Evaluation of Transit Applications of Advanced Parking Management Systems
Final Evaluation Report

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16. Abstract

Throughout the United States, transportation agencies have begun implementing advanced parking information systems to increase customer satisfaction and to improve traffic operations. Through the use of variable message signs, these systems provide motorists with real-time information about parking availability at appropriate decision points on their route so that they can make an informed decision about where to park. These systems are being deployed in a variety of environments including central business districts, airports, and transit park-and-ride lots. The goals in deploying such a system can vary depending on the operating environment. When deployed in a transit environment, goals can include improved user satisfaction, increased parking utilization at a lot that is currently under-utilized, and increased transit ridership.

This report presents the results of an independent national evaluation of two transit applications of parking management systems: one that was deployed in conjunction with two Metra Stations in suburbs southwest of Chicago, Illinois and the other which was deployed in conjunction with two Metro Stations in Montgomery County, Maryland.

The study documents quantified system impacts in terms of parking utilization, transit ridership and mode choice, traffic circulation within and between transit park and ride lots, and customer satisfaction. It also includes an institutional issues review that includes organizational and institutional challenges encountered by the project stakeholders throughout the course of deployment and operation of these systems.

The evaluation involved conducting passenger intercept surveys of transit riders, gathering data on transit ridership, gathering archived system data that documents in and out counts at the lots, as well as conducting a series of interviews with the staff.

The results of the study indicate that it is unclear whether the parking management systems increased parking utilization or transit ridership, or whether they reduced circulation within and between park-and-ride lots. The results do indicate that commuters are in general satisfied with the sign locations and accuracy (and that they would like to see similar signs at other locations). In terms of mode share, although not many, a few respondents did indicate that the signs have affected how often they take transit and that he parking availability information has caused them to take transit rather than driving. Finally, the results show that, depending on the circumstances, parking management systems can increase driver awareness of parking alternatives or reduce circulation within and between lots.

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ABBREVIATIONS

COTS	Commercial-off-the-shelf
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
GCM	Gary-Chicago-Milwaukee ITS Priority Corridor
ITS	Intelligent Transportation Systems
ITS JPO	Intelligent Transportation Systems Joint Program Office
MCDOT	Montgomery County Department of Transportation
MOE	Measure of Effectiveness
RTA	Chicago Regional Transportation Authority
USDOT	United States Department of Transportation
VMS	Variable Message Signs
WMATA	Washington Metropolitan Area Transit Authority

EXECUTIVE SUMMARY

Throughout the United States, transportation agencies have begun implementing advanced parking information systems to increase customer satisfaction and to improve traffic operations. Through the use of variable message signs, these systems provide motorists with real-time information about parking availability at appropriate decision points on their route so that they can make an informed decision about where to park. These systems are being deployed in a variety of environments, including central business districts, airports, and transit park-and-ride lots. The goals in deploying such a system can vary depending on the operating environment. When deployed in a transit environment, goals can include improved user satisfaction, increased parking utilization at a lot that is currently under-utilized and increased transit ridership.

As the exact benefits of deploying a parking management system in a transit environment have yet to be determined, the United States Department of Transportation's (USDOT) ITS Joint Program Office and Federal Transit Administration (FTA) elected to pursue a national evaluation of this technology. The USDOT selected an independent evaluation team to assess the impacts of two recent deployments: one in Chicago, Illinois and the other in Montgomery County, Maryland. The evaluation team worked closely with the project participants to obtain the data required to conduct a successful evaluation of these two deployments.

This report documents the findings of this independent evaluation. The study documents quantifiable system impacts in terms of parking utilization, transit ridership, traffic circulation, and customer satisfaction. This report also includes institutional issues and lessons learned by the project stakeholders throughout deployment and operation of these systems. The four core objectives of the evaluation were as follows:

- Assess the impact of the systems on ridership and parking utilization
- Assess the impact of the systems on mode choice
- Assess the impact of the systems on time spent searching for spaces (circulation within and between lots)
- Assess the impact of the systems on customer satisfaction

The evaluation involved the following data collection and analysis activities:

- Before/after analysis of transit ridership numbers.
- Before/after analysis of transit station parking utilization based on archived system in/out counts, manual in/out counts, and parking revenue data.
- Analysis of customer intercept surveys and of a focus group.

SUMMARY OF FINDINGS

The results of the analyses are summarized here according to each of the four core evaluation objectives:

- Assess the Impact of the System on Ridership and Parking Utilization.
- Assess the Impact of the System on Mode Choice.
- Assess the Impact of the System on Time Spent Searching for Spaces (Circulation within and between lots).
- Assess the Impact of the System on Customer Satisfaction.

Assess the Impact of the System on Ridership and Parking Utilization

The evaluation team looked at a variety of data sources to determine the impact of the system on parking utilization. Additionally patrons were surveyed about the impact of the system on their commute patterns.

For the Chicago site, the stations did have slightly higher utilization after the system was in place (1 to 5.5 percent higher). In terms of utilization throughout the day, there was no change at Hickory Creek, and only a slight change in utilization at Tinley Park (slightly more people boarded the late morning trains causing the peak to occur approximately one hour later than in the previous year). In terms of mid-day utilization specifically, in general, there are very few people boarding trains during the mid-day and the system did not cause a significant increase in mid-day arrivals. This is not surprising considering that neither station was at or near capacity during the timeframe of the study (the Tinley Park Station reached a maximum of 82 percent capacity, and Hickory Creek reached 74 percent capacity). Additionally, no focus group participants reported that the parking lot has ever been full when they personally wanted to park and use Metra.

In the case of the Montgomery County project, it was expected that the system would result in a change in parking utilization throughout the day at Glenmont (rather than an increase in peak utilization, since it was known that the garage is already at capacity on a typical weekday). The data show that there was a 20 percent drop in the number of patrons arriving at Glenmont before 8:00AM, but that the garage now fills at a faster rate. This could be an indication that commuters no longer feel the need to arrive early in order to get a parking space, and that they now go directly to Glenmont [when the signs tell them that there is availability] instead of bypassing Glenmont as they might have done previously, thinking that it was full.

For the Norbeck lot it was thought that the system might increase awareness, and thereby, utilization of the lot. It was found that, in fact, very few people use the Norbeck lot for the purposes of boarding the Metro at Glenmont. This appears to be due to the fact that Norbeck does not serve as a viable option for most commuters. Some feel that it adds too much time to their commute and others do not park there since they are unfamiliar with the Norbeck bus schedules.

Assess the Impact of the System on Mode Choice

Since it was thought that lack of parking might be a perceived barrier to transit, it was hypothesized that some motorists might be encouraged to switch modes to transit after seeing a sign indicating that there is in fact parking available (in particular on days of heavy traffic). Surveys provided insight into this at both sites. In both cases very few respondents indicated that the signs have affected how often they take transit. In Montgomery County however, many indicated that the signs have improved their awareness of parking alternatives for the Red Line. In fact, one-third of those surveyed at Norbeck indicated that they were not aware of the lot before the signs were installed.

Assess the Impact of the System on Time Spent Searching for Spaces

It was also thought that the system would save time for commuters. Again surveys provided insight. For the Chicago project, most respondents indicated that the signs have not influenced them because they have never experienced difficulty finding parking. However, some did indicate that the signs have saved them time in finding a parking space, particularly at Tinley Park where there are multiple lots.

For the Montgomery County project, responses were different as expected since the Glenmont garage is typically at capacity on weekdays and parking is more of a challenge. Most survey respondents indicated that there has been at least one time that they have been unable to find a space at Glenmont, and nearly one-fifth reported that they often spent time circling the garage looking for a space before the system was installed. About a quarter of respondents reported that they feel that the signs have made a difference to them and that the signs have reduced the amount of time that they spend looking for a space. Although the team was not able to obtain a statistically significant sample size, the data that the team was able to obtain show that circulation appears to have reduced significantly. It appears that 57 percent fewer vehicles left the Glenmont Garage during the peak hour after the system was installed as compared to before the system was installed. The environmental impact associated with 46 fewer vehicles circulating through the garage each day is equivalent to an emissions savings of 10.490 tons of carbon dioxide (or 20,980 lbs) over the course of a year.

Assess the Impact of the Systems on Customer Satisfaction

In general, for both projects, survey results indicate that commuters are satisfied with the sign locations and accuracy and that they would like to see similar signs at other locations. Although few respondents agree that the signs have improved their overall commuting experience, when asked whether they would like to see similar signs installed at other stations, many reported that they would.

CONCLUSIONS

The following is a summary of the conclusions regarding the hypotheses developed for this evaluation:

Chicago Project

- Hypothesis: The system will increase parking utilization at the Mokena/Hickory Creek and the Tinley Park/80th Avenue Station parking lots. *The hypothesis is inconclusive.* Although both stations did have slightly higher utilization after the system was in place (1 percent higher at Tinley Park and 5.5 percent higher at Hickory Creek), it is unclear whether these increases can be attributed to the system. Any number of factors such as population increases or rising gas prices could have caused a portion of this ridership increase. Furthermore, the system only benefits those who *drive* to the station (rather than those who walk/bike or use kiss-and-ride), and some of this ridership increase could in fact be comprised of individuals who walk or bike to the station, or who use the kiss-and-ride facility. Finally, on the converse, any ridership increases that did result from the system could have been masked by decreases in ridership that were expected to result from riders being drawn over to any adjacent Metra line due to service improvements.
- Hypothesis: The system will positively affect customer satisfaction. *This hypothesis is supported by the customer intercept surveys.* Survey results indicate that commuters are satisfied with the sign locations and accuracy and that they would like to see similar signs at other locations. Although few respondents agree that the signs have improved their overall commuting experience, when asked whether they would like to see similar signs installed at other stations, many reported that they would.
- Hypothesis: The system will reduce traffic circulation between the north and south Tinley Park/80th Avenue Station parking lots. *This hypothesis is inconclusive based on the archived*

system data and the customer intercept surveys. Although unnecessary circulation between the lots was thought to be a problem, it does not appear that any patrons left the lot during the AM peak period indicating that all vehicles entering the lot were able to find a parking space. The primary reason for this is that the Tinley Park Station never reached capacity during the timeframe of the study (even at its peak, the lots at this station were only at 82 percent capacity). However, the survey results provide some indication the system has helped commuters. Ninety-six percent of respondents there indicated that they have always been able to find a parking space since the system was added, while only 83 percent indicated that they were previously able to find a space.

- Hypothesis: The system will reduce traffic circulation between the Tinley Park/80th Avenue station and the Mokena/Hickory Creek station. *This hypothesis is inconclusive based on the archived system data and the customer intercept surveys.* Although unnecessary circulation between these two stations was thought to be a problem, it does not appear that any patrons left either of the lots during the AM peak period, indicating that all vehicles entering the lot were able to find a parking space. The primary reason for this is that neither stations reached capacity during the timeframe of the study (even at its peak, Tinley Park only reached 82 percent capacity and Hickory Creek only reached 74 percent capacity).
- Hypothesis: The system will result in an increase in ridership on the Rock Island District Line as parking utilization increases at the Tinley Park/80th Avenue and Mokena / Hickory Creek Stations. *This hypothesis is inconclusive.* Although both stations did have slightly higher ridership after the system was in place (an 8.9 percent increase at Hickory Creek and a 7.1 percent increase at Tinley Park when comparing 2006 data to 2002 data), it is unclear whether these increases can be attributed to the system. Any number of factors such as population increases or rising gas prices could have caused a portion of this ridership increase. Furthermore, the system only benefits those who *drive* to the station (rather than those who walk/bike or use kiss-and-ride), and some of this ridership increase could in fact be comprised of individuals who walk or bike to the station, or who use the kiss-and-ride facility. Finally, on the converse, any ridership increases that did result from the system could have been masked by decreases in ridership that were expected to result from riders being drawn over to any adjacent Metra line due to service improvements.
- Hypothesis: The system will result in an increase in transit mode share among commuters whose origins lie near the Mokena/Hickory Creek and Tinley Park/80th Avenue Stations. *This hypothesis is supported by the customer intercept surveys.* Though not many, a few respondents did indicate that the signs have affected how often they take transit. Two percent of Hickory Creek Station respondents and 4 percent of Tinley Park Station respondents reported that the parking availability information has caused them to take Metra instead of driving.
- Hypothesis: The system will result in an increase in mid-day arrivals at the Mokena/Hickory Creek and the Tinley Park/80th Avenue Station parking lots. *This hypothesis is not supported by the data.* There was no change in utilization at Hickory Creek, and only a slight change in utilization at Tinley Park (slightly more people boarded the late morning trains causing the peak to occur approximately one hour later than in the previous year). In terms of mid-day utilization specifically, in general, there are very few people boarding trains during the mid-day and the system did not cause a significant increase in mid-day arrivals. This is not surprising considering that neither station was at or near capacity during the timeframe of the study (the Tinley Park Station reached a maximum of 82 percent capacity, and Hickory

Creek reached 74 percent capacity; additionally, no focus group participants reported that the parking lot has ever been full when they personally wanted to park and use Metra).

Montgomery County Project

- Hypothesis: The system will increase driver awareness of parking alternatives when riding the Red Line in Montgomery County. *This hypothesis is supported by the customer intercept surveys.* Approximately one quarter of respondents (27 percent at Norbeck and 17 percent at Glenmont) indicated that they agreed or strongly agreed that the signs have improved their awareness of parking alternatives for the Red Line. Furthermore, one-third of respondents parking at the Norbeck Park-and-Ride lot indicated that they did not know about the lot prior to the signs.
- Hypothesis: The system will positively affect customer satisfaction. *This hypothesis is supported by the customer intercept surveys.* Survey results indicate that commuters are satisfied with the sign locations and accuracy and that they would like to see similar signs at other locations. Although few respondents agree that the signs have improved their overall commuting experience, when asked whether they would like to see similar signs installed at other stations, many reported that they would.
- Hypothesis: The system will reduce circulation within the Glenmont Garage. *This hypothesis is supported by the customer intercept surveys.* Most survey respondents indicated that there has been at least one time that they have been unable to find a space at Glenmont, and nearly one-fifth reported that they often spent time circling the garage looking for a space before the system was installed. About a quarter of respondents reported that they feel that the signs have made a difference to them and that the signs have reduced the amount of time that they spend looking for a space. The data show that circulation has been reduced significantly – it appears that nearly 43 percent fewer vehicles are now leaving the Glenmont Garage in the morning hours, and this could equate to an emissions savings of 69,556 pounds of carbon dioxide over the course of a year.
- Hypothesis: The system will increase parking utilization at the Norbeck park-and-ride Lot while maintaining the current parking utilization at the Glenmont Metro Station. *This hypothesis is inconclusive.* It was impossible to ascertain from the data whether utilization of the Norbeck lot increased among commuters using Glenmont. However, anecdotal evidence indicates that very few people use the lot for the purposes of boarding the Metro at Glenmont. When surveying patrons at this lot, the evaluation team inquired about how full the lot is on a typical day, and on both days the team was told by survey respondents and by the shuttle bus operator that the lot typically contains only 30 cars. The parking utilization at the Glenmont Garage has not changed since the system was added.
- Hypothesis: The system will increase transit ridership on the Red Line as the parking utilization at the Norbeck park-and-ride lot increases. *This hypothesis is not supported by the data.* In looking at monthly weekday boardings at the Glenmont and Wheaton Stations over the past 3 years, there is no indication that ridership has increased at either station since the signs were installed. Furthermore, since usage of the Norbeck lot does not appear to have increased since the signs were installed, it does not seem reasonable that any increase in ridership at Glenmont would have been the result of the system.
- Hypothesis: The system will result in an increase in transit mode share among commuters whose origins lie near the Glenmont Station. *This hypothesis is supported by the customer intercept surveys.* Though not many, a few respondents did indicate that the signs have

affected how often they take transit. Four to 13 percent of respondents at Glenmont and 9-18 percent of respondents at Norbeck gave responses that would indicate that they feel the signs have affected how often they ride Metro.

1 INTRODUCTION

1.1 Overview

Throughout the United States, transportation agencies have begun implementing advanced parking information systems to increase customer satisfaction and to improve traffic operations. Through the use of variable message signs (VMS), these systems provide motorists with real-time information about parking availability at appropriate decision points on their route so that they can make an informed decision about where to park. These systems are being deployed in a variety of environments, including central business districts, airports, and transit park-and-ride lots. The goals in deploying such systems can vary depending on the operating environment. When deployed in a transit environment, goals can include improved user satisfaction, increased parking utilization at a lot that is currently under-utilized, and increased transit ridership.

As the exact benefits of deploying a parking management system in a transit environment have yet to be determined, the United States Department of Transportation's (USDOT) ITS Joint Program Office and Federal Transit Administration (FTA) elected to pursue a national evaluation of this technology. The USDOT selected an independent evaluation team to assess the impacts of two recent deployments: one in Chicago, Illinois and the other in Montgomery County, Maryland. The evaluation team worked closely with the project participants to obtain the data required to conduct a successful evaluation of these two deployments.

This report documents the findings of this independent evaluation. The study documents quantifiable system impacts in terms of parking utilization, transit ridership, traffic circulation, and customer satisfaction. This report also includes institutional issues and lessons learned by the project stakeholders throughout deployment and operation of these systems.

1.2 Organization of the Report

The remainder of the Evaluation Report is structured as follows:

- **Section 2 – Chicago Project:** This section provides background information on the Chicago project, information about the goals and objectives of the evaluation of that project, information about the data sources that were used in the study, and information about the findings of the evaluation.
- **Section 3 – Montgomery County Project:** This section provides background information on the Montgomery County project, information about the goals and objectives of that project, information about the data sources that were used in the study, and information about the findings of the evaluation.
- **Section 5 – Institutional Issues and Lessons Learned:** This section provides information on institutional issues and lessons learned by the project stakeholders throughout the course of the deployment and operation of these systems.
- **Section 6 – Conclusions:** This section provides a summary of the findings of the study as well as overall conclusions.

2 CHICAGO PROJECT

2.1 Project Background

In the interest of providing better and more useful information to motorists, the Chicago Regional Transportation Authority (RTA) and Metra (the commuter rail system serving the Chicago Metropolitan area), decided to undertake a pilot project to test the usefulness of a real-time parking information system for two of their commuter rail stations in suburban Chicago. This system development and demonstration effort was funded by RTA and by the Federal Highway Administration (FHWA) through the Gary-Chicago-Milwaukee (GCM) Intelligent Transportation Systems (ITS) Priority Corridor program administered by the Illinois Department of Transportation. In total, the cost of the Metra project was approximately $1 million, which included construction of the signs as well as purchasing and installing the hardware and software. In addition to this, the cost of concept development was approximately $100,000, and the cost of the engineering design, or design specifications, was approximately $150,000.

The system, which has been in place since August 26, 2006, provides travelers with real-time information about parking availability at key decision points along the nearby Interstate and key arterials for two Metra park-and-ride lots. The system also provides riders with additional parking signage and guidance around the two transit stations, while supplying Metra with real-time information about parking utilization at these stations. In providing additional information to motorists, RTA and Metra hoped the system would improve customer satisfaction and possibly draw in new riders.

As a first step in considering a parking management project, RTA conducted a feasibility study in 1998. As part of this feasibility study, the agency surveyed 316 patrons at various Metra Commuter Rail stations during and immediately following the morning (AM) peak. The surveys, consisting of 11 core questions, focused on station parking, station signage, and the types of information that riders would like to see posted on variable message signs. The survey found that a majority (62 percent) of all transit riders felt that signage around transit stations could be improved. Further, the survey found that over three-quarters of regular transit riders (commuters) felt that parking guidance information was a significant issue.[1]

Four main corridors were originally considered for this project, with two or three stations under consideration along each corridor. Some of the key factors considered in selecting project locations included: land configuration, fill rates in the parking facilities, lot size, the presence and location of nearby arterials, and growth areas in the surrounding communities.

After careful consideration, RTA and Metra agreed to implement the pilot project at two stations along the Rock Island Line, a line that provides service from downtown Chicago to the City of Joliet, Illinois. The two stations selected are adjacent stations located near the end of the Rock Island Line: the Tinley Park/80th Avenue Station and the Mokena/Hickory Creek Station. These locations were chosen because of their optimal combination of location and ridership. At the time of the feasibility study, the parking facilities at the Tinley Park/80th Avenue Station

[1] Wilbur Smith Associates. "Parking Management Systems: Needs Assessment Report" prepared for Metra as part of the project design effort, July 2002.

were often at or near capacity, while the lots at the Mokena/Hickory Creek Station typically had excess capacity. Given the proximity of these two stations, RTA and Metra representatives expected that the real-time information provided by the system would increase parking utilization at the Mokena/Hickory Creek Station, both through new riders and through a change in utilization among existing Rock Island Line patrons (i.e., some of those who used to park at Tinley Park/80th Avenue might now begin parking at Mokena/Hickory Creek). It was expected that the system would result in an increase in parking utilization at the Hickory Creek Station while maintaining parking utilization at the Tinley Park Station, thereby translating into an increased number of transit riders on the Rock Island Line.

2.2 System Description

The RTA/Metra parking management guidance system is comprised of two main components: parking monitoring and an en-route information system. The parking monitoring component monitors the number of vehicles entering and exiting all commuter lots at the two Metra Commuter Rail Stations. The en-route information system (the dynamic message signs), communicates parking availability information to drivers along key expressways and arterials. A map of the deployment area and the approximate location of each sign are shown in Figure 1. This map illustrates the station locations with respect to the expressway (Interstate 80) and the arterials. Figure 2 presents a diagram of the message signs and the information that is presented on them. The photo inset of the communications tower in Figure 2 indicates its location at the Mokena/Hickory Creek Station.

Figure 1. Area Map Showing Station Locations in Relation to Sign Locations. [2]

[2] Google Map of Mokena, Illinois, <http://maps.google.com/>.

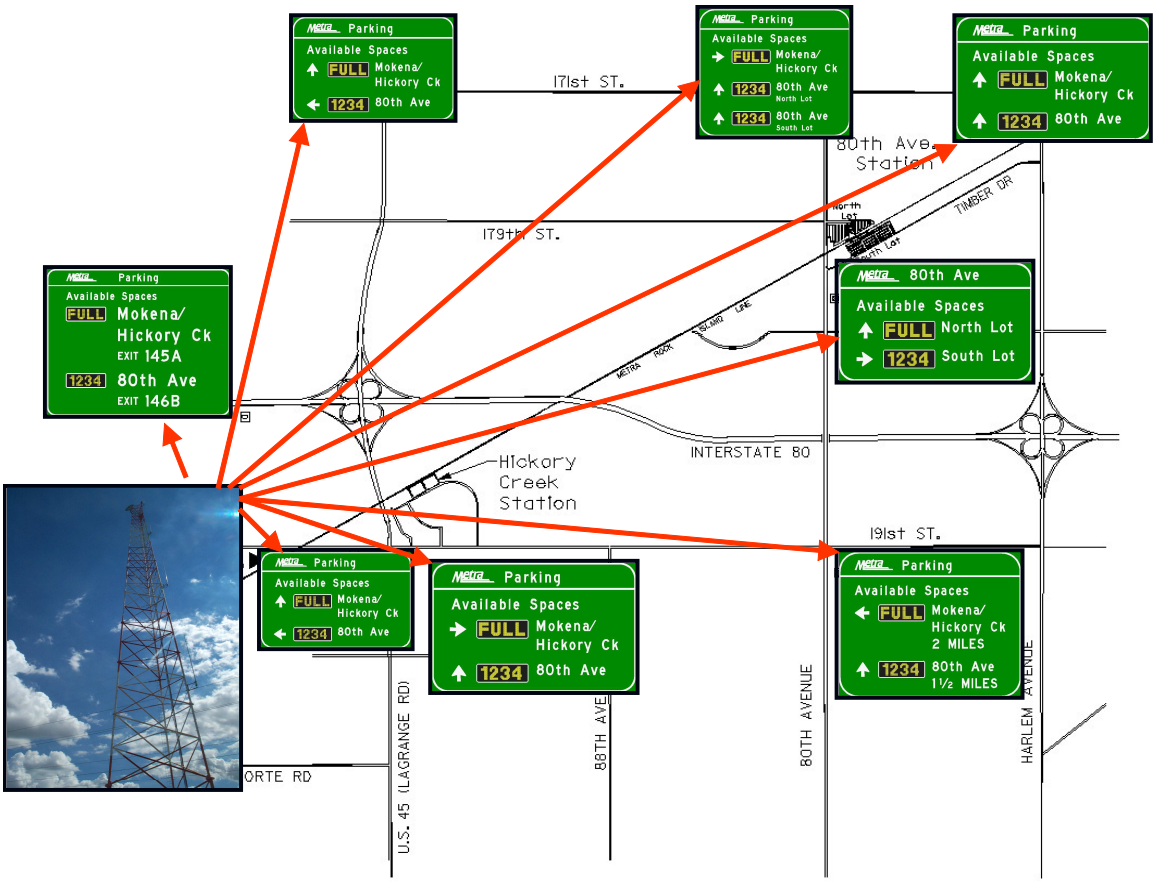

Figure 2. System Map.[3]

2.2.1 The Parking Monitoring Component

The parking monitoring component includes vehicle detection devices at each of the stations' entrance and exit points.[4] The vehicle detection system utilizes two-channel loop detectors that maintain a wired connection with the cluster management server.[5] The loop detection devices beneath the pavement magnetically detect vehicles entering and leaving the parking lots. An example of detector placement is depicted in Figure 3.

As shown in Figure 4, plastic delineators channelize traffic to ensure that vehicles do not cross over into the other direction of traffic and get counted incorrectly. As vehicles are counted, this information is communicated to a central workstation that maintains a real-time space inventory.

[3] HNTB Corporation, RTA, Metra, "Parking Management Guidance System" plans.
[4] HNTB Corporation, "Parking Management Guidance System" plans. Metra project number BN 3591-5710-2005.
[5] Metra, "Parking Management Guidance System: Specifications" Supplementary Conditions, (October 31, 2003), p. SC-5.

Figure 3. Example of Loop Detector Placement.[6]

Figure 4. Flexible Delineators Channel Traffic into Lanes to Ensure Accurate In/Out Counts.[7]

[6] HNTB Corporation, RTA, Metra, "Parking Management Guidance System" plans.
[7] Ibid.

The communications tower has line-of-sight contact with all of the variable message signs. Based on the number of remaining spaces, the dynamic message signs are updated from the cluster management server through the spread-spectrum radio link. Metra then monitors real-time information from two workstations in their downtown headquarters. This allows Metra system administrators to diagnose and troubleshoot any issues that arise.

2.2.2 The Traveler Information Component

The parking management guidance system is equipped with eight variable message signs (VMS). The locations of these signs were indicated in the system map shown previously in Figure 2. As shown in Figure 5, the signs involve a static element that provides positive guidance to the parking facilities at each station along with a dynamic element that presents real-time parking availability information.[8] Two signs are solar powered as electrical power was not feasible at these sign locations.

The vehicle count presented on the VMSs can be updated at an interval set by system administrators. The signs are updated approximately every 5 minutes.

Figure 5. Chicago's Signs Provide Real-Time Information about the Number of Spaces Available at Two Metra Stations.

[8] HNTB Corporation, RTA, Metra, "Parking Management Guidance System" plans.

2.3 Description of Deployment Sites

The Tinley Park/80th Avenue and Mokena/Hickory Creek Stations are situated on the Rock Island Line just off Interstate-80, approximately 30 miles southwest of downtown Chicago. The Rock Island Line offers service from downtown Chicago to the City of Joliet, Illinois. Figure 6 depicts the Rock Island Line and the location of the two transit stations.

Although the Mokena/Hickory Creek and Tinley Park/80th Avenue Stations are located relatively close to one another (approximately 5 miles apart), the Hickory Creek Station receives significantly less ridership on an average weekday. According to Metra's most recent ridership survey (conducted in November 2006),[9] the Tinley Park/80th Avenue Station currently serves approximately 2,287 riders per day on weekdays, while the Mokena/Hickory Creek Station serves approximately 1,133 riders per day on weekdays.

There is anecdotal evidence that many area residents, including some current Metra riders, are unacquainted with the location of the Hickory Creek Station. Therefore, it was thought that one obstacle that could be preventing potential riders from using the Hickory Creek Station as an alternate to the Tinley Park Station is Metra's zone-based fare structure. Although parking fees are the same for both stations ($1.00 per day), and although the Hickory Creek Station is located adjacent to the Tinley Park Station, the fare is more expensive from Hickory Creek since it is located in a different zone (Hickory Creek is located in Zone F, while Tinley Park is in Zone E). As a result, some motorists may decide to park at the Tinley Park/80th Avenue Station rather than the Mokena/Hickory Creek Station because the train fare is less expensive (for riders using a monthly pass, boarding at Tinley Park rather than Hickory Creek would result in a savings of $11 each month (a 10 percent savings).[10]

[9] "Commuter Rail System Station Boarding/Alighting Count, Train-by-Train Detail, Fall 2006", Metra Office of Planning & Analysis, January 2007 (data for Rock Island Line collected on Tuesday, November 14, 2006).
[10] Metra Fare Chart (effective June 1, 2002): http://Metrarail.com/Data/fares-2002-chart.html, accessed February 1, 2007.

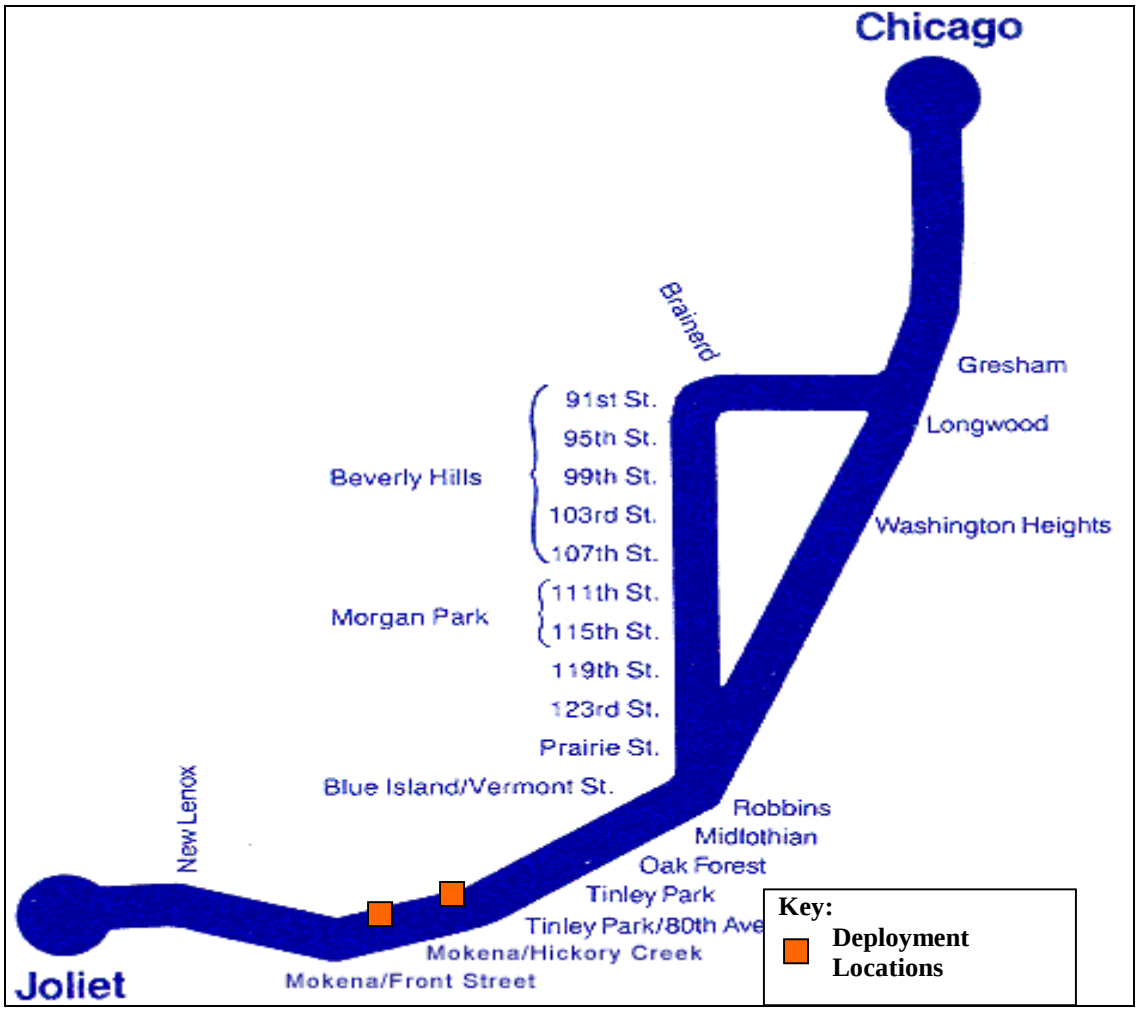

Figure 6. Rock Island Line and Deployment Sites.[11]

2.3.1 Tinley Park/80th Avenue Station

The Tinley Park/80th Avenue Station is situated in a high-growth area and has two parking lots, one to the north of the station and one to the south. Both lots are operated and maintained by the Village of Tinley Park. In total, the station has approximately 2,300 surface spots, 40 of which are designated as handicapped. It is important to note that prior to the addition of 300 new parking spaces in the summer of 2005, the lot was at full capacity on an average weekday. During a site visit in September 2005 it was noted that the lots were not at full capacity.

Various factors may influence a motorist's decision to park in either the north or south lot. For example, patrons who prefer the south lot may do so as it provides faster access/egress to the active-track platform (trains typically arrive and depart from the south track at this station and all pedestrian crossings are at-grade as shown in Figure 7, meaning that if a patron arrives at the

[11] Metra Rock Island District Map, <http://Metrarail.com/Sched/ri/ri.shtml>.

platform once the train is already there, they would have to wait for the next train since they would not be able to board). Conversely, patrons who prefer the north lot may do so as it typically allows for easier access to major arterials, which can help them make a quick exit at the end of the day. As shown in Figure 8, patrons leaving from the north lot have direct access to 80th Avenue, the roadway used to exit the Tinley Park/80th Avenue station (note that 80th Avenue dead ends at the north lot). Patrons leaving the south lot must yield to heavy southbound traffic (on 80th Avenue) in order to make a left-hand turn onto southbound 80th Avenue. As a result, it often takes more time for patrons to exit the south lot.

During the site visit, it was noted that unnecessary circulation was occurring as motorists tried unsuccessfully to park in their preferred lot before resorting to the other lot. Now that the system is in place, the two VMSs located closest to the Tinley Park Station provided parking availability information for the north and south lots (as shown in the schematic in Figure 2). This additional information was expected to eliminate any unnecessary circulation between the two Tinley Park lots.

Figure 7. Both Stations have an At-Grade Pedestrian Crossing.

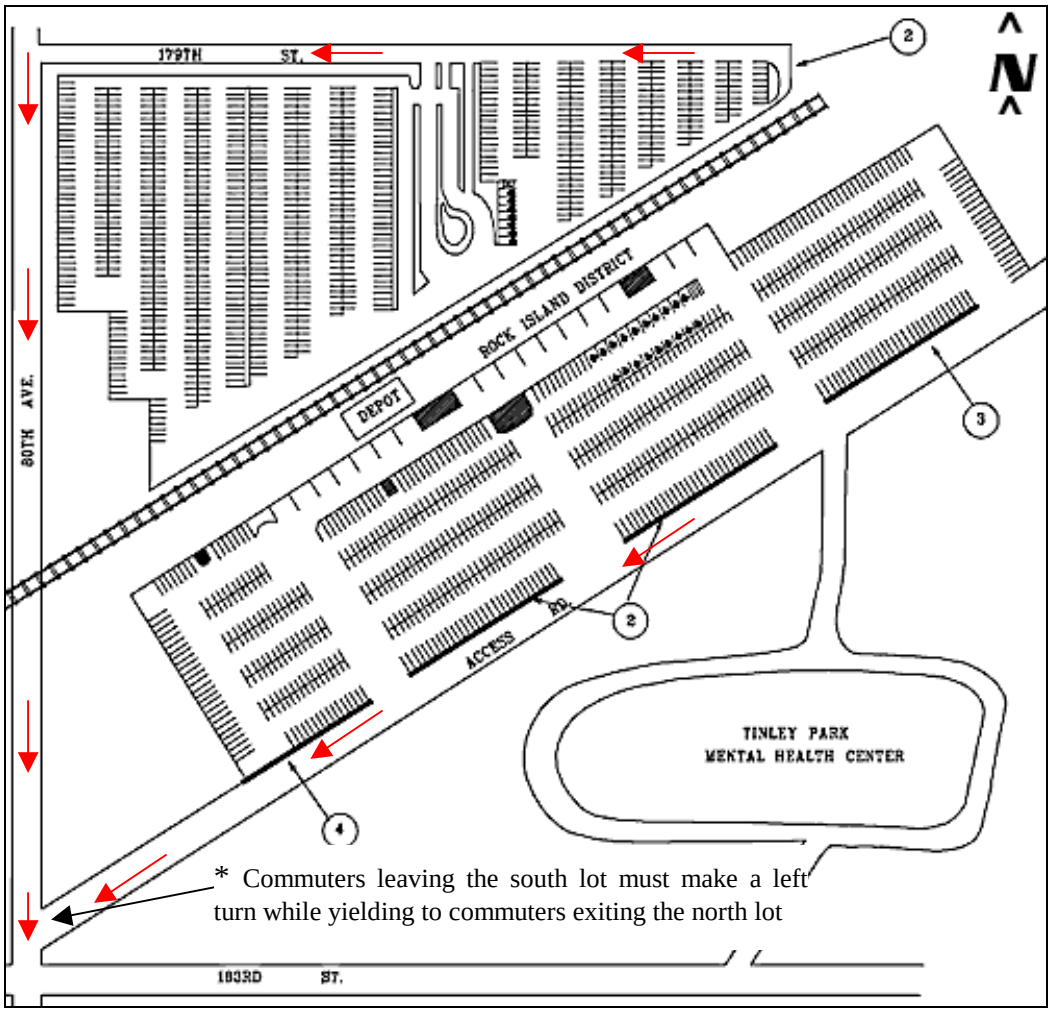

Figure 8. Schematic of Tinley Park/80th Avenue Station.[12]

2.3.2 Mokena / Hickory Creek Station

The Mokena/Hickory Creek Station is located one stop further away from downtown Chicago. It is operated and maintained by the Village of Mokena and consists of one lot with multiple entrances and exits onto Hickory Creek Drive as shown in Figure 9. A total of 1,300 parking spaces are currently available at this station. During the planning of the project, Metra estimated that approximately 70-80 percent of the parking spaces at this station were utilized on an average weekday.[13]

[12] Metra Rail Mokena/Hickory Creek Station Summary, <http:www.Metrarail.com/Station-maps/6251.gif>, last accessed April 21, 2008.
[13] Ibid, <http://www.Metrarail.com/Sched/ri/hicory_creek.html>, last accessed April 21, 2008.

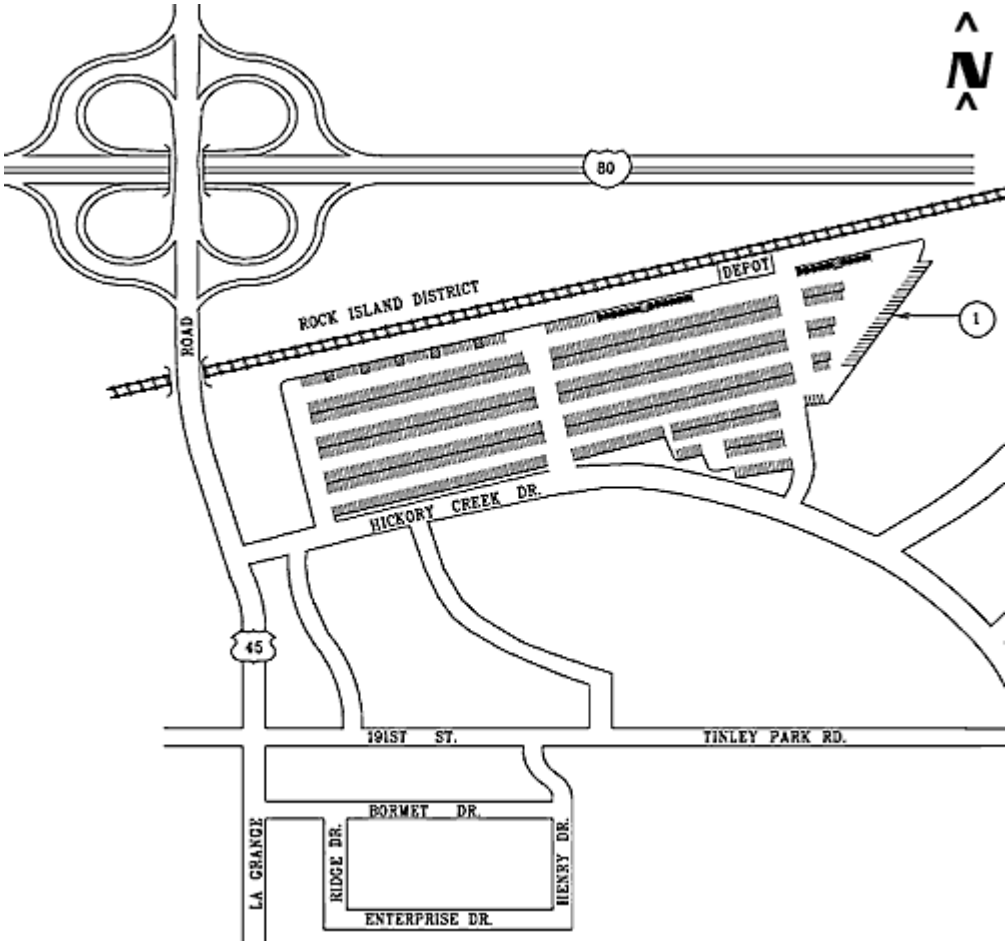

Figure 9. Schematic of Mokena / Hickory Creek Station.[14]

2.4 Evaluation Approach / Data Collection Methodologies

A set of test hypotheses was developed to assess the impacts of the system at the Tinley Park and Hickory Creek Stations. Each hypothesis was tested by collecting data before and after system deployment and by analyzing this data to determine if there is a measurable difference that can be attributed to the system. The specific test hypotheses for the evaluation were divided into two categories: key and secondary. While both sets of hypotheses are important to this evaluation, it is believed that the key hypotheses have greater value for determining the impacts of the system. The hypotheses are provided below.

Key Hypotheses:

- The system will increase parking utilization at the Mokena/Hickory Creek and the Tinley Park/ 80th Avenue Station parking lots.
- The availability of real-time information will positively affect customer satisfaction.

[14] Metra Rail Mokena/Hickory Creek Station Summary, <http:www.Metrarail.com/Station-maps/6251.gif>, last accessed April 21, 2008.

Secondary Hypotheses:

- The system will reduce traffic circulation between the north and south Tinley Park/80th Avenue Station parking lots.
- The system will reduce traffic circulation between the Tinley Park/80th Avenue Station and the Mokena/Hickory Creek Station.
- The system will result in an increase in ridership on the Rock Island District Line as parking utilization increases at the Tinley Park/80th Avenue and Mokena/Hickory Creek Stations.
- The system will result in an increase in transit mode share among commuters whose origins lie near the Mokena/Hickory Creek and Tinley Park/80th Avenue Stations.
- The system will result in an increase in mid-day arrivals at the Mokena/Hickory Creek and the Tinley Park/80th Avenue Station parking lots.

Table 1 outlines the hypotheses for the Chicago evaluation, and for each hypothesis, identifies one or more MOEs that will be used to assess the hypothesis. The data sources and analysis approaches that will be used to compute the MOEs are also illustrated.

Table 1. Evaluation Approach for Chicago Project

Hypothesis	MOE	Data Source	Proposed Analysis
The system will increase parking utilization at the Mokena/Hickory Creek and the Tinley Park/80th Avenue Station parking lots.	Parking utilization at both lots.	In and out counts at both lots via system.	Before/after comparison of parking utilization at both lots.
The system will positively affect customer satisfaction.	Rider-reported level of satisfaction with transit.	Customer intercept surveys.	Analysis of surveys.
The system will reduce traffic circulation between the north and south Tinley Park/80th Avenue Station parking lots.	Rider-reported improvements in traffic circulation.		
The system will reduce traffic circulation between the Tinley Park/80th Avenue station and the Mokena/Hickory Creek station.			
The system will result in an increase in ridership on the Rock Island District Line as parking utilization increases at the Tinley Park/80th Avenue and Mokena / Hickory Creek Stations.	Ridership on the Rock Island District Line and ridership on the SouthWest Service Line.	Two days of ridership data collected from 5:00AM to 12:00PM at each of four stations: - Tinley Park / 80th Avenue - Mokena / Hickory Creek - 153rd / Orland Park - 179th / Orland Park	Before/after comparison of ridership figures at the four stations.

Hypothesis	MOE	Data Source	Proposed Analysis
	Rider-reported transit-use.	Customer intercept surveys.	Analysis of surveys.
The system will result in an increase in transit mode share among commuters whose origins lie near the Mokena/Hickory Creek and Tinley Park/80th Avenue Stations.	Rider-reported transit-use.	Customer intercept surveys.	Analysis of surveys.
The system will result in an increase in mid-day arrivals at the Mokena/Hickory Creek and the Tinley Park/80th Avenue Station parking lots.	Number of patrons arriving during the mid-day at each of the lots.	Mid-day in/out vehicle counts at both lots via system.	Before/after comparison of number of vehicles entering/exiting both lots during mid-day.
The system will result in a reduction in circulation within the Mokena/Hickory Creek and the Tinley Park/80th Avenue Station parking lots.	Number of drivers unable to find a parking space at each of the lots.	In and out counts at both lots via system.	Before/after comparison of number of vehicles exiting both lots during AM peak period.
	Rider-reported ease of finding a parking space.	Customer intercept surveys.	Analysis of surveys.

2.4.1 Ridership and Parking Utilization Data

In order to determine if there were any changes in parking utilization at the Mokena/Hickory Creek and the Tinley Park/80th Avenue parking lots after the addition of the parking information system, the evaluation team reviewed a range of data sources.

It would seem logical to first look at Metra ridership data to see if ridership changed at either of the two stations. However, since Metra offers a wide range of ticket classes (one-way, 10-ride, monthly), and since tickets are verified through ticket-checking on the train rather than through electronic means, it is difficult to obtain an accurate measure of ridership based on ticket sales alone (e.g., a patron who typically makes more than 15 round trips on Metra each month would find it more economical to purchase a monthly pass than a series of 10-ride tickets, and there is no way to know how often they are making a trip). As a result, the only detailed ridership numbers available are those provided by a system-wide boarding-and-alighting study that Metra conducts every 4 years. The evaluation team obtained and reviewed data from the two most recent studies that were conducted in 2002 and 2006.

The team also obtained archived system data from Metra documenting hourly in/out vehicle counts. The "after" data provided by Metra to the team covered the time period August 29, 2006-August 20, 2007. To obtain comparable data on parking utilization at the two stations before the addition of the system, RTA and Metra agreed to leave the system turned "off" to motorists for two weeks in August 2006 after the counting and recording mechanism was in

place and operating properly to the best of their knowledge. The "before" data provided by Metra to the team covered the time period August 14, 2006-August 28, 2006.

Another source of data that provides some insight into ridership is parking usage as recorded based on parking sales at the two stations. Patrons are required to pay one dollar each time they park, and these funds are collected through an honor system. These funds are collected and recorded on a daily basis by the jurisdiction responsible for the station (in the case of the Tinley Park Station, the Village of Tinley Park maintains the lot and collects the fees). The evaluation team obtained data from the Village of Tinley Park and the Village of Mokena and compared these data with data archived by the system to get a sense for the accuracy of the data.

2.4.2 Customer Intercept Surveys

The primary method used to obtain customer reactions to the system was through an intercept survey of transit riders. Surveys were administered at the Hickory Creek and Tinley Park stations over a two-day period in March 2007. The surveys were designed to address the following hypotheses:

- The availability of real-time parking information will positively affect customer satisfaction.
- The accuracy of real-time parking information will reduce driver frustration.
- The availability of parking information will help drivers determine when to exit the freeway.
- The system will increase parking utilization at the two lots.
- Metra ridership and mode share will increase as parking utilization increases.
- Circulation will be reduced within the lots at both stations.
- Circulation will be reduced between the two lots at the Tinley Park/80th Avenue Station.

The survey instruments can be found in the Appendix. The survey is comprised primarily of multiple choice questions to ensure that it could be completed in less than 5 minutes so that it would not intrude upon the riders' daily commute.

The survey team consisted of four members of the evaluation team who distributed surveys, as well as two staff from RTA who supported the effort by collecting surveys from patrons as they exited the train at the LaSalle station downtown. The team distributed and collected surveys at the Hickory Creek Station on Tuesday, March 13, 2007 and at the Tinley Park Station on Wednesday, March 14, 2007.[15] Surveys were distributed throughout the entire duration of the morning at both stations, beginning with the first departing train at 5:22 AM / 5:26 AM, and ending with the last train of the morning departing at 10:41 AM / 10:44 AM (see the train schedule shown in Table 2).

Surveyors intercepted patrons as they arrived on the platform, explaining the purpose of the survey and asking that they take a few minutes to complete the survey either while waiting for the train or while riding the train, explaining that there would be survey collectors at the LaSalle Station downtown). If the respondent agreed to take the survey, they were then provided a hard copy of the survey (printed front-to-back on heavy cardstock) along with a golf-sized pencil.

[15] The evaluation team intentionally avoided Mondays and Fridays for data collection since ridership tends to be lower on those days.

Surveyors screened for patrons meeting the following three criteria:

- *They drove and parked at the station that day (or they typically drive and park at the station).* The rationale behind this criterion was that since the system does not benefit those who walk or bike to the station or those who use the kiss-and-ride facility, it is only useful to gather inputs from those who drive.
- *They have seen the new signs.* In order to gather sufficient information regarding customer's perceptions of the signs, it was important to survey patrons who had seen the signs and would therefore be able to provide insightful responses. Note that this criterion did not limit the sample since nearly every individual approached indicated that they had seen the signs.
- *They will be alighting the train at the LaSalle Station.* Due to the way in which the surveys were collected, only those alighting at LaSalle could complete the survey. As expected based on Metra's knowledge of ridership patterns, this criterion did not limit the sample at all since every patron approached by the survey team met this criteria.

To determine a target sample size, the evaluation team looked to the most recent ridership numbers that were available at the time of the survey collection (those collected by Metra in the fall of 2002).[16] The total number of daily boardings at the two stations in 2002 was 3,193. Given these ridership figures, the surveyors' goal was to collect 625 surveys in total between the two stations, or approximately 20 percent of the total estimated boardings. Given that the numbers indicated that ridership was higher at the Tinley Park/80th Avenue Station (approximately twice that of the Hickory Creek Station), the goal was to obtain at least 425 surveys at the Tinley Park Station, and at least 200 surveys at the Mokena/Hickory Creek Station.

The evaluation team collected 578 surveys at Tinley Park (exceeding the target of 425 surveys), and 324 surveys at the Mokena/Hickory Creek Station (again exceeding the target of 200 surveys), for a total of 902 responses. This sample accounts for approximately 28 percent of total boardings at the two Rock Island Line stations. The response rate at both stations was high: 64 percent at Hickory Creek and 56 percent at Tinley Park.

[16] "Commuter Rail System Station Boarding/Alighting Count, Train-by-Train Detail, Fall 2002," Metra Office of Planning & Analysis, January 2003.

Table 2. Schedule for Rock Island Line

Mokena / Hickory Creek	Tinley Park - 80th Ave	Chicago (LaSalle St.)
5:22 AM	5:26 AM	6:14 AM
5:51 AM	5:56 AM	6:45 AM
6:10 AM	6:15 AM	7:02 AM
6:32 AM	6:37 AM	7:27 AM
6:49 AM	6:54 AM	7:44 AM
7:08 AM	7:13 AM	8:01 AM
7:23 AM	7:28 AM	8:12 AM
7:38 AM	7:43 AM	8:27 AM
7:56 AM	8:01 AM	8:48 AM
8:41 AM	8:44 AM	9:45 AM
9:41 AM	9:44 AM	10:45 AM
10:41 AM	10:44 AM	11:45 AM

2.4.3 Focus Group

In order to better understand how users and potential users of the Metra Rock Island District commuter train line feel about and respond to the several message signs that convey parking availability at the Mokena/Hickory Creek and Tinley Park/80th Avenue locations, the evaluation team conducted a focus group in October 2007. The focus group was designed to address the following topic areas:

- Commuting Patterns and Options
- Mode Choices
- Driving Conditions/Use of Pre-Trip Traveler Information
- Perceptions of the Parking Information Signs

The 90-minute focus group was conducted at a professional focus group facility in Mokena, Illinois and was led by a professional facilitator. Two members of the evaluation team observed the group. Participants were informed that the study team would be observing their responses to the questions but they were not in any way affiliated with the local or State Departments of Transportation, or with Metra or RTA.

The focus group facilitator screened for a mix of participants. All participants indicated that they commute to downtown Chicago at least 3 times each week during the morning rush hour and that the beginning of their commute is along I-80. The facilitator then screened to ensure that the group contained a mix of those who:

- Typically commute via the Rock Island Line, but just started riding within the last year (with the idea that those who began riding Metra within the past year may have made the switch due to the signs).
- Typically do not ride the Rock Island Line but say they would definitely consider riding.

- Typically do not ride the Rock Island Line but say they might consider riding.

Ten people were selected to participate in the focus group. Six selected were males and four were females. All had been in the area for at least 2 years with three people living in the area for more than 20 years. Four of the people indicated that they currently use Metra as their primary means for commuting, and of the remaining six (who all typically commute by car), half indicated that they would definitely consider riding Metra and the other half indicated that they might consider riding Metra. The participants had a mix of education levels with seven of the ten having completed at least some college or having a college degree.

2.5 Findings

2.5.1 Impact of the System on Ridership, Parking Utilization, & Arrival Patterns

The project stakeholders and evaluation team expected that use of the two stations might increase as a whole due to the system since it was thought that lack of parking at stations along the Rock Island Line might be a perceived barrier to riding Metra.

2.5.1.1 Ridership based on Metra Boarding-and-Alighting Studies

As discussed previously, it would seem logical to first look at Metra ridership data to see if ridership changed at either of the two stations. However, since Metra offers a wide range of ticket classes (one-way, 10-ride, monthly), and since tickets are verified through ticket-checking on the train rather than through electronic means, it is difficult to obtain an accurate measure of ridership based on ticket sales alone (e.g., a patron who typically makes more than 15 round trips on Metra each month would find it more economical to purchase a monthly pass than a series of 10-ride tickets, and there is no way to know how many trips monthly passholders make each month) As a result, the only detailed ridership numbers available are those provided by a system-wide boarding-and-alighting study that Metra conducts every 4 years.

The two most recent studies (conducted in 2002 and 2006) show that there were 1,133 weekday boardings at the Hickory Creek Station in 2002,[17] and that the boardings increased to 1,224 in 2006[18] (an 8.9 percent increase over 2002). At the Tinley Park Station the numbers climbed from 2,287 weekday boardings in 2002, to 2,448 boardings in 2006 (a 7.1 percent increase). The parking management system was turned on to motorists in August 2006, so it is possible that some portion of this increase could be due to the system. However, any increases in ridership resulting from the system could be masked by decreases in ridership that were expected to result from riders being drawn over to the adjacent SouthWest Service Line due to service improvements.[19] In addition, any number of factors such as population increases or rising gas

[17] "Commuter Rail System Station Boarding/Alighting Count, Train-by-Train Detail, Fall 2002," Metra Office of Planning & Analysis, January 2003 (data for Rock Island Line collected on Tuesday, October 29, 2002).

[18] "Commuter Rail System Station Boarding/Alighting Count, Train-by-Train Detail, Fall 2006," Metra Office of Planning & Analysis, January 2007 (data for Rock Island Line collected on Tuesday, November 14, 2006).

[19] As of January 2006, twice as many trains now serve the SW line each weekday. Metra origin-destination studies indicate that commuters who live near the SouthWest Service Line previously traveled out of their way to ride the Rock Island Line because the service was more frequent than the SouthWest Service Line and because service ran later in the evening. As a result of this service change, Metra expected to see a slight decrease in ridership on the Rock Island Line as some commuters switched to the SouthWest Service Line. Metra expected that it might take as long as 12 months for ridership on the two lines to reach steady state following this change (Information gathered through phone conversation with Metra's Director of Planning on November 21, 2005).

prices could have caused a portion of the ridership increase. Furthermore, the system only benefits those who *drive* to the station (rather than those who walk/bike or use kiss-and-ride), and some of this ridership increase could in fact be comprised of individuals who walk or bike to the station, or who use the kiss-and-ride facility.

2.5.1.2 Ridership based on Archived In/Out System Data

A better indicator of whether the system caused an increase in ridership would be the number of vehicles parking at the station before and after the addition of the parking management system (with the assumption that most vehicles parking in the lot are single occupancy vehicles). This eliminates those who walk/bike or use kiss-and-ride. The evaluation team looked at the archived system data (in/out counts at parking lots at the two stations) to determine if any difference in parking utilization or arrival patterns were evident in the data. After reviewing the data archived for the time period August 14, 2006 – August 20, 2007, the evaluation team selected two dates to use for determining trends in lot usage. The original intent had been to compare the entire 2 weeks of "before" data to the same 2 weeks of "after" data from the following year – or to at least compare one full week of data from each year – but unfortunately there was not one week for which the data was complete in both 2006 and 2007 that could be used for comparison. The data contained numerous inconsistencies, which made comparing dates/days more difficult than had been anticipated.

The two dates selected for comparison purposes were August 17, 2006 (before the system), and August 9, 2007 (after the system). Note that both dates are Thursdays to ensure a meaningful comparison. These dates are used for comparison throughout the report, and for matters of simplification they are referred to by month and year only. Note that the system does not archive in/out counts directly; rather it records the number of vehicles entering and exiting the lot during each 10-minute period as well as the number of "free" spaces as determined by the system algorithms. Therefore, the evaluation team determined the number of spaces occupied by subtracting the number of "free" spaces from the total number of spaces,[20] and by then calculating the entrances and exits for each 10 minute increment based on changes in space availability.

Figure 10 shows parking utilization at the two lots throughout select months during 2006 and 2007 (note that the system was turned on to the public in August 2006, so this graphic represents utilization *after* the system was in place). Data from January 2007 and September 2008 were missing significant pieces of data and were therefore not included in this comparison. The average number of occupied spaces by month for Hickory Creek ranged from 802-958 with the greatest number of occupied spaces registering in March and the lowest in December 2006. Tinley Park had a bit more fluctuation, with space utilization ranging from 1,607-1,878. The greatest number of occupied spaces was recorded in October 2006 and the lowest number was recorded in November 2006. It is not surprising that the numbers were lowest in November and December due to the holiday season.

However, November 2007 data showed a significant increase in usage from 2006 to 2007. In November 2006 an average of 806 spaces were used in Hickory Creek with that number jumping

[20] Note that the "total" was actually the threshold used in the system as described earlier.

to 931 in November 2007 (an increase of 15.6 percent). At Tinley Park the result was the same. In November 2006 an average of 1,607 spaces were used and in November 2007 that number rose to 1,808 (a 12.5 percent increase). Data for October 2006 and 2007 showed a slight decrease in average usage with a 1 percent decline at Hickory Creek and a 3 percent decline at Tinley Park. December 2006 and 2007 showed a slight increase in usage with a 7.1 percent increase at Hickory Creek and 2.1 percent increase at Tinley Park.

Surprisingly, neither station appears to be at or near capacity (even at its peak, Tinley Park was only at 82 percent capacity and Hickory Creek was at 74 percent capacity).

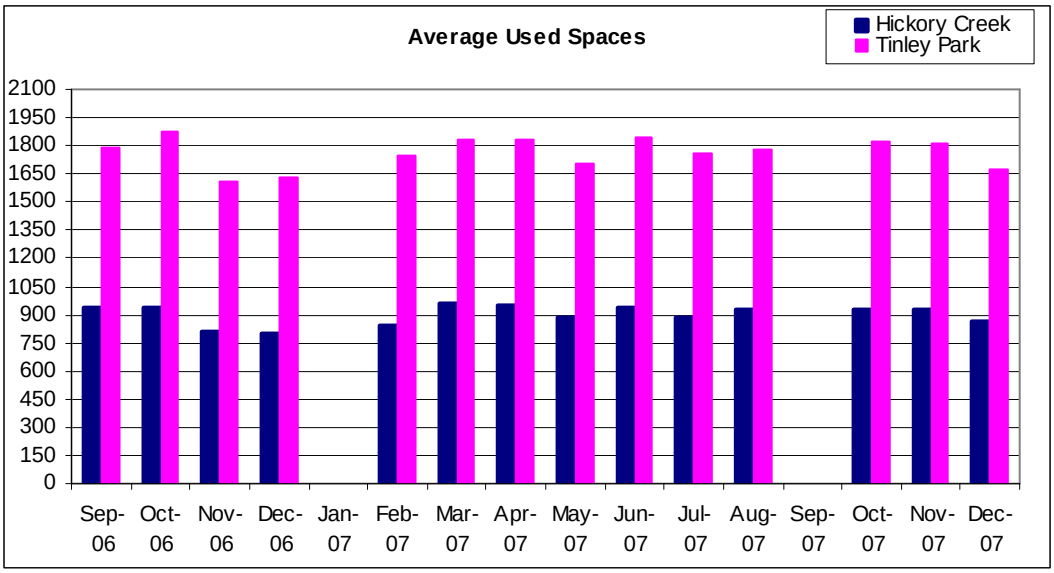

Figure 10. Average Spaces Occupied during Select Months in 2006 and 2007 after System Deployment

Figure 11 and Figure 12 show the space utilization at the Hickory Creek Station and the Tinley Park Station before and after the addition of the parking information system. Recall that the August 2006 data points reflect data collected during the 2-week test phase that occurred before the system was turned on to the public, while the August 2007 data points reflect data collected a year after the system was turned on to motorists.

As can be seen in the graphs, peak daily utilization at Hickory Creek was 5.5 percent higher in August 2007 as compared to August 2006 (923 as compared to 875), while it was only 1 percent higher at Tinley Park (1,820 as compared to 1,802). Again it is impossible to know whether the system directly caused either of these increases or whether they were simply caused by factors such as population increases or rising gas prices.

In terms of utilization throughout the day, there was no change at Hickory Creek (the utilization level off starting around 8:00 AM, and later finally peaked between 12:30 and 1:00 PM in both years) but the peak utilization did change somewhat at Tinley Park. As with Hickory Creek, the utilization began leveling off around 8:00AM in both years, but the time that it finally reached its peak was between 11:40 AM and 12:30 PM in 2006, and at 1:40 PM in 2007.

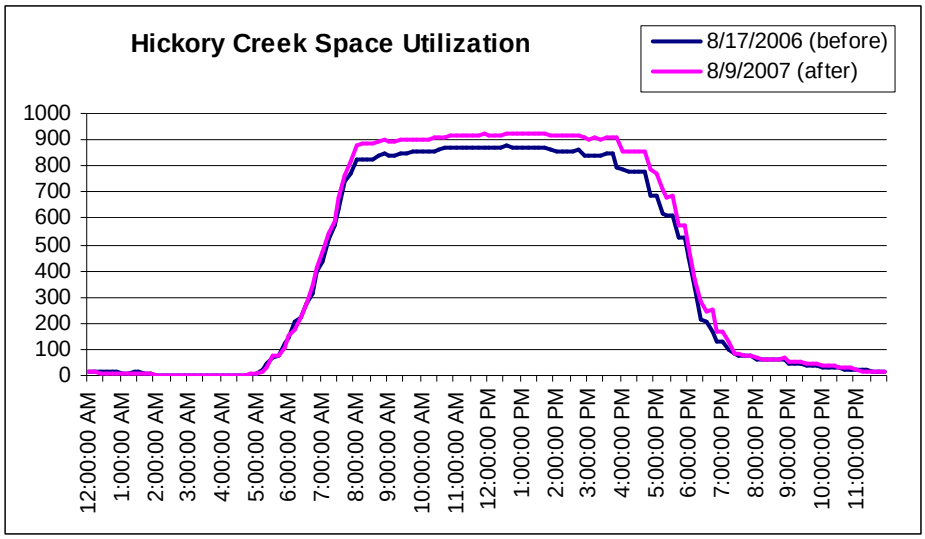

Figure 11. Space Utilization at Hickory Creek Station.

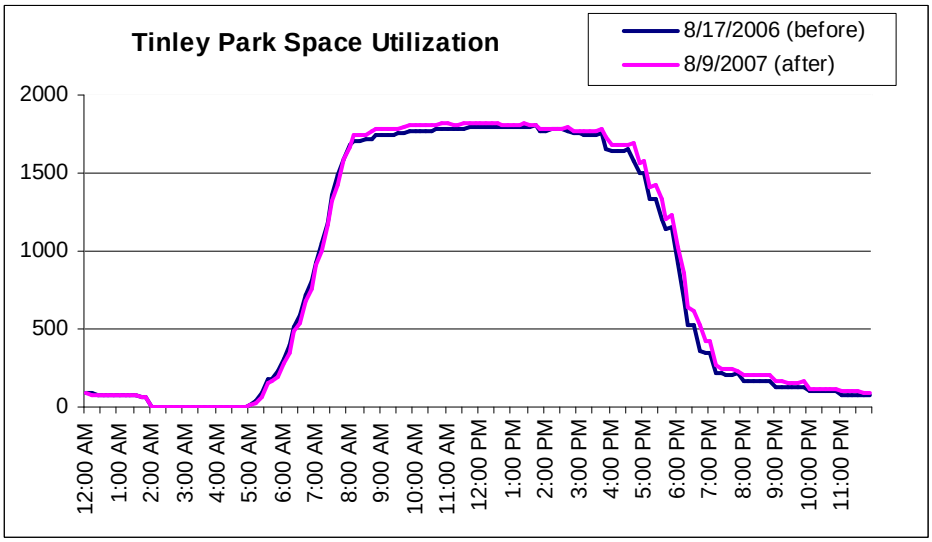

Figure 12. Space Utilization at Tinley Park Station.

2.5.1.3 Ridership based on Parking Revenue Collected

Another source of data that provides some insight into ridership is parking usage as recorded based on parking sales at the two stations. Patrons are required to pay one dollar each time they park, and these funds are collected through an honor system (before leaving the lot, patrons place a dollar in a slot assigned to their parking space). These funds are collected and recorded on a daily basis by the jurisdiction responsible for the station (the Village of Tinley Park maintains the lot and collects the fees at the Tinley Park Station; the Village of Mokena maintains the lot at the Hickory Creek Station). The evaluation team obtained data from the Village of Tinley Park for the period of time August 2006 to September 2007, and compared these data with data archived by the system to get some sense for the accuracy of the data. For simplification purposes, Figure 13 shows a small slice of this comparison for a period of 8 business days in November 2007. As can be seen in the graph, the Metra data follows the same pattern as the

Village data with only small discrepancies between the two data sets (2.5 percent or less). This small discrepancy is likely due to either lack of payment by some patrons or due to some small inaccuracies in the system.

The evaluation team also obtained data from the Village of Mokena for August 2006 and 2007 and compared these data with in/out data archived by the system. Discrepancies between these data sets were a little larger, ranging from 2.7 percent to 7.6 percent. However, as with Tinley Park, the numbers from the archived system data were slightly but consistently higher than those from the parking payment data. From a customer perspective it is better to under-report than over-report the number of spaces available.

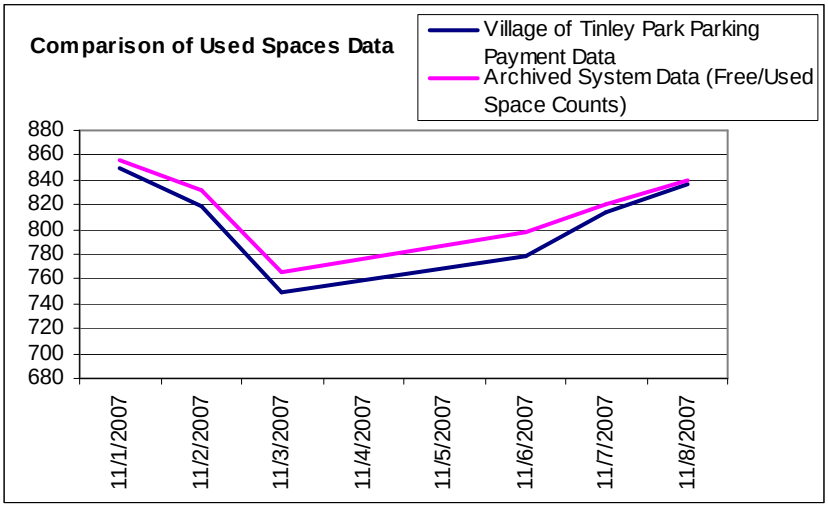

Figure 13. Comparison of Used Spaces Data Collected by the Village of Tinley Park and Metra.

It was expected that the system might result in an increase in arrivals during mid-day hours in particular, as those departing later in the morning might have previously avoided taking Metra, thinking that the parking lot would be full. Therefore when looking at patterns in arrival rates, the team focused in particular on the mid-day period. The data show that there are very few arrivals during the mid-day, and that the system did *not* cause a significant increase in mid-day arrivals at either lot. As shown in Figure 14 and Figure 15, at Hickory Creek there were a total of 10 mid-day arrivals in August 2006 (defined as those arriving between 11:00 AM and 2:00 PM), and 15 in August 2007. At Tinley Park there were a total of 31 mid-day arrivals in August 2006, and 18 in August 2007. The low number of mid-day arrivals is not surprising considering that the train departs these stations only every hour beginning around 9:00 AM.

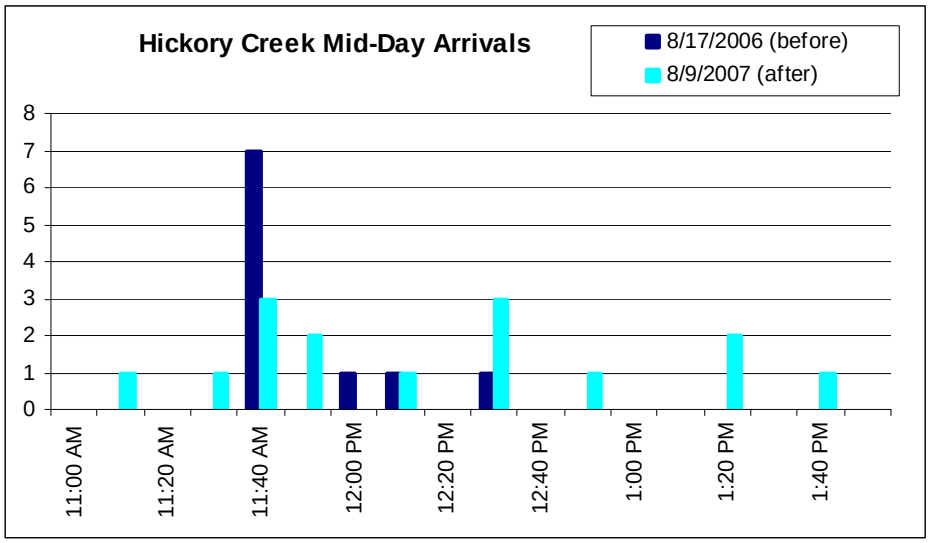

Figure 14. Vehicle Entrances during Mid-Day (11:00 AM-2:00 PM) at Hickory Creek.

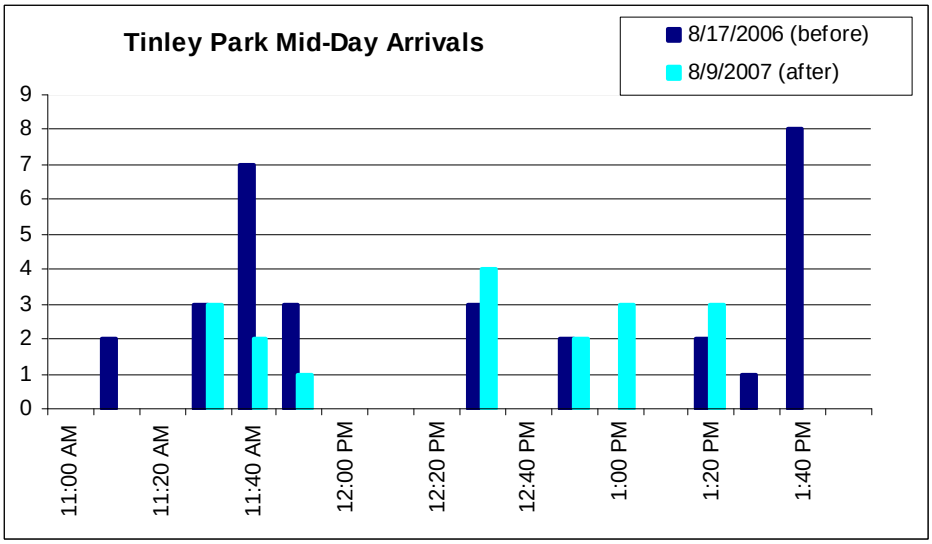

Figure 15. Vehicle Entrances during Mid-Day (11:00-2:00 PM) at Tinley Park.

2.5.2 Impact of the System on Mode Choice

Since it was thought that lack of parking at Metra Stations along the Rock Island Line might be a perceived barrier to riding Metra, it was hypothesized that some motorists might be encouraged to switch modes to transit after seeing a sign indicating that there is in fact parking available (in particular on days of heavy traffic). To assess this directly from respondents, respondents were asked a number of questions on the survey related to mode choice; a portion of the focus group focused on issues related to mode choice as well.

2.5.2.1 Focus Group

For the focus group, the screener ensured that one-third of the group was comprised of individuals who indicated that they began riding Metra regularly within the past year (i.e., since the signs were installed), with the idea that it would be interesting to learn whether the signs

played any role in their decision. However, as it turned out, most of these individuals who recently made the switch to Metra attributed their decision to a change in their job where travel to downtown Chicago became necessary and the Metra Rock Island commuter train option became a feasible option. One participant indicated that he takes Metra whenever possible, but that he often has to drive since he needs access to his car. This particular individual attributed his choice to ride Metra as a constant trade-off to be made between the cost of traveling by car (with the cost of parking being a significant factor) versus by train. No one, however, mentioned concerns about parking availability at Metra Stations as a factor in their decision.

It should be noted that the focus group members who regularly use the Tinley Park and Hickory Creek Stations clearly did not perceive parking to be a problem. Aside from only one mention of a 4-day "carnival" festival held on a "good portion" of the parking lot at the Hickory Creek station every year during the summer (which a group member remarked was announced in advance to Metra users), no one had any recollection of the parking lot ever being full when they personally wanted to park and use Metra. Furthermore, and most probably due to personal experiences, no one had any fear of not being able to find a parking space when they needed one. When probed directly, people replied that they were confident in being able to find parking spots when they needed to use the train.

While the focus group participants indicated that they do not currently rely on the signs, nearly all saw value to having the signs at some time in the future when circumstances make the signs relevant and useful. Circumstances that participants mentioned included roadway construction and inclement weather conditions, both of which were cited as factors that can add to the frustrations of driving. However, the single factor that focus group members saw as having the largest contribution to the signs being used and relied upon more often was the increase in commuting demand for Metra that would naturally be expected with population growth as the suburbs surrounding the stations become more completely developed and populated (note that data show that the parking lots at these two stations are only at 85 percent capacity on even the busiest weekdays).

2.5.2.2 Survey

On the survey, respondents were first asked whether the parking space information displayed on the new signs has *ever* caused them to take Metra when they were originally planning to drive to their final destination. This question did not apply to approximately one-quarter of the respondents (26 percent on average between the two stations) since they reported that they almost always use Metra (approximately 84 percent of respondents reported that they use Metra four to five times per week). Of the remaining respondents, only 2 percent of Hickory Creek Station respondents and 4 percent of Tinley Park Station respondents reported that the parking availability information has caused them to take Metra instead of driving (see Figure 16).

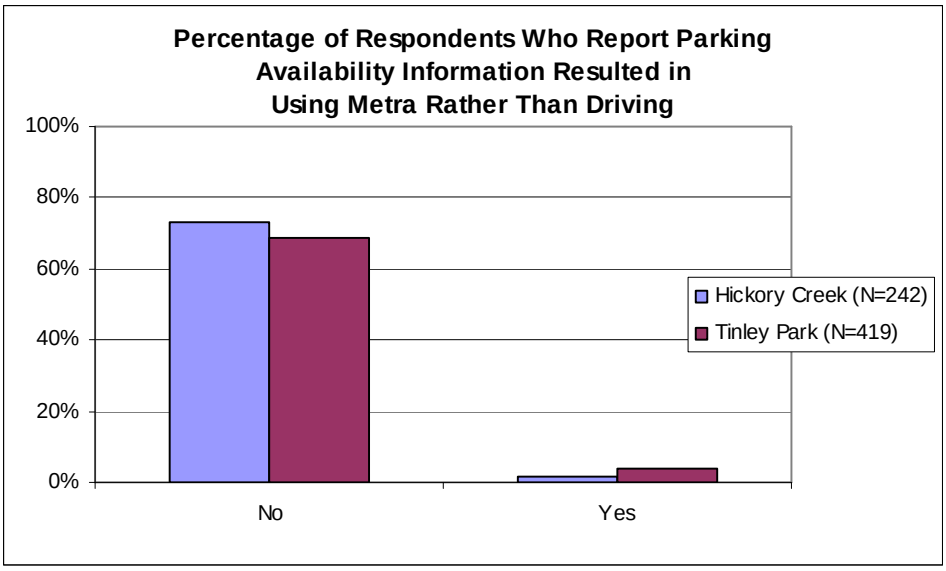

Figure 16. Reported Change in Plans from Driving To Riding Metra.

Next respondents were asked if they feel that the signs have caused them to ride Metra more often. Figure 17 shows that only 4 percent of Hickory Creek respondents and 5 percent of Tinley Park respondents indicated that they feel the signs have led them to ride Metra more frequently (those answering disagree or strongly disagree) while over half of the respondents at both stations (54 percent at Hickory Creek and 56 percent at Tinley Park) indicated that the signs have *not* affected how often they ride Metra (those answering disagree or strongly disagree). A number of respondents answered "N/A" to this question, and the evaluation team believes that many of these respondents are those who do not benefit from the system since they typically arrive at the station early in the morning when there is still sufficient parking.

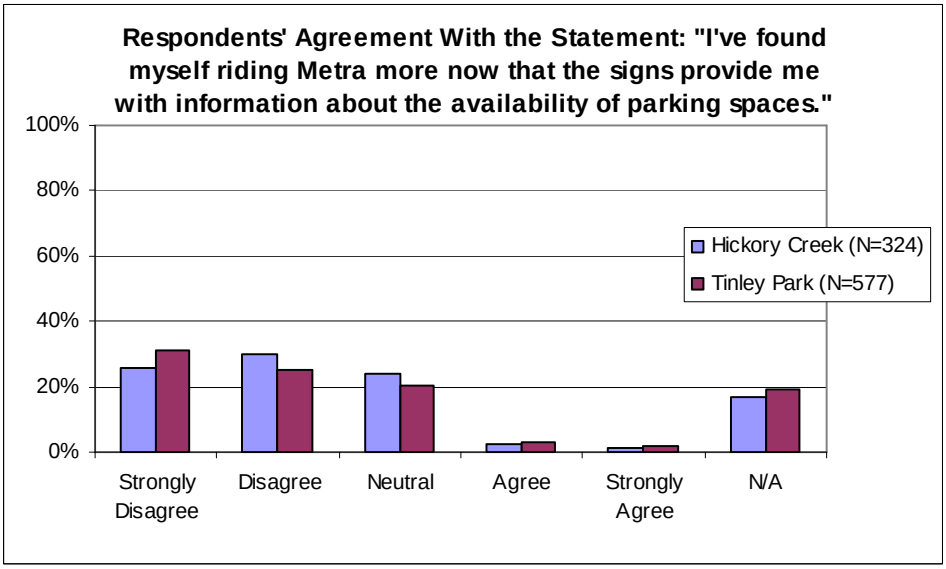

Figure 17. Influence of the Signs' Presence on Frequency of Riding Metra.

Finally respondents were asked whether they agree that the information on the signs has *not* affected how often they rode Metra. As shown in Figure 18, a strong majority at respondents at

both stations (79 and 76 percent at the Hickory Creek Station and Tinley Park Stations, respectively) agreed or strongly agreed that the signs have *not* affected how often they ride Metra. Only 7 percent of Hickory Creek respondents and 9 percent of Tinley Park respondents disagreed or strongly disagreed with this statement, indicating that these respondents feel that they now ride Metra more frequently because of the signs.

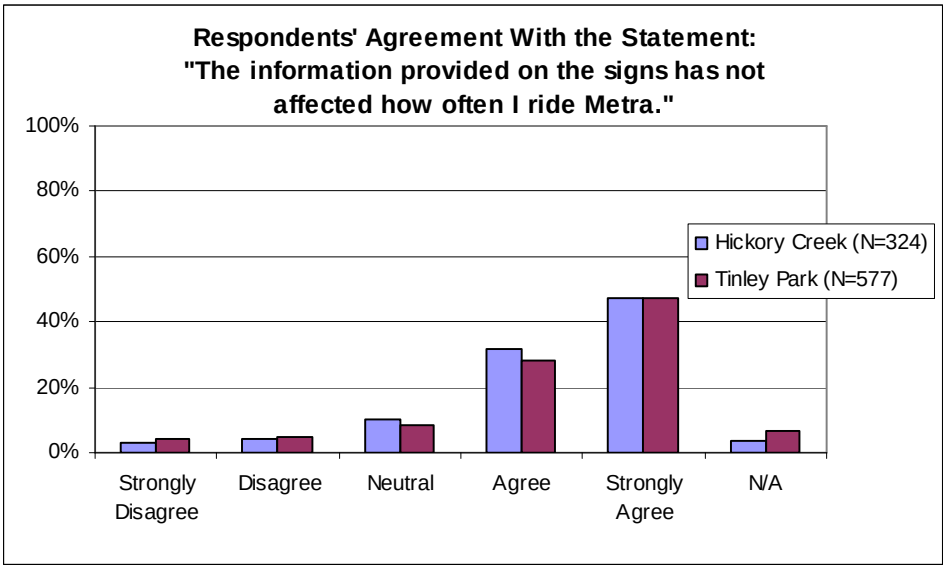

Figure 18. Influence of the Sign Information on Metra Riding Frequency.

2.5.3 Impact of the System on Circulation within and between Lots

As previously discussed, when this project was in its planning stages, unnecessary circulation was occurring between the two lots at the Tinley Park station as many motorists were attempting to park in their "preferred" lot first before resorting to the other lot when finding that the first lot was full. The system was expected to eliminate this unnecessary circulation between the two Tinley Park lots.

As previously discussed, in looking at the data, it does not appear that lack of parking was an issue at the time the system was installed.[21] However, despite the fact that the lots never reached full capacity, patrons may have still felt that the signs saved them time in knowing which lot had availability. In order to determine whether this is the case, the evaluation team examined the in/out counts collected by the system at the two stations. In addition, respondents were asked about circulation on the survey.

[21] Recall that this is in part due to the fact that 300 additional parking spaces were added at the Tinley Park Station in the summer of 2005, which increased parking capacity. As mentioned previously, this could also be due to the fact that service was improved on an adjacent line in January 2006 thereby reducing demand on the Rock Island Line.

2.5.3.1 System In/Out Counts

To determine whether unnecessary circulation remained an issue at the time that the system was deployed[22] and, if so, whether the system remedied this situation, the evaluation team looked to the archived system data. The specific focus was on the number of vehicles exiting the lot during the AM peak period before and after system implementation with the thought that patrons would only be leaving the lot during the AM peak period if they could not find parking. One constraint that should be noted in this analysis is that vehicles dropping off passengers at the "kiss-and-ride" area use the same entry/exit point as those entering the lot to park. As a result, kiss-and-ride vehicles entering and exiting the lot are counted by the system along with vehicles entering the lot to park. However, it seems reasonable to assume that the number of kiss-and-ride vehicles did not change as a result of the system, so any change in vehicles leaving the lot after not finding parking should be apparent.

As with the parking utilization analysis, the evaluation team compared the "before" data that was collected by the system during the 2-week period when it was turned "off" to motorists, to the "after" data archived by the system. From the data, it does not appear that any of the lots reached capacity during the timeframe of the study (whether before or after). As a result, it appears that no vehicles were leaving the lot during the AM peak period other than those using the kiss-and-ride facility.

2.5.3.2 Survey

To determine if parking was a problem at these stations prior to the addition of the signs, and if it is a problem now, survey respondents were asked to report whether they have ever arrived at a station only to find that there were no spaces available. Figure 19 shows responses regarding space availability *prior to* the parking availability signs being put in operation and Figure 20 shows responses regarding space availability *since* the parking availability signs were put in operation.

It does not appear that the information has helped patrons at Hickory Creek. Hickory Creek respondents' answers were relatively unchanged, with 94 and 96 percent, respectively, reporting that they were always able to find a space before and after the addition of the system. At Tinley Park, however, it appears that the system has made a difference. Only 83 percent of respondents indicated that they had previously always been able to find a space, while 96 percent reported that they have always been able to find a space since the system was in place. The reason for this jump, however, could be due to the fact that Metra added 300 new spaces to the Tinley Park lot in the summer of 2005 (one year prior to when the system was turned on to the public in August 2006), and respondents could have recalled incorrectly when responding to this question.

[22] Note that it was uncertain whether parking was still a concern at the Tinley Park Station since 300 parking spaces were added to the lot in the summer of 2005, after the site had already been selected. Prior to the addition of these parking spaces, however, the lot was at full capacity on an average weekday.

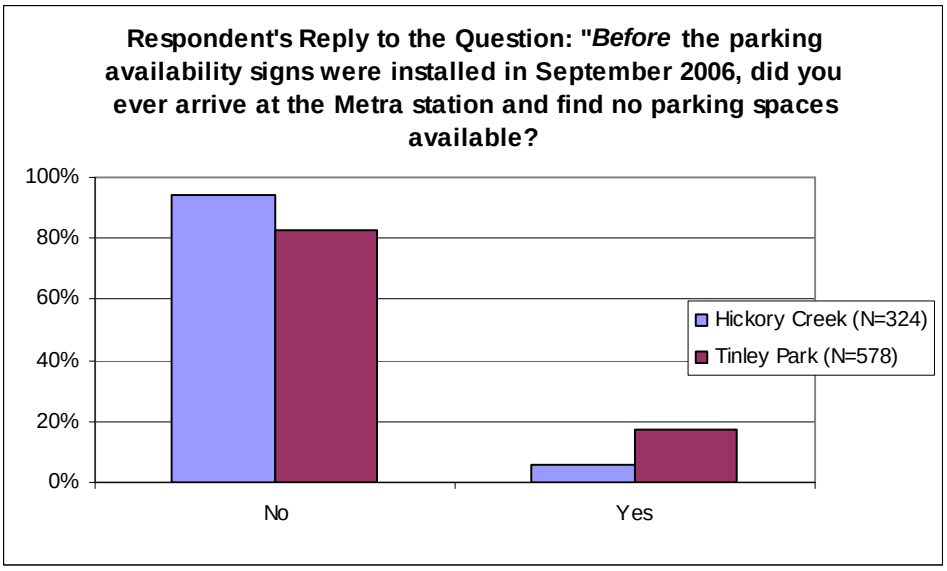

Figure 19. Percentage of Respondents Reporting They Found No Spaces Available Prior to the Parking Availability Signs.

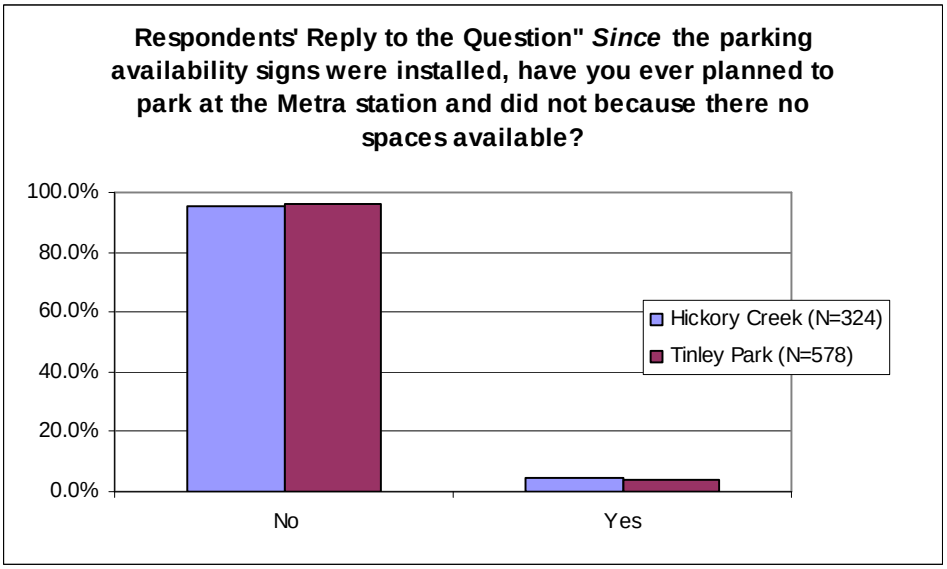

Figure 20. Percentage of Respondents Reporting They Found No Spaces since the Addition of the Parking Availability Signs.

When asked, "What did you do when you found that there was no parking [prior to the addition of the signs]?" Tinley Park respondents provided responses shown in Figure 21. Note that some respondents selected more than one alternative, resulting in a total of 118 responses. Although there was a fairly even split between the five response choices provided, the three most frequent responses were: *(1)* Parked at the Mokena/Hickory Creek Station, 28 percent; *(2)* Drove to my final destination instead of taking Metra, 26 percent; and *(3)* Other, 23 percent. Of the 27 respondents who answered "Other," some common responses included: parked illegally, parked elsewhere, stayed home, or arrived late at destination.

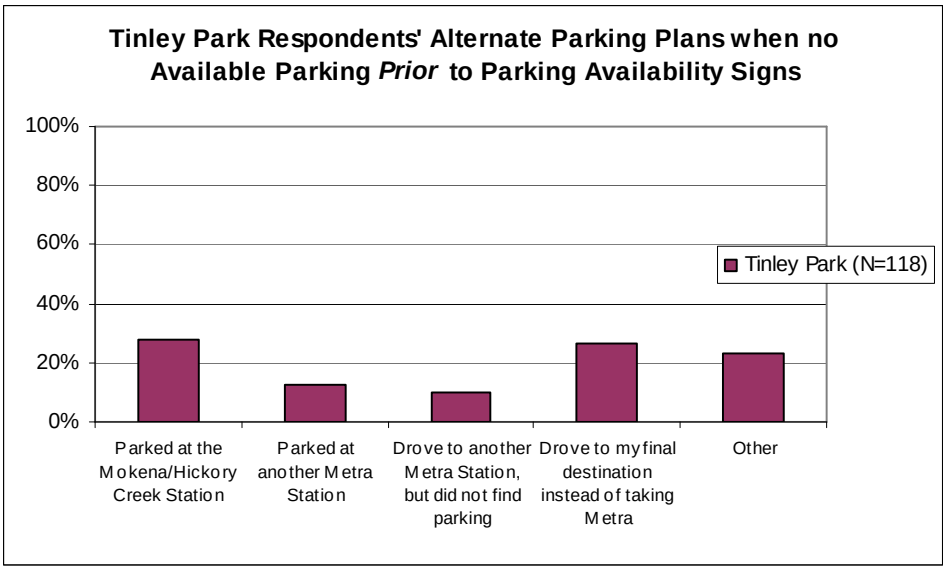

Figure 21. Alternative Plans by Tinley Park Station Respondents upon Finding No Spaces Available Prior to the Presence of Signs.

Respondents were also asked if they feel that the signs have *not* made any difference to them because they have never had trouble finding parking. Figure 22 shows that 73 percent of all respondents on average agreed or strongly agreed that the signs have *not* influenced them because they have never experienced difficulty finding parking. This is consistent with responses to the earlier questions related to parking availability.

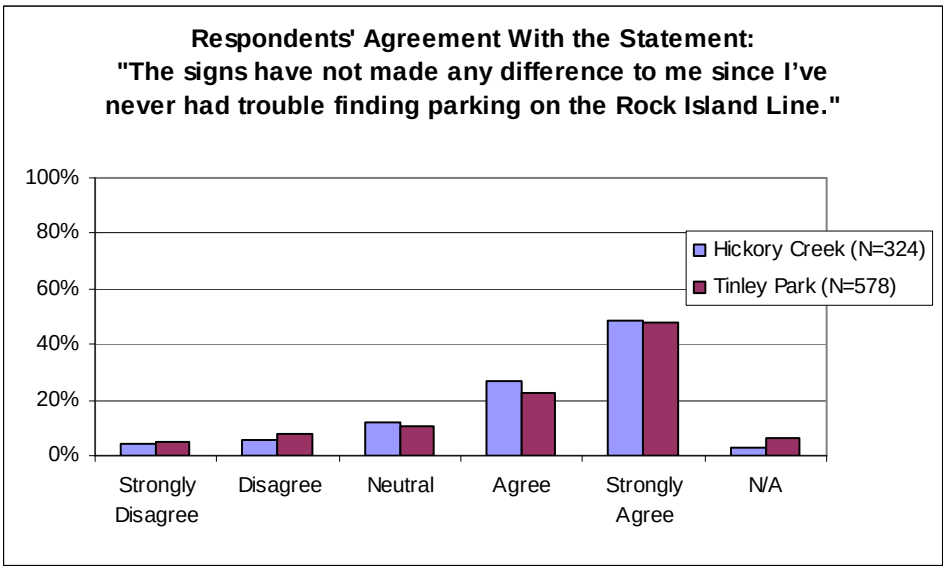

Figure 22. Influence of Signs on Finding Parking.

Figure 23 shows respondents' perceptions of whether or not the signs have reduced the amount of time that they spend searching for available spaces. There was no marked difference in responses between those parking at Hickory Creek versus Tinley Park. Only 14 percent of respondents on average indicated that they feel that the signs have saved them time in finding a parking space. Approximately 42 percent of respondents indicated that the signs do not reduce

the amount of time they spend searching for a space (answering disagree or strongly disagree), with the remaining respondents indicating that they felt neutral on this topic or that they felt that this question did not apply to them.

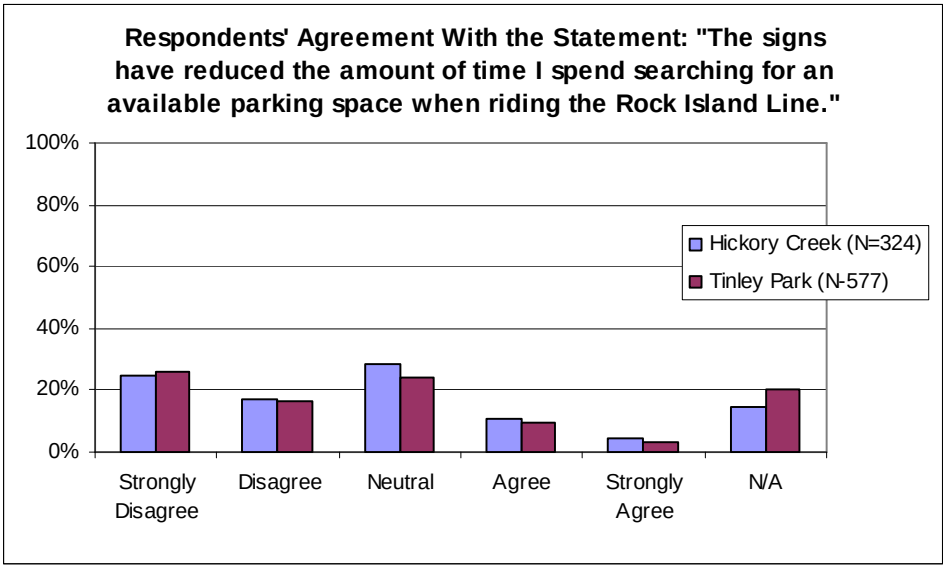

Figure 23. Influence of Signs on Time Spent Searching for a Space.

2.5.4 Customer Satisfaction with the Signs

Several questions on the survey and in the focus group addressed customer satisfaction with the signs. As for the focus group, it should first be noted that all focus group participants had awareness of and familiarity with the signs. In fact, early in the session, a group member brought up the existence of one of those signs before any mention of the signs was made by the facilitator (this was during a discussion of typical commute patterns).

During the focus group discussion, the focus group members discussed and were subsequently probed about the reliability of the signs. Most members indicated that they trust the information displayed on the signs. Participants indicated that they considered the updates to be accurate, and some even mentioned having personally seen the numbers on the signs change, reflecting either a reduction or increase in the number of available parking spaces.

Interestingly, a brief discussion unfolded at one point by a group member surrounding what he would do if he saw only a small number of available spaces displayed on the signs (such as "50"), and he indicated it was likely he would drive rather than risk losing time searching and not finding a parking space (others in the group seemed to agree with this assessment). Another interesting finding of the focus group was that only about half of the group thought the signs were updated in an automated way. Other respondents thought that the signs were updated by lot attendants conducting periodic visual assessments of how many spaces remained.

Survey results indicate that both Hickory Creek and Tinley Park respondents were satisfied with the sign locations and accuracy and would like to see similar signs at other Metro locations. Respondents from both locations disagreed or strongly disagreed, however, that the information of the signs had improved their overall commuting experience.

First respondents were asked if they feel that the signs are appropriately located along their morning commute so that they are able to make important decisions about their trip. Figure 24 shows that commuters at both stations seem to be generally satisfied with the locations of the signs. Nearly half (46 percent) of respondents at Hickory Creek and 41 percent of respondents at Tinley Park responded positively (agreed or strongly agreed) that they were satisfied with the location of the signs.

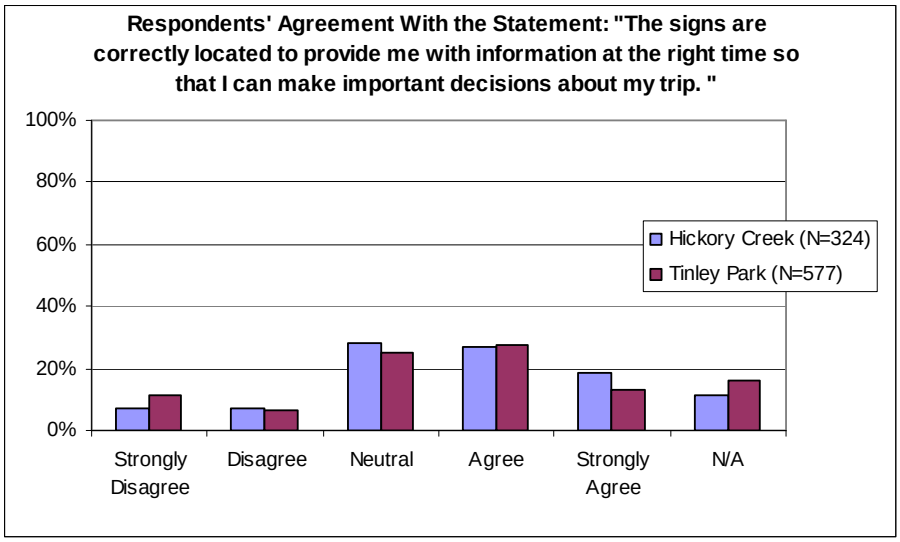

Figure 24. Satisfaction with Sign Location.

Next respondents were asked for their impression of the accuracy of the signs. As shown in Figure 25, on average, 51 percent of respondents indicated that they believe that the sign information is accurate (answering agree or strongly agree). Only 5 percent of respondents indicated that they feel that the information on the signs is not accurate (answering disagree or strongly disagree). Note that many selected the "neutral" response to this question.

Respondents were also asked if they felt that the information on the signs had improved their overall commuting experience. Figure 26 shows that very few respondents agreed with the statement that the parking signs have improved their overall commuting experience. Only 18 percent of respondents at the Hickory Creek Station answered agree or strongly agree, and only 19 percent of respondents at the Tinley Park Station answered agree or strongly agree. Thirty-five percent of all respondents said they were neutral and 31 percent said they disagreed or strongly disagreed that the signs have improved their overall commuting experience.

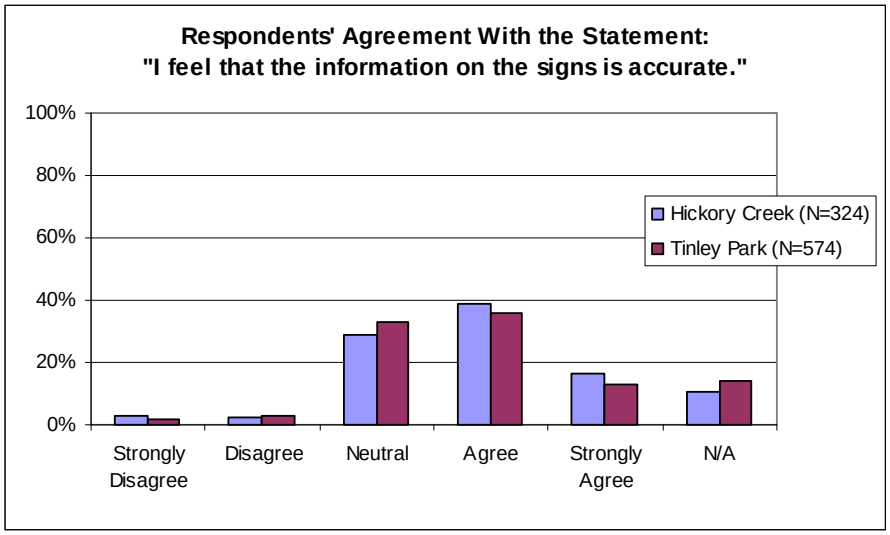

Figure 25. Satisfaction with Sign Accuracy.

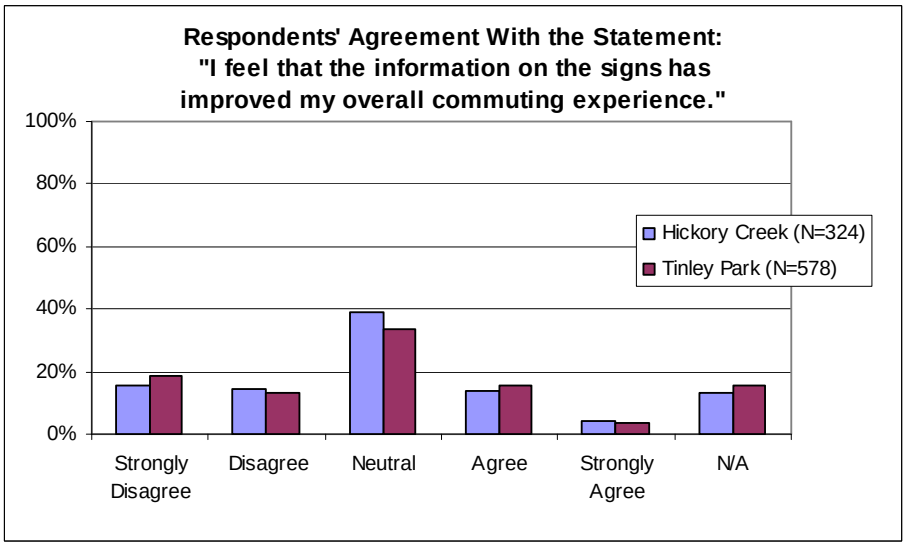

Figure 26. Satisfaction with Commuting Experience.

Finally, respondents were asked whether they would like to see similar signs installed at other Metra stations. Consistent with some of the earlier survey questions related to customer satisfaction, the responses were fairly evenly split between neutral and agree, with only 10 and 16 percent of respondents at Hickory Creek and Tinley, respectively, reporting that they would not like to see similar signs at other stations. Approximately one-third (38 percent) of all the responses were neutral, and approximately one-third reported that they would like to see more signs (39 percent of Hickory Creek respondents and 35 percent of Tinley Park respondents).

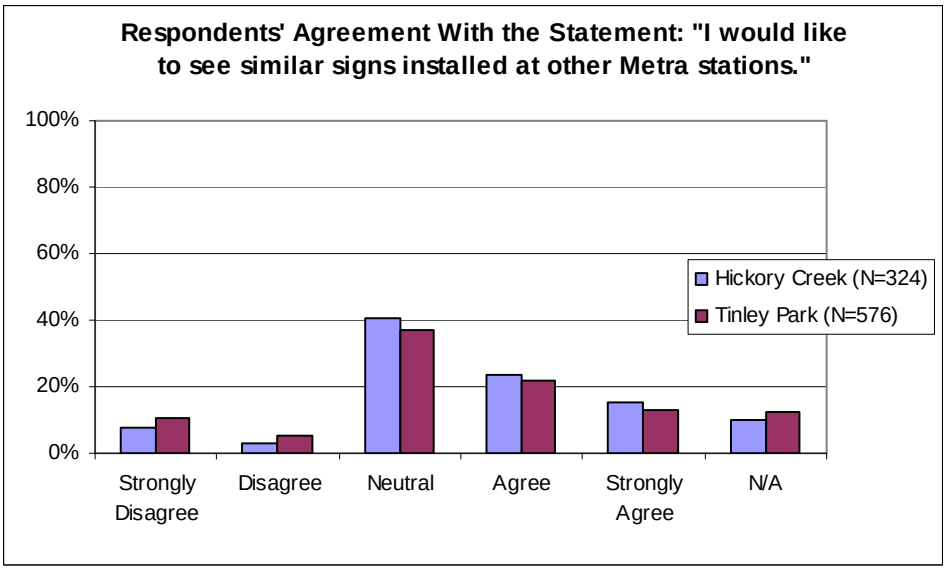

Figure 27. Desire for Expansion of the Sign Program.

3 MONTGOMERY COUNTY PROJECT

3.1 Project Background

The Montgomery County project began as an ITS operational test. The advanced parking information system there, which has been in place since April 23, 2007, provides information about parking availability at the Glenmont Metro park-and-ride lot located in Montgomery County, Maryland. The Montgomery County Department of Public Works and Transportation (MCDOT) is the lead agency for the project, and they undertook the project to encourage greater utilization of Maryland's transit facilities by providing commuters with more timely information about parking availability at transit stations.

MCDOT chose to implement system at the Glenmont Metro garage and at the Norbeck bus/park-and-ride lot. The Glenmont Station is a Washington Metropolitan Area Transit Authority (WMATA) Metro facility and is located at the intersection of Georgia Avenue and Layhill Road, approximately 3 miles outside of the Capital Beltway (Figure 28 below shows the Glenmont Metro Station location [shown in the red box] in relation to the Metro system and the Capital Beltway [shown in gray]). Patrons must pay $4.00 to park at the station. The Glenmont Metro parking garage has approximately 1,781 parking spaces and, of these, 32 are reserved for patrons with disabilities and 280 are reserved for those who purchase the space in advance (after 10:00AM any unused reserved spaces are available to the general public).

The Glenmont park-and-ride lot is at capacity on most weekdays. As a result, many motorists arrive at the Glenmont Station only to find that there is no parking available. These individuals must either find alternate parking at another Metro station or drive directly to their destination. The primary objective of the system, therefore, was to inform en-route motorists when the Glenmont lot has reached capacity and to suggest alternate parking facilities including the nearby Wheaton Metro Station and the Norbeck park-and-ride lot.

Figure 28. Location of Glenmont Metro Station in Relation to Metro System.

As shown in Figure 29 below, the Wheaton Metro Station is the next station on the Red Line on the way into downtown Washington, DC. According to MCDOT, the Wheaton Station is very rarely at capacity on weekdays, so this provides one viable alternative for commuters. Another alternative is the Norbeck park-and-ride facility, located approximately 4 miles north of the Glenmont Station. There are approximately 250 parking spaces at the Norbeck lot, and it is free to park there; however, patrons must pay bus fares to transfer to the

Glenmont Station. Bus service is provided by both Metrobus and Montgomery County Ride On. The fare is $1.25 for the inbound trip and $0.35 for the return trip with Metrorail transfer. Metrobus service operates each weekday from 6:30-9:00 AM and from 4:50-7:30 PM with 15 minute headways, while Ride On service operates from 5:40-8:30 AM with 20-30 minute headways and from 4:00-6:45 PM with 25 minute headways. It is believed that the limited hours (e.g., no mid-day service) may contribute to underutilization of the Norbeck lot.

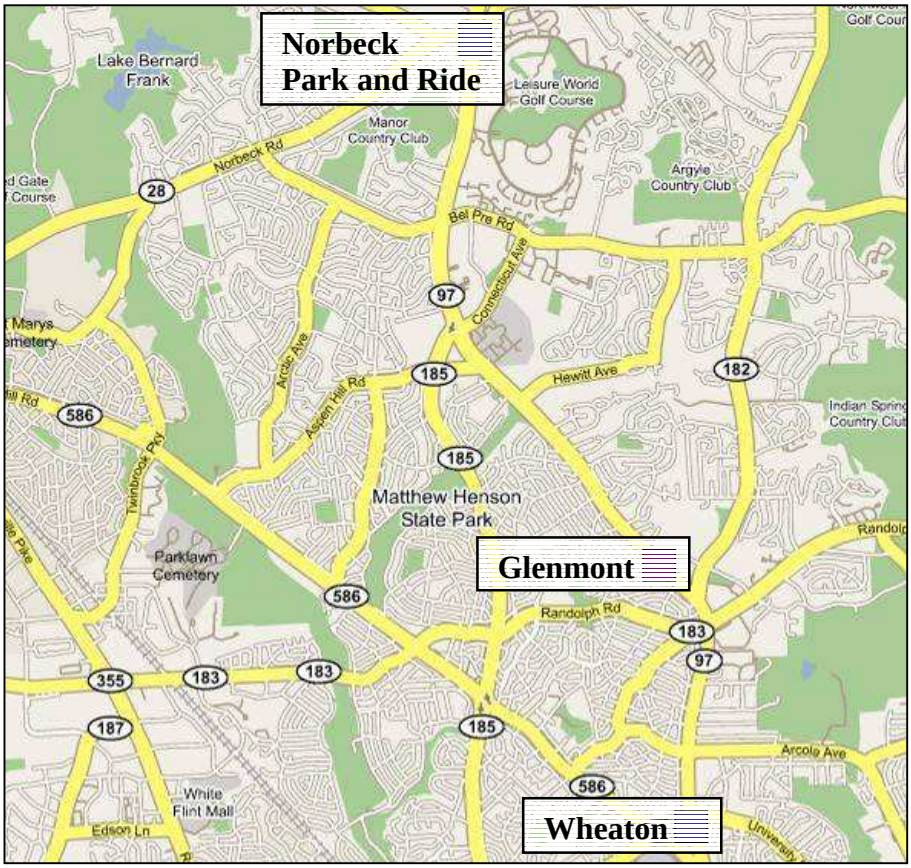

Figure 29. Map of Metro Stations and Park and Ride Lots.[23]

3.2 System Description

The Montgomery County system consists of two main components: video detection systems and VMS. Video detection systems monitor the four garage entrances and exits at the Glenmont Parking Garage. Each video detection system monitors and counts vehicle ingress and egress at that particular entrance. The location of the Glenmont entrances and the corresponding video detectors are shown in Figure 30.

[23] Google Map of Montgomery County, Maryland, <http://maps.google.com/>.

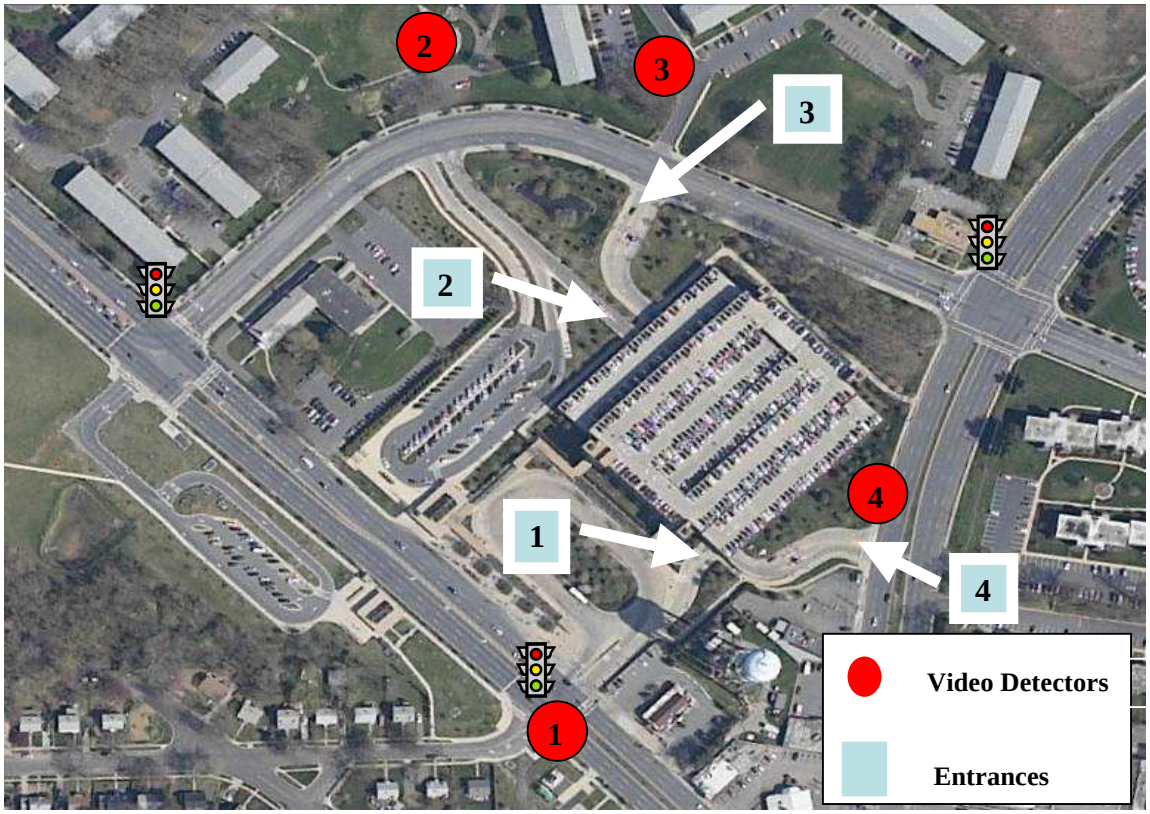

Figure 30. Glenmont Metro Station Video Detection Locations and Entrances.[24]

In addition to the video detection systems, the system also includes a total of three trailer-mounted VMSs which convey real-time information about parking availability to transit users while en-route. Instructions are fed to the signs through cellular modems. The signs are programmed to display messages based on thresholds set by the project team to alert commuters when there are no more spaces available. For the purpose of this project the team selected a threshold of 1,300 spaces after evaluating the rate of cars entering the lot during the peak period, the number of cars already in the lot, and the time delay of information being posted to the signs to allow for the last remaining spots to be filled.

As shown in Figure 31, there is a static sign mounted on the variable message sign that says, “Glenmont Parking Info.” The dynamic portion of the sign activates at 5:30 AM at which time it displays "SPACES AVAIL" until the Glenmont facility reaches capacity. Once the lot is full, the first message set on all of the signs reads, “NON RSVD SPACES FULL.” The second message set varies depending on the location of the sign. The second message set on the two VMSs located near Glenmont (sign #3 in Figure 32) is “USE WHEATON STATION.” The two VMSs located near the Norbeck lot (signs #1 and 2 in Figure 32) display the message “USE P&R ON NORBECK.”

[24] Aerial photograph of Glenmont Metro Station, courtesy of Montgomery County.

Figure 31. Glenmont VMS Signs.

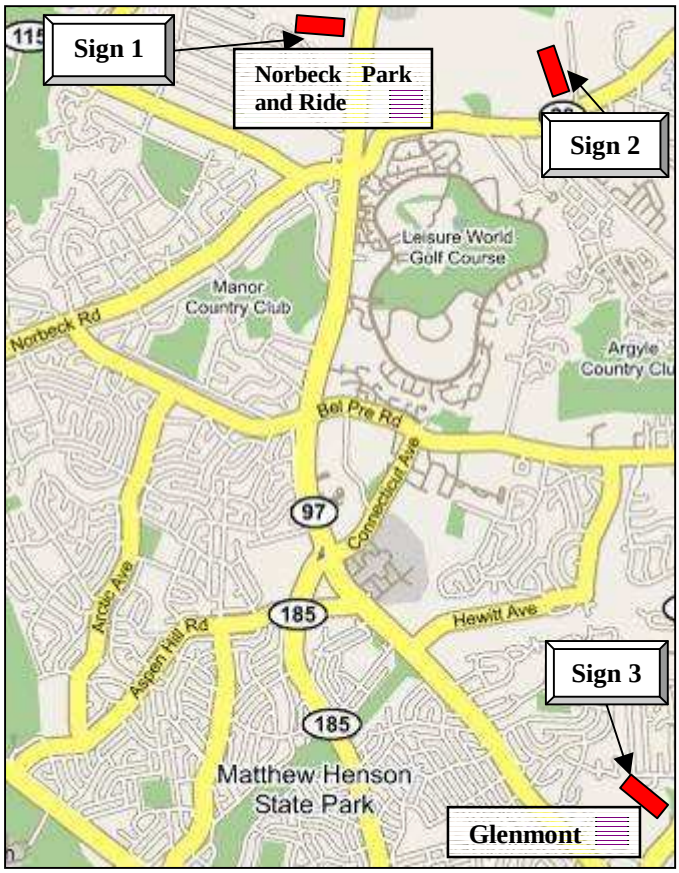

Figure 32. VMS Locations in Montgomery County, MD.[25]

3.3 Evaluation Approach / Data Collection Methodologies

A set of test hypotheses was developed to assess the impacts of the system at the Glenmont and Norbeck parking facilities. Each hypothesis was tested by collecting data before and after system deployment and by analyzing this data to determine if there is a measurable difference

[25] Google Map of Montgomery County, Maryland, <http://maps.google.com/>.

that can be attributed to the system. The specific test hypotheses for the evaluation have been divided into two categories: key and secondary. While both sets of hypotheses are important to this evaluation, it is believed that the key hypotheses have greater value for determining the impacts of the system. The hypotheses are provided below:

Key Hypothesis:

- The system will increase driver awareness of parking alternatives when riding the Red Line in Montgomery County.
- The system will positively affect customer satisfaction.

Secondary Hypotheses:

- The system will reduce circulation within the Glenmont Garage.
- The system will increase parking utilization at the Norbeck Park-and-Ride Lot while maintaining the current parking utilization at the Glenmont Metro Station.
- The system will increase transit ridership on the Red Line as the parking utilization at the Norbeck Park-and-Ride lot increases.
- The system will result in an increase in transit mode share among commuters whose origins lie near the Glenmont Station.

Table 3 outlines the hypotheses for the Montgomery County evaluation, and for each hypothesis, identifies one or more MOEs that will be used to assess the hypothesis. The data sources and analysis approaches that will be used to compute the MOEs are also illustrated.

Table 3. Evaluation Approach for Montgomery County Project.

Hypotheses	MOE	Data Source	Proposed Analysis
The system will increase driver awareness of parking alternatives when riding the Red Line in Montgomery County.	Rider-reported awareness of parking alternatives.	Intercept surveys in the "After" case at the Glenmont Metro Station and Norbeck park-and-ride lot.	Analysis of surveys.
The system will positively affect customer satisfaction.	Rider-reported level of customer satisfaction.		
The system will reduce circulation within the Glenmont Garage.	Number of vehicles leaving the Glenmont Garage during the AM peak.	In/out counts at the Glenmont Garage during the AM peak period from the system.	Before/after analysis.

Hypotheses	MOE	Data Source	Proposed Analysis
The system will increase parking utilization at the Norbeck park-and-ride Lot while maintaining the current parking utilization at the Glenmont Metro Station.	Parking utilization at Glenmont.	National Evaluation: - Archived in/out system data ("after" data and 2 weeks of "before" data collected before the system is turned on to the public). - In/out counts before/after system deployment (5 continuous weekdays). Local Evaluation: - In/out counts before/after system deployment (5 continuous weekdays). - Parking occupancy data before and after system deployment (1 weekday).	Before/after analysis.
	Parking utilization at Norbeck.	National Evaluation: - In/out counts before/after system deployment (5 continuous weekdays). Local Evaluation: - In/out counts before/after system deployment (3 continuous weekdays).	Before/after analysis.
The system will increase transit ridership on the Red Line as the parking utilization at the Norbeck park-and-ride lot increases.	AM peak period boardings at the Glenmont and Metro Station on the Red Line.	Ridership data from WMATA.	Before/after analysis.
	Rider-reported transit use.	Customer intercept surveys.	Analysis of surveys.
The system will result in an increase in transit mode share among commuters whose origins lie near the Glenmont Station.	Rider-reported transit use.	Customer intercept surveys.	Analysis of surveys.

3.3.1 Ridership and Parking Utilization Data

As with the Chicago project, one source of data to provide an indication of parking utilization is the system itself. The parking management system collects and archives in/out counts at the Glenmont Garage on a continual basis in 15-minute increments and, to enable the evaluation team to obtain "before" data, Montgomery County agreed to leave the system "turned off" to motorists for a full week after system functionality tests had been performed and the system was fully operational (for the period of time May 21-25, 2007).

The evaluation team also used various other sources to supplement these data including data from the following sources:

- *Automated in/out counts* – Montgomery County's local evaluation team collected in/out data at the Glenmont Garage and the Norbeck lot on a range of dates both before and after system deployment. Data that are presented in this report include:
  - In/out counts collected at the Glenmont Garage and the Norbeck Park-and-Ride lot in 15-minute increments in July/August 2005 and May 2006 (*before* system deployment).
  - In/out counts at the Glenmont Garage in 1-hour increments for the week of June 12-19, 2007, and August 21-23, 2007 (*after* system deployment).
  - In/out counts at the Norbeck lot in 5-minute increments from 12:00PM on Tuesday, September 25, 2007, through 12:00 PM on Thursday, September 28, 2007 (*after* system deployment).
- *Manual in/out counts* – Montgomery County's local evaluators conducted manual observations as well:
  - In/out counts were collected at the Glenmont parking garage in 15-minute increments for the time periods July 28-August 4, 2005 (before system deployment).
  - In/out counts at the Norbeck lot in 15-minute increments from 5:30-8:55 AM on Wednesday, September 26, 2007 (after system deployment).

The evaluation team also worked with WMATA to obtain ridership data for the Red Line. The evaluation team analyzed and compared before and after ridership data to determine if the system has in fact had an impact on the number of boardings at Glenmont.

3.3.2 Customer Intercept Surveys

In order to assess customer satisfaction with parking information system, the evaluation team administered surveys to patrons parking at the Glenmont Metro Station and at the Norbeck Park-and-Ride lot. Surveys were designed to address the following hypotheses:

- The system will increase driver awareness of parking alternatives when riding the Red Line in Montgomery County.
- The system will positively affect customer satisfaction.
- The system will reduce circulation within the Glenmont Garage.
- The system will increase parking utilization at the Norbeck Park-and-Ride Lot while maintaining the current parking utilization at the Glenmont Metro Station.
- The system will increase transit ridership on the Red Line as the parking utilization at the Norbeck Park-and-Ride lot increases.

- The system will result in an increase in transit mode share among commuters whose origins lie near the Glenmont Station.

The survey also sought to determine if there are other barriers to parking at Norbeck that are unrelated to the system. The survey format was comprised solely of multiple choice and check box questions to ensure that it could be completed in just a few minutes so as to not intrude on the riders' daily commute and also allowed for a greater response rate. The complete survey instrument can be found in the Appendix.

Surveyors administered customer intercept surveys at the Glenmont Metro Station during two consecutive 3-hour mid-week PM peak periods (4:00-7:00 PM on Tuesday, June 12, 2007 and Wednesday, June 13, 2007[26]). The evaluation team selected the PM period over the AM period since it would have been difficult to capture enough patrons willing to complete the survey while waiting for the train in the morning since patrons are anxious to board a train and the train headways are very small during the peak periods (trains arrive and depart approximately every 6 minutes).

To obtain surveys, surveyors approached patrons as they alighted trains, and then screened to target those who indicated that they drove and parked at the Glenmont Station garage that day (many patrons walk to the station or use the kiss-and-ride facility, and would therefore not have a need for the system). Of those who indicated that they did drive and park at Glenmont that day, surveyors then asked them to complete the survey. Surveyors read questions to the respondents to encourage participation and to expedite completion of the surveys. In total the team was able to obtain 322 surveys over the two-day period, just exceeding the goal of 317 surveys (the evaluation team arrived at this goal based on an estimated population of 1,800,[27] a confidence level of 95 percent, and a confidence interval of +/- 5).[28]

At the Norbeck lot, surveyors administered surveys on the same two days, but during the AM peak (from 7:00 AM – 9:00 AM). On average, buses depart the Norbeck lot every 10 to 15 minutes during the AM peak, so unlike at Glenmont, this presented a good opportunity to administer surveys while patrons were waiting for the bus to arrive. The evaluation team screened patrons to target those who were taking the bus to the Glenmont Station that day (some patrons park at Norbeck to take the bus to another destination and therefore do not use the system). As with Glenmont, surveyors read questions to the respondents to encourage participation and to expedite completion of the surveys.

At Norbeck, surveyors were able to obtain surveys from every patron who parked there and met the screening criteria. However, on both days that the survey collection was conducted, the Norbeck lot was nearly empty so the evaluation team was in fact only able to collect 11 surveys over the two-day period. The evaluation team inquired about how full the lot is on a typical day, and on both days the team was told by survey respondents and by the shuttle bus operator that the lot typically contains only 30 cars. Interestingly enough, on both days that the surveys were conducted, the Glenmont Garage filled to capacity by 7:40 AM, leaving ample opportunity for

[26] Note that although surveys were collected during a summer month when traffic is typically lower, it is important to note that public schools were in session at the time that the surveys were collected.
[27] This estimate is based on the fact that there are 1,800 parking spaces in the Glenmont Garage and based on the assumption that the garage is at full capacity on an average weekday and the assumption that most vehicles are single occupancy vehicles.
[28] Calculation performed using Sample Size Calculator at: http://www.surveysystem.com/sscalc.htm

commuters to park at Norbeck. This may indicate that despite the presence of message signs advising people that the garage is full (and recommending Norbeck as an alternative), commuters are still electing not to park there. At the start of the evaluation it was thought that there might not be an increase in parking utilization at Norbeck for a number of reasons. First is simply a limitation of the system: the sign recommends Norbeck as an alternative, but is not able to provide information regarding where Norbeck is located. As a result, patrons may not park there simply because they do not know where the lot is located.

Furthermore, it may not be possible to detect an increase in parking utilization at Norbeck simply because patrons may not view Norbeck as a viable alternative to Glenmont. First, the location of the Norbeck lot may not be convenient for many patrons (particularly for those who live between Norbeck and Glenmont as they would have to travel out of their way to park at Norbeck). Second, the bus service between Norbeck and Glenmont may not be appealing to patrons for any number of reasons (e.g., it does not run late enough in the evenings, it does not offer mid-day service, it takes too long, it is not reliable, it is not frequent enough). Finally, some patrons may simply perceive that parking at the Wheaton Metro Station is a better alternative to Glenmont than the Norbeck lot.

3.4 Findings

3.4.1 Impact of the System on Ridership, Parking Utilization, & Arrival Patterns

It would typically be expected that the addition of a parking information system would draw in new riders and result in an increase in parking utilization. However, in the case of the Montgomery County project, the garage is typically at capacity on weekdays,[29] so instead it was expected that the system would result in a change in parking utilization throughout the day at Glenmont (for example, that arrival patterns throughout the morning hours would change as commuters become more familiar with when the lots fill up based on the information provided on the signs). For the Norbeck lot, it was thought that the system might increase awareness, and thereby utilization, of the lot. To determine if this was the case, the evaluation team looked at parking utilization at both Glenmont and Norbeck.

In order to assess the impact of the system on parking utilization at the Glenmont Metro Station, the evaluation team looked at the archived system data from before and after system deployment. To supplement these data and to verify system accuracy,[30] the evaluation team used magnetic cards[31] to collect in/out counts at the Glenmont Garage for 5 weekdays before and after the signs were deployed and functioning. Data were collected in July/August 2005, May 2006, and June/August 2007.[32]

[29] Archived in/out count data from parking management system.
[30] The system uses video detection, which is known to be somewhat unreliable during conditions such as snow or rain.
[31] In this data collection procedure, magnetic cards are secured to the pavement. Magnetic inductance detects vehicles as they pass over the card, and the total number of vehicles is recorded in specified time increments.
[32] Data collected during the week of June 2007 encountered a collection failure for one of the entrances at the Glenmont metro station. In order to offset this collection failure, entrance four data was supplied from a week in August 2007. The data collection by the local evaluation team in August occurred when the APMS were not on display to the public as they were undergoing testing and software upgrades. The evaluation team ran comparisons of the August 2007 and June 2007 to ensure that there were no significant anomalies and found that the data followed the same trend lines and therefore could be used to supplement the missing entrance data.

Data for the 2-week period in July/August 2005 has been combined into one lump set of data due to the fact that counters at some of the garage entrances and exits failed on certain days during the data collection. For example, the "Thursday data" shown here actually represents data collected on two consecutive Thursdays (July 28, 2005, and August 4, 2005) due to counter failures at various times throughout the day, and data from August 3, 2005, is used for Wednesday comparisons since the July 27th data set was incomplete. Therefore, for Glenmont, July/August 2005 data and May 25-26, 2006 data (both collected before system deployment) are compared to August 22-24, 2007 data (collected after system deployment).

3.4.1.1 Parking Utilization at Norbeck

The parking management system does not monitor or measure parking utilization at the Norbeck lot, so in order to assess the impact of the system on parking utilization there, data on in/out counts at the lot had to be collected specifically for the purposes of this study. Again magnetic cards were used to collect data before and after system deployment. However, it was impossible to ascertain from the data whether utilization of the lot increased among commuters using Glenmont. The data were clouded by the fact that it appears that many patrons park there overnight and that others use the lot for multiple reasons including for carpooling and for taking the bus to other destinations. However, anecdotal evidence indicates that very few people use the lot for the purposes of boarding the Metro at Glenmont. When surveying patrons at this lot, the evaluation team inquired about how full the lot is on a typical day, and on both days the team was told by survey respondents and by the shuttle bus operator that the lot typically contains only 30 cars. It is thought that the limited hours may contribute to the underutilization of the Norbeck lot.

3.4.1.2 Parking Utilization at Glenmont

In order to determine the impact of the system on parking utilization at the Glenmont Metro Station, the evaluation team first looked at detailed data on space availability that had been manually collected by the local evaluation team in December 2004.[33] For this data collection effort, parking space availability was recorded by space type on December 2, 2004, from 5:30 AM-2:15 PM. These data provide some insight into how quickly the garage fills. The data collected show that more than half of the regular and handicapped parking spaces were filled by 7:00 AM, and that by 8:15AM all but one (which remained open all day) non-reserved space remained unoccupied (the reserved spaces did not fill to capacity).

Next the evaluation team looked to manual observations that were conducted during June and August 2007 by the local evaluation team. Consistent with the December 2004 data collected, these data show that the garage roof parking spaces (the spaces that typically fill last) were filled between 7:38-8:20 AM. Using 8:00 AM as a benchmark time to compare the utilization at Glenmont over time, the data collected in August 2005 (before the system) indicate that there were on average 1,460 cars in the lot; in August 2007 (after the system) there were 1,646 cars in the lot. The 13 percent increase in those arriving before 8:00AM after the addition of the system could be an indication that commuters realized the need to arrive early in order to get a parking space once the system was in place.

[33] Montgomery County retained a local evaluation team to study the system and report on the impacts of the system.

Figure 33 shows space utilization at the Glenmont Garage throughout the morning hours during the three data collection periods. As expected, the largest influx of cars occurred during the AM morning peak hours (5:00-7:00 AM).

Note the anomaly of the continued increase in arrivals throughout the late morning in 2005. On that particular day the arrivals show increased activity between 11:00AM-2:00PM and again between 4:00-6:00PM, indicating that there was likely an event downtown that would have caused there to be increased Metro usage on that day.

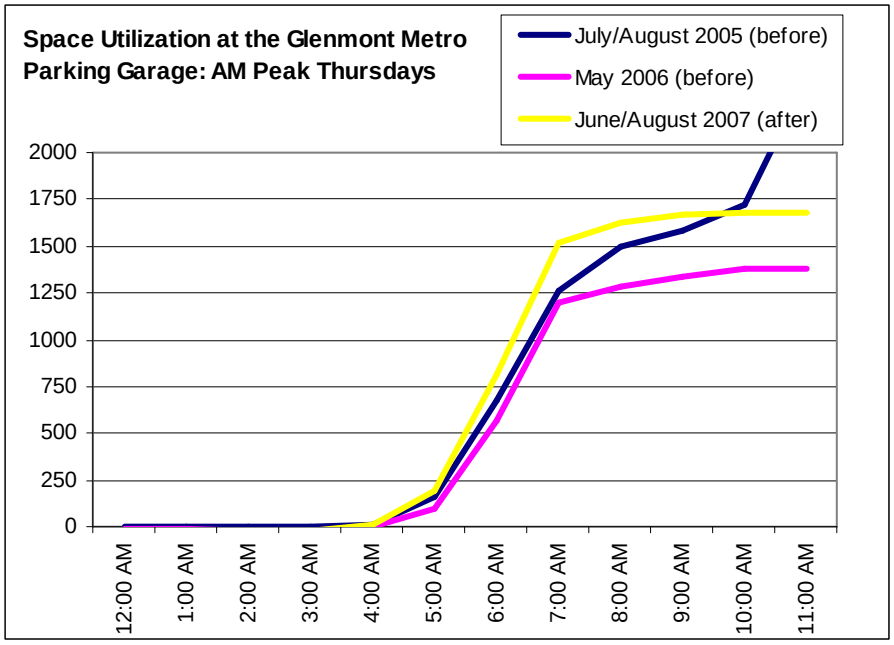

Figure 33. Space Utilization at Glenmont on Thursdays.

3.4.1.3 Ridership

To determine if the system had any impact on ridership, the evaluation team first analyzed ridership data from WMATA to see if any notable increases in ridership had occurred since the signs became operational. Since the Glenmont parking garage is typically at capacity, any increase in ridership there would indicate either an increase in those parking at Norbeck (i.e., to access Glenmont) or an increase in those arriving at Glenmont through some other means (i.e., walk, bike, kiss-and-ride).

In looking at monthly weekday boardings at both stations over the past 3 years, there is no indication that ridership has increased at either station since the signs were installed. In addition, since usage of the Norbeck lot does not appear to have increased since the signs were installed, it does not seem reasonable that any increase in ridership at Glenmont would have been the result of the system.

3.4.1.4 Mode Share

Survey respondents were asked in two different ways whether they felt that the signs have had any impact on how often they ride Metro. As shown in Figure 34 and Figure 35, approximately 50 percent of respondents answered "N/A" to both questions.[34] When asked to what extent they agree with the statement, "*The information provided on the signs has not affected how often I ride Metro,"* approximately 45 percent of respondents at Norbeck and 30 percent of respondents at Glenmont reported that they felt that the signs have *not* impacted their decision to ride the Metro. This is most likely due to the fact that a good deal of respondents (89 percent of those at Glenmont) already ride the Metro four to five times a week. Thirteen percent of respondents at Glenmont and 18 percent of respondents at Norbeck gave responses that would indicate that they feel the signs *have* affected how often they ride Metro.

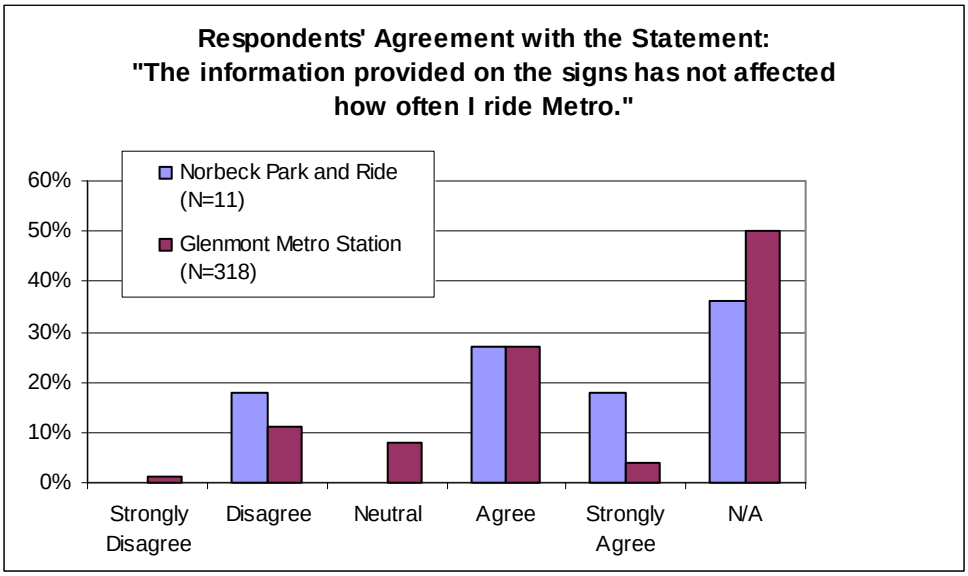

Figure 34. Influence of Sign Information on Frequency of Riding Metro.

When asked more directly (by indicating to what extent they agree with the statement, *"I've found myself riding Metro more now that the signs provide me with information about the availability of parking spaces"*), again many respondents selected "N/A." An average of 25 percent of respondents reported that they do *not* feel that they ride Metro more often now that the signs provide them with information about the availability of parking spaces (see Figure 35) while 9 percent of respondents at Norbeck and 4 percent of respondents at Glenmont indicated that they signs *have* affected how often they ride Metro (responding disagree or strongly disagree).

[34] At the Glenmont Metro Station, many of the respondents interviewed reported that they arrive very early in the morning and therefore have not taken notice of the signs since they do not have issues finding a parking spot. At the Norbeck Park-and-Ride Lot, nearly 50 percent of respondents reported that they usually park there so they do not pay attention to the signs. For both of these reasons, there was a high percentage of "not applicable" responses to select survey questions.

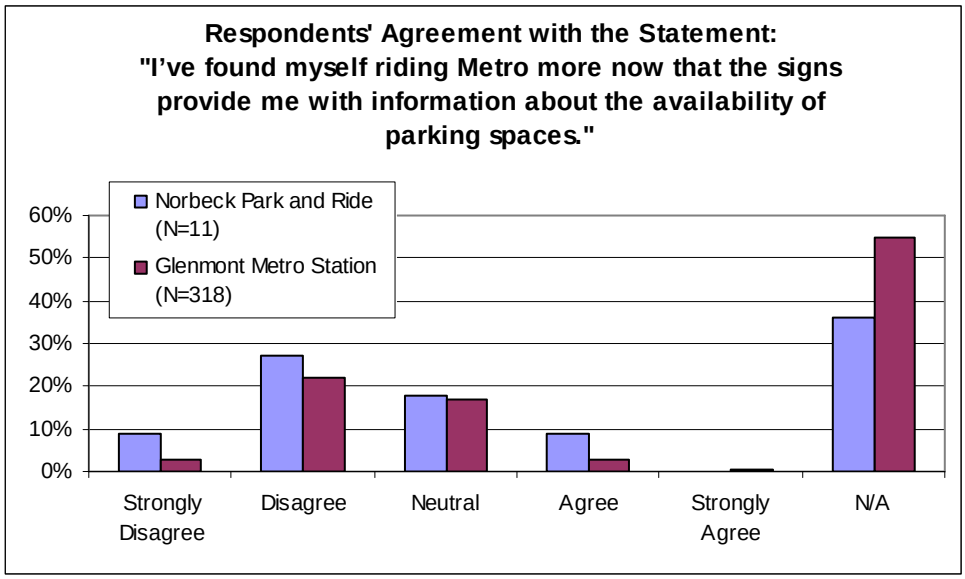

Figure 35. Influence of the Signs on Frequency of Riding Metro.

3.4.2 Impact of the System on Awareness of Parking Alternatives

Figure 36 shows respondents' level of agreement with whether the message signs have improved their awareness of parking alternatives. Twenty-seven percent of respondents at Norbeck and 17 percent at Glenmont indicated that they agreed or strongly agreed that the signs have improved their awareness of parking alternatives for the Red Line. Thirty percent of respondents at Norbeck indicated that they did not know about the lot prior to the signs, which explain why the Norbeck responses were more positive.

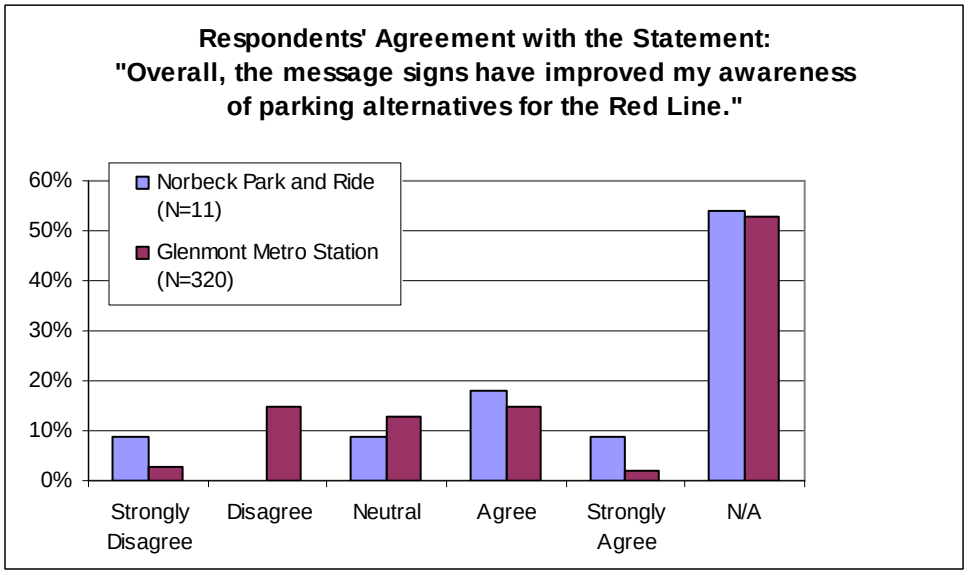

Figure 36. Influence of the Signs on Awareness of Parking Alternatives for the Red Line.

To determine if the signs have raised awareness about the Norbeck Lot, the Norbeck respondents were asked whether they knew about the Park-and-Ride Lot before the installation of the signs. Seventy percent of respondents said they had known about the lot, while 30 percent said that

they were not aware of the location prior to the installation of the signs. Respondents were also asked how often they park at Norbeck. Fifty percent of respondents said they usually park there, 38 percent said they rarely park there, and one respondent said that they were parking there for the first time. When asked why they did not park there more often, one said he will most likely park there again as he found it online and this was his first time there; another said he normally walks to Norbeck but was running late this morning; and a third commented that he normally drives to work.

When asked why they parked at Norbeck on the day of the survey, 20 percent of respondents reported that it was because they saw a message sign saying that the Glenmont station was full, 30 percent reported that they normally park there because Glenmont is usually full, and 20 percent reported that they normally park there because it is less expensive (see Figure 37).

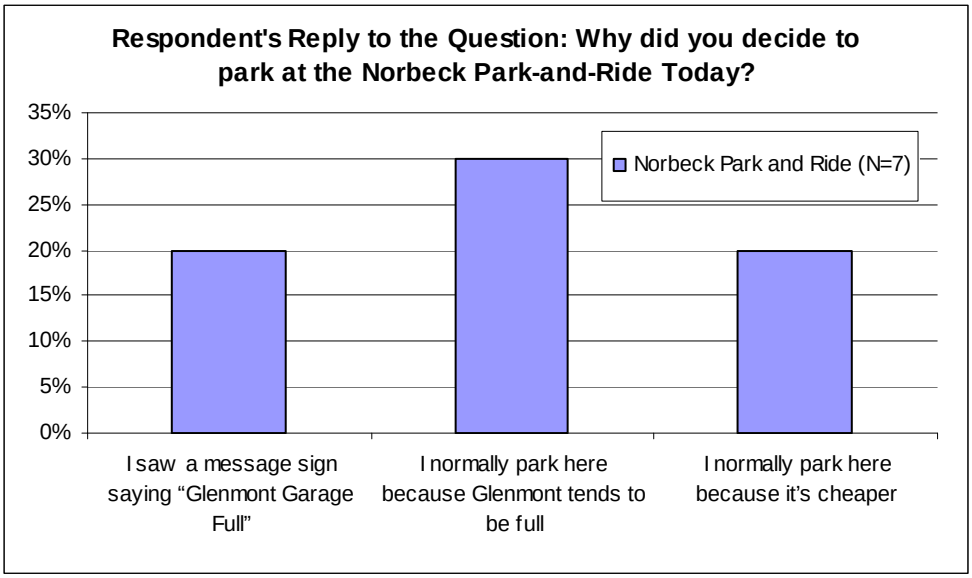

Figure 37. Reasons Respondents Parked at Norbeck.

3.4.3 Impact of the System on Circulation within Glenmont Garage

It was hypothesized that the parking information system would reduce or eliminate circulation within the Glenmont Garage. That is, those motorists who would previously circle through a full garage looking for a space would now know that the lot was full and would avoid entering it altogether. In the absence of the system, this unnecessary traffic circulation results in wasted time for potential transit patrons, and more significantly, a loss of potential riders for the Metro system, as many of these motorists simply drive directly to their final destination when unable to find parking.

In order to assess whether the system did in fact reduce this unnecessary circulation, the evaluation team looked at a surrogate measure. Specifically, the team looked at the number of vehicles exiting the lot during the AM peak period (5:00-9:00 AM), as there should be very few if any patrons leaving the lot during the this time with the exception of those who are unable to find parking.

Figure 38 displays the number of vehicles exiting the Glenmont Garage during the AM peak hour on Tuesdays and Thursdays during May 2006 (before) and June 2007 (after). As

hypothesized, the number of cars exiting the parking garage during the morning peak hours was lower after installation of the signs.

Before the system was installed, 161 vehicles left the lot during the AM peak hour (between 7:00 AM and 8:00 AM) in total over the 2-day period, while only 70 vehicles left the lot during that same timeframe after the system was installed. This represents a 57 percent reduction in vehicles circulating within the garage, or 46 fewer vehicles circulating each day. Interestingly enough the data did not show this same reduction between the hours of 8:00 AM and 9:00 AM. In fact, there was no apparent difference between the number of vehicles leaving the lot during this hour when comparing the before and after data (66 vehicles left the lot during this hour after the system while 74 vehicles left the lot during this hour before the system). Reasons for this are uncertain. However, what it could suggest is that commuters who arrive later in the peak period know that their alternative options are increasingly limited and thus are more likely to "ignore" the lot full signs and investigate for themselves.

If the system did in fact result in 46 fewer vehicles circling the garage to find parking on a typical day (since the signs would have warned them in advance and they would have avoided the garage altogether), it is interesting to consider what the environmental impact associated with this reduction in travel would be.

The emission reduction can be calculated by assigning a "gas usage" number to each circulating vehicle. If it is assumed that each motorist who circulates within the garage uses the amount of gas that would be equivalent to traveling 2 miles, emissions savings resulting from the wasted trips through the garage would equate to 10.490 tons of carbon dioxide (or 20,980 lbs) over the course of a year.[35]

[35] Native Energy CO2 Emissions Calculator: http://www.nativeenergy.com/pages/travel_calculator/30.php (accessed April 21, 2008)..

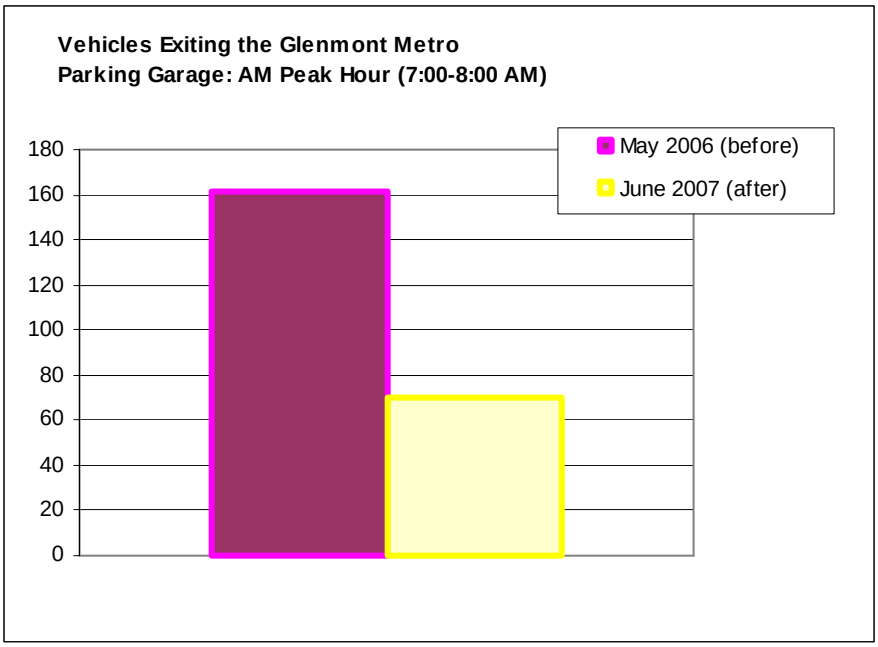

Figure 38. Vehicles Exiting Glenmont during AM Peak (7:00-9:00AM).

To get a sense for how difficult it is to find parking at the Glenmont Metro Station, respondents there were asked if there has ever been a time that they could not find parking at the station. Sixty-six percent responded that there has been at least one time that they were unable to find a space. Of those who have not had trouble with parking, many reported that this is because they intentionally arrive early to ensure that they will not have trouble finding a space; in addition (as expected), some indicated that parking is not a concern for them since they have a reserved parking space.

Figure 39 shows responses to whether respondents ever spent time circling the Glenmont Garage prior to the signs. Forty percent of Norbeck respondents and 16 percent of Glenmont respondents agreed or strongly agreed that before the signs they often spent time circling the garage looking for a space.

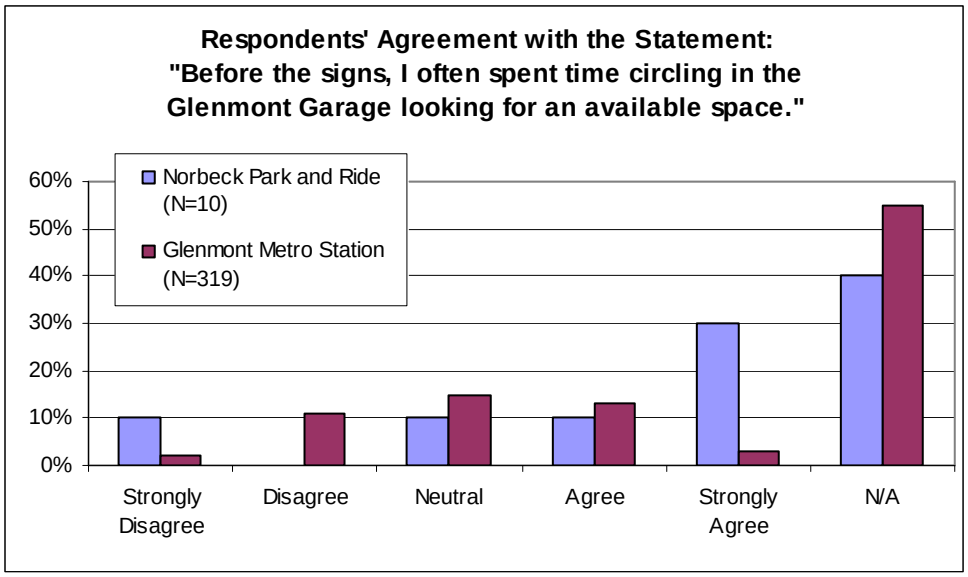

Figure 39. Percentage of Respondents Who Reported Circling the Garage Looking for a Space.

For those who reported that they have had trouble finding a parking spot at Glenmont in the past, respondents were asked to identify locations where they have parked as an alternative to Glenmont. Figure 40 shows that half of the respondents reported that they have parked at the nearby Wheaton Metro Station, and 1 percent (only 2 people) reported they have parked at the Norbeck Park-and-Ride lot. In addition to the categories listed here, some respondents commented that they have parked illegally, parked at the Silver Spring Metro Station, waited for a spot to open up, or simply returned home and worked from there.

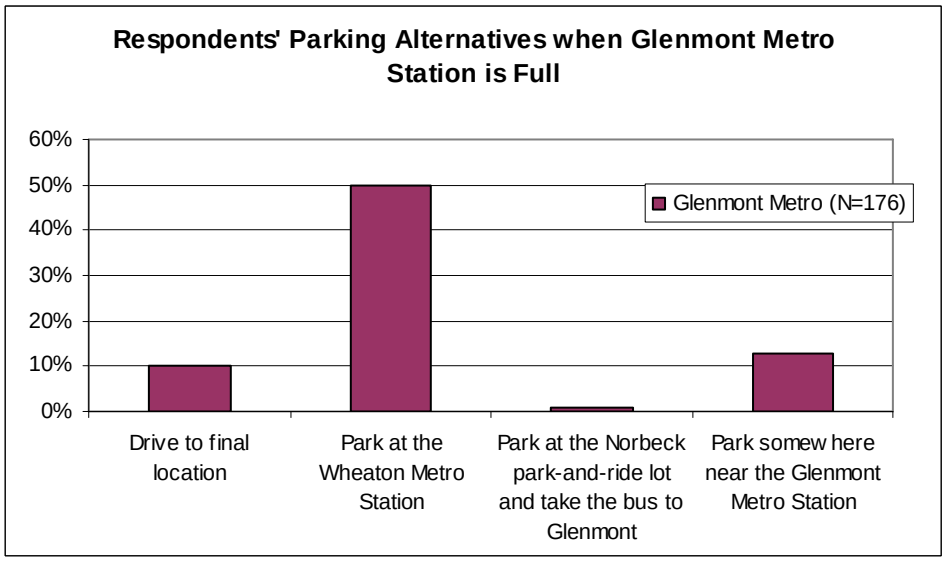

Figure 40. Reported Alternate Parking Options for Glenmont Metro Station.

Respondents at the Glenmont Metro Station were also asked how often they park at the Norbeck Park-and-Ride Lot, and if they reported that they rarely or never do, they were asked why they do not. Five percent of respondents reported that they rarely park at the Norbeck Park-and-Ride,

47 percent of respondents indicated that they have never parked there but were aware of the location, and 46 percent reported that they were not aware of the location of the lot. Of the respondents who reported that they were aware of the Norbeck Park-and-Ride option but have not parked there, 34 percent indicated that the reason they do not park there is because it is out of their way, 17 percent reported that they do not need to park at Norbeck as they do not typically have trouble finding a spot at Glenmont, and 11 percent responded that they were unfamiliar with the bus schedules at Norbeck. In addition to those comments, respondents commented that parking at Norbeck adds too much time to their commute, that they simply do not want to park there, and that they have a reserved spot at the Glenmont Station.

Respondents were asked if they agreed that the signs had *not* made any difference to them since they have *never* had trouble finding parking on the Red Line. Twenty-seven percent of Norbeck respondents and 18 percent of Glenmont respondents felt that the signs *had* made a difference to them because they have experienced trouble finding a parking spot at Glenmont (answering disagree or strongly disagree). Seventeen percent of Norbeck respondents and 21 percent of Glenmont respondents said that the signs had *not* made any difference to them because they have never had trouble finding a spot at Glenmont (answering agreed or strongly agreed). Some of the respondents commented that they did not trust the information on the signs so they would still look for a space even if the sign told them that the lot was full.

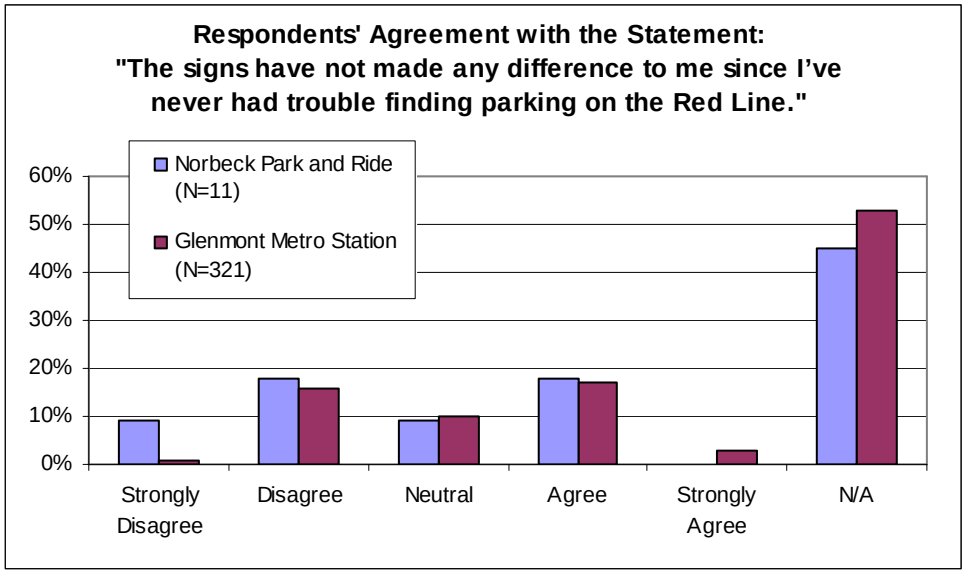

Figure 41. Influence of the Signs on Finding Parking.

Respondents were asked if they thought that the signs have reduced the amount of time they spend searching for an available parking space. Figure 42 shows that 70 percent of respondents at Norbeck believed that the signs have reduced the amount of time they spend looking for a space (answering agreed or strongly agreed) while only 16 percent of respondents at Glenmont felt that the signs have reduced the amount of time they spend looking for a space.

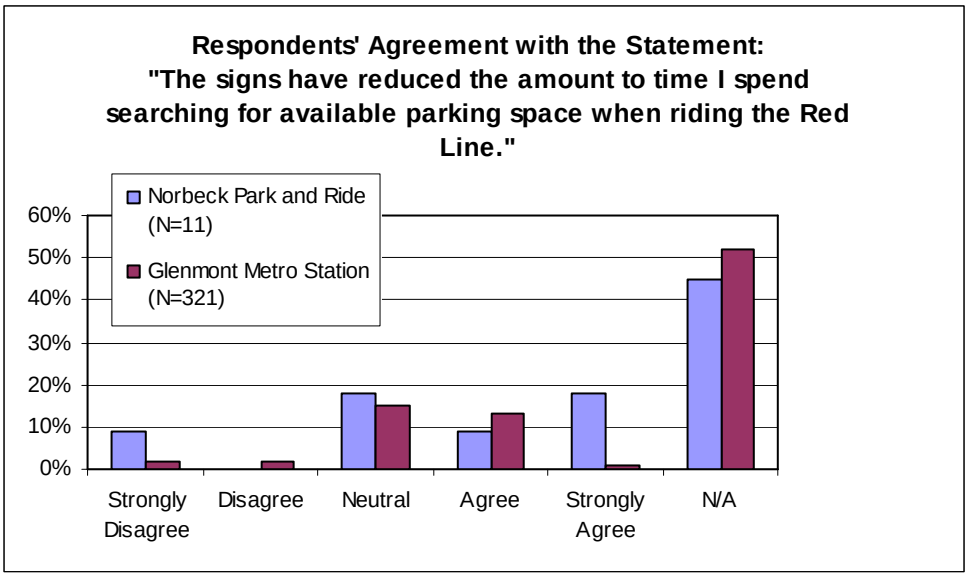

Figure 42. Influence of Signs on Time Spent Searching for a Space.

The evaluation team hypothesized that the signs would increase driver awareness of parking alternatives. Figure 43 shows respondents' agreement with whether the message signs have improved their awareness of parking alternatives. Over half of respondents selected "N/A", indicating that they were already aware of parking options for the Red Line. Twenty-seven percent of respondents at Norbeck and 17 percent of respondents at Glenmont indicated that they agree or strongly agree that the signs have improved their awareness of parking alternatives for the Red Line. Thirty percent of respondents parking at the Norbeck Park-and-Ride lot said they did not know about the lot prior to the signs which may be part of the reason the Norbeck responses were more positive (only nine percent of those at Norbeck disagreed or strongly disagreed with this statement).

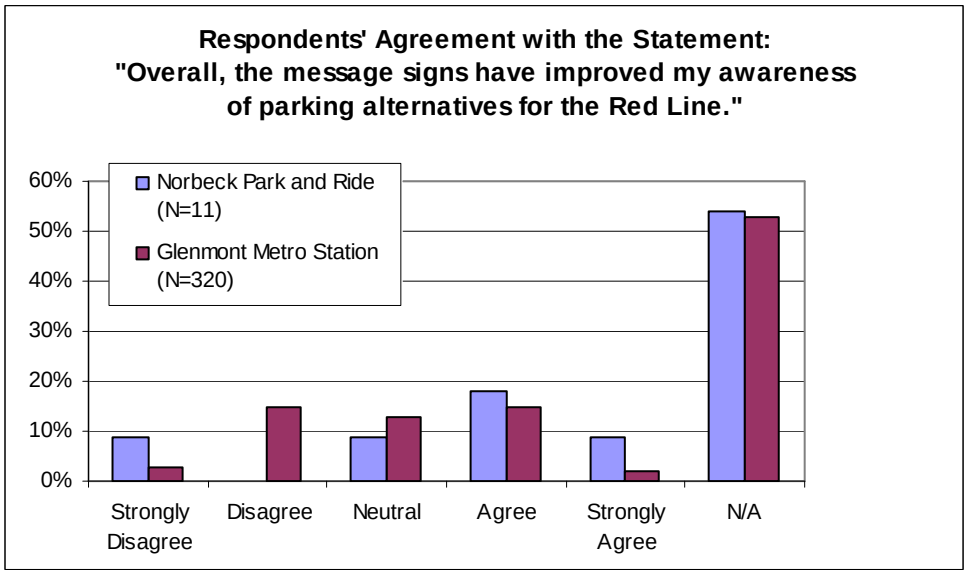

Figure 43. Influence of the Signs on Awareness of Parking Alternatives for the Red Line.

3.4.4 Customer Satisfaction with the Signs

Survey results indicate that both Glenmont and Norbeck respondents were satisfied with the sign locations and accuracy and would like to see similar signs at other Metro locations. Respondents at Norbeck had more positive feedback to offer than those at Glenmont. Glenmont respondents were neutral in their response to whether the information on the signs had improved their overall commuting experience.

Respondents were asked if during their normal commute they have ever seen a message sign (like the one shown in Figure 31) showing parking availability for the Glenmont Metro Station garage. Figure 44 shows that 91 percent of Norbeck Park-and-Ride respondents reported that they have seen the signs and 61 percent of Glenmont Metro respondents reported that they have seen the signs. Surprisingly, nearly 40 percent of those parking at the Glenmont Metro Station reported that they have never seen the signs. This may be due to the fact that some respondents commented to the surveyors that they arrive so early in the morning they do not have to worry about finding a spot, so even if there were a sign along their commute they probably would not have noticed it.

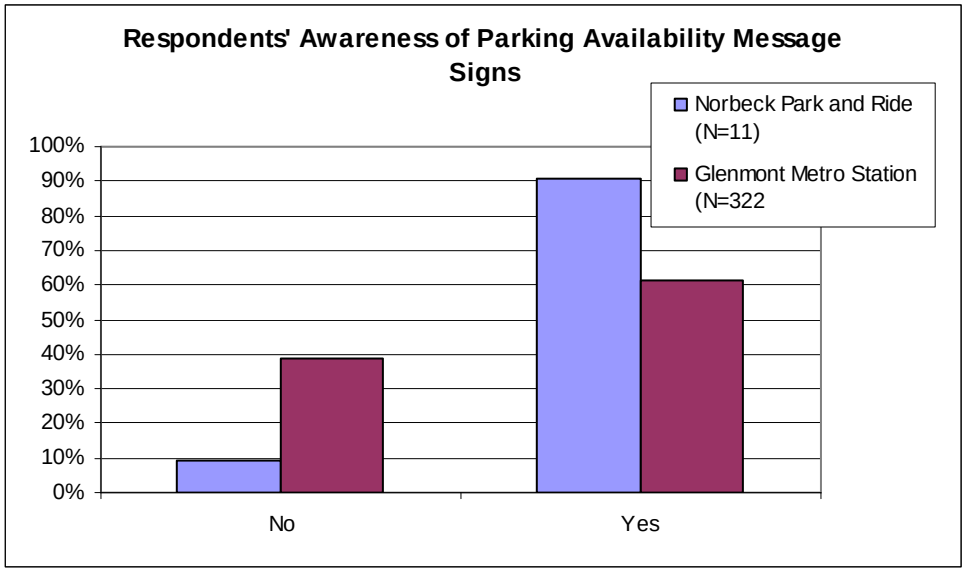

Figure 44. Glenmont Parking Availability Sign on Norbeck Road.

Respondents who reported having seen a parking availability message sign on their normal commute were then asked to identify the location(s) where they had seen the signs. Figure 45 shows that the two most common sign locations that respondents reported having seen were on Georgia Avenue and Layhill Road. Sixty-four percent of respondents at Norbeck reported seeing the sign on Georgia Avenue, 27 percent on Norbeck Road, and 9 percent on Layhill Road. Thirty-three percent of respondents at Glenmont reported seeing the sign on Georgia Avenue, 6 percent on Norbeck Road, and 57 percent on Layhill Road.

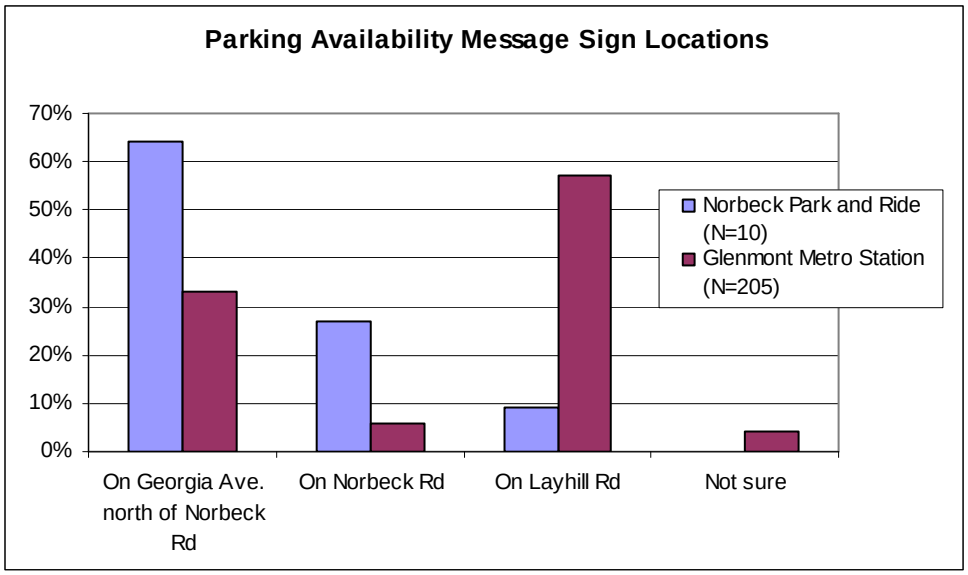

Figure 45. Reported Awareness of Parking Availability Message Sign Locations.

Respondents were asked if they were satisfied with the location of the signs on their morning commute to see whether the signs were located in appropriate areas to give them enough time to make decisions regarding their trip. Forty percent of respondents at Norbeck responded that the signs were appropriately located (recall that 64 percent see the sign on Georgia Avenue). Twenty-eight percent of Glenmont respondents agreed that the signs were appropriately located (recall that 57 percent see the sign on Layhill Road). Ten percent of Norbeck respondents and 9 percent of Glenmont respondents said the signs were *not* located in an appropriate place for them to make decisions regarding their morning commute.

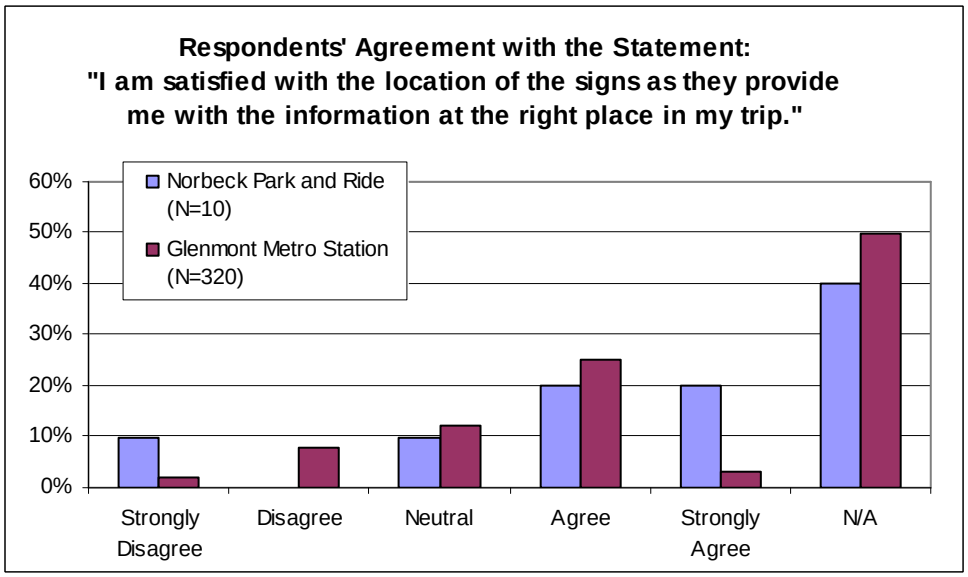

Figure 46. Reported Satisfaction with Sign Location.

Figure 47 shows respondents' perception of sign accuracy. On average, 23 percent of respondents felt that the sign information was accurate (answering agree or strongly agree). No

respondents at Norbeck responded that they did not think the signs were accurate whereas 9 percent of respondents at Glenmont responded that they did not think the signs were accurate.

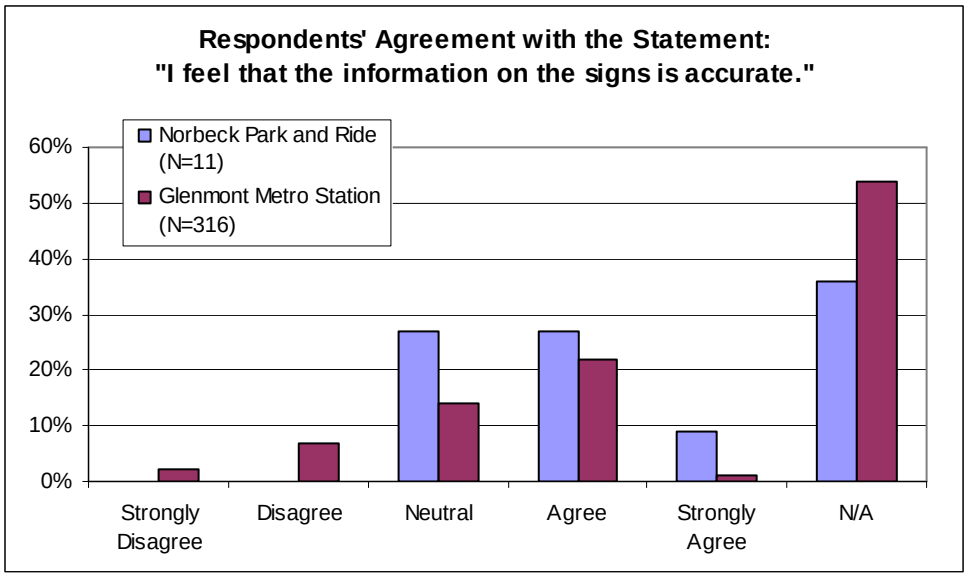

Figure 47. Reported Satisfaction with Sign Accuracy.

Figure 48 shows responses related to the influence of the parking availability signs on the "overall commuting experience." Twenty-seven percent of respondents at the Norbeck Park-and-Ride Lot reported that the signs have in fact improved their overall commuting experience while no respondents at Norbeck reported that the signs have not improved their commute. Glenmont respondents were evenly split, with 14 percent of respondents reporting that the signs have improved their commuting experience and 14 percent reporting that the signs have not improved their overall commuting experience.

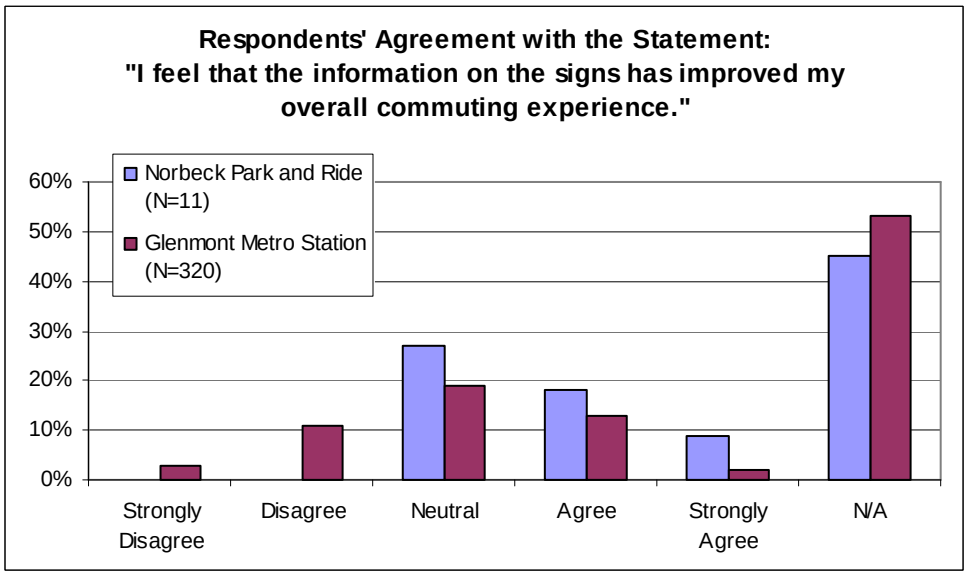

Figure 48. Reported Influence of the System on Satisfaction with Overall Commuting Experience.

Finally, respondents were asked if they would like to see similar signs installed at other Metro stations. At the Norbeck Park-and-Ride Lot, 55 percent of respondents indicated that they *would* like to see the signs while no respondents answered they would *not* like to see them. At the Glenmont Metro Station 30 percent of respondents said they *would* like to see the signs at other Metro stations while 4 percent of respondents said they would *not*. Again for this question there were a high number of respondents who answered "not applicable."[36]

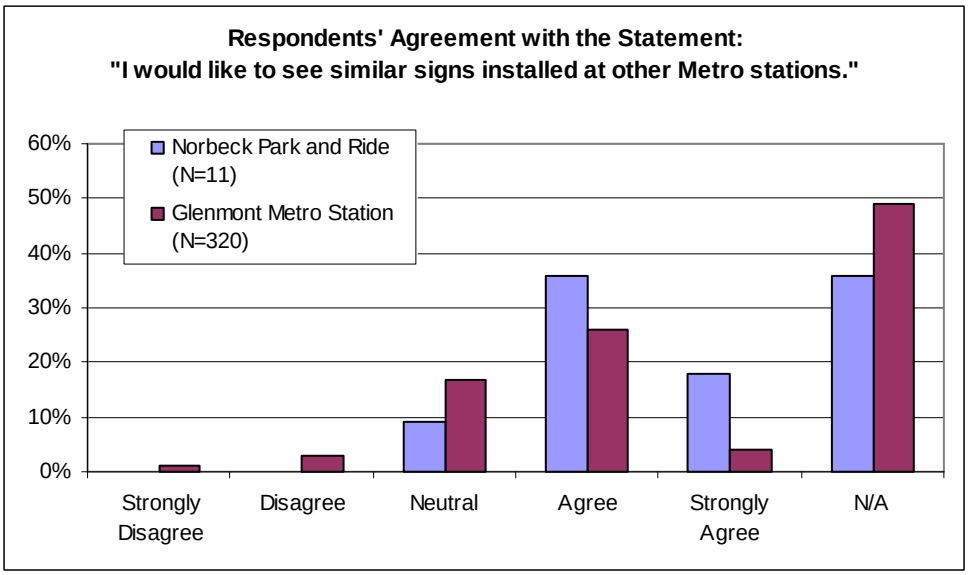

Figure 49. Desire for Expansion of the Sign Program.

[36] At the Glenmont Metro Stations many of the respondents interviewed reported that they arrive very early in the morning and therefore have not taken notice of the signs since they do not have issues finding a parking spot. At the Norbeck Park-and-Ride Lot, nearly 50 percent of respondents reported that they usually park there so they do not pay attention to the signs. For both of these reasons, there was a high percentage of "Not Applicable" responses to select survey questions.

4 INSTITUTIONAL ISSUES AND LESSONS LEARNED

In addition to the evaluation areas previously discussed, the evaluation team also worked with the project stakeholders to document institutional challenges, technical issues, and lessons learned encountered throughout deployment and operation of these systems. The information was gathered through a variety of methods, including reviewing meeting minutes and conducting formal and informal interviews with stakeholders and project partners.

4.1 Deployment Lessons Learned

One lesson reported with regard to technology is that it is important to conduct a field study during the design engineering phases prior to deployment of any project relying on radio frequency or other similar communications technologies. Unique capital requirements resulting from unforeseen field conditions is quite a common reality for ITS applications. Metra learned early on into the construction process (during the Radio Frequency Field Study, which they called for in the contractual specifications) that installation of repeater poles at various sites would be required to ensure uninterrupted, seamless wireless transmission between data controllers and signs. When relying on radio transmissions, topographical encumbrances and other radio transmission interferences should be expected. In the case of the Metra project, it was found that a highway vehicle weigh station located within the project radius would cause radio frequency interference.

It is also important to realize that permit issues can require a significant amount of time, particularly if multiple jurisdictions are involved; the Chicago project stakeholders experienced delays in obtaining some of their permits.

4.2 Technology Lessons Learned

One lesson reported with regard to technology is that, depending on what is available off-the-shelf, consider customized software if the project budget can accommodate it. At the time that Montgomery County began their project, they were not aware of any product on the market that did exactly what they needed. Since they did not have a large enough budget to have software designed for the specific purpose of this project, they had to modify commercial-off-the-shelf (COTS) traffic control software, which was not ideal. Some specific limitations that the county faced as a result of not being able to have customized software are as follows:

- In order to change the messages displayed and to set the thresholds for when the messages display, the software communicates with the variable message signs via a cellular modem. Due to budget limitations, they have only one cellular modem. As a result, the modem must call the signs one at a time when relaying information, and they feel that this has led to moderate delays in updating the information on the signs.
- Since there was no test set for the system, it was difficult to determine if the software had a bug in the testing phase (i.e., if the project team wants to test the software, they have to do it with the live system).
- Montgomery County's system did not have the capability to update any of the signs independently of the others, which they found to be limiting. For their particular situation it would have been preferable to be able to update the signs independently. The reason for this is that the bus that provides service between the Norbeck park-and-ride lot and the Glenmont

Metro Station ends morning service at 8:55 AM, so it is important that the signs do not recommend Norbeck after this time. As a result, Montgomery County had to make the decision not to display parking information on any of their signs after 9:00AM.

- Montgomery County's system also does not allow for the built-in "threshold" to vary by day of week. This can pose a challenge since the number of vehicles remaining overnight in the lots tends to vary by day of week and because the fill rate also tends to vary by day of week. They found that the fill rate on Fridays is significantly lower than on other weekdays. Consequently the algorithm that works on other days of the week does not apply on Fridays. As a result, the county made the decision not to operate the signs on Fridays.

Another lesson is that it is important to be aware of the inherent limitations of the technology. Specific examples of this are as follows:

- In the case of the Montgomery County project, the team knew that the video detection technology they were using would have weather-related limitations. They have found that heavy rain results in erratic counts, and during the winter season the team found that snow plows dumped snow onto pedestrian walkways, causing pedestrians to enter the detection zone and be mistakenly counted as vehicles.
- The Chicago stakeholders also experienced challenges with snow and special events. After a sizable Chicago snow storm, some spaces in the lot become blocked with snow piles, which resulted in the system reporting that there were available spaces when in fact many were unusable. Chicago did find that special events can be accommodated with their system. For example, every summer a carnival takes place at the Hickory Creek station. To accommodate this, the Mokena police contact Metra in advance with an estimate of the number of spaces that will be occupied. Metra then adjusts the baseline "threshold" within the system and it adjusts the numbers accordingly.
- In the case of the Chicago project, the signs operate using an unlicensed radio frequency, which has resulted in a few minor problems caused by the antennas being blocked by streetlights since the antennas require line of sight. The use of antennas, however, was more economical than burying cable would have been. The project team expects, however, that this may be a recurring issue given the expected future development of the area surrounding these stations, which may result in more interference in the future.
- In retrospect, the Chicago project stakeholders feel that they should have selected a full matrix sign instead of the limited numeric dynamic signs that were selected. A full matrix sign would have provided the capability to display other information beyond parking space availability.

4.3 Operations and Maintenance Lessons Learned

An important consideration with regard to operations and maintenance is that, for this type of system to be reliable in the long run, staff should expect that they will likely need to change the settings manually at times. For example, Montgomery County found that the fill rate slowed significantly during the summer months when traffic is typically lighter; as a result, the county had to adjust the system's algorithms a few times a year to accommodate this variation. In order to do this, it is critical to ensure that those who will be responsible for monitoring and maintaining the system are trained on how to use the equipment if they were not involved in the software development and/or testing.

Another important consideration is that a monitoring system that is built into the design can save time and help the project team ensure system reliability. The Montgomery County staff elected to install a camera on the top of the Glenmont Garage to aid in remote monitoring of the system (see camera views in Figure 50[37]), and they have found it to be extremely useful in monitoring the system on a regular basis. They generally check in on the system at least once a week to see if it appears to working properly based on how full the top level of the garage looks as compared to how many spaces the system shows to be remaining.

For Metra, the remote user interface consists of a dedicated laptop that provides the information that is currently on each sign, a configuration of the lot assemblies, and also an error-checking mechanism (errors are indicated with a red dot). It also allows the user to update or shut off the signs remotely. Currently, the system does not fail often but it requires constant monitoring. They find that it works best to leave the system up and running consistently in the background.

Figure 50. Camera View of Parking Garage for Monitoring Montgomery County System.

It is critical to identify up front what agency (and what staff position in particular) will ultimately be responsible for monitoring and maintaining the system after it is in place (particularly as maintenance can be costly depending on the system). This could be the contractor who designed and/or installed the system if desired. It is also important to clearly denote where and how all maintenance activities should be documented. As an example, the Chicago project's maintenance schedule calls for the following activities:[38]

- On an annual basis, clean solar and LED windows.
- On a biannual basis, clean and inspect cabinets, replace filters, perform a count survey (to include verification of available parking spaces with sign display), perform a loop survey (to include verification of proper loop detection), perform a delineator survey, and adjust equipment setting.

One lesson to keep in mind regarding maintenance costs is that RTA and Metra have found that the solar batteries need to be replaced quite often. One of their signs is solar powered because there was no electrical line available at the sign location. At the time of design, it appeared that

[37] Composite photo series compiled from photo series captured by camera mounted on Glenmont Parking Garage, courtesy of Montgomery County.
[38] Metra Parking Management System Maintenance Schedule obtained from Metra December 12, 2007.

it was more costly to run an electrical line to the sign than to use a battery. In retrospect, however, the batteries required by the solar powered sign have been very expensive, and have less capacity than the electrical signs. Therefore, in the long run, extending the electrical line is likely to have been more cost effective.

A unique issue that the Chicago stakeholders faced was that at the time of their initial design, there were no American companies that created or manufactured this type of system. The project team contracted with a European developer since these types of systems were more prevalent in Europe at the time. Consequently, the team encountered issues with some of the manuals and programming being in another language, making software customization and software updates a challenge.

4.4 Contracting Lessons Learned

An important lesson with regard to contracting is that, in retrospect, the Chicago team feels that the lump sum contracting vehicle utilized may have not been the best choice for this type of system. The selected type of contract used meant that the city had to select the lowest bidder and it also meant that the contractor did not have an incentive to finish the project quickly once encountering problems. Looking back, the team believes that a cost plus fixed fee contract may have been more appropriate as this type of arrangement would have given vendors an incentive to complete the deployment more quickly, and it would have allowed the team to make a qualifications-based selection.

Another contracting lesson that the stakeholders passed on is that they feel that a design-build model might be more appropriate for this type of technology than a design-bid-build model.

4.5 Institutional Lessons Learned

It is also important to keep all potentially affected organizations informed of work planned as part of the project. Some of the stakeholders felt that without close coordination, their projects would not have been possible. They indicated that active coordination among the various levels of government helped stave off unnecessary future costs and potential relocation of systems. Below are some examples of coordination that the Chicago project stakeholders faced throughout the course of their project deployment:

- The Village of Tinley Park, which had been a strong proponent of the demonstration from the beginning, had plans for the installation of new custom street lights throughout the area which could have directly interfered with underground work being conducted by Metra. Synergies were realized in "dove-tailing" those efforts with Metra's field contractor, who coordinated the electrical connections with the Village's contractors.
- Future electrical hook-up and camera links for the Village of Tinley Park (a Public Works / Public Safety initiative) were included in later designs and installed at the Tinley Park / 80th Avenue site.
- Early on in the project one of the signs had to be moved due to concerns expressed by one of the localities regarding aesthetics.
- It was necessary to coordinate Will County roadway construction with transformer installation and underground work being done simultaneously by Metra.

- After the initial planning, but before installation was complete, an ongoing development posed a conflict with one of the sign locations: a drugstore that was under development proposed an entrance that conflicted with the proposed location for the sign.

The most important institutional lesson learned that both project teams passed on to the evaluation team is that it is critical to involve all appropriate stakeholders in a formal and collaborative manner throughout the planning, deployment, and operations phases of a multi-jurisdictional project such as this. Parking management systems are often integrated into urban or neighborhood environments and, as such, take time to deploy and require a diverse group of stakeholders. Late-breaking or unresolved stakeholder concerns can stall the effort indefinitely. To prevent stalling, the project stakeholders should obtain formal endorsement from the leadership of all jurisdictions involved. The mayor or county executive should seek city or county council endorsement and should designate a staff member or a specific public agency as their organization's champion for the system. This champion will exercise executive leadership with in the stakeholder group and will represent the project in any public policy discussions and funding processes. Identify and define the role of the champion and ensure that the project stakeholders work from a formal charter that binds the member organizations to the effort and provides a forum for resolution of issues.

5 SUMMARY AND CONCLUSIONS

This document has presented the evaluation strategies and objectives, the data collection methodologies, and the findings of this evaluation. Presented here is a brief summary of the findings and conclusions.

5.1 Summary of Findings

The results of the analyses are summarized here according to each of the four core evaluation objectives:

- Assess the Impact of the System on Ridership and Parking Utilization
- Assess the Impact of the System on Mode Choice
- Assess the Impact of the System on Time Spent Searching for Spaces (Circulation within and between lots)
- Assess the Impact of the System on Customer Satisfaction

5.1.1 Assess the Impact of the System on Ridership and Parking Utilization

The evaluation team looked at a variety of data sources to determine the impact of the system on parking utilization. Additionally patrons were surveyed about the impact of the system on their commute patterns.

For the Chicago site, the stations did have slightly higher utilization after the system was in place (1 to 5.5 percent higher). In terms of utilization throughout the day, there was no change at Hickory Creek, and only a slight change in utilization at Tinley Park (slightly more people boarded the late morning trains causing the peak to occur approximately one hour later than in the previous year). In terms of mid-day utilization specifically, in general, there are very few people boarding trains during the mid-day and the system did not cause a significant increase in mid-day arrivals. This is not surprising considering that neither station was at or near capacity during the timeframe of the study (the Tinley Park Station reached a maximum of 82 percent capacity, and Hickory Creek reached 74 percent capacity). Additionally, no focus group participants reported that the parking lot has ever been full when they personally wanted to park and use Metra.

In the case of the Montgomery County project, it was expected that the system would result in a change in parking utilization throughout the day at Glenmont (rather than an increase in peak utilization, since it was known that the garage is already at capacity on a typical weekday). The data show that there was a 20 percent drop in the number of patrons arriving at Glenmont before 8:00AM, but that the garage now fills at a faster rate. This could be an indication that commuters no longer feel the need to arrive early in order to get a parking space, and that they now go directly to Glenmont [when the signs tell them that there is availability] instead of bypassing Glenmont as they might have done previously, thinking that it was full.

For the Norbeck lot it was thought that the system might increase awareness, and thereby, utilization of the lot. It was found that, in fact, very few people use the Norbeck lot for the purposes of boarding the Metro at Glenmont. This appears to be due to the fact that Norbeck does not serve as a viable option for most commuters. Some feel that it adds too much time to their commute and others do not park there since they are unfamiliar with the Norbeck bus schedules.

5.1.2 Assess the Impact of the System on Mode Choice

Since it was thought that lack of parking might be a perceived barrier to transit, it was hypothesized that some motorists might be encouraged to switch modes to transit after seeing a sign indicating that there is in fact parking available (in particular on days of heavy traffic). Surveys provided insight into this at both sites. In both cases very few respondents indicated that the signs have affected how often they take transit. In Montgomery County however, many indicated that the signs have improved their awareness of parking alternatives for the Red Line. In fact, one-third of those surveyed at Norbeck indicated that they were not aware of the lot before the signs were installed.

5.1.3 Assess the Impact of the System on Time Spent Searching for Spaces

It was also thought that the system would save time for commuters. Again surveys provided insight. For the Chicago project, most respondents indicated that the signs have not influenced them because they have never experienced difficulty finding parking. However, some did indicate that the signs have saved them time in finding a parking space, particularly at Tinley Park where there are multiple lots.

For the Montgomery County project, responses were different as expected since the Glenmont garage is typically at capacity on weekdays and parking is more of a challenge. Most survey respondents indicated that there has been at least one time that they have been unable to find a space at Glenmont, and nearly one-fifth reported that they often spent time circling the garage looking for a space before the system was installed. About a quarter of respondents reported that they feel that the signs have made a difference to them and that the signs have reduced the amount of time that they spend looking for a space. Although the team was not able to obtain a statistically significant sample size, the data that the team was able to obtain show that circulation appears to have reduced significantly. It appears that 57 percent fewer vehicles left the Glenmont Garage during the peak morning hours after the system was installed as compared to before the system was installed. The environmental impact associated with 46 fewer vehicles circulating through the garage each day is equivalent to an emissions savings of 10.490 tons of carbon dioxide (or 20,980 lbs) over the course of a year.

5.1.4 Assess the Impact of the Systems on Customer Satisfaction

In general, for both projects, survey results indicate that commuters are satisfied with the sign locations and accuracy and that they would like to see similar signs at other locations. Although few respondents agree that the signs have improved their overall commuting experience, when asked whether they would like to see similar signs installed at other stations, many reported that they would.

5.2 Conclusions

Based on the results of this evaluation and the conclusions drawn, the hypotheses stated up front have either been supported by the results of the evaluation, have not been supported by the results of the evaluation, or are inconclusive at this time.

5.2.1 Chicago Project

- Hypothesis: The system will increase parking utilization at the Mokena/Hickory Creek and the Tinley Park/80th Avenue Station parking lots. *The hypothesis is inconclusive.* Although

both stations did have slightly higher utilization after the system was in place (1 percent higher at Tinley Park and 5.5 percent higher at Hickory Creek), it is unclear whether these increases can be attributed to the system. Any number of factors such as population increases or rising gas prices could have caused a portion of this ridership increase. Furthermore, the system only benefits those who *drive* to the station (rather than those who walk/bike or use kiss-and-ride), and some of this ridership increase could in fact be comprised of individuals who walk or bike to the station, or who use the kiss-and-ride facility. Finally, on the converse, any ridership increases that did result from the system could have been masked by decreases in ridership that were expected to result from riders being drawn over to any adjacent Metra line due to service improvements.

- Hypothesis: The system will positively affect customer satisfaction. *This hypothesis is supported by the customer intercept surveys.* Survey results indicate that commuters are satisfied with the sign locations and accuracy and that they would like to see similar signs at other locations. Although few respondents agree that the signs have improved their overall commuting experience, when asked whether they would like to see similar signs installed at other stations, many reported that they would.
- Hypothesis: The system will reduce traffic circulation between the north and south Tinley Park/80th Avenue Station parking lots. *This hypothesis is inconclusive based on the archived system data and the customer intercept surveys.* Although unnecessary circulation between the lots was thought to be a problem, it does not appear that any patrons left the lot during the AM peak period indicating that all vehicles entering the lot were able to find a parking space. The primary reason for this is that the Tinley Park Station never reached capacity during the timeframe of the study (even at its peak, the lots at this station were only at 82 percent capacity). However, the survey results provide some indication the system has helped commuters. Ninety-six percent of respondents there indicated that they have always been able to find a parking space since the system was added, while only 83 percent indicated that they were previously able to find a space.
- Hypothesis: The system will reduce traffic circulation between the Tinley Park/80th Avenue station and the Mokena/Hickory Creek station. *This hypothesis is inconclusive based on the archived system data and the customer intercept surveys.* Although unnecessary circulation between these two stations was thought to be a problem, it does not appear that any patrons left either of the lots during the AM peak period, indicating that all vehicles entering the lot were able to find a parking space. The primary reason for this is that neither stations reached capacity during the timeframe of the study (even at its peak, Tinley Park only reached 82 percent capacity and Hickory Creek only reached 74 percent capacity).
- Hypothesis: The system will result in an increase in ridership on the Rock Island District Line as parking utilization increases at the Tinley Park/80th Avenue and Mokena / Hickory Creek Stations. *This hypothesis is inconclusive.* Although both stations did have slightly higher ridership after the system was in place (an 8.9 percent increase at Hickory Creek and a 7.1 percent increase at Tinley Park when comparing 2006 data to 2002 data), it is unclear whether these increases can be attributed to the system. Any number of factors such as population increases or rising gas prices could have caused a portion of this ridership increase. Furthermore, the system only benefits those who *drive* to the station (rather than those who walk/bike or use kiss-and-ride), and some of this ridership increase could in fact be comprised of individuals who walk or bike to the station, or who use the kiss-and-ride facility. Finally, on the converse, any ridership increases that did result from the system

could have been masked by decreases in ridership that were expected to result from riders being drawn over to any adjacent Metra line due to service improvements.

- Hypothesis: The system will result in an increase in transit mode share among commuters whose origins lie near the Mokena/Hickory Creek and Tinley Park/80th Avenue Stations. *This hypothesis is supported by the customer intercept surveys.* Though not many, a few respondents did indicate that the signs have affected how often they take transit. Two percent of Hickory Creek Station respondents and 4 percent of Tinley Park Station respondents reported that the parking availability information has caused them to take Metra instead of driving.
- Hypothesis: The system will result in an increase in mid-day arrivals at the Mokena/Hickory Creek and the Tinley Park/80th Avenue Station parking lots. *This hypothesis is not supported from the data.* There was no change in utilization at Hickory Creek, and only a slight change in utilization at Tinley Park (slightly more people boarded the late morning trains causing the peak to occur approximately one hour later than in the previous year). In terms of mid-day utilization specifically, in general, there are very few people boarding trains during the mid-day and the system did not cause a significant increase in mid-day arrivals. This is not surprising considering that neither station was at or near capacity during the timeframe of the study (the Tinley Park Station reached a maximum of 82 percent capacity, and Hickory Creek reached 74 percent capacity; additionally, no focus group participants reported that the parking lot has ever been full when they personally wanted to park and use Metra).

5.2.2 Montgomery County Project

- Hypothesis: The system will increase driver awareness of parking alternatives when riding the Red Line in Montgomery County. *This hypothesis is supported by the customer intercept surveys.* Approximately one quarter of respondents (27 percent at Norbeck and 17 percent at Glenmont) indicated that they agreed or strongly agreed that the signs have improved their awareness of parking alternatives for the Red Line. Furthermore, one-third of respondents parking at the Norbeck Park-and-Ride lot indicated that they did not know about the lot prior to the signs.
- Hypothesis: The system will positively affect customer satisfaction. *This hypothesis is supported by the customer intercept surveys.* Survey results indicate that commuters are satisfied with the sign locations and accuracy and that they would like to see similar signs at other locations. Although few respondents agree that the signs have improved their overall commuting experience, when asked whether they would like to see similar signs installed at other stations, many reported that they would.
- Hypothesis: The system will reduce circulation within the Glenmont Garage. *This hypothesis is supported by the customer intercept surveys.* Most survey respondents indicated that there has been at least one time that they have been unable to find a space at Glenmont, and nearly one-fifth reported that they often spent time circling the garage looking for a space before the system was installed. About a quarter of respondents reported that they feel that the signs have made a difference to them and that the signs have reduced the amount of time that they spend looking for a space. The data show that circulation has been reduced significantly – nearly 50 percent fewer vehicles are now leaving the Glenmont Garage in the morning hours.

- Hypothesis: The system will increase parking utilization at the Norbeck park-and-ride Lot while maintaining the current parking utilization at the Glenmont Metro Station. *This hypothesis is inconclusive.* It was impossible to ascertain from the data whether utilization of the Norbeck lot increased among commuters using Glenmont. However, anecdotal evidence indicates that very few people use the lot for the purposes of boarding the Metro at Glenmont. When surveying patrons at this lot, the evaluation team inquired about how full the lot is on a typical day, and on both days the team was told by survey respondents and by the shuttle bus operator that the lot typically contains only 30 cars. The parking utilization at the Glenmont Garage has not changed since the system was added.
- Hypothesis: The system will increase transit ridership on the Red Line as the parking utilization at the Norbeck park-and-ride lot increases. *This hypothesis is not supported by the data.* In looking at monthly weekday boardings at the Glenmont and Wheaton Stations over the past 3 years, there is no indication that ridership has increased at either station since the signs were installed. Furthermore, since usage of the Norbeck lot does not appear to have increased since the signs were installed, it does not seem reasonable that any increase in ridership at Glenmont would have been the result of the system.
- Hypothesis: The system will result in an increase in transit mode share among commuters whose origins lie near the Glenmont Station. *This hypothesis is supported by the customer intercept surveys.* Though not many, a few respondents did indicate that the signs have affected how often they take transit. Four to 13 percent of respondents at Glenmont and 9-18 percent of respondents at Norbeck gave responses that would indicate that they feel the signs have affected how often they ride Metro.

APPENDIX