APPLICATION OF GIS TO A PARKING STUDY IN NEWTON

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Abstract

This project evaluates the use of a Geographic Information System (GIS) for parking management within the city of Newton. In order to demonstrate the utility of GIS, the project team performed a parking study. Through field surveys and data collection, our project team assessed the parking situation in Newton Centre caused by the competition between commercial, residential and commuting interests, using GIS. This project also evaluates the ability to expand this management tool to the entire city.

1 Introduction

One of the most important factors in the success of a central business district is the availability of accessible parking. Patrons must be able to park easily and inexpensively in parking spaces that allow enough time for shopping or work. These needs must be balanced against the possibility of these spaces being used by people with other purposes. In order to determine adequate parking for the area businesses while limiting the number of other users who occupy these spaces, many municipalities perform intensive studies on their parking situation.

The city of Newton, a suburb of Boston, is one such municipality. Faced with the parking needs of residents, commercial establishments, commuters using public transportation and the employees of businesses within the city, Newton conducted a thorough traffic study in 1988. This study outlined several different solutions that could help the city to manage its parking more efficiently.

In the 15 years that have passed since that study was completed, the demand for parking in Newton has not decreased. Although some of the solutions offered by the study were implemented, many were determined to be too expensive or too difficult to maintain. Since these steps were not taken, the parking situation in Newton has not improved.

Today, however, a new tool may help Newton city managers balance parking needs. In the time that has passed since that study was completed, computer technologies like Geographic Information Systems (GIS) have become one of the essential tools of city management. The ability that GIS offers to easily search and display data has made the job of city planners more focused and efficient. The goal of this project is to apply GIS technology to existing parking areas to demonstrate the benefits of the technology. This study focuses on the use of GIS technology in parking management for the village of Newton Centre and is intended to assist the Newton Department of Public Works Engineering Division in developing a well-balanced parking policy that will improve the quality of life for city residents.

The following chapters will contain background information, the methodology for the project and our results and analyses.

- Chapter 2 is the executive summary of the project
- Chapter 3 contains information about the city of Newton and the village of Newton Centre. It focuses on the means of transportation to these areas, including the major highways and the MBTA transit system in addition to the parking policies that are currently in place in Newton Centre.
- Chapter 4 describes the methodology we used to collect and analyze parking data. This chapter describes the goals of our projects, and details the methods we used to accomplish them.
- Chapter 5 presents the results of the project.
- Chapter 6 contains the analyses of the project.
- Chapter 7 presents conclusions and recommendations.
- Chapter 8 is the project bibliography

- Appendix A describes the Newton Department of Public Works and the Engineering Division
- Appendix B describes the MBTA transit system
- Appendix C is a technical report of Newton's GIS
- Appendix D contains the data collection forms used in the project
- Appendix E contains full-size copies of all figures and maps used in this project.
- Appendix F describes the coding scheme that was created for this project

2 Executive Summary

Parking has become one of the most important factors that city planners have to account for in their work. Lack of accessible parking can hurt local business and decrease the quality of life for residents. Due to the importance of parking, city managers must study and analyze parking. The goal of this project was to both utilize GIS technology to provide Newton city officials and residents with innovative parking solutions and to generate a strategy for the city to expand the basis of our efforts into a parking management system capable of providing permanent solutions to parking problems. The spatial scope of this study consisted of the commercial core and surrounding residential neighborhoods of the village of Newton Centre.

In order to demonstrate the utility of GIS in parking management, we performed a parking study and analyzed the unique benefits that GIS offers. Our project team created GIS map layers, and used the technology to manage and analyze the data we collected during a parking study. We compared the results of our study with those of a professional consulting agency to analyze the differences in the approach and the results. Finally, we outlined a strategy for the application of a GIS-based parking management system for the city of Newton.

Upon completion of this parking study, we were able to conclude that GIS can be used as a powerful analytical tool. Using a GIS makes it possible to store data about individual parking spaces in a logical and precise way. Through simple searches, it is possible to view the many different types of parking that exist in a city the size of Newton. The ability to sort the different characteristics of a parking space by location and to view these characteristics on a map make GIS an invaluable tool. Another benefit of GIS is the ability to easily update the map layers. Every time a new space is added, or characteristics of an old space are changed, it is far easier to update the information digitally than in a traditional system.

Based on this conclusion, we recommend that Newton engineers perform a citywide parking study utilizing GIS. In order to properly utilize GIS, city engineers would need to be trained in the use of the GIS, as well as GIS-compatible database and spreadsheet software. Additionally, they would need to create a coding scheme that uniquely identifies each parking space, and then periodically enter data about all of the parking spaces into a database. This report demonstrates the benefits of a GIS-based parking management system, and describes a procedure that Newton could use to switch to such a system.

3 Background

The purpose of this chapter is to provide information that is fundamental to our project. This chapter describes the city of Newton and its residents, as well as provide an overview of Newton Centre's current parking conditions.

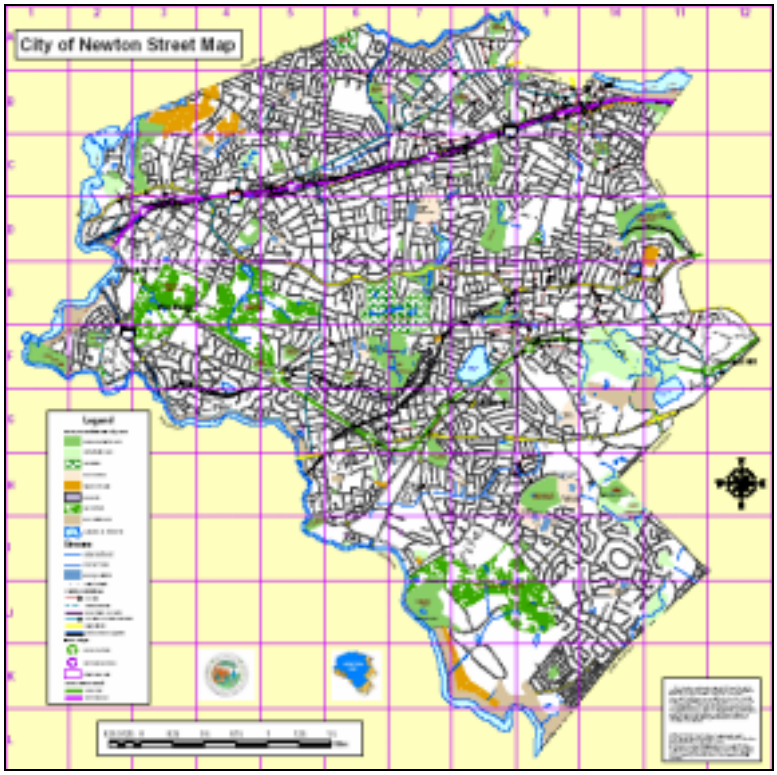

Figure 1 Map of the City of Newton[1]

3.1 City of Newton

This section will give an overview of Newton as well as the village of Newton Centre. The goal of this overview is to describe the study area.

Newton is an 18-square mile city, located west of Boston. Figure 1 is a map of the city of Newton. Newton was founded in 1688 and became a city in 1873. Today, Newton is comprised of 13 village centers. These village centers are semi-autonomous divisions, which help the city government to manage Newton. These sub-divisions allow city planners to plan urban development in a village-specific manner. This type of planning has enabled the city of Newton to maintain much of its small-village flavor even though it is one of the larger cities in Massachusetts. One of the busiest villages in Newton is the village of Newton Centre. It is the complex blend of residents, consumers, employees, and commuters that make Newton Centre an ideal test site for the application of GIS software in parking management.

[1] City of Newton. "City of Newton Street Map". n.d. < http://www.ci.newton.ma.us/main.htm >. (21 February 2002).

3.1.1 Ne wton Centre

Newton Centre is one of the thirteen villages that make up the city of Newton. The village developed in 1720 because it was a prime location for mills. Over the years, the character of the village has changed dramatically. The process of modernization that occurred in Newton Centre during the 1950's helped transform the area from an industrial zone into the mixture of commercial and residential that it is today. Currently there are 2,700 houses located in Newton Centre, which accommodate approximately 8,000 residents. [2]

3.2 Transportation

As a suburb of Boston, there are numerous ways to get to Newton. The Masspike/I-90, Route 128/I-95, Route 9 and several subway and bus lines all converge in Newton. Newton is along several routes heading towards Boston so it is subject to much of the traffic headed there. This section focuses on transportation into Newton.

3.2.1 Private Transportation

Traffic from the Massachusetts Turnpike (Masspike or I-90) is one factor that contributes to local traffic in Newton. The Masspike is a 123-mile highway, completely funded by tolls, advertising and leasing of land/air rights. Another major highway that passes through Newton is Route 128/I-95, which many commuters use to get to work in Boston. Route 9 is a traditionally crowded commuter and retail roadway. In addition to the highways, Newton is also served by a variety of public transportation routes. While Newton Centre is not directly affected by through traffic, its proximity to these major routes means that it is affected by commuters along these routes.

3.2.2 Public Transportation

Public transportation in Newton primarily consists of the MBTA lines that run through the city. Although the MBTA is widely used by Newton residents, the city has attempted intra-city public transportation with minimal success. This section describes public transportation within Newton.

3.2.2.1 MBTA

As part of the greater Boston area, Newton residents benefit from one of the best public transportation systems in America. Created on August 3, 1964, the Massachusetts Bay Transportation Authority (MBTA) was formed with the stated goal of implementing a new concept in regional mass transportation. The creation of the "T", as the subway came to be known, was one of the first such attempts at an integrated regional mass transportation solution. The MBTA immediately requested funding from the

[2] Terrain. "Unsprawl Case Study, Newton Centre". n.d. < http://www.terrain.org/Archives/Issue_2/Newton_Centre/newton_centre.html >. (21 February 2002).

newly created federal Urban Mass Transportation Administration (UMTA). To date, over $3.5 billion of federal funds have been used to secure rights to existing commuter rails, or to build new ones.[3] By constantly improving and expanding the service area of the subway, the MBTA has achieved its original goal. The MBTA is currently the fourth largest mass transit system in the U.S., serving a population of 2.6 million people, with an average weekday rider ship of 1.1 million. Refer to Figure 2 for an overview of the MBTA transit system. For more details on the workings of the MBTA, refer to Appendix B.

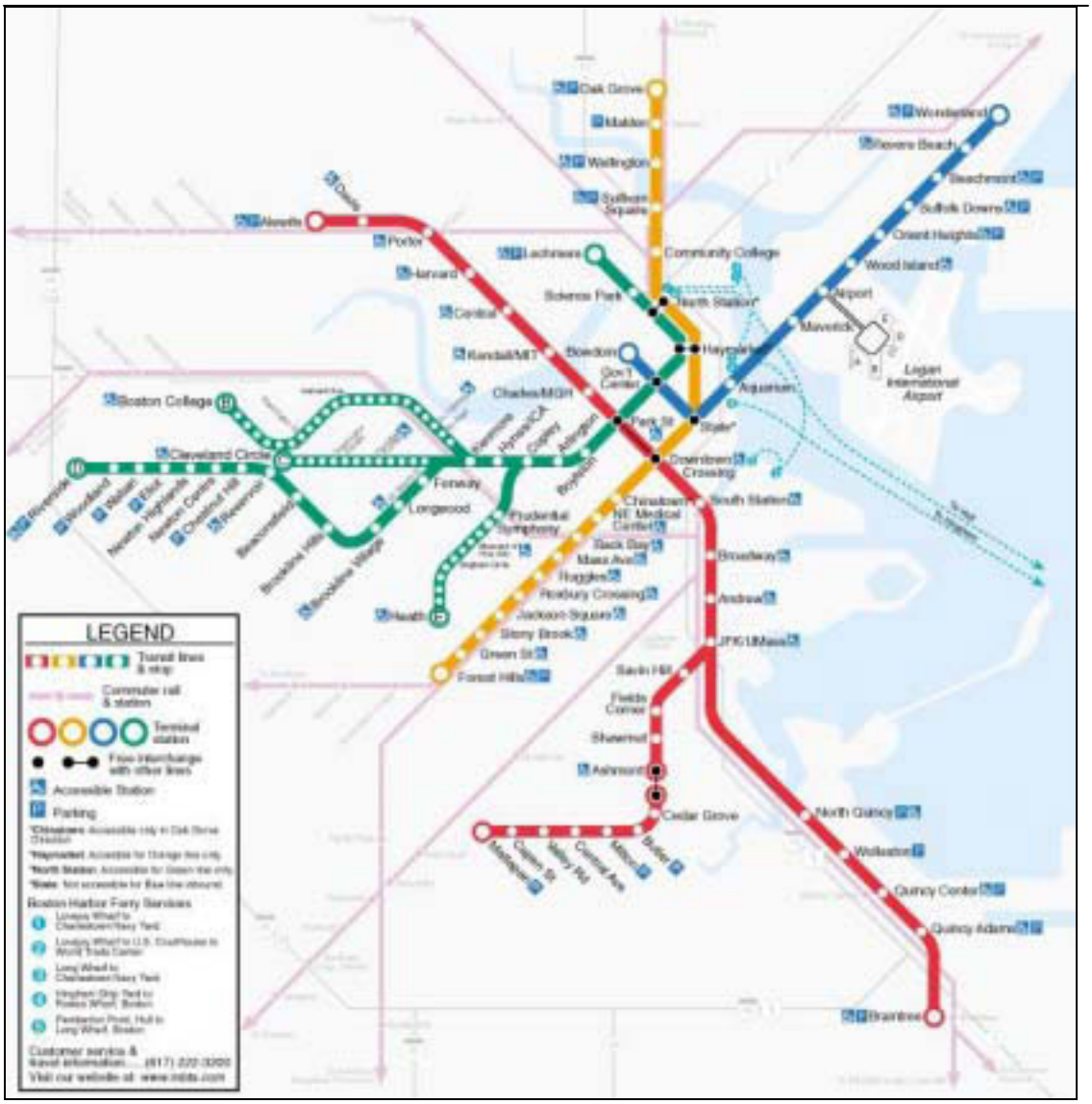

Figure 2 Overview of the MBTA Transit System[4]

[3] MBTA. "History of the T" n.d. < http://www.mbta.com/profile/glance/history/regional.cfm >. (25 February 2002).
[4] MBTA. "Subway Service". n.d. < http://www.mbta.com/schedmaps/subway/index.cfm >. (21 February 2002).

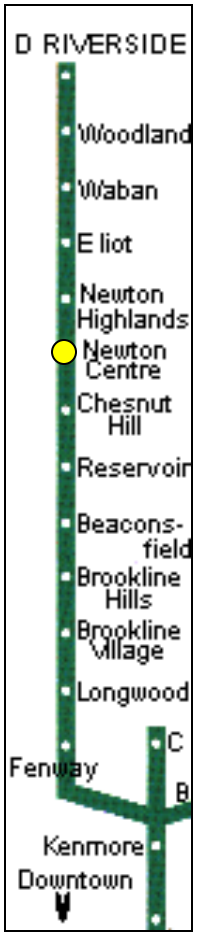

Figure 3 Diagram of the Riverside D Branch of the Green Line[5]

Newton lies along the green line of the MBTA transit system. The green line is its longest line at 25.3 miles. On an average day, the green line will serve 200,000 riders, which is 20% of the total subway usage.[6] The green line separates into four branches. Figure 3 is a diagram of the D branch of the green line, which passes through Newton. Highlighted in yellow is the Newton Centre stop, which is within the study area of this project. Newton Centre relies heavily upon this public transportation system. Everyday, approximately 1100 people board the Green Line from the Newton Centre stop.[7]

Of the MBTA riders who commute from Newton Centre to Boston, only 60 percent have access to a car.[8] Without the transit system, they would be unable to get to Boston easily. Seventy percent of the Newton Centre commuters walk to the station compared to only 12 percent that park and ride. Fifty percent of the Newton Centre commuters are able to walk to the transit stop in less than 5 minutes and 90 percent are within 15 minutes.[9]

According to 1990 Census figures, residents of Newton Centre have 1.81 automobiles per household. This is higher than the 1.64 average of Boston, but it is low for a suburb, where many people commute.[10] Despite the fact that many Newton Centre residents commute, there is a parking problem within the city. This situation forces Newton city planners to take a proactive stance on parking and traffic policy.

3.2.2.2 Nexus

One method that Newton attempted to use to reduce their high parking demand was the creation of an intra-city shuttle bus system called the "Nexus". The goal was to provide Newton residents with a safe and inexpensive alternative to private transportation. However, as of April 2003, the Nexus has been shut down due to a lack of use. The failure of the Nexus system is indicative of the problems faced by city managers in Newton. Despite their attempts to improve the parking situation, it is difficult to make the changes work. Although the Nexus was designed to fulfill a perceived need, city managers overestimated the

[5] MBTA "The Green Line/Train D". n.d. < http://www.mbta.com/schedmaps/subway/d-line.cfm >. (21 February 2002).
[6] MBTA "Ridership". n.d. < http://www.mbta.com/Profile/glance/ridership.cfm >. (25 February 2002).
[7] Terrain. "Unsprawl Case Study, Newton Centre". n.d. < http://www.terrain.org/Archives/Issue_2/Newton_Centre/newton_centre.html >. (21 February 2002).
[8] Terrain. "Unsprawl Case Study, Newton Centre". n.d. < http://www.terrain.org/Archives/Issue_2/Newton_Centre/newton_centre.html >. (21 February 2002).
[9] Terrain. "Unsprawl Case Study, Newton Centre". n.d. < http://www.terrain.org/Archives/Issue_2/Newton_Centre/newton_centre.html >. (21 February 2002).
[10] Terrain. "Unsprawl Case Study, Newton Centre". n.d. < http://www.terrain.org/Archives/Issue_2/Newton_Centre/newton_centre.html >. (21 February 2002).

demand for the service. Due to its low usage, the Nexus failed to address the parking concerns of Newton residents and city officials. The persistence of a parking problem in Newton and within the village of Newton Centre has led to the need for an in-depth review of parking policies and management.

3.3 Parking

Parking management has become one of the most important tools for city managers. Decisions on parking can affect many facets of city life, including traffic, population and the success of area businesses. In the city of Newton, traffic engineers for the Department of Public Works are responsible for studying parking and creating proposals for parking policies. These proposals are then brought to the traffic council for review. If the policy is approved by the council, it is brought to the board of Aldermen for final approval. Proposals that are approved by the board of Aldermen become official policies.

3.3.1 Parki ng Management

Over the past several decades, many municipalities in the Northeast are facing similar parking problems. Cities have grown up around villages that were planned for pedestrian or horse traffic and were not developed for the parking demands that automobiles have created. There is not enough open space in many cities to create more parking without sacrificing the quality of life that the residents expect. Finally, the high cost for construction of parking facilities has led to a more careful evaluation of parking management.

The goal of parking management is to maximize the utility of existing spaces through restrictions and fares. Good parking management allows adequate parking for residents, patrons and employees, while discouraging unwanted parkers. In order to achieve this parking balance, traffic engineers study the availability of parking and how it is being used. Based on these studies, a traffic engineer can propose the construction of additional spaces, the creation or modification of parking restrictions and fares or an increase in enforcement of restrictions or fares. These are the major methods that an engineer can use to improve the parking situation in their study area.

3.4 Case Studies

For this project, we examined three parking studies that were done in Eastern Massachusetts within the last 20 years. These studies offer insight into the methods that traffic engineers use to study and analyze parking. The studies in Natick and Needham, two suburbs similar to Newton, help to provide general ideas about parking studies, while the report on Newton Centre contains results and proposals that are directly applicable to our project.

3.4.1 Natick

The Natick Center parking study was performed by Vanasse/Hangen Associates in 1982.

The study was commissioned to provide parking proposals that would assist in the revitalization of the town commercial core. The first step of the study was to determine the parking supply in Natick Center. This was done through an inventory of the spaces within the study area. The next step was to determine the parking characteristics. This involved detailed parking surveys that helped to determine how the available spaces are being used. These surveys included a turnover study, which involved recording the state of every parking space on a regular basis. This allowed the engineers to determine how long people were staying in each space and how frequently the spaces were being used. The next step in the process was to determine the demand for parking spaces. This study was done using trip generation averages. The total number of trips generated in an area is the estimated parking demand. The final step in the study was to compare the parking supply to the parking demand to find the total parking need. Parking need was found by subtracting total parking supply from total parking demand. If the number is positive, that number is the parking deficit.

Out of this study, the following proposals were made for Natick Center:

- Construct additional parking lots
- Increase meter fees
- Create additional short-term spaces by restructuring the off-street lots
- Improve signage and access to parking facilities to increase their usage
- Increase enforcement
- Improve parking maintenance, to increase the desirability of off-street lots

3.4.2 Needham

The Needham Parking Feasibility Study was performed in 1987 by Vanasse Hangen Brustlin, Inc. This study was intended to help revitalize the Needham Downtown area through improved parking facilities. This study was performed by traffic engineers from the same consulting firm as the Natick parking study, so the methodology was extremely similar. The following proposals came out of the Needham Study:

- Construction of additional parking spaces
- Changes in parking management including changes to pricing policies and time regulations
- Increased enforcement

3.4.3 Ne wton Centre

In 1985, Mayor Theodore D. Mann initiated a study of future land use within the city, specifically within the village centers. This study was performed by the private consulting firm Connery Associates. Later, the firms of Segal/DiSarcina Associates and Paul C.K. Lu Associates were contracted to assist in the study. Although this study had a greater scope than parking, the development of improved parking management was one of the primary proposals resulting from the study.

The study was performed on both a citywide and village-by-village basis. The section of the report on the village of Newton Centre was completed in 1988. The report of the study does not detail the methods that were used but it contains the results as well as the proposals.

The parking section of the Newton Centre study states that there was a parking deficit of 579 spaces. The study determines that supply was only 67% of the demand, and that the demand for spaces was most severe east of Centre Street. The study decided that these parking problems were creating a spillover of commercial-oriented parkers into residential areas, as well as people who were meter feeding and double parking.

Based on these findings, the following proposals were made:

- Reconfigure Lyman Street as a single aisle, double loaded street with angled parking. This proposal would lead to an increase of 50 spaces.
- Develop a three-level parking facility at the Cypress Street Lot. The bottom and top floors of the facility would be for long-term parking, while the at grade portion would be used for two-hour parking. This would lead to an estimated increase of 100 spaces.
- Construct a two-level parking garage under the Langley Road/Beacon Street Lot. The garage would be used for long-term employee parking, and the at-grade portion could be reconfigured as a village green.
- Create parking prohibitions in the neighborhoods that would limit long-term parking. Two hour parking between 10 A.M. to 5 P.M. would help to limit commuter or employee parking.

In the 15 years that have passed since this report was submitted, most of these proposals have not been implemented. Neither of the proposed parking garages have been built, nor has Lyman Street been reconfigured. The only one of these recommendations that was applied was the parking restrictions in neighborhoods. Without the construction of additional parking facilities, Newton Centre is still faced with a parking problem. One possible solution to their problem is to increase the level of parking management within the city. This could be achieved through the power of GIS technology.

3.5 Geographic Information System Applications in Community Management

GIS software is the next step forward in sophistication for traffic engineers in developing a thorough and successful parking management program for communities. Benefits of a GIS include superior aesthetics, enhanced detailing, organized electronic data retention, improved analytic capabilities, and possible long-term savings from a clerically updatable system. Some drawbacks of a GIS consist of a large initial investment of time and money for proper set up, quality control and technical skills that are required for success.

3.5.1 Improved Analytic Capabilities

A GIS enables a user to view multiple pieces of information on a single screen. This provides a great amount of potential for engineers to analyze data on a more in-depth level than is otherwise possible. One of the many analytical benefits of a GIS is the ability to find trends from groups of data. Instead of comparing long columns of data from a database, a GIS can display these data as a map layer. Another benefit that the system presents as an analytical tool is the ability to move from single snapshot views of a problem area to a set of averages, peaks, and optimums taken over days, months, or years. This ability to store and evaluate data over both the short-term and the long-term is extremely important in many aspects of city management. GIS technology is also able to work on different scales easily. City managers can look at individual spaces on a single street as easily as they can look at all the parking spaces in a village or the entire city. Once the GIS has been set up to look at parking problems, it can look at any scale as easily.

All of these benefits are useful for parking studies, and would have aided in previous studies. These benefits speed up the analytical process and allow engineers to look at the problem more closely. These are some of the aspects of GIS that make it a useful tool for city managers.

3.5.2 Data Storage and Maintenance

Another distinct advantage of a GIS is to provide a single repository for all data about an area, one that can be visually displayed and kept in organized tabular form. Once the initial venture to produce a working GIS system for the city of Newton is made, GIS can be used for future analysis instead of further outside consulting. Another advantage of software use is that after the initial data collection, maintaining the system becomes largely clerical instead of laborious.

The city of Newton is an ideal location for a demonstration of the applicability of GIS to parking management. Newton has already developed its own award-winning GIS system that currently displays, among many other things, the physical structure of the city from natural entities such as green space and bodies of water, to its block and street infrastructure, including zoning, property lines, buildings, and curbs. The physical layout of Newton is also an advantage because it is possible to add villages to the system singularly, which potentially lessens any problems caused by the large initial efforts a GIS-based management system could impose. With this infrastructure in place, it is a much smaller task to develop the GIS tools to aid in parking management. However, because of the potential drawbacks of GIS, it is necessary to demonstrate its utility in parking management.

4 Methodology

This study focuses on the effects of traffic in Newton Centre and intends to assist the Newton Traffic Engineering Division in developing a parking management methodology that will improve the quality of life for city residents. Our project proposes to use GIS to assist long-term solution of perceived traffic problems in the village center. The goal of this methodology is to perform a parking study that will demonstrate the utility of GIS. By completing this study, and comparing it to traditional studies, we can make conclusions about the benefits of GIS.

In order to accomplish this goal there are three types of data that were collected:

- Parking Supply
- Parking Characteristics
- Business Type Data

The sections that follow describe the process used to gather this data. Sections 3.1, 3.2 and 3.3 identify necessary terms, and specify the parameters of the study and the dates during which we conducted our research. Sections 4.4-4.6 outline the steps to collect data for parking supply, parking characteristics and business type data, respectively. Section 4.7 describes the methods we used to create possible policy proposals. Refer to Figure 4 for the schedule for this project.

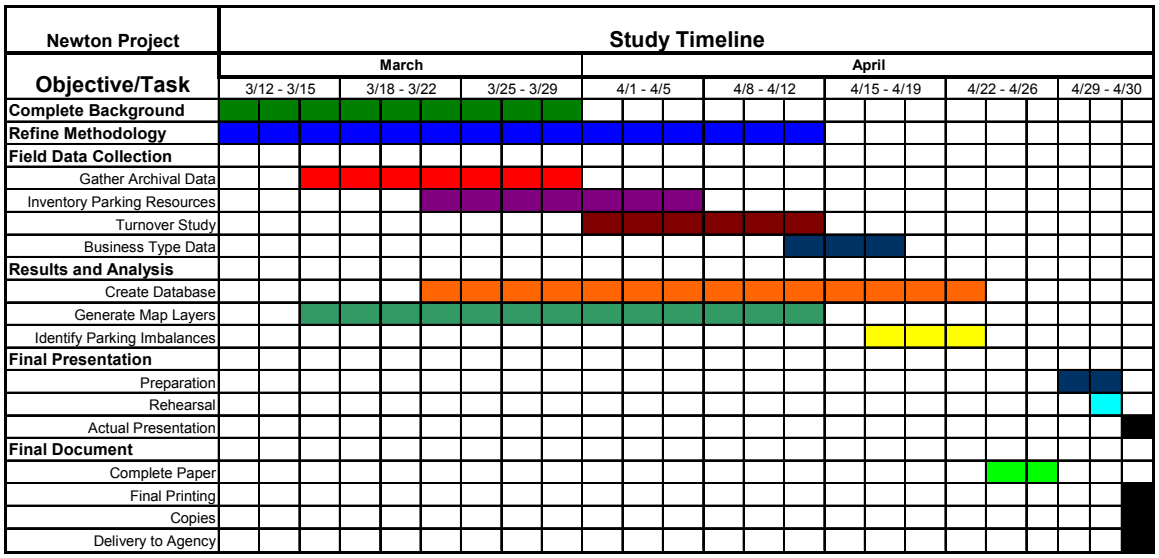

Figure 4 Project Schedule

4.1 Domain of Inquiry and Definitions

This project is primarily concerned with the parking situation in Newton Centre. This project studies on- and off-street parking and focuses on publicly owned lots. The following are definitions of terms used in this report:

- *Parking*: The standing of a vehicle, whether occupied or not, otherwise than temporarily for the purpose of a while actually engaged in loading or unloading, or in obedience to an officer or traffic signs or signals, or while making emergency repairs or, if disabled, while arrangements are being made to move such vehicle.
- *Public Parking:* Any parking available for general parking use.
- *Restricted Parking:* Any parking not available for general public use.
- *On-Street Parking:* Any parking on city streets. On street parking is generally public parking.
- *Off-Street Parking:* Any parking that is not on city streets. Parking lots and driveways are both examples of off street parking.
- *Short-term Parking:* Any parking that is less than three hours.
- *Long-term Parking:* Any parking that is greater than three hours.

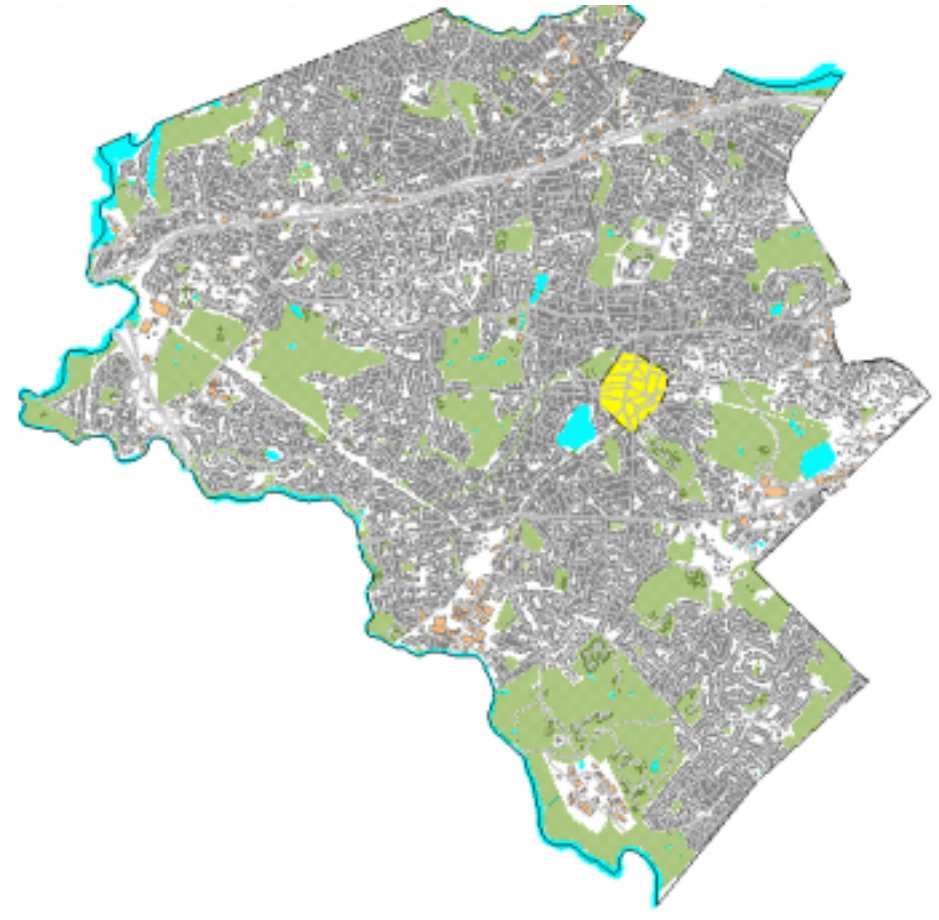

Figure 5 Project Study Area

4.2 Study Area

This project covers the central core of the village of Newton Centre as shown (in yellow) in Figure 5. This area includes many of the retail properties in Newton Centre, and contains public and residential zones. This area was defined by the sponsor and it was chosen because it represents residential areas that are being affected by non-residents parking and disturbing the residents.

4.3 Project Time Scope

This study was conducted between March 12, 2002 and April 30, 2002. The parking demand in Newton Centre has been shown to reach peak use at the lunchtime hour of noon. This time of peak use was prioritized for data collection.

4.4 Determination of Parking Supply

The first step of the project was to complete an inventory of all parking spaces within the Newton Centre study area. This inventory contains information about the spaces including restrictions, cost and time of enforcement. For this study, we used the geographic information system software MapInfo to display the results of our count.

4.4.1 Create GIS Map Layer of Parking Spaces

In order to inventory the parking spaces, we had to have a precise understanding of the location of all relevant parking spaces. Therefore, the first step for this section was to create a GIS map layer that outlined the location of all the parking spaces within the study area. Using recent orthographic photos of the study area, we identified all of the marked spaces. A layer was drawn that outlines each individual parking space. Each space was given a unique identification, as described in Appendix F. Using this identification, a database was created which stores all of the pertinent data about the parking space.

4.4.2 Create Forms and Gather Parking Space Data

Once each space has been uniquely identified in MapInfo with a database created to store the data about the parking spaces, the next step is to go into the field and gather the data. To facilitate this step, the parking spaces layer created in section 4.4.1 were brought into the field, creating a link between the physical parking spaces and their corresponding database location.

The next step was to generate forms that aid in data collection. For each parking space, we created a form to record all of the information that will be in the database. These forms are linked to the parking spaces through the space identification. Please refer to Appendix D for an example of the data collection forms we used for this section.

4.4.3 Populate Database with Supply Data

The final step in this section was to enter the collected data into the database. Starting with the first parking space, we matched up the forms to their corresponding database location. In order to facilitate this step, a coding scheme was created, which is the result of a compound key. For a description of this coding scheme, please refer to Appendix F.

4.5 Determination of Parking Characteristics

The next step, after the determination of the parking supply, was to determine how that parking supply is being used. These types of data are known as the parking characteristics, and are found by performing a turnover study. In order to perform this study within the period of the project, we selected a smaller characteristic study area that would be indicative of the problems faced by Newton Centre. We opted to study the Cypress Street parking lot (off-street) and Herrick Street, Braeland Avenue and Chase Street (on street) on Thursday, April 4, 2002 and the Cypress Street lot, Herrick Street, Braeland Avenue and Union Street on Saturday, April 6, 2002. This area was chosen because it represented a mixture of parking types and contained the mix of residential and commercial zoning that we needed to study. Most importantly, it contains the subway station, and surrounding areas. Once we performed this study, the data was entered into the database.

4.5.1 Perform Turnover Study

The standard method for determining parking characteristics is by performing a turnover study. The desired study area was divided into several sections, which can be walked in 30-minute intervals. GIS maps of these smaller sub-sections were brought into the field. On 4/4/2002, we performed a 12-hour turnover study. Beginning at 7 AM, and repeated in 30-minute intervals until 7 PM, the license plate of each car in the sub-section was recorded into a table. The index numbers for each parking space correspond to a space on

the GIS map layers. Similarly, on 4/6/2002 we performed a 4-hour turnover study. Please refer to Appendix D for an example of the data collection form we used for this section.

4.6 Collection of Business Type Data

In order to estimate the demand for parking in Newton Centre, we collected information about the business types along Herrick Road and Union Street. This data can be obtained by unobtrusive observation. The business type can be divided into services, stores or restaurants. This data, along with the hours of operation and approximate number of employees per shift, provide the basis for an estimate of the parking demand. Please refer to Appendix D for an example of the data collection sheet that was used to gather the parking demand data.

4.7 Creation of Possible Parking Solutions

The final step is to propose ways to improve the parking situation in Newton. This is the major goal of the project and the two objectives of this section are described in Chapter 5 and Chapter 6 respectively.

4.7.1 Analy ze Data

The next step is to gather and analyze all the data. MapInfo was used extensively for this analysis, because it is capable of demonstrating trends in a visual manner. The major goal of the analysis chapter (Chapter 6) is to demonstrate current parking need as an example of the analysis that is possible using GIS. Parking need can be understood as the difference between parking supply and parking demand. While it is difficult to directly compare parking demand to parking supply using our methodology, it is possible to examine qualitatively a relationship between parking problem areas and the demand on the system. Through the use of GIS, our analysis demonstrates this relationship.

4.7.2 Propose Possible Solutions

The ultimate goal of this project is to be able to create several possible solutions that could help to alleviate or eliminate the parking problem in Newton Centre, while providing the city direction on the application of GIS technology for parking management. Therefore, the final step in the project is to propose solutions that are based on the data that we have collected and analyzed during the project. The use of GIS gives us the ability to demonstrate visually the effects of different proposals, therefore making it easier to compare their effectiveness. Chapter 7 is a discussion of the possible solutions that we suggested.

5 Result s

This section contains the results of the project. These results were obtained by following the methodology described in Chapter 4 and are the basis for the analysis described in Chapter 6. All of the maps created in this chapter were made with a GIS (MapInfo), and are a demonstration of the abilities of GIS. All maps and figures that are displayed in this chapter are reproduced at full size in Appendix E.

5.1 Parking Supply

Newton Centre has a parking supply of 1065 parking spaces. The breakdown of these spaces is shown in Table 1. Of these 1065 parking spaces, 530 are off-street parking spaces and 535 are on street.

SUMMARY OF PARKING SUPPLY								
		Type (Hours)						
	Category/Location	*0.5*	*1*	*2*	*3*	*12*	*Undesignated*	*Totals*
Off-Street								
	Public (Totals)	**0**	**0**	**155**	**128**	**95**	**0**	**378**
	Cypress				19	38		57
	Langley			155				155
	Pelham				68	21		89
	Pleasant				41	36		77
	Private (Totals)	**132**	**0**	**0**	**0**	**0**	**20**	**152**
	Private	74						74
	Walgreens	58						58
	Cypress						20	20
On-Street								
	Metered (Totals)	**0**	**236**	**10**	**0**	**0**	**0**	**246**
	BEACON		49					49
	BRAELAND		6					6
	CENTRE		37					37
	HERRICK		25					25
	LANGLEY		50					50
	PELHAM		4					4
	PLEASANT		5					5
	SUMNER		25					25
	UNION		35	10				45
	By Sign Designation (Totals)	**0**	**28**	**111**	**0**	**0**	**111**	**250**
	BOWEN						44	44
	BRAELAND						23	23
	CENTRE GREEN		9					9
	CHASE			28				28
	EVERETT			31				31
	GIBBS			19				19
	LYMAN		19					19
	PLEASANT			23				23
	SUMNER			10				10
	TYLER						35	35
	WILLOW						9	9
	Restricted (Totals)	**0**	**0**	**0**	**0**	**0**	**39**	**39**
	CRESCENT						12	12
	PELHAM						27	27
Combined	All Above	132	264	276	128	95	170	1065

Table 1 Parking Supply Data

5.1.1 Off-Street Parking

There are four public off-street facilities in the Newton Centre study area, and several private off-street parking lots. In order of size, the four public facilities are the Langley Road lot (155 spaces), the Pelham Street lot (89 spaces), the Pleasant Street lot (77 spaces) and the Cypress Street lot (57 spaces). These four lots contain 378 spaces, which is 35% of the total parking in the Newton Centre study area. In addition to these lots, there are also three major off-street private lots that were included in this study. These private lots contain 152 parking spaces, which is 14% of the parking supply within the study area.

The four public lots are metered lots, with a parking rate of $.25/hour. As shown in Figure 6 the majority of the off-street parking is designated for short-term parking.

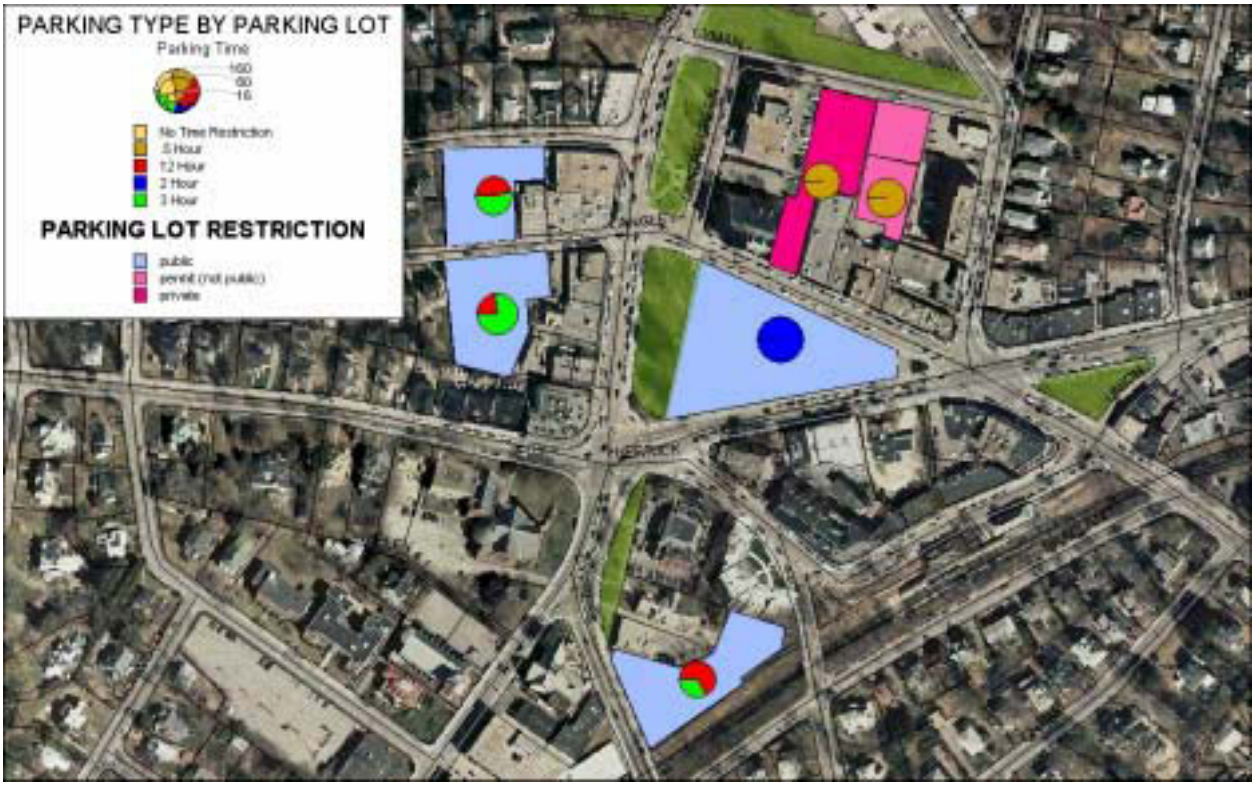

Figure 6 Map of Parking Type by Parking Lot

5.1.2 On-Str eet Parking

There are approximately 535 on-street parking spaces in the study area. There are 246 metered parking spaces, approximately 250 sign-designated spaces and 39 restricted parking spaces. As shown in Figure 7, the metered spaces are in the village core. The majority of these on-street spaces cost $.50/hour.

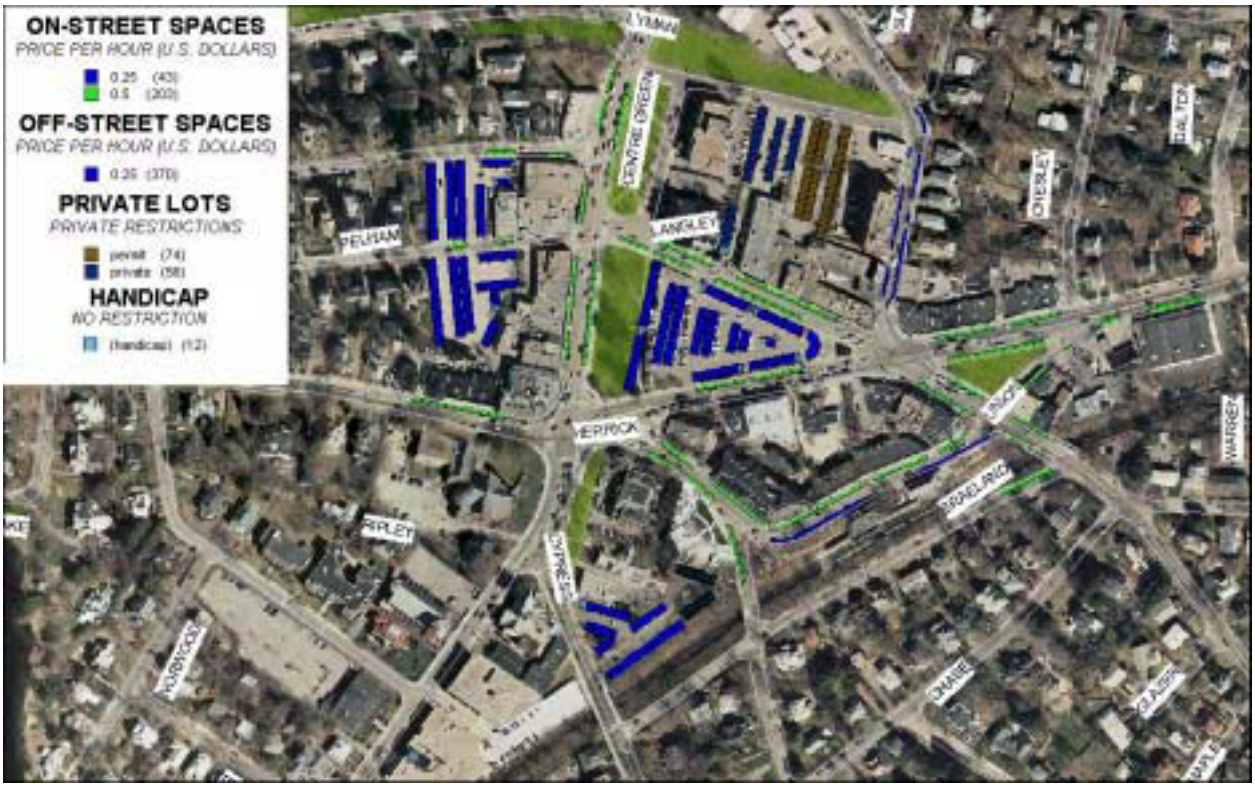

Figure 7 Map of Parking Costs

5.2 Parking Characteristics

Turnover studies were performed on Thursday, April 4, 2002 and Saturday, April 6, 2002 to determine how parking is used within Newton Centre. Some of the characteristics that we studied include rates like daily percent use of the spaces, average parking duration, number of violations per hour, compliance, and average turnover, in addition to specific study information such as number of spaces and cars counted in the study period. Figure 8 is a map of the spaces that were studied and cataloged in the inventory supply data. On Thursday, 129 spaces were studied, which is approximately 12% of the spaces in the Newton Centre study area. On Saturday, 137 spaces were studied, accounting for 13% of the total parking supply.

SUMMARY OF PARKING CHARACTERISTICS 4/4/2002												
TIME BLOCK	NUMBER OF SPACES	AVG DURATION BY SPOT	AVG NUM PARKING BETWEEN 2 AND 4 HOURS	AVG NUM PARKING <1 HOUR	AVG NUM PARKING >4 HOUR	AVG PERCENT USE OF SPOT	NUM OF DAILY SPACES	NUM OF OVERTIME USERS	AVG TURN OVER BY SPOT	NUMBER OF CARS	NUMBER OF VIOLATIONS	COMPLIANCE
BRAELAND STREET METERED NORTH FACE 1H-PARKING	6	0.59	8	3.17		40%	150	9	3.67	28	12	82%
BRAELAND STREET NON-METERED NORTH FACE 12H-PARKING	23	3.79		1.47	1.00	73%	576		1.39	55	7	98%
CYPRESS LOT METERED 12H-PARKING	38	5.68		1.50	1.03	93%	950	2	1.50	95	47	95%
CYPRESS LOT HANDICAP	2	2.02		1.50	1.00	40%	50		1.00	4	0	100%
CYPRESS LOT METERED 3H-PARKING	19	1.68		2.17	1.00	73%	475	16	3.89	93	34	91%
HERRICK STREET METERED WEST FACE 1H-PARKING	14	0.55		7.07		79%	364	39	8.86	138	51	82%
CHASE STREET NON METERED NORTH FACE 2H-PARKING	27	1.19	6	1.47	1.00	29%	675	11	1.04	51	4	97%
TOTAL	129	2.21	7.08	2.62	1.01	61%	3240	77	3.05	464	155	92%

Table 2 Parking Characteristics for 4/4/2002

SUMMARY OF PARKING CHARACTERISTICS 4/6/2002												
TIME BLOCK	NUMBER OF SPACES	AVG DURATION BY SPOT	AVG NUM PARKING BETWEEN 2 AND 4	AVG NUM PARKING <1 HOUR	AVG NUM PARKING >4 HOUR	AVG PERCENT USE OF SPOT	NUM OF DAILY SPACES	NUM OF OVERTIME USERS	AVG TURN OVER BY SPOT	NUMBER OF CARS	NUMBER OF VIOLATIONS	COMPLIANCE
BRAELAND STREET METERED NORTH FACE 1H-PARKING	6	1.16	6.33	2.80	1.00	85%	54	5	2.17	19	13	75%
BRAELAND STREET NON METERED NORTH FACE 12H-PARKING	26	2.52	7.50	1.30	1.00	93%	234		0.65	43	18	92%
UNION STREET METERED SOUTH FACE 1H-PARKING	10	1.31	8.00	2.38	1.00	99%	90	13	2.20	32	9	90%
CYPRESS LOT METERED 12H-PARKING	38	2.56	7.55	1.62	1.00	94%	342		0.74	66	13	96%
CYPRESS LOT HANDICAP	2	0.02		2.00		22%	18		1.00	2	0	100%
CYPRESS LOT METERED 3H-PARKING	19	0.87	7.38	2.11		88%	171	1	2.16	60	1	99%
HERRICK STREET METERED WEST FACE 1H-PARKING	14	0.69	8.00	2.69		104%	134	23	3.14	58	0	100%
HERRICK STREET METERED EAST FACE 1H-PARKING	11	0.86	8.00	4.22	1.00	99%	99	11	3.45	49	5	95%
UNION STREET METERED SOUTH FACE 1H-PARKING	11	1.78		2.63	1.00	100%	99	11	1.91	32	7	93%
TOTAL	137	1.31	7.54	2.42	1.00	87%	1241	64	1.94	361	66	93%

Table 3 Parking Characteristics for 4/6/2002

Figure 8 Map of Parking Characteristics Study Area

Table 2 is a summary of the turnover study that was performed on Thursday 4/4/2002, and Table 3 is a summary of the study for Saturday 4/6/2002. The following paragraphs highlight certain important aspects of this table.

5.2.1 Daily Utilization

The daily utilization measures what percentage of the time parking spaces are in use. On 4/4/2002, 464 cars parked in the study area. Overall, the daily space usage was 61%, which means that over half of the time we spent in the field, the spaces studied were being used. This percentage is especially affected by the Braeland Avenue meter spaces (40% usage) and Chase Street (28% usage) which bring the daily usage down significantly. The Cypress Street parking lot is highly used, with a daily utilization of approximately 86%. Figure 9 shows the daily utilization per space for Thursday.

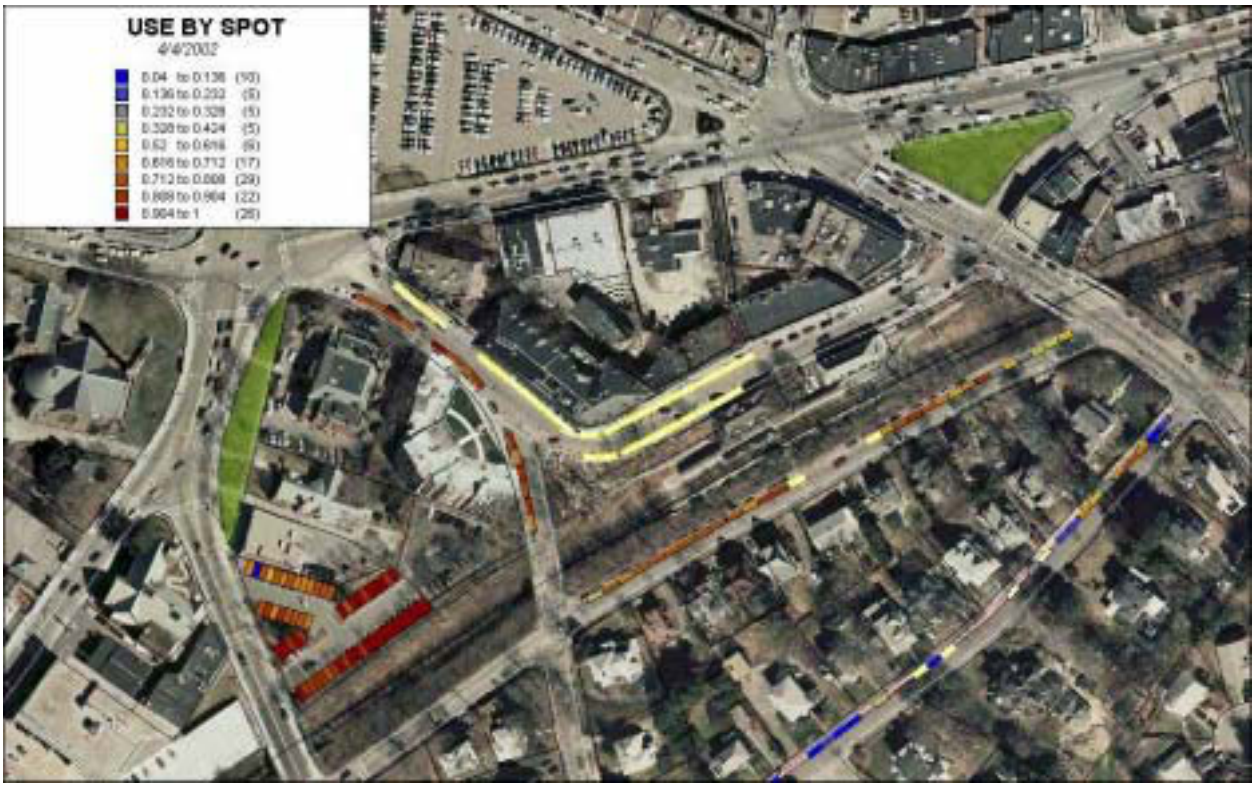

Figure 9 Percent Time Use by Space for 4/4/2002

The overall utilization for Saturday was 87%. The utilization of the Cypress Street lot was 91%. It is important to note that the Saturday study was conducted during peak hours, so the daily utilization should be higher. Figure 10 is the daily utilization map by space for Saturday.

Figure 10 Percent Time Use by Space for 4/6/2002

5.2.2 Average Duration

"Average duration" is an average of the length of time that cars are staying in the parking spaces. This statistic is important because it helps to determine if parking spaces are being used for short-term or long-term parking. During the 4/4/2002 study period, the total average duration was approximately 2.21 hours. Figure 11 shows the average duration by space for Thursday. The Cypress Street lot long-term spaces had an average duration of 5.7 hours and the Braeland Avenue non-metered spaces had an average duration of 3.8 hours. The Herrick Street metered spaces and the Braeland Avenue metered spaces both had an average duration under one hour.

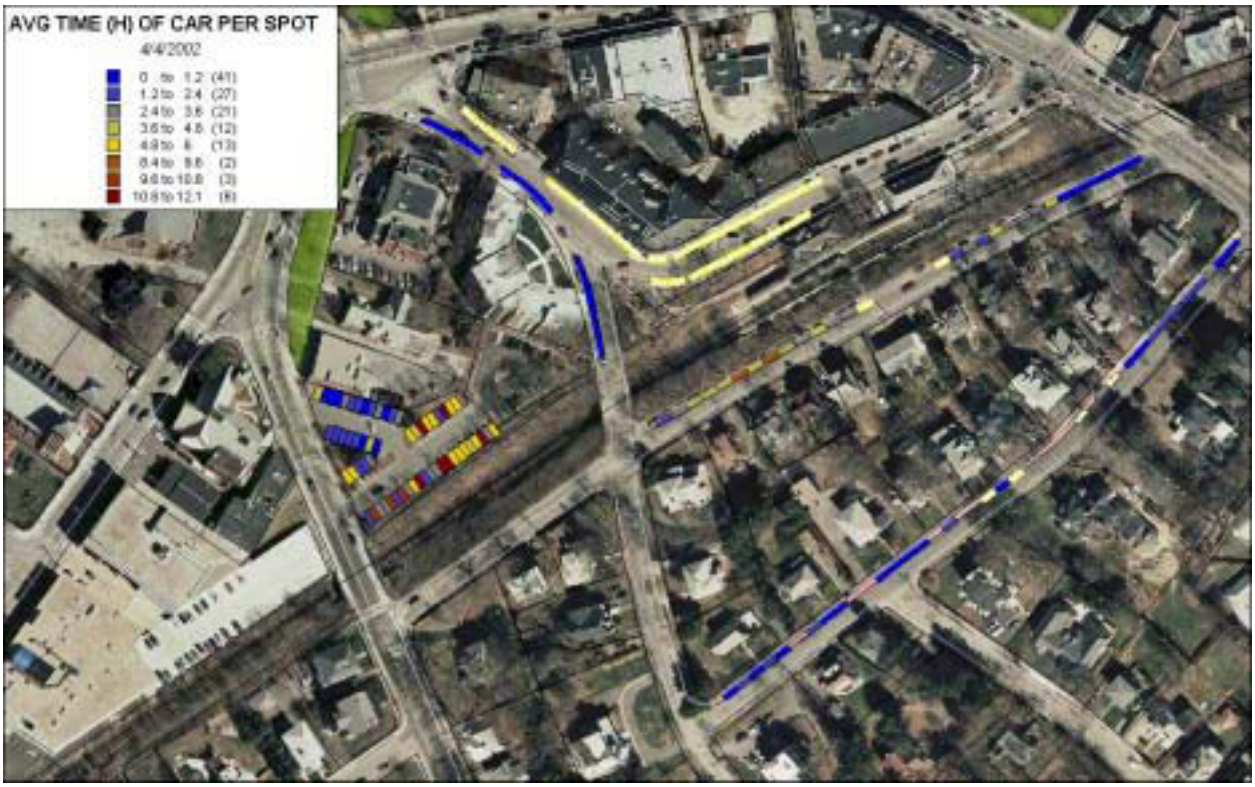

Figure 11 Average Duration for 4/4/2002

The average duration for 4/6/2002 was 1.3 hours. It is important to note that the 4/6/2002 data cannot be directly compared to the 4/4/2002 data because the study period was significantly shorter. Figure 12 is the average duration by parking space for Saturday. The average duration for the Cypress Street long-term spaces was 2.6 hours, and the average duration for the Braeland Avenue non-metered spaces was 2.5 hours. Two points of particular interest are the Union Street spaces and the Braeland Avenue metered spaces, both of which have an average duration of greater than one hour. Both of these areas are 1-hour maximum parking, so an average duration greater than an hour would indicate that people are parking illegally there.

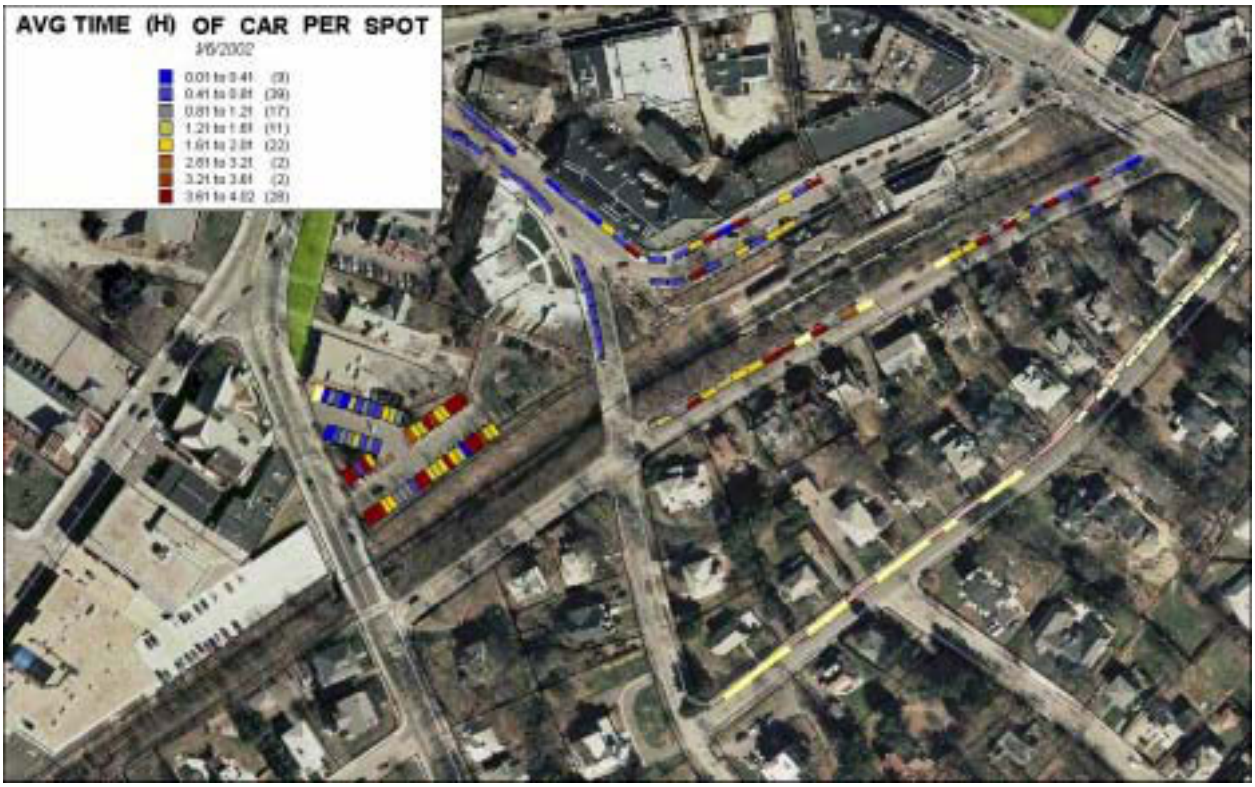

Figure 12 Average Duration for 4/6/2002

5.2.3 Compliance with Parking Regulations

The turnover study provides insight about the level of compliance with city parking regulations. Compliance is a measure of what percentage of the people parking are doing so illegally. Another problem, related to compliance, is people parking for longer than intended in short-term spaces. By putting more money into the meters, or meter feeding, they appear to be parked legally.

On 4/4/2002, most cars parked in metered spaces appear to be there legally. The total compliance was 91%, although both Herrick Street and the Braeland Street metered spaces were only 82% in compliance. Figure 13 shows the total number of parking meter violators for each space on 4/4/2002. Additionally, Figure 14 shows the number of cars that are staying in a space longer than intended. Both of these figures show that there is a problem with people misusing parking spaces within the Newton Centre study area. Section 6.2.2 focuses on the problem of meter feeding in Newton Centre.

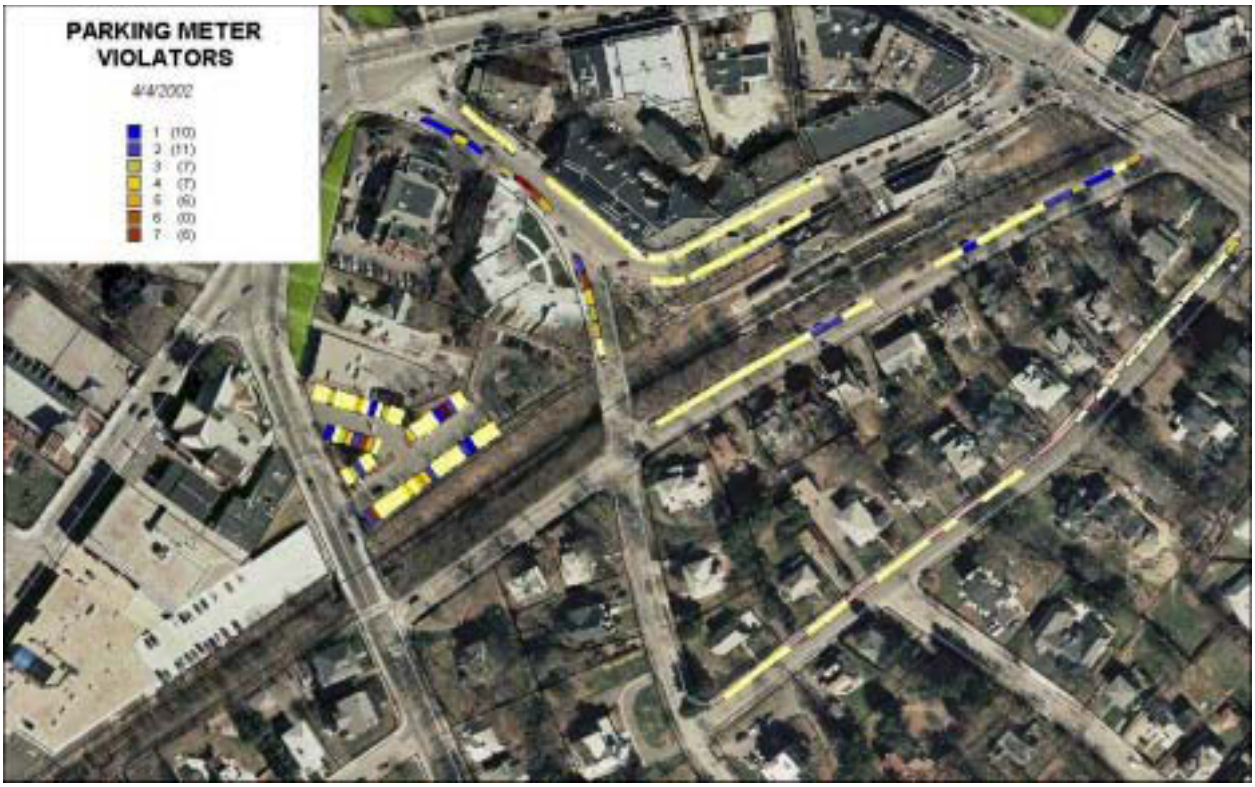

Figure 13 Number of Parking Meter Violators by Space

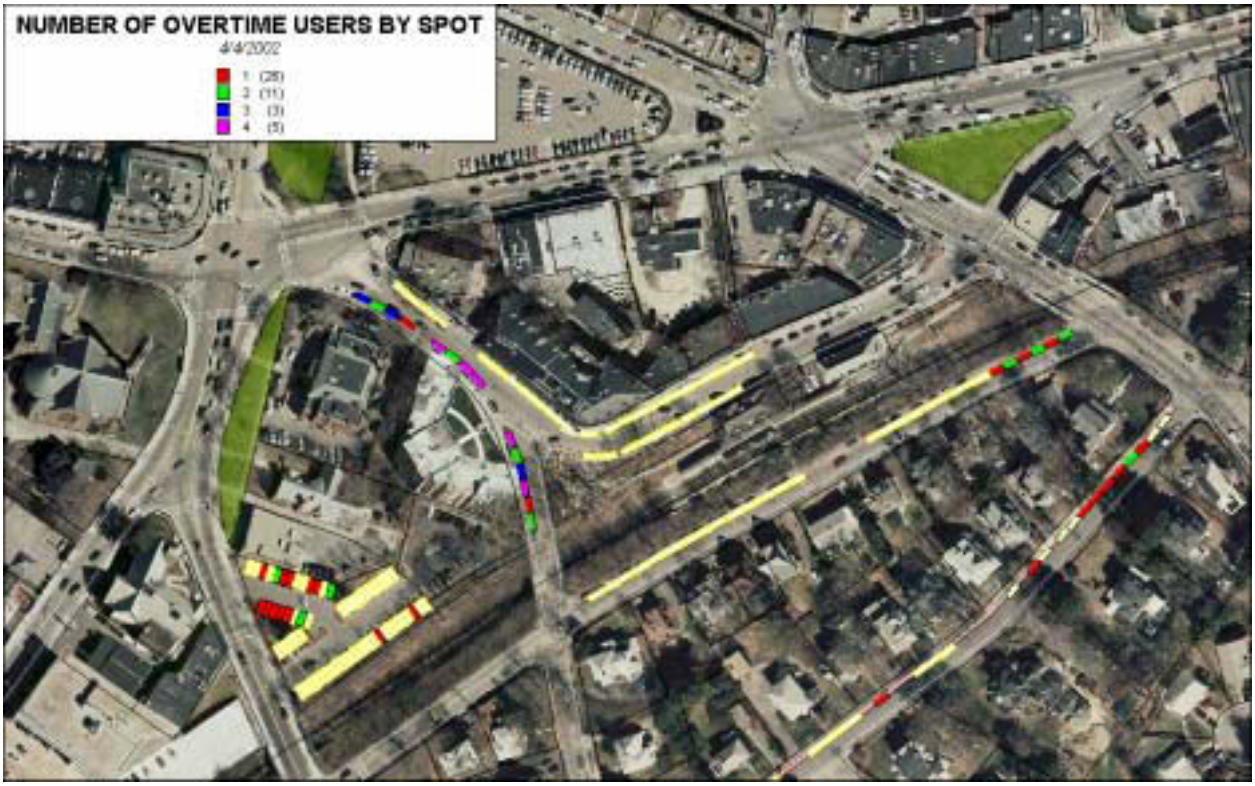

Figure 14 Number of Over Time Users by Space

5.3 Parking Demand

The Herrick/Union/Langley block, which was the focus of the demand study, contains approximately 110 different businesses. Of these businesses, the average opening time is 9:30 AM and the average closing time is 6:00 PM. These businesses employ approximately 245 employees per shift. Please refer to Table 4 for more information about the business type data.

Business Type Averages				
Business Type	**Number of Businesses**	**Average Opening Time**	**Average Closing Time**	**Average Number of Employees**
Restaurant	8	8:00 AM	9:00 PM	3
Services	73	9:30 AM	5:30 PM	2
Sales	24	9:30 AM	5:30 PM	2
Total	105	9:30 AM	6:00 PM	2

Table 4 Business Type Data

6 Analysis

The goal of this analysis is to evaluate the parking situation in Newton Centre, and to demonstrate the level of analysis that can be done using GIS technology. Among the residents and business owners, there is a perceived parking problem, specifically a deficiency in parking spaces and the resulting "spill over" of non-residential parking into residential areas. In order to study these claims, we evaluated the parking deficiency, and then studied areas within the village where there were other types of parking problems. In this chapter, we will demonstrate that there is not an overall parking deficiency but there are problem areas within the village that could benefit from changes in parking management. In order to complete this study within the allotted time, we focused our study on the southern end of Newton Centre, including Chase St., Braeland Ave., Herrick Rd., Union St. and the Cypress St. lot. Although a study that focuses on such a limited area is unable to make conclusive proposals for the entire village, the area's problems are still indicative of the problems that face the village core. Therefore, any problems found in this study area are still relevant in an evaluation of the entire city.

6.1 Parking Deficiency in Newton Centre

In order to evaluate the parking deficiency in Newton Centre, we examined the parking characteristics, specifically the "percent full" data. These data measure the level of utilization of the parking areas. Figure 15 is a graph of the percent full of different parking lots as a function of time for 4/4/2002. The point of particular interest on this graph is that most of the lots are only full during the hours between 11:30 AM – 2:30 PM. These three hours, which cover the lunch hours for local clientele and employees, are a problem period for an area like Newton Centre because of its many restaurants and shops. By contrast, it is easy to find parking spaces within the study area at other times during the day.

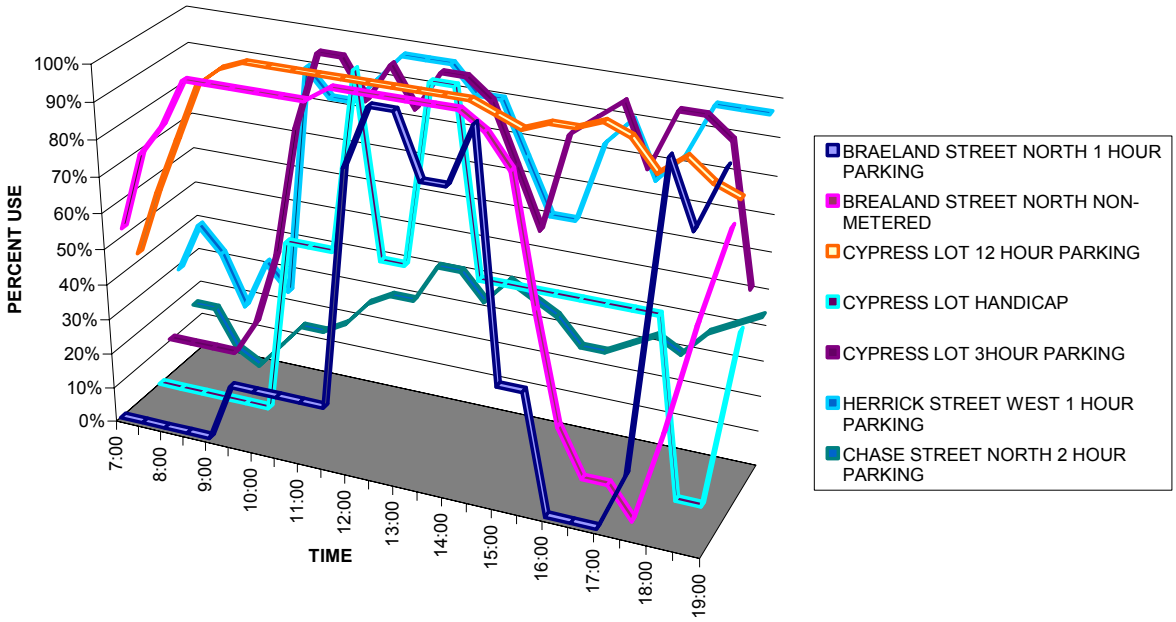

Figure 15 Peak Demand by Hour for 4/4/2002

The turnover study for 4/6/2002 reveals that there is a parking problem during the hours between 11:00 AM – 2:00 PM on Saturdays. Figure 16 is a graph of the peak demand by hour for 4/6/2002. The lack of parking during this three-hour parking period is most likely contributing to the public perception that there is a parking problem within Newton Centre. However, the fact that the problem occurs during a short time does not make clear that there is a parking problem overall in Newton Centre. At peak times, there is definitely a deficiency of parking spaces, but for the majority of the time there is an abundance of available parking spaces. Therefore, it is likely that a combination of the parking deficiency at peak times with other smaller parking problems is leading to the perception that Newton Centre has a severe parking problem.

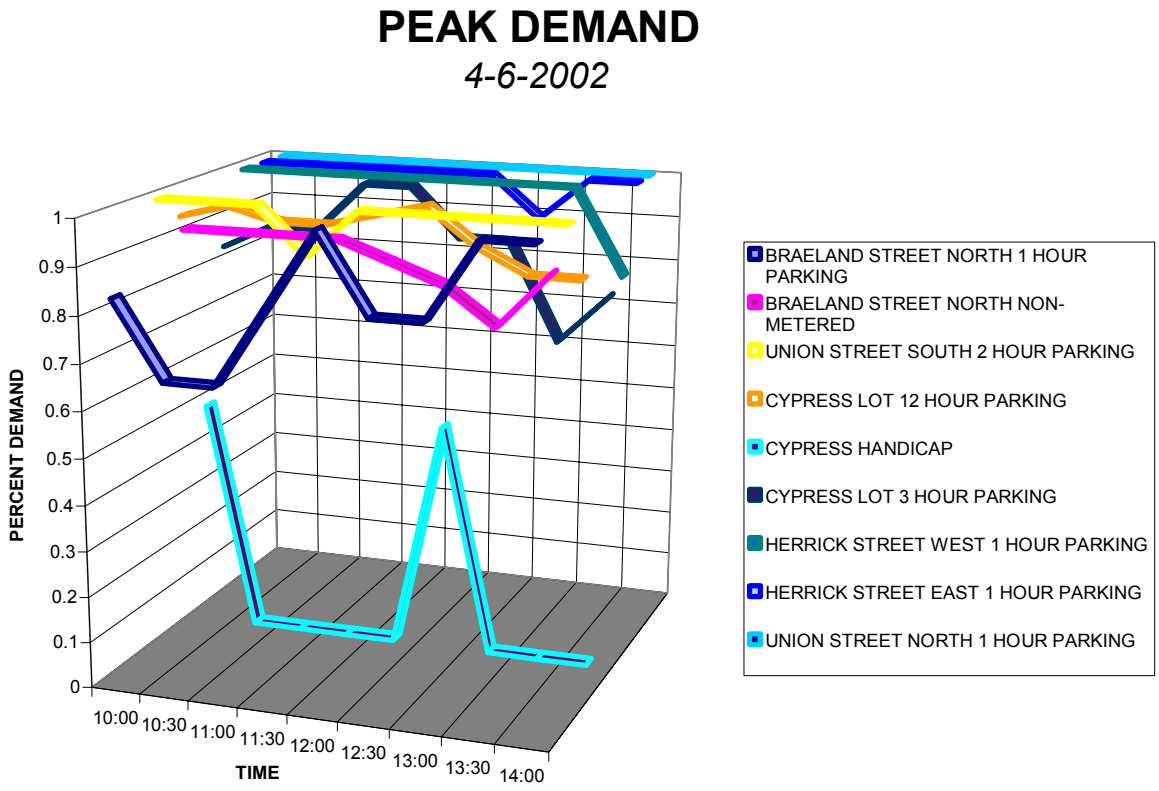

Figure 16 Peak Demand by Hour for 4/6/2002

6.2 Misuse of Parking Spaces

One of the most difficult problems to overcome in parking management is the misuse of parking spaces, either deliberate or unintentional. Misuse of a parking space would include staying in a space longer than intended, by "meter feeding" or parking short-term in a long-term space. These actions can be difficult to regulate, because it is hard to force people to use the spaces correctly. However, misuse of parking spaces is also one of the problems that can cause the most trouble for city managers. Through misuse of designated spaces, parkers can exacerbate a small parking problem, or even create the perception of a parking problem that does not exist. Since this misuse can have such a large impact upon the parking situation in a municipality, it is important to identify areas where these kinds of problems are occurring. The two types of misuse that were the most prevalent within the study area were misuse of long-term spaces and meter feeding.

6.2.1 Misuse of Long-Term Space

The availability of easily accessible long-term parking spaces is extremely important to the viability of a business district. Employees that drive to work must have a place to park their vehicle without the threat of a

ticket or towing. Providing long-term parking can be made the responsibility of the employer, but only if adequate space exists to provide parking areas. This is usually not the case in a village-center style business district, and is definitely not the case for the majority of Newton Centre. Therefore, the long-term parking must come in the form of public lots. The village of Newton Centre offers three lots with long-term parking (12 hour), for a total of 95 spaces. The Cypress St. lot offers the most long-term spaces, with 38. In addition, the Cypress St. lot offers 18 short-term (3-hour) spaces.

In a mixed-use lot like this, one of the most problematic issues arises when people who need a short-term space park in long-term spaces. This is an issue because there are such a limited number of long-term spaces within the village center. The only time that it would seem reasonable for a person who intends to stay for less than three hours to park in long-term parking, is if there was no available short-term parking. While this is possible, it is unlikely during most of the day.

In order to evaluate if people are misusing long-term spaces, we evaluated how frequently people park in long-term spaces for less than three hours when there was short-term parking available to them. During our 4/4/2002 study, we found 14 occurrences in the Cypress St. lot alone. This means that 14 people chose to use long-term spaces to park for less than three hours, when short-term parking was available to them. There seem to be several reasons that this could occur. It could be that the long-term spaces were not clearly designated, and that people were unintentionally misusing the spaces. A second possible reason could be that people who parked in the long-term spaces intended to use them for a longer time, but their length of stay ended up being shorter.

Although misuse of long-term spaces is always a problem, this misuse is the most detrimental to the parking system when it occurs during the early morning hours (7 AM – 10 AM). This is a problem because these are the peak hours for employees and commuters to park for the day. If someone is parked in one of these spaces for the short-term, it prevents someone from parking there for the day. Figure 17 is a graph of the time during which people were misusing the long-term spaces. Of the 14 occurrences, seven of them (50%) occurred by 10 AM. Due to the importance of properly used long-term parking spaces, this misuse is a serious problem for Newton Centre's parking balance.

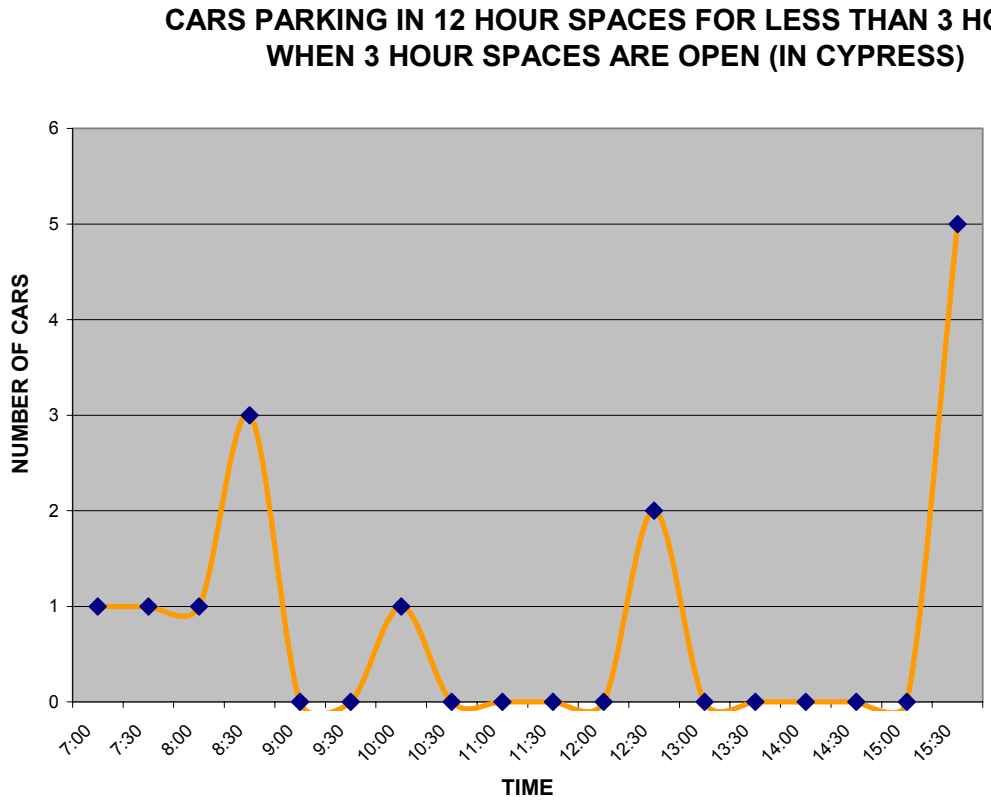

Figure 17 Misuse of Cypress Long-Term Parking Spaces 4/4/2002

6.2.2 Meter Feeding

The act of meter feeding, where people make additional trips to the meter to pay for more time, is a problematic issue to address because many people do not understand that it is a misuse of the parking space. For many people, the perception is that meters exist for the sole purpose of generating revenue. While making money is definitely a primary result of metered spaces, they are also one way in which traffic engineers can exert influence over the parking patterns in an area. By making people pay to park, meters can force people to evaluate the importance of their trip and possibly seek alternative methods of transportation. By increasing the costs of meters in the busiest areas, traffic engineers can also encourage people to park in more outlying off-street areas.

City planners within Newton have used meters extensively in Newton Centre to help regulate parking in the area. The majority of on-street parking within the village core is 1-hour to prohibit long-term parking on the streets, and the rate at $.50/hour is intended to force people into the four off-street lots, which are less expensive. Since parking regulation is such an important part of metering, it becomes a problem when people feed the meters in order to stay in a space longer than intended. Although the city generates the same amount of revenue from the meter either way, the act of meter feeding means that the parking is not being

used the way the city intended. In order to find the number of people who were meter feeding, we compared the number of people who were in a parking space longer than it was designated, but who were not in violation. Figure 18 is a map of the metered spaces in our turnover study area, colored by the number of meter feedings that occurred on 4/4/2002. On this day, there was a significant problem with meter feeding, especially on Herrick Street. The 35 occurrences we recorded during a 12-hour study period suggest that almost three people per hour are feeding the meters to stay additional time on this street. It is important to note, however, that the majority of the people who are meter feeding do not usually stay longer than one additional hour beyond the original allowance.

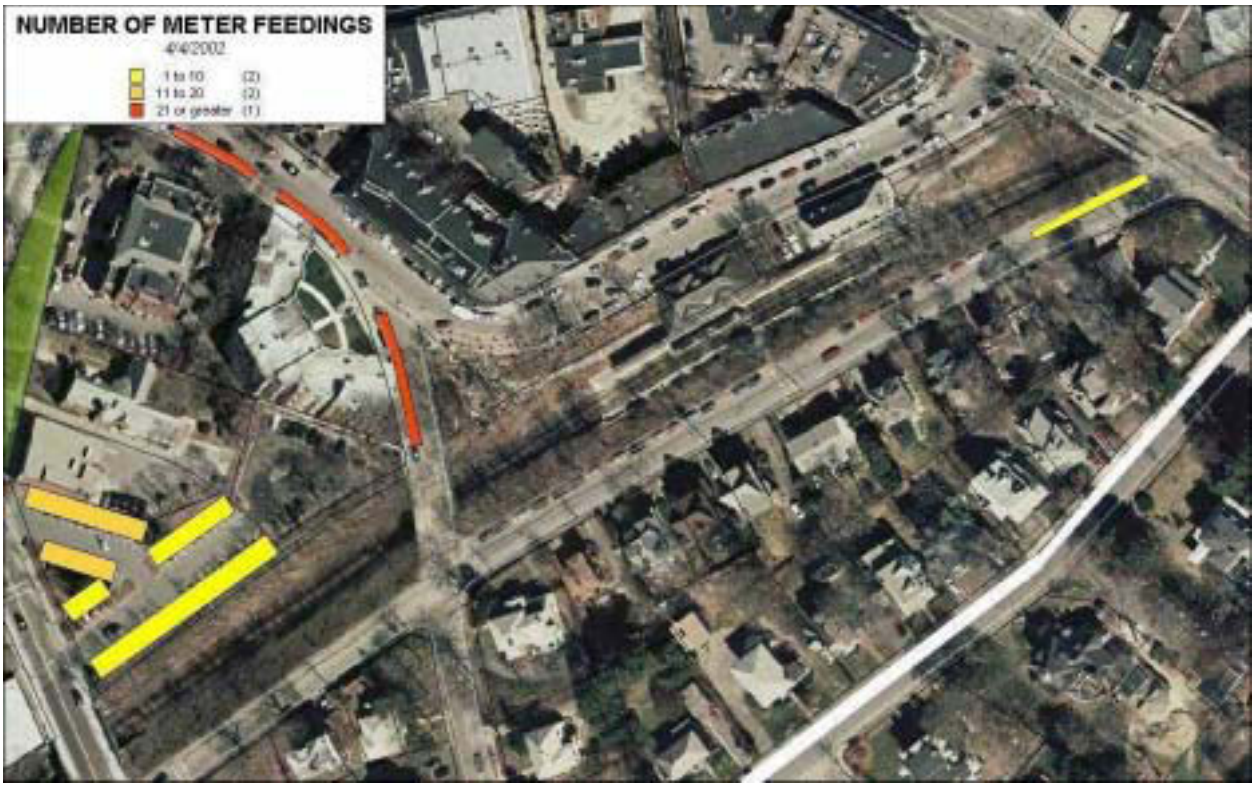

Figure 18 Meter Feeding 4/4/2002

The situation for 4/6/2002 appears even more problematic. During a four-hour study period, there were 23 occurrences on Herrick St., which means that nearly six cars per hour were overstaying the intended time. Figure 19 is map of the meter feeding on 4/6/2002. It is possible that the rise of meter feeding on a Saturday is due to the increase of people who are trying to run errands in the village and need to stay longer than the allotted time.

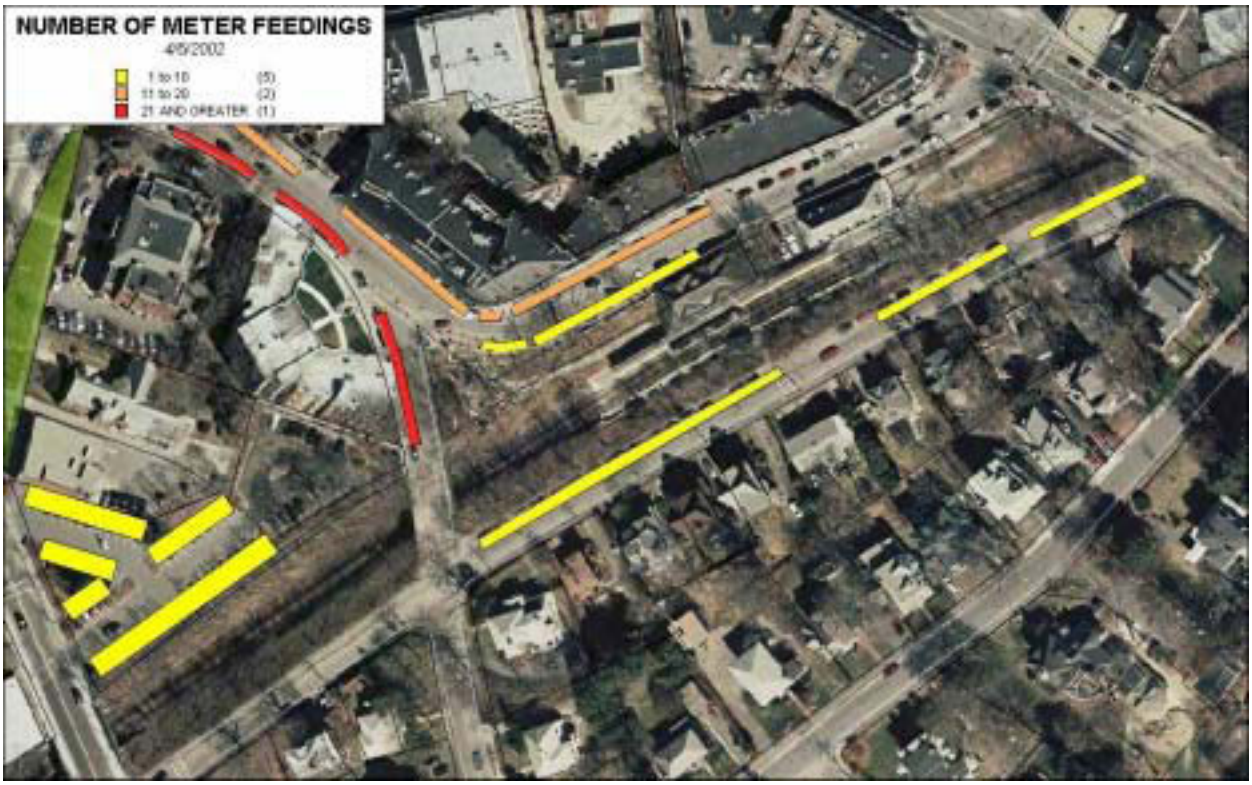

Figure 19 Meter Feeding 4/6/2002

6.3 Parking User Characteristics

For a highly centralized area like Newton Centre where space that is close to the village center is extremely valuable, it is especially important that this space be used as effectively as possible. When it comes to parking spaces, this means that the spaces need to be used by the people that most benefit the municipality. Residents, employees and patrons are the most important users of parking spaces because of the revenue that they generate. People who are using Newton Centre as an inexpensive parking lot while they commute into the city do not offer as much of a benefit. If commuters use the majority of the parking spaces and deprive others from using them, that would constitute a problem. One way to estimate how many commuters are using the parking areas of Newton Centre is to chart the accumulation of cars over time. Since the majority of the businesses within the turnover study area do not open until 9:30 AM (as shown in Table 4), cars arriving significantly before then may be commuters. Figure 20 is a map that shows the demand as a function of time by parking area. The two areas of particular interest for this evaluation are the Braeland Ave. non-metered spaces and the Cypress St. lot 12-hour spaces. These are the only areas for long-term parking within the turnover study area. Evaluation of this map shows that at 7:00 AM, the Braeland Ave. spaces and the Cypress St. lot spaces are both nearly 50% full. At this time in the morning, there is a possibility that many of the people parking are commuting in to the city. By 9:30 AM, when the majority of the local businesses are open, both areas are nearly full, which indicates that employees are also utilizing the

long-term spaces. Although both of these long-term parking areas are used very similarly, it is important to note that it costs $.25/hour to park in the Cypress St. lot. The only drawback to parking on Braeland Ave is the parking ban from 4 PM – 6 PM. This prohibition likely prevents many, but not all, commuters from parking free on Braeland Ave. What is unclear from the data is how many spaces are being used by commuters that could be used by employees. For most of the working day, both lots are completely full, so it is possible that there are employees who are unable to drive to work because of the lack of long-term parking spaces.

Figure 20 Demand by Lot for 4/4/2002

6.4 Parking Spillover into Residential Areas

One problem that our sponsor was particularly interested in was the possibility that non-residents were parking on residential streets during peak hours, due to parking deficiencies. In order to study this spillover effect, we included Chase St. in our 4/4/2002 turnover study. Chase St. is four blocks away from the village center, and is in a residential neighborhood. In order to prevent non-residents from long-term parking on Chase St., there is a two-hour maximum stay during the hours of 7 AM – 7 PM. Therefore while it would not be possible to park on Chase St. and commute into the city, it would be possible to park and walk into the village center for lunch.

Figure 20 illuminates this spillover problem. It is important that the maximum use on Chase St. is less than 50%. If there is a spillover problem, it is not a significant one. The times of the peak usage are from

12:30 PM – 1:30 PM and from 6:30 PM – 7:00 PM. The fact that one of the peaks occurs during the time of peak usage for the entire study area would seem to imply that the people are using Chase St. to park when other parking is unavailable, but this is not necessarily true. The fact that the peak usage around lunchtime is very similar to the peak usage at the end of the day suggests that it is possible that people are returning to their homes during lunchtime, and again at the end of the day. While it is possible that there are some non-residents parking on Chase St., these people are not depriving the residents from parking spaces, and do not seem to be creating a significant problem.

6.5 Evaluation of Previous Parking Studies

As noted above, Newton has undergone previous parking studies. In 1988, Newton hired professional consulting companies to study many aspects of the city including the parking. At the time, the people within the city government were trying to decide how to best develop the different villages. Parking was one of the major concerns, and became one of the focuses of the study. This section is a comparison of that parking study to the one that we performed using GIS.

One point that is important to notice is that both studies followed a very similar methodology for data collection. Both studies begin by taking an inventory of the parking supply. Next, both studies perform a turnover study to evaluate the parking characteristics. Finally, both studies collected the business type and location to estimate the demand. The step that significantly differentiates our study from those that took place in 1988 is our manipulation of these data. In a traditional study, engineers would use the data to analyze specific problems within the city. The time and effort associated with manually calculating different characteristics make it difficult to broaden the range of study beyond pre-determined situations. In a GIS-based study, however, the use of computers allows for deeper study into specific situations. Once the data have been entered into the system, it is an easy task to search the data to examine problem situations. Although it is possible to search the data for a small study area, for a city the size of Newton, it becomes extremely time consuming to search manually.

Once the data have been entered and analyzed, the next advantage of a GIS-based study is the display of the results. In a traditional study, the results are usually displayed in two ways: graphs are used to display total breakdowns (i.e. total parking by time, or total parking by price) and tables are used to show how these totals are broken down by street. It is nearly impossible to display the results in a meaningful way on a space-by-space basis in a traditional study. For a GIS-based study, however, it is an easy task. Once the data have been entered into the system, displaying the space-by-space results is trivial. This becomes extremely important when trying to show the results to people who may not be familiar with the study area. Reading a table of streets and their parking supply is only useful if the reader can associate the street with its location relevant to other parking areas. By displaying it on a map, however, it becomes easy to see the inter-related parking areas.

The study that was performed in 1988 concluded that Newton Centre was faced with an overall parking deficiency of 675 parking spaces. This conclusion was based on a demand/supply comparison that shows a supply that is only 67% of demand. They also found that this deficiency results in problems including meter feeding, spillover into residential areas and excessive violations of parking meters. Based on these conclusions the engineers performing the parking study made many recommendations for the improvement of Newton Centre's parking problem. The recommendations made by the study broke down to six main points:

- Reconfiguration of Lyman Street to a single aisle, double loaded, parking lot.
- A three level parking facility on the current site of the existing Cypress Street lot.
- A two level parking garage constructed underneath the current Langley parking lot.
- The reduction of parking time restriction in various areas.
- A ban placed on parking from 6:00-8:45AM, in certain lots and streets to discourage commuter parking.
- Increased enforcement of parking regulations.

It is important to note that three of these recommendations require construction of additional parking spaces. This construction would address the need for spaces, but it would require a significant investment. The other three recommendations are intended to prevent parking spillover and to decrease parking violations. These recommendations would require a small investment for signage changes, and possibly additional personnel to increase enforcement, but they may have helped to improve the parking situation in Newton Centre.

7 Conclusions and Recommendations

Based on our analysis of the data, the following conclusions about parking were made:

- Although a parking deficiency may exist, it is only a severe problem from 11 AM – 2 PM
- Long-term spaces are being misused as short-term spaces
- Meter feeding is occurring in short-term on-street parking spaces, decreasing the intended turnover
- The long-term parking is used completely, and a significant portion of this use is for commuters
- Parking spillover into residential areas occurs, although it does not occur at levels that deprive residents of parking spaces
- Areas where non-metered spaces are being used as long-term parking could be metered to increase revenue
- Use of GIS technology in parking management will enable the city of Newton to improve the utilization of its parking resources.

With these conclusions in mind, we make the following recommendations to help alleviate the parking problem in Newton Centre.

7.1.1 Evaluation of Business Density in the Village Center

The parking deficiency that was documented in 1988, and that continues to exist in Newton Centre is important because it affects the viability of the village center as a business district. If people cannot park in the village center, or just as importantly, if they do not think they can park, they will avoid the village center. Therefore, there are several steps that city managers can take to help this situation. One important step is to evaluate the business density within the village center. Currently, there are not enough parking spaces within the village center for all of the businesses. While the subway allows people to come to the village without a vehicle, it is unlikely that this can provide enough customers to maintain all of the businesses. If building additional parking facilities is not a possibility, then city officials must evaluate if the current business density is sustainable with current parking situation. If not, then steps could be taken to decrease the number of businesses.

7.1.2 Increase of Existing Supply Use

Another partial solution of the parking deficiency is to increase the use of spaces that already exist. One method is to improve signage, so that people know where to find parking that is appropriate for their needs. Where parking signs already exist, it is important to include an indication of what type of parking (long-term or short-term) exists in the lot. For the Newton Centre lots, the Pleasant St., Pelham St. and

Cypress St. lots would all be long-term/short-term designated, and the Langley St. lot would be short-term designated.

Another possibility to increase usage is to run an intra-village shuttle during times of peak demand. People who are coming to the village for lunch or shopping may not want to walk ten minutes across busy streets. Therefore, they would be unwilling to use open spaces if they are too far away from their destination. However, if a shuttle existed that could take them from their parking lot to their destination, they may be more inclined to park where there is available space. These shuttles would only be needed during time of peak demand.

Although Newton attempted a shuttle system (Nexus) that did not succeed, a shuttle system in Newton could work. One problem with the Nexus was that it took too long, because it went to many of the different villages. An average route took almost an hour, which meant that people could be waiting a long time before the Nexus was available. An intra-village shuttle, however, could run frequently during time of peak demand to decrease waiting time.

7.1.3 Creation of Minimum Time Parking Meters in Long-Term Lots

One of the problems that were observed during this parking study is the misuse of long-term spaces. This problem occurs at all hours of the day, but it is most detrimental when it occurs in the morning and deprives people of long-term spaces. One way to limit this misuse is to implement minimum stays at long-term parking meters. Implementing a minimum three-hour stay at long-term spaces would force people to consider which space they use, and ultimately to choose the parking that is most appropriate for their stay. In order to make this work, two steps would need to happen. The first is to set the parking meters so that they do not begin to run until at least three hours have been purchased (currently $.75). The next step would be to clearly indicate this change, both on the meters themselves and on signage around the meters. Initially it may be difficult to make people change habits that have developed over the years. In order to make sure that a change is made, enforcement must be increased immediately after the change until it is clear that people are using the spaces as intended. It is unlikely that this change would increase revenue for the city, but it would increase the supply of long-term spaces for their proper use.

7.1.4 Evaluation of On-street Meters

Meter feeding is another problem that affects Newton Centre. Meter feeding is especially prevalent during peak hours, which limits the amount of customers who can come to Newton Centre facilities. Therefore, it is necessary to examine meter feeding, and determine how best to solve the problem. There are two possible solutions, which are based upon different philosophies. One solution is to increase the enforcement to deter people from meter feeding. Enforcement agents could record license plate number, or mark the car in some way to indicate when they were first observed. If the car is still there when the agent returns, even if the meter does not indicate a violation, the agent could write a warning or a ticket showing

that they were staying for too long. While this would increase the turnover, and force people to use the meters correctly, it creates an environment where people would not want to come to the village. Another way to evaluate the problem is to look at the cause of the problem. If spaces are being used for longer than is intended this is the result of some other problem. Lack of properly designated spaces or spaces that are designated incorrectly can force people to meter feed. Therefore, another solution is to try to solve these problems. Within Newton Centre, it is possible that the problem is that spaces are not designated correctly. The majority of people stayed for only an extra hour beyond the original designation. By evaluating the businesses that are around the meters, it is possible that the one-hour meters on Herrick St. and Union St. are inadequate for people. By only allowing people to stay for an hour, these meters limit how many businesses a person can visit. An increase to two-hour meters for many of these spaces would allow people to visit more businesses while they are in the village center, without having to meter feed. This would make people more likely to visit the center, because they could do their shopping without having to worry about the parking. Since these two different recommendations are different views of the same problem, Newton city officials must evaluate which solution best fits with their plan for the village center.

7.1.5 Evaluation of Employee Parking Availability

During this study, we found that a significant portion of the long-term parking in Newton Centre is used by commuters. Since the parking lots are full for the majority of the day, it is possible that commuters are depriving Newton Centre employees of parking spaces. If this is occurring, this situation requires some analysis by Newton city managers. There is not nearly enough long-term parking to satisfy the needs of the employees affiliated with Newton businesses. The addition of commuters using the long-term parking only exacerbates this situation. One approach to the problem is to leave the situation alone, with the philosophy that is the responsibility of the private businesses to find parking for their employees. Another is to lease a private lot for use by area businesses. Each business could then receive a certain number of parking permits to distribute to its employees. These permits would allow the employees to park in the private lot during certain hours. A third option is to construct a parking garage that is dedicated to long-term employee parking, and charge a fee to recoup the costs of construction.

7.1.6 Prevention of Parking Spillover

Although parking spillover did not seem to be a severe within Newton Centre, it does exist and this can be a problem for residents. Parking on residential streets creates unnecessary and unwanted traffic. Consequently, it is important to limit spillover when it happens. One method that seems to be effective is to put two-hour parking limits on residential streets during business hours (7 AM – 7 PM). If this regulation is enforced, it will discourage parking on these streets for long periods. However, people move to a city like Newton specifically to avoid these types of restrictions. Another drawback to this regulation is that it makes it difficult for people to have guests during the day. If a house has a one-car driveway, then a guest would be

forced to park on the street. Even though they are using the parking correctly, there is no way for an enforcement agent to tell the difference.

A different proposal that could solve this problem could be permit parking on residential streets. The city could issue a certain number of permits to each house based on the number of registered vehicles. These permits could be made as stickers to be displayed in the rear window. Each house could also receive one guest permit that could be hung from the rear view mirror. This would allow each house to park their vehicle on the street, as well as one guest, during business hours. Failure to display a permit would result in a parking violation. This could help to limit spillover, without limiting the residents. The drawbacks to this system include cost of enforcement, cost for the creation, distribution and management of the permits, and an increased effort on the part of the residents.

7.1.7 Creation of Additional Metered Spaces

Within Newton Centre, there are places where non-metered spaces are being used as long-term parking spaces. One example of this is on Braeland Ave. There are approximately 23 spaces on Braeland Ave. that are non-metered. Upon evaluation of these spaces, it is apparent that they are used in an extremely similar manner to the long-term spaces in the Cypress St. lot. The main difference is that the Cypress St. lot is generating revenue, while the Braeland Ave. spaces are not. Due to their proximity to the subway station, the Braeland Ave. spaces are desirable and could be making money for the city. By designating 23 metered parking spaces on this street, the city could possibly generate over $15,000 of additional revenue, assuming that metering the spaces does not decrease the usage. There would be an initial cost for marking the spaces and installing the meters, but this cost would eventually be regained by the revenue that the spaces generate.

Many of these suggestions require a further analysis on the specific problem that they are trying to solve. Tools such as surveys, focus groups and cost analysis can all be applied to the specific problems once they have been identified. However, in order to identify these problems it is necessary to perform an overall parking study. Due to the cost of professional consulting agencies, it is difficult to perform these studies frequently. However, the existence of a GIS-based parking management system can help to decrease these costs. After the initial investment of time and money to perform a citywide GIS-based study, it would be inexpensive to perform further studies. Since the data exist in a digital format, it is easy to update the system as changes are made to parking spaces. Therefore, when the need arises to perform a parking study, no time needs to be spent performing an inventory of the parking spaces. The first step in any future study could be a turnover study. Since a turnover study is an easy data collection process, there is no need for professionals to gather the data. Once the data is entered into the database, engineers can save time by using analytical tools that have been previously developed to examine how the problems have changed over time. Since the same system would be used each time, it would be easy to compare current data to past data to examine trends.

Since there are so many advantages to having a GIS-based parking management system, we recommend that the city of Newton implement such a system.

7.1.8 Proposed GIS-based Parking Management System for Newton

The following is a proposed process for implementing a GIS-based parking management for Newton. This proposal is based on the fact that Newton already has a detailed GIS in place, making the addition of parking map layers an easy process. Additionally, there are already people with training in the necessary programs in Newton's GIS department who can make the switch to GIS easier. Initially it will be difficult to change to GIS, but once it is done, there are many long-term benefits.

7.1.8.1 Create Existing Parking Infrastructure and Characteristics in MapInfo

To create the existing parking in Newton our project team suggests following the steps we outlined in our Methodology of this report. In summary, the process utilized existing orthographic photos to draw parking spaces, then trips into the field to verify and finish detail on parking amenities and collect space specific parking characteristic data, including enforcement hours, price to park, time and user restriction, etc.

7.1.8.2 Create Unique Coding Schemes for Parking Management System

To achieve maximum usefulness from a GIS program, it is necessary to be as specific about spaces as possible. In order to sort through the many spaces that will exist in the database, each space must have a specific code or identification. Parking zones and reference structure such as block and street will likely require unique codification also. Again, to see how our project team handled this task refer to the Methodology Chapter of this report.

7.1.8.3 Train Necessary Employees in GIS

The City of Newton has a proficient and able GIS department to complete all the compulsory tasks required for the creation of the previous steps. However the parking and traffic engineers, and also whomever will provide necessary clerical work on the parking management system will possibly require training in MapInfo, Microsoft Access, and Microsoft Excel, as needed to perform proper analysis and upkeep of the system. Training for this program is widely available, and for the city of Newton's purposes, it may be available in-house from the GIS department.

7.1.8.4 Obtain Data as Required for Parking Management

The acquisition of parking data should become increasingly cheaper and simpler for the city of Newton with the implementation of this plan. Where in prior projects the city has consulted outside contractors to collect data and perform analysis, now the data collection process is simplified to the point where students could be hired on an interim basis to simply collect the data that necessitates fieldwork, such as car counts for turnover studies. Also where our project team was unable to obtain sensitive data which

would have been invaluable for analysis, the city has access to a range of information including; parking enforcement data such as tickets and other violations, business information registered with the town planning board including the ability to increase this information by requiring incoming businesses to provide new data relevant to parking in order to obtain necessary permits, and also the ability to run the license plate numbers it collects for further analysis.

7.1.8.5 Data Entry

After the data is collected by the means specified above, this data must be entered in to the parking management system. Our project team found the easiest means for this task to be to enter the data in Microsoft Excel, then import it into Microsoft Access, where it is capable of being joined into MapInfo for various purposes.

7.1.8.6 Perform and Save Queries

Some information that will be extracted from the data will be constantly useful. Microsoft Access has the ability to save queries, which take ordinary entered data and computes figures such as turn over rates, compliance rates, average violations, etc. These queries can be run for each time new data is brought into the system, and also can compute and update new averages for different selected time spans. To ensure the correct selection of queries, our project team suggests a meeting or series of meetings between officials trained in traffic and parking studies, along with a well-trained programmer experienced in running Access queries, and familiar with MapInfo. These queries will remain permanent to the system. The city of Newton should have officials capable of this objective in its current Engineering and GIS departments.

7.1.8.7 Decide Upon Parking Needs and Requirements of Newton

To eventually achieve a well-balanced parking structure in the city of Newton, the city itself must first decide how it will prioritize and dictate a desired balance of parking users. This balance is a touchy decision, but one that only the city itself can decide, as any town has expectations to meet from its citizens, those including both safe and secure parking, but also commercial and public properties, which themselves require parking for existence also. To decide upon this balance our project team suggests a series of meetings or focus groups, that would include random citizens, public officials both political and engineers, and respected businessmen of the city. This would provide insight from elected town officials, professional engineers, businessmen, and citizens, which should determine a proper balance for the city.

7.1.8.8 Conduct Regular Analysis

To ensure the parking management system is effective a regular analysis of all parking data must be conducted. Our project team would suggest initially that analysis be performed on a semi-annual basis for a period of two years, at which point the process should be reviewed and changed accordingly.

7.1.8.9 Incorporate Long-term Parking Goals into Urban Planning Efforts

To cost effectively solve any parking problem, changes must be made in community infrastructure. For example, if Newton Centre residents ultimately decide there is too much of a parking problem from either commercial properties or commuters utilizing the MBTA subway station, then the city of Newton's urban planning division should be properly notified so goals to the extent of reducing commercial business in the village by five percent over ten years, or even the possibility of terminating the subway stop in the village can then be examined. What this step will provide the city is a cost effective, and environmentally friendly (in contrast to building more parking lots) solution to a drastic parking problem that is beyond even proper utilization of their current parking infrastructure.

This IQP represents the first joint endeavor between WPI and the city of Newton Department of Public Works. Our experience suggests great potential for future ventures that would benefit students and the city. Some of these projects include a complete parking study of Newton Centre, preparing the city for a widespread implementation of GIS-based parking management, and the determination and incorporation of additional elements of a GIS program for the city traffic engineering division.

A complete parking study of Newton Centre would present the city of Newton with conclusive evidence of the benefits of a GIS-based parking management system, provide virtually all queries for analysis the city could need in further studies, and offer the village improved parking management and cost effective long-term solutions. A subsequent IQP project team would be able to easily conduct a full parking study on the village because this IQP has already created map layers of all available parking in Newton Centre with parking characteristics attached. We have also created a functioning database that works as the backbone of the GIS software as well as a repository for parking data, a unique identification and coding scheme for spaces and attributes, a detailed methodology, and lastly many necessary queries previously tested and saved. A move to GIS-based parking management would be revolutionary for the city of Newton, it is important for them to act with caution, as well as providing insight to any traffic problems occurring in Newton Centre, this study would allow the city to make a knowledgeable decision on the subject.

To manage a successful transformation to GIS-based parking management, many complicated and possibly problematic steps could be accomplished by an IQP team. To ease the transition for the city, the following tasks the team could focus upon are listed here. A first step would be organizing the cooperation between the GIS and Traffic Engineering departments; this would involve detailing where responsibility and authority over different aspects of the parking management system would lie, and specific employees that could accomplish the necessary work. Next, training manuals for specific procedures required in parking management for GIS software, database software, and data entry could decrease any necessary costs for training the city may have had to provide. After that, the team could organize focus groups, consisting of selected city officials, respected businessmen from the town, and residents. The purpose of these meetings

would be to determine to desired balance of parking users for the city of Newton. One advantage of GIS is the ability to make accurate estimations of what type of driver is utilizing parking spaces based on the dynamics of how they park. With this information, different regulations and restriction can be made to attempt to adjust the balance of users to what the city desires, thus eliminating problems from commuters or employees taking up available parking if that is undesired. A final aspect of this IQP could be to perform cost analysis studies, comparing a detailed GIS-based study and a traditional consulted study. This comparison would include not just overall costs, but details of data collection costs, analysis costs, and the cost to shift employee's focus. At the conclusion of this study, the city of Newton would be prepared to make the transition to a GIS-based parking management system if so desired.

The parking problems that face the city of Newton, and other cities like it, are too complex to be solved by any one solution. The creation of new spaces, better utilization of existing spaces and a closer examination of the factors that create parking problems are all parts of the solution. This project demonstrates that GIS technology can assist in all of these facets of parking management. The implementation of the parking management system that we have outlined would lead to an improved parking situation in Newton and ultimately improve the quality of life for Newton residents.

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