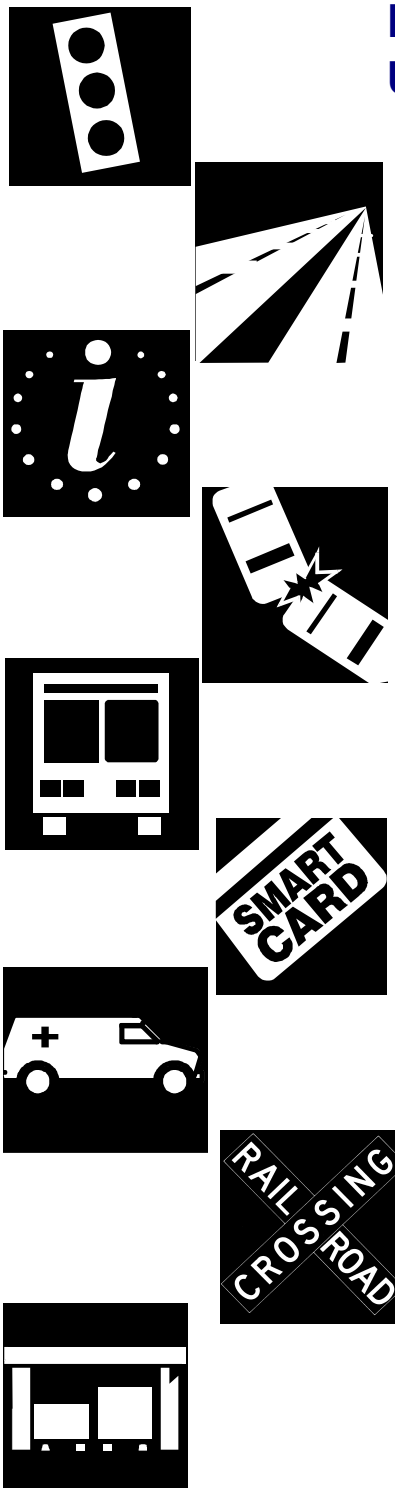

ITS BENEFITS: DATA NEEDS UPDATE 2000

Prepared in Connection with the
12 July ITS BENEFITS DATA NEEDS WORKSHOP

29 August 2000

By:
MITRETEK SYSTEMS

Allen T Proper
(202) 488-5705
aproper@mitretek.org

Rob Maccubbin
(202)488-3032
robert.maccubbin@mitretek.org

FAX: (202) 863-2988

EXECUTIVE SUMMARY

Since December of 1994, the United States Department of Transportation's (U.S. DOT's) Joint Program Office (JPO) for Intelligent Transportation Systems (ITS) has been actively collecting information regarding the impact of ITS projects on the operation of the surface transportation network. The evaluation of ITS and precursor systems is an ongoing process. Significant knowledge is available for many ITS services, but gaps in knowledge also exist.

To aid the distribution of the information collected, the JPO has sponsored the development of a web-based version of the ITS benefits database. The database is available by visiting www.its.dot.gov/eval/itsbenefits.htm. The benefits database summarizes both national and international benefits described in evaluations, conference papers, and other reports. It is currently searchable by ITS component, performance measure, and by location.

The purpose of this report is to summarize and highlight where gaps or limited knowledge exists concerning the benefits of ITS services. It concentrates on the areas of metropolitan and rural ITS user services, and is intended to point out where additional evaluation of those services may be needed. Other areas, such as Commercial Vehicle Operations and Intelligent Vehicles, are not covered in this report. These areas also have a number of evaluation efforts and operational tests, and therefore their own evaluation component. The gaps highlighted are used to show where little data have been collected in a particular measure or ITS service. The lack of benefits data in an ITS service area does not mean that the service is not a good one. Rather it indicates where more evaluation may be needed to understand the full impacts of the service. In many cases, ITS services contain broad societal benefits or other intangible effects that may not be measurable. The list is intended to assist the JPO and to provide some guidance to researchers for establishing which gaps are considered to be the most important and determining where limited evaluation resources may provide the most advantage.

The information presented in this report was developed as a result of a workshop sponsored by the Benefits Evaluation and Cost (BEC) committee of ITS America. The workshop was held on 12 July, 2000 and involved members of a data needs task force. The purpose of the task force was to develop, review and rate the listing of data needs. The rating of the data needs lists was accomplished in the form of a survey sent to the 31 members of the task force, of which 23 attended the workshop, and 18 returned the survey. Survey participants where asked to rate the items in the data needs list based on their assessment of the importance of conducting further evaluation in that ITS area. The rating occurred on a scale of 0 to 5 with 0 being no importance, and five being high importance.
Tables ES-1 and ES-2 summarize the results of the survey for metropolitan ITS services and metropolitan integration links. Table ES-3 summarizes the results for rural

ITS areas. Entries in the tables have been sorted on the mean value of the importance rating. For each question, the mean was calculated based on the number of responses received. The total number of responses was different for some services. It is believed this is a result of individuals who returned the survey only rating those areas that they had experience with or knowledge of.

The results of the survey regarding metropolitan application areas do not clearly indicate ITS implementation areas with a strong need for benefits evaluation or those for which the task force feels sufficient data exists. However, the rank ordering of the application areas based on average priority rating provides an indication of where the task force members see the greatest need for additional research.

While participants felt that incident management systems have been adequately evaluated, they felt existing evaluations had been focused primarily on freeway systems and that additional information is required on the impact of these systems within Arterial Management. This research area was of particular interest to those at the workshop representing localities. Survey respondents where also interested in the benefits of data archiving, a service recently added to the National ITS Architecture and subsequently added to the benefits classification taxonomy. Task force members placed particular importance on this area given the lack of existing studies and the need for benefits data to help those implementing ITS understand the importance of data archiving.

The third most important category to task force members was operations and maintenance. Though not previously an application area classified under metropolitan systems, participants felt that significant benefits can be achieved from implementing these systems in urban areas and desired evaluations of urban implementation of these systems. Highway-Rail Intersection systems where the fourth highest rated application area among survey respondents.

Task force members were most interested in evaluation of integration between Arterial Management or Incident Management with other ITS implementations. Many of the integration links with the highest average priority ratings involve some combination of Arterial Management, Incident Management, or Emergency Management with another ITS component. Evaluation to determine benefits of communication links between Emergency Management and Incident Management is a significant interest of the committee.

Priority ratings for rural application areas were somewhat lower than for urban areas. Many of the task force members are involved in metropolitan ITS implementation, however, and the scores would likely have been higher had more representatives involved in rural ITS taken part in the committee. The area of greatest interest to task force members within rural application areas was emergency services, likely due to the longer average emergency response times in rural areas. Due to time constraints, there was little discussion of rural data needs at the workshop.

Table ES-1: Survey Results for Evaluation Priorities of Metropolitan Application Areas

Metropolitan Application Area	Study in Progress	Number of Entries (*1*)	Total Score (*2*)	Number of Responses	**Mean Score**
Arterial Management Systems - Incident Management	No	0	66	16	4.13
Information Management - Data Archiving	No	0	65	16	4.06
Operations & Maintenance	No	0	63.5	16	3.97
Highway-Rail Intersection	Yes	2	63	17	3.71
Regional Multimodal Traveler Information - Behavior Changes	Yes	1	58	16	3.63
Arterial Management Systems - Information Dissemination	No	0	57	16	3.56
Arterial Management Systems - Traffic Surveillance	No	0	56	16	3.50
Transit Management Systems - Transit Management	No	0	59	17	3.47
Freeway Management Systems - Information dissemination	No	2	53	16	3.31
Freeway Management Systems - Traffic Surveillance	No	0	53	16	3.31
Transit Management Systems - Transit Information	No	1	55	17	3.24
Transit Management Systems - Security	No	0	54	17	3.18
Electronic Fare Payment	No	3	49.5	17	2.91
Parking Management	No	0	46.5	16	2.91
Arterial Management Systems - Traffic Control - Signal Priority - Transit	Yes	4	49	17	2.88
Arterial Management Systems - Public Safety - Enforcement	No	4	46	17	2.71
Transit Management Systems - Transit Management - Maintenance	Yes	0	46	17	2.71
Freeway Management Systems - Traffic Control - Freeway Entrance - Ramp Metering	No	8	32	16	2.00

1. Reflects number of entries in the database as of 30 June 2000.

2. Respondents rated the importance of benefits evaluation in each application area on a scale from 0 to 5 with 0 representing "no importance" and 5 representing "high importance".

Table ES-2: Survey Results for Evaluation Priorities of Metropolitan Integration Links

Metropolitan Integration Links	Study in Progress	Number of Entries (*1*)	Total Score	Number of Responses	**Mean Score**
Link 2: Arterial Management to Freeway Management	No	0	66	16	4.13
Link 5: Incident Management to Arterial Management	No	0	66	16	4.13
Link 21a: Emergency Management to Incident Management	No	0	66	16	4.13
Link 21b: Emergency Management to Incident Management	No	0	66	16	4.13
Link 7: Incident Management to Emergency Management	No	3	65.5	16	4.09
Link 4: Arterial Management to Incident Management	No	1	61	15	4.07
Link 1: Arterial Management to Regional Multimodal Traveler Information	No	1	64	16	4.00
Link 22: Emergency Management to Arterial Management	No	0	62	16	3.88
Link 23: Highway-rail intersection to Incident Management	No	0	61	16	3.81
Link 25: Incident Management intra-component	No	0	60.5	16	3.78
Link 8: Incident Management to Freeway Management	No	1	60	16	3.75
Link 11: Freeway Management to Arterial Management	No	0	59.5	16	3.72
Link 26: Arterial Management intra-component	No	1	59	16	3.69
Link 28: Electronic Toll Collection intra-component	No	0	56.5	16	3.53
Link 18: Electronic Toll Collection to Arterial Management	No	0	56	16	3.50
Link 24: Highway-rail intersections to Arterial Management	No	0	55	16	3.44
Link 6: Incident Management to Regional Multimodal Traveler Information	No	7	53	16	3.31
Link 30: Freeway Management intra-component	No	0	52.5	16	3.28
Link 3: Arterial Management to Transit Management	No	0	55	17	3.24
Link 13: Freeway Management to Incident Management	Yes	4	51	16	3.19
Link 14b: Transit Management to Regional Multimodal Traveler Information	No	1	53.5	17	3.15
Link 10: Freeway Management to Regional Multimodal Traveler Information	No	2	50	16	3.13
Link 16a: Transit Management to Arterial Management	No	4	53	17	3.12

1. Reflects number of entries in the database as of 30 June 2000.

Table ES-2 (continued)

Metropolitan Integration Links	Study in Progress	Number of Entries (*1*)	Total Score	Number of Responses	Mean Score
Link 27: Electronic Fare Payment intra-component	No	0	53	17	3.12
Link 17: Electronic Toll Collection to Freeway Management	No	0	49	16	3.06
Link 9: Incident Management to Transit Management	No	0	49	17	2.88
Link 29: Transit Management to Incident Management	Yes	0	48	17	2.82
Link 19: Electronic Toll Collection to Electronic Fare Payment	No	0	47.5	17	2.79
Link 14a: Transit Management to Regional Multimodal Traveler Information	No	3	46.5	17	2.74
Link 20: Electronic Fare Payment to Transit Management	No	0	46	17	2.71
Link 15b: Transit Management to Freeway Management	No	0	44	17	2.59
Link 16b: Transit Management to Arterial Management	No	0	41	17	2.41
Link 12: Freeway Management to Transit Management	Yes	0	39	17	2.29
Link 15a: Transit Management to Freeway Management	No	0	36.5	17	2.15

1. Reflects number of entries in the database as of 30 June 2000.

Table ES-3: Survey Results for Evaluation Priorities of Rural Application Areas

Rural Application Area	Study in Progress	Number of Entries (*1*)	Total Score	Number of Responses	Mean Score
Emergency Services	No	0	61.5	16	3.84
Operation and Maintenance	No	0	55.5	16	3.47
Crash Prevention and Security	No	1	54.5	16	3.41
Surface Transportation Weather	Yes	1	54.5	16	3.41
Transit and Mobility	No	0	54	17	3.18
Travel and Tourism	No	0	48.5	16	3.03
Traffic Management	No	1	44	16	2.75

1. Reflects number of entries in the database as of 30 June 2000.

Participants were also asked to allocate 100 points to the importance of evaluation in each of the few good measure areas employed by the ITS program. Table ES-4 lists the average number of points assigned to each measure by the survey respondents regarding the need for additional research in the area of each of these benefit measures. Task force members placed the highest research priority on the ability of ITS implementation to improve safety and mobility.

Table ES-4: Survey Results for Point Assignment to Benefit Measures

Goal Area	**Measures**	Total Score	Number of Responses	**Mean Score**
Improve Safety	Crashes Fatalities	432	18	24.00
Improve Mobility	Travel Time Delay Reliability	324	18	18.00
Increase Efficiency	Throughput Effective Capacity	262	17	15.41
Driver Response	Behavior Changes	168	17	9.88
Customer Satisfaction		171	18	9.50
Increase Productivity	Costs	157	18	8.72
Improve Environment	Emissions	152	18	8.44
Conserve Energy	Fuel Consumption	114	18	6.33

1 INTRODUCTION

Since December of 1994, the United States Department of Transportation's (U.S. DOT's) Joint Program Office (JPO) for Intelligent Transportation Systems (ITS) has been actively collecting information regarding the impact of ITS projects on the operation of the surface transportation network. The evaluation of ITS and precursor systems is an ongoing process. Significant knowledge is available for many ITS services, but gaps in knowledge also exist.

To aid the distribution of the information collected, the JPO has sponsored the development of a web-based version of the ITS benefits database. The database is available by visiting www.its.dot.gov/eval/itsbenefits.htm. The benefits database summarizes both national and international benefits described in evaluations, conference papers, and other reports. It is currently searchable by ITS component, performance measure, and by location.

The purpose of this report is to summarize and highlight where gaps or limited knowledge exists in ITS services. It concentrates on the areas of metropolitan and rural ITS user services, and is intended to point out where additional evaluation of those services may be needed. Other areas, such as Commercial Vehicle Operations and Intelligent Vehicles, are not covered in this report. These areas also have a number of evaluation efforts and operational tests, and therefore their own evaluation component. The gaps highlighted are used to show where little data have been collected in a particular measure or ITS service. The lack of benefits data in an ITS service area does not mean that the service is not a good one. Rather it indicates where more evaluation may be needed to understand the full impacts of the service. In many cases, ITS services contain broad societal benefits or other intangible effects that may not be measurable. The list is intended to assist the JPO and to provide some guidance to researchers for establishing which gaps are considered to be the most important and determining where limited evaluation resources may provide the most advantage.

This information presented in this report was developed as a result of a workshop sponsored by the Benefits Evaluation and Cost (BEC) committee of ITS America. The workshop was held on 12 July, 2000 and involved members of a data needs task force. The purpose of the task force was to develop, review and rate the listing of data needs. The rating of the data needs lists was accomplished in the form of a survey sent to the 31 members of the task force, of which 23 attended the workshop, and 18 returned the survey. Survey participants where asked to rate the items in the data needs list based on their assessment of the importance of conducting further evaluation in that ITS area. The rating occurred on a scale of 0 to 5 with 0 being no importance, and five being very important.

1.1 STRUCTURE OF THIS REPORT

This main body of this report discusses the availability of data in the ITS benefits database. Individual data needs are also discussed for metropolitan ITS application areas and metropolitan integration in section 2 and section 3, respectively. Data needs for rural ITS applications are then highlighted in section 4. The appendix is a detailed summary of individual survey results and summaries of results by stakeholder perspectives (i.e. Federal, State, Local government).

The remainder of this section summarizes the taxonomy and measures used in the benefits evaluation process along with a short discussion on the integration of metropolitan ITS user services.

This report is structured similarly to the ITS Benefits:1999 Update report[1]. It is organized along a taxonomy for classifying ITS benefits data. The taxonomy groups benefits data into two major components: Intelligent Infrastructure and Intelligent Vehicles. These components are then divided into program areas and specific ITS application areas. While this taxonomy was not intended to reflect the official structure of the ITS program, it has proven useful in promoting discussion within the ITS community and has been used to demonstrate the breadth of the ITS program. Currently the taxonomy is in the process of being updated to reflect the most recent accepted views of the classification of the data. Therefore, there are minor differences in the classification of benefits data in this report and the classification of data in the 1999 update report. The most evident changes are in the Rural ITS Program which has been significantly expanded. An illustration of the current taxonomy is shown in Figures 1a and 1b.

[1]"Intelligent Transportation Systems Benefits: 1999 Update," ITS Joint Program Office, Publication No. FHWA-OP-99-012, May, 1999.

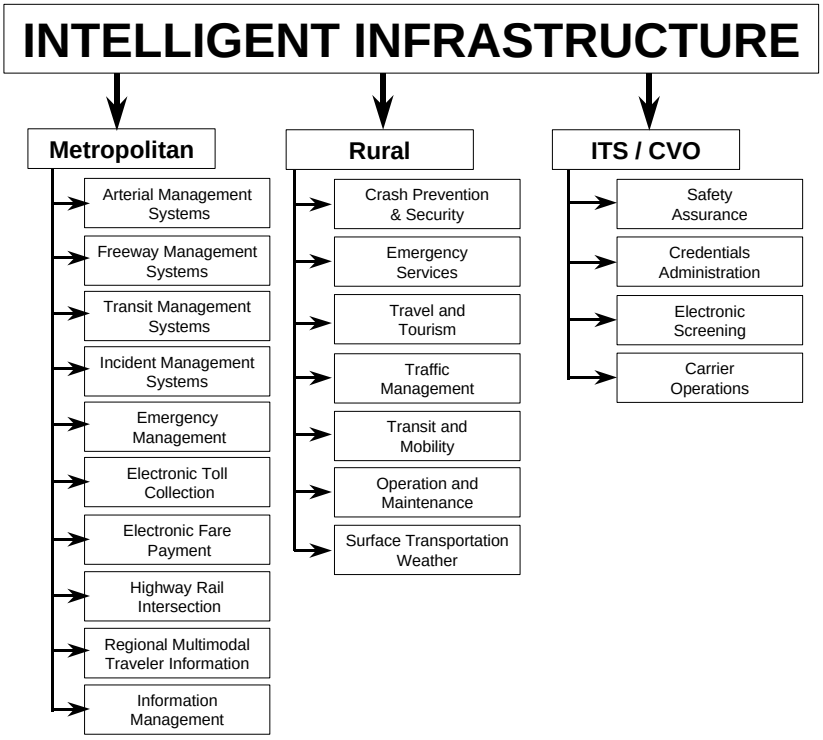

Figure 1a: Intelligent Infrastructure Taxonomy for Reporting ITS Benefits

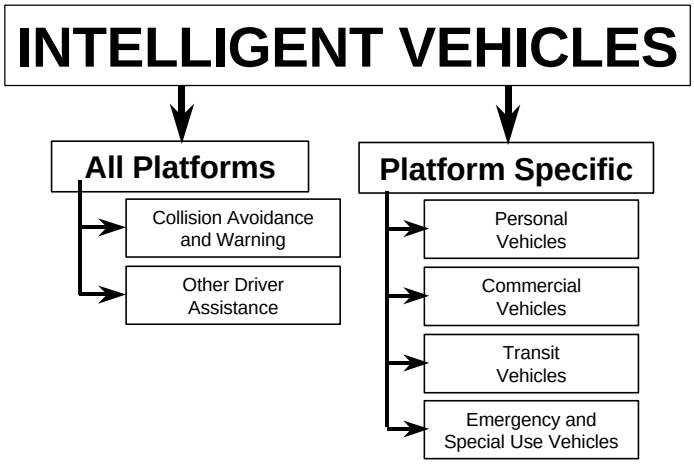

Figure b: Intelligent Vehicle Taxonomy for Reporting ITS Benefits

To track the progress toward meeting ITS program goals, the JPO has identified and established a set of measures of effectiveness. These measures are termed “A Few Good Measures” and are used as a standard in the reporting of much of the ITS benefits data currently available. Data collected is not limited to these measures, additional measures are also reported when available. The few good measures are:

- Safety: usually measured by impacts on crashes, injuries, fatalities
- Delay: usually measured in units of time
- Cost: measured in monetary amount
- Effective Capacity: measured in throughput or traffic volumes
- Customer Satisfaction: usually results from user surveys, and
- Energy and Environment: usually measured in fuel consumption and emissions.

Additionally, one of the powerful aspects of ITS is the capability of components to share information and resources with other components. This integration of individual components allows the formation of a unified regional traffic control and management system. To better describe the flow of information between components, a number of "Integration Links" have been developed for the metropolitan ITS infrastructure. These links represent both inter- and intra-component sharing of information. Each of the links has been assigned a number and an origin/destination path from one component to another. For example, metropolitan integration link number 29 is from Transit Management to Incident Management and represents the ability of transit agencies to notify incident management agencies of incident location, severity and type. A figure depicting the links in metropolitan integration and definitions of the links can be found in section 3.

For a more complete understanding of these components, integration and how they can be interpreted, the reader is referred to the following documents. Both documents are available on the FHWA electronic document library at www.its.dot.gov/welcome.htm.

- “Tracking the Deployment of Integrated Metropolitan Intelligent Transportation Systems Infrastructure in the USA: FY 1997 Results,” Document No. 5883, September 1998.
- “Measuring ITS Deployment and Integration,” Document No. 4372, January 1999.

2 METROPOLITAN ITS DATA NEEDS

Metropolitan ITS consist of those program areas that are primarily implemented in urban and suburban geographic locations. This does not imply that these systems are not implemented in or do not impact other geographic settings. However, they are more often associated with urban areas.

2.1 Arterial Management Systems

Most data collected regarding Arterial Management Systems highlights delay and travel time savings. Impacts on safety have also been reported. Very little data exists for impacts on throughput and cost savings. Table 2.1a summarizes the number of entries in the database that correspond to a particular benefit measure.
Benefits related to arterial surveillance have not been explicitly reported. However, these benefits may be realized in other program areas. Therefore, surveillance-related benefits may be better represented by the integration of components.

Traffic signal control has shown to yield significant benefits. Data reported includes the effects on mainline traffic through adaptive signal control. Primarily, these data are from the implementations of the SCOOT and SCATS signal systems. Also, some data have been collected for bus priority control. Although these programs have proven delay reduction along with safety improvements for vehicles on localized routes, few evaluation results have been reported on larger system-wide effects.

The impacts of providing information to travelers concerning arterial conditions is limited in the database. Travelers may use information to choose alternate routes to avoid congestion. Primarily, travel time and delay savings data are expected to yield significant insight into the effectiveness of this service.

Some data have been collected on the safety impacts of automated red light running enforcement. Most automated enforcement data states impacts on the number of violations. Although this data are highly correlated with incident occurrence, not enough evaluation data exists to draw good conclusions about the effect on safety.

Table 2.1a: Database Entries for Arterial Management Systems

Component / User Service	Number of Entries	Safety	Delay & Time	Throughput	Cust. Satis.	Fuel & Envri.	Cost	General
Arterial Management Systems								
Traffic Surveillance	0							
Traffic Control / Adaptive Signals	9	1	8					1
Traffic Control / Signal Priority	4	1	3					
Traffic Control / Pedestrian	1	1						1
Traffic Control / Other	2	1	2			2	1	
Information Dissemination	0							
Public Safety / Enforcement	4	3						1
Other	4	1	4	1		2	1	
Total	24	8	17	1	0	4	2	3

Table 2.1b: Survey Results for Evaluation Priorities of Arterial Management Systems

Metropolitan Application Area	Study in Progress	Number of Entries (*1*)	Total Score	Number of Responses	Mean Score
Arterial Management Systems - Incident Management	No	0	66	16	4.13
Arterial Management Systems - Information Dissemination	No	0	57	16	3.56
Arterial Management Systems - Traffic Surveillance	No	0	56	16	3.50
Arterial Management Systems - Traffic Control - Signal Priority - Transit	Yes	4	49	17	2.88
Arterial Management Systems - Public Safety - Enforcement	No	4	46	17	2.71

1. Reflects number of entries in the database as of 30 June 2000.

Table 2.1b, above, displays the results from the survey. Tucson, Arizona is currently known to have a study in progress or planned for signal priority. It is expected that when complete the study may have an evaluation report that could contain data for the database. The mean priority rating along with the number of responses for each application area is also presented. A specific element of ITS implementations repeatedly raised, but not previously called out as a specific research area under arterial management systems is incident management. Members of the task force felt a strong need for additional benefits information regarding incident management programs along arterial roadways. Evaluation of different techniques for disseminating information along arterials was also mentioned as a research need.

2.2 Freeway Management Systems

The majority of the data currently available for Freeway Management Systems is centered around safety improvements, delay reduction and travel time savings. Much of the data reflects the effects of ramp metering. A significant portion of the ramp metering data was done several years ago and is becoming dated. Therefore, there may be a need to update the results with impacts from newer implementations, or to revisit sites that have been studied in the past. Table 2.2a summarizes the number of entries in the database related to Freeway Management Systems.
Freeway traffic surveillance and information dissemination benefits are sometimes not reported as part of freeway management. However, the integration of the these types of services with other services (such as incident management) helps to provide the impacts realized by the other services. Few results have been reported that indicate the number of travelers that make use of this type of information to change modes, routes, or time of departure.

Table 2.2a: Database Entries for Freeway Management Systems

Component / User Service	Number of Entries	Safety	Delay & Time	Throughput	Cust. Satis.	Fuel & Envri.	Cost	General
Freeway Management Systems								
Traffic Surveillance	0							
Traffic Control	8	4	4	3	1		1	1
Information Dissemination	2	2						
Public Safety / Enforcement	2	2						
Other	3	2	3	1		1	1	
Total	15	10	7	4	1	1	2	1

Table 2.2b: Survey Results for Evaluation Priorities of Freeway Management Systems

Metropolitan Application Area	Study in Progress	Number of Entries (*1*)	Total Score	Number of Responses	Mean Score
Freeway Management Systems - Information dissemination	No	2	53	16	3.31
Freeway Management Systems - Traffic Surveillance	No	0	53	16	3.31
Freeway Management Systems - Traffic Control - Freeway Entrance - Ramp Metering	No	8	32	16	2.00

1. Reflects number of entries in the database as of 30 June 2000.

Table 2.2b displays the mean priority ratings given by respondents regarding application areas within freeway management systems. Within freeway management systems, interest in additional benefits information is greatest for information dissemination and traffic surveillance systems. There was little interest among the stakeholders participating in the task force in updating information on the benefits of freeway entrance ramp metering systems.

2.3 Transit Management Systems

Table 2.3a: Database Entries for Transit Management Systems

Component / User Service	Number of Entries	Safety	Delay & Time	Throughput	Cust. Satis.	Fuel & Envri.	Cost	General
Transit Management Systems								
Transit Management	4		2				2	1
Transit Information	1						1	
Other	4	3	3			1	3	
Total	9	3	5	0	0	1	6	1

Table 2.3b: Survey Results for Evaluation Priorities of Transit Management Systems

Metropolitan Application Area	Study in Progress	Number of Entries (*1*)	Total Score	Number of Responses	Mean Score
Transit Management Systems - Transit Management	No	0	59	17	3.47
Transit Management Systems - Transit Information	No	1	55	17	3.24
Transit Management Systems - Security	No	0	54	17	3.18
Transit Management Systems - Transit Management - Maintenance	Yes	0	46	17	2.71

1. Reflects number of entries in the database as of 30 June 2000.

Although some data exists for Transit Management Systems, there has not been enough data reported to develop general conclusions. Much of the data collected references the use of automated vehicle location (AVL) or computer aided dispatch (CAD) systems. These systems can be used to develop more efficient schedules which may provide advantages in service reliability. It is expected that results will show savings in travel time, and improved customer satisfaction with service. Table 2.3a summarizes the number of entries currently available in the database for Transit Management Systems. An evaluation project in Riverside, California is investigating the benefits of ITS deployment in the maintenance area of Transit Management.

There are also a few implementations of providing information to transit users. Most of these implementations are focused on providing route information. A few services are also showing expected time of arrival of transit vehicles at stations. Although these types of implementations may not directly influence travel time, they are expected to yield benefits related to customer satisfaction.

There was considerable interest among the task force members in obtaining additional benefits information for the various aspects of transit management. Areas of interest included the impact of ITS on transit management, including automatic vehicle location (AVL), computer aided dispatch (CAD), and, to a lesser extent, maintenance. Additional benefits information was also deemed necessary in the areas of transit information systems and application of ITS technologies to transit security. These responses are reflected in the survey results summarized in Table 2.3b.

2.4 Incident Management Systems

Incident management systems tend to be highly integrated with roadway surveillance and emergency response systems. Therefore, much of the data currently reported, although not usually specifically stated, reflects this integration. Significant data exists that demonstrates that these systems are effective in reducing non-recurring delay and reducing the travelers cost due to delay. Table 2.4a summarizes the number of entries currently in the database related to Incident Management. The main interest of the task force members with regard to these systems is collecting information on the benefits of Incident Management on arterials, as mentioned in Section 2.1 of this report.

Table 2.4a: Database Entries for Incident Management Systems

Component / User Service	Number of Entries	Safety	Delay & Time	Throughput	Cust. Satis.	Fuel & Envri.	Cost	General
Incident Management Systems								
Surveillance	1		1			1	1	
Detection	2		2					
Response	6	1	3		3	1	4	
Other	3		1			1	1	
Total	12	1	7	0	3	3	6	0

2.5 Emergency Response

Impacts of emergency response are often influenced heavily by related incident management systems. Data that have been reported reflect safety related impacts. It is expected the most data reported will be included with the integration of emergency response with incident management. Primary benefits are expected to include the reduction in time required to dispatch and arrive at accident locations. Additional benefits are related to safety and victims receiving prompt medical attention. Table 2.5a summarizes the number entries in the database by measure for Emergency Response. The task force did not discuss Emergency Response at the Data Needs Workshop.

2.6 Electronic Toll Collection

Table 2.5a: Databases Entries for Emergency Response

Component / User Service	Number of Entries	Safety	Delay & Time	Throughput	Cust. Satis.	Fuel & Envri.	Cost	General
Emergency Response								
Emergency Management	4	4	2					
Emergency Vehicle	1	1						
Total	5	5	2	0	0	0	0	0

Table 2.6a: Database Entries for Electronic Toll Collection

Component / User Service	Number of Entries	Safety	Delay & Time	Throughput	Cust. Satis.	Fuel & Envri.	Cost	General
Electronic Toll Collection								
Toll Administration	2						2	
Toll Collection	2	1	1			1	1	
Toll Vehicle	1					1		
Total	5	1	1	0	0	2	3	0

Electronic Toll Collection (ETC) is one of the ITS program areas where little new benefits information is required to support implementation. Benefits due to impacts on the cost of toll administration, management and collection have been demonstrated. Vehicle delay reduction and throughput at toll plazas have been proven to be very high. Therefore, many of the recent reports for applications of ETC have concentrated on the accuracy and improvements in vehicle identification. Technologies are now capable of identifying vehicles at mainline speeds and at a high rate of accuracy. As a result, throughput is maximized, and delay that would occur at toll plazas is substantially reduced. One respondent felt that additional information on the benefit of electronic toll collection systems was necessary, particularly in the area of safety impacts.

2.7 Electronic Fare Payment

Electronic Fare Payment is another ITS program area where little benefits information has been required to justify implementation. Electronic fare payment tests are ongoing in both bus and rail systems which address customer convenience and security. Primary benefits appear to be realized in the money handling operations of service providers.

Table 2.7a: Database Entries for Electronic Fare Payment

Component / User Service	Number of Entries	Safety	Delay & Time	Throughput	Cust. Satis.	Fuel & Envri.	Cost	General
Electronic Fare Payment								
Electronic Fare Payment	3						1	2
Total	3	0	0	0	0	0	1	2

Table 2.7b: Survey Results for Priority Ratings of Electronic Fare Payment

Metropolitan Application Area	Study in Progress	Number of Entries (*1*)	Total Score	Number of Responses	Mean Score
Electronic Fare Payment	No	3	49.5	17	2.91

1. Reflects number of entries in the database as of 30 June 2000.

Based on the average priority rating given by those participating in the task force, electronic fare payment was somewhat less important than other areas of ITS implementation. One issue with this type of fare payment is to determine the relative benefits of various types of fare media.

2.8 Highway Rail Intersection

Several operational tests involving coordinating traffic signals and notifying vehicles of approaching trains at intersections are currently being developed and implemented. A few pilot projects are now in progress to test new technologies, but have yet to produce quantitative data on benefits. Benefits are expected to be concentrated in accident reduction and possibly time savings. However, major efforts in educating the public on rail crossing safety and programs such as “Operation Lifesaver” may overshadow some results obtained by this ITS program area.

The information in Table 2.8b shows that the task force members have considerable interest in assessments of the benefits of highway-rail intersection improvements.

Table 2.8a: Database Entries for Highway Rail Intersection

Component / User Service	Number of Entries	Safety	Delay & Time	Throughput	Cust. Satis.	Fuel & Envri.	Cost	General
Highway Rail Intersection								
Surveillance	0							
Traffic Control / Signal Systems	1	1						
Information Dissemination	0							
Public Safety / Enforcement	1	1						
Total	2	2	0	0	0	0	0	0

Table 2.8b: Survey Results for Priority Rating of Highway Rail Intersection

Metropolitan Application Area	Study in Progress	Number of Entries (*1*)	Total Score	Number of Responses	Mean Score
Highway-Rail Intersection	Yes	2	63	17	3.71

1. Reflects number of entries in the database as of 30 June 2000.

2.9 Regional Multimodal Traveler Information

Benefits data related to regional multimodal traveler information highlights customer satisfaction. To date, few data have been collected on how this information changes traveler behavior. It is expected that this information may influence travelers to change mode of travel, route, or departure time under specific conditions to avoid delays or improve their ability to arrive at their destination on time.

Table 2.9a: Database Entries for Regional Multimodal Traveler Information

Component / User Service	Number of Entries	Safety	Delay & Time	Throughput	Cust. Satis.	Fuel & Envri.	Cost	General
Regional Mutimodal information								
Regional Multimodal Travel	7		1		4	1		1
Other	1				1			
Total	8	0	1	0	5	1	0	1

Table 2.9b: Survey Results for Regional Multimodal Traveler Information

Metropolitan Application Area	Study in Progress	Number of Entries (*1*)	Total Score	Number of Responses	Mean Score
Regional Multimodal Traveler Information - Behavior Changes	Yes	1	58	16	3.63

1. Reflects number of entries in the database as of 30 June 2000.

As indicated in Table 2.9b, there was considerable interest among the participating stakeholders in the benefits of regional multimodal traveler information. The particular interest of the group was determining the ability of these systems to get travelers to change their behavior based on information provided. A case study evaluation of providing multimodal information to travelers is currently underway in Miami (Dade County), Florida that when complete may contain related benefits information.

Table 2.10: Survey Results for Priority Rating of Data Archiving

Metropolitan Application Area	Study in Progress	Number of Entries (*1*)	Total Score	Number of Responses	Mean Score
Information Management - Data Archiving	No	0	65	16	4.06

1. Reflects number of entries in the database as of 30 June 2000.

2.10 Data Archiving

As indicated by the values in Table 2.10, a particular area of interest among task force members was data archiving. Participants felt that there was a great need for additional information on the benefits of this relatively new ITS implementation area. Participants expressed interest in the information to help convince decision-makers of the importance of archiving data, as well as some concern over institutional issues regarding private companies unwilling to publicly distribute data collected by their companies. There is currently no data in the database that refers to the benefits of data archiving.

Table 2.11: Survey Results for Priority Ratings of Other Metropolitan Related Areas

Metropolitan Application Area	Study in Progress	Number of Entries (*1*)	Total Score	Number of Responses	Mean Score
Operations & Maintenance	No	0	63.5	16	3.97
Parking Management	No	0	46.5	16	2.91

1. Reflects number of entries in the database as of 30 June 2000.

2.11 Other Metropolitan Related Areas

The task force discussed several areas of ITS implementation that were not previously included in the taxonomy for classifying ITS benefits. Table 2.11 contains survey results for these areas. One area of interest was the need for information on using ITS to improve the operations and maintenance of urban transportation systems. While these benefits are currently under investigation in rural areas, the task force felt that benefits from these systems were also applicable to metropolitan areas. Parking management was also raised as an important new area in ITS, with a corresponding need for evaluation of potential benefits from these systems.

3 METROPOLITAN ITS INTEGRATION DATA NEEDS

Figure 3 illustrates the numbered links that represent the flow of information between metropolitan ITS components. Much of the data collected regarding integration illustrates benefits to delay and travel time savings or cost savings. A few evaluation studies are currently planned or in progress that may include results for several integration links. Table 3a summarizes the number of entries currently in the database related to metropolitan ITS integration links. Following that is a listing of the definitions of each of the metropolitan integration links.

Little data have been reported for components that use information collected using arterial management (links 1,2,3,4). It is expected that the primary benefit for these integration links would be delay and travel time savings. The sharing of information between arterial management and freeway management (links 2 and 11) which can be used to change ramp metering rates and traffic signal times, may yield significant advantages.

Figure 3: Metropolitan Integration Links

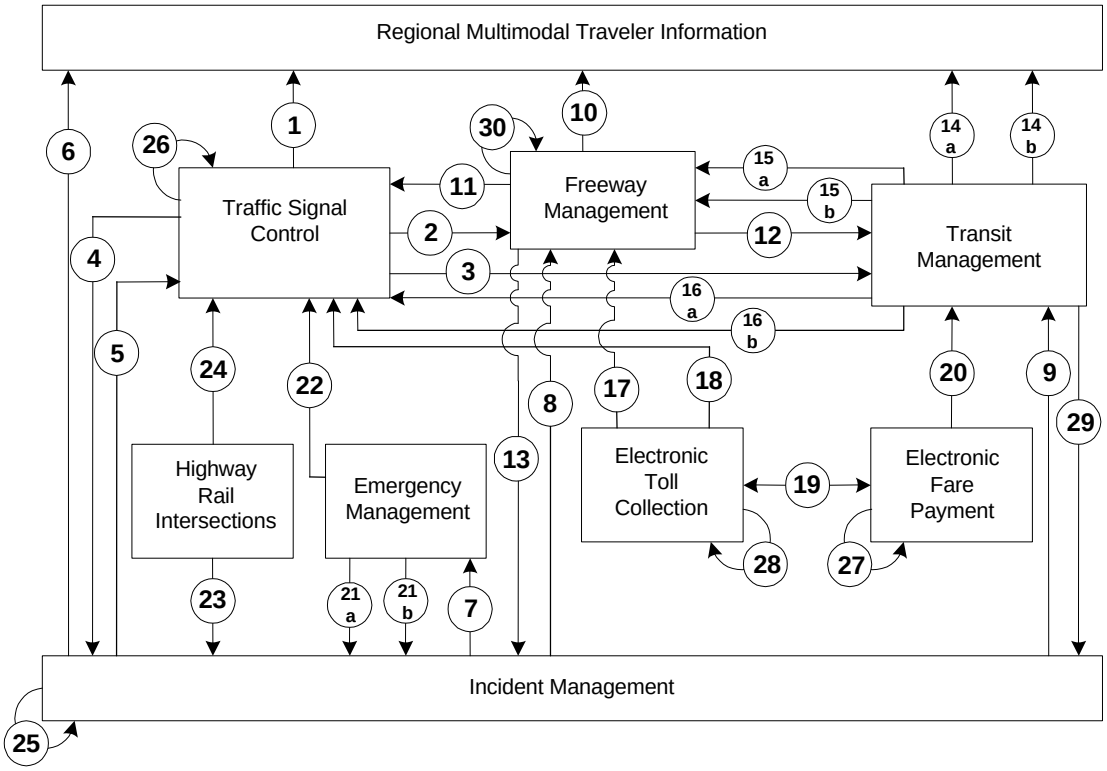

Table 3a: Database Entries for Metropolitan Integration Links

Component / User Service	Number of Entries	Safety	Delay & Time	Throughput	Cust. Satis.	Fuel & Envri.	Cost	General
Metropolitan Integration								
Link 1: Arterial Mgmt to Multimodal Info.	1		1				1	
Link 2: Arterial Mgmt to Freeway Mgmt								
Link 3: Arterial Mgmt to Transit Mgmt							1	
Link 4: Arterial Mgmt to Incident Mgmt	1		1					
Link 5: Incident Mgmt to Arterial Mgmt								
Link 6: Incident Mgmt to Multimodal Info.	7	2	5	1	3	1	3	
Link 7: Incident Mgmt to Emergency Mgmt	3		3				1	
Link 8: Incident Mgmt to Freeway Mgmt	1		1				1	
Link 9: Incident Mgmt to Transit Mgmt								
Link 10: Freeway Mgmt to Multimodal Info.	2		2				2	
Link 11: Freeway Mgmt to Arterial Mgmt								
Link 12: Freeway Mgmt to Transit Mgmt								
Link 13: Freeway Mgmt to Incident Mgmt	4	1	4				2	
Link 14a: Transit Mgmt to Multimodal Info.	3				2			1
Link 14b: Transit Mgmt to Multimodal Info.	1							1
Link 15a: Transit Mgmt to Freeway Mgmt								
Link 15b: Transit Mgmt to Freeway Mgmt								
Link 16a: Transit Mgmt to Arterial Mgmt	4	1	3					
Link 16b: Transit Mgmt to Arterial Mgmt								
Link 17: ETC to Freeway Mgmt								
Link 18: ETC to Arterial Mgmt								
Link 19: ETC to Electronic Payment								
Link 20: Electronic Fare to Transit Mgmt.								
Link 21a: Emergency Mgmt to Incident Mgmt								
Link 21b: Emergency Mgmt to Incident Mgmt								
Link 22: Emergency Mgmt to Arterial Mgmt								
Link 23: Highway-rail to Incident Mgmt								
Link 24: Highway-rail to Arterial Mgmt								
Link 25: Incident Mgmt intra-component								
Link 26: Arterial Mgmt intra-component	1		1					
Link 27: Electronic Payment intra-component								
Link 28: ETC intra-component								
Link 29: Transit Mgmt to Incident Mgmt								
Link 30: Freeway Mgmt intra-component								
Total	28	4	21	1	5	1	11	2

Definitions of the metropolitan integration links represent both inter- and intra-component sharing of information. Each of the links has been assigned a number and an origin/destination path from one component to another as illustrated in Figure A-3. The definitions used are the most recent version from the draft report titled “Tracking the Deployment of the Integrated Metropolitan Intelligent Transportation Systems Infrastructure in the USA: FY 1999 Results,” Prepared by Oak Ridge national Laboratory and Science Applications International Corporation for the U.S. Dept. of Transportation’s ITS Joint Program Office dated March 2000.

Link 1: Arterial Management to Regional Multimodal Traveler Information: Arterial travel time, speed and condition information are displayed by Regional Multimodal Traveler Information media.

Link 2: Arterial Management to Freeway Management: Freeway Management Center monitors arterial travel times, speeds, and conditions using data provided from Arterial Management to adjust ramp meter timing, lane control or HAR in response to changes in real-time conditions on a parallel arterial.

Link 3: Arterial Management to Transit Management: Transit Management adjusts transit routes and schedules in response to arterial travel times, speeds, and conditions information collected as art of Arterial Management.

Link 4: Arterial Management to Incident Management: Incident Management monitors real-time arterial travel times, speeds, and conditions using data provided from Arterial Management to detect arterial incidents and manage incident response activities.

Link 5: Incident Management to Arterial Management: Arterial Management monitors incident severity, location, and type information collected by Incident Management to adjust traffic signal timing or provide information to travelers in response to incident management activities.

Link 6: Incident Management to Regional Multimodal Traveler Information: Incident location, severity and type information are displayed by Regional Multimodal Traveler Information media.

Link 7: Incident Management to Emergency Management: Incident severity, location and type data collected as part of Incident Management are used to notify Emergency Management for incident response.

Link 8: Incident Management to Freeway Management: Incident Severity, location, and type data collected by Incident Management are monitored by Freeway Management for the purpose of adjusting ramp meter timing, lane control or HAR messages in response to freeway or arterial incidents.

Link 9: Incident Management to Transit Management: Transit Management adjusts transit routes and schedules in response to incident severity, location, and type data collected as part of Incident Management.

Link 10: Freeway Management to Regional Multimodal Traveler Information: Freeway travel time, speed and condition information are displayed by Regional Multimodal Traveler Information.

Link 11: Freeway Management to Arterial Management: Freeway travel time, speeds, and conditions data collected by Freeway Management are used by Arterial Management to adjust arterial traffic signal timing or arterial VMS messages in response to changing freeway conditions.

Link 12: Freeway Management to Transit Management: Transit Management adjusts

transit routes and schedules in response to freeway travel times, speeds, and conditions information collected as part of Freeway Management.

Link 13: Freeway Management to Incident Management: Incident Management monitors freeway travel time, speed, and condition data collected by Freeway Management to detect incidents or manage incident response.

Link 14a: Transit Management to Regional Multimodal Traveler Information: Transit routes, schedules, and fare information are displayed on Regional Multimodal Traveler Information media.

Link 14b: Transit Management to Regional Multimodal Traveler Information: Transit schedule adherence information is displayed on Regional Multimodal Traveler Information media.

Link 15a: Transit Management to Freeway Management: Freeway ramp meters are adjusted in response to receipt of transit vehicle priority signal.

Link 15b: Transit Management to Freeway Management: Transit Vehicles equipped as probes are monitored by Freeway Management to determine freeway travel speeds or travel times.

Link 16a: Transit Management to Arterial Management: Traffic signals are adjusted in response to receipt of transit vehicle priority signal.

Link 16b: Transit Management to Arterial Management: Transit vehicles equipped as probes are monitored by Arterial Management to determine arterial speeds or travel times.

Link 17: Electronic Toll Collection to Freeway Management: Vehicle equipped with electronic toll collection tags are used as probes and monitored by Freeway Management to determine freeway travel speeds or travel times.

Link 18: Electronic Toll Collection to Arterial Management: Vehicle equipped with electronic toll collection tags are used as probes and monitored by Arterial Management to determine arterial travel speeds or travel times.

Link 19: Electronic Toll Collection to Electronic Fare Payment: Transit operators accept ETC issued tags to pay for transit fares.

Link 20: Electronic Fare Payment to Transit Management: Rider ship details collected as part of Electronic Fare Payment are used in transit service planning by Transit Management.

Link 21a: Emergency Management to Incident Management: Incident Management is notified of incident location, severity and type by Emergency Management to identify incidents on freeways or arterials.

Link 21b: Emergency Management to Incident Management: Incident Management is notified of incident clearance activities by Emergency Management to manage incident response on freeways or arterials.

Link 22: Emergency Management to Arterial Management: Emergency Management vehicles are equipped with traffic signal priority capability.

Link 23: Highway-rail intersection to Incident Management: Incident Management is notified of crossing blockages by Highway-rail intersection to manage incident response.

Link 24: Highway-rail intersections to Arterial Management: Highway-rail intersection and Arterial Management are interconnected for the purpose of adjusting traffic signal timing in response to train crossing.

Link 25: Incident Management intra-component: Agencies participating in formal working agreements or incident management plans coordinate incident detection, verification and response.

Link 26: Arterial Management intra-component: Agencies operating traffic signals along common corridors sharing information and possible control of traffic signals to maintain progression on arterial routes.

Link 27: Electronic Fare Payment intra-component: Operators of different public transit services share common electronic fare payment media.

Link 28: Electronic Toll Collection intra-component: Electronic Toll Collection agencies share a common toll tag for the purpose of facilitating “seam less” toll transactions.

Link 29: Transit Management to Incident Management: Transit agencies notify Incident Management agencies of incident locations, severity and type.

Link 30: Freeway Management intra-component: Agencies operating freeways within the same region share freeway travel time, speeds and condition data.

Table 3b contains the results of the survey of opinions from task force members regarding the need for additional benefits information on each of the various integration links for metropolitan ITS. Results are presented in order of importance as reflected by the mean score.

Table 3b: Survey Results for Priority Ratings of Metropolitan Integration Links

Metropolitan Integration Links	Study in Progress	Number of Entries (*1*)	Total Score	Number of Responses	**Mean Score**
Link 2: Arterial Management to Freeway Management	No	0	66	16	4.13
Link 5: Incident Management to Arterial Management	No	0	66	16	4.13
Link 21a: Emergency Management to Incident Management	No	0	66	16	4.13
Link 21b: Emergency Management to Incident Management	No	0	66	16	4.13
Link 7: Incident Management to Emergency Management	No	3	65.5	16	4.09
Link 4: Arterial Management to Incident Management	No	1	61	15	4.07
Link 1: Arterial Management to Regional Multimodal Traveler Information	No	1	64	16	4.00
Link 22: Emergency Management to Arterial Management	No	0	62	16	3.88
Link 23: Highway-rail intersection to Incident Management	No	0	61	16	3.81
Link 25: Incident Management intra-component	No	0	60.5	16	3.78
Link 8: Incident Management to Freeway Management	No	1	60	16	3.75
Link 11: Freeway Management to Arterial Management	No	0	59.5	16	3.72
Link 26: Arterial Management intra-component	No	1	59	16	3.69
Link 28: Electronic Toll Collection intra-component	No	0	56.5	16	3.53
Link 18: Electronic Toll Collection to Arterial Management	No	0	56	16	3.50
Link 24: Highway-rail intersections to Arterial Management	No	0	55	16	3.44
Link 6: Incident Management to Regional Multimodal Traveler Information	No	7	53	16	3.31
Link 30: Freeway Management intra-component	No	0	52.5	16	3.28
Link 3: Arterial Management to Transit Management	No	0	55	17	3.24
Link 13: Freeway Management to Incident Management	Yes	4	51	16	3.19
Link 14b: Transit Management to Regional Multimodal Traveler Information	No	1	53.5	17	3.15
Link 10: Freeway Management to Regional Multimodal Traveler Information	No	2	50	16	3.13
Link 16a: Transit Management to Arterial Management	No	4	53	17	3.12

1. Reflects number of entries in the database as of 30 June 2000.

Table 3b (continued)

Metropolitan Integration Links	Study in Progress	Number of Entries (*1*)	Total Score	Number of Responses	Mean Score
Link 27: Electronic Fare Payment intra-component	No	0	53	17	3.12
Link 17: Electronic Toll Collection to Freeway Management	No	0	49	16	3.06
Link 9: Incident Management to Transit Management	No	0	49	17	2.88
Link 29: Transit Management to Incident Management	Yes	0	48	17	2.82
Link 19: Electronic Toll Collection to Electronic Fare Payment	No	0	47.5	17	2.79
Link 14a: Transit Management to Regional Multimodal Traveler Information	No	3	46.5	17	2.74
Link 20: Electronic Fare Payment to Transit Management	No	0	46	17	2.71
Link 15b: Transit Management to Freeway Management	No	0	44	17	2.59
Link 16b: Transit Management to Arterial Management	No	0	41	17	2.41
Link 12: Freeway Management to Transit Management	Yes	0	39	17	2.29
Link 15a: Transit Management to Freeway Management	No	0	36.5	17	2.15

1. Reflects number of entries in the database as of 30 June 2000.

The benefit of integrating arterial management with other ITS implementations appears to be a major interest of the task force participants. Many of the integration links with the highest average priority ratings involve some combination of arterial management or incident management with other ITS services.

Responses from the task force seem to indicate little interest in the benefits of integrating transit management with other metropolitan ITS elements. The relative position of the links involving transit management in Table 3b, combined with comments received with the surveys indicate that there is interest in integration between transit and arterial management, as most transit operations take place on arterial roadways.

4 RURAL ITS DATA NEEDS

Few evaluation studies have been published that provide benefits data in rural ITS program areas and components. Most of the available data are for road weather maintenance operations. At this time no general conclusions can be made about the impacts of rural services. Therefore, data are needed across all related program areas and components. Table 4a summarizes the number of entries currently available in the database for all rural ITS areas.

Survey results shown in Table 4b, indicate that priority ratings for rural ITS are somewhat lower than metropolitan areas. However, those responding to the survey are primarily from metropolitan areas. Higher ratings probably would have occurred if the survey had been given to those implementing or working with rural ITS. Results show that emergency services for rural areas have the highest priority. ITS services to assist with roadway operations and maintenance also have a very high priority.

Table 4a: Database Entries for Rural ITS Areas

Component / User Service	Number of Entries	Safety	Delay & Time	Throughput	Cust. Satis.	Fuel & Envri.	Cost	General
Crash prevention and security								
Detection	1	1						
Total	1	1	0	0	0	0	0	0
Component / User Service	**Number of Entries**	**Safety**	**Delay & Time**	**Throughput**	**Cust. Satis.**	**Fuel & Envri.**	**Cost**	**General**
Emergency Services								
Detection	0							
Response	0							
Information Dissemination	0							
Total	0	0	0	0	0	0	0	0
Component / User Service	**Number of Entries**	**Safety**	**Delay & Time**	**Throughput**	**Cust. Satis.**	**Fuel & Envri.**	**Cost**	**General**
Travel and Tourism								
Traveler Information	0							
Revenue Collection	0							
Total	0	0	0	0	0	0	0	0
Component / User Service	**Number of Entries**	**Safety**	**Delay & Time**	**Throughput**	**Cust. Satis.**	**Fuel & Envri.**	**Cost**	**General**
Traffic Management								
Surveillance	0							
Traffic Control	1	1						
Informaiton Dessemination	0							
Total	1	1	0	0	0	0	0	0
Component / User Service	**Number of Entries**	**Safety**	**Delay & Time**	**Throughput**	**Cust. Satis.**	**Fuel & Envri.**	**Cost**	**General**
Transit and Mobility								
Demand Responsive/Paratransit	3						3	
Transit Management	0							
Traveler Information	0							
Electronic Payment	0							
Total	3	0	0	0	0	0	3	0
Component / User Service	**Number of Entries**	**Safety**	**Delay & Time**	**Throughput**	**Cust. Satis.**	**Fuel & Envri.**	**Cost**	**General**
Operation and Maintenance								
Fleet Management	0							
Infrastructure Maintenance	0							
Weather Maintenance	3	1	1				3	
Work Zone Management	0							
Information Dissemination	0							
Total	3	1	1	0	0	0	3	0
Component / User Service	**Number of Entries**	**Safety**	**Delay & Time**	**Throughput**	**Cust. Satis.**	**Fuel & Envri.**	**Cost**	**General**
Surface Transportation Weather								
Monitoring	1						1	
Data Collection	0							
Information Deissemination	0							
Total	1	0	0	0	0	0	1	0

Table 4b: Survey Results for Rural Application Areas

Rural Application Area	Study in Progress	Number of Entries (*1*)	Total Score	Number of Responses	**Mean Score**
Emergency Services	No	0	61.5	16	3.84
Operation and Maintenance	No	0	55.5	16	3.47
Crash Prevention and Security	No	1	54.5	16	3.41
Surface Transportation Weather	Yes	1	54.5	16	3.41
Transit and Mobility	No	0	54	17	3.18
Travel and Tourism	No	0	48.5	16	3.03
Traffic Management	No	1	44	16	2.75

1. Reflects number of entries in the database as of 30 June 2000.

5 Benefits Measures

Survey respondents were also asked to distribute 100 points among the few good measures based on how they viewed the importance of concentrating evaluation efforts in each of the ITS program goal areas. Although some survey respondents and participants in the task force indicated concern that safety may be under represented by the group, the results show that safety is rated as the most important measure. Improving mobility (represented by travel time, delay savings, and reliability) is the second most important goal area. These results might be expected as they are the two most common issues brought up by the traveling public.

Environmental concerns such as fuel efficiency and emissions are rated the lowest. This result is consistent with what has been reported in the past regarding the environmental effects of ITS. In most cases, environmental benefits from a given project can only be estimated by analysis and simulation. The problems related to regional measurement include the small impact of individual projects and large numbers of exogenous variables including weather, contributions from non-mobile sources or other regions, and the time evolving nature of ozone pollution. Small-scale studies, so far, generally show positive impacts for ITS on the environment. These result from smoother and more efficient flows in the traffic system. However, the environmental impact of travelers reacting to large-scale deployment in the long term are not well understood.

Table 5: Survey Results for the Few Good Measures

Goal Area	Measures	All Stakeholders		
		Total Score	Number of Responses	**Mean Score**
Improve Safety	Crashes Fatalities	432	18	24.00
Improve Mobility	Travel Time Delay Reliability	324	18	18.00
Increase Efficiency	Throughput Effective Capacity	262	17	15.41
Driver Response	Behavior Changes	168	17	9.88
Customer Satisfaction		171	18	9.50
Increase Productivity	Costs	157	18	8.72
Improve Environment	Emissions	152	18	8.44
Conserve Energy	Fuel Consumption	114	18	6.33

6 Summary of Findings and Recommendations

Reviewing the results of the Data Needs workshop presented in previous sections of this report, there is an apparent need for additional information on the impact of ITS in each of the areas discussed. Participants indicated interest in evaluation results for almost all program areas discussed. The results from surveying meeting participants do not allow an easy determination of which categories of implementations are most important for continued evaluation. However, the rank ordering of the application areas based on average priority rating provides an indication of where the task force members see the greatest need for additional research.

The discussion at the data needs workshop and responses to the surveys distributed after the meeting did not generate a clear consensus on the application areas within ITS where the benefits evaluation need is greatest, or where enough data already exists. However, the ranking of application areas based on the average priority rating assigned by the task force members provides an idea of the relative importance of the various areas. Future data needs assessments may benefit from a more extended discussion of the existing knowledge of the benefits of ITS. A possible format for future efforts would be a half-day session dedicated to informing committee members on the known benefits in various ITS implementation areas, followed by a subsequent session to determine where the greatest evaluation needs lie. Separating the two tasks would allow workshop participants to weigh the existing knowledge in different areas prior to establishing priorities for additional research.

The following figures summarize the survey results, displaying the average priority rating assigned by workshop participants to various program areas. More detailed information is available in the appendix which can be used to determine the number of respondents assigning each priority rating to each application area. The more detailed information can also be used to depict the distribution of rating assigned by different stakeholder groups represented at the workshop.

The overview chart in Figure 6.1 demonstrates the lack of a clear dividing line between areas of ITS implementation with a strong need for benefits evaluation and those for which sufficient data exists.

While participants felt that Incident Management Systems have been adequately evaluated, they felt existing evaluations had been focused primarily on freeway systems and that additional information is required on the impact of these systems within Arterial Management Systems. This research area was of particular interest those at the workshop representing localities. Survey respondents where also interested in the benefits of data archiving, a service recently added to the National ITS Architecture and subsequently included in the benefits classification taxonomy. Task force members placed particular importance on this area given the lack of existing studies and the need for benefits data to help those implementing ITS understand the importance of data archiving.

The third most important category to task force members was operations and maintenance. Though not previously an application area classified under metropolitan systems, participants felt that significant benefits can be achieved from implementing these systems in urban areas and desired evaluations of urban implementation of these systems. Highway-Rail Intersection systems where the fourth highest rated application area among survey respondents.

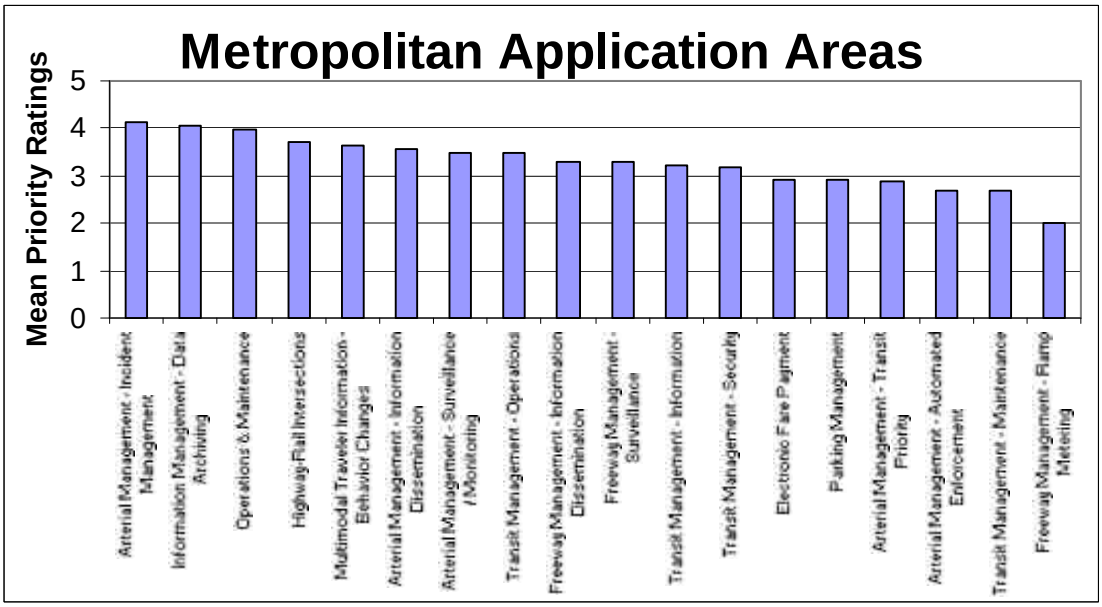

Figure 6.1: Survey Results for Evaluation Priorities of Metropolitan Application Areas

Task force members were most interested in integration between arterial management and incident management with other metropolitan areas. Many of the integration links with the highest average priority ratings involve some combination of arterial management, incident management, or emergency management with other ITS components. Evaluation to determine benefits of communication links between Emergency Management and Incident Management is of particular importance to the committee.

Responses from the task force seem to indicate little interest in the benefits of integrating transit management with other metropolitan ITS elements. This may reflect the belief that ITS can benefit both transit and highway modes, but that little can be gained from attempts to integrate ITS applications in the two areas. Task Force members did discuss the need for evaluation of benefits from the integration of arterial management systems with transit management systems as most urban transit operations occur on arterial roadways.

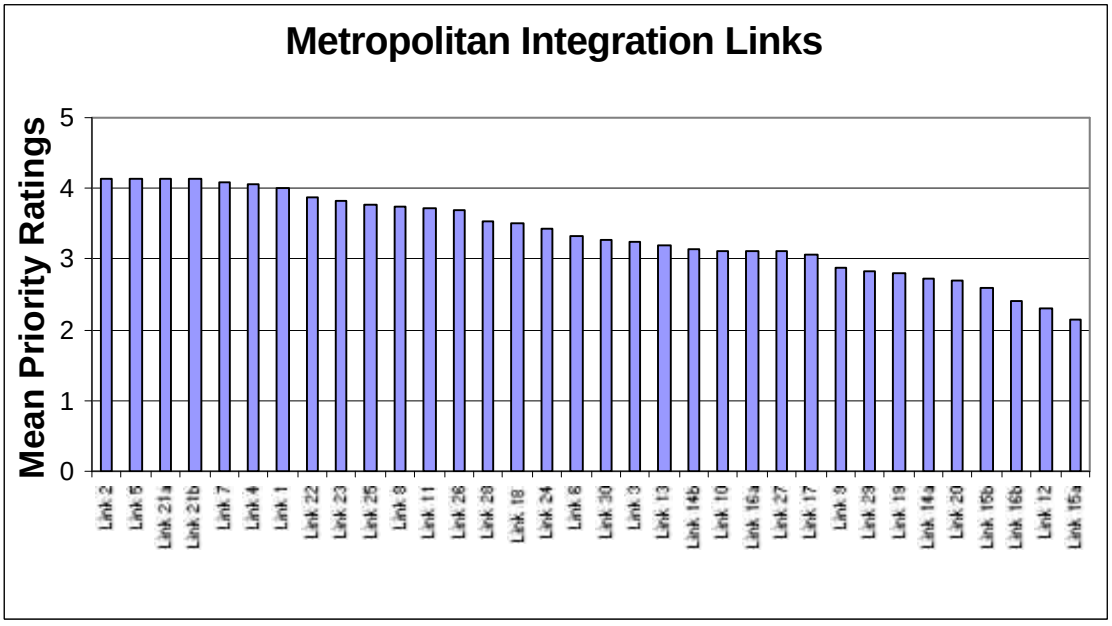

Figure 6.2: Survey Results for Evaluation Priorities of Metropolitan Integration Links

Priority ratings for rural application areas were somewhat lower than for urban areas. Many of the task force members are involved in metropolitan ITS implementation, however, and the scores would likely be higher had representatives involved in rural ITS been included in the committee. The area of greatest interest to task force members within rural application areas was emergency services, likely due to the longer average emergency response times in rural areas. There was little discussion of rural data needs at the workshop. Task force members indicated in the survey that there was some interest in studying the potential economic impacts for area businesses where tourist information is provided.

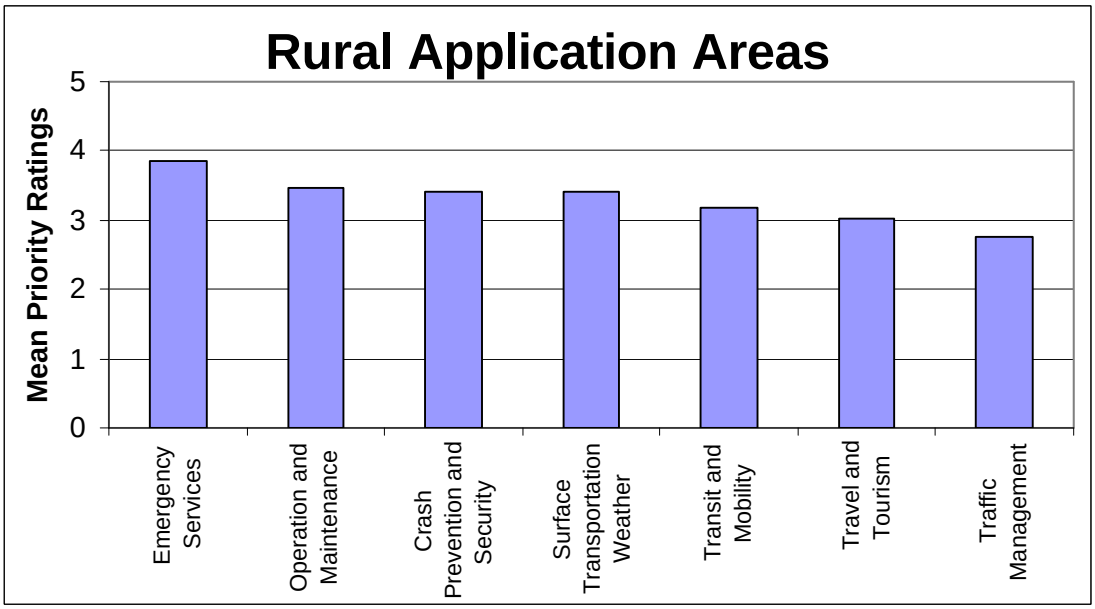

Figure 6.3: Survey Results for Evaluation Priorities of Rural Application Areas

Workshop participants were also asked to allocate 100 points to the importance of additional evaluation effort regarding the Few Good Measures associated with the ITS program. Responses indicate that the areas of highest importance to workshop attendees are similar to the top concerns of the traveling public: improving safety and mobility. The third most important measure is the ability of ITS to improve the efficiency of the transportation facilities. Energy and environment measures ranked last in the average number of points assigned by workshop participants. This likely reflects the perception that ITS can provide minimal benefit in these areas, and the difficulty in assessing changes to these measures due to the localized impact of many ITS implementations.

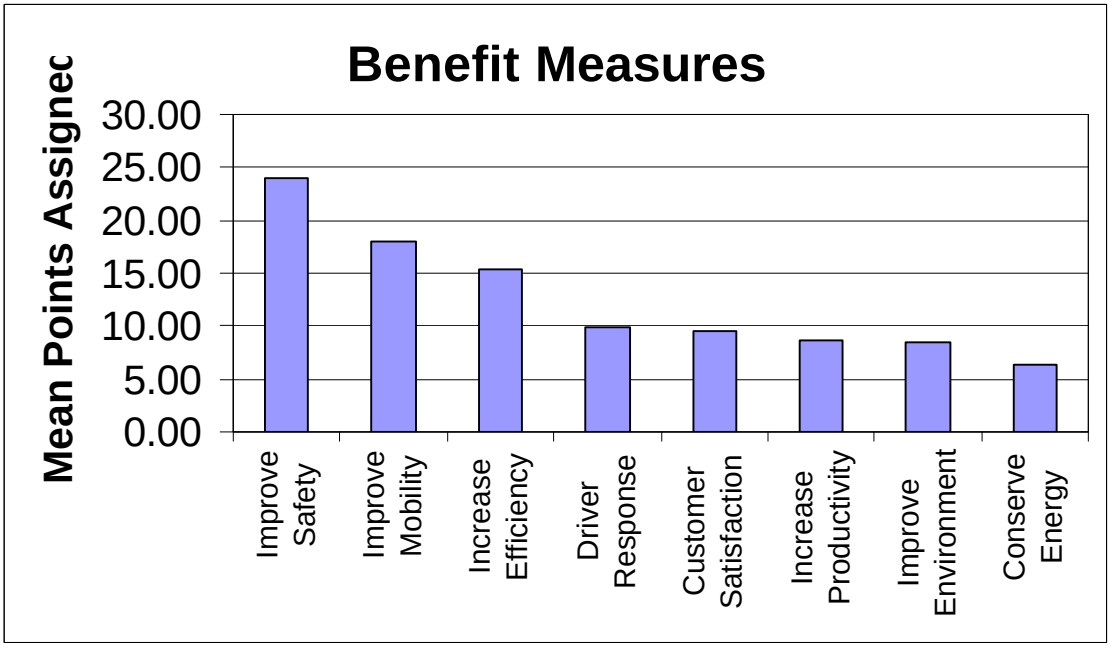

Figure 6.4: Survey Results for Benefit Measures Point Assignment

Appendix:

Survey Results

This appendix shows in more detail the results of the survey sent to task force members. Task Force members were asked to rate Metropolitan ITS areas, Metropolitan Integration Links and Rural ITS areas using the scale provided in the box below. Ratings were based on where members felt additional data would help fill gaps in the knowledge base and provide the greatest benefit to decision makers, local government agencies, researchers, etc.

Evaluation Scale
0 - No Importance
1 - Minimal Importance
2
3 - Moderate Importance
4
5 - High Importance

Task force members were also asked to allocate 100 points across the goal areas. This was used to assist in rating the importance of additional evaluation efforts regarding the Few Good Measures associated with the ITS program.

Survey results are sorted by the mean score over all stakeholders. Also, mean scores are presented for each of the five stakeholder groups. The number of survey responses from each stakeholder group are shown in the table below.

Stakeholder Group	**Number of Surveys Received**
Federal Government	4
State Government	2
Local Government	2
Consultants	8
Industry	2
Total Surveys received	18

Table A-1: Survey Results for Priority Ratings of Metropolitan Application Areas

Metropolitan Application Area	Study in Progress	Number of Entries*	All Stakeholders			Mean Scores for Stakeholder Groups				
			Total Score	Number of Responses	**Mean Score**	Federal Government	State Government	Local Government	Consultants	Industry Society
Arterial Management Systems - Incident Management	No	0	66	16	4.13	4.67	4.00	5.00	3.71	4.00
Information Management - Data Archiving	No	0	65	16	4.06	4.33	3.50	3.50	4.14	4.50
Operations & Maintenance	No	0	63.5	16	3.97	2.83	4.50	4.50	4.14	4.00
Highway-Rail Intersection	Yes	2	63	17	3.71	4.33	4.50	2.50	3.75	3.00
Regional Multimodal Traveler Information - Behavior Changes	Yes	1	58	16	3.63	4.00	3.50	3.50	3.57	3.50
Arterial Management Systems - Information Dissemination	No	0	57	16	3.56	3.00	4.00	4.00	3.29	4.50
Arterial Management Systems - Traffic Surveillance	No	0	56	16	3.50	4.00	4.00	4.50	2.86	3.50
Transit Management Systems - Transit Management	No	0	59	17	3.47	4.00	1.50	3.00	4.14	2.50
Freeway Management Systems - Information dissemination	No	2	53	16	3.31	4.33	5.00	1.50	3.00	3.00
Freeway Management Systems - Traffic Surveillance	No	0	53	16	3.31	3.33	5.00	3.50	2.86	3.00
Transit Management Systems - Transit Information	No	1	55	17	3.24	3.00	2.50	3.00	3.71	3.00
Transit Management Systems - Security	No	0	54	17	3.18	3.75	1.50	1.50	4.14	2.00
Electronic Fare Payment	No	3	49.5	17	2.91	2.63	4.00	2.00	2.86	3.50
Parking Management	No	0	46.5	16	2.91	1.83	1.50	2.50	3.71	3.50
Arterial Management Systems - Traffic Control - Signal Priority - Transit	Yes	4	49	17	2.88	2.75	2.50	3.50	2.86	3.00
Arterial Management Systems - Public Safety - Enforcement	No	4	46	17	2.71	3.33	2.00	2.50	2.63	3.00
Transit Management Systems - Transit Management - Maintenance	No	0	46	17	2.71	2.25	1.00	2.50	3.43	3.00
Freeway Management Systems - Traffic Control - Freeway Entrance - Ramp Metering	No	8	32	16	2.00	1.33	2.00	1.00	2.71	1.50

* Reflects number of entries in the database as of 30 June 2000.

Table A-2: Survey Responses for Evaluation Priorities of Metropolitan Integration Links (2 pages)

Metropolitan Integration Links	Study in Progress	Number of Entries*	All Stakeholders			Mean Scores for Stakeholder Groups				
			Total Score	Number of Responses	**Mean Score**	Federal Government	State Government	Local Government	Consultants	Industry Society
Link 2: Arterial Management to Freeway Management	No	0	66	16	4.13	3.33	4.50	4.50	4.14	4.50
Link 5: Incident Management to Arterial Management	No	0	66	16	4.13	3.67	4.00	4.00	4.29	4.50
Link 21a: Emergency Management to Incident Management	No	0	66	16	4.13	3.33	5.00	4.00	4.29	4.00
Link 21b: Emergency Management to Incident Management	No	0	66	16	4.13	3.00	5.00	3.50	4.57	4.00
Link 7: Incident Management to Emergency Management	No	3	65.5	16	4.09	3.50	4.50	4.00	4.14	4.50
Link 4: Arterial Management to Incident Management	No	1	61	15	4.07	4.33	3.50	4.00	4.14	4.00
Link 1: Arterial Management to Regional Multimodal Traveler Information	No	1	64	16	4.00	4.33	4.00	3.50	4.14	3.50
Link 22: Emergency Management to Arterial Management	No	0	62	16	3.88	3.67	3.00	4.00	4.29	3.50
Link 23: Highway-rail intersection to Incident Management	No	0	61	16	3.81	3.33	4.00	3.00	4.14	4.00
Link 25: Incident Management intra-component	No	0	60.5	16	3.78	3.83	5.00	3.00	3.57	4.00
Link 8: Incident Management to Freeway Management	No	1	60	16	3.75	4.00	5.00	3.00	3.43	4.00
Link 11: Freeway Management to Arterial Management	No	0	59.5	16	3.72	2.83	4.00	3.50	4.00	4.00
Link 26: Arterial Management intra-component	No	1	59	16	3.69	2.33	4.00	4.50	3.86	4.00
Link 28: Electronic Toll Collection intra-component	No	0	56.5	16	3.53	4.17	5.00	1.50	3.29	4.00
Link 18: Electronic Toll Collection to Arterial Management	No	0	56	16	3.50	4.33	3.00	3.00	3.57	3.00
Link 24: Highway-rail intersections to Arterial Management	No	0	55	16	3.44	2.67	1.50	3.00	4.29	4.00
Link 6: Incident Management to Regional Multimodal Traveler Information	No	7	53	16	3.31	4.00	4.50	2.00	3.14	3.00
Link 30: Freeway Management intra-component	No	0	52.5	16	3.28	2.83	4.50	1.50	3.71	3.00
Link 3: Arterial Management to Transit Management	No	0	55	17	3.24	3.00	2.50	3.50	3.57	3.00
Link 13: Freeway Management to Incident Management	Yes	4	51	16	3.19	3.33	5.00	3.00	2.43	4.00
Link 14b: Transit Management to Regional Multimodal Traveler Information	No	1	53.5	17	3.15	3.13	2.50	3.00	3.86	1.50
Link 10: Freeway Management to Regional Multimodal Traveler Information	No	2	50	16	3.13	3.33	4.50	3.50	2.86	2.00
Link 16a: Transit Management to Arterial Management	No	4	53	17	3.12	3.25	2.00	4.00	3.43	2.00
Link 27: Electronic Fare Payment intra-component	No	0	53	17	3.12	3.50	0.50	2.50	3.57	4.00

* Reflects number of entries in the database as of 30 June 2000.

Table A-2 (continued)

Metropolitan Integration Links	Study in Progress	Number of Entries*	All Stakeholders			Mean Scores for Stakeholder Groups				
			Total Score	Number of Responses	**Mean Score**	Federal Government	State Government	Local Government	Consultants	Industry Society
Link 17: Electronic Toll Collection to Freeway Management	No	0	49	16	3.06	3.67	4.00	1.50	3.29	2.00
Link 9: Incident Management to Transit Management	No	0	49	17	2.88	3.25	2.50	2.50	3.00	2.50
Link 29: Transit Management to Incident Management	Yes	0	48	17	2.82	2.00	4.50	2.50	3.14	2.00
Link 19: Electronic Toll Collection to Electronic Fare Payment	No	0	47.5	17	2.79	2.38	1.50	2.00	4.00	1.50
Link 14a: Transit Management to Regional Multimodal Traveler Information	No	3	46.5	17	2.74	3.38	2.50	3.00	2.71	1.50
Link 20: Electronic Fare Payment to Transit Management	No	0	46	17	2.71	2.50	1.50	2.50	3.57	1.50
Link 15b: Transit Management to Freeway Management	No	0	44	17	2.59	2.25	3.50	2.50	2.86	1.50
Link 16b: Transit Management to Arterial Management	No	0	41	17	2.41	2.25	1.50	2.50	2.71	2.50
Link 12: Freeway Management to Transit Management	Yes	0	39	17	2.29	2.25	2.50	2.00	2.29	2.50
Link 15a: Transit Management to Freeway Management	No	0	36.5	17	2.15	2.38	1.50	1.00	2.57	2.00

* Reflects number of entries in the database as of 30 June 2000.

Table A-3: Survey Responses for Evaluation Priorities of Rural Application Areas

Rural Application Area	Study in Progress	Number of Entries*	All Stakeholders			Mean Scores for Stakeholder Groups				
			Total Score	Number of Responses	**Mean Score**	Federal Government	State Government	Local Government	Consultants	Industry Society
Emergency Services	No	0	61.5	16	3.84	4.17	2.5	3.50	4.14	4.00
Operation and Maintenance	No	0	55.5	16	3.47	4.50	2.5	3.50	3.14	4.00
Crash Prevention and Security	No	1	54.5	16	3.41	4.50	1.5	3.00	3.57	3.50
Surface Transportation Weather	Yes	1	54.5	16	3.41	3.17	4	3.00	3.43	3.50
Transit and Mobility	No	0	54	17	3.18	3.75	2.5	3.00	3.29	2.50
Travel and Tourism	No	0	48.5	16	3.03	1.83	4.5	2.50	3.14	3.50
Traffic Management	No	1	44	16	2.75	2.67	4	2.50	2.43	3.00

* Reflects number of entries in the database as of 30 June 2000.

Table A-4: Survey Results for Benefits Measures Point Assignment

Goal Area	Measures	All Stakeholders			Mean Scores for Stakeholder Groups				
		Total Score	Number of Responses	**Mean Score**	Federal Government	State Government	Local Government	Consultants	Industry Society
Improve Safety	Crashes Fatalities	432	18	24.00	35.00	22.50	25.00	20.25	17.50
Improve Mobility	Travel Time Delay Reliability	324	18	18.00	16.25	22.50	22.50	17.38	15.00
Increase Efficiency	Throughput Effective Capacity	262	17	15.41	12.50	20.00	17.50	15.29	15.00
Driver Response	Behavior Changes	168	17	9.88	8.75	7.50	8.50	10.86	12.50
Customer Satisfaction		171	18	9.50	11.25	7.50	3.50	10.50	10.00
Increase Productivity	Costs	157	18	8.72	7.50	5.00	8.50	9.38	12.50
Improve Environment	Emissions	152	18	8.44	5.00	10.00	11.00	9.00	9.00
Conserve Energy	Fuel Consumption	114	18	6.33	3.75	5.00	3.50	8.13	8.50