

# **Advanced Parking Information System Evaluation Report**

**Prepared for:**

**Minnesota Department of Transportation  
City of St. Paul  
Federal Highway Administration**

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## **Executive Summary**

### **Introduction**

The Minnesota Department of Transportation (Mn/DOT), under the Minnesota Guidestar program, in partnership with the Federal Highway Administration (FHWA), City of St. Paul and AGS Group, and with the participation of ten Civic Center/Rice Park area parking facilities, has concluded an ITS operational test of an advanced parking information system in downtown St. Paul. In general, the test consisted of the implementation and operation of electronic signs displaying real-time parking availability information for special events in the Civic Center/Rice Park area of downtown St. Paul.

This report documents the evaluation analysis and results of the operational test. The evaluation assesses the impact/effect of the advance parking information system on the motoring public, parking facility operators, roadway system operations, and other ITS systems in St. Paul, and documents the system costs, technical capabilities, transferability, and any legal or institutional issues encountered during the test.

### **Test Period**

The implementation of Advanced Parking components was conducted in late 1995 and early 1996. The system first became partially operational in March 1996 during the State High School Tournaments and fully operational in November 1996. The system will continue in full operations indefinitely after the operational test.

### **Data Gathering and Data Set**

Several pieces of data were collected as part of the operational test's independent evaluation. Those data collection activities are described below:

Motorist Surveys - A mail-back questionnaire was distributed to motorists as they exited participating parking facilities during special events in downtown St. Paul. A total of 9,750 questionnaires were distributed during the Minnesota State High School Wrestling and Boys Basketball Tournament in March 1996. Of the 9,750 distributed, only 122 (1.25%) questionnaires were returned. However, since the implementation of Advanced Parking components was delayed and the system was only partially operational, it was determined that the results from the questionnaire were not representative of a fully operational system. The results of the March 1996 survey were not used in the evaluation.

During the Smithsonian Exhibition in October/November 1996, a total of 9,500 questionnaires were distributed. Of the 9,500 distributed, 139 (1.5%) questionnaires were returned. The results of these surveys were used to evaluate the motorists' assessment of Advanced Parking.

Parking Operator Interviews - Participating parking operators were interviewed in April 1997 to evaluate the parking operators' assessment of Advanced Parking. At least one representative from each of the ten participating parking facilities were interviewed.

Traffic Related Data - Traffic related data includes turning movement counts at West 7th St. & Kellogg Blvd. and West 7th Street & West 5th Street, travel time studies on two routes, parking

occupancy routes, and roadway volume counts. Traffic related data was collected during the following events:

- 1995 Boys Basketball Tournament, March 23-25, 1995
- Rainbow Foods Kids Fest, February 25, 1996
- 1996 Wrestling Tournament, February 29, 1996
- 1996 Hockey Tournament, March 7, 1996
- 1996 Boys Basketball Tournament, March 21, 1996
- Smithsonian Exhibition, November 1 and November 8, 1996

Due to a combination of Advanced Parking installation delays, system malfunctions, and a lack of before/after data comparison components, only the traffic-related data collected during the Smithsonian Exhibition were used to evaluate the impact of Advanced Parking on roadway system operations.

Project Partner Interviews - Project partners were interviewed in April/May 1997 to document any legal or institutional issues encountered during the operational test and to determine the transferability of Advanced Parking. There were a total of nine persons interviewed who represented FHWA, Mn/DOT, city of St. Paul Department of Public Works, city of St. Paul Department of Planning and Economic Development, and AGS Group.

### **Report Format**

The Evaluation Report is structured in two main sections. *Evaluation of Operational Test* section reports on general findings which address each of the Evaluation Goals and Objectives and draws conclusions for each. *Individual Test Plan Evaluations* section reports on more specific findings for each hypothesis tested during the operational test. There are eight Individual Evaluation Test Plans and each has its own subsection as described in the Detailed Evaluation Plan.

### **Relation to ITS National Goals**

The ITS National Goals are addressed by the St. Paul Advanced Parking Information System Operational Test goals. The chart on the following page shows the relationship of Advanced Parking Goals to ITS National Goals. Advanced Parking in St. Paul did not demonstrate increased efficiency and capacity of the surface transportation system, which would reduce energy and environmental costs, but it did not decrease them either. It is believed that Advanced Parking enhances personal convenience and comfort, enhances present and future productivity of event parking, and will help create an environment for ITS to flourish -- by enabling other U.S. cities to develop and deploy similar systems.

	National ITS Goals					
St. Paul Advanced Parking Goals	Improve the safety of the Nation's surface transportation system	Increase the operational efficiency and capacity of the surface transportation system	Reduce energy and environmental costs	Enhance present and future productivity	Enhance personal mobility, convenience and conform of the surface transportation system	Create an environment in which development and deployment of ITS can flourish
1. Evaluate user acceptance of Advanced Parking						
2. Evaluate the potential impacts on the surface transportation system and the affected environment						
3. Evaluate the applicability of Advanced Parking to support other ITS projects in St. Paul						
4. Evaluate technical performance of Advanced Parking						
5. Document the costs of Advanced Parking						
6. Document the effect of institutional, legal and private sector issues						
7. Evaluate the transferability of the system						

## Key Findings

Evaluation of the St. Paul Advanced Parking Information System Operational Test had the following results:

1. Advanced Parking is perceived beneficial to the participating parking operators and the city of St. Paul; each would like the system to continue and be expanded throughout the downtown, and be used weekdays.
2. Most motorists responding to the mail-back survey thought the system has value; results on the use and efficiency of the system are inconclusive; there were insufficient evaluation funds to perform a more effective survey.
3. There were some improvements on the surface transportation system, but the improvements could not be attributed directly to Advanced Parking; estimated delay per vehicle decreased at critical intersections, and travel time on selected routes decreased.

4. Advanced Parking signs with full matrix displays have sufficient capabilities to support other traffic functions in downtown St. Paul; Advanced Parking counter signs alone do not have sufficient capabilities to support other traffic functions in downtown St. Paul.
5. Advanced Parking performed well technically after the system was debugged; system components are integrated and function as designed.
6. Advanced Parking provides real-time parking information. The accuracy of the information is directly dependent on the parking operators' cooperation in setting the counters.
7. It costs about \$2,425 per month to operate and maintain the current system.
8. There were no institutional, legal, or private sector issues which had a significant effect on the operational test.
9. Private sector contributions accounted for more than 21% of the cost of the operational test; public partners indicated satisfaction in the level of private sector participation in the funding of the test.
10. Advanced Parking is transferable to other cities without significant modification.

### **Lessons Learned**

1. The roles and responsibilities of each public and private partner need to be clearly identified to ensure efficient implementation, operation, and maintenance of the system.
2. Participating parking facilities need adequate operator training, communication, and support in order to effectively operate their portion of the system and deal with unplanned circumstances and technical difficulties. Operators also need to stay on top of staff training, particularly with staff turnover.
3. A contractor with similar traffic control equipment installation experience is critical in order to prevent delays in installation and operation.
4. Project scheduling should allow for a system validation and testing period to identify and correct any functional problems within the system prior, to full operation and evaluation.

### **Purpose of Operational Test**

The purpose of the St. Paul Advanced Parking Information System (Advanced Parking) operational test is to determine the ability of an automated, real-time parking information and guidance system to:

- Provide efficient and user-friendly access to special event parking
- Reduce travel and congestion by motorists in search of parking in downtown St. Paul
- Improve management and utilization of parking resources in the Civic Center/Rice Park area of downtown St. Paul.

### **Background**

One of the primary focuses of downtown economic activity is the visitor industry. Downtown St. Paul has more than four million visitors each year. Although adequate parking is currently available in the downtown, many visitors experience difficulty in finding the available parking.

The city of St. Paul facilitated the implementation and evaluation of the operational test. The test was to demonstrate the practical means of extending Minnesota Guidestar, Mn/DOT's Intelligent Transportation System program, beyond the transit and roadway components of the

travel system to include management of trip ends and the parking component of the total travel system involving both private and public parking facilities.

### **Description of Operational Test**

Mn/DOT (Minnesota Guidestar), the project manager, teamed with several public partners, FHWA, city of St. Paul Department of Planning and Economic Development, city of St. Paul Department of Public Works, and one private partner, AGS Group, to conduct a one-year St. Paul Advanced Parking operational test. The test was performed in the Civic Center/Rice Park area of downtown St. Paul.

While downtown St. Paul did not have a shortage of parking during the operational test, a perceived lack of ready access to parking had been repeatedly identified as a problem in the downtown area. The operational test consisted of the following:

- Determination of parking stall occupancy by participating parking operators during special events in downtown St. Paul and instantaneous transmission of available parking to the Saint Paul Traffic Control Center (TCC)
- Instantaneous transmission of information on available parking by the St. Paul TCC to electronic message signs
- Wireless, automated parking advisory signs placed at appropriate locations to display the number of stalls available at parking ramps or lots with direction arrows to the ramps or lots

The participating parking facilities and operators included the following:

- Victory Ramp (Victory Parking Inc.)
- Garrick Ramp (Victory Parking Inc.)
- Civic Center Ramp (APCOA Inc.)
- Radisson Hotel Ramp (Radisson Hotel)
- Landmark Ramp (Central Parking)
- Lowry Ramp (Central Parking)
- Cleveland Circle Lot (Emperial Parking); the Plaza Lot withdrew from the test due to a change in operations and technical issues
- United Gold Ramp & Surface Lot (United Hospital)

### **Operational Test Objectives**

The test was designed to accomplish the following:

- Provide motorists coming to Civic Center/Rice Park area events with real-time information regarding the occupancy status of parking facilities plus directions for the best routes to open parking facilities using an automated system of variable message signs.
- Improve event traffic flow, reduce congestion, improve air quality, and avoid backups onto the freeways.
- Coordinate development and operation of an advanced parking information system with the Major Traffic Generator Signing Project (a joint Mn/DOT, city of St. Paul, and city of Minneapolis initiative to manage special event traffic) and the During Incidents Vehicles Exit to Reduce Travel time project (DIVERT, a joint Mn/DOT and City of St. Paul

initiative to manage traffic diverted by freeway incidents) which are currently being planned and implemented through the Minnesota Guidestar program.

- Develop inter-jurisdictional operations and maintenance strategies.
- Involve public and private parking facility operators, as well as Civic Center and Ordway operators, in project funding and in development of a marketing strategy.
- Create understandable, user-friendly, fast and effective access for motorists coming to Civic Center/Rice Park area events.
- Maximize use of existing visitor parking in the Civic Center/Rice Park area.

### **Evaluation of Operational Test Goals and Objectives**

The evaluation goals are general statements that define the "hoped for" outcomes of the Evaluation Plan -- what the evaluation is striving to accomplish. The overall findings of the Advanced Parking evaluation goals and objectives are presented below:

#### **Goal 1 - *Evaluate user acceptance of Advanced Parking***

The users of Advanced Parking during the operational test were: participating parking operators, city of St. Paul, motorists attending special events, Mn/DOT and FHWA. There was definite acceptance of Advanced Parking by the participating parking operators and the City of St. Paul, and general acceptance by motorists, Mn/DOT and FHWA.

#### **Objective 1.1 - *Assess the value/worth of Advanced Parking to the motorist***

Evaluation of the value of Advanced Parking to motorists is based on a mailback postcard survey. This type of survey typically has a very small return, and those returned cannot be considered a valid statistical sample. However, there were insufficient funds budgeted for the operational test evaluation to perform a more effective survey.

A total of 19,250 mail-back motorist surveys were distributed at participating parking facilities -- 9,750 during the Minnesota State High School Wrestling and Boys Basketball Tournaments in March of 1996, and 9,500 during the Smithsonian Exhibition in November of 1996. Although the system was thought to be fully operational in March of 1996, there were several technical failures during the events (e.g., system shutdowns, inaccurate parking occupancy data) and responses from those events (122 out of 9,750) are not included in the evaluation. The 9,500 mail-back surveys were distributed November 4-10, 1996 during the Smithsonian Exhibition and 139 (1.5%) were returned.

It is concluded that Advanced Parking has value to the motorists -- based on those motorists responding to the survey.

Findings of Objective 1.1 (based on the mailback survey) are summarized below:

- Most responders found the parking availability signs easy or somewhat easy to understand and follow
- Less than half of the responders who saw the Advanced Parking signs used them to find parking.
- Over half of the responders who used Advanced Parking found it helpful in deciding where to park compared to the last time they parked in this area of St. Paul before Advanced Parking

- There was an overall improvement in travel time on selected routes within the project area.

**Objective 1.2 - Assess the value/worth of Advanced Parking to the parking operator**

There is a value of Advanced Parking to the parking operator. Findings of Objective 1.2 are summarized below:

- Operators perceive the system as beneficial.
- Occupancy rates at participating parking facilities were higher; however, it is unclear if it is due solely to Advanced Parking.

**Objective 1.3 - Assess the value/worth of Advanced Parking to the City of St. Paul**

All the project partners recognized the value/worth of Advanced Parking to the city. City of St. Paul officials indicated the value of Advanced Parking is measured by the potential impact of the surface transportation system as well as potential economic impacts of Advanced Parking. City officials believe Advanced Parking will enhance the ability of St. Paul to attract special events and potentially provide more efficient access to downtown businesses. The city would like to expand the system throughout the downtown.

**Objective 1.4 - Assess the value/worth of Advanced Parking to FHWA**

The value of Advanced Parking to FHWA is linked to the impact of Advanced Parking on the ITS national goals shown in the chart on the following page. Advanced Parking in St. Paul did not demonstrate increased efficiency and capacity of the surface transportation system, which would reduce energy and environmental costs, but it did not decrease them either. It is believed that Advanced Parking enhances personal convenience and comfort, enhances present and future productivity of event parking, and will help create an environment for ITS to flourish – by enabling other U.S. cities to develop and deploy similar systems.

**Objective 1.5 - Assess the value/worth of Advanced Parking to Mn/DOT**

- Advanced Parking was beneficial to Mn/DOT for the following reasons:
- The partnership between Mn/DOT and St. Paul went well
- The public/private partnership went well
- The operational test was completed on schedule and within budget
- Advanced Parking has the potential to benefit other Minnesota cities

**Goal 2 - Evaluate the potential impacts on the surface transportation system and the affected environment.**

There were some improvements on the surface transportation system, but it could not be determined that the improvements were attributable to Advanced Parking.

**Objective 2.1 - Assess the net effect on congestion within the project area.**

The net effect of Advanced Parking on traffic congestion is limited. The findings of Objective 2.1 are summarized below:

- Level of Service at selected intersections did not change, however estimated delay per vehicle was reduced
- Travel Time on selected routes improved (decreased)



**Objective 2.2 - *Assess the volume of traffic rerouted as a result of the system.***

There was no evidence of a change in the proportion of volume at key locations in the project area based on parking availability information provided by the system.

**Goal 3 - *Evaluate the applicability of Advanced Parking to support other ITS projects in St. Paul.***

Advanced Parking signs with full matrix displays could be used to support other ITS projects in St. Paul. The extent of support the Advanced Parking system could provide to specific ITS projects was not determined.

**Objective 3.1 - *Assess the applicability of the system for extension to support other traffic functions in downtown St. Paul.***

The findings of Objective 3.1 are as follows:

- Advanced Parking signs with full matrix displays have sufficient capabilities to support other traffic functions in downtown St. Paul.
- Advanced Parking counter signs alone do not have sufficient capabilities to support other traffic functions in downtown St. Paul

**Goal 4 - *Evaluate the technical performance of the Parking Information System.***

The technical performance of the system was acceptable after an ample "debugging" period.

**Objective 4.1 - *Assess the performance and reliability of the overall system.***

**Objective 4.2 - *Document the amount of time the system was operational and available.***

The findings of Objective 4.1 and 4.2 are presented below:

- The system operated without any logged failures 55% of the operational test.
- After a six-month "debugging" period, the system operated without any logged failures 96% of the time.

**Objective 4.3 - *Assess how well the system components were integrated together and performed.***

The evaluation found the system components were well integrated and functioned as designed.

**Objective 4.4 - *Assess the performance of the parking management systems to provide accurate, real-time parking information.***

Advanced Parking provides real-time parking information. The accuracy of the information is directly dependent on the parking operators' cooperation in setting the counters.

**Goal 5 - *Document the costs of the Parking Information System.***

All project costs and partner contributions were documented by entity and were used to estimate the cost of continued use and future expansion.

**Objective 5.1 - *Document the actual costs (by entity) of the operational test.***

The documented total costs of the operational test was \$1,190,000. The contributions by project partner are summarized below:

MN Guidestar \$850,500\* 71.5%  
 City of St. Paul \$ 84,300 7.1%  
 AGS Group \$189,500 15.9%  
 Parking Facilities \$ 65,700 5.5%

\* Includes \$600,000 FHWA support.

**Objective 5.2 - Estimate the operational costs for future deployment.**

The estimated operational costs for future deployment are presented below. A full explanation of the cost estimation is found in the *System Cost Test Plan Evaluation*.

<u>Management and Coordination</u>		<u>Equipment and Installation</u>	
System Planning and Design	\$3,000/loc.	Electronic Signs	\$49,550/sign
System Deployment	\$3,500/loc.	Static Signs	\$2,270/sign
Management and Coordination	\$2,300/loc.	Communication Lines	\$4,620/loc.
Total	\$8,800/loc	Parking Facility Equipment	\$7,310/facility
<u>Operations and Maintenance</u>		System Software	variable
Labor	\$1,125/mth.	Startup/Testing/Training	\$1,700/loc.
Communication Lines	\$1,300/mth.		
Total	\$2,425/mth		

**Goal 6 - Document the effect of institutional, legal, and private sector issues.**

There were no institutional, legal, or private sector issues which had a significant effect on the operational test.

**Objective 6.1 - Identify significant institutional and legal issues encountered with initiating and implementing the operational test, and appraise the extent of their impacts.**

There were several institutional issues identified, however they had little or no effect on the operational test. The findings for Objective 6.1 are presented below:

- No legal issues identified.
- Roles and responsibilities of project partners were not clearly defined early in the test.
- Communication between project partners is very important.

**Objective 6.2 - Identify concerns and objections of parking facility operators to share real-time information, and summarize how resistance was overcome.**

There was only one parking facility operator who raised a concern about displaying availability information. The concern was that their business did not have anything to gain since their ramp typically reached capacity without Advanced Parking. Furthermore, they were concerned about the system displaying erroneous information, as it could only hurt their business. No other concerns or objections of parking facility operators were raised.

**Objective 6.3 - Identify level of participation from parking operators that were approached to participate in the test and reasons for low/no participation.**

There was an excellent level of participation from parking operators. All parking operators who were approached about the operational test chose to participate. In fact, there were parking operators who wanted to participate but could not, in order to keep the size of the system at a reasonable level for the test. One operator withdrew during the test because of what is perceived

to be a lack of interest, since the lot is used during the weekdays for employee parking, and only on evenings and weekends for event parking.

**Objective 6.4 - *Identify significant institutional issues that may impact the development of the system or the long-term operation of the parking information system.***

There were no significant institutional issues identified that would impact the deployment of the system or the long term operation of the parking information system.

**Objective 6.5 - *Identify the level of private sector participation in the funding of the test.***

Private sector contributions accounted for more than 21% of the cost of the operational test. Public partners indicated satisfaction in the level of private sector participation in the funding of the test.

**Objective 6.6 - *Document any lessons learned in soliciting and obtaining private sector support.***

There were several lessons learned in soliciting and obtaining private sector support and are presented below:

- Public education and involvement early on would help to promote private sector participation and contributions.
- Marketing and salesmanship skills are needed to attract private sector participation and contributions.

**Goal 7 - *Evaluate the transferability of the system.***

The system is transferable without significant modification.

**Objective 7.1 - *Assess the influence of St. Paul-specific characteristics, and external factors, on outcome of the operational test.***

There were no St. Paul-specific characteristics or external factors which unduly influenced the outcome of the operational test.

**Objective 7.2 - *Document "lessons learned" from the operational test, based on practical experience, and suggest system modifications for deployment in St. Paul and other sites.***

The following lessons were learned:

- The roles and responsibilities of each public and private partner need to be clearly identified to ensure efficient implementation, operation, and maintenance of the system.
- Participating parking facilities need adequate operator training, communication, and support in order to effectively operate their portion of the system and deal with unplanned circumstance and technical difficulties. Operators also need to stay on top of staff training, particularly with staff turnover.
- A contractor with similar traffic control equipment installation experience is critical in order to prevent delays in installation and operation.
- Project scheduling should allow for a system validation and testing period to identify and correct any functional problems within the system prior to full operation and evaluation.

There were several suggested system modifications identified by project partners:

- Do not combine two parking facilities' available spaces on one sign panel.

- Add signs on the surrounding freeways that identify the event and direct the motorist to the desired exit.
- Improve the accuracy and transmission speed of the information to the signs.
- Add more signs.
- Increase the visibility of signs (letter height, size of sign, color, etc.).

## Motorist Assessment Test Plan Report

### Objective 1.1 - Assess the value/worth of Advanced Parking to the motorist

The purpose of this objective is to assess the motorists' perceptions of Advanced Parking. Specifically, the evaluation assessed the percentage of motorists who saw the message signs and, of those who saw the signs, how easy it was to understand and follow them. Additionally, the evaluation will determine if the motorists perceived a decrease in the time it took to park due to the message signs.

The primary source of data is a postcard mail-back survey distributed to motorists parked at participating parking facilities during the selected special events. The survey was handed to the motorists when they were exiting the parking facility after the event. The motorists were expected to complete the survey and deposit it into the mail. See the Appendix for a sample of the parking survey questionnaire.

**Note:** It was anticipated that surveys would also be distributed at non-participating parking facilities during the selected special events, based on a discussion with the operator of these lots. The closest lot to the Civic Center was the West Publishing Parking Lot, which was operated on the "honor system". The lot operator agreed to provide a person to distribute surveys during special events, but discontinued this after the first event because very few event-goers parked there. Other non-participating parking facilities in or around the project area did not remain open during Civic Center evening and weekend events.

### Summary of Findings

- 91% of the survey respondents who saw the matrix signs said they were easy to understand and follow.
- 40% of the respondents who saw the matrix signs said they used them to find parking.
- 87% of those who said they used the signs found them helpful in deciding where to park, compared to the last time they parked in this area.
- 45% of the survey respondents said they saved an average of 11 minutes compared to the last time they parked in this area
- 98% of survey respondents who used the static signs directing them *to* parking facilities found them easy to follow.
- 88% of respondents who used the static signs directing them *from the parking facility to the special event* found them easy to follow.
- 83% of respondents who used the static signs for directions *from the parking facility to the freeway system* after the event found them easy to follow.

### Key Conclusions

- Motorists found Advanced Parking easy to understand and follow.
- Those people who used Advanced Parking found it helpful.
- Due to a very small response to the survey (1.4% overall), the results may not be representative.

**Hypothesis 1.1.1 - *There are a greater number of motorists who perceive a benefit of the parking availability (matrix) signs, compared to those who do not.***

## **MOE 1 - Ease/difficulty in finding parking before and during the test.**

### **Discussion of Findings**

A total of 9,500 mail-back surveys were distributed November 4-10, 1996 during the Smithsonian Exhibition and 139 (1.5%) were returned. Of the 139 respondents, 113 (81%) reported they saw the Advanced Parking signs on their way to park. 104 respondents (90%) said it was easy to understand and follow the signs; however, only 46 (40%) actually used the parking availability information on the signs to find parking that day. When asked to recall the last time they parked in the project area, 40 (87%) of the 46 respondents who used the Advanced Parking signs to park, indicated the Advanced Parking signs showing available parking were helpful in deciding where to park. There were 39 (34%) respondents who found it easier to park this time while 61 (53%) did not find it any easier; 32 (28%) reported it saved them time parking. The average estimated perceived time savings was 11 minutes.

### **Supporting Data**

The motorist survey responses applicable to **Hypothesis 1.1.1** are summarized below. A total of 19,250 mail-back motorist surveys were distributed at participating parking facilities during the Minnesota State High School Wrestling and Boys Basketball Tournaments in March of 1996 and during the Smithsonian Exhibition in November of 1996. Although the system was thought to be fully operational in March of 1996, there were several technical failures during the events (e.g., system shutdowns, inaccurate parking occupancy data) and responses from those events (122 out of 9,750) are not included in the evaluation. The following summary represents the returned surveys distributed November 4-10, 1996 during the Smithsonian Exhibition when the system was fully operational. A total of 9,500 surveys were distributed and 139 (1.5%) were returned.

3. On your way to park at this location, did you see any message signs about available parking in downtown garages or lots?

Total	139	
Yes	113	81.30%
No or don't recall	23	16.5%
No Response	3	2.2%

4. How easy is it to understand and follow the signs?

Total	115	
Very Easy	57	49.6%
Somewhat Easy	47	40.9%
Not Easy	11	9.6%
No Response	0	0.0%

Did you use the signs to find your parking space?

Total	115	
Yes	46	40.0%

No	69	60.0%
No Response	0	0.0%

Think about the time(s) you parked in this area at about the same time of day.

6a. Were the signs showing available parking helpful in deciding where to park compared to last time?

Total	46	
Yes	40	87.0%
No	6	13.0%

6b. Was it easier to find a place to park compared to last time?

Total	115	
Yes	39	33.9%
No	61	53.0%
No Response	15	13.0%

6c. Did it take less time to find parking compared to the last time?

Total	115	
Yes	32	27.8%
No	48	41.7%
Don't Know	14	12.2%
No Response	21	18.3%

6d. By how many minutes?

Total	69
Don't Know	6
Average of 63 Responses	11 Min.

The results for **Hypothesis 1.1.1** are mixed. Of the respondents who saw the parking availability signs on their way to park, over 90% found them very easy or somewhat easy to understand and follow, but only 40% said they used the information on the signs to find parking. There may have been some uncertainty as to what is meant by "using the sign" to find parking. If the motorist had predetermined where he or she was to park and the Advanced Parking sign showed available spaces at that location, did the motorist "use" that information to park where he/she had planned? The answer should be "yes" but it is believed that most responded "no" unless they diverted to another location because of the signs.

However, of the 40% who said they used the information on the signs to find parking, nearly all found it helpful to find a place to park compared to the last time they parked in this area.

It is concluded that the parking availability signs are beneficial to the motorist requiring parking.

**Hypothesis 1.1.2 - There are a greater number of motorists who find the static signs helpful in locating the desired parking ramp, the special event from the parking ramp, and access to I 35E and I-94 from the parking ramp, compared to those who do not.**

**MOE 2 - Adequacy of signing/directions from the parking stall to the event and finding route home after the event.**

### Discussion of Findings

A total of 9,500 mail-back surveys were distributed November 4-10, 1996 during the Smithsonian Exhibit and 139 (1.5%) were returned. Question 7 on the survey was directed at Hypothesis 1.1.2. Of the 139 respondents, 64 (46.0%) indicated they did not see or did not use the static signs directing them to parking facilities. Of the 66 (47%) individuals who used the static signs, 65 (98%) found the static signs very easy or somewhat easy to follow. Of the 139 total respondents, 69 (49.6%) indicated they did not see or did not use the static signs directing them from the parking facility to the special event. Of the 48 (35%) individuals who used the static signs, 42 (88%) found the static signs very easy or somewhat easy to follow. Of the 139 total respondents, 55 (39.6%) indicated they did not see or did not use the static signs directing them from the parking facility to the freeway system after the event. Of the 70 individuals who used the static signs, 58 (83%) found the static signs very easy or somewhat easy to follow.

### Supporting Data

The motorist survey responses applicable to **Hypothesis 1.1.2** are summarized below. A total of 19,250 mail-back motorist surveys were distributed at participating parking facilities during the Minnesota State High School Wrestling and Boys Basketball Tournaments in March of 1996 and during the Smithsonian Exhibition in November of 1996. However, Advanced Parking was not fully operational in March of 1996 and responses from those events (122) are not included in the summary. The summary below represents the returned surveys distributed November 4-10, 1996 during the Smithsonian Exhibition. A total of 9,500 surveys were distributed and 139 (1.5%) were returned

7. Regarding the various arrow direction signs, please indicate your reaction to each type:

	All Respon- dents (139)		Respon- dents who followed the signs			
	Did not see or did not use	No response	Total	Very Easy	Somewhat Easy	Not Easy
A – Signs TO where you parked	64 (46.0%)	9 (6.5%)	66 (47.5%)	33	32	1
B – Signs FROM where you parked TO the special event	69 (49.6%)	22 (15.8%)	48 (34.5%)	20	22	6
C – Signs FROM where you parked TO I-35E or I-94	55 (39.5%)	14 (10.1%)	70 (50.4%)	35	23	12



## Conclusions

The survey results clearly indicate the motorists who used the static signs in locating the desired parking ramp, the special event from the parking ramp, and access to I-35E and I-94 from the parking ramp found the signs *very easy* or *somewhat easy* to follow. It is assumed that if the motorist used the signs and found them easy to follow, then the signs were helpful. Persons familiar with downtown St. Paul would not be looking for directional signing.

### **Measurement 1.1.3 - *Surveys of motorists will identify reasons why they used non-participating operators and how the parking system could be improved to assist the motorist.***

The following motorist survey questions were used for this measurement.

8. If you saw either the parking availability or arrow directions signs, please indicate how they can be improved.

9. Please tell us other ways that the parking information system could be improved.

### **MOE 3 - Reasons why event motorists used non-participating operators**

### **MOE 4 - How the system could be improved to assist the motorist**

MOE 3 and the first part of **Hypothesis 1.1.2** were to be addressed by a second motorist survey distributed at non-participating parking facilities, however the second survey was not implemented since there were no non-participating parking lots available for survey distribution, as previously discussed under Supporting Data for Hypothesis 1.1.1.

## Discussion of Findings

A total of 9,500 mail-back surveys were distributed at participating parking facilities on November 4-10, 1996 during the Smithsonian Exhibition and 139 (1.5%) were returned. Questions 8 and 9 on the survey were directed at **MOE 4** and the second part of **Hypothesis 1.1.2**. Of the 139 total respondents, 70 did not respond to question 8 about the *parking availability signs*. Of the 69 who did respond:

- 31.9% indicated there was no need for improvement of the parking availability signs,
- 39.1% indicated a need for larger signs or lettering,
- 31.9% indicated a need for more signs,
- 13.0% indicated a need for more information,
- 11.6% indicated a need for better color coordination, and
- 8.7% indicated a need for more or different graphics.

Of the 139 total respondents, 81 did not respond to question 8 about the *static directional signs*. Of the 58 who did respond:

- 31.0% indicated there was no need for improvement of the static directional signs,
- 36.2% indicated a need for larger signs or lettering,
- 39.7% indicated a need for more signs,
- 22.4% indicated a need for more information,
- 20.7% indicated a need for better color coordination, and

10.3% indicated a need for more or different graphics.

Of the 139 total respondents, 73 provided suggestions on how the parking information system could be improved (Question 9), 40 of which are applicable to Advanced Parking. Those responses are tabulated below.

10 individuals indicated the parking information system was a "good job",  
8 individuals indicated the signs were confusing,  
7 individuals indicated a need for better sign visibility,  
4 individuals indicated a need for more frequent updating of information,  
4 individuals indicated a need for more signs directing to freeways,  
3 individuals indicated a need for earlier information signs, and  
4 individuals suggested offering a parking guide.

### **Supporting Data**

The motorist survey responses applicable to **Hypothesis 1.1.2** are summarized below. The summary below represents the returned surveys distributed November 4-10, 1996 during the Smithsonian Exhibition.

#### **Recommended Improvements**

	<u>Availability Signs</u>	<u>Directional Signs</u>
No Need for Improvement	22	18
Larger Sign/Lettering	27	21
More Signs	22	23
Better Color Coordination	8	12
More Information	9	13
More/Different Graphics	6	6
Other	6	4
Total Respondents	69	58

### **Conclusions**

The survey return rate was very low and therefore the results may not be representative of the people attending special events in downtown St. Paul. Also, the maximum allowable size of a postcard limited the number of questions in the survey, and of course there was no opportunity to probe answers to the questions. It is recommended that for future projects of this nature, techniques should be explored to increase public awareness of the project. To determine motorists' opinions of Advanced Parking, on-site surveys during the events, or telephone surveys of pre-event ticket holders after the event are recommended.

## **Parking Operator Assessment Test Report**

### **Objective 1.2 - Assess the value/worth of the system to the parking operator.**

The purpose of this objective is to determine the value of Advanced Parking and how it could be improved from the perspective of the parking operator.

The evaluation relies on occupancy data, with and without the Advanced Parking system, and operator interviews. The occupancy data reflects the number of parking spaces filled during each selected special event at each of the participating facilities. The operator interviews were designed to disclose the value of the system to the parking operator from the perspective of the parking operator.

Occupancy data was obtained automatically at participating parking facilities for all selected events. A moderator conducted face-to-face interviews with the parking operators. The interview responses were tape recorded and transcribed into a permanent record.

**Note:** During the planning of the evaluation, operators of non-participating parking facilities in the project area indicated they would be open during events. Therefore, it was anticipated that occupancy data would be collected for non-participating parking facilities during the selected special events. However, during the operational test period these facilities were not open or were operated without an attendant. As a result, occupancy data was not collected for those facilities.

### **Summary of Findings**

- Parking occupancy rates increased when Advanced Parking was used
- Parking operators see the system as beneficial
- Most operators are interested in continued participation and expansion of the system throughout downtown and weekdays.
- Parking facility operators need information about ongoing costs before they can determine their willingness to pay.

### **Key Conclusions**

- Due to fluctuations in special event attendance during the test, it cannot be stated conclusively that parking facility occupancy rates were higher due solely to the use of Advanced Parking.
- The use of Advanced Parking is a benefit to the city of St. Paul.
- Based on comments from participating parking facility operators, the system should be expanded throughout downtown and used each weekday in addition to special events.

**Hypothesis 1.2.1 - *The occupancy rates for participating operators will be higher when Advanced Parking is in use.***

**Hypothesis 1.2.2 - *The occupancy rates for non-participating operators will be lower when is not in use.***

***MOE 5 - Percent occupancy of parking facility per event during the test compared with percent occupancy before the test, relative to other facilities before and during the test and size of event..***

**Discussion of Findings**

Participating parking facility occupancy rates were collected during the Smithsonian Exhibition on Friday, November 1, 1996 (without Advanced Parking) and Friday, November 8, 1996 (with Advanced Parking). The overall average number of parking spaces available decreased by an average of 27% with the use of Advanced Parking, hence the occupancy rates for participating facilities were higher when Advanced Parking was used. However, the attendance of the Smithsonian Exhibition was 29% higher November 8, 1996 than it was November 1, 1996.

Daily occupancy rates were also collected during the 1995 and 1996 Minnesota State High School Wrestling, Hockey, and Basketball Tournaments at the Civic Center Ramp, Victory Ramp, and Garrick Ramp. During the Wrestling Tournament, there was an 8.6% increase in the number of vehicles parked (occupancy) at the Civic Center Ramp in 1996 (with Advanced Parking) when compared to 1995 (without Advanced Parking). The Victory-Garrick Ramps experienced a similar increase of 11.8% from 1995 to 1996. Attendance for the 3-day Wrestling Tournament also increased by 22.3% from 1995 to 1996. The Hockey and Basketball Tournaments yielded similar findings. The Civic Center Ramp occupancy during the Hockey Tournament increased by 14.2% from 1995 (without Advanced Parking) to 1996 (with Advanced Parking). The Victory-Garrick Ramps occupancy during the Hockey Tournament increased by 4.5% from 1995 to 1996. The attendance for the 4-day Hockey Tournament was approximately the same in 1995 and 1996. The Civic Center Ramp occupancy during the Basketball Tournament increased by 8.9% from 1995 (without Advanced Parking) to 1996 (with Advanced Parking). The Victory-Garrick Ramps occupancy during the Hockey Tournament was approximately the same in 1995 and 1996. The attendance for the 4-day Basketball Tournament increased by 5.9% from 1995 to 1996.

**Supporting Data**

Table 1 below summarizes the average available parking in the Civic Center/Rice Park area during the Smithsonian Exhibition between 11:00 a.m. and 8:00 p.m. "Before" data was collected on Friday, November 1, 1996 and represents parking conditions without the use of Advanced Parking. "After" data was collected on Friday, November 8, 1996 and represents parking conditions with the use of Advanced Parking. The Smithsonian Exhibition daily attendance for both days is also summarized.

**Table 1 - Parking Occupancy With and Without Advanced Parking During Smithsonian Exhibition**

	Average Number of Spaces Available			Smith- sonian Atten- dance		
Parking Ramp	Without Advanced Parking	With Advanced Parking	% change	Before	After	% change
Civic Center	286	137	-52%			
Garrick	117	117	0%			
Landmark	9	5	-44%			
Lowry	93	76	-18%			
Radisson	96	46	-52%			
Victory	259	243	-6%			
Total	860	624	-27%	17,000	22,000	29%

Table 2 below summarizes the total parking occupancy at the Civic Center, Victory, and Garrick Ramps during the Minnesota State High School Wrestling, Hockey, and Basketball Tournaments. "Before" data was collected in March 1995 and represents parking conditions without the use of Advanced Parking. "After" data was collected in March 1996 and represents parking conditions with the use of Advanced Parking. Each tournament's total attendance is also summarized.

**Table 2 - Parking Occupancy With and Without Advanced Parking During High School Wrestling, Hockey, and Basketball Tournaments**

	Parking Occu- pancy (# of vehicles)								
	Civic Center Ramp			Victory- Garrick Ramp			Event Atten- dance		
Event	1995	1996	% change	1995	1996	% change	1995	1996	% change
Wrestling Tournament	6807	7391	8.6%	3590	4014	11.8%	47,552	58,161	22.3%
Hockey Tournament	7844	8959	14.2%	5091	5319	4.5%	86,211	85,924	-0.3%
Basketball Tournament	6354	6922	8.9%	3715	3741	0.7%	42,592	45,096	5.9%

## Conclusions

The occupancy rates for participating parking facilities were higher when Advanced Parking was used than when it was not. However, the attendance for the study events was also higher on the days when Advanced Parking was used. Therefore, it is unclear whether or not the higher occupancy rates are due to the use of Advanced Parking or in response to the higher attendance

figures. Based on the parking occupancy data summarized above, the results for the hypothesis are inconclusive.

**Hypothesis 1.2.3 - *There are a greater number of parking operators in the test who find the system advantageous than those who do not.***

The following parking operator interview questions were used to measure hypothesis 1.2.3.

Do you think the Advanced Parking system was a benefit to you during the test?

Do you think it was beneficial to the city? To the parking public?

Should the city continue to use the system?

Should the city expand its use throughout the downtown? Throughout each weekday?

Would you want to be a participant if the system is continued ----  
in its present form (events only)  
if it is expanded throughout the downtown?  
if it is used throughout each weekday?  
other options?

Are you willing to pay for onsite operating and maintenance costs if the system is continued?

How can the system be improved?

**MOE 6 - *Operator assessment of continued use of the system after the test for events and be a participant..***

**MOE 7 - *Willingness of operator to pay for on-site system operating and maintenance costs if the system is continued.***

**MOE 8 - *Operator assessment of employing the system at other times.***

**MOE 9 - *How the system could be improved to assist the operator.***

**MOE 19 - *Number of system component failures, by component.***

### **Discussion of Findings**

50% of the operators said that the Advanced Parking system was a benefit to them. One of the specific benefits that was mentioned by some of the operators was the Advanced Parking counters gave them another system to use to monitor activity at their location. Also, one operator thought the system was good advertising for the ramp when signs indicated other ramps/lots were full while there was still space available indicated for their location. The cases where operators thought that the Advanced Parking system was not a benefit to them can be attributed

primarily to their location and the nature of their operation. For example, a ramp that is always one of the first to become full during an event was less likely to see the benefits of the system.

A vast majority (83%) of the operators think that the Advanced Parking system is a benefit to the city of St. Paul and the parking public. It was perceived that since visitors to downtown St. Paul were able to more easily find available parking, the city benefited from their positive experience.

67% of the operators indicated they would want to be a participant if use of the system is continued for events only or expanded throughout the downtown. 50% of the operators interviewed stated they would continue to participate if operation of the system is expanded throughout each weekday. The parking operators did not offer any other possible options for continued use of the system.

Only one operator stated he would not be willing to pay for onsite costs for continued use of the system because he thought the parking system was not a benefit to his operation. Therefore, he would not want to pay for ongoing operation and maintenance. The other five operators who were interviewed said their willingness to pay for ongoing operation and maintenance costs would depend on how much those costs would be.

There was support among the parking operators for employing the system at times other than special events. 83% said it should be expanded throughout downtown, and 67% think it should be used each weekday.

The parking operators did make some suggestion on how the system can be improved. The following are listed in no particular order.

- Add information signs on freeways near downtown
- Replace "Reserved" message with "Contract Only"
- Do not combine two facilities on one sign panel
- Improve the accuracy and speed of the counts
- Increase the number of signs

## **Conclusions**

Private parking operators see the system as a benefit to the city, the parking public and to themselves. Therefore, from the parking operators perspective, the system should continue to operate for events and its operation should be expanded throughout downtown and used each weekday. Based on this view from the operators who participated in the operational test, the city of St. Paul should be successful in gaining support from other private parking operators for expansion of the system.

Estimated ongoing operations and maintenance costs for each operator need to be determined before they can make an assessment on their participation in the payment of these costs. Willingness to participate will also be based upon the perceived benefit to the parking operators to continue to operate the system.

Operators are generally satisfied with the system and think it could be improved through minor improvements and additions.



## Roadway System Impacts Test Plan Report

### **Objective 2.1 - Assess the net effect on congestion within the project area.**

The purpose of this objective is to determine the potential impacts of Advanced Parking on the surface transportation system in the Civic Center/Rice Park area of downtown St. Paul.

The evaluation utilized traffic volumes and turning movement counts at selected locations, and travel-time runs for selected special events using Advanced Parking and compared them to similar events without Advanced Parking. The traffic volume and turning movement counts were collected at the locations specified on the following maps and correlated with available parking spaces displayed on the signs.

Traffic volumes were collected using portable tube counters which were laid across the pavement and counted the number of vehicles that passed over them. Data was collected in fifteen-minute intervals and provides a directional distribution of traffic. The tube counters were put in position two hours before the beginning of the event and were picked up the following day. Turning movement counts were manually collected at two key intersections in the project area. Two individuals collected turning movements using hand-held traffic counters at each intersection beginning one and a half hours before the event and lasting for two hours. The number of available parking spaces were counted and posted every 15 minutes for the participating facilities, beginning one hour before the event. Two persons conducted the travel-time runs using a stop watch. Eight runs were conducted on each route.

### **Summary of Findings**

The key findings addressing the effectiveness of Advanced Parking to manage congestion within the project area during special events using Advanced Parking compared to similar events not using Advanced Parking are presented below:

- Level of Service at key intersections did not change
- Estimated delay per vehicle at key intersections was reduced by 7.1% while total volume increased by 11.5%
- Travel Time on major streets in the project area was reduced by 3.8%
- Stopped-time Delay on major streets in the project area was reduced by 8.3%

### **Key Conclusions**

It is difficult to draw any clear conclusions from the key findings above since they are all based on a one-day before/after comparison. However, the findings are promising since the attendance at the "after" event was substantially higher, as were the associated traffic volumes on major streets. It is noteworthy that with higher attendance and traffic volumes, the traffic conditions actually improved rather than worsened. Nonetheless, it is difficult to associate these improvements strictly with the operation of Advanced Parking.

***Hypothesis 2.1.1 - There is an improvement in the level of service at selected intersections during special events using Advanced Parking compared to similar events not using Advanced Parking.***

**MOE 10 - Change in Level of Service at key intersections in the project area before and during the test at special events.**

**Discussion of Findings**

Level of Service (LOS) was calculated at the intersections of West 7th Street & Kellogg Blvd. and West 7th Street & West 5th Street during the Smithsonian Exhibition on Friday, November 1, 1996 and Friday, November 8, 1996. The Advanced Parking signs were operating on Friday, November 8, 1996 but not on Friday, November 1, 1996. Analysis was conducted using the principles of the Highway Capacity Manual, 1994 Edition and the Highway Capacity Software, Release 2.3 - Signals.

With the system "turned off", the intersection of West 7th Street & Kellogg Blvd. operated at a LOS C and had an estimated delay of 21.1 sec/veh during the 12:00 to 2:00 p.m. time period. With the system "turned on", the same intersection operated at a LOS C and had an estimated delay of 19.0 sec/veh. The total intersection volume during the 12:00 to 2:00 p.m. time period was 5,787 vehicles without Advanced Parking and 6,682 vehicles with Advanced Parking.

With the system "turned off", the intersection of West 7th Street & West 5th Street operated at a LOS B and had an estimated delay of 13.0 sec/veh during the 12:00 to 2:00 p.m. time period. With the system "turned on", the same intersection operated at a LOS B and had an estimated vehicle delay of 12.6 sec/veh. The total intersection volume during the 12:00 to 2:00 p.m. time period was 4,501 vehicles without Advanced Parking and 4,785 vehicles with Advanced Parking.

**Supporting Data**

The table below summarizes the impact of Advanced Parking on key intersections in the project area. "Before" data was collected on Friday, November 1, 1996 during the Smithsonian Exhibition and represents conditions without the use of Advanced Parking. "After" data was collected on Friday, November 8, 1996 during the Smithsonian Exhibition and represents conditions with the use of Advanced Parking.

		Level of Service		Vehicle Delay (sec/veh)			Inter-section volume (veh)		
	Time Period	Before	After	Before	After	% change	Before	After	% change
W. 7 <sup>th</sup> St. and Kellogg Blvd.	12-1pm	C	C	24.6	18.3	-25.6%	3087	3280	6.3%
	1-2pm	C	C	17.2	19.7	14.5%	2700	3402	26.0%
	12-2pm	C	C	21.1	19.0	-10.1%	5787	6682	15.5%
W. 7 <sup>th</sup> St. and W. 5 <sup>th</sup> St.	12-1pm	B	B	12.0	12.7	5.8%	2238	2353	5.1%
	1-2pm	B	B	14.0	12.5	-10.7%	2263	2432	7.5%
	12-2pm	B	B	13.0	12.6	-3.1%	4501	4785	6.3%
System Total	12-2pm	C	C	17.6	16.3	-7.1%	10,288	11,467	11.5%

## Conclusions

The findings discussed above do not support **Hypothesis 2.1.1** - *There is an improvement in the level of service at selected intersections during special events using Advanced Parking compared to similar events not using Advanced Parking.* Level of Service at the intersections of West 7th Street & Kellogg Blvd. and West 7th Street & West 5th Street remained steady at LOS C and LOS B, respectively, during the Smithsonian Exhibition with and without the use of Advanced Parking. Although the level of service at the intersections did not change, there were some noteworthy improvements at the intersection of West 7th Street & Kellogg Blvd. The estimated vehicle delay decreased by 10.1% while the total intersection volume increased by 15.5% when Advanced Parking was used. These findings are substantial since vehicle delay is directly dependent on volume. The estimated vehicle delay and intersection volume at the intersection of West 7th Street and West 5th Street remained relatively constant at -3.1% and 6.3% respectively, with and without the use of Advanced Parking.

**Hypothesis 2.1.2** - *There is an improvement in the travel time on major streets in the project area during special events using Advanced Parking compared to similar events not using Advanced Parking.*

**MOE 11** - *Change in travel time on major streets in the project area before and during the test at special events.*

## Discussion of Findings

Travel time data was collected on two routes during the Smithsonian Exhibition on Friday, November 1, 1996 and Friday, November 8, 1996. The Advanced Parking signs were operating on Friday, November 8, 1996 but not on Friday, November 1, 1996. Eight travel time runs were conducted on each route for each event.

With the system "turned off", travel time on Route 1 averaged 6.76 minutes and the average stopped time delay was 2.36 minutes during the 12:00 to 2:00 p.m. time period. With the system "turned on", the average travel time on Route 1 was 6.18 minutes and the average stopped time delay was 2.01 minutes.

With the system "turned off", travel time on Route 2 averaged 6.75 minutes and the average stopped time delay was 1.57 minutes during the 12:00 to 2:00 p.m. time period. With the system "turned on", the average travel time on Route 2 was 6.81 minutes and the average stopped time delay was 1.60 minutes.

## Supporting Data

The table below summarizes the results of travel time studies conducted within the project area. "Before" data was collected between 12:00 - 2:00 p.m. on Friday, November 1, 1996 during the Smithsonian Exhibition and represents conditions without the use of Advanced Parking. "After" data was collected between 12:00 - 2:00 p.m. on Friday, November 8, 1996 during the Smithsonian Exhibition and represents conditions with the use of Advanced Parking. Eight travel time runs were conducted during these time periods on each route for each event.

	Travel Time (min)			Stopped Time Delay (min)		
Route	Before	After	% change	Before	After	% change
Route 1	6.76	6.18	-8.6%	2.36	2.01	-15.05%
Route 2	6.75	6.81	0.9%	1.57	1.60	1.9%
Total	13.51	12.99	-3.9%	3.93	3.61	-8.3%

## Conclusions

The findings discussed above do support **Hypothesis 2.1.2** - *There is an improvement in the travel time on major streets in the project area during special events using Advanced Parking compared to similar events not using Advanced Parking.* Travel time on Route 1 improved during the Smithsonian Exhibition. There was a 8.6% decrease in travel time and 15.0% decrease in stopped time delay on Route 1 when Advanced Parking was used compared to when Advanced Parking was not used. Travel time on Route 2 remained relatively constant during the Smithsonian Exhibition. There was a 0.9% increase in travel time and 1.9% increase in stopped time delay on Route 2 when Advanced Parking was used compared to when Advanced Parking was not used. Although travel time and stopped time delay increased slightly on Route 2, the cumulative result was positive. The cumulative average travel time and stopped time delay on Route 1 and 2 decreased by 3.9% and 8.3% respectively when Advanced Parking was used compared when Advanced Parking was not used.

## Objective 2.2 - Assess the volume of traffic rerouted as a result of the system.

### Summary of Findings

The key volume findings addressing the effectiveness of Advanced Parking to reroute traffic within the project area using Advanced Parking are presented below

- Eastbound Kellogg Blvd. at Washington Street increased by 26.1%.
- Northbound Wabasha Street at Kellogg Blvd. increased by 21.1%.
- Southbound St. Peter Street at 6th Street increased by 25.8%
- West 7th Street and Kellogg Blvd. Intersection Volume increased by 15.5%.
- West 7th Street and 5th Street Intersection Volume increased by 6.3%.

### Key Conclusions

There were several changes in the traffic distribution on selected roadways based on parking availability information presented by Advanced Parking. However, the results of the ability of Advanced Parking to reroute traffic within the project are inconclusive since it is unclear whether the changes in the volume distribution are due to Advanced Parking or due to an overall increase in volume in the project area.

## Hypothesis 2.2.1 - *Traffic flow in the affected area will improve due to Advanced Parking.*

**MOE 12** - *Change in traffic volumes on selected roadway segments in the project area before and during the test at special events.*

### Discussion of Findings

**Note:** Local references to street directions are used. Traditionally, Seventh Street is considered E/W, Kellogg Blvd. from Washington Street to the east is E/W, Kellogg Blvd. from Seventh Street to the north is N/S, and St. Peter and Wabasha Streets are N/S.

Traffic volume data was collected at several locations during the Smithsonian Exhibition to determine the effect of Advanced Parking on the distribution of traffic in the project area (see the following page for traffic volume locations). Traffic volumes were compared at strategic locations based on information displayed on specific Advanced Parking signs. There are applicable comparisons during the 12:00 to 2:00 p.m. time period for the Smithsonian Exhibition on Friday, November 1, 1996 (without Advanced Parking) and Friday, November 8, 1996 (with Advanced Parking). On Friday, November 1, 1996, the Civic Center Ramp had an average of about one hundred spaces available and the Advanced Parking signs were off. On Friday, November 8, 1996, the Civic Center Ramp was at capacity and the Advanced Parking signs were on.

Information on four specific signs (#5, 8, 9 and 10 shown on the following page) were correlated with traffic volumes at several strategic locations. When Sign #10 indicated the Civic Center Ramp was closed, the volume on EB Kellogg Blvd. at Washington Avenue was 26.1% higher than when Sign #10 was blank and the Civic Center ramp had space available. Concurrently, the number of vehicles turning left from SB Kellogg Blvd. to EB West 7 th St. increased by 22.5% when Sign #10 indicated the Civic Center Ramp was full.

When Sign #5 indicated the Civic Center Ramp was closed, the volume on NB Wabasha Street was 21.1% higher than when Sign #5 was blank and the Civic Center ramp had space available. The volume on WB Kellogg Blvd. at Washington Avenue was unsuccessfully collected on November 8, 1996 and is not available for comparison.

During the 12:00 to 2:00 p.m. time period, sign #9 also indicated the Civic Center Ramp was closed. During this time, the number of vehicles turning right from EB 5th Street to WB 7th Street was 13.0% higher than when Sign #9 was blank and the Civic Center ramp had space available. Concurrently, the volume proceeding on EB 5th Street at 7th Street also increased by 36.1% when Sign #9 indicated the Civic Center Ramp was full.

During the 12:00 to 2:00 p.m. time period, sign #8 also indicated the Civic Center Ramp was closed. During this time, the number of vehicles proceeding WB on West 7th Street at 5th Street remained the same when Sign #8 was blank and the Civic Center ramp had space available. Concurrently, the volume proceeding on SB St. Peter Street at 6th Street increased by 25.8% when Sign #8 indicated the Civic Center Ramp was full.

### **Supporting Data**

The following tables summarize the data correlation between parking occupancy information displayed on the Advanced Parking signs with the traffic volume distribution data at selected points within the project area. The November 1, 1996 data was collected during the Smithsonian Exhibition in the 12:00 to 2:00 p.m. time period when the Civic Center Ramp had an average of 100 open parking spaces and the Advanced Parking signs were not operating. The November 8, 1996 data was also collected during the Smithsonian Exhibition in the 12:00 to 2:00 p.m. time

period when the Civic Center Ramp was full and the Advanced Parking signs displayed the parking information.

Sign #10 – SB Kellogg Blvd. At Smith Street

	EB Kellogg Blvd. at Washington St.			SB Kellogg Blvd. To EB 7 <sup>th</sup> St.		
	Nov. 1, 1996	Nov. 8, 1996	% change	Nov. 1, 1996	Nov. 8, 1996	% change
12-1pm	389	490	26.0%	303	318	6.0%
1-2pm	432	545	26.1%	248	357	44.0%
12-2pm	821	1035	26.1%	551	675	22.5%

Sign #5 – WB Kellogg Blvd. At Wabasha Street

	WB Kellogg Blvd. at Washington St.			NB Wabasha north of Kellogg Blvd.		
	Nov. 1, 1996	Nov. 8, 1996	% change	Nov. 1, 1996	Nov. 8, 1996	% change
12-1pm	621	N/A	N/A	358	428	19.6%
1-2pm	585	N/A	N/A	363	445	22.6%
12-2pm	1206	N/A	N/A	721	873	21.1%

Sign #9 – EB 5<sup>th</sup> Street at Fifth/Main/Sixth

	EB 5 <sup>th</sup> St. to WB 7 <sup>th</sup> St.			EB 5 <sup>th</sup> St. at West 7 <sup>th</sup> St.		
	Nov. 1, 1996	Nov. 8, 1996	% change	Nov. 1, 1996	Nov. 8, 1996	% change
12-1pm	112	149	33.0%	256	279	9.0%
1-2pm	165	164	0.6%	173	305	76.3%
12-2pm	277	313	13.0%	429	584	36.1%

Sign #8 – SB St. Peter Street at W. 7<sup>th</sup> Street

	WB W. 7 <sup>th</sup> St. at 5 <sup>th</sup> St.			SB St. Peter at 6 <sup>th</sup> St.		
	Nov. 1, 1996	Nov. 8, 1996	% change	Nov. 1, 1996	Nov. 8, 1996	% change
12-1pm	693	702	1.3%	419	550	31.3%
1-2pm	629	622	-1.1%	470	568	20.9%
12-2pm	1322	1324	0.1%	889	1118	25.8%

## Conclusions

For each of the four sign information/traffic volume comparisons, a change in the distribution of traffic was expected. For the Sign #10 volume comparison, it was expected that there would be a change in the distribution of volume from EB Kellogg Blvd. at Washington Street to the left turn movement from SB Kellogg Blvd. to EB West 7<sup>th</sup> Street. It was expected that when the motorists received the information that the Civic Center Ramp was full, they would change routes at Kellogg Blvd. and West 7<sup>th</sup> Street to pursue parking in the Rice Park area as specified

on the Advanced Parking sign. There was a 22.5% increase in the number of vehicles turning left from SB Kellogg Blvd. to EB 7 th Street; however the volume on EB Kellogg Blvd. At Washington Street, which was expected to decrease, increased by 26.1 %. The results for Sign #10 are inconclusive since it is unclear whether the change in the volume distribution was due to Advanced Parking or an overall increase in volume in the project area.

For the Sign #5 volume comparison, it was expected that there would be a change in the distribution of volume on WB Kellogg Blvd. at Washington Street to the right turn movement from WB Kellogg Blvd. to NB Wabasha Street. It was expected that when the motorists received the information that the Civic Center Ramp was full, they would change routes at Kellogg Blvd. and Wabasha Street to pursue parking at the Victory Ramp as specified on the Advanced Parking sign. There was a 21.1% increase in the number of vehicles turning right from WB Kellogg Blvd. to NB Wabasha Street, however the volume on WB Kellogg Blvd. At Washington Street was not available for analysis. The results for Sign #5 are inconclusive since it is unclear whether the change in the volume distribution was due to Advanced Parking or an overall increase in volume in the project area.

For the Sign #9 volume comparison, it was expected that there would be a change in the distribution at the EB approach of 5th Street at 7th Street. It was expected that when the motorists received the information that the Civic Center Ramp was full, they would not turn right to go toward the Civic Center, rather they would proceed on 5 th Street to pursue parking in the Rice Park area as specified on the Advanced Parking sign. There was a 36.1% increase in the number of vehicles proceeding on EB 5th Street, however the number of vehicles turning right, which was expected to decrease, increased by 13.1%. The results for Sign #9 are also inconclusive since it is unclear whether the change in the volume distribution was due to Advanced Parking or an overall increase in volume in the project area.

For the Sign #8 volume comparison, it was expected that there would be a change in the distribution at the SB approach of St. Peter Street at West 7th Street. It was expected that when the motorists received the information that the Civic Center Ramp was full, they would not turn right to go toward the Civic Center, rather they would proceed on St. Peter Street to pursue parking at the Victory and Garrick ramps as specified on the Advanced Parking sign. There was a 25.8% increase in the number of vehicles proceeding on SB St. Peter Street, however the number of vehicles turning on WB West 7th Street, which was expected to decrease, remained the same. The results for Sign #8 are also inconclusive since it is unclear whether the change in the volume distribution was due to Advanced Parking or an overall increase in volume in the project area.

## Support Other St. Paul ITS Projects Test Plan Report

### **Objective 3.1 - Assess the applicability of the system for extension to support other traffic functions in downtown St. Paul.**

The purpose of this objective is to assess the potential of Advanced Parking to support other ITS programs of Minnesota Guidestar in downtown St. Paul.

The evaluation relies on the sign manufacturers' specifications, which outline the sign capabilities.

### **Summary of Findings**

- counter signs have variable message capabilities (one line, 4" characters, 7 characters per line, fixed and sequenced messages)
- full matrix displays have variable message capabilities (one line, 9" characters, 8 characters per line, fixed and sequenced messages; OR two line, 4" characters, 16 characters per line, fixed and sequenced messages).
- although the electronic signs are not designed to be fully portable, they could be moved to another location with an appropriate foundation, a power supply, and other component/system modifications.

### **Key Conclusions**

Both the counter and full matrix signs currently have the capability to accommodate variable messages that can be programmed from the St. Paul Traffic Control Center (TCC) and displayed in real-time. However, it may be difficult to use the counter signs to support other traffic functions in downtown St. Paul, aside from parking availability. Since the counter sign displays are physically correlated with a particular parking facility on the sign, it would be extremely difficult for the motorist to comprehend a non-parking related message. The counter signs with full matrix displays on the other hand, could be used to support other traffic functions since the matrix is physically independent of any parking facility on the sign.

### **MOE 14 - Capability of the signs to accommodate variable messages that can be programmed by the TCC (St. Paul Traffic Control Center) and displayed in real-time.**

### **Discussion of Findings**

There are two types of electronic Advanced Parking sign configurations; counter signs and counter signs with a full matrix display.

Typical Counter Sign – The counter signs have been designed specifically for displaying parking space availability information for particular garages, however they are equipped with a seven character LED display (4" character height) that can display any type of ASCII message. In normal operation they are displaying the number of available parking spaces. There are 10 counter signs in the project area, 6 of which have the full matrix display as well.

Typical Counter Sign with Full Matrix Display – The counter signs with full matrix display are a general purpose sign with all the capabilities of the counter signs as well as a full matrix display. The display is made by a full matrix zone (96 pixel wide by 16 pixel high). The matrix can



display one line of 8 characters (9" character height) or two lines of 16 characters (4" character height). The matrix can store up to 10 messages and can display up to 7 sequenced messages at a time. In normal operation, the signs are displaying the number of available parking spaces on the counter portion of the sign while the full matrix display provides event messages. There are 6 counter signs with full matrix displays in the project area.

### **Conclusions**

Both the counter and full matrix signs currently have the capability to accommodate variable messages that can be programmed from the St. Paul Traffic Control Center (TCC) and displayed in real-time. A fixed message or a sequence of messages can be sent to any particular counter sign by a manual override from the TCC. Each sign has its own address. However, it may be difficult to use the counter signs to support other traffic functions in downtown St. Paul, aside from parking availability. Since the counter sign displays are physically correlated with a particular parking facility on the sign, it would be extremely difficult for the motorist to comprehend a non-parking related message. The counter signs with full matrix displays on the other hand, could be used to support other traffic functions since the matrix is physically independent of any parking facility on the sign. The full matrix display also has the adequate space available (two lines with 16 four-inch characters each) and can store up to 10 sequenced messages and display up to 7 sequenced messages at a time.

### **MOE 15 - Ability of the signs to be moved to other locations and operated in a wireless mode.**

#### **Discussion of Findings and Conclusions**

Although the electronic signs are anchored to a concrete foundation, they are somewhat transportable. However, in order to relocate a sign, a new foundation and power supply are needed. Since radio communications are used, establishing a communication link to the new site is not difficult. Relocating an existing sign requires new or modified sign panels. Due to the modular design of the sign components, this could be done relatively easily and inexpensively. Also, some reprogramming at the central computer would be necessary. Therefore, although the electronic signs are not designed to be fully portable, they could be relocated as described above.

## **Technical Assessment Test Plan Report**

### **Objective 4.1 - Assess the performance and reliability of the overall system.**

### **Objective 4.2 - Document the amount of time the system was operational and available.**

The purpose of these objectives is to assess the technical performance of the system and its components to provide accurate, reliable, real-time information.

The evaluation relies on operating and maintenance records kept throughout the operational test. The system operators (TCC personnel, participating parking facilities) documented system component failures. A log sheet was provided to system operators for this purpose.

### **Summary of Findings**

- System was operated 2188 hours between March 1, 1996 and March 31, 1997.
- During the period of March 1, 1996 and March 31, 1997, 33 system failures were logged.
- 21 of the 33 failures were a result of either a lightning strike at one of the facilities or failures of the garage operators to correctly operate the system.
- The system operated without any logged failures 1209 hours or 55% of the time the system was in operation.
- From November 1996 to March 1997, the system was fully functional (no logged failures) over 96% of the time it was operating.

### **Key Conclusions**

- Once the system was "debugged" it was very reliable.
- Operational test schedules need to allow for system validation and testing prior to full operation and evaluation.

### **MOE 16 - Percent of time during the test that the system was operating (available).**

### **Discussion of Findings**

From March 1, 1996 through March 31, 1997 the system was operated 2188 hours. During that period, 33 failures were logged by the city of St. Paul Public Works Department. 21 of the 33 failures were a result of either a lightning strike at one of the facilities or failures of the garage operators to correctly operate the system. As a result, the system operated with some type of system failure during a scheduled event for a total of 909 hours. Therefore, the system operated without any logged failures during scheduled events 1209 hours or 55% of the time the system was operational. See the Appendix for detailed failure log.

An analysis was done to determine on a monthly basis the amount of time the system operated without logged failures during scheduled events. Percentages ranged from 0% to 100% fully functional. For the purposes of this analysis, fully functional is defined as operating without any logged failures. There was one 4-month period, May-96 through Aug-96 where the system operated 100% of the time with at least one logged failure. However, during this period the equipment failures were isolated primarily to one parking facility. Full functionality of the system improved greatly beginning in Nov-96. The system was fully functional nearly 849 hours of the 880 hours the system was operated, or over 96% of the time.

## Supporting Data

### Percent of the Time During the Test that the System Was Operating (Available)

Month	Hours On	Hours Fully Functional	% Fully Functional	Cumulative Hours On	Cumulative Hours Fully Functional	Cumulative % Fully Functional
Mar-96	105	98	93%	105	98	93%
Apr-96	89	53	60%	194	151	78%
May-96	174	0	0%	368	151	41%
Jun-96	158	0	0%	526	151	29%
Jul-96	227	0	0%	753	151	20%
Aug-96	168	0	0%	921	151	16%
Sep-96	134	68	51%	1055	219	21%
Oct-96	253	141.5	56%	1308	360.5	28%
Nov-96	268	246	92%	1576	606.5	38%
Dec-96	124	124	100%	1700	730.5	43%
Jan-97	177	177	100%	1877	907.5	48%
Feb-97	146	136.5	93%	2023	1044	52%
Mar-97	165	165	100%	2188	1209	55%

## Conclusions

System reliability increased significantly after the first six months of operation. This type of system "debugging" is expected during the implementation of a system of this type. Therefore, it is important to allow adequate time to "debug" systems when they are first brought online since system failures may adversely effect the public acceptance and evaluation of the system. Therefore, project schedules should allow for a validation and testing period to identify and correct any functional problems within the system before full operation and evaluation begins.

**Objective 4.3 - Assess how well the system components were integrated together and performed.**

## Summary of Findings

- 33 "System Failures" were recorded between March 1, 1996 and March 31, 1997.
- 73% of the logged failures were hardware related.
- 45% of logged failures were the result of action by a system operator.
- Software accounted for 9% of logged failures.

**Note:** The total percentage for failures listed above exceeds 100% due to several of the system breakdowns having multiple type codes listed (e.g. HS).

## Key Conclusions

- System components were well integrated and functioned as designed.
- Non-continuous (special events only) use of the system may have contributed to some of the component breakdowns.

## **MOE 18 - Description of the system components (data collection and communications) and assessment of their interface.**

### **Discussion of Findings**

This section provides a general description of the data collection and communication components of the Advanced Parking system. In general, the system is comprised of data collection equipment at each of the participating parking facilities, communication from the data collection equipment to the phone company via dedicated phone lines, a T1 telephone line from the phone company to the central computer, and then wireless communication from the central computer to the electronic signs.

### ***Parking Facility Equipment***

Parking facility equipment consists of loop detectors for counting vehicles and computer processing equipment to calculate the number of available parking spaces and communicate that information to the central computer located in the St. Paul City Hall Annex building.

### ***Parking Facilities to Central Computer Communications***

The data from the controllers at the parking facilities is transmitted to US West over dedicated private phone lines. At US West the signals are combined and sent to the City Hall Annex over a T1 telephone line. In order for the system to work properly with the system software, the same communication technology had to be used for each parking facility.

### ***Central Computer at St. Paul Traffic Control Center (TCC)***

A Pentium personal computer (PC) located at the St. Paul City Hall Annex controls the Advanced Parking system. Incoming data signals from the 10 parking facilities are broken down using a channel bank located near the computer. The PC includes a special board which processes information from the system software before it is transmitted to the field via a radio modem/wireless transmitter.

### ***Central Computer to Electronic Sign Communications***

The communications from the central computer to the signs happens in two stages. First, the signal is sent via RAM radio communications to a RAM base station. From there the data is again sent via wireless communication technology to each electronic sign.

### ***Electronic Signs***

There are three types of electronic signs that make up the guidance component of the Advanced Parking system. There is a Master Sign that integrates all of the electronics needed to operate the signs. These electronics include power supplies, command electronics and communications electronics. The Master Sign "manages" all other signs at the same location. In addition, there is a Slave Sign that can display a seven-character message that it receives from the Master Sign. Finally, there is the Full Matrix Sign. This sign can display two-line messages with sixteen characters per line.

### **Conclusions**

The Advanced Parking system is comprised of reliable, previously field tested components. Parking facility operators indicated the equipment functioned properly and required very little

intervention on their part. Many of the Advanced Parking components have been successfully used extensively in Europe. A significant difference with the St. Paul system was its use for special events only. All existing systems in Europe are operated continuously. Although there isn't specific data which supports this, it was thought that the non-continuous operation contributed to some of the system component problems.

## **MOE 19 - Number of system failures, by component.**

### **Discussion of Findings**

City of St. Paul staff recorded system breakdowns using the System Component Failure Log. 33 system breakdowns were recorded between March 1, 1996 and March 31, 1997. Each system breakdown was classified using a type code (H = Hardware; S = Software; O = Operator). Two or more codes for the same logged failure indicate a combination of causes. Of the 33 logged system breakdowns for the period indicated above, 24 (73%) were hardware related. Three (9%) of the logged failures can be attributed to system software and 15 (45%) are the result of action by an operator. It should be noted that the total percentage exceeds 100% due to several of the system breakdowns having multiple type codes listed (e.g. HS).

The number of system failures, by component, was determined by analyzing the action taken to repair the breakdown. This analysis was done for only those logged failures that indicated the cause was hardware or software related, or a combination of the two. There were 26 such logged failures between March 1, 1996 and March 31, 1997. Controllers and telephone communications combined for 17 (65%) of the 26 logged failures. There were 10 (38%) logged failures involving controllers. For eight (80%) of those, the action to repair was to reset the controller. Six (86%) of the seven telephone communication failures were no carrier from the US West equipment.

### **Supporting Data**

The following table summarizes the failures by component and the associated action to repair them for the period March 1, 1996 through March 31, 1997.

#### **Frequency Distribution of Action to Repair - By Component**

<b>Component</b>	<b>Action to Repair</b>	<b>Occurrences</b>
<i>Controller</i>	Reset Controller	8
	Repair Controller	1
	Replace Controller	1
<b>Subtotal</b>		10
<i>Communications</i>	No Carrier (US West)	6
	Replace Comm. Line	1
<b>Subtotal</b>		7
<i>Modem</i>	Reset Modem	1
	Replace Modem	1
<b>Subtotal</b>		2

<i>Breaker</i>	Replace Breaker	2
<b>Subtotal</b>		2
<i>Amp</i>	Tune Amp	1
<b>Subtotal</b>		1
<i>Detector</i>	Repair Detector	2
<b>Subtotal</b>		2
<i>Central Computer</i>	Reboot	1
<b>Subtotal</b>		1
<i>Unknown</i>		1
<b>Total</b>		26

### **Conclusions**

Overall the system functioned very well. The system software was very reliable and no significant hardware problems were encountered. Support from the various project partners in resolving systems problems when they arose was good.

Nearly half of all logged system failures between March 1, 1996 and March 31, 1997 were the result of action by a system operator. Information gathered from interviews with system operators, both public and private, indicated that the roles and responsibilities for the various parties involved were not always clearly defined and understood. Operations and maintenance planning and training of personnel is very important.

## System Costs Test Plan Report

**Objective 5.1** - *Document the actual cost (by entity) of the operational test.*

**MOE 20** - *Total project costs of each member of the Project Management Team, including labor, over the life of the project.*

### Discussion of Findings

The evaluation of MOE 20 relies on documentation of all capital, equipment, installation, maintenance, and operating costs of the Advanced Parking system components as well as all contributions from participants involved in the project. The total cost of the Advanced Parking operational test was \$1,190,000.

### Supporting Data

The contributions of each member of the Project Management Team are summarized in Table 8-1 below.

**Table 8-1: Operational Test Contributions**

	Mn/DOT*	City of St. Paul	AGS Group	Parking Facilities	TOTAL
Operational Test Total	\$850,500	\$84,300	\$189,500	\$65,700	\$1,190,000

\*Includes \$600,000 FHWA support.

The detailed project costs incurred by each test participant are summarized in Table 8-2 on the following page. Please note that in some cases, the cost incurred by test participants does not represent the participant's total contribution. Mn/DOT, city of St. Paul, and the participating parking facilities contributions include the costs incurred by the design and evaluation consultants and a portion of the costs incurred by the sign manufacturer.

**Objective 5.2** - *Estimate the operational costs for future deployment.*

**MOE 21** - *Estimate operating and maintenance costs of future deployment in St. Paul.*

### Discussion of Findings

The evaluation of MOE 21 relies on the Advanced Parking cost information documented under MOE 20. The documented costs incurred during the operational test are used to determine unit costs for each of the key components of Advanced Parking.

### Supporting Data

The total and unit costs of Advanced Parking components and their estimated cost for future deployment are presented below in Table 8-3.

**Table 8-3: Cost of System Deployment**

Components	Total Cost Incurred	Units*	Unit Cost	Cost of Future Deployment**
<b>Management and Coordination</b>				
System Planning and Design	\$74,250	20 locations	\$3,700/location	\$3,00/location
System Development	\$81,100	20 locations	\$4,050/location	\$3,500/location
Management and Coordination	\$54,750	20 locations	\$2,750/location	\$2,300/location
Test Evaluation	\$109,200	7 special events	\$15,600/event	\$0
Marketing	\$8,900	N/A	N/A	N/A
<b>Equipment and Installation</b>				
Electronic Signs	\$495,500	10 matrix signs	\$49,550/sign	\$49,550/sign
Static Signs	\$81,700	46 static signs	\$1,780/sign	\$1,780/sign
Communication Lines	\$92,400	20 locations	\$4,620/location	\$4,620/location
Parking Facility Equipment	\$73,100	10 facilities	\$7,310/facility	\$7,310/facility
System Software	\$39,300	1 system	\$39,300/system	Variable***
Startup/Testing/Training	\$40,500	20 locations	\$2,025/location	\$1,700/location
<b>Operations and Maintenance</b>				
Labor	\$18,600	14 months	\$1,325/month	\$1,125/month
Communication Lines	\$20,700	16 months	\$1,300/month	\$1,300/month

\* Units: locations = number of electronic signs (10) and parking facilities (10)  
special events = Civic Center Events matrix signs = electronic signs

\*\* Future Deployment Costs are estimated based on total costs incurred and lessons learned during the operational test. Some unit costs for future deployment were estimated 15-20% less than costs incurred during the operational test.

\*\*\* The total cost of software development consists of both fixed and variable costs. The variable costs are a function of what the changes to the system are. The fixed cost each time a software change is needed is \$10,450.

This includes travel and one week on-site testing. The variable costs, depending on what has to be done, are:

- \$2,300 per sign for a new sign on an existing mast
- \$4,246 per mast for a new mast (up to 5 signs)
- \$4,220 per new garage

Example: two new garages, three masts and one sign on an existing mast are added to the system. The cost of software development would be:  
 $\$10450 + 2 \times \$4220 + 3 \times \$4246 + \$2300 = \$33928$ .





## **Legal, Institutional and Private Sector Issues Test Plan Report**

**Objective 6.1** - *Identify significant institutional and legal issues encountered with initiating and implementing the operational test, and appraise the effect of their impacts.*

### **Summary of Findings**

- No legal issues were identified.
- Institutionally, roles and responsibilities for project participants must be clearly defined and documented early in the project.
- Clear communication between project partners is very important.

### **Key Conclusions**

- The institutional issues identified had little or no effect on the operational test.

**Measurement 6.1.1** - *The institutional, legal and private sector issues encountered will be provided by the City of St. Paul and the parking facility operators.*

**MOE 22** - *List of institutional and legal issues encountered.*

### **Discussion of Findings**

Staff from Mn/DOT, city of St. Paul Public Works Department, city of St. Paul Planning and Economic Development Department, and Edwards & Kelcey, Inc. were interviewed to identify any institutional, legal and private sector issues that came up during the Advanced Parking operational test.

In general, the interviewee accounts' indicated that the project went smoothly with few institutional, legal or private sector issues arising. No legal issues were identified. Overall, the test went very well and much was learned.

Communication between the parties involved was seen as very important. At times, communication was not as good as it could have been. However, the overall management and coordination of the project was very effective.

The partnerships formed for the operational test were very successful. The relationships between the agencies involved in the test were seen as very good. This can be attributed, in part, to trained and experienced project managers.

There was a consensus among those interviewed that the roles and responsibilities of everyone involved needed to be better defined. In particular, the responsibility for maintaining equipment at private facilities was not clearly defined. In addition, operations and maintenance for post operational test operation was not adequately addressed.

### **Supporting Data**

A complete summary of all discussions with those interviewed is in the Appendix.

## **Conclusions**

- Roles and responsibilities for project participants must be clearly defined and documented early in the project.

### **MOE 23 - *Assessment of effects of institutional and legal issues on test.***

## **Discussion of Findings**

It was believed that the issues identified by the project participants had little or no effect on the operational test. However, the uncertainty surrounding some roles and responsibilities may have lead to an increase in the amount of time to complete some of the work.

## **Supporting Data**

A complete summary of all discussions with those interviewed is in the Appendix.

## **Conclusions**

- Roles and responsibilities for project participants must be clearly defined and documented early in the project, to ensure efficient progression of the operational test.
- These issues had little or no effect on the operational test.

### **Objective 6.2 - *Identify concerns and objections of parking facility operators to share real time information, and summarize how resistance was overcome.***

## **Summary of Findings**

- One participating parking operator was not sure what they had to gain by being involved in the test since they were already at 98% of capacity.
- No other concerns or objections of parking facility operators were raised.

## **Key Conclusions**

- Advanced Parking operators should understand the potential impacts of displaying inaccurate information.
- All test participants should retain a thorough understanding of the potential overall benefits for the motoring public, rather than only focusing on their own benefits.

### **MOE 24 - *List of concerns/objections of parking operators to release real-time information, by type of operator (public, private).***

### **MOE 25 - *Summary of how parking operators' concerns were resolved.***

## **Discussion of Findings**

There were very few concerns/objections to releasing real-time parking availability information. One participating parking operator wondered what they had to gain by being involved in the test. Their concern was if the system had problems and inaccurate information was displayed, it would hurt their business because they are typically at 98% capacity.

## **Supporting Data**

A complete summary of all discussions with those interviewed is in the Appendix.

## **Conclusions**

- Advanced Parking operators should understand the potential impacts of displaying inaccurate information.
- All test participants should retain a thorough understanding of the potential overall benefits for the motoring public, rather than only focusing on their own benefits.

**Objective 6.3 - *Identify level of participation from the parking lot operators that were approached to participate in the test and reasons for low/no participation.***

## **Summary of Findings**

- None of the parking operators who were approached about the operational test chose not to participate.
- There were parking operators who wanted to participate but could not in order to keep the size of the system at a reasonable level for the test.
- There were no complaints from non-participating parking operators.

## **Key Conclusions**

- The level of participating from parking operators was outstanding. All operators that were approached to participate in the test participated.

**MOE 26 - *Level of participation from the parking lot operators that were approached to participate in the test and reasons for low/no participation.***

## **Discussion of Findings**

The level of participation from parking operators was 100%. No parking operators who were approached about the operational test chose not to participate. There were parking operators who wanted to participate but could not in order to keep the size of system at a reasonable level for the test. There were no complaints from non-participating parking operators.

## **Supporting Data**

A complete summary of all discussions with those interviewed is in the Appendix.

## **Conclusions**

The level of participation from parking operators was outstanding. All operators that were approached to participate in the test participated. There should be no problem finding parking operators to participate in future deployment since the city of St. Paul has already been approached by non-participating parking operators who want to be involved.

**Objective 6.4 - *Identify significant institutional issues that may impact the deployment of the system or the long-term operation of the parking information system.***

## **Summary of Findings and Conclusion**

- There were no significant institutional issues identified that would impact the deployment of the system or the long-term operation of the parking information system.

### **MOE 27 - *Assessment of effect of institutional issues on deployment of the system.***

#### **Discussion of Findings**

It was thought that the issues identified by the project participants had little or no effect on the operational test. However, the uncertainty surrounding some roles and responsibilities may have lead to an increase in the amount of time to complete some of the work.

#### **Supporting Data**

A complete summary of all discussions with those interviewed is in the Appendix.

#### **Conclusions**

The effect of the institutional issues encountered during the operational test on the deployment of the system are minimal. All issues encountered could easily be addressed prior to future deployment based on the documented lessons learned from the operational test.

### **Objective 6.5 - *Identify the level of private sector participation in the funding of the test.***

#### **Summary of Findings**

Private sector contributions accounted for more than 21% of the cost of the operational test. The combined participating parking operator contribution was \$65,700 (5.5%) and the AGS Group (sign manufacturer) contribution was \$189,500 (16%).

#### **Key Conclusions**

- Public participants indicated satisfaction in the level of private sector participation in the funding of the test.

### **MOE 28 - *Comparison of private sector participation with total cost of test.***

#### **Discussion of Findings**

Private sector contributions accounted for more than 21% of the cost of the operational test. The combined participating parking operator contributions were \$65,700 (5.5%) and the AGS Group (sign manufacturer) contribution was \$189,500 (16%). The AGS Group's contribution included a 30% discount on signs and services.

#### **Supporting Data**

Detailed cost and contribution information can be found in the System Costs Test Plan Report.

#### **Conclusions**

Public participants indicated satisfaction in the level of private sector participation in the funding of the test.

**Objective 6.6 - *Document any lessons learned in soliciting and obtaining private sector support.***

**MOE 29 - *Lessons learned in soliciting and obtaining private sector contributions.***

### **Summary of Findings**

Interviews with project participants indicated that there is a need for good marketing and salesmanship to attract private sector participation and contribution. Some indicated that training in those areas may be needed. Early public involvement and education would help to promote private sector participation and contributions.

### **Supporting Data**

A complete summary of all discussions with those interviewed is in the Appendix.

### **Lessons Learned**

- Marketing and salesmanship skills are needed to attract private sector participation and contribution.
- Public education and early involvement would help to promote private sector participation and contributions.

## **Transferability Assessment Test Plan Report**

**Objective 7.1** - *Assess the influence of St. Paul-specific characteristics and external factors on outcome of the operational test.*

**Assessment 7.1.1** - *St. Paul characteristics and external factors that affected the test will be identified and their influence on test results will be determined.*

**MOE 30** - *List of St. Paul characteristics and external factors that could affect the test.*

**MOE 31** - *Assessment of influence of St. Paul characteristics and external factors on test results.*

### **Discussion of Findings**

There were very few St. Paul specific characteristics that may have affected the operational test. One St. Paul specific characteristic is the ambiance of the Rice Park area which attracts visitors to downtown St. Paul; however it is unclear what, if any, effect this characteristic had on the operational test. Another St. Paul characteristic is the method of payment at participating parking facilities. Some of the parking facilities charged a flat event rate whereas other facilities charged an hourly rate. The method of payment may have had an impact on the motorists' decision of where to park, although persons unfamiliar with St. Paul parking rates may not have known the cost until after the event. Although this characteristic may have affected the operational test, it would be very difficult to quantify its impact.

Construction in the project area may have been an external influence on the operational test. Road construction and Civic Center expansion construction restricted vehicular and pedestrian traffic on Kellogg Blvd. throughout the operational test. The Wabasha Street bridge over the Mississippi River was closed in Fall 1996 for reconstruction. Construction in the project area probably affected travel time and the distribution of traffic; however, the construction was occurring with and without Advanced Parking which should not have affected the change in travel time and traffic distribution.

### **Conclusions**

Although St. Paul characteristics and construction in the project area affected travel time and the distribution of traffic, they did not affect the outcome of the operational test.

**Objective 7.2** - *Document "lessons learned" from the operational test, based on practical experience, and suggest system modifications for deployment in St. Paul and other sites.*

### **Summary of Findings and Key Conclusions**

Lessons learned from the operational test are documented under Assessment 7.2.1. Generally, the lessons learned can easily be addressed prior to future deployment and will substantially improve the implementation, operation, and maintenance of the system.

Suggested system modifications from the operational test are documented under Assessment 7.2.2. The most beneficial modification would be the addition of signs on I-94 and I-35E that would identify the special event and direct motorists to use a specific freeway exit.

**Assessment 7.2.1 - *Lessons learned from the operational test will be determined from discussions with the Project Management Team and test results.***

**MOE 32 - *Lessons learned from test.***

### **Discussion of Findings and Conclusions**

There were a total of four Lessons Learned documented through the operational test. Although only four were documented, each were identified by several of the project partners at different occasions.

### **Supporting Data**

The following "Lessons Learned" were determined from discussions with the Project Management Team and test results:

1. *Lesson Learned* - The roles and responsibilities of each public and private partner need to be clearly identified to ensure efficient implementation, operation, and maintenance of the system.
2. *Lesson Learned* - Participating parking facilities need adequate operator training, communication, and support in order to effectively operate their portion of the system and deal with unplanned circumstance and technical difficulties. Operators also need to stay on top of staff training, particularly with staff turnover.
3. *Lesson Learned* - A contractor with similar traffic control equipment installation experience is critical in order to prevent delays in installation and operation.
4. *Lesson Learned* - Project scheduling should allow for a system validation and testing period to identify and correct any functional problems within the system prior to full operation and evaluation.

**Assessment 7.2.2 - *The evaluation of the operational test results, including parking operator and TCC interviews, will identify possible modifications of the system for deployment in St. Paul and other sites.***

**MOE 33 - *Suggested system modifications for deployment in St. Paul.***

**MOE 34 - *Suggested system modifications for deployment in other sites.***

### **Discussion of Findings and Conclusions**

There were several suggestions for system modifications made by parking operators and motorists. Most suggestions, although understandable, may not justify changes to the system. Suggestions included adding more signs, improving the visibility of the signs, and not combining



two facilities on one sign panel. While these suggestions are understandable, it is important to remain aware of the danger of developing a "too complex" system. Furthermore, specific facility information could be provided in each facility's immediate location.

It would be helpful to have signs on I-94 and I-35E that would identify the special event and direct motorists to the exit that would facilitate access to available parking.

### **Supporting Data**

The following suggested system modifications were identified through parking operator and TCC interviews, motorist surveys, and operational test results:

1. Do not combine two parking facilities' available spaces on one sign panel.
2. Add signs on the surrounding freeways that identify the event and direct the motorist to the desired exit.
3. Improve the accuracy and transmission speed of the information to the signs.
4. Add more signs.
5. Increase the visibility of signs (letter height, size of sign, color, etc.).