IV. Transportation & Accessibility along University Avenue

x. THE PEDESTRIAN ENVIRONMENT

by katie purdham

This Chapter's Questions:

1. Why is a high-quality pedestrian environment important and what can be gained from implanting pedestrian-friendly amenities?

2. What is the built environment currently like at the intersection of University and Snelling Avenue, and what are plans for the future?

3. Why do pedestrians currently use University and what do they think of the pedestrian environment?

Chapter Outline:

I. Introduction and the Importance of the Pedestrian Environment
II. The Built Environment
III. Pedestrian Motivations
IV. Conclusion

I. The Pedestrian Environment

City streets accommodate many different forms of transportation. Historically, the streetscape has changed based on the popular mode of transportation at the time. In today's streets, it is common to find that they are designed with cars as their primary concern, and other forms of transportation are designed around the needs of the car.

"The kernel of dispute is the transportation engineer's focus on 'traffic flow' in moving motor vehicles as efficiently as possible – this contrasts with the pedestrian advocate's desire for 'place' as the intimate context of urban life that is threatened by cars."[1] This juxtaposition of the desires of cars and the desires of pedestrians and other forms of transportation can be analyzed in the built environment. The way in which an area is designed can indicate for whom it is designed. For example, differences in corner radii, length of intersections, timing at intersections, and width of sidewalk can all indicate the consideration given to pedestrians in the planning of the street.

A high-quality pedestrian environment is important because it can affect the decisions that individuals make when choosing a form of transportation. Various reasons, such as convenience, attractiveness, and safety, influence individuals' decisions to walk. The less attractive or safe individuals think an area is, the less likely they are to walk there.[2] If there are too many factors dissuading individuals from walking, and if they have access to other forms of transportation, they will many times choose one of these other modes of transportation.

It is important to consider the needs of pedestrians for several reasons. From a public health perspective, walking can be a useful alternative to using public transportation or driving. Increasingly, statistics are showing that the United States has a problem with physical inactivity. Of all adults in the United States, less than half participated in a healthy level of physical activity.[3] Higher levels of inactivity are also leading to a higher level of mortality, obesity, and chronic disease. Even slight changes in physical activity levels could improve the fitness of many American lives. One way of promoting physical activity is to create a more pedestrian-friendly streetscape. If shifts were made in the planning of streets to accommodate pedestrians, people might consider walking as another viable form of transportation and there could be major increases in the quality of life and health of many people.[4]

A better pedestrian environment can also lead to more people choosing to walk instead of using public transportation or personal vehicles. A trend away from motorized vehicles would also be beneficial for several reasons. It would lead to less dependence on fossil fuels and help to improve the environment by using less gasoline and causing less pollution. [5]

It is also important to consider the needs of pedestrians to create streets that are safer from crime. "A well-used city street is apt to be a safe street. A deserted city street is apt to be unsafe." [6] Traffic safety can also be a concern for pedestrians in areas where the street is oriented towards the needs of cars and not the needs of pedestrians.

Beyond simply acting as thoroughfares for motor vehicles, urban streets often double as public spaces. The relationship between making a street safe and making it livable has been a concern for many, and these two goals have many times been viewed as opposing. It has been argued that the more trees, benches, lights, and other amenities there are, the more distracting they become to drivers. One study found the opposite to be true. The areas in which there were more amenities, the fewer traffic accidents occurred on the roads. It was speculated that the drivers were more attentive because there were more amenities and a more visible pedestrian environment. So, conversely, when drivers are in areas where there are few signs of a pedestrian environment, the less attentive to pedestrians the driver becomes.[7]

The aim of this project is to document the pedestrian environment on University Avenue before the implementation of the light rail. Currently, it is a corridor that is strongly oriented toward cars and other motorized vehicles and there is little consideration of the pedestrian environment or bicyclists. The plans for after the light rail aim to change this.

The intersection of University Avenue and Snelling Avenue will be used as a case study. First, I will analyze the built environment focusing on University and Snelling as it is now and what the plans are for the future of this intersection and University Avenue more broadly. Then I will discuss the results of a survey conducted at this intersection about individuals' motivations for being a pedestrian on University Avenue. It is important to create and promote a quality pedestrian environment for everyone who lives, works, and visits University Avenue.

II. THE BUILT ENVIRONMENT

The built environment is the physical layout of the street. This can indicate who and what the designers planned the streets for.

The corner radius can be an important measure of street orientation. The corner radius "specifies the radius of a circle that matches the corner's rounding."[8] The tighter the radius, the more pedestrian-friendly the street is and the wider the radius the more car-friendly it is.

Intersections can also indicate orientation. The amount of time allotted for pedestrians to cross the street and for cars to cross the intersections can indicate who or what the designers planned the street for. Speed limit can also have a huge impact on pedestrian safety. The higher the speed limit the faster cars can get to their destination, but the less safe it is for pedestrians.

Amenities and physical appearance are also quite important. Amenities and physical appearance can promote better livability. Along with this, improved livability can promote a better sense of community and a safer neighborhood.

The scale of the corridor is another important factor. It is important to consider whether it is built at a human scale or a scale for vehicles because this can change the way in which the area is used.

The Current Built Environment of Snelling Avenue and University Avenue

The area surrounding the intersection of Snelling and University Avenue is a prime example of the way in which University Avenue is oriented.

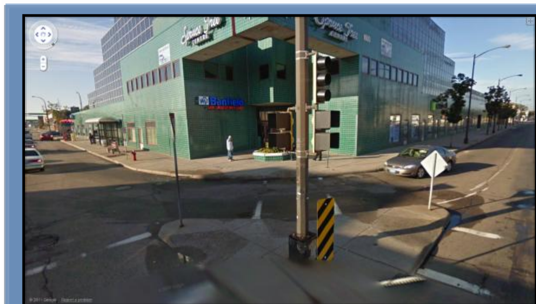

Figure 1: Wide corner radius and pedestrian island on the corner of University and Snelling by the Spruce Tree Centre

The corner radius is extremely wide and there are several islands in the crosswalks (see figure 1). The crosswalks are quite long and there is little time for pedestrians to cross traffic.

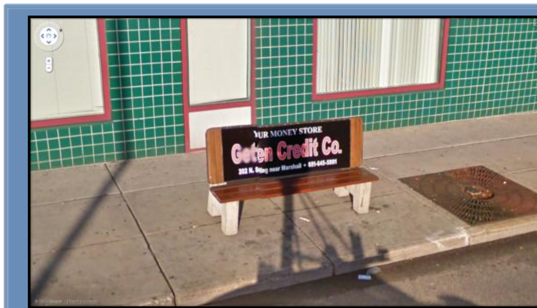

Figure 2: Pedestrian amenities next to the Spruce Tree Centre

The amenities (see Figure 2) at this intersection are sparse, consisting primarily of several benches and street lamps, and often there is trash along the sidewalk.

Figure 3: The vast expanses of the Midway Shopping Center

The Midway area (Figure 3) is an example of a space that is created at a scale compatible with motor traffic. With its large parking space and its relative inaccessibility to pedestrians, it is obviously oriented for cars and other personal vehicles. It is also created at such a large scale that it is friendly to cars quickly passing by, but there are few details small enough to interest pedestrians.

The Future Built Environment of the Central Corridor

The current plans for the Central Corridor include many improvements for pedestrians. In order to improve pedestrian safety and convenience at intersections, there are plans for more bulb-out corners (corners that jut into the street and reduce pedestrian crossing time) and to provide pedestrians with more time to cross intersections. Crosswalk lines will also be made clearer; instead of two parallel lines, a system of "piano lines" (a series of horizontal lines alternating between paint and asphalt) will be implemented.

In terms of amenities, there are several proposed changes. An improvement to the lighting of the

Central Corridor has been proposed. An improvement in lighting would add to the overall atmosphere and help to create a feeling of safety. There are also plans to add more benches for pedestrian use. Finally, in Minnesota winters, snow can create significant problems for any form of transportation, and there are plans to increase awareness of snow removal ordinances in order to keep the sidewalks walkable.[9]

THE FUTURE BUILT ENVIRONMENT OF SNELLING AND UNIVERSITY AVENUE

The current plans for the intersection of Snelling and University and the surrounding area intend to create "a beautiful urban place with pedestrian-friendly, attractive tree-lined boulevards."

In several areas there are designs to create open public spaces and showcase public art. One of the largest changes would be the addition of a green space called "Snelling Commons" where the old Bus Barn site is currently located.

They also plan on creating a more pedestrian-friendly atmosphere by improving amenities and creating an improved atmosphere. The sidewalk width will be changed to a minimum of fourteen feet and amenities will be added including the addition of trees along the streets.

Plans are currently in place to open up access to the areas surrounding Midway. The Saint Paul City Council is aiming to create more accessibility to pedestrians in the area by creating more transit accessibility and by improving the crossings along the freeway.

Another major shift in the pedestrian area planned for after the implementation of the light rail is the creation of a more pedestrian-friendly design scale. Many of the new shopping areas and residential spaces are designed to be on the ground floor of buildings and at eye level for pedestrians compared to the current Midway autocentric scale.[10]

These changes are ideal and are in the action plans set out by the Saint Paul City Council. However, they are dependent on funding and are not yet a certainty.

III. PEDESTRIAN MOTIVATIONS

In documenting the corridor as it is now, it is important to consider the views of pedestrians on University Avenue. In order to obtain current opinions on the pedestrian environment I conducted a survey. This survey aimed to measure the different reasons that individuals choose to walk on University Avenue as opposed to either taking a different route or to using a different form of transportation.

METHODS

I relied heavily on the work of previous studies in regards to the methodology used in this survey. I went to the corner of University and Snelling and asked people to complete the survey on four different occasions at one hour intervals. The dates and times that I surveyed pedestrians were: 1) March 26th, 5:50-6:50 pm; 2) March 28th, 8:20- 9:20 pm; 3) April 12th; 5:07-6:07 pm; 4) April 13th, 4:55-5:55 pm.

I chose to find participants at bus stops because these areas tended to have large numbers of individuals present and many people taking the bus had been (or would shortly be) walking on University Avenue.[11]

The survey consisted of two parts. The first part asked for background information including whether the participant lived or worked on University Avenue, how many times a week they walked on University Avenue, their age, and their gender. The second part asked them to rate several factors on how much they influence their decision to walk with 5 being the most important and 1 being the least important. The factors they were asked to rank were distance (to destination), traffic safety, crime safety, aesthetics, pedestrian amenities, pedestrian accessibility, and other factors. It also asked for other factors that might influence their decision to walk and if they had any other comments.

Other Variables

There were several variables that could have interfered with the data. On multiple occasions participants asked for definitions of the words (mainly aesthetics and amenities) or did not understand the rating system. I would construct the survey differently now, but I think that most individuals understood the survey after explanation.

There were several participants that were visibly intoxicated or consuming alcohol and other drugs at the time of the survey. Also many of the individuals made comments either on the survey or orally about how or if this survey would affect the implementation of the light rail or the construction and were more interested in advocating a position than in participating in the survey. This could partially be due to the fact that the latter two survey times were conducted once construction had started.

Results and Analysis

The data were analyzed by averaging the responses to the different factors and examining if they correlated with any of the background information from part 1. For example, I analyzed whether or not living on the avenue affected individuals' opinions towards the factors for walking on University Avenue. A score of 5 would mean that every individual in that category rated it at its top value and score of 1 would mean that every individual scored it at its lowest value.

Live and Work on University Avenue

The data for individuals living and working on University Avenue were correlated quite strongly with one another. The individuals that lived and worked on University Avenue were significantly less concerned (about .5 value difference) about crime, aesthetics, and pedestrian amenities than those that did not live or work on University Avenue.

Date and Time

There was a significant difference between the time of the day and the number of men and women that took surveys. Overall, there were significantly less women than men that participated in the survey (20 women and 40 men). The later the time that the surveys were distributed the fewer women responded. The second survey time was from 8:20-9:20 p.m. on a

Monday night and only one woman completed a survey. It is possible that there were fewer women willing to fill out the surveys at this time, but from personal observations there were also fewer women present than at any of the other times. No data were collected on this however. The other data differences between date and time did not follow any noticeable patterns.

Gender

Males generally rated everything slightly lower than females (with the exception of pedestrian amenities which they rated .1 higher than females). Pedestrian amenities and aesthetics were rated of similarly low importance to both categories. Males rated pedestrian access and traffic safety .5 point lower than females. There were two categories that males rated as significantly less important than females. Males rated distance to be .7 points less important and crime safety to be 1.1 points less important than females. The difference between concern of crime safety and the lack of females present in the evening are both interesting and possibly correlated; however, we do not have relevant data to make firm conclusions about these results.

Age

The most distinguishing aspects of the differences between ages were in the 19-25 year old age group. The other groups had relatively similar patterns, but the 19-25 year old age group varied more than the others. They were significantly less concerned with aesthetics and amenities and significantly more concerned with traffic safety and distance. The two older categories were slightly more concerned about pedestrian access than the two younger categories.

Overall

There were a few trends in the overall data, but it differed less than when comparing the individual categories. There was only a .8 difference between the highest-ranked and the lowest-ranked category. The two highest-ranked categories were distance and pedestrian access, which could in part be due to the fact that all of the participants were taken from the bus stop area. The middle two categories were crime safety and traffic safety and the two categories rated of least importance were pedestrian amenities and aesthetics. This is what was to be expected and these data follow trends from other similar studies.[12]

Open-Ended Comments and Personal Interactions

The most common comments received were either about the light rail (for and against) and about the construction taking place. The comments about construction were generally quite negative and several stated that they could not write down their actual feelings because it was too inappropriate.

There were several comments that made discouraging remarks about the aesthetics of the area and the lack of pedestrian amenities. One participant stated that, “It’s not that pretty, but the people are usually fine and everything is nearby.” This, along with the survey results, suggests that individuals walk on University due to its proximity and convenience rather than for personal enjoyment. Another participant commented that “I’m glad I don’t have far to walk to get the bus." Several other people also stated that they only walk on University out of necessity.

There were also several comments made about safety, both in terms of traffic and crime. One person commented that, "Cars have to slow down more often!" Another wrote, "Be careful after dark." During the evening survey time, there were two or three individuals that told us that we should leave because it was not safe for us. It is worth noting that these are only perceptions and I do not provide data on actual rates of crime or traffic incidents.

IV. Conclusion

The pedestrian environment is a crucial part of any streetscape. It can promote a sense of community and livability as well as promote a healthier lifestyle and improve the environment. The intersection of University and Snelling currently has a car-oriented built environment and is not pedestrian friendly, but the plans for the future of this area seem promising.

Table 1: Survey Results

	Gender			Age					Work			Live			Date					Overall
		Male	Female		<18	19-25	26-45	46-77		Yes	No		Yes	No		3/26	3/28	4/12	4/13	
Distance		3.5	4.2		4	4.2	3.8	3.3		3.8	3.8		3.6	3.8		3.5	3.3	4.3	3.9	3.8
Traffic		3.4	3.9		3.5	3.9	3.6	3.4		3.6	3.7		3.6	3.6		3.4	3.4	3.7	3.7	3.6
Crime		3	4.1		3.7	3.4	3.5	3.2		3.1	3.6		2.8	3.6		3.2	3.1	3.3	4.1	3.5
Aesthetics		2.8	3		3.1	2.4	3.1	3.3		2.6	3		2.4	3.1		3	2.9	2.7	3	3
Pedestrian Amenities		3.3	3.2		3.5	2.7	3.6	3.7		2.9	3.5		3.1	3.4		3	3.6	3	3.6	3.3
Pedestrian Access		3.5	4		3.4	3.3	3.9	3.8		3.6	3.8		3.1	4		3.2	3.9	3.8	4	3.8

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xi. GRAVITY MODELING OF COMMUTING ALONG UNIVERSITY AVENUE POST-LIGHT RAIL CONSTRUCTION

by adam van der sluis

This Chapter's Questions:

1. What is the current inflow and outflow of work along University Avenue?

2. Will city planners be able to meet their goal of having an increase in the number of people who live and work along the Central Corridor?

3. If this goal is to be met, what will the Central Corridor look like after LRT construction?

Chapter Outline:

I. Introduction

The construction of the light rail along University Avenue is meant to serve many purposes. The most obvious is that of transit and the assumed associated benefits: less congestion, higher connectivity, and easier access for those who would otherwise not be very mobile. Other reasons have to do with economic development. In the vein of development, advocates of the light rail want to see the residents who live along the University Avenue Corridor work along the Avenue. In this chapter, I will discuss the status quo in terms of how many people who live along the Avenue work elsewhere, as well as how many people travel to the Avenue for work. What is the pattern of this distribution today, before the construction of the light rail? And how will these patterns change after the construction of the Light Rail along University Avenue? I will use the Gravity Model to examine this question.

II. The Gravity Model

The Gravity Model is a model in urban geography derived from Newton's law of gravity. Newton's law states that: "Any two bodies attract one another with a force that is proportional to the product of their masses and inversely proportional to the square of the distance between them."[1] When used geographically, the words 'bodies' and 'masses' are replaced by 'locations' and 'importance' respectively, where importance can be measured in terms of population numbers, gross domestic product, or any other appropriate variables. The Gravity Model is therefore based upon the idea that as the importance of one or both of the locations increases, there will also be an increase in movement between them.[2] However, as the distance between two places increases, there will be less movement. This phenomenon is known as distance decay.[3] Specifically, it is the Gravity Model of Migration that I will be using in this chapter. As the importance of the Central Corridor increases, movement of people—specifically workers—should increase.

Though there are many potential applications of the Gravity Model, I intend to use it to see how movement to University Avenue will change with the introduction of the light rail. I will measure the movement to University Avenue not in terms of general population along the Avenue, but in the number of residents who will move from employment located elsewhere to employment along the corridor. There does not seem to be much precedent in the existing academic literature for using the Gravity Model to make predictions about movement of workers over small distances (less than 10 miles).

It is interesting to look at how much the Gravity Model has changed over time, and why it has changed. In the article "The Parameters of the Gravity Model are Changing—How and Why?" the author Kauko Mikkonen says these changes are coming about because of the changes in service in "gravity centers."[4] Very generally, changes in service refers to the evolution in the basic uses of a specific place. This applies in the case of University Avenue, which can be considered a gravity center, and which will have an even greater pull with the construction of the light rail. The construction of the light rail itself could be considered a change in service. Also, additional service changes would occur as a result of the different Avenue landscape brought about by the light rail. It is easy to imagine how stores, restaurants, and residences will change along the Avenue during and after the construction of the light rail.

In a Gravity Model study involving an extended period of time, I would need to account for service changes in the model. For this chapter, however, I am looking at a relatively short period of time, as the predictions I make will be for the year 2020. As mentioned above, any changes in services would be due to the construction of the light rail, which will occur after the completion of this chapter. Those changes would perhaps need to be taken into account with any follow-up study. Even then, the actual impact of those changes may not yet be felt.

The Gravity Model is among the most commonly used models in urban geography to explain patterns of transportation and land use change. In an article by Iacano et al in the *Journal of Planning Literature* called "Models of Transportation and Land use Change: A Guide to the Territory" the Gravity Model is discussed, specifically in the context of the transportation-land use relationship.[5] Another paper that utilizes the Gravity Model is titled "Gravity Models for Dynamic Transport Planning: Development and Implementation in Urban Networks." In this article, the author Theodore Tsekeris proposes some extensions to the Gravity Model in order to improve its capabilities, specifically for predicting transport demand. The conventional Gravity Model accounts for inter-period, or long-term evolution of travel demand. Tsekeris proposes a new form of the Gravity Model that takes into account both the inter-period and intra-period, or short-term evolution of travel demand.[6]

Though this is an interesting extension of the Gravity Model that certainly seems to enhance its efficacy, I do not take the intra-period evolution of demand into account in this model. This is partially because the parameters for the Gravity Model become significantly more complicated by using these extensions, but also because, as with the Mikkonen article, the changes observed with an intra-period evolution of demand will be negligible within the context of the model I will use.

When using the Gravity Model, it is usually the case that destinations are not homogeneously distributed. Sander Veenstra developed a model that takes into account this random distribution. In an interesting example, he tested his new model in a survey of grocery shopping trips in the Dutch city of Almelo. As would be expected, the new model out-performed the traditional Gravity Model.[7] This approach could well have been applicable to my analysis if I had used distinct areas for study. I will be looking at two main areas: a clearly defined portion of University Avenue, and the area that can only be called "the area outside of the Central Corridor." Because one of these areas is not strictly defined, Veenstra's method cannot be included.

III. Current Patterns of Work

In order to make the comparison between workplaces along University and residences on the Avenue, I will use data on how many people who live along University Avenue go elsewhere to work, and how many people must travel to University Avenue to get to their workplace. The group of interest for planners and developers—and thus for me—is the overlap of those two groups: the number of people who both live and work along the Corridor. These data were obtained from the Minnesota Department of Employment and Economic Development.[8]

In this paper, I define University Avenue as the area that includes all of the Census block groups bordering the Avenue. I looked at the three most recent years with available data: 2007, 2008, and 2009. Though there are data from all three years, I will refer to 2009 in this discussion for two reasons:

1. There is very little change from year to year.
2. Because 2009 is most recent, it should most closely resemble what the current composition of workers along the corridor looks like.

People who work along the corridor generally live away from University Avenue. Of the 267,758 people who work along University Avenue, 258,317 (96.5%) live somewhere else, while the remaining 9,441 (3.5%) live in the vicinity. Relatedly, people who live along the corridor generally work elsewhere. Of the 26,634 people living in the area, 17,193 (64.6%) work outside of the vicinity, with the remaining 9,441 (35.4%) working along the corridor.

Some reasons for these patterns may be because of job availability. The number of jobs along University Avenue assumedly makes up a small percentage of the total number of jobs in the entire Twin Cities metro area. Thus, based simply on probability, any given person is more likely to work away from University Avenue than within the corridor. But distance decay also plays a role in where people decide to work. The farther away the workplace is located, the less desirable it is to work there.

Figure 1: 2009 Map of Inflow/Outflow of Workers near University Ave.

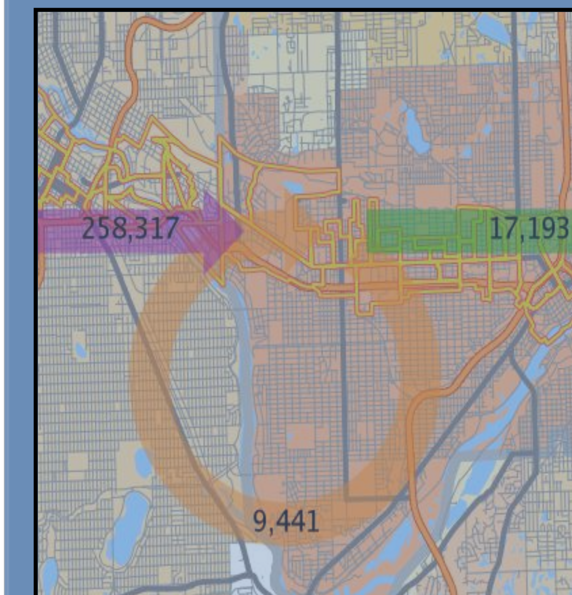
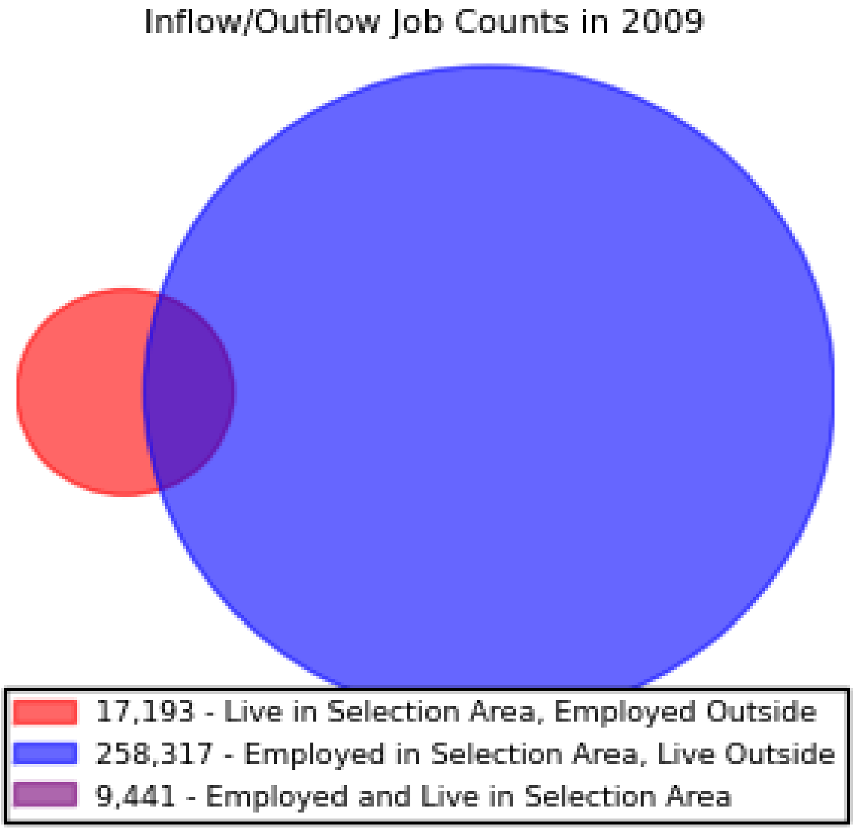


TABLE 1: INFLOW/OUTFLOW JOB COUNTS IN 2009



Inflow/Outflow Job Counts (All Jobs)

	2009	
	Count	**Share**
Employed in the Selection Area	267,758	100.0%
Employed in the Selection Area but Living Outside	258,317	96.5%
Employed and Living in the Selection Area	9,441	3.5%
Living in the Selection Area	26,634	100.0%
Living in the Selection Area but Employed Outside	17,193	64.6%
Living and Employed in the Selection Area	9,441	35.4%

This means that, though there are more possibilities for jobs elsewhere, the travel required to get to the workplace should make it less desirable to work there; as a result, work along the corridor should be more desirable. Also, though only a small percentage of the total number of jobs in the metro area, more than a quarter-million jobs are available in this area, and only a small percentage of these jobs are filled by residents of University Avenue.

The above reasons come from the perspective of the resident looking for work; that is, asking the question of why somebody who lives along University Avenue does not also work there. It is also interesting to look at the perspective of those who work along the Avenue: if somebody works in an area, why not live in the area?

No matter which perspective is used, it appears from first glance that the construction of the light rail will make it easier for those who work along the Avenue to live there; vice versa, people who already live along University should have an easier time with work along the Corridor. As a result, there should be a higher rate of people who both live and work along the Avenue

IV. Methods

To estimate how much higher this rate will be, I use the Gravity Model. I begin with the simplest form of the Gravity Model, which is as follows:

$$\frac{\text{population}_1 \times \text{population}_2}{\text{distance}^2}$$

This formula measures the relative bond between two places. For example, to measure the bond between Los Angeles and New York City, we would multiply their populations (20,124,377 and 15,781,273, respectively) to get 317,588,287,391,921 Then, we divide that number by the distance between the two cities (2462 miles) squared (6,061,444). The result is 52,394,823.

Utilizing the same method for two urban areas—Tucson, AZ and El Paso, TX—that are closer in distance, the result is 8,038,300. That means that the relative bond between Los Angeles and New York City is more than six times stronger than the relative bond between Tucson and El Paso, despite the greater distance between Los Angeles and New York City. As mentioned at the beginning of this chapter, the Gravity Model of Migration is the most appropriate use of the Gravity Model for predicting the movement of workers. Specifically, I will use the Lowry Migration Model as the basis for the model that will answer the research question.

Aspects of the basic formula for the Gravity Model can be seen in the Lowry Model, introduced by Ira Lowry in his 1966 book, "Migration and Metropolitan Growth: Two Analytical Models." Lowry's Model essentially says that migration from point A to point B is directly related to high wages at Point B, low relative unemployment at Point B, and a large civilian labor force at either the origin and/or destination point. Additionally, migration is inversely related to high wages at Point A, low unemployment at Point A, and increasing distance between Point A and Point B.[9] The theory can be generally represented by the formula:

$$M_{AB} = k\left[\frac{u_A}{u_B} \times \frac{w_B}{w_A} \times \frac{L_A L_B}{D_{AB}}\right] e_A$$

where,
M=number of migrants
L= persons in labor force
u=unemployment in %
w=hourly wage in manufacturing
D=airline distance
k=gravitational constant
e=error term

The $\frac{L_A L_B}{D_{AB}}$ term is essentially the same as the simple form of the Gravity Model introduced at the beginning of this section.

Because the Lowry Model seems to be the most applicable to answer my research question, I altered the model in order to better fit the needs of this chapter. The new version of the model is as follows:

$$M_{AB} = k\left[\frac{L_A L_B}{D_{AB}}\right] e_{A1}$$

where,
M=number of workers
L= persons in labor force
D=average commute distance
k=population growth constant
e=error term

The terms involving unemployment rates and hourly wages were removed for two reasons: 1) unemployment and wages will not significantly explain any change in the number of people living in an area, and 2) the wage term especially would have been an inaccurate measure since the data include all types of jobs with a wide range in salary, translating to a wide range in hourly wages.

V. Results and Predictions of Future Patterns of Work

With this formula, Point A will be the University Avenue Corridor, while Point B will be a larger area that includes all places of work outside of the University Avenue Corridor. L_A, then, is 9,441, the number of people who live in the Corridor who also work along the Corridor. L_B is 17,193, the number of people who live in the Corridor but work elsewhere.

Finding the distance between point A and point B (D_{AB}) is less straight forward; because Point A and Point B are large areas rather than actual points, there can be no unique straight-line distance. Instead, I use the average commuting distance. This is calculated by multiplying the average commuting time with the average speed during a give commute. I make the assumption that average commuting speed is 25 miles per hour. Based on the 2000 Census, average commute time for a Ramsey County resident is 21.2 minutes, or 0.353 hours.[10] Multiplied by 25, the result is 8.83 miles as the average commuting distance for a commuter along the University Avenue Corridor.

TABLE 2: EMPLOYMENT AND LIVING IN SELECTION AREA

Selection Area Labor Market Size (All Jobs)						
	2009		2008		2007	
	Count	Share	Count	Share	Count	Share
Employed in the Selection Area	267,758	100.0%	273,856	100.0%	266,882	100.0%
Living in the Selection Area	26,634	9.9%	27,909	10.2%	27,448	10.3%
Net Job Inflow (+) or Outflow (-)	241,124	-	245,947	-	239,434	-

In-Area Labor Force Efficiency (All Jobs)						
	2009		2008		2007	
	Count	Share	Count	Share	Count	Share
Living in the Selection Area	26,634	100.0%	27,909	100.0%	27,448	100.0%
Living and Employed in the Selection Area	9,441	35.4%	10,080	36.1%	9,596	35.0%
Living in the Selection Area but Employed Outside	17,193	64.6%	17,829	63.9%	17,852	65.0%

In-Area Employment Efficiency (All Jobs)						
	2009		2008		2007	
	Count	Share	Count	Share	Count	Share
Employed in the Selection Area	267,758	100.0%	273,856	100.0%	266,882	100.0%
Employed and Living in the Selection Area	9,441	3.5%	10,080	3.7%	9,596	3.6%
Employed in the Selection Area but Living Outside	258,317	96.5%	263,776	96.3%	257,286	96.4%

Source: U.S. Census Bureau, OnTheMap Application and LEHD Origin-Destination Employment Statistics (Beginning of Quarter Employment, 2nd Quarter of 2002-2009)

The two constants in this formula are the error term and the population growth constant. For the error term, I use $\frac{1}{1000}$ to account for the fact that Lowry's model deals with large distances, usually in thousands of miles. In this case, the distance will be less than 10, so the error term must adjust for that difference. In place of the gravitational constant, I use the estimated rate of population growth for Saint Paul as a constant, which is 1.1008.[11] This represents the expected rate of growth as predicted by the Metropolitan Council for Saint Paul as a whole.

Plugging in these numbers, the formula shows that M_{AE} = 2,292. This is the number of people living along the University Avenue Corridor who would move from their job away from the Corridor to a job whose workplace is located along University. In order to accommodate this, an additional 2,292 jobs will need to be created there. Currently, 35.4% of all workers living along the Corridor also work there. With the predicted additional jobs in the area, there would then be 44% of all workers living along University who also work there.

Planners and developers generally say that they would like more people to both live and work along the Avenue. However, there has not been a clearly specified goal in terms of a percentage of all the University residents who also work along the Avenue. The light rail will create increased accessibility, and the stated goals of developers will create some sort of push to have more people who both live and work along the University Avenue Corridor. Because of these factors, I think a goal of having 50% of all Corridor residents also working along the Avenue is reasonable. This means that, in addition to the 2,292 workers predicted by the model, 1,584 people would need to change their job place from outside of the Avenue to a location along the Avenue.

Altogether, this would mean a minimum increase of 3,876 jobs, which is a 1.5% increase in job availability even without considering additional jobs for those who do not live along University. With the above increase in jobs, the total number of jobs along the Corridor would increase to 271,634. With this addition, 4.9% of all Corridor jobs would be covered by those who live along the Avenue, a 1.5% increase from today. While this predicted increase would seem rather minimal, it is quite high in the context of today's struggling economy. If the same 1.5% increase is applied to the remaining jobs along the Central Corridor, the total increase in jobs would be 4,015. This increase may act as a catalyst for even further development that would allow for more people to both move to and work along the Corridor.

People living and working along the Central Corridor

	Number of People	Percent of Total Corridor Residents
Currently:	9,441	45.40%
Predicted:	11,733	44%
Goal:	13,317	50%

All of these numbers, however, are calculated with the assumption that the overall population of the Corridor will remain constant. Of course, the probability of that happening is almost zero, because part of the development plans include increasing the number of people living along the Corridor.

One way to predict how many additional people will live along the Corridor is by assuming that the percentage of total jobs occupied by people who live along University will increase by 10%. Again, it is a goal of planners and developers to provide the means for this increase. The fact that this goal has not been officially declared is probably due to the difficulty in trying to make that prediction.

Using a rate of 45.4% (10% more than that current rate) for the percentage of all the people who live along University Avenue and who also work there, we would expect a total of 29,332 total people to live along the Corridor. This is an increase of 2,698 from the current population of 26,634, a population growth rate of 10.1%.

This estimation needs to be put into some sort of context before drawing any strong conclusions. If 2,292 additional people who live along the Avenue will then begin to work along the Corridor area by 2020, the resulting 10.1% population increase seems to be quite high. In comparison, the city of Saint Paul as a whole is expected to experience a 4.92% increase in population over the same time period.[12]

People living along the Central Corridor

	Number of People	Growth Rate
Currently:	26,634	-
Predicted:	29,332	10.1%

If anything, this could be a maximum number of people moving to the Corridor. That being said, it would not be unheard of for this area to experience a higher rate of growth than the city as a whole. It is possible, if not likely, that residents will move to the Corridor from other parts of Saint Paul to take advantage of new living and work opportunities. Additionally, the recently released numbers in the census suggest that the suburbs may be losing population because of people moving back to the city. This would be an advantageous place for individuals to relocate when moving from suburban areas.

VI. Conclusions

These results have implications for how developers and planners look to allocate land use as the interest in the land surrounding the Corridor begins to increase. If the number of people living along the corridor is going to increase, then developers need to be able to provide housing for an additional 2,698 people. With those additional people moving to the Central Corridor, there need to be jobs to support both the group of people newly moving to the area, as well as for those who will not be living along the Avenue.

In this chapter, I used the Gravity Model to make an estimation as to how many people will be drawn to this area to work. From that, I made predictions about how many people will also be moving to the Corridor, and what developers will need to do in order to meet their goals.

The Gravity Model can be used to make predictions about where people will both work and live along

University Avenue. It is difficult, however, to be completely accurate with these predictions. The basic Gravity Model itself is not meant to produce an exact estimate of where people will go and what that will mean for an area. The extension of the Gravity Model that I use inevitably provides what amounts to a very rough estimate for the number of people who live along the light rail. Additionally, there is a long list of factors that could contribute to a higher or lower number of residents of the Central Corridor changing their workplace so that they can then also work along the Avenue. The construction of the light rail will change many things along the Corridor, including the connectivity of the Avenue, availability of housing, and not only the possibility for employment but also the types of available employment opportunities. The accuracy of these predictions could be tested by a follow-up study done after the construction of the light rail and the resulting developments.

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xii. LRT Traffic Impacts

by troy groenke

This Chapter's Questions:

1. How will LRT affect travel patterns of conventional motorists traveling both along and across University Avenue?

2. What is the current distribution of noise/sound pollution along the route?

3. What are feasible, cost-effective solutions to mitigate potential problems?

Chapter Outline:

I. Introduction and Overview

This chapter seeks to examine, quantify and analyze effects of LRT transit on levels of service to conventional motorists along the University Avenue corridor. Specifically, this study focuses on the area between Dale Street and Fairview Avenue. Unsolved problems regarding the prioritization of traffic signals along the Hiawatha LRT line have created apprehension surrounding the impacts of train right-of-way at key intersections along the University Avenue route.

There has been insufficient focus placed on planning for traffic congestion problems facing motorists traveling along and/or across University Avenue. This study combines the findings of local traffic research efforts with original calculations to define problem traffic areas and present workable solutions.

Additionally, this chapter presents original data outlining the spatial distribution of noise (i.e. “sound pollution”) along the route. Collecting data on sound distribution now, before the line has been installed, ensures the opportunity for comparative research on the spatial distribution of noise pollution in the future.

Snelling and University Ave. Photo credit Laurie McGinly

II. Dale to Fairview: Level of Service

The installation of LRT along the University Avenue corridor will require the line to be located down the center of University Avenue. This configuration will place eastbound and westbound vehicle lanes along both sides of the LRT. For safety purposes, it is desirable to reduce the number of north-south crossing streets, in order to eliminate the amount of traffic that will be crossing in front of the trains. The University Avenue corridor will require the closing of approximately one-third of University Avenue’s cross streets between Dale Street and Fairview Avenue. As such, city authorities have been working with the Met Council to address concerns regarding the redistribution of cross traffic along the Avenue from minor streets to larger arteries. Using a transportation analysis index called “Level of Service,” the Met Council has released a study simulating the impacts LRT will likely have on mid-corridor traffic patterns.

a. "Level of Service" description

In order to interpret and understand the results presented by the Met Council, it is necessary to understand the "level of service" analysis framework used by researchers to simulate changes in traffic conditions due to the proposed street closures. "Level of Service" (LOS) is a transportation analysis framework that uses a letter-grading rubric (A-F) to determine the effectiveness of transportation infrastructure.

LOS "A" is described as conditions where traffic flows at or above the posted speed limit and all motorists have complete mobility between lanes. While it may be tempting to aim for an "A" Level of Service, this is largely unrealistic in urban areas during daytime traveling hours. Urban areas more typically adopt standards varying between "C" and "E", depending on the area's size and characteristics. "F" is sometimes allowed in areas with improved pedestrian, bicycle or mass transit alternatives.

Several studies prepared by the Met Council seek to estimate the impact of the LRT line on LOS along the corridor. These studies use advanced traffic modeling to assess the hypothetical impacts of future use patterns in three key areas: along the route itself, along adjacent transit routes, and at key highway exits within a one mile proximity to the route.

b. Summary of Met Council LOS Study

Published June 2008, Met Council's "Traffic Study #5 Synchro Analysis Mid Corridor- Two Lane Traffic Evaluation of University Avenue" sought to model the impacts caused by removing one lane of traffic on either side of the LRT line, as currently being proposed in the corridor from Dale St. to Fairview Ave. While the modeling software used in the Met Council's simulation is complex, a flaw in the analysis exists: *the study fails to account for predicted increases in traffic volumes caused by the diversion of traffic from north-south side streets that have been closed due to LRT construction*. The study acknowledges this limitation, making the prediction that, in reality, level of service to motorists will be even worse than is predicted in the study.[1]

Detailed results of the analysis, including AM and PM peak hour results are shown on the following page. The following summarizes the results:

1. In the AM peak hour, two intersections are at LOS E (Eustis St. and Cromwell Ave.) and two intersections at LOS F (Snelling Ave., and Raymond Ave.).
2. In the PM peak hours, three intersections are at LOS E and **10 intersections at LOS F** (see next page).
3. The SimTraffic analysis of the corridor results in significant queuing and delays at almost every intersection. Due to the study's assumptions, discussed earlier, the resulting operation of the traffic lanes is predicted to actually be worse than indicated in the level of service tables on the following page.
4. The average travel speed for the PM peak hour under the modeled, two-lane scenario is **5 mph** eastbound and **10 mph** westbound (compared to 18 mph eastbound and 19 mph westbound under existing conditions).

Use the following table as a guide to interpret the table of results on the following page:

Summary Table of LOS Indicators

LOS Grade	Wait at signalized intersections	Traffic flow conditions
A	< 10 seconds	Free
B	11 – 20 seconds	Reasonable
C	21 – 35 seconds	Stable
D	36 – 55 seconds	Less stable
E	56 – 80 seconds	Unstable
F	> 81 seconds	Breakdown

c. Analysis of Met Council LOS Study

The study does additionally run a simulation with a 10% reduction in traffic volume, but results remain similar. It becomes evident that LRT will have a negative impact on traffic flow along University Avenue, even in a best-case scenario. It is undisputed that traffic will be slowed noticeably while traveling along the Avenue. Met Council's study, however, makes no mention of the influence of *north-south* cross traffic on LOS for streets surrounding the Avenue.

d. North-South Crossing Redistribution

This chapter argues that the closing of north-south cross streets (servicing traffic *across* the Avenue) will cause increased traffic flow at signalized north-south intersections such as Snelling Ave. and Lexington Ave. No formal study has been completed to estimate the impacts of closing these intersections. While the building of a full-scale traffic model is beyond the scope of this chapter, this study will use traffic data to predict the impact of LRT on the redistribution of north-south cross traffic patterns surrounding the corridor.

Using public data on vehicle trips provided by the Minnesota Department of Transportation (MnDot), it is possible to roughly calculate the number of north-south vehicle crossings that will be redistributed to larger intersections. Without modeling this increase, though, it will be impossible to quantifiably estimate the degree to which these conditional changes in traffic volumes will affect wait times at signalized intersections.

e. Methods: North-South Traffic Analysis

In order to estimate the number of vehicle trips that will be re-routed due to the blockage of north-south intersections, the intersection slated for closure must first be identified. The following is a list of intersections that will lose north-south connectivity, as outlined in Met Council's "Issue 17b: Reconstruction of University Avenue Right-of-Way:"[2]

Cross Street Name
St. Albans Street
Avon Street
Milton Street
Oxford Street
Dunlap Street
Syndicate Street
Albert Street
Simpson Street (one side only)
Asbury Street (one side only)
Herschel Street
Wheeler Street
Beacon Street

Met Council Traffic Study #5
RESULTS
Synchro Analysis Mid-Corridor –
Two Lane Traffic Evaluations

AM Traffic Conditions:

University Avenue Intersections		Existing Conditions LOS	Existing Conditions Delay	Two-Lane Section LOS	Two-Lane Section Delay
University Avenue	Eustis Street	B	14.8	E	71.5
University Avenue	Cromwell Avenue	C	27.8	E	65.1
University Avenue	Franklin Avenue	A	9.8	A	7.6
University Avenue	Raymond Avenue	D	53.7	F	88.1
University Avenue	Hampden Avenue	A	8.6	D	40.2
University Avenue	Vandalia Street	B	19.4	C	22.3
University Avenue	Cleveland/Transfer	B	12.1	C	22.2
University Avenue	Prior Avenue	B	18.4	C	21.1
University Avenue	Fairview Avenue	B	17.5	C	23.1
University Avenue	Aldine Street	A	7.6	B	12.9
University Avenue	Fry Street	A	5.5	C	20.3
University Avenue	Snelling Avenue	C	25.0	F	87.6
University Avenue	Pascal Street	A	8.2	B	17.7
University Avenue	Albert Street	A	3.6	B	12.2
University Avenue	Hamline Avenue	C	22.8	C	25.2
University Avenue	Lexington Pkwy	C	32.6	D	36.8
University Avenue	Victoria Street	B	11.7	B	15.8
University Avenue	Dale Street	C	23.0	C	32.1
University Avenue	Western Avenue	B	12.1	B	19.2
University Avenue	Marion Street	B	14.8	B	19.2
University Avenue	Rice Street	C	24.3	C	29.1

PM Traffic Conditions:

University Avenue Intersections		Existing Conditions LOS	Existing Conditions Delay	Two-Lane Section LOS	Two-Lane Section Delay
University Avenue	Eustis Street	D	37.1	F	214.9
University Avenue	Cromwell Avenue	C	23.4	F	101.5
University Avenue	Franklin Avenue	A	6.8	C	31.9
University Avenue	Raymond Avenue	C	34.5	F	141.8
University Avenue	Hampden Avenue	A	6.2	C	25.9
University Avenue	Vandalia Street	D	51.7	F	109.2
University Avenue	Cleveland/Transfer	B	15.8	E	71.9
University Avenue	Prior Avenue	C	26.5	D	41.8
University Avenue	Fairview Avenue	C	24.4	C	33.3
University Avenue	Aldine Street	B	11.1	C	30.2
University Avenue	Fry Street	A	5.3	B	19.9
University Avenue	Snelling Avenue	D	52.5	F	101.4
University Avenue	Pascal Street	B	18.4	F	91.7
University Avenue	Albert Street	B	11.5	F	97.3
University Avenue	Hamline Avenue	D	36.3	F	155.3
University Avenue	Lexington Pkwy	E	79.3	F	216.0
University Avenue	Victoria Street	B	15.4	E	67.8
University Avenue	Dale Street	C	33.2	F	155.2
University Avenue	Western Avenue	B	13.9	E	64.2
University Avenue	Marion Street	B	19.9	D	42.5
University Avenue	Rice Street	C	23.0	D	47.8

* Delay times listed in seconds.

These twelve streets are of the lowest road-level classification, and as such, MnDot does not compile and release traffic volume data. The best data available are for streets of the next-highest volume classification (e.g. Victoria, Hamline, Pascal).

The following table summarizes trip data at the most detailed level provided by MnDot (2008):

Road Name	Traffic Volume
Dale St.	~20,000 / day
Victoria St.	~ 4,000 / day
Lexington Ave.	~ 31,000 / day
Hamline Ave.	~ 11,000 /day
Pascal St.	~ 7,000 / day
Snelling Ave.	~ 33,000 / day
Fairview Ave.	~ 8,000 / day

Green = Municipally Managed Road
Blue = County Road
Red = State Trunk Highway Route

Because MnDot does not offer traffic volume data for the smallest cross streets, and because gathering empirical vehicle trip data is beyond the scope of this study, estimating traffic volumes of the minor streets must prove sufficient for this study. In order to do this, a principal assumption must be clarified:

Because the streets scheduled to lose north-south connectivity are of lesser classification than streets for which traffic data are currently available, it can be assumed that the volume of traffic crossing at the minor streets is less than the volume of traffic crossing the Avenue at any of the larger intersections.

For the purposes of this study, classifying road types will be determined by comparing known road conditions against a traffic volume rubric provided by the DRA (Digital Road Atlas).[3]

DRA Traffic Volumes:
(By subclass)

Road Classification	# Vehicle Trips
Local	1.0 * Local Traffic
Collector Minor	2.08 * Local Traffic
Collector Major	2.35 * Local Traffic
Arterial Minor	3.71 * Local Traffic
Arterial Major	4.22 * Local Traffic
Highway Minor	5.39 * Local Traffic
Highway Major	8.75 * Local Traffic
Freeway	27.58 * Local Traffic

In order to estimate the amount of traffic on local streets along University Avenue, we must classify – according to the DRA rubric – roads for which traffic data are available:

Road Name	Traffic Volume	DRA Classification
Dale	~20,000	Arterial Major
Victoria	~ 4,000	Collector Minor
Lexington	~31,000	Highway Major
Hamline	~11,000	Collector Major
Pascal	~ 7,000	Collector Minor
Snelling	~33,000	Highway Major
Fairview	~8,000	Collector Minor

Now that the roads for which known volume data are available have been classified, it is possible to divide the traffic volume of a known street by the ratio outlined by the DRA, to arrive at the approximate traffic volume for the local streets surrounding larger roadways. The calculation is carried out as follows:

$$\text{Local road volume (estimated)} = \frac{\text{Known volume of similar street}}{\text{DRA subclass ratio}}$$

Calculated estimated traffic volumes at local streets:

Local Road	Known similar street	Ratio	Estimated traffic volume
St. Albans	Victoria	2.08:1	2,000
Avon	Victoria	2.08:1	2,000
Milton	Victoria	2.08:1	2,000
Oxford	Lexington	5.39:1	5,000
Dunlap	Lexington	5.39:1	5,000
Syndicate	Hamline	2.35:1	4,500
Albert	Pascal	2.08:1	3,500
Simpson (one side)	Pascal	2.08:1	1,750
Asbury (one side)	Pascal	2.08:1	1,750
Herschel (one side)	Fairview	2.08:1	2,000
Wheeler	Fairview	2.08:1	4,000
Beacon	Fairview	2.08:1	4,000
TOTAL TRAFFIC			37,500

f. Analysis of this estimation figure

It is important to note that not every one of the estimated 37,500 vehicles that contact University Ave on a daily basis will be trying to *cross* the Avenue's median by making either a left turn or a direct crossing. Some traffic will presumably turn right. Traffic turning right onto the Avenue will not be affected by the closing of the median.

It is important to estimate the turning behavior of motorists into three categories:

1. Avenue crossing
2. Left turn
3. Right Turn

Because the medians have not yet been closed, this study must rely on work done by traffic engineers in other cities to estimate the *probability* that traffic will execute one of the three behaviors outlined above. These behavioral probabilities can be used to improve the study's estimation of re-routed vehicles. Using these probabilities, an estimate of the number of cars executing left turns or avenue crossings will be compiled.

After reviewing academic literature studying the mathematical probability of traffic distribution at signalized intersections, it becomes clear that the *Poisson* statistical distribution will best estimate the behavior of traffic at the intersections in question.[4,5]

An algorithm based off Poisson probability provides the most accurate behavior estimations in situations where traffic flow is light and drivers have freedom to exhibit relatively random driving behaviors (i.e. that traffic is not being systematically "guided" towards a particular location). This probability distribution is well suited to the small, local intersections currently under study.

Unfortunately, developing a customized algorithm capable of delivering statistically significant estimations falls well beyond the scope of this study. Instead, it must suffice to trust the results of similar studies undertaken by traffic laboratories, accepting that results of such studies would be similar to results if a more in-depth study were to be undertaken here.

Academic literature substantiates the assertion that traffic behavior in circumstances similar to those along University Avenue will exhibit a reasonably random distribution of turning patterns.[5] The Poisson statistical distribution produces relatively random estimations of behavior at low traffic volumes. As such, it is reasonable to assume that the three traffic behaviors occur relatively equally, as is concurrent with other studies.

Therefore, if it is assumed that these three behaviors occur roughly equally, then it can also be assumed that by restricting crossing access at the intersections in question, two-thirds of the 37,500 total vehicle trips (25,000 vehicle trips) will need to be re-routed due to the LRT because they will not be able to execute a left turn or a complete Avenue crossing.

Though the estimated 25,000 re-routed vehicle trips are spatially dispersed across approximately two and one-half miles; the estimated re-routing is roughly comparable to re-directing one major arterial passage. This analysis has shown that more consideration should be given to the amount of traffic that will need to be relocated after the twelve medians are closed to through traffic.

g. Problems with this estimation

It is important to recognize several problems that impact estimates of numbers of vehicle trips that need to be re-routed due to median closures. The first problem arises in the calculation formula itself. If traffic volume on local routes is being calculated based on a ratio of local traffic volume to the assumed volume on a larger neighboring road, it is apparent that, in some cases, using a larger road in the calculation will inflate the volume estimates for the local street.

For example, when calculating the estimated traffic volume for Asbury Street, the closest street for which data are available is Snelling Avenue. The calculated estimated volume for Asbury, using the formula outlined previously, returns an estimated flow of 1,900 trips per day. Using a smaller neighboring street in the calculation, Pascal, returns the value of 1,750 trips per day. This represents approximately an eight percent difference of estimated volume for Asbury. Though eight percent may not at first seem like a significant difference between estimates, statistical discrepancies this large add up quickly when calculating thousands of trips.

A source for this error in the calculation stems from the formula's presumption of a positive correlation between traffic volume on local streets and traffic volume on arterial routes. In reality, an inverse relationship often exists. To explain: a positive correlation between traffic flows indicates that the more motorists use an arterial route to cross the Avenue, the *more* vehicles use local routes to cross. In reality, if motorists are using arterial routes to cross the Avenue, that leaves *fewer* motorists using local streets. As such, the formula used to estimate vehicle trips could be changed to better account for this inverse affect.

To conclude, traffic turning onto or crossing University Avenue at north-south, unsignalized intersections is currently only challenged by east and westbound traffic traveling along the

Avenue. Once the LRT is installed, these motorists must factor in the right-of-way of the LRT. Given the suspected increase in congestion along the Avenue (as discussed in the Met Council's Level Of Service/Traffic Study #5), coupled with the addition of LRT right-of-way, it is reasonable to expect that motorists could prefer to travel to a signalized intersection in order to cross the Avenue with a greater deal of safety. This shift in traffic patterns will only add to the congestion predicted by Met Council reports at signalized intersections. More serious attention needs to be paid to alleviating congestion at signalized intersections along the LRT.

"Noisy Traffic" Photo credit Bristol City Council

III. Noise Pollution

Noise pollution is excessive or displeasing human or machine-created environmental noise that disrupts the balance of life.[6] Noise pollution tends to be spatially distributed unevenly over urban landscapes; construction zones, transportation corridors (both automobile and rail) and industrial areas all experience increased levels of noise in comparison to quieter, residential areas. The distribution of noise pollution impacts the health of humans and animals, decreases desirability for some types of development, and has been known to decrease efficiency in the work place.

University Avenue transverses a diverse and unique landscape. Residential developments, warehouse buildings, factories, restaurants, and commercial offices sit side by side – all sustained by the Avenue that facilitates the efficient movement of people and goods. Currently, the corridor supports automobile, freight (truck), and freight train (1-2 blocks off the road corridor) activity. However, the addition of LRT traffic along the Avenue could permanently change the distribution of noise along the route.

As such, it is of great importance to capture the current distribution of sound distribution along the route, so that further studies may be completed in the future. As stated prior, the redistribution of noise pollution along the route may have impacts on human and environmental heath as well as property values and overall desirability for certain locations.

a. *Sound Level Collection Methods*

Sound level is measured using a Sound Pressure Level (SPL) meter; levels are measured in decibels (dB). See the following table for help interpreting SPL measurements:

Source/Activity	Indicative noise level dB (A)
Threshold of hearing	0
Rural night-time background	20-40
Quiet bedroom	35
Wind farm at 350m	35-45
Car at 40mph at 100m	55
Busy general office	60
Truck at 30mph at 100m	65
Pneumatic drill at 7m	95
Jet aircraft at 250m	105
Threshold of pain	140

In this study, SPL values were collected using a model 33-2055 Digital-Display Sound-Level Meter purchased from RadioShack (aprox. $50). The meter's calibration was set to "A" weighting, the standard setting used to measure most legally-mandated sound-level requirements.

Readings were taken between 5:00 – 6:00 PM on a Wednesday evening in April 2011. All twenty-five intersections along the route between Dale St. and Fairview Ave were sampled on the north side of the street. Readings were omitted at intersections experiencing abnormal disruptions due to construction projects.

The following table summarizes the data collected for this study:

Street Name:	Min Level:	Max Level	DB Range	Pollution Level
Dale St.	72 db	77 db	5 db	Red
St. Albans St.	61 db	71 db	10 db	Green
Grotto St.	61 db	72 db	11 db	Green
Avon St.	63 db	72 db	9 db	Green
Victoria St.	72 db	78 db	6 db	Red
Milton St.	65 db	73 db	8 db	Yellow
Chatsworth	64 db	74 db	10 db	Yellow
Oxford St.	64 db	72 db	8 db	Green
Lexington	71 db	77 db	6 db	Red
Dunlap St.	60 db	69 db	9 db	Green
Griggs St.	61 db	71 db	10db	Green
Syndicate St.	60 db	69 db	9db	Green
Hamline Ave.	72 db	78 db	6 db	Red
Albert St.	61 db	70 db	10 db	Green
Pascal St.	62 db	71 db	9db	Green
Simpson St.	x	x	x	x
Asbury St.	x	x	x	x
Snelling Ave.	72 db	79 db	7 db	Red
Fry St.	63 db	72 db	9 db	Green
Pierce St.	x	x	x	x
Aldine St.	63	74	9 db	Yellow
Herschel St.	x	x	x	x
Wheeler St.	64 db	73 db	9 db	Yellow
Beacon St.	62 db	72 db	10 db	Green
Fairview Ave.	70 db	78 db	8 db	Red

KEY:

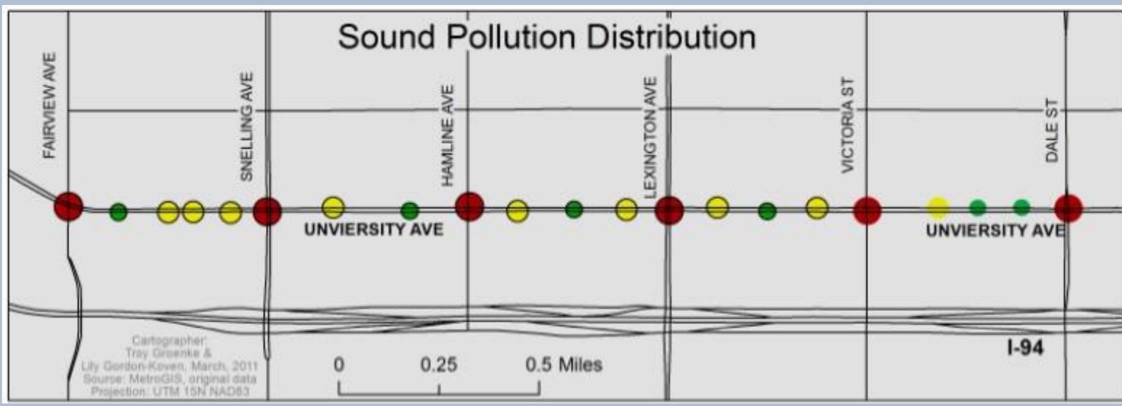
Green	=	Peak 70-72 db
Yellow	=	Peak 73-74 db
Red	=	Peak 75-79 db

b. *Analysis of Sound Level Data*

Going into the study, it seemed reasonable to assume that sound levels would be higher at intersections that carried high traffic volumes. As expected, signalized intersections did indeed carry higher maximum sound-level values than non-signalized intersections.

Another trend present in the data pertains to the *range* of values at a given intersection. Signalized intersections not only showed higher overall SPL peak levels, they had higher minimum values as well. Two possible reasons explain such a decrease in range:

First, during peak hours at signalized intersections, cars frequently wait in queue lines at stoplights in order to pass through intersections. Rarely, if ever, does the flow of traffic



along the Avenue disperse to the extent that there is a sizable "gap" between each vehicle.

Higher traffic density equates not only to slower travel, but louder travel as well. Engine noise caused by frequent vehicle acceleration compounds and increases overall volume levels, keeping minimum SPL values higher than at non-signalized intersections.

At non-signalized intersections traffic passes the intersections more sporadically, even at peak hours. As such, the minimum sound level threshold is much lower. But when cars, trucks, and busses pass the intersection, volume levels spike momentarily.

The second factor contributing to the narrower range of sound values at signalized intersections is the increased presence of north-south cross traffic. At minor intersections, only the occasional car enters from the north or south. At major signalized intersections, cars traveling north-south wait in queue lines to cross University Avenue. This scenario creates sound levels of more uniformity than experienced at intersections without traffic converging from all directions, because there is always traffic crossing the Avenue.

Limitations to the data / items for consideration include: the fact that data were only collected on one occasion; data were only collected at one time of day; and, preliminary LRT construction was already underway, potentially impacting normal travel patterns along the Avenue.

Photo credit: Pioneer Press

IV. Solutions: Dale to Fairview

As discussed in section II, there is little doubt that installing LRT along the University Avenue corridor will decrease the level of service for traditional motorists traveling both along and/or across the Avenue. Traffic problems along University Avenue have the potential to become highly politicized, as motorists and University Avenue businesses will both likely be affected by LRT construction and implementation.

If local residents become frustrated with traffic pattern changes, it would not be the first time Minnesotans have taken issue with increasing traffic congestion as a result of LRT construction and implementation. Negative feelings remain after signal light delays along the mid-corridor sections of the Hiawatha Line created levels of congestion motorists were unprepared for in 2004.[7] Because the University Avenue LRT will use "absolute pre-empt" right-of-way measures at signal lights (the same right-of-way measures currently in place on the Hiawatha line), authorities must be careful that all measures are taken to ensure as little disturbance to conventional motorists as possible along University Avenue.

Each day, University Avenue handles tens of thousands of vehicle trips along its length; however, as discussed, the Avenue meets several major arterial north-south intersections between Dale St. and Fairview Ave. MnDot traffic records show that collectively, there are as many as 150,000 vehicle trips that *cross* University Avenue every day. Even a small increase in travel time crossing the Avenue can have large impacts on commute times for motorists, especially during peak hours.

This section of the chapter is devoted to outlining and discussing ways transportation authorities can use preemptive planning to curtail as many negative traffic impacts as possible.

In a best-case scenario, there would be minimal disruption to motor vehicle patterns upon LRT installation. However, as discussed, current studies show that more dramatic impacts are likely to occur along the Avenue. Careful forethought can help planners prepare for these predicted changes, avoiding unreasonable levels of traffic congestion once LRT operation commences.

Two options for mitigation will now be addressed: first, the removing of right-of-way conflicts entirely (i.e. building bridges and tunnels), and second, the reconfiguration of right-of-way privilege at intersections where traffic-LRT convergence is inevitable (i.e. removing LRT "absolute pre-empt" right-of-way status).

a. Solution 1: Right-of-way Removal

The single most effective way to reduce right-of-way conflicts at signalized intersections along the University Avenue LRT corridor between Dale St. and Fairview Ave. would be to build new transportation infrastructure intended to separate the right-of-way of the trains from the right-of-way of motor vehicle traffic. Put simply, this constitutes building bridges or tunnels to get motor vehicles past the tracks. For purposes of this study, it is assumed that tunneling under the LRT is a prohibitively expensive option due to the increased costs of utility and sewer relocation. Even so, building bridges still carry large up-front investments, but this form of infrastructure enhancement offers the complete removal of right-of-way conflict once implemented.

An example of this type of infrastructure can be found a few blocks south of University Avenue at the intersection of Hamline Avenue, Selby Avenue, Ayd Mill Road South, and the Ayd Mill Road rail corridor. At this juncture, two bridges carry traffic over multiple sets of rail tracks, eliminating the need for a barricade-style train crossing intersection.

Utilizing such designs along University Avenue would undoubtedly present spatial challenges. Often, little "extra" room exists between the curbs of north-south cross streets, adjacent parking lots and businesses, and University Avenue itself. Because of this, possible bridge sites must be carefully chosen, and may favor intersections that are not currently principal north-south arterial routes.

Proposing the addition of such improvements so late in the planning process may prove difficult, especially in a fiscally conservative political climate. However, with long-term traffic forecasts expected to grow, in the long term such infrastructure enhancements would help to ease stress on motorists well into the future.[8]

b. Solution 2: Right-of-Way Prioritization

All "governed" intersections through which motorists travel (i.e. stoplights and rail crossings) use some form of right-of-way allocation method to control the flow of traffic in way that maintains efficiency while providing periodic priority to specialized vehicles (e.g. emergency responders and freight trains). When a governed intersection is relatively isolated, such as at a lone signal light in a rural town, prioritization algorithms are very simple and straightforward. However, more complex, integrated prioritization systems are put to use in transport corridors that have several governed intersections in succession. In these scenarios, coordinated prioritization can help traffic flow smoothly through an entire corridor with minimal interference.

Because public transit must stop between signalized intersections to pick up passengers, it is often provided with prioritized right-of-way through signalized intersections. This ensures the rapid transit vehicles are not stopping both at station locations as well as at signalized intersections. When transit vehicles are on an automated schedule that does not fluctuate over time, traffic planners can sometimes program train movements into neighboring signal-control algorithms.[9] However, in the case of LRT along the University Avenue corridor, trains will be controlled in real time using human conductors; therefore, the automatic integration of train movements into a fixed stoplight algorithmic sequence is impossible.

c. Current Prioritization Along University

University Avenue depends on dozens of signalized intersections to facilitate the efficient movement of motor vehicle traffic throughout the corridor (several of these intersections are located in the mid-corridor study area). The Avenue currently operates with stoplights in a coordinated mode to provide for the efficient travel both along and across the Avenue.

The University Avenue LRT is slated to operate under an "absolute pre-empt" state of right-of-way status between Dale Street and Fairview Avenue. This status grants trains full intersection preference regardless of auto traffic, and gives trains authority even over emergency vehicles.

This "absolute pre-empt" prioritization is already being used along the Hiawatha Corridor in southeast Minneapolis along Hiawatha Ave./Hwy. 55. Residents and citizens that commute along the highway have reported waiting up to fifteen minutes at a single stoplight intersection. In 2006, the Federal Transit Administration re-calibrated the stoplight algorithms, and wait times were reduced. However, highway users still report taking thirty minutes or more to travel a stretch of road that used to take fifteen minutes or fewer before the LRT was installed.[10]

It is important to clarify a key difference between the Hiawatha Avenue LRT and University Avenue LRT: The Hiawatha LRT travels *parallel* to the highway, not directly down the middle. As such, the Hiawatha LRT does not impact drivers maneuvering turns on the side of the road not housing the rail line.

Because of its location down the middle of the avenue, the University Avenue LRT will be in direct conflict with a greater percentage of motorists interacting with the Avenue. This subtle difference has the potential to have large impacts on wait times and congestion levels for motorists traveling along and across the Avenue.

d. Possible Alternatives

Other LRT systems throughout the world offer examples of different ways in which LRT can interact with automobiles. Alternative right-of-way formats compromise the train's authority at major signalized intersections so as to optimize automobile traffic flows in conjunction with train efficiency. These approaches decrease dependability of train scheduling, and add minutes to overall train travel times; however, they avoid maximum degradation to the street traffic system. While the comparative advantage of the train to the auto is decreased slightly, major traffic delays can often be avoided.[11]

Photo credit: MPR

V. Policy Recommendations

Supported by the findings of the Met Council as well as original research presented prior, it seems probable that traditional motor vehicle traffic along University Avenue may experience increases in congestion upon the installation of LRT, especially in the mid-corridor section where LRT will meet several north-south arterial roadways.

I recommend that planning authorities consider the following alternatives to alter rights-of-way, better facilitating the movement of vehicles across the Avenue:

1. Revisit options for right-of-way removal, including but not limited to the building of bridges and tunnels. Consider removing right-of-way even at non-arterial intersections, as space availability permits.

2. Reconsider the "absolute pre-empt" right-of-way status for LRT trains at major signalized intersections (e.g. Snelling Avenue). The LRT trains could maintain absolute pre-empt right-of-way status at less-prominent intersections.

3. Consider the integrated synchronization of train schedules (at least from Dale St. to Fairview Ave.) within an automatically-administered transit control system. Removing human piloting of the trains for this stretch of track would allow for the mathematical efficiency of transit coordination along this section of the University Avenue corridor.

4. Lastly, I recommend transit authorities take the opportunity to study traffic redistribution impacts in every way possible, so as to aid future LRT planning efforts both in the Twin Cities as well as across the nation.

As witnessed by the pushback government planners experienced following Hiawatha LRT traffic disruption, it will be best not to take a "wait and see" approach to traffic mitigation along University Avenue. The project stands to lose the support of thousands of motorists that depend on an efficient trip along and/or across the mid-corridor sections of University Avenue. Instead of taking chances, planners and lawmakers owe it to citizens to do their homework, revisit areas of opaqueness, and make sure sufficient and concrete plans are in place to ensure the future efficiency of mid-corridor motorways.

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