal
- **Time 1:** Wednesday, Jan. 25, 8-9AM
  - **Weather:** Partly cloudy, Windy, 32°F
  - **Additional Comments:**
    - Loading truck blocked view of entire intersection
    - Hard to count the intersection, so busy
    - Probably want to count mid-block to idea of what is happening per street and not the intersections
    - People rarely wait for crossing signal
- **Time 2:** Wednesday, Jan. 25, 12-1PM
  - **Weather:** Partly Cloudy, Windy, 37°F
  - **Additional Comments:**
    - Very busy for only two counters
    - Either one person to count at the end of each street or count the street mid-block

Table 1: Counting data collected during our project in Worcester

Count Number	Location	Date	Day of Week	Start Time	Duration (hrs)	Weather	Temperature (°F)	Bicycle		Unassisted Pedestrian		Assisted Pedestrian	
								Adult	Child	Adult	Child	Adult	Child
1	Lincoln Square	1/23/17	Monday	8:00:00 AM	1	Snow	31	2	0	113	0	0	0
2	Main & Pleasant	1/25/17	Wednesday	9:00:00 AM	1	Partly Cloudy	32	2	0	270	2	1	0
3	Park & Chandler	1/21/17	Saturday	12:30:00 PM	1	Sunny	47	5	0	66	5	1	1
4	Lincoln Square	1/23/17	Monday	11:55:00 AM	1	Snow	33	4	0	67	1	2	0
5	Park & Chandler	1/24/17	Tuesday	8:00:00 AM	1	Snow/Rain	32	0	0	7	0	0	0
6	Main & Pleasant	1/25/17	Wednesday	8:00:00 AM	1	Partly Cloudy	37	5	0	708	9	0	2
7	Front & Foster	1/20/17	Friday	10:00:00 AM	1	Cloudy	34	0	0	108	4	3	3
8	Park & Chandler	1/24/17	Tuesday	12:00:00 PM	1	Rain	33	0	0	20	1	0	0
9	Lake & Belmont	1/19/17	Thursday	8:00:00 AM	1	Clear	32	1	0	15	0	0	0
10	Front & Foster	1/20/17	Friday	2:00:00 PM	1	Cloudy	38	0	0	145	5	4	3
11	Lake & Belmont	1/22/17	Sunday	2:05:00 PM	1	Windy	43	1	0	24	0	0	0
12	Lake & Belmont	1/19/17	Friday	12:00:00 PM	1	Partly Cloudy	42	0	0	45	1	0	0
13	Franklin & Portland	2/14/17	Tuesday	1:45:00 PM	2	Partly Cloudy	33	2	0	337	5	1	0
14	Front & Foster	2/16/17	Thursday	4:00:00 PM	2	Windy	30	4	0	160	0	0	7

Appendix C: Group Talk Protocol and Notes

Resource Persons: Leadership Group at WalkBike Worcester

Introduction: We are the WalkBike Worcester IQP Team from WPI: Joseph Atchue, Jacob Mikolajczyk, Kamyar Sajjadi, and Brady Snowden. We are here to lead a discussion about Worcester's current biking and walking situation

Date: February 2, 2017

Discussion points:

- Current concerns when walking/biking in Worcester
    - Both yours and what you feel the public believes
- Ways improvements can be made to Worcester's walking/biking current status
- What are your visions for a walk/bike friendly city?

Data Analysis/Key Points:

- Concurrent pedestrian signals would be much more efficient for crosswalks
    - Pedestrians would not have to wait as long to cross, and so they wouldn't jaywalk as much
- Crosswalks that are signaled would be much safer for pedestrians crossing wide streets and rotaries
- Bike lanes should be made more prominent so that drivers take notice of them and don't just drive over the painted lines marking them
- There needs to be more bike parking around the city
    - People would be more apt to ride their bikes around the city if there was bike parking around the city
- There should be streets just for pedestrians and cyclists
    - For their safety and benefits
- Kids should walk or bike to school if they live close enough
    - Routes should also be marked that are safe for people to walk or bike to work or school
    - Incentives for people to walk or bike to school or work could get more people to walk and bike around the city

Full Minutes:

- A seasonal problem that Worcester faces is the lack of snow removal from sidewalks
    - Sidewalk conditions overall are not good
    - When crossing a street, visibility from drivers is a problem to pedestrians
    - It is better to have concurrent pedestrian signals that turn with the traffic lights
        - Many people are forced to jaywalk because the signal takes too long to change

        - Giving the drivers the ability to turn right on red and left on green with concurrent pedestrian signals makes it dangerous for pedestrians
            - There should be yield signs and no turn on red signs for the drivers
- Crosswalks that go over four lanes of traffic (2 lanes in each direction) can be dangerous; i.e., Chandler Street
    - Drivers would go around cars that have stopped in another lane for a crossing pedestrian (there has been a pedestrian death reported on Chandler Street because of this)
        - There are many pedestrians on Park Avenue and Chandler Street, so there should be signaled crosswalks to cross those streets to make it safer for pedestrians to cross
- Many driveways are blind in Worcester, making it a hazard for pedestrians who are walking by one
    - There are also a lack of sidewalks on many streets (i.e., in front of WSU) and many that disappear
- Drivers tend to go fast around rotaries, so there should be signals for pedestrians to cross
    - People should also show intent to cross instead of just crossing and catching drivers off-guard; make the drivers stop for you
- There is a lack of bike lanes and routes, and there is also no maintenance to keep the painted lines that show where a bike lane is currently
    - There is/was one on Southbridge Street, but drivers would drive on it, so the paint is gone
        - Bike lanes are not validated by drivers
        - May Street's and Winter Street's bike lanes are also not validated, because drivers drive all the way to the shoulder
    - Potholes are also a big problem for cyclists, because they can cause crashes
        - Frost heaves also create bumps in the road
        - There is also no visibility for cyclists in Worcester
    - Drivers go too fast on Lincoln Street to be able to safely ride your bike there
    - Drivers feel like cyclists do not belong in rotaries, so there should be painted lanes for them
- There is also a lack of bike parking around the city as a whole, so there is no encouragement for people to ride their bikes around the city to get to places
    - Union Station's bike locker idea should be copied around the city; or at the very least, bike racks
- Parking meters could be incorporated to include bike racks
- Crossing signals should be made concurrent with the traffic signals
    - Snow removal should be kept-up with, along with sidewalk upkeep
    - If there are more trees on sidewalks, then that creates shade, which will make people want to walk more
    - Sidewalks should also be made level after frost heaves create bumps in the pavement
- Bus scheduling needs to be better so people would use it more

- Incentives from school or work could get people biking and walking more; i.e., money
    - Pedestrian crossings should be shoveled and cleared completely, along with school routes
- People actually don't want street trees or sidewalks in front of their house because they don't want to clear the sidewalk or rake up the leaves left by the tree
- There should be some pedestrian-only streets; i.e., Highland Street or Elm Street
    - Could have a tunnel under Highland Street for traffic, so people could walk from Park Avenue to Main Street
- San Francisco has something called 'the wiggle,' which is a curved street for cyclists that are on hills so that they can avoid traffic
    - "Worcester Wiggle"
    - E-Bike Share Program
    - Could make some streets bike boulevards; or even just improvements on current streets for cyclists
- Kids should be walking and biking to school more, especially since many of them live close enough to the school already
    - Shorter trips around the city should be walked and biked more
- Routes can be mapped-out that are safe for walking and cycling so that people can ride their bikes or walk to either work or to school

Appendix D: Interview Protocols and Notes

1: Dominic Goulding, Avid Cyclist

Introduction: We are a research team from WPI working with WalkBike Worcester: Joseph Atchue, Jacob Mikolajczyk, Kamyar Sajjadi, and Brady Snowden. We are interviewing you today to get your view on Worcester's current walkability and bikeability.

Date: November 22, 2016

Questions

- Do you prefer to walk or bike as a means of transportation?
  - Why is one superior to the other?
- Why do you like/dislike to bike?
  - Do you bike for recreation? Commuting? Exercise?
- Why do you like/dislike to walk?
  - Do you walk for recreation? Commuting? Exercise?
- Do you like to bike in the city or in more rural areas? Why?
  - City roads or open roads?
  - What do you dislike about the other?
- Do you walk places in Worcester? How often? Why?
- Do you bike places in Worcester? How often? Why?
  - If not, what are the obstacles that prevent you from doing so?
- What limits biking in the city?
  - Safety? Accessibility? Other?
- Do you feel safe when walking/biking in the city?
  - How might the city make improvements to make you feel safer biking/walking?
- How do you feel about driving in the city versus walking/biking?

Data Analysis/Key Points:

- He would ride from his home in Princeton, MA to WPI when the weather permitted, which averages to about 40 miles of riding per day
- Cycling is much better for the environment than driving a car
- He only rides his bike throughout Worcester if he has to
  - Salisbury Street is really the only street he rides his bike on in Worcester
  - Riding in rural areas is better because of less noise and traffic
- In Worcester, the worst things are inconsiderate drivers, potholes, and a lack of bike lanes
- If bike lanes are put in, they need to be maintained
- Walking is more enjoyable than driving short trips and trying to find a parking spot
  - There is "safety in numbers," so if there were more cyclists and walkers, it would be better for everyone

- Children in the US are taught that a bike is a toy to outgrow, not a mode of transportation
    - Children are not taught how to ride their bike on the road properly

Full Minutes:

- He worked in the EcoTarium until 2007
    - He would ride 40 miles a day to and from the EcoTarium when the weather permitted him to do so
        - Through the summer and B Term
- He lived in England, so cycling was a means of transportation
    - He runs for exercise
    - For 2 months a year on Nantucket he rides for exercise, during the IQP, at the project center
- Cycling is better for the environment
    - He would leave his car at WPI at the beginning of the week, bringing his clothes and anything else he needed, and return home Friday driving his car
- He doesn't ride in the city very much, only Salisbury Street
    - He would bike in the city if he needed to
        - Broken glass on the streets was a problem in Worcester, until they cleaned it up
- He prefers riding in rural areas because there is less traffic and you're able to avoid potholes and other obstacles
    - City drivers heckle cyclists and throw things at you
        - It's just more pleasant to ride in rural areas because of the scenery and less pollution
- His route to the EcoTarium, when he would ride there for work, was to ride through Sterling, into West Boylston to Plantation Street in Worcester, to the EcoTarium
    - He avoided the city because he didn't want to stop - he would wear cleats
- There are no bike lanes in Worcester, and the drivers are bad
    - When it snows out, riding is impossible
- If he is advising an IQP team, he'll walk to the Worcester Project Center
    - He'll walk anywhere within a 1.5-mile radius around the WPI campus
- It's quicker to walk than it is to get to your car, drive it there, and then park it
    - It's also more enjoyable to walk
        - But walking in Worcester can be unpleasant
- There is a need to have separate bike lanes in Worcester
    - For example, bike lanes in Washington, D.C., are too crowded by walkers and people to ride your bike on them - safer to ride in the road

        - It’s better to ride on the road if you’re riding your bike at 20 mph for ~30 miles a day
    - London has good public transportation and it was too far for him to ride to where he needed to go
        - Melbourne was good for riding
- Riding to work requires you to bring clothes, have a shower, and have a locker for your gear
- Bike lanes need to be maintained
    - Riding in the city has the danger of being ‘doored’ by a parked car - “nerve wracking”
    - You can ride around D.C. year-round because the weather doesn’t get too bad, even in the winter
- There needs to be a delay for traffic lights so cyclists can get started first before the cars start; also, some lights don’t change when you ride your bike to an intersection, so you have to wait for a car to show up
    - Drivers, in general, don’t know how it is to ride your bike on the road
- He tries to avoid and to minimize driving in the city
    - Driving is safer than biking in Worcester
        - It is better to cycle now than it was in the past 30 years
- It’s better to drive when you’re doing errands
    - It is also more efficient to run and to do your errands at the same time
    - There is “safety in numbers,” so it would be better to have more walkers and bikers
        - Drivers would be able to get used to walkers and bikers through this way
    - Some rules need to change to make it safer for bikers on the road - some rules are just “stupid”
- In the US, a bike is seen as a “toy” for kids to get over and grow out of; a bike is not seen as a feasible form of transportation; children are not taught the correct way to ride a bike on the road
- Groups/stores to look up:
    - Fritz
    - Barney’s
    - Worcester Wheelmen

2: Kate Ito, Regional Planner at the Metropolitan Area Planning Council (MAPC)

Introduction: We are a research team from WPI working with WalkBike Worcester: Joseph Atchue, Jacob Mikolajczyk, Kamyar Sajjadi, and Brady Snowden. We are interviewing you today to get your view and experience with the Local Access Score tool and the implementation of a bike and pedestrian counting program.

Date: January 24, 2017

Questions:

- What is your level of familiarity with bicycle and pedestrian counting programs?
    - If familiar, could you tell us about what you know?
- What are some ways the Local Access program can be used?
    - Specifically, with regards to a counting program.
- Have any cities adopted the LAS for planning purposes?
    - If so, where and what for?
- What do the scores generated by the program actually mean?
    - What is a good score? A bad score?
    - What factors are considered in the scores?
    - How does it gather data to determine a score?
- What are some problems that a city like Worcester could face when trying to implement a counting program?
- We are trying to get Worcester to adapt the LAS to establish a sustainable counting program, what data from the LAS could assist in this process?
    - Do you have recommendations for how this could be done?
- How can we use the Local Access Score to determine count locations that are representative of a study area?
- What are some factors that might be missed by the Local Access Score that we should consider for our project?
- What methods can be used to prioritize locations with the Local Access Score for development of a counting program?

Data Analysis/Key Points:

- The easiest way to do counts is to divide streets into categories based on their Local Access Score and then randomly selecting streets from these categories to perform the counts at
- Scores are from 0-100 for the LAS
    - There are forms for biking and walking, giving a total score of accessibility
        - A highly-utilized section of road with attractive destinations would get a high score
        - A section with unsafe infrastructure and few destinations would get a low score
    - Worcester streets can be compared to one another directly through their scores
    - The online map gives a relative sense of the data but GIS is required to go in depth

- The LAS is an asset to a counting program, not a replacement
    - Counts made in one street can estimate numbers for another street with a similar score
    - Adds a level of robustness to a counting program
- Starting points to count at vary with the location
    - Get a sense using similar cities as a comparison to Worcester
        - See how many counts they did to get enough data
    - Categorize roads in Worcester to be counted in each category
    - Typically want to look at mid-block so you can see how one street relates to another
    - Hard to relate intersections so this could get time consuming if you want to count at intersections
    - Only use intersections for turning data
        - There is usually higher-volume just on a straight street

Full Minutes:

➔ She's reviewed both automatic and manual counting program projects, most recently in Washington state

➔ Representative counting programs are used to estimate travel patterns and volume

◆ Use of a half-mile radius from the counting location of the Local Access Score (LAS) to categorize those locations

➔ Counts can be done most easily by dividing streets into categories based on the LAS and then randomly selecting streets from the categories to do the counts at

➔ LAS uses prioritized locations for walking and biking

◆ Uses shops/restaurants, transit, schools, and etc.

- Further development is still needed to use the LAS for counting purposes

➔ Scores are from 0-100 for the LAS; a table using the Local Access Score (LAS) explains those scores, can see full dataset using GIS

◆ There are forms for biking and walking, giving a total score of accessibility out of 100

- A highly-utilized section of road with attractive destinations would get a high score
- A section with unsafe infrastructure and few destinations would get a low score

◆ Compare Worcester streets to one another

◆ The online map gives a relative sense but to go in depth need GIS

➔ Time and money are the two largest obstacles for Worcester to overcome in order for it to implement a counting program

◆ Massachusetts does have a counting program portal online

◆ Typically relies on volunteers and can be time consuming

➔ The LAS is an asset to a counting program

◆ Comparisons to other streets in Worcester can be made

- Counts made in one street can estimate numbers for another street with a similar score
- Adds a level of robustness to a counting program

➔ The more data that is collected by counts would give representative numbers but LAS can help with prioritizing locations

➔ The idea is to count a few roads and determine how they relate to similar roads in the area using the LAS

➔ For the counting program in Princeton she is currently involved in, representative streets are categorized as high, medium, or low level of walking and biking utilization

➔ Retail shops, schools, parks (open spaces), and transit are currently used for the LAS

- This is the current utilization data used thus far for the LAS
- Other things to consider and are not yet modelled

➔ Prioritization process is still undergoing changes

- Methodology for using the LAS is planned to be published later this year
  - Would add to our project and could assist users further
- Decreasing the amount of roads to count on would be the best way to go

➔ Starting points to count on vary with the location

- Get a sense using similar cities as a comparison to Worcester
  - See how many counts they did to get enough data
- Categorize roads in Worcester to be counted in each category
- Typically want to look at mid-block so you can see how one steet relates to another
- Hard to relate intersections so this could get time consuming if you want to count at intersections
- Only use intersections for turning data
  - There is usually higher-volume just on a straight street

➔ Ask Worcester city officials about any counting locations being used now or that have been used

3: Dan Daniska and Rob Raymond, Planners, Central Massachusetts Regional Planning Commission (CMRPC)

Introduction: We are a research team from WPI working with WalkBike Worcester: Joseph Atchue, Jacob Mikolajczyk, Kamyar Sajjadi, and Brady Snowden. We are interviewing you today to understand your views and experiences with implementing bicycle and pedestrian improvements and counting programs in Worcester.

Date: January 31, 2017

Questions:

1. What is your level of familiarity with bicycle and pedestrian counting programs?
    a. If familiar, could you tell us about what you know?
2. Do you believe Worcester should implement a counting program? Why?
3. What obstacles do you believe the city would face if it were to implement a counting program?
4. What sort of data from the counting program would be useful for planners?
    a. Is direction and turning data useful?
    b. Is gender useful? Age range?
5. Have bicycle and pedestrian counts been done in Worcester in the past? Where? How?
    a. If yes, is that data available? Where?
6. What resources are available to implement a bicycle and pedestrian counting program?
7. We plan to test a pilot counting program with volunteers. Could you recommend a few people to us who could volunteer for this?
8. Would you be more interested in installing automatic counting devices or have counts done every so often with volunteers and portable equipment?
    a. How would you weigh costs of each approach versus the accuracy and benefits attained?
9. What is your vision for a walk/bike friendly Worcester?

Data Analysis/Key Points:

- Funding for counting programs are limited
    - Public Health and Public Works can be granted funds by state if they propose importance of a counting program
    - Human resources are usually the largest limitation
    - Worcester has not done any counts in the past five years
- Locations with schools and major destination should be prioritized for counting
- Early fall and spring are the best times to count
    - 1:30 hour counts, one in the morning, one in the afternoon
- Volume and raw numbers of bicycle and pedestrian are the most important reason counts are done

    - It would identify what and where improvements are needed
- Level of detail counts should provide:
    - Age range can be important to identify more specific improvements
    - Gender identification seems unnecessary
    - Numbers of jaywalkers can be useful
    - Should only double-count pedestrians and/or cyclists if they pass by the counting location in a separate 15-minute period
- Busy locations such as Downtown can greatly use automatic counters because of the high volume
    - Busy intersections can count turning; smaller, less busy roads can have counting locations just on a straight patch of the road
- Counting program pilots should start small and basic, work up towards getting bigger and possibly more complex

Full Minutes:

- CMRPC has done counts by order of for Safe Route to School Project
    - 1:30 hour counts, one in the morning, one in the afternoon
- 3 hours counts on the weekend on locations other than schools
- Counts can help with improvements to sidewalks
    - Sidewalks are in generally poor condition
    - There have not been any dedicated counts in Worcester, only some project specific ones
- Funding is limited
    - Public Health and Public Works can be granted funds by state if they propose importance of a counting program
    - Human resources are usually the largest limitation
- Early fall and spring are the best times to count
- Locations with schools and major destination should be prioritized for counting
- Volume and raw numbers of bicycle and pedestrian are the most important reason counts are done
    - It would identify what and where improvements are needed
    - Age range is important to identify more specific improvements
    - Gender identification seems unnecessary
    - Numbers of jaywalkers can be useful
    - Worcester has not done any counts in the past five years
- Busy locations such as Downtown can greatly use automatic counters because of the high volume
- One of the obstacles pedestrian face are the limited amount of yellow ramps by the crosswalks
- Rob Raymond:
    - City doesn’t care about walking and biking around Worcester
        - Counts have been done, but only in conjunction with traffic counts during rush hour, so not an accurate amount of pedestrians or cyclists
    - There are currently no permanent counters in Worcester

        - They could be useful
            - Could be hidden under a panel to keep away from people who would want to steal it
        - Video detection equipment can be very expensive
    - Biggest problems are accuracy and costs
    - Counts have been done on rail-trails in and around Worcester
        - Used brackets for age, gender, and how/what they were using to move
            - It can be difficult to decipher age and separating gender is utterly useless
            - Should only double-count pedestrians and/or cyclists if they pass by the counting location in a separate 15-minute period
                - It's more about volume on a sidewalk/road for pedestrians
    - Big and busy intersections can count turning; smaller, less busy roads can have counting locations just on a straight patch of the road
    - Cut-through streets for pedestrians and cyclists could be useful to the people of Worcester
        - But walking is not so bad in Worcester at this moment in time
            - More bike-friendly through more bike lanes and/or bike paths
    - Should start small and basic, work up towards getting bigger and possibly more complex

4: Gerald Powers, Co-Chair at WalkBike Worcester

Introduction: We are a research team from WPI working with WalkBike Worcester: Joseph Atchue, Jacob Mikolajczyk, Kamyar Sajjadi, and Brady Snowden. We are interviewing you today to understand your views and experiences with implementing bicycle and pedestrian improvements and counting programs in Worcester.

Date: January 17, 2017

Questions:

1. What obstacles do you believe the city would face if it were to implement a counting program?
2. What is your vision for a walk/bike friendly Worcester?
3. Has the city ever tried to implement complete streets without a counting program in place?
    a. If so, what were the major factors considered when designing the project?
4. Which areas in Worcester do you believe bicycle and pedestrian counts should be done?
    a. Why those locations?
    b. What benefit do you believe the data will provide to the city?
    c. Use a map of the city to get specific details.
5. Would you be more interested in a permanent counting program or one that can be done every so often with volunteers and portable equipment?
    a. How would you weigh costs of each approach versus the accuracy & benefits attained?
6. Why does WalkBike Worcester prefer to use the Local Access Score?
    a. What data do you believe it will provide?
    b. How can it assist in establishing a counting program?
    c. Has WalkBike Worcester ever considered a different program?
    d. Have you personally used the Local Access Score in the past? If so, what is your opinion on it and how do you think we should use it?

Data Analysis/Key Points:

- Walkability and bikeability are complementary to each other when improved
    - Bike lanes make it safer for pedestrians
        - Pedestrians will step into a bike lane instead of oncoming traffic when crossing streets
    - Traffic that is allowed to use the full lane takes away any space for a bike lane
        - Wide streets let car drivers drive faster which makes the infrastructure unsafe for cyclists and pedestrians
    - Residential streets do not need bike lanes because of their low speed limits and street parking
    - Bike lanes could be put next to car parking, making it safer for pedestrians
- The largest obstacle is getting the political will to get the counting program going

    - The Worcester Chamber of Commerce and the Department of Health are both on board
    - Forces are and should be coming together to overcome this problem
- Data-driven analysis of accidents can fix areas that need improvement
    - Accident-prone areas should be fixed over wear-worn roads
        - Base-to-top method: stopping minor accidents will also help stop more major accidents
- Worcester has never implemented complete streets
    - Infrastructure should be engineered to accommodate to what people do, not what the city wants them to do
    - Goldstar Boulevard is wide enough to be a complete street
    - All arterial and sub-arterial lanes should have bike lanes, making it the simplest solution
    - Attractiveness of the areas walked and biked play a big role in how many people will walk and bike those areas
        - Street trees
- Crossing signals need improvement
    - Flashing yellow lights are more effective than crossing signals as they are quicker to respond to someone crossing
    - Need for signal timing that can respond quickly when a cyclist or pedestrian is present.
- The more flexible and viable option would be a temporary counting program
    - Temporary manual counts with volunteers are more realistic and provide representative numbers
    - It could be done once because pedestrian counts will most likely not change in a given area for a long period of time

Full Minutes:

- WalkBike Worcester has been interested in a counting program for 7 years
    - The focus is on bike paths; the Wachusett Greenway rail trail was their inspiration
    - Bike paths are not realistic in the city because the off-road space needed is not there
- There is land available for the Providence-Worcester bike path, but the communities don’t want to front the costs or the labor for the project
    - Worcester’s Section 7 already has the land and the money available for the project
- Walkability and bikeability are complementary to each other when improved
    - Bike lanes make it safer for pedestrians
        - They can accommodate each other
        - Pedestrians will step into a bike lane instead of oncoming traffic when crossing streets
    - The largest obstacle is getting the political will to get the counting program going
        - The Worcester Chamber of Commerce and the Department of Health are both on board

        - Many of the streets are wide enough to accommodate bike lanes
        - Forces are coming together to overcome this problem
    - Another big obstacle is whether the infrastructure is in place or not
        - Streets are wide enough on arterial routes to accommodate bike lanes
        - Parking is one of the most important things for a city so it's hard to take that away to add in bike lanes at times.
    - Traffic that can use the full lane takes away any space for a bike lane
        - Residential streets do not need bike lanes because of their low speed limits and street parking
    - Chandler Street
        - Parking is allowed on both sides of the street past Park Avenue
        - However, parking isn't marked and the street isn't marked as being two lanes so cars tend to drift from side to side.
        - There is room to add in marked parking with a bike lane next to a single travel lane on this road.
    - Bike lanes could be put next to car parking, making it safer for pedestrians
        - Those same travel lanes are too wide for a single lane of traffic to drive in, making it unsafe
    - A road audit of Main Street reveals many sideswipes because drivers swerved in and out of lanes, due to very wide roads
        - Should change to single-lanes in each direction
    - Data-driven analysis of accidents can fix these areas
        - Accident-prone areas should be fixed over wear-worn roads
            - Base-to-top method: stopping minor accidents will also help stop more major accidents
    - Focus money on correcting the accidents happening instead of just paving over roads so people can drive faster.
    - Complete-streets implementation
        - Should fill-in empty spaces left by the tearing-down of old buildings to make people want to walk and/or bike there
            - Cut-down on parking garages
                - Jeff Specks, *Walkable Cities*
            - Street trees make it better for everyone
        - Parking lots can be expensive in the city
        - Better sidewalks, attractive storefronts, less parking, and street trees and/or plants
            - Street parking is good because it makes pedestrians feel safer
            - Cars travel on wider streets, making it more dangerous for everyone
        - Attractiveness of the areas walked and biked play a big role in how many people will walk and bike those areas
            - Street trees, many benefits
- Worcester has never implemented complete streets

    - Should engineer to accommodate what people do, not what you want them to do
    - Goldstar Boulevard is wide enough to be a complete street
- All arterial and sub-arterial lanes should have bike lanes, making it the simplest solution
    - The adoption of a complete streets program would take a long time for Worcester to implement
        - Make streets safer, not better for drivers to go faster
        - Need to change the priority from smooth roads to safe roads
- The more flexible and viable option would be a temporary counting program
    - Temporary manual counts with volunteers are more realistic and provide representative numbers
    - It could be done once because pedestrian counts will most likely not change in a given area for a long period of time
        - Counters do not tell how many people would use the street if it was more accessible and safe
    - Volumes of traffic data are time sensitive
- Crossing lights could count pedestrians and change the time to cross accordingly - no technology out there on the market currently
    - Expensive and not as precise as manual counting
        - The Department of Public Works could set interval times for high-traffic on crosswalks
            - Flashing yellow lights are more effective than crossing signals
            - They are quicker to respond to someone crossing
    - Need for signal timing that can respond quickly when a cyclist or pedestrian is present.

5: Zach Dyer, Deputy Director of the Department of Public Health

Introduction: We are a research team from WPI working with WalkBike Worcester: Joseph Atchue, Jacob Mikolajczyk, Kamyar Sajjadi, and Brady Snowden. We are interviewing you today to understand your views and experiences with implementing bicycle and pedestrian improvements and counting programs in Worcester.

Date: January 23, 2017

Questions:

1. Do you believe Worcester should implement a bicycle and pedestrian counting program?
    a. Why?
2. What obstacles do you believe the city would face if it were to implement a bicycle and pedestrian counting program?
3. Why would the health department be interested in this project?
4. What is the health department's current involvement on this subject?
    a. Would the department like to be involved in a project of this sort?
5. How could this project be beneficial to the health department?
6. How do you think an increase in walking and biking could affect the city?
7. What is your vision for a walk/bike friendly Worcester?

Data Analysis/Key Points:

- Count data would be analyzed for this purpose, very beneficial
    - Public Health Department usually has one person for physical work
    - Interns and administrative groups do data-collecting
        - One person in charge of physical activity work
        - They have about 25 interns during the summer
- Bike-share programs could increase walking and biking
    - Department of Public Health is usually asked for information regarding this topic
    - Makes for a healthier community and easier accessibility
    - A network that allows for more walking and biking
- DPH performs a community health improvement plan every 3 years, last one was in 2016
    - One part included increasing walking and biking in Worcester's schools
    - Safe Routes to Schools program assists with increasing volume of kids walking and biking
- Worcester has one of the highest walk-to-work rates in the region
    - But mostly due to the fact that many people need to walk to work because they have no car, they don't have a choice
- Counting is all about choosing the right intersection or section of road to optimize resources
    - Should be around transit, schools, residential areas, etc.

        - Could use transit data for where and how many people are getting on and off the buses
    - Also counts must be done at the correct time to get the data needed
- Schools are a good indicator of walking and biking in a community and can make full use of improvements
    - Kids living in a half mile radius from the school ideally 100% should be walking/biking to school
    - Large amount of student walkers and bikers are in high school; drops off significantly for elementary schools
    - Safety is the largest factor: no sidewalks, snow cover, being hit by a car, crime rate
        - But crime depends more on the neighborhood than anything else
    - Time-management: students and parents need to have their lives revolve around walking or biking to school
    - Biking is not inherently safe to do in Worcester, so many people end up riding their bike on the sidewalks

Full Minutes:

- It is difficult for the Department of Public Health and the Department of Public Works to add more projects to their agenda with limited resources, such as a counting program
    - The CMRPC and the state usually handles traffic counts
        - Not handled by the city, so bicycle and pedestrian counts would be a difficult responsibility
        - Recorded roadways would be useful for a pedestrian and bicycle count
- There is interest in new infrastructure for cyclists and pedestrians
    - There has been work towards infrastructure for several years
    - Data would be analyzed for this purpose, very beneficial
        - Public Health Department usually has one person for physical work
        - Interns and administrative groups do data-collecting
            - One person in charge of physical activity work
            - They have about 25 interns during the summer so organizing something for them to do a project like this would not be impossible
- They have a Community Health Improvement Plan every 3 years, last one was in 2016
    - One part included increasing walking and biking in Worcester
        - School program(s)
        - Commuters’ Breakfast with WalkBike Worcester and active commuters
            - Try to advocate for increasing volumes
    - Safe Routes to schools program assists with increasing volume of kids walking and biking
    - Should make sure that transit in the area is good
    - Bike-share programs could increase walking and biking
        - Department of Public Health is usually asked for information regarding this topic
        - Makes for a healthier community and easier accessibility

        - A network that allows for more walking and biking
- Making infrastructure improvements near transit is important because those using transit must walk or bike in order to get to their destinations
- Walkable/bikeable communities are essential to everyday life - the whole network that allows for the this is the important piece
- Worcester has one of the highest walk-to-work rates in the region
    - But mostly due to the fact that many people need to walk to work because they have no car, they don't have a choice
- Schools are a good indicator of walking and biking in a community
    - Good places to focus on improvements
    - Kids living in a half mile radius from the school ideally 100% should be walking/biking to school
    - Proximity to schools, or other places, is very important
        - Kids who live close to a school should be either walking or biking to school
        - Large amount of walkers and bikers to high school; drops off significantly for elementary schools
            - Safety is a big factor: no sidewalks, snow cover, being hit by a car, crime rate
                - But crime depends more on the neighborhood than anything else
            - Time-management: students and parents need to have their lives revolve around walking or biking to school
            - Biking is not inherently safe to do in Worcester, so many people end up riding their bike on the sidewalks
- Counting is all about choosing the right intersection or section of road so optimize resources
    - Should be around transit, schools, residential areas, etc.
        - Could use transit data for where people are getting on and off the buses
    - Also counts must be done at the correct time to get the data needed

6: Stephen Rolle, Director of Planning for the City of Worcester

Introduction: We are a research team from WPI working with WalkBike Worcester: Joseph Atchue, Jacob Mikolajczyk, Kamyar Sajjadi, and Brady Snowden. We are interviewing you today to understand your views and experiences with implementing bicycle and pedestrian improvements and counting programs in Worcester.

Date: January 30, 2017

Questions:

1. What is your level of familiarity with bicycle and pedestrian counting programs?
   a. If familiar, could you tell us about what you know?
2. Do you believe Worcester should implement a counting program? Why?
3. What obstacles do you believe the city would face if it were to implement a counting program?
4. What sort of data from the counting program would be useful for planners?
   a. Is direction and turning data useful?
   b. Is gender useful? Age range?
5. Have bicycle and pedestrian counts been done in Worcester in the past? Where? How?
   a. If yes, is that data available? Where?
6. What resources are available to implement a bicycle and pedestrian counting program?
7. We plan to test a pilot counting program with volunteers. Could you recommend a few people to us who could volunteer for this?
8. Would you be more interested in installing automatic counting devices or have counts done every so often with volunteers and portable equipment?
   a. How would you weigh costs of each approach versus the accuracy and benefits attained?
9. What is your vision for a walk/bike friendly Worcester?

Data Analysis/Key Points:

- There is little to no pedestrian and bicycle data, but it would benefit Worcester if they had that type of data
- The lack of resources is a large obstacle
  - Need to pay for equipment and staff
- Volume data for pedestrians is most important
  - Categorize into light, medium, and heavy bicycle and pedestrian traffic
    - Can help inform decision-making
- Level of detail count data should include:
  - Age could be a useful thing to bracket
    - Make for wheelchair accommodations
  - Specification of gender seems unimportant
  - Observations should be made of the existing and the non-existing infrastructure at count locations

    - Cyclist use of helmets could be useful; also, how and where cyclists are using the infrastructure
    - Cyclists' directions traveled and routes taken are useful
        - They are good at selecting routes that are best-suited for them unlike pedestrians
    - Pedestrians' direction is not needed as much
- Automatic counters could be useful at busy locations
    - A cost-benefit analysis could be helpful
        - Lower costs are preferred by the city rather than accuracy

Full Minutes:

- It had been a long time since he had done any work in municipal transportation engineering
    - Have completed counts a long time ago using hand counters, about 20 years ago
        - Has done pedestrian and bicycle projects
- There is little to no pedestrian and bicycle data, but it would benefit Worcester if they had that type of data
    - He has worked in a suburb of Seattle, counting at intersections every 3 years
        - Current information would be valuable
        - The manual counting was done by 4-6 college interns all summer
            - It was supplemented with automatic traffic counters
                - It was done in the morning and afternoon peaks at all arterial intersections with some midday counts at certain locations
- The lack of resources is the biggest obstacle
    - Need to pay staff and for equipment
- Could just 'ballpark' bicycle and pedestrian traffic at an intersection
    - Categorize into light, medium, and heavy bicycle and pedestrian traffic
        - Can help inform decision-making
- Gives a general sense of activity
    - Cyclists' directions traveled and routes taken are important
        - They are good at selecting routes that are best-suited for them unlike pedestrians
- Volume of pedestrians is most important
    - Pedestrian's direction is not needed as much
- Age could be a useful thing to bracket
    - Make for wheelchair accommodations
        - There is a question to the usefulness of bracketing male and female
        - Helmets and no helmets could be useful; also, how and where they are using the infrastructure
            - This is more so directed at the cyclists
- It would be good to have a comment area for what cyclists are doing and the infrastructure conditions
- The Department of Public Works could provide data on previous counts done in Worcester; also, regional counts from the CMRPC

    - There are no known good databases with valuable information
- WalkBike Worcester is the best resource for volunteers; college students could also be a valuable resource for volunteers
    - Dan Daniska should be asked about people who could volunteer to test our pilot counting program
- It's good to start with the Transportation Department
- Observations should be made of the existing and the non-existing infrastructure around Worcester
- Automatic counters could be useful
    - Video cameras could be interesting for automatic counts
        - Cameras are installed at new traffic lights and it could be something to consider to integrate counting cameras into those as well
    - A cost-benefit analysis could be helpful
        - Lower costs are preferred by the city rather than accuracy so the CBA might not be that helpful because the cheapest option is going to be the option they take
- Vision: There needs to be planning for the accommodation for all forms of transportation to safely and efficiently move around Worcester
    - Need to factor it into future decision-making
        - There needs to be an integrated plan for cyclists around the city
        - The streets and sidewalks need to be safe, comfortable, and inviting for pedestrians to travel on
            - Streets should be designed to accommodate pedestrians
            - There should be lighting, street trees, well-maintained sidewalks, etc.

7: Paul Moosey, Commissioner of the Department of Public Works; Mark Elbag, Director of Engineering

Introduction: We are a research team from WPI working with WalkBike Worcester: Joseph Atchue, Jacob Mikolajczyk, Kamyar Sajjadi, and Brady Snowden. We are interviewing you today to understand your views and experiences with implementing a counting program in Worcester.

Date: February 13, 2017

Topics:

- Talk about manual and automatic pedestrian and cyclist counting programs
- Emphasize our methodical way of doing this project
- Talk about all the research we've done to back our data

Questions:

- What is your level of familiarity with bicycle and pedestrian counting programs?
  - If familiar, could you tell us about what you know?
- Do you believe Worcester should implement a bicycle and pedestrian counting program?
  - Why?
- What obstacles do you believe the city would face if it were to implement a counting program?
- What resources are available to implement a bicycle and pedestrian counting program?
- Have bicycle and pedestrian counts been done in Worcester in the past? Where? How?
  - If yes, is that data available? Where?
- Why would the Department of Public Works be interested in this project?
- What is the DPW's current involvement in improving biking and walking?

Data Analysis/Key Points:

- There are so few cyclists around the City of Worcester that it is not very useful to perform counts on cyclists
- Biggest problem concerning counts is cost and the prospect of taking away from another project
  - More people are advocating for parking over bike lanes
- The DPW sees automatic counters as more cost-efficient than manual counting
- Shared bike lanes are safer and more suited to a city like Worcester than just jumping right into painted, independent bike lanes
  - Dangerous for cyclists in bike lanes when there is parallel parking or when people are not aware that people are utilizing the bike lane, so they just drive over it
- Any type of counting program for pedestrians and cyclists needs to either be implemented as part of a larger project, or have money set aside in a budget for it

Full Minutes:

- The Department of Public Works does mostly pedestrian and vehicle traffic counts

    - There are so few cyclists that they do not count them
        - The DPW and the CMRPC both do these types of counts frequently, several times a year
- They would focus counts for cyclists where there are currently bike lanes implemented
    - Cost is the biggest factor in doing these counts
- It is also about construction, for parking would have to be taken away for there to be bike lanes put in
    - Counts would ultimately be irregular
- Money would have to be taken away from repaving or repair costs for roads to implement improvements
- It could be added into the budget for one year
    - It would still replace something else that they could be doing
        - Need a benefit for the costs of doing a pedestrian and cyclist count
    - Need to find out where people are cycling and where they are not cycling for where bike lanes should be implemented
- Their data can be requested, but much of it is sporadic and not very reliable
    - The CMRPC has much more reliable data
- They would need to implement bike lanes or perform counts as part of a larger project or because the city council wants them to do so
- Counts are currently performed manually at intersections
    - Automatic counters are seen as more reliable than manual counters
- For example, off-set intersections need manual counters
    - There is also the missing volume from people disobeying traffic laws
- Counts currently done are either project dependent or requested by city council
- They currently have pneumatic tubes, which are very old and not good for counting pedestrians
    - They do, however, measure axial length to distinguish between cars, trucks and bicycles
- The DPW would be interested in any data from counts done already
    - The data could be useful for them
    - Would like data for the major arteries in the city
    - Could also use recommendations on devices for automatic counting
        - Which one counts turning, counts more accurately, or is cheaper
- The data could either validate or negate the need for bike lanes on new projects, in turn saving the city money
    - Sometimes this does not work because the funding requires bike lanes, but they could get a waiver if they have the data
- Volunteers would need training and the data from a third party could be suspect
    - There are usually low volumes from manual counts because of the limited timeframe of the actual count
- Employees in the department who would be counting would need to be paid
- The data needs to be useful to the DPW, not just data to have
    - The ends need to justify the means; i.e., taking away parking
        - Need to work around a project

- They need to make sidewalks ADA-compliant
    - They would need money for a bike lane study
        - They only put in bike lanes now because some funding requires them
    - They could update signals; add ramps; fix sidewalks
- For a shared lane, there needs to be 15 feet of road per lane; but there needs to be more than 15 feet for a traffic lane and an independent bike lane
    - There would need to be at least 30 feet of road for a two-lane road with two separate bike lanes in each direction
        - Shared lanes are safer
        - Lines are currently just driven over
    - 12+5 feet for one vehicle lane with a separated bike lane
- There is a false sense of security in a painted bike lane for cyclists
    - There needs to be more cyclists to make drivers more aware of them
- Shared vs. independent bike lanes
    - Should start with shared lanes first and increase bike traffic up to independent bike lanes
        - I.e., Southbridge Street bike lane starts and goes nowhere, and is constantly being driven over
            - It just doesn't make sense
    - In many cities, bike lanes are usually used for delivery drop-offs in commercial areas
- There are going to be bike lanes implemented on Main Street
    - Parallel parking is dangerous for cyclists

Appendix E: Counting Protocol

1. **Select specific locations for the manual counts through the Local Access Score**

See Appendix G for details.

2. **Determine the count dates and times based on the specific counting locations**

Dates

Late September to early October is the accepted national bicycle and pedestrian count period. Early to mid-May would also be an acceptable period. A one-week window during one of these periods should be chosen to do the bicycle and pedestrian counting. Counters may select a single date within this window to complete their counts.

Times

The recommended peak period counting times are:

- *Weekday, 7-9AM*
- *Weekday, 4-6PM*

The actual peak periods may vary considerably depending on the counting location. Weekend counts may be desired for certain locations in addition to weekdays.

3. **Obtain counters**

One counter is required for each location. However, it would be ideal to have two counters, especially at busy locations. Counters should be identified and secured well ahead of time.

4. **Provide the manual counting form to the counters**

This is the only needed form to perform the count. This form should be provided to counters prior to the day of the count.

5. **Notify counters of what to bring on the day of counting**

Counters should provide themselves with their own writing utensils, water, writing surface, timing device, and appropriate clothes for the weather.

6. **Counters arrive at their designated counting location early**

Counters should arrive at their designated counting location approximately 10-15 minutes early.

7. **Submit counting data**

The coordinating body of the manual count should provide the counter with instructions on how to submit their counting data.

Appendix F: Manual Counting Form

Bicycle & Pedestrian Manual Counting Form

Date: ______ / ______ / ______	**Day of Week** (*circle*): Sun Mon Tues Wed Thurs Fri Sat
Location (*Street name or intersection, nearest address if applicable*):	**Type of Count** (*circle*): Pedestrian Bicycle Both
Start Time: _____ : _____ AM / PM (*circle*)	**Count Duration** (*in hours*):
Counter Name(s):	**Counter Telephone:**
Counter Email:	**Weather** (*circle and complete*): *Precipitation*: yes / no *Notes:* *High (°F):* _____ *Low (°F):* _____

Guidelines for using this form:

- Please read and complete all fields on both sides of this form.
- Count all cyclists and pedestrians crossing in your view under their appropriate categories. ***Make one tally each time a person comes into your view.***
- Remember to make the tallies small but legible so that the boxes do not fill up too quickly.
- Count for two hours in 15-minute intervals, changing rows every 15 minutes. Record your start time and duration above.
- Count the number of people on the bicycle (i.e. cyclists), not the number of bicycles.
- Pedestrians include all people not on bicycles. Record pedestrians using wheelchairs, skates, scooters, skateboards, canes, crutches, walkers, etc. in the "Assisted Pedestrians" columns.
- Do your best when traffic volumes are high or people talk to you; it is easy to lose count. Do your best, but note if/when you lose track.
- Write down any comments about infrastructure conditions at your counting location in the "Notes" section *(i.e. sidewalks not well maintained, pedestrians given enough time to cross, crosswalk not clearly marked, etc.).*
- Write down any additional comments you feel are relevant in the "Notes" section.
- Sometimes one category will end up having more data than the others causing the cells to fill up too quickly. The last column of the table should be used for the overflow data. If used, fill in the top cell with the overflowing category designation.

Location	**Cyclists**		**Pedestrians**				
			Unassisted		*Assisted*		
Time	Adult	Child	Adult	Child	Adult	Child	
:00-:15							
:15-:30							
:30-:45							
:45-:00							
Hour 1 Subtotal							
:00-:15							
:15-:30							
:30-:45							
:45-:00							
Hour 2 Subtotal							
Hour 1 + 2 Subtotal							
Total All Attributes							

Notes:

Appendix G: Location Selection Manual

Counting Location Selection How-To Manual

This manual provides a complete walkthrough for using the MAPC Local Access Score to select the optimal locations for bicycle and pedestrian counting. It is critical for municipalities to focus and prioritize their bicycle and pedestrian investments where they will have the biggest impacts on safety, convenience, and congestion relief. We highly recommend that you familiarize yourself with the Local Access Score by reading the User's Guide:
http://localaccess.mapc.org/assets/pdfs/LocalAccess_User_Guide.pdf
Below are the major steps for selecting counting locations with details for completion enclosed.

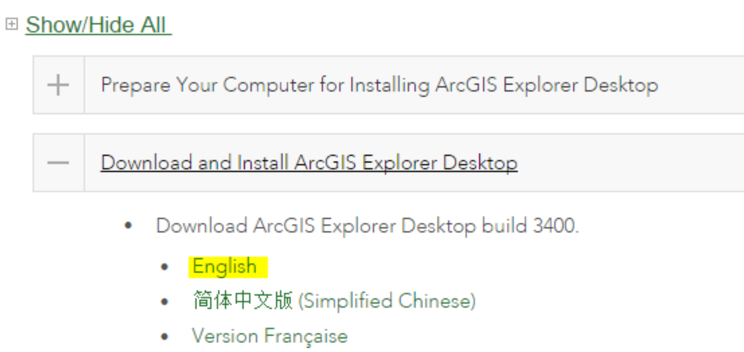
1) Downloading and installing ArcGIS

To use the Local Access Score database, you would need a mapping software installed. We recommend using ArcGIS because it is freely available to download and compatible with most windows computers.

a) You can confirm your system's compatibility by reading the system requirements of ArcGIS here: http://desktop.arcgis.com/en/arcmap/10.3/get-started/system-requirements/arcgis-engine-system-requirements.htm

b) Go to: http://www.esri.com/software/arcgis/explorer-desktop/download

c) Click the plus sign located to the left of "Download and Install ArcGIS Explorer Desktop", from there click the "English" link and your download will begin.



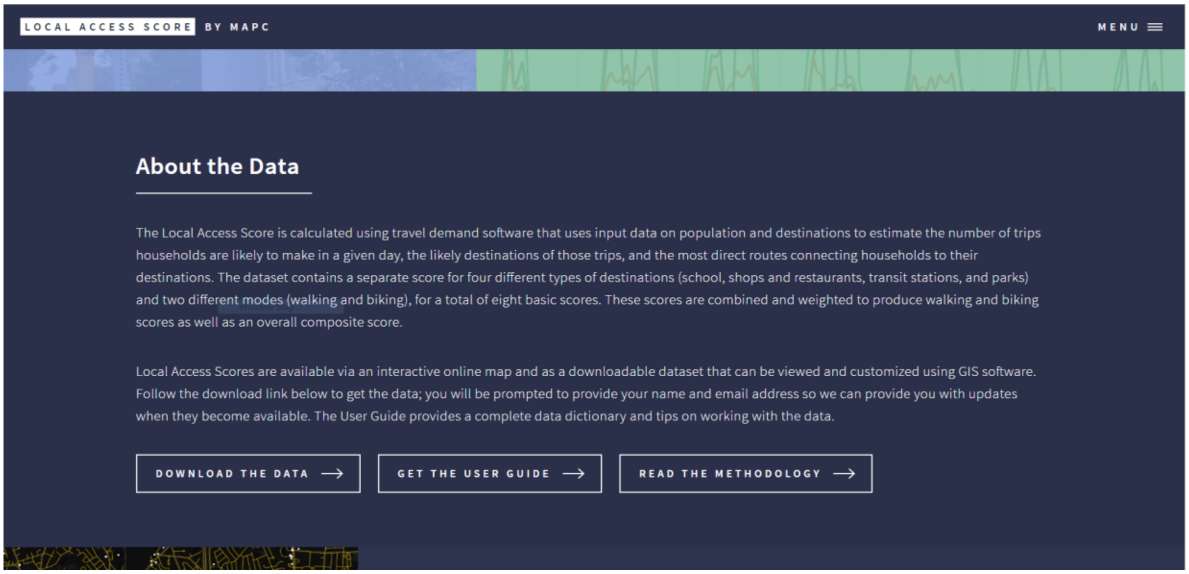
d) Once the download is complete, run the "ArcGISExplorerDownload.exe" file and follow the instructions to complete your installation.

2) Downloading the Local Access Score dataset

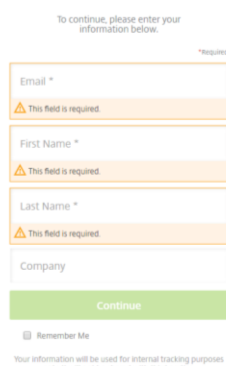
To use Local Access Score for selecting count locations, you would need to download the database provided by MAPC:

a) Go to this link: http://localaccess.mapc.org/

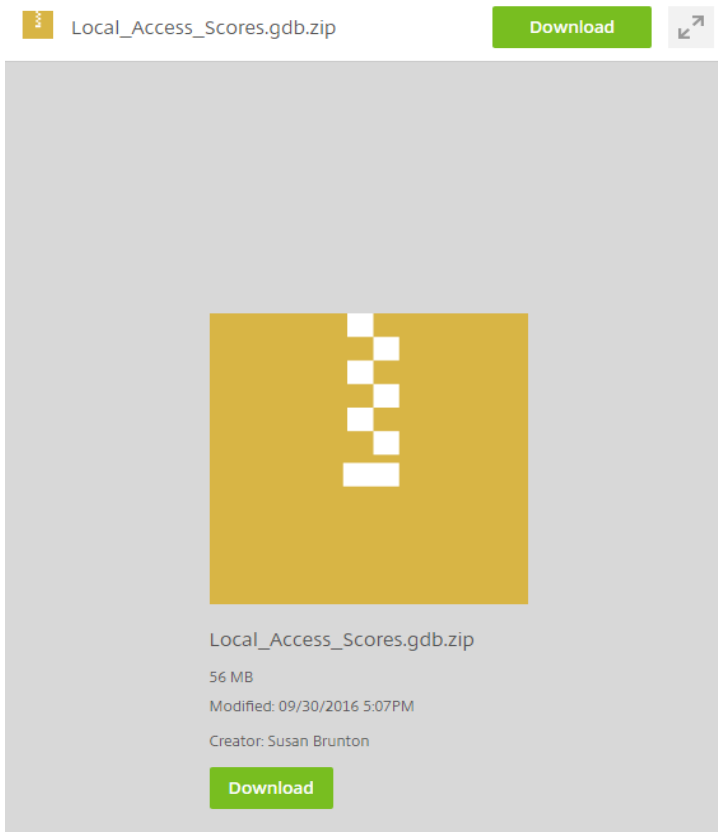
b) Scroll down on the page to the "About the Data" section and click "Download the Data".



c) Enter your information to access the download link.



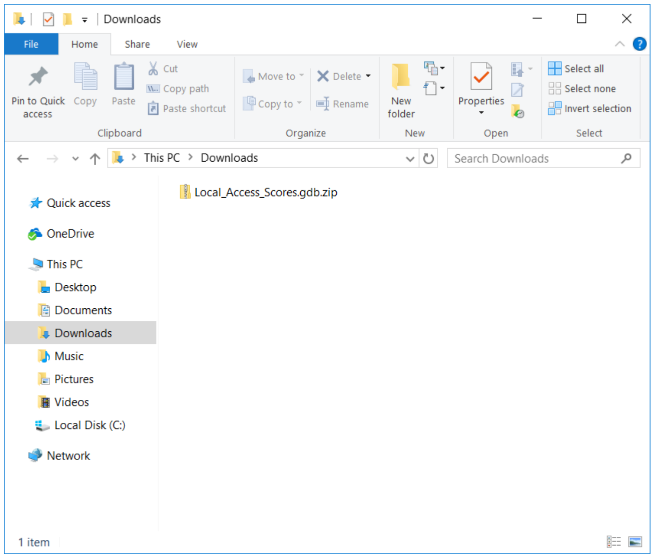
d) Click either of the "Download" buttons to download the Local Access Scores as a zip file.


Local_Access_Scores.gdb.zip
Download
Local_Access_Scores.gdb.zip
56 MB
Modified: 09/30/2016 5:07PM
Creator: Susan Brunton
Download

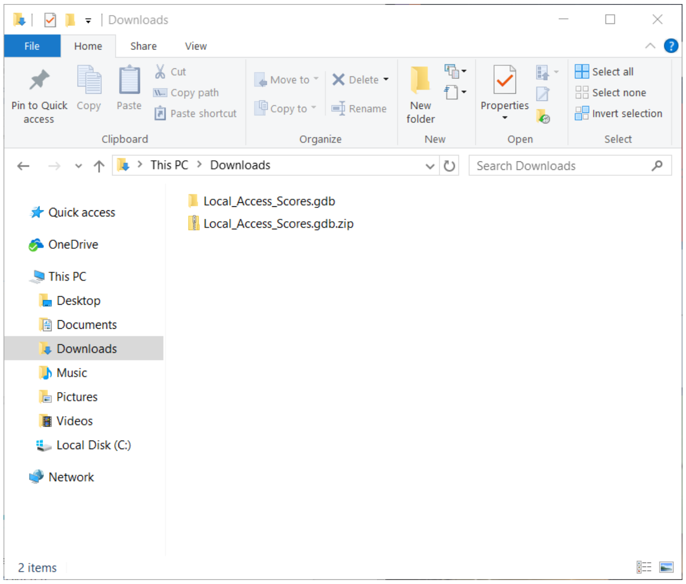
3) Importing the Local Access Score data to ArcGIS

The Local Access Score data needs to be imported into ArcGIS to be used as a layer over the map. This layer will highlight all the streets accompanied by their data. Layers are crucial for selecting locations as they can show data on a map. The steps below can take you through adding the database as layer.

a) Navigate to the location of the Local Access Score zip file on your computer.

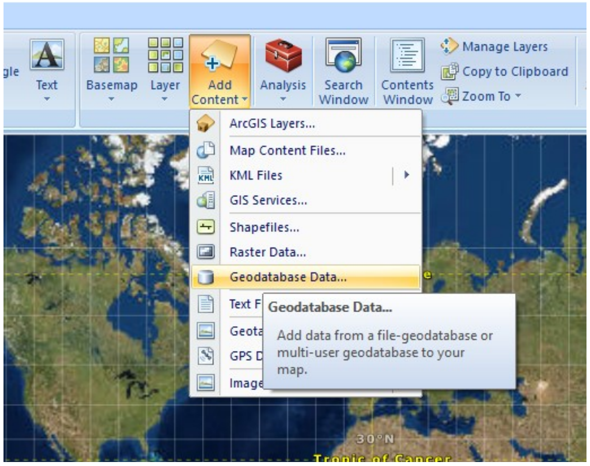


b) Right-click and extract the contents of the zip file to the desired location.

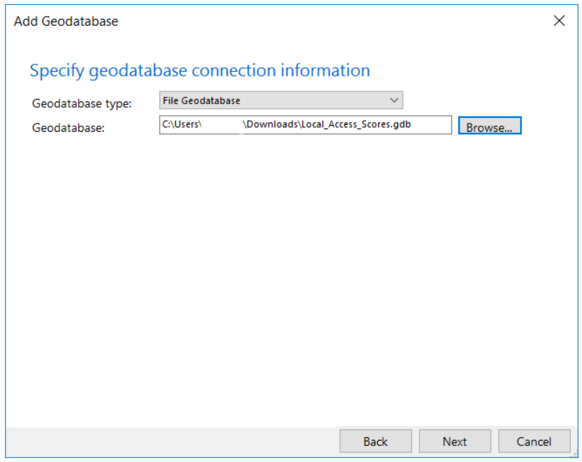


c) Launch the ArcGIS Explorer Desktop software installed in *Step 1*. If you are asked to associate kml files when opening ArcGIS, click "No".

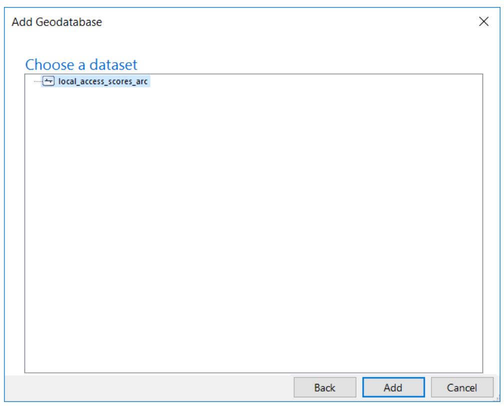
d) In the "Map" section on the toolbar, click the "Add Content" dropdown menu, and select the "Geodatabase" option.



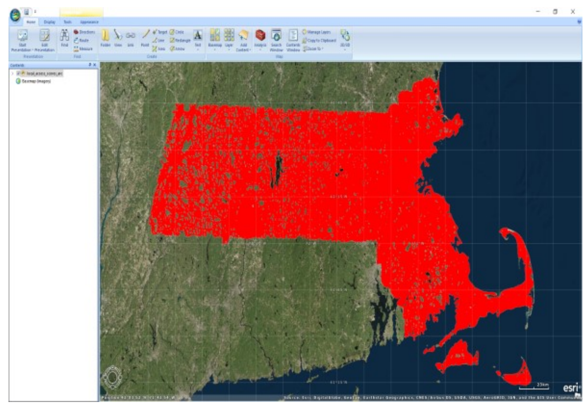
e) Ensure that "File Geodatabase" is selected in the "Geodatabase Type" field, and browse to the location of the extracted .gdb file.



f) Select the “local_access_scores_arc” dataset to add it to the ArcGIS software, then click “Add”.



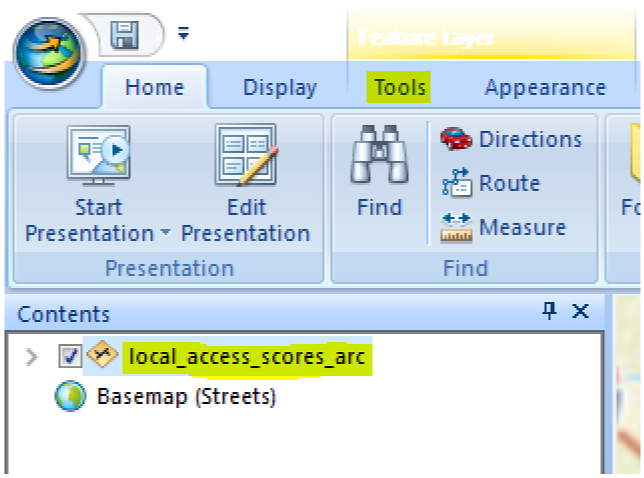
→



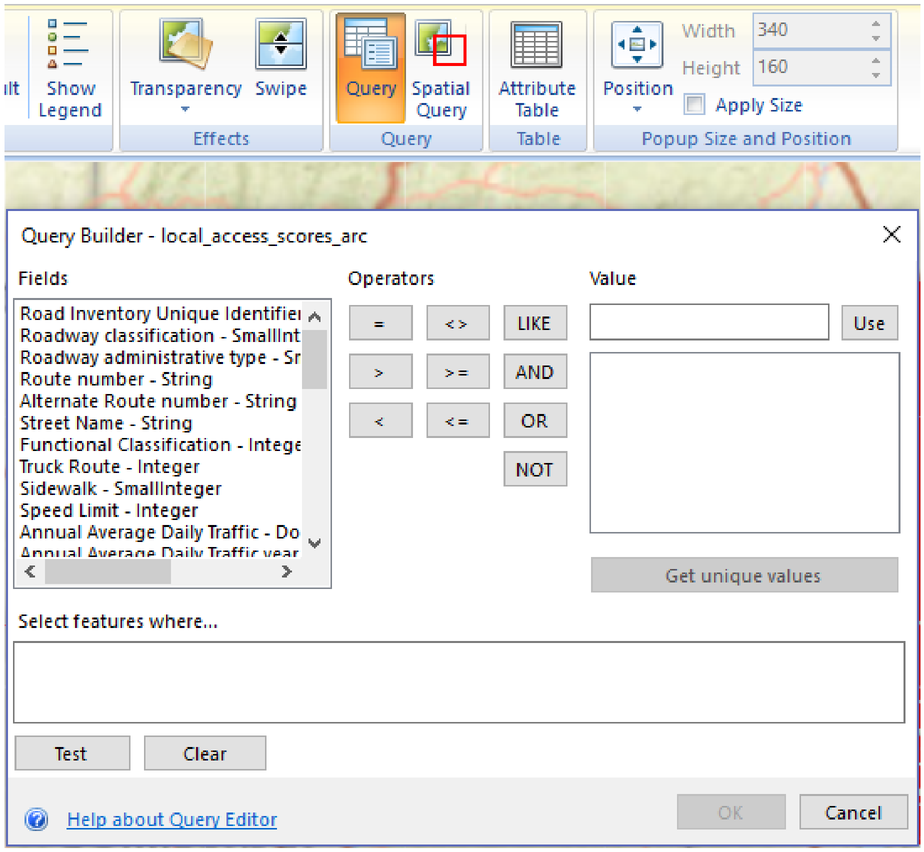
4) Clip Worcester's Local Access Score data

The database of Local Access Score covers all of Massachusetts and working with all the data can slow down some systems. Since location selection is only being done in Worcester, you can limit ArcGIS to only show Worcester's data. This would allow for faster use of the software. You can follow the steps below to achieve this:

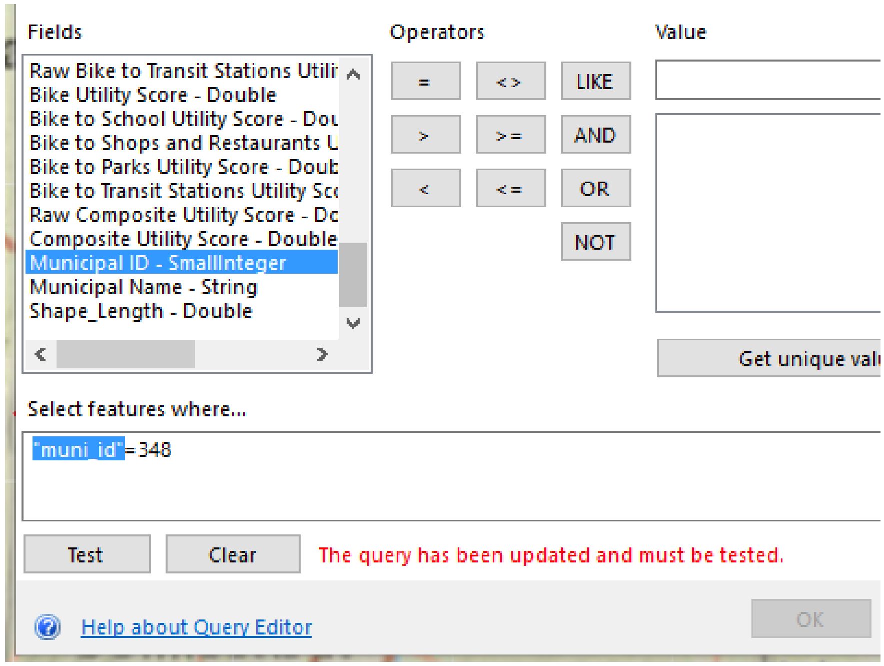
a) Working with the data from the entire state of Massachusetts is undesired because you will only want to query scores within Worcester; therefore, the data should be clipped to only present the scores for Worcester. This can be easily done within ArcGIS. First, click "local_access_scores_arc" within the "Contents" window located on the left. Then click the "Tools" tab as shown below, highlighted in yellow.



b) Click the “Query” button that appears above the map.



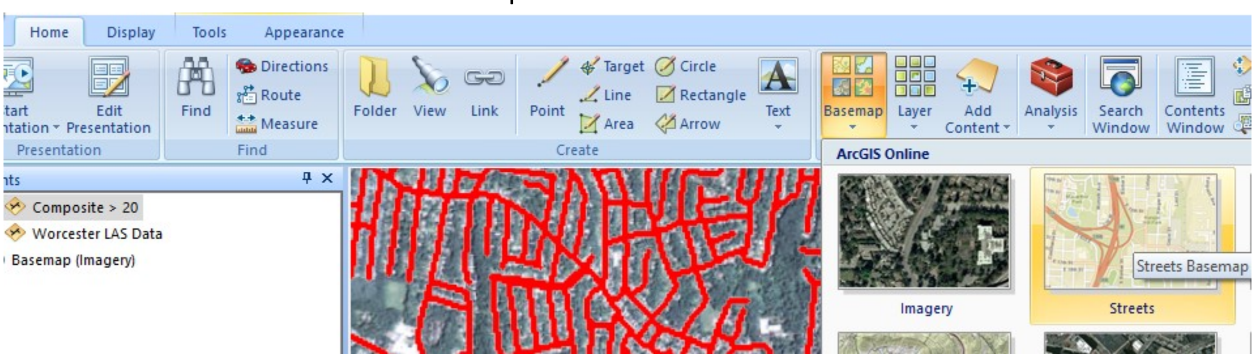
c) Within this menu, in the “Fields” section, scroll down until you reach “Municipal ID - SmallInteger”. Click this and navigate to the “Select features where…” pane where “muni_id” appears. Type “=348” next to this as shown.



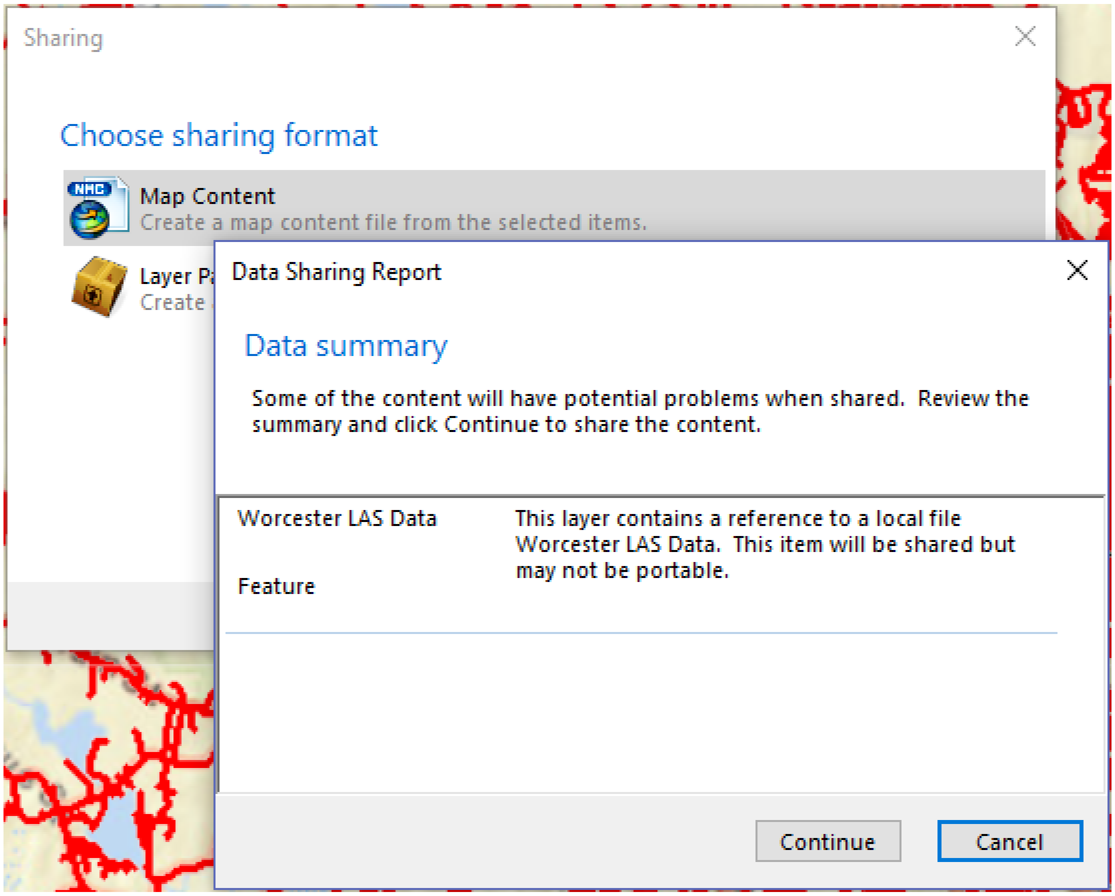
d) Click the "Test" button and after the test is complete, click "OK".

e) ArcGIS will query a feature layer that only shows the scores for Worcester. This layer will appear in the "Contents" window as "local_access_scores_arc ("muni_id"=348)". Right-click this layer, and click "Rename" and give it a name such as "Worcester LAS Data".

f) Before saving this layer, you might want to change the Basemap. To do this, click the "Home" tab in the top left and then click "Basemap". It is recommended to select the "Streets" basemap as shown.

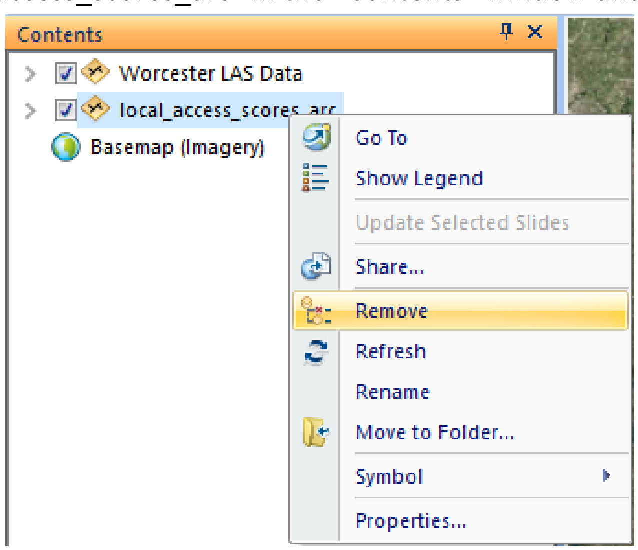


g) Right-click the newly named layer and click "Share...". In the window that opens, click "Map Content" and a "Data Sharing Report" window will open. Click "Continue".

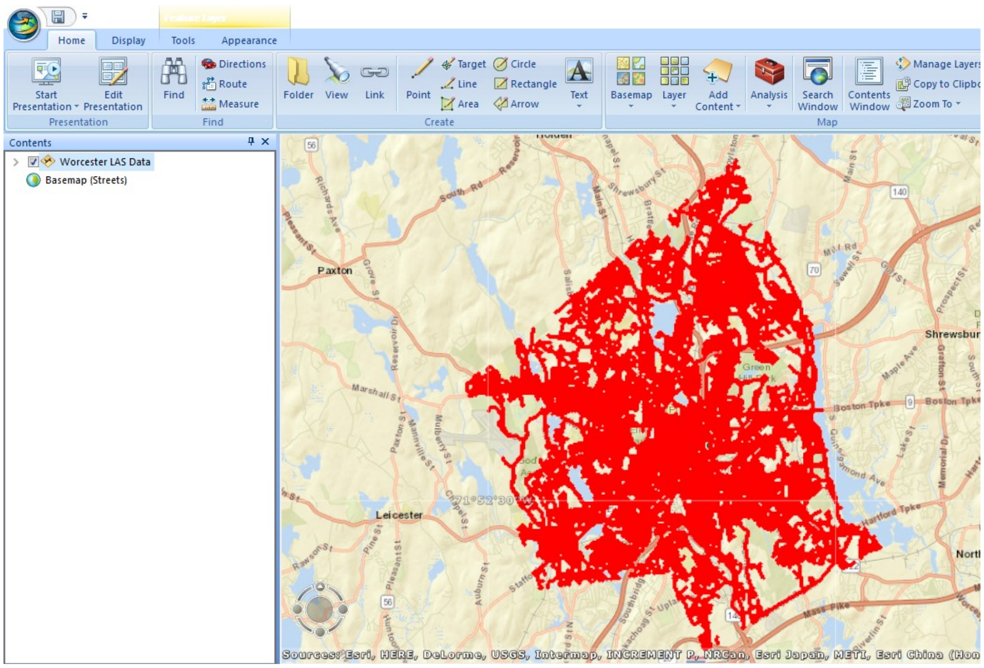


h) Click “File” and save the “Worcester LAS Data.nmc” file to your desired location.

i) The data will now been clipped and the entire state data can be removed. Right-click “local_access_scores_arc” in the “Contents” window and click “Remove”.



j) Click “Yes” when it asks if you want to remove the data. You will now only be viewing the Worcester LAS Data and you can move to the next step.



NOTE: *Next time, you open ArcGIS, instead of loading "local_access_scores_arc.gdb", you will follow the same steps, but this time you will load the "Worcester LAS Data.nmc" file that you saved. To do this go to "Add Content", this time click "Map Content Files…" and locate the "Worcester LAS Data.nmc" file you saved in Step 4g.*

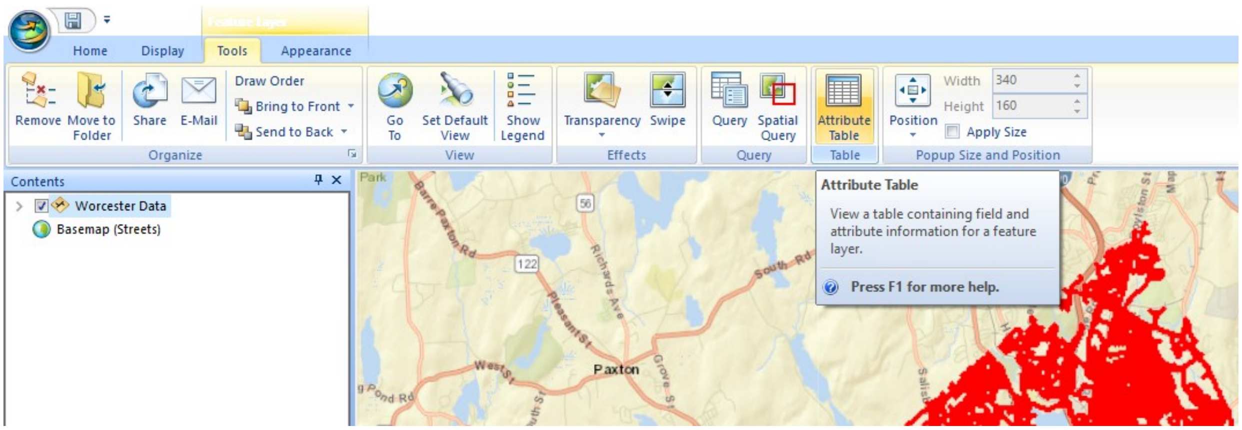
***NOTE**: You can skip Step 5 if you have the provided Worcester Local Access Score data Excel spreadsheet.*

5) Generate Worcester's Local Access Score data table

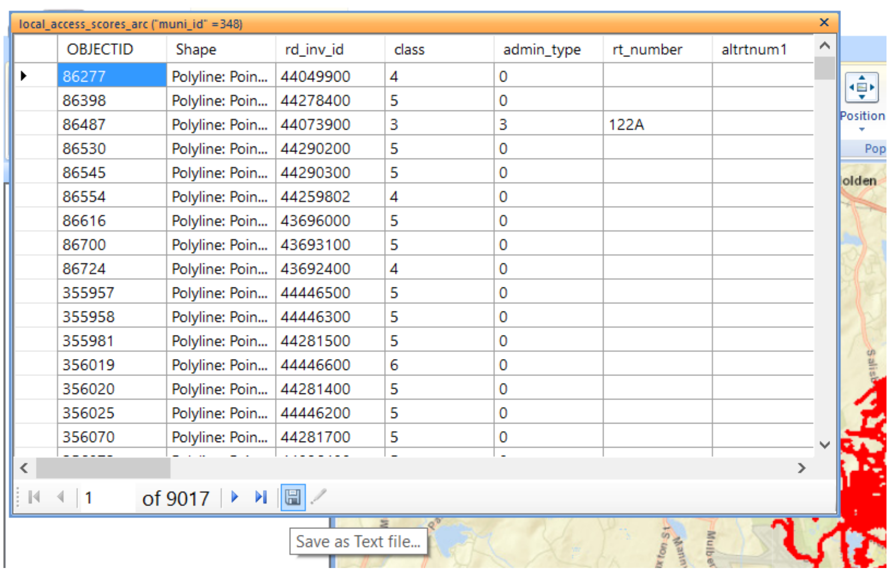
Although use of layers of data in ArcGIS is necessary to select locations, having the data in a table can let you sort the scores. By sorting the scores on a table, you can easily determine the highest scoring segments and gather other info. You can follow the next steps to extract this table:

a) Click on the layer of Worcester data in the "Contents" panel on the left, then open the "Tools" tab and select "Attribute Table".

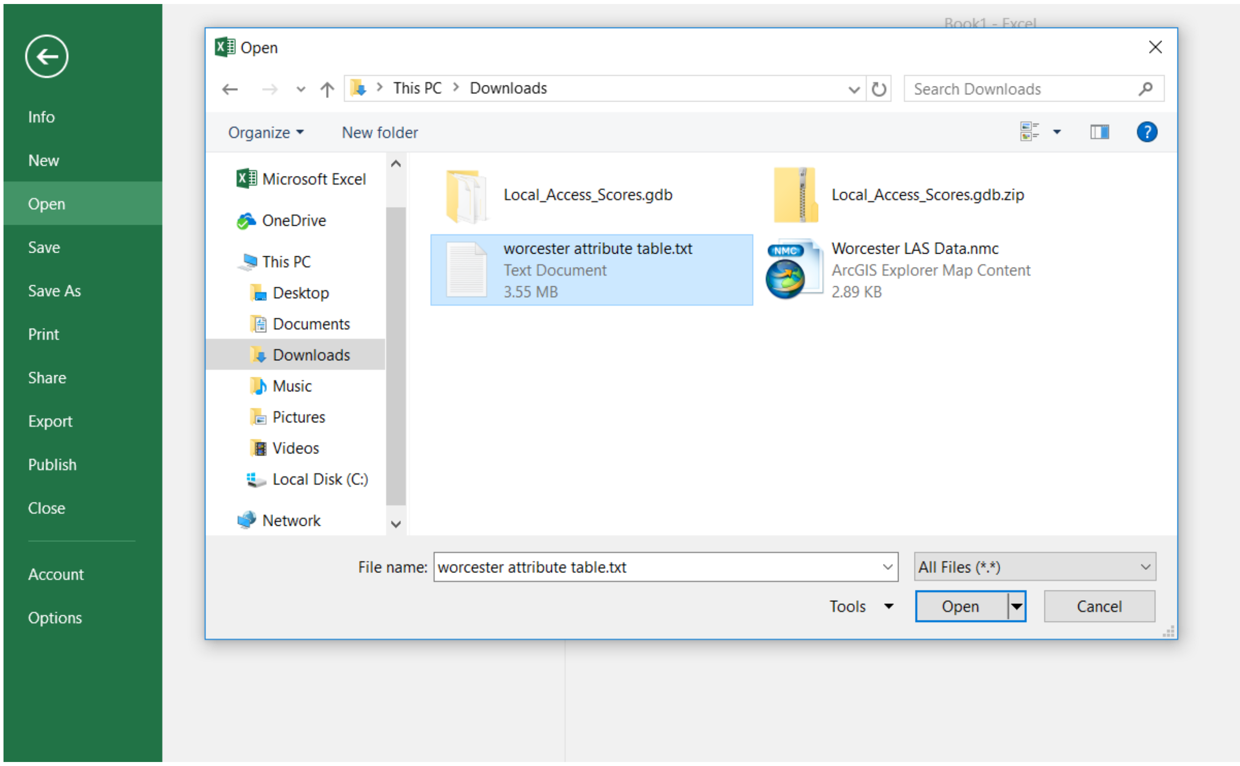
NOTE: *Due to the size of the attribute table, it is possible that the program can become slow or crash during this step.*



b) Once the attribute table has opened, click the save icon at the bottom of the table window. Save the resulting text file in a desired location.

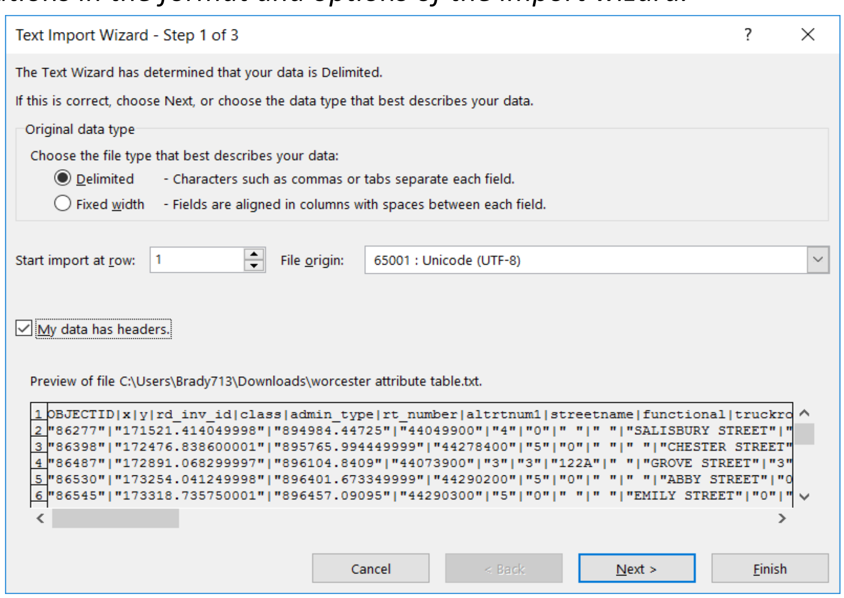


c) Launch Microsoft Excel, and navigate to the "Open" dialogue. Use the dropdown menu at the bottom of the window to select "All files (*.*)", then select the file you saved in step 5b. This will launch the "Text Import Wizard".

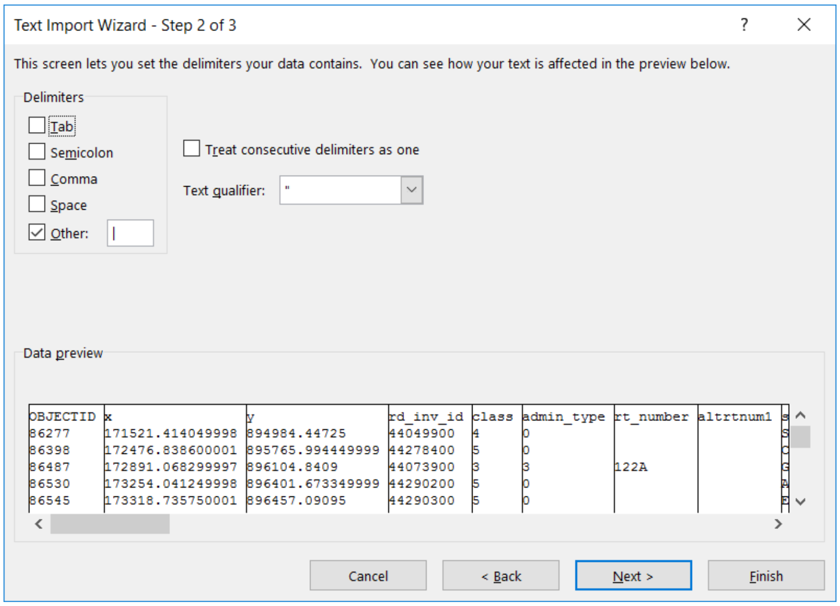


d) On the first page of this wizard, choose the "Delimited" radio button, and check the "My data has headers" checkbox. Click "Next".

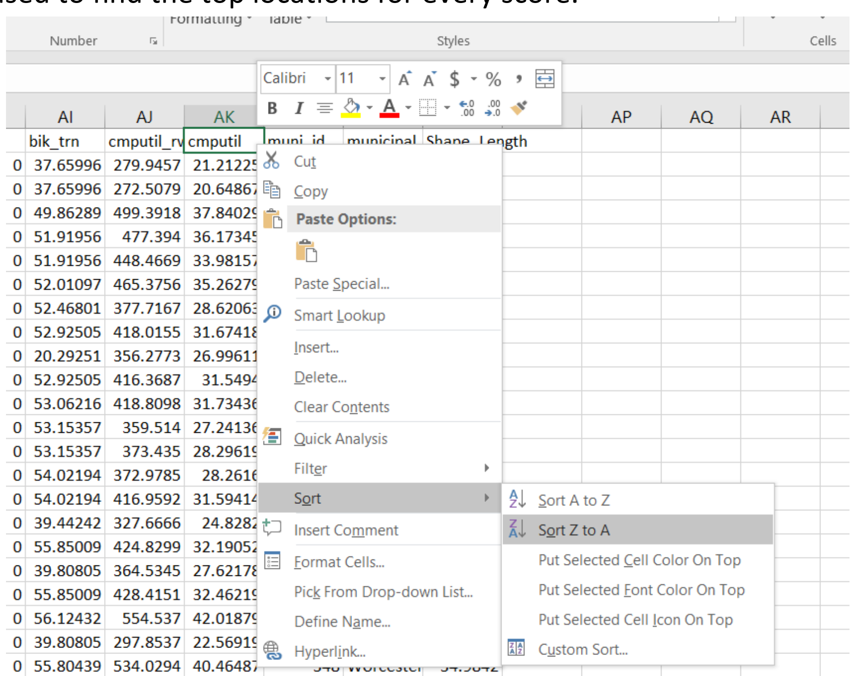
NOTE: *This guide uses Microsoft Excel 2016. Other versions of Excel may have slight variations in the format and options of the import wizard.*



e) On the second page of the wizard under the “Delimiters” section, uncheck “Tab” and check “Other:”. In the field next to “Other:”, type “|”, which is located above the enter key on the keyboard. Click “Finish” to import the data table for the selected street segments into Excel.



f) Right click on a cell in the data column, then hover over “Sort” and choose “Sort Largest to Smallest” to bring the highest scores in that column to the top. This can be used to find the top locations for every score.

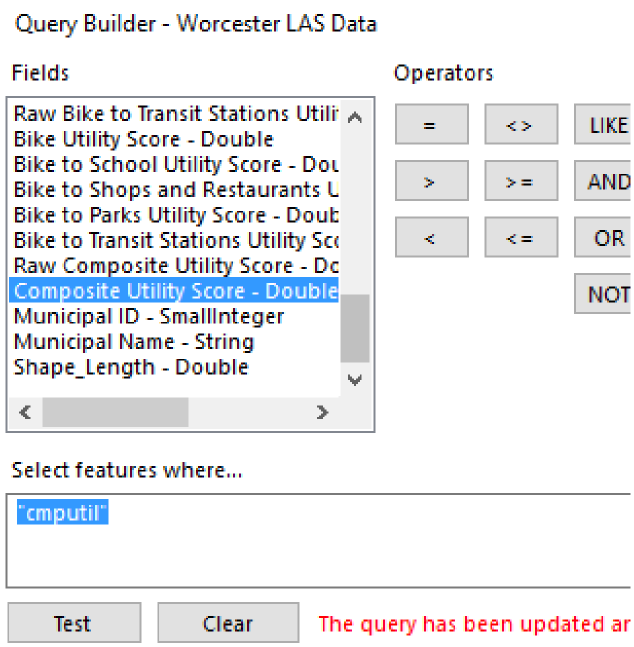


6) Query Worcester LAS data by desired category using ArcGIS

In this step, you will select the highest scoring street segment as a count location. The scores can depend on specific destinations and modes of travel. You can select which destinations and what modes of travel you want the score to represent. The steps for selecting count locations based on desired categories are listed below:

a) Using a method similar to the one used to isolate the Worcester data; the streets with highest Local Access scores for the desired category can be queried. With the "Worcester LAS Data.nmc" loaded into ArcGIS, click "Worcester LAS Data" in the "Contents" windows. Open the "Tools" tab and navigate to the "Query" menu located at the top center of the screen.

b) Scrolling through the "Fields" section, you will see multiple variables. Each segment of road has data for each of these variables with scores. For this particular example, we will be querying by the composite bike and walk score, which is the combined walkability and bikeability score. Scroll down to "Composite Utility Score - Double" and click it. "Cmputil" will be added to the "Select features where…" box.



NOTE: *Never use the "Raw" scores. They are used to generate the actual scores to a rescaled range from 0-100 so they have little meaning for this application*

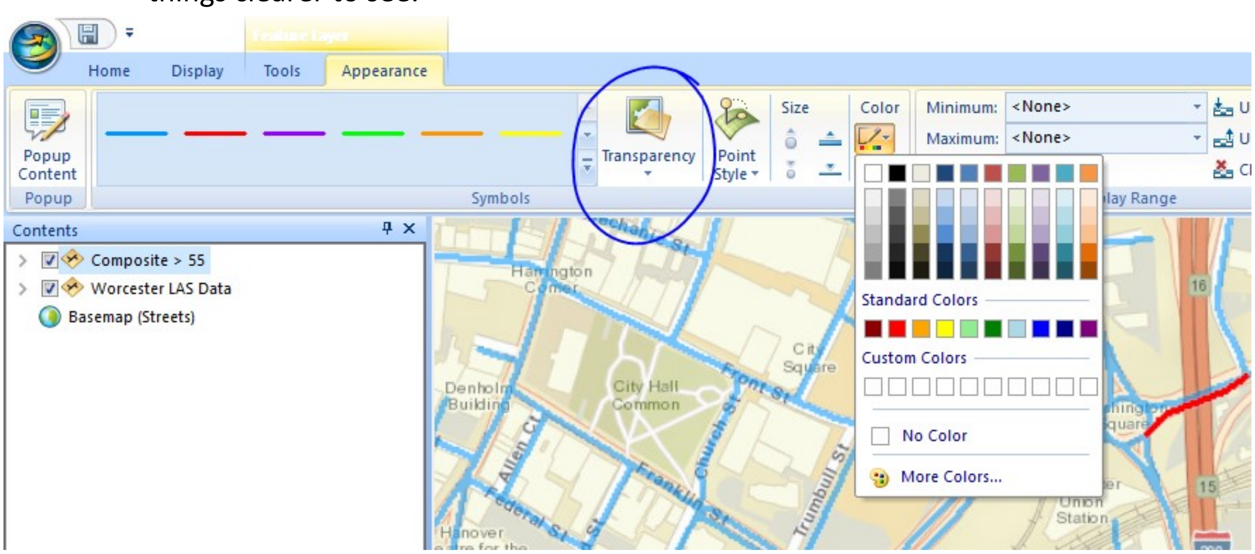
c) From here, you can choose what value you want to query by. In most cases, you will want to look for locations where scores are higher than a certain threshold value. The following list contains the values, based on comparisons to other scores throughout Worcester, that will give you the locations in the city with the highest score in that category to start your querying:

i) Walk Utility Score -- “wlk”>50
ii) Walk to School Utility Score -- “wlk_sch”>35
iii) Walk to Shops and Restaurants Utility Score -- “wlk_shp”>9
iv) Walk to Parks Utility Score -- “wlk_prk”>40
v) Walk to Transit Stations Utility Score -- “wlk_trn”>90
vi) Bike Utility Score -- “bik”>44
vii) Bike to School Utility Score -- “bik_sch”>26
viii) Bike to Shops and Restaurants Utility Score -- “bik_shp”>6
ix) Bike to Parks Utility Score -- “bik_prk”>6
x) Bike to Transit Stations Utility Score -- “bik_trn”>99
xi) Composite Utility Score -- “cmputil”>55

d) To query by one of these scores, click the desired score in the “Fields” section; the variable name will be added to the “Select features where…” box. You can then click in that same box and select “>” and the value for querying. For the Composite Utility Score example, type “>55”.

e) Once you have done this, click “Test” and when the test is complete, hit “OK”.

f) At this point, you should have two layers in your “Contents” window on the left. From here, you might want to rename the newly added layer, as shown in step 4e. In addition, you will want to change the color of the new layer so it will stand apart from the rest of the Worcester data. To do this, click the new layer in the “Contents” window and navigate to the “Appearance” tab. Select the color you desire, also the transparency of this layer and other layers can be adjusted within this menu to make things clearer to see.



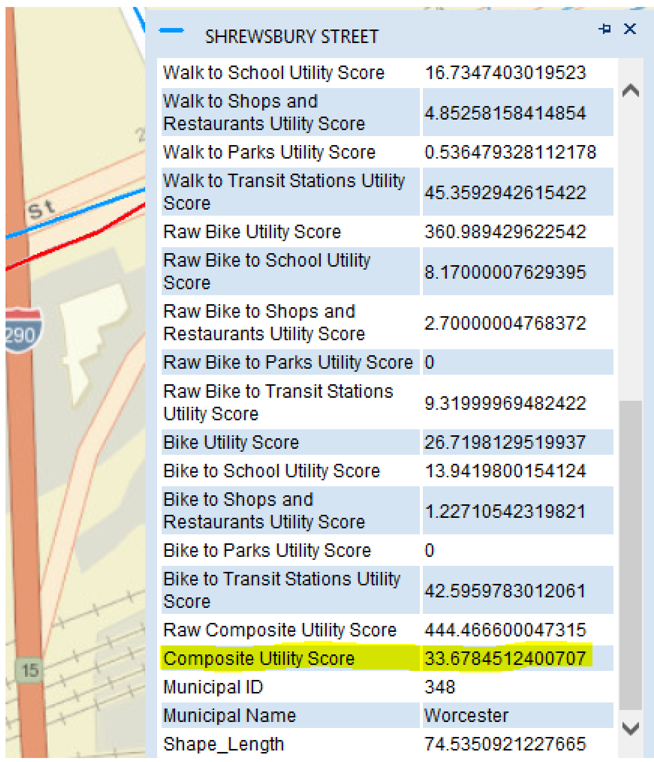
g) After changing the color of the queried score, you will be left with one highlighted, visible segment. The next step will assist you with selecting where to do the count at that segment (intersection or midblock).

7) Determine whether to count an Intersection or Midblock

After selecting the segment from step 6, you will need to determine whether an intersection count or a midblock count would be most beneficial. Some streets lead to a busy intersection and some street are only busy in their segments. By determining where the highest volume is, you can cut down on needed resources by narrowing down the list of locations that need to be counted. The steps below will determine the count site:

a) If the segment connects to one or two intersections, check the scores of the segments at each intersection at the end of the highlighted segment.

b) Click on each of the adjacent segments. A table will pop up showing all the data provided for that segment.



Walk to School Utility Score	16.7347403019523
Walk to Shops and Restaurants Utility Score	4.85258158414854
Walk to Parks Utility Score	0.536479328112178
Walk to Transit Stations Utility Score	45.3592942615422
Raw Bike Utility Score	360.989429622542
Raw Bike to School Utility Score	8.17000007629395
Raw Bike to Shops and Restaurants Utility Score	2.70000004768372
Raw Bike to Parks Utility Score	0
Raw Bike to Transit Stations Utility Score	9.31999969482422
Bike Utility Score	26.7198129519937
Bike to School Utility Score	13.9419800154124
Bike to Shops and Restaurants Utility Score	1.22710542319821
Bike to Parks Utility Score	0
Bike to Transit Stations Utility Score	42.5959783012061
Raw Composite Utility Score	444.466600047315
Composite Utility Score	33.6784512400707
Municipal ID	348
Municipal Name	Worcester
Shape_Length	74.5350921227665

c) Locate the score you filtered by in *Step 6b*.

d) If the adjacent segments at an intersection have similar scores (within 10% of the score) to the previously selected segment, count the ***intersection*** that has the higher segment scores.

e) If the adjacent segments have much lower scores (greater than 10% difference) to the previously selected segment, then the count will be done ***midblock***.

f) For this example, the "Composite Utility Score" for this adjacent segment is more than 20 points lower than the selected segment; therefore, the count at this segment would be done midblock.

8) Select more counting locations

Finishing all steps through step 7 will yield one counting location. You can generate more counting locations by repeating some of the steps. Steps below highlight what to repeat:

a) Go back to the sorted Excel spreadsheet. Locate the next highest score in the category you are working in.

  i) The corresponding segment should have a different street name to ensure the count is not done close to the previous. Repeat step 8a until you have a different street name from the previous segment.

b) Repeat *Step 6*, filtering by the score you just located in the spreadsheet.

  i) To filter by this score, choose a value that would include the new segment. For this example, you would filter scores ">51.8".

Composite
55.11013678
51.88302401
51.58397346

  ii) If the segment is very close to the segments already counted, or is one of the segments that connect to an intersection that was counted, select another segment.

c) Repeat *Step 7*.

d) Repeat *Step 8* for the desired number of counting locations.