

NCHRP 08-36, Task 104

Performance-Based Planning and Programming Pilots

Requested by:

American Association of State Highway and
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Executive Summary

To help advance the state of the practice in performance-based planning and programming, the National Cooperative Highway Research Program (NCHRP) and the American Association of State Highway and Transportation Officials (AASHTO) Standing Committee on Planning sponsored a series of three pilot studies. The objectives of this effort were to:

- Move the conversations of transportation performance measures and performance-based planning and programming from that of a conceptual framework to realistic examples;
- Examine how state DOTs can work with regional and local stakeholders in relating national transportation performance measures to the state and regional levels; and
- Identify barriers and obstacles for integrating performance measures into the planning and programming process, and document strategies used to overcome them and additional strategies that might be considered in the future.

The pilots conducted throughout this research effort addressed several aspects of performance-based planning and programming. They illustrated how a conceptual performance-based framework can be translated to practical, realistic processes. Each pilot involved transportation practitioners working together across agencies to discuss real world challenges. The participants also discussed and tested approaches for addressing these challenges that fit within the limitations of existing data resources, technical capabilities, and organizational structures.

From the three pilots emerged a set of common themes and lessons learned that may be applied by transportation agencies nationwide to advance the state of the practice in performance-based planning and programming. In addition, the pilot participants identified opportunities for additional national research and capacity building.

PILOT ACTIVITIES

Throughout this effort, the research team addressed several performance-based planning concepts and techniques. Following is a list of activities conducted as part of the three pilots. For referencing purposes, the pilot location (Kansas City region, Maryland/D.C. region, or Pennsylvania) is provided in parenthesis.

- Evaluated models for collaborative planning across state, regional, and local transportation agencies (all pilot locations).

- Assessed potential national performance measures in terms of their ability to support performance-based planning and programming (all pilot locations).
- Compared performance measures and measure definitions across agencies (Kansas City region) and modes (Maryland/D.C. region).
- Evaluated the relationship between performance-based planning and programming and the federally required transportation planning process (all pilot locations).
- Discussed regional, cross-agency sharing of performance data and analysis (all pilot locations).
- Developed an initial data sharing implementation planning (Kansas City region and Maryland/D.C. region).
- Developed a process for incorporating safety performance measures into the planning and programming process (Kansas City region).
- Piloted a process for using congestion performance measures to identify multimodal hotspots and to identify and prioritize strategies to address them (Maryland/D.C. region).
- Developed a sample performance-based project justification report (Maryland/D.C. region).
- Illustrated the use of national data and tools to conduct tradeoff analysis for pavement and bridge preservation programs (Pennsylvania).
- Explored options for identifying priority corridors at the state and regional levels and incorporating the results into a performance-based planning and programming process (Pennsylvania).
- Assessed alternative approaches for prioritizing preservation projects within a performance-based framework (Pennsylvania).

COMMON THEMES

The following common themes emerged from the pilots:

- There was consensus among all participating agencies regarding the benefits of performance-based planning and programming and the benefits of increased collaboration. At each pilot location, the agencies plan to keep moving forward, building from the pilot work.
- The participating agencies found the pilot workshops to be an excellent opportunity for sharing their existing planning practices. In this respect, the pilots served as regional peer exchanges.
- A commonly discussed next step is to "do something concrete" so that agencies can point to a success and build momentum. The importance of building momentum suggests that incremental process improvements are

better than waiting until the “ideal” comprehensive performance-based approach is possible.

- Each of the pilots addressed a different subset of the performance measures being considered for national implementation. The pilots illustrated that these measures can support performance-based planning at the state and regional levels. However, they also showed that project-level decisions require additional data and measures.
- At the beginning of each pilot, data availability was discussed as a potential barrier to performance-based planning. In each pilot though, quite a bit of work was done with existing data. Data availability turned out not to be a significant barrier. However, there were major challenges associated with turning the available data into useable information that could support transportation decisions.
- Another significant opportunity for data improvement is in the area of data sharing between agencies.
- A fundamental challenge to collaborative performance-based planning is when the process moves from a group of agencies working together to prioritize strategies to when a single agency (or group of agencies) becomes responsible for funding and implementing them. At this point in the process, the results of the collaborative process need to compete with the implementing agency’s other needs and priorities. Sustained coordination at the upper management and technical levels was identified as an important strategy to address this challenge.
- Another challenge is effectively communicating the results of performance analysis so that they can better influence decision making process. Improving the interface between technical analysis and decision making is important for advancing performance-based planning and programming. Participants also noted the need to communicate how the public benefits from transportation expenditures rather than relying solely on performance measures.
- Silo-based planning and budgeting is a significant impediment to performance-based planning. Options discussed for addressing this challenge include increased coordination across agencies and silos, beginning network-level analysis by identifying the portion of the budget that is flexible, and conducting tradeoff analysis assuming total flexibility and using the results to communicate the adverse implications of silo-based budgets to decision makers.
- While there are still some technical issues to address, the biggest barriers to collaborative performance-based planning and programming are organizational and institutional. Therefore, strong support from upper management can make a significant impact.

- In each pilot, the performance-based planning and programming process aligned well with the federally-required planning process. The pilot work illustrated the use of performance management techniques to enhance the steps in the federal process.

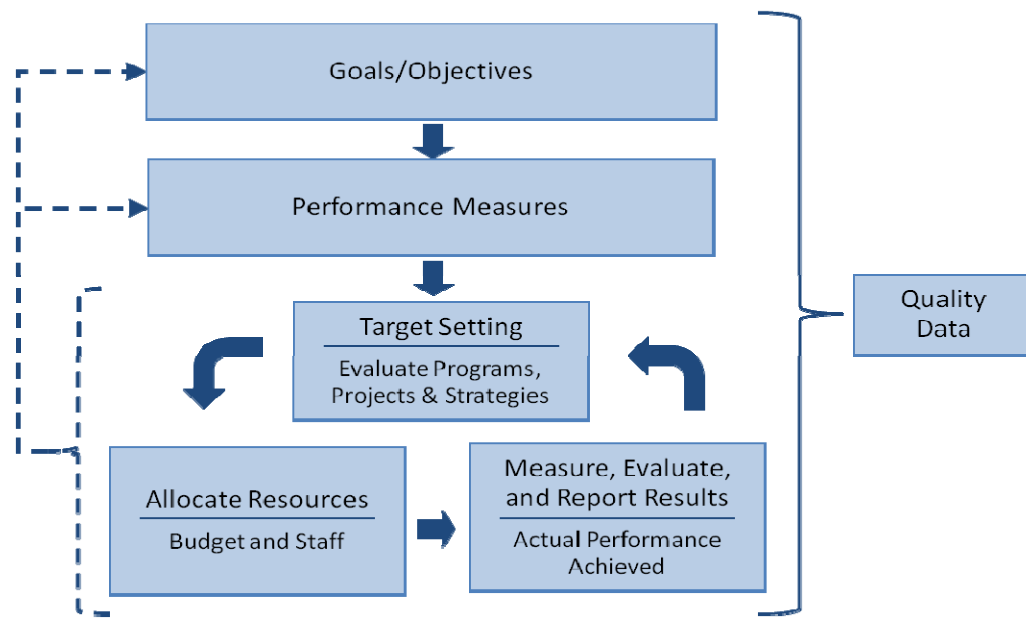
1.0 Introduction

Recent economic, political, and social trends have placed greater emphasis on public-sector accountability and cost-effectiveness. In response, transportation agencies throughout the United States are increasingly focused on performance-based planning and programming. Additionally, there is significant momentum towards a national performance-based transportation program. While the details of any national program are still in flux, there is a growing appreciation for the benefits of a performance-based transportation planning and programming process for individual agencies, regardless of what happens at the national level.

There have been a number of recent, high-profile efforts to assemble practitioners from across the United States to share their performance-based planning and programming practices and to identify opportunities and challenges for advancing the state of the practice. For example, the 2009 CEO Leadership Forum on Performance-based Management in State Departments of Transportation (DOTs) developed a framework to show how performance management techniques could be applied within the transportation context.¹ This framework has evolved since then, with the current version depicted in Figure 1.1.

¹ University of Minnesota Center for Transportation Studies and Cambridge Systematics, 2009 CEO Leadership Forum – Performance-Based Management in State DOTs – Summary Report, October 2009.

Figure 1.1 Performance-Based Planning and Programming Framework



Source: Cambridge Systematics

Subsequently, participants at the 2010 National Forum on Performance-Based Planning and Programming expressed a desire to translate this framework into concrete guidance that relates more directly to their planning and programming practices.² This forum also identified several challenges associated with implementing a performance-based planning and programming process:

- Difficulties in developing a collaborative process that deals with multiple agencies and multiple goals;
- Inconsistencies in performance measures used by agencies;
- Financial constraints and restrictions on the use of transportation funds;
- Technical and institutional challenges associated with using performance targets to influence funding decisions;
- Technical and financial difficulties associated with the data and tools required for performance-based planning and programming; and
- Constraints regarding staff capacity and capability to implement and manage a performance-based process.

² Cambridge Systematics, High Street Consulting Group, et al., *National Forum on Performance-Based Planning and Programming – Forum Proceedings*, developed through NCHRP Project 20-24(58), September 2010.

To explore these and other challenges in more detail and to translate performance-based planning and programming concepts into real-world transportation planning applications, the National Cooperative Highway Research Program (NCHRP) and the American Association of State Highway and Transportation Officials (AASHTO) Standing Committee on Planning sponsored a series of three performance-based planning and programming pilot studies (NCHRP Project 8-36 Task 104). The objectives of this effort were to:

- Move the conversations of transportation performance measures and performance-based planning and programming from that of a conceptual framework to realistic examples;
- Examine how state DOTs can work with regional and local stakeholders in relating national transportation performance measures to the state and regional levels; and
- Identify barriers and obstacles to integrating performance measures into the planning and programming process, and document strategies used to overcome them and additional strategies that might be considered in the future.

This report summarizes the results of these pilots. It documents the pilot activities, next steps for the agencies involved (for implementation outside of this research effort), transferable lessons learned for transportation agencies nationwide, and opportunities for additional national research.

1.1 SELECTION OF PILOT LOCATIONS

The three locations selected for the pilots were the Kansas City region, the Maryland/Washington D.C. region, and Pennsylvania. These three locations were selected after taking several factors into consideration:

- **Framework Coverage** – At a high level, performance-based planning and programming covers a wide range of goal areas and agency functions. As shown in Table 1.1, each pilot location focused on a different goal area and covered different components of the performance-based planning and programming framework. The Kansas City region pilot focused on incorporating safety into the planning and programming process; the Maryland/D.C. region pilot focused on congestion with a heavy emphasis on multimodal hotspots; and the Pennsylvania pilot focused on bridge and pavement preservation.

Table 1.1 Performance-Based Planning and Programming Framework Coverage

Pilot Location	Goal Area	Performance-Based Planning and Programming Elements					
		Goals	Measures	Targets	Resource Allocation	Monitoring	Data
Kansas City	Safety		✓		✓	✓	✓
Maryland/D.C.	Congestion		✓		✓	✓	✓
Pennsylvania	Preservation		✓	✓	✓	✓	✓

- **Planning Scale and Agency Type Distribution** – To address the challenge of developing a collaborative performance-based process across multiple agencies, each pilot involved several agencies, as illustrated in Tables 1.2 and 1.3.

Table 1.2 Geographic Scale and Agency Type Distribution

Pilot Location	Participation by Agency Type					
	DOT	MPO	RPO	Transit	Federal	Other
Kansas City	2	✓	✓	✓	✓	Multiple
Maryland/D.C.	✓	✓		Multiple	✓	
Pennsylvania	✓	Multiple	Multiple			

Table 1.3 Participating Agencies

Kansas City	Maryland/D.C. Region	Pennsylvania
<ul style="list-style-type: none"> • Kansas DOT • Missouri DOT • Mid-America Regional Council (MARC) • Kansas City Area Transportation Authority (KCATA) • Federal Highway Administration (FHWA) • Kansas Traffic Safety Resource Office • City of Grandview, MO • City of Olathe, KS • City of Overland Park, KS • Wyandotte County Health Dept. • Pioneer Trails Regional Planning Commission • Midwest Research Institute Global 	<ul style="list-style-type: none"> • Maryland DOT/ State Highway Administration (SHA) • National Capital Region Transportation Planning Board (TPB)/Metropolitan Washington Council of Governments (COG) • Washington Metropolitan Transit Agency (WMATA) • AASHTO • Federal Transit Administration (FTA) • Montgomery County • Prince George's County • Maryland-National Capital Park and Planning Commission (M-NCPPC) 	<ul style="list-style-type: none"> • Pennsylvania DOT • Delaware Valley Regional Planning Commission (DVRPC) • Southwestern Pennsylvania Commission (SPC) • North Central Pennsylvania Regional Planning and Development Commission • Adams County Transportation Planning Organization • Southern Alleghenies Planning and Development Commission

- **Geographic Scale** – To further distinguish among the pilots, each location focused on applying performance-based planning and programming at a different geographic scale. Kansas City considered safety from a regional perspective within the MPO boundary, the Maryland/D.C. pilot focused on congestion at the corridor level within two counties, and the Pennsylvania pilot considered bridge and pavement preservation from both the statewide and regional perspectives.
- **Maturity and Experience** – The pilots involved agencies that had already initiated progress on advancing one or more elements of performance-based planning and programming. This approach enabled the participating agencies to use the pilots to build upon previous efforts. In the Kansas City region, both DOTs have relatively mature processes for monitoring systems-level safety performance as well as an active regional safety coalition that facilitates data sharing, safety planning, and the implementation of safety initiatives. Several recent initiatives in the Maryland/D.C. region have applied performance data to identify bus priority corridors and bus priority hotspots. The region's planning partners had identified an opportunity to expand these analyses to include roadway, bicycle, and pedestrian performance data to identify multimodal hotspots. The Pennsylvania DOT

recently developed a statewide performance report. The performance measures included in the report were selected through a collaborative working group of DOT, metropolitan planning organizations (MPO), and regional planning organization (RPO) representatives. The DOT and its planning partners were interested in further incorporating the performance measures into the planning and programming process.

- **Willingness to Collaborate** – Meeting the objectives of this research effort required a commitment from the participating agencies to work together to address the challenges and opportunities of performance-based planning and programming.

1.2 PILOT APPROACH

The pilot project spanned one year and each pilot was organized around a set of three main activities:

- **Workshop #1** – The objective of the first workshop was to customize the scope of the pilot to address the participating agencies' specific situation and needs. The research team opened the workshops by introducing the concepts of performance-based planning and programming and provided an overview from the national perspective. Through a facilitated discussion, the participants then discussed how performance measures are currently used by the participating agencies, identified opportunities for improvement, and prioritized a list of activities that could be addressed as part of the pilot.
- **Implementation Work** – For each pilot location, the research team developed a custom work plan to address the activities identified during Workshop #1. Over a period of several months, the work was performed by a combination of the research team and volunteers from the participating agencies.
- **Workshop #2** – The second workshop focused on reviewing the results of the implementation work, discussing key issues and lessons learned, and identifying next steps for continued work by the participating agencies after conclusion of this research effort.

1.3 REPORT ORGANIZATION

This report summarizes the pilot activities at each pilot location (Sections 2.0 through 4.0). Section 5.0 summarizes the overall findings, common themes that emerged from the three pilots, lessons learned, and potential implications for the national discussion on performance-based planning and programming.

2.0 Kansas City Region Pilot

The Kansas City pilot concentrated on incorporating safety performance measures and data into the planning and programming process. The pilot addressed specific measures, organizational issues, resource allocation decisions, and data issues.

The transportation planning agencies in the region, Kansas DOT, Missouri DOT, the Mid-America Regional Council (MARC), and the Kansas City Area Transportation Authority (KCATA) have mature processes for monitoring system-level safety performance. Participants in the pilot included representatives from these agencies, along with representatives from the Federal Highway Administration (FHWA), Kansas Traffic Safety Resource Office, the cities of Grandview (MO), Olathe (KS), and Overland Park (KS); and the Pioneer Trails Regional Planning Commission.

2.1 BACKGROUND/EXISTING CONDITIONS

In 2005, the region's safety coalition, referred to as Destination Safe, developed a *Kansas City Regional Transportation Safety Blueprint*, to support one of four regional transportation goals adopted in MARC's 2002 long range transportation plan, *Transportation Outlook*: "...improve the safety, security and well-being of the traveling public." A safety chapter for the Kansas City regional long-range transportation plan (LRTP), *Transportation Outlook 2030 Update*, was developed and aligned with the Regional Blueprint. The Regional Blueprint was updated in 2009 and updated priorities *were* reflected in the new *Transportation Outlook 2040*. The next Regional Blueprint update is scheduled for 2013 and an updated Kansas City regional LRTP is scheduled for 2015.

Existing Resources

Prior to the first workshop, held in November 2011, the research team compiled an inventory of existing safety performance measures reported by the participating agencies (Tables 2.1 through 2.4). Overall, there are significant resources to draw upon as the region works to further integrate safety performance into the planning and programming process. Examples include the existing measures and data, recent efforts to identify safety emphasis areas and strategies, and the creation of the Destination Safe Coalition, which is a regional coalition focused on improving transportation safety (see Coalition detail below).

Table 2.1 Existing Safety Measures in Kansas City Region, Fatality-Related Measures

	Total #	5-Year Avg	Rate	Impaired Driver	Motor-cycles	Commer- cial Vehicles	Bike/ Ped	Work Zone	Rail	Seat Belt	Driver Age	Other
Kansas DOT	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Fatalities due to: roadway departures; intersections; curves; collision with a fixed object; all-terrain vehicle; farm equipment; adverse weather conditions; in the dark with no street lights; in the dark with street lights on, distracted driver
Missouri DOT	✓			✓	✓	✓	✓	✓	✓		✓	Number of fatalities for children under 13 years of age
MARC		✓		✓	✓		✓			✓	✓	Aggressive driver fatalities
KCATA	✓		✓				✓					# of passengers; # of revenue facility occupants; # of employees; # of occupants of other vehicles; # of trespassers; # of suicide-related fatalities

Definitions: Kansas DOT – “A traffic-related death as a roadway user dying within 30 days of a crash”
Missouri DOT – “The person was dead or dies within 30 days (late death) of the crash date from crash related injuries”
KCATA – “Death, confirmed within 30 days of a reported transit incident, due to a collision, derailment, fire, hazardous material spill, Act of God, evacuation, security incident or other incident. Also includes transit related suicides”

Sources for Tables 2.1 through 2.3

Kansas DOT – Kansas Strategic Highway Safety Plan (SHSP), and SHSP Quarterly Dashboard Report
Missouri DOT – MoDOT TRACKER, Measures of Departmental Performance, and Performance Data Report
MARC – Transportation Outlook 2040 Performance Measures Progress Report Summary, and KC Region Fatality Report
KCATA – National Transit Database (NTD) Documentation

Table 2.2 Existing Safety Measures in Kansas City Region, Serious Injury-Related Measures

	Total #	Impaired Driver	Motorcycles	Commercial Vehicles	Bike/Ped	Work Zone	Rail	Other
Kansas DOT	✓	✓	✓					Injuries at intersections; injuries due to: distracted driver, aggressive driver, older drivers, alcohol
Missouri DOT	✓	✓	✓	✓	✓	✓	✓	
MARC	✓							
KCATA	✓				✓			# of injured: passengers, facility occupants, employees injured, occupants of other vehicles, trespassers

Definitions: Kansas DOT – “A roadway user left physically or mentally diminished after a crash, also defined as a Type A injury”
Missouri DOT – “When observed at the scene, the person sustained non-fatal injuries that prevent walking, driving, or continuing activities the person was capable of performing prior to the crash. Transport by ambulance from the scene does not necessarily indicate the individual sustained disabling injuries.”
MARC – “Disabling injury”
KCATA – “Physical harm to persons that requires immediate medical attention away from the scene”

Table 2.3 Existing Safety Measures in Kansas City Region, Examples of Other Safety-Related Measures

Kansas DOT	Property damage only crashes, # of teen alcohol related crashes, # of local projects with law enforcement agencies participating in impaired driving deterrence programs, seat belt usage, child restraint usage, locations improved
Missouri DOT	Number of nighttime crashes, seat belt usage, safety impacts of various project types, number of law enforcement citations for various programs, sign/stripping visibility, etc
KCATA	Collisions, derailments, major security incidents, fires, other accidents "not otherwise classified", total incidents

Destination Safe Coalition

The Destination Safe Coalition is a partnership between local agencies involved in improving transportation system safety. Destination Safe establishes the region's transportation safety priorities, coordinates the region's safety planning, and implements coordinated efforts that improve transportation system safety. The Coalition engages a wide range of community sectors, including law enforcement, engineers, safety advocates, public health officials, citizens, trauma room nurses, transit coordinators, public works managers, emergency service providers, bike/ped advocates, local officials, planners, and others, to discuss transportation system safety in the bi-state Kansas City region.

source: <http://www.marc.org/transportation/safety/destinationsafe.htm>

Role of Safety in the Regional Planning Process

Participants in both the first and second workshops noted that a significant portion of the region's previous safety analysis and planning efforts focused on behavior issues (i.e., issues that can be addressed through education and enforcement). Participants during Workshop #1 identified the following options for incorporating safety performance data into the planning and programming process from an engineering perspective (i.e., safety issues that can be addressed with capital projects):

- **Consider the tradeoff between allocating available funds between a safety program and other programs, such as preservation and capacity.** While feasible, participants felt it could be difficult to shift funds to the safety program from other programs given the significant gap between resources and needs in these other programs.
- **Evaluate and prioritize projects within the safety program.** Participants noted that existing practices in this area include using safety funds to address a relatively small number of safety hotspots. They suggested that while it is important to identify some specific high-priority hotspots, there would be a benefit to programming some portion of safety funds on a lump sum basis rather than a project-specific basis. This approach would enable projects to be grouped for more efficient implementation (for example, implementing a cable median barrier program), and provide flexibility for addressing safety issues as they emerge.
- **Consider safety data in the prioritization of non-safety projects.** Participants noted difficulties in using safety data as a prioritization factor when prioritizing specific non-safety projects, such as roadway expansion projects. These difficulties occur because there is a wide and sporadic distribution of fatalities and series injuries across the network. In support of this observation, participants noted that the DOTs currently consider safety

when prioritizing projects, but that the inclusion of safety data does not appear to significantly influence the end result.

- **Using safety data to influence the delivery of non-safety projects.** Participants noted example strategies that could be incorporated into non-safety projects, such as adding a rumble strip whenever a roadway is resurfaced. These strategies could be incorporated into transportation plans as regional policies, with the goal of achieving a steady improvement in safety over time. Of all the options discussed during the first workshop, participants identified this one as the highest priority for the region. This discussion was carried forward into the implementation work and the second workshop, which is reflected further below.

Challenges

Participants in Workshop #1 discussed two main types of challenges related to collaborative performance-based planning and programming: organizational issues and data issues. While these topics were discussed during the workshop from the perspective of safety, they are also relevant for other goal areas. Example organizational issues include defining a geographic boundary for the collaborative effort, identifying roles and responsibilities, the potential need for a new organizational body to drive the effort, and defining the authority of this body relative to the authority of the participating agencies. Example data issues include creating a thorough inventory of existing data, understanding what specific data items decision makers need for a performance-based process, developing the mechanics of sharing data between different agencies, and conflicting approaches for collecting and reporting seemingly consistent data items (such as serious injuries).

2.2 PILOT IMPLEMENTATION ACTIVITIES

The research team undertook a series of implementation activities for the Kansas City pilot focused on three opportunities identified during Workshop #1:

- Using safety performance measures to identify regional engineering-related safety emphasis areas, and developing guidance for addressing these areas through non-safety programs;
- Exploring organizational models for regional collaborative safety planning that could be transferable to other goal areas; and
- Facilitating a workshop with data owners throughout the region to address the data-related activities needed to support collaborative performance-based safety planning.

The research team worked with MARC staff to identify and obtain the necessary data for analyzing and identifying potential safety priorities. For the purpose of this effort, data analysis focused on the seven counties included in the MARC

MPO boundary (Johnson, Leavenworth, and Wyandotte on the Kansas side, and Cass, Clay, Jackson, and Platte on the Missouri side). The team analyzed the available data and prepared a series of summary sheets showing fatalities and serious injuries by crash type to identify potential safety emphasis areas for the region as a whole. The team also identified potential variations in emphasis areas between states, counties, and/or functional class. The resulting emphasis areas were then compared to the Statewide Strategic Highway Safety Plans (SHSPs) for Kansas and Missouri. Finally, the statewide plans and *Regional Transportation Plan Blueprint* were reviewed for potential safety strategies that could be implemented at the regional level through policies impacting non-safety programs.

To conduct a case study of the region's existing safety coalition, the research team interviewed members of the Destination Safe Coalition, selecting interviewees to represent a broad cross section of geography, interests, organizations, and backgrounds. The team also researched three other regional safety coalition models and identified the organizational structure, objectives, and tasks for each of those other regional coalitions. Member feedback and information gathered on other regional safety coalitions was presented and discussed during a Destination Safe meeting to spark discussion about possible next steps the group might want to consider.

Finally, data owners were brought together in a half day meeting following Workshop #2 to discuss needs and opportunities for safety data to support the proposed performance-based planning approach. The meeting addressed data requirements to support performance-based decision-making, additional safety data elements for consideration, data consistency (definitions, collection, reporting), a framework for data sharing and analysis, and next steps toward a regional safety data implementation plan.

The following sections summarize the work completed for each of these tasks and related discussion with participants during Workshop #2.

Using Performance Measures to Identify Safety Policies

The data analysis task focused on two performance measures (motor vehicle-related fatalities and serious injuries). The objective of this task was to identify example safety policies appropriate for the transportation planning process. The process involved:

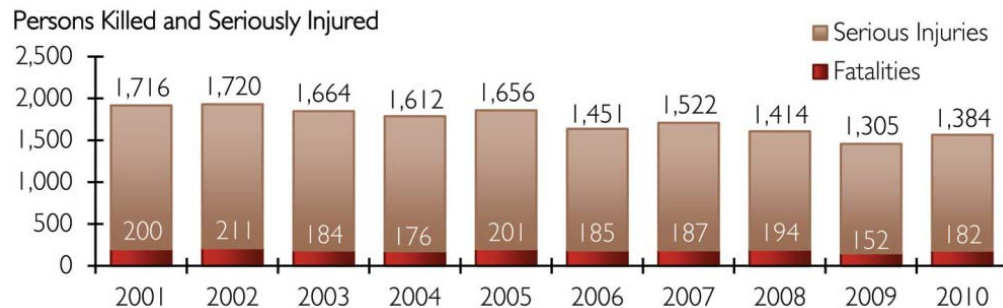
1. Analyzing performance data in order to identify engineering-related safety emphasis areas;
2. Identifying strategies to address these emphasis areas; and
3. Identifying example safety policies for incorporating these strategies into the planning process.

Identifying Emphasis Areas

The research team began by analyzing data and preparing a factsheet that summarizes overall fatality and serious injury trends for the MARC region (see Appendix A). The analyses addressed:

- Ten year trend of fatalities and serious injuries (see Figure 2.1);
- Five year urban versus rural fatalities and serious injuries;
- Five year fatalities by crash type; and
- Five year fatalities and serious injuries by crash type (see Table 2.4)

Figure 2.1 Fatalities and Serious Injuries in MARC



Source: Cambridge Systematics

While this effort aimed to identify infrastructure related safety issues to address in the MPO transportation plan, data was initially analyzed across a variety of crash types to set the analysis within the greater regional safety context.

It was also necessary to show the different breakdowns of fatalities and serious injuries for the MARC region as a whole, as well as by MARC-Kansas, MARC-Missouri, urban, rural, and individual county. This allowed identification of differences or anomalies requiring consideration in developing region-wide policies to improve safety. The results are shown in Table 2.4. In the table, the top five crash types for each geographic area are highlighted.

Table 2.4 Fatalities and Serious Injuries by Crash Type and County

Fatalities and Serious Injuries, 2006 to 2010												
	MARC	MARC-Kansas	MARC-Missouri	Urban	Rural	Johnson (Kansas)	Leavenworth (Kansas)	Wyandotte (Kansas)	Cass (Missouri)	Clay (Missouri)	Jackson (Missouri)	Platte (Missouri)
Total	7,976	2,116	5,860	1,793	252	1,175	216	725	387	1,182	3,864	427
Infrastructure												
Run-off-Road	2,583	859	1,724	2,091	458	403	109	347	142	363	1,030	189
Intersection	3,213	615	2,598	2,984	207	404	56	155	125	510	1,872	91
Head-On	536	176	360	412	107	85	33	58	42	79	199	40
Fixed Object	1,173	574	599	959	168	270	68	236	39	98	434	28
Work Zone	185	79	106	164	16	50	5	24	6	32	57	11
Horizontal Curves	1,485	386	1,099	1,234	234	176	59	151	52	273	631	143
Highway/ Railway Crossing	6	1	5	6	0	0	0	1	0	3	2	0
Driver Behavior												
Aggressive	2,740	642	2,098	2,389	335	300	70	272	122	431	1,384	161
Speeding	2,290	542	1,748	1,965	311	217	69	256	101	313	1,189	145
Impaired	1,368	437	931	1,161	191	214	58	165	58	175	626	72
Seat Belt Use	2,243	1,035	1,208	1,901	310	627	86	322	110	257	744	97
Distracted	2,014	604	1,410	1,757	240	335	56	213	81	279	963	87
Young Drivers (15-24)	2,046	905	1,141	1,642	261	486	84	335	79	261	706	95
Older Drivers (65+)	694	298	396	606	76	163	31	104	41	91	248	16
Special User												
Pedestrian	478	103	375	457	17	51	13	39	13	38	304	20
Bicyclists	113	33	80	107	5	25	2	6	6	14	57	3
Vehicles												
Motorcycles	933	298	635	777	150	162	47	89	44	148	380	63
Heavy Trucks	332	134	198	274	55	72	14	48	19	37	118	24
School Bus	24	6	18	22	2	1	0	5	2	6	10	0
Vehicle-Train	7	0	7	5	2	0	0	0	0	3	3	1
Vehicle-Animal	58	15	43	43	15	8	4	3	5	12	21	5

Source: Cambridge Systematics

Finally, the research team reviewed emphasis areas identified in the Kansas and Missouri SHSPs to see how the regional priorities aligned with statewide priorities.

Notable conclusions drawn from the data analysis regarding the Kansas City region, and confirmed through discussions with the participating pilot agencies included:

- General trends demonstrate fatalities and serious injuries have decreased over the last ten years (down by 8.5 percent), but still have a ways to go;
- Crash related fatalities and serious injuries primarily occur in urban areas, with 87 percent on urban facilities compared to 12 percent on rural facilities;
- The overall leading crash types in the region appear fairly consistent across the different geographic breakdowns, while the specific ranking may differ slightly; and
- Leading crash types in the region also align with many of the emphasis areas identified in the two statewide SHSPs.

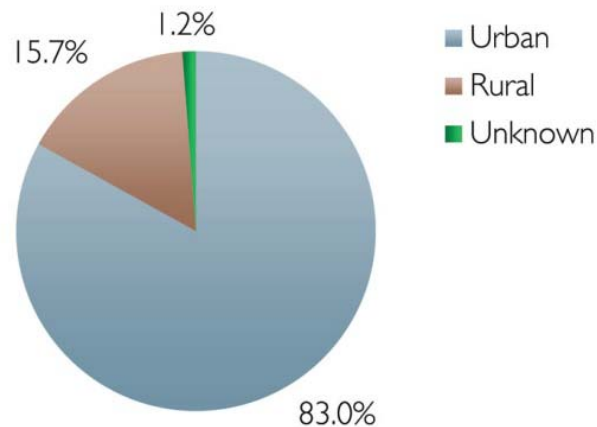
For the purpose of identifying example infrastructure related safety improvement strategies, the research team selected horizontal curves and intersection emphasis areas for further analysis.

Identifying Strategies to Address Emphasis Areas

The process for identifying strategies to reduce fatalities and serious injuries on horizontal curves and intersections in the MARC region began by determining whether there is a subset of the system which can be prioritized for improvement.

The research team further analyzed data related to the two specific emphasis areas and developed individual fact sheets for each (see Appendix A). Again, fatality and serious injury trends in recent years demonstrated improvements but still flagged the need for further attention, with a large majority of each type of crash occurring predominantly on urban roadways (Figure 2.2).

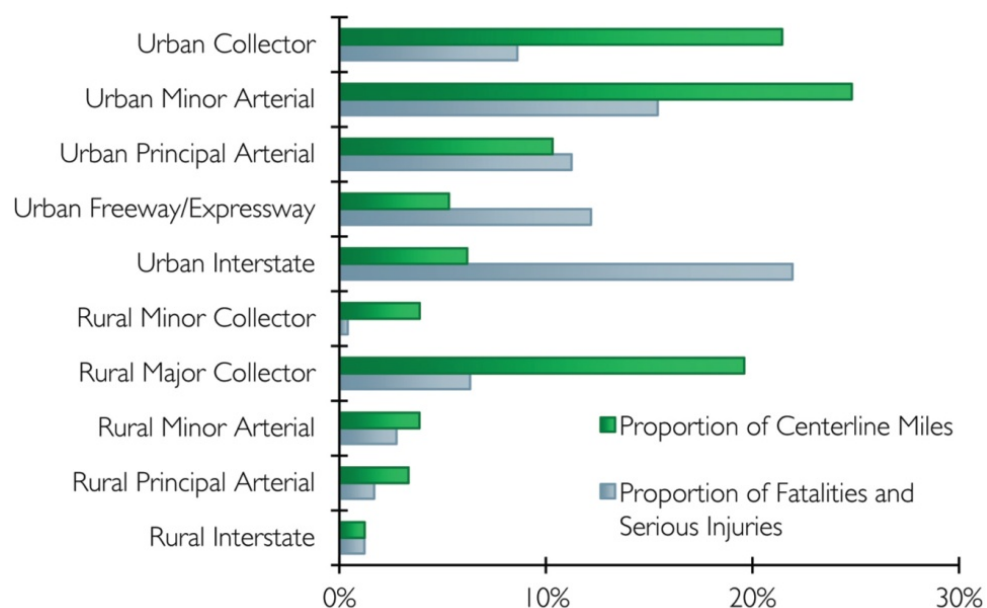
Figure 2.2 Horizontal Curve Fatalities and Serious Injuries – 2006 to 2012 Urban/Rural Split



Source: Cambridge Systematics

To explore further, the research team disaggregated the data by roadway functional classification. Analysis pointed toward particular functional classifications experiencing a disproportionate number of fatalities and serious injuries. In the case of horizontal curves, combined urban interstates and freeways/expressways represent 34 percent of fatalities and serious injuries, but only 12 percent of total centerline miles within the MARC MPO (see Figure 2.3). This result suggests one way to prioritize safety investments for reducing horizontal curve crashes might be to focus strategies on these particular facilities.

Figure 2.3 Comparison of Proportion of Horizontal Curve Fatalities & Serious Injuries and Centerline Miles



Source: Cambridge Systematics

Pilot participants reacted positively to the general approach and the concept of disaggregating the fatality and serious injury performance measures to further focus safety investments on particular roadways. They also suggested other roadway characteristics, such as volume, may serve as better factors for consideration. Detailed discussions about other potential data elements were reserved for the following half-day workshop on data.

The research team went on to explore potential strategies for reducing horizontal curve crashes on such facility types. Again, the two statewide SHSPs provided a source of information given that both address horizontal curves and have identified key strategies for safety improvements. Comparing the two plans to identify overlapping strategies for reducing horizontal curve fatalities and serious injuries found Missouri's strategy to "expand and maintain roadway visibility features (signing such as curve signs and pavement marking such as

optical speed bars)” consistent with Kansas’ broader strategy of deploying low cost safety improvements at horizontal curves.

Incorporating Strategies into the Plan as Policies

Based on the preceding data analysis and seeking to align with statewide priorities and key safety strategies in both Kansas and Missouri, the research team drafted the following example policy statements for potential inclusion in the region’s LRTP:

MARC will coordinate with implementing agencies to expand and maintain signage where appropriate to reduce the occurrence of severe crashes on horizontal curves, with an emphasis on urban interstates and freeways/expressways.

MARC will coordinate with implementing agencies to consider installation of roundabouts where appropriate to reduce the occurrence and severity of intersection crashes, with an emphasis on urban principal and minor arterials.

Each policy statement is worded deliberately to include four important elements:

- The MPO does not itself implement such projects, therefore it is necessary to “coordinate with implementing agencies,” which may be either the state DOTs or local agencies.
- Each policy promotes a specific safety countermeasure identified through a data-driven, performance-based process, which also considers statewide priorities to maximize support from the DOTs.
- Following the analysis, each policy statement focuses efforts on particular roadway functional classifications. Depending on the manner in which the analysis is conducted going forward, the basis for this focus may be a factor other than functional classification (e.g., traffic volumes). The idea is to make an evidence-based conclusion to focus implementation on areas with the greatest potential to reduce fatalities and serious injuries rather than just implementing a strategy everywhere.
- Having identified the focus roadway type does not necessarily mean implementation should occur on all such roadways, but prioritizes those roadways for further consideration. Data analysis through this step has been conducted on a macro level. Implementation still requires project-level considerations to ensure the strategy is indeed appropriate at any given location based on the specific nature of the site and surroundings.

Destination Safe Case Study

As recommended by the participants in Workshop #1, the research team conducted a case study of the Destination Safe Coalition. Destination Safe is a bi-

state safety coalition that has been functioning in the Kansas City region for nearly 10 years. The purpose of the case study was to:

- Evaluate the coalition as a model for collaborative regional planning; and
- Identify transferable lessons to other performance areas and other parts of the country.

The research team conducted interviews with Destination Safe members to gather background information and identify successes and areas where the coalition could have a greater impact. In addition, an electronic survey was administered to all members to offer a broader opportunity to provide feedback. After collecting data from coalition members, the research team met with the Destination Safe Leadership Team and conducted a workshop with the pilot study participants to discuss findings and lessons that might be applied to other collaboration efforts or performance goal areas. A summary of findings is provided below.

Background

In 2004, the Missouri DOT SHSP, *Blueprint for Safer Roadways*, was developed in consultation with many safety advocates including engineers, law enforcement, educators, and emergency responders. Prior to the Blueprint, Missouri had never had a statewide safety goal. The Blueprint established the fatality reduction goal of 1,000 or fewer fatalities by 2008. One of the key principles guiding the development of the Blueprint was deploying safety targets at both the state and regional level. The plan outlined a strategy to organize regional safety coalitions to work in concert with the Missouri Coalition for Roadway Safety. As a result, Destination Safe was developed in the Kansas City area.

Since its inception, Destination Safe has grown to now include members from 13 counties in Kansas and Missouri. Members represent a variety of disciplines including emergency responders, law enforcement officials, researchers, insurance providers, planners, public works officials, and transit providers. The coalition receives \$150,000 annually from the Missouri DOT to fund education and enforcement projects that support the goals of the Blueprint. In addition, the Kansas DOT accepts project proposals from the coalition for funding.

Destination Safe's mission is to reduce fatalities, injuries, property damage, and economic and social costs of transportation-related incidents by developing, implementing, and enhancing a comprehensive transportation safety blueprint for the bi-state Kansas City metro and rural areas. MARC provides staff support to Destination Safe. The coalition's responsibilities include:

- Developing the *Kansas City Regional Transportation Safety Blueprint*;
- Scoring safety project applications;
- Selecting priority projects to either receive Missouri DOT funds or to recommend to the Kansas DOT for funding;

- Conducting multi-disciplinary safety audits; and
- Reporting safety statistics to the MARC Total Transportation Policy Committee.

The primary focus of Destination Safe has been on behavioral issues (addressed through education and enforcement) rather than engineering issues (typically addressed with capital transportation projects). The study team worked with coalition members to understand the implications of addressing engineering issues in order to capture lessons learned for other goal areas such as preservation and congestion.

Findings

The following findings are based on information gathered from Destination Safe members, workshop participants through interviews, an on-line survey, and workshop meetings:

- **Strengths.** Participants felt Destination Safe is an effective model for cross-agency collaboration, prioritizing issues and consensus building. In fact, more than 80 percent of respondents indicated that the coalition collaborates well. In addition, the interviews and survey examined Destination Safe's effectiveness at meeting its goals. Approximately, 86 percent of respondents indicated that the coalition has been effective at meeting its goals.

Members cited a number of other strengths of the coalition. For example, it provides a forum for discussing a number of diverse perspectives, it allows representatives from different agencies to develop connections, and enables the region to identify cross-agency solutions.

- **Areas that could be improved.** Members indicated that some areas are more effective than others. For example, members reported that Destination Safe is most effective at meeting goals that relate to education, enforcement, and combining diverse opinions and perspectives. Areas where members cited that they could be more effective include getting more local officials/staff participation, particularly engineers; increasing the consistency of participation; and making meetings more effective by allowing more discussion time and less presentation time.
- **Decision-making.** The interviews and survey evaluated the process by which Destination Safe makes decisions; specifically it examined the role data plays in decision-making. Members cited that data was a major driver in the process. However, other factors come to play as well. For example, many decisions are heavily influenced by the amount of funding available. Community representatives can be influential as well, and strategies that have proven positive outcomes are often used to guide the process.
- **Targets versus trends.** Members indicated that one of the keys to their effectiveness is that the coalition does not set specific performance targets, but rather focuses on trend lines (i.e. continual improvement over time).

They felt that this was important because it is easier for all of the participating agencies to reach agreement on the overall direction of improvement rather than on a specific target value. The members felt this flexibility enables the group to focus on the overall mission of the coalition, which is to improve safety in the region over time, rather than debating specific levels of improvement.

Lessons Learned from Other Safety Coalitions

As part of this pilot, the research also reviewed safety coalitions in Michigan, Wyoming, and Louisiana. Through this research and discussions with members from these organizations, certain ideas began to emerge as the hallmarks of a successful coalition, including:

- **Don't be afraid to pick and implement projects.** Members need to see progress in order to stay involved. Cheyenne, Wyoming has found that implementing projects (intersection improvements) has been the best way to demonstrate the coalition's worth. This gives members a sense of accomplishment, which helps justify the time they spend away from their offices participating in the safety coalition meetings. It also helps in the recruitment of new members by being able to demonstrate how influential the coalition can be.
- **Develop measures that allow you to demonstrate progress.** This can include very specific data measures to more general talking points about how objectives were adopted by major organizations like DOTs or MPOs. This is essential for having some accountability in the coalition for the decisions that have been made. In addition, it can be a helpful promotional tool when trying to attract additional funding or members.
- **Data can dissuade common perceptions.** Louisiana's coalition had many members who felt that child safety had to be a top priority. However, statistics suggested it was not as big of a need as other areas like impaired driving. Thus, the coalition was able to use data to drive the priorities to meet the greatest needs. This is a particularly valuable lesson for safety coalitions because the issues they deal with tend to be very emotional. Data can be critical for helping guide the discussions and decision making to keep it on the right track.
- **Building/growing the coalition:** Look for organizations with similar goals on which to piggyback. For example, in the infancy stages of their coalition, Louisiana benefitted by having their meetings immediately following another safety group in the region. This approach helped the coalition to attract members and build partnerships in key networks.

Transferable Lessons

In the evaluation of Destination Safe and the other safety coalitions identified above, there are certain lessons that could be transferrable to other regions

seeking to establish a multi-agency group in support of performance-based planning:

- **Multi-disciplinary approach is critical.** Destination Safe's strength can be attributed to the fact that it has representation from multiple disciplines. For some members, this is their only opportunity to interact with members from another discipline.
- **Seed money is needed and/or a real role in decision-making.** Destination Safe would not have been able to launch if not for the seed money by the Missouri DOT. This money was critical for attracting members and allowing the coalition to have some influence on decision-making. Once Destination Safe attracted members, another important element was creating a culture where the DOTs and MPO were willing to work in collaboration.
- **One option for addressing the challenges of implementing performance management concepts across agencies is to use trends rather than specific targets.** Evaluating and discussing how performance changes over time can help focus member agencies on achievement of an overall goal, rather than trying to reach agreement on a specific target value. In this approach though, it would be important to ensure that targets set by the individual agencies are consistent with and support the multi-agency goals.
- **Personalities and staffing matters.** It is important to identify a champion to push for the development of a coalition. It is also critical to build participation with the right people, both in terms of adequate staffing and in creating a coalition where the members' personalities gel in a way that is effective for consensus building.
- **Accountability is best seen as two-pronged.** Coalition members are accountable to each other for the work that occurs within the coalition. In addition, a different kind of accountability and motivation can be created so that members are encouraged to try to influence decision-making in their own agency based on the approaches and lessons learned from other coalition members.

Coordinating Safety Data

Having walked through the data analysis approach for using safety performance measures to drive policy development during Workshop #2, the research team convened a subsequent half-day discussion to focus on setting the stage for a regional data implementation plan that would support such an approach.

Data Requirements

Participants identified safety data items they felt necessary to support performance-based decision making, as well as additional safety data elements that could be considered in future analysis. The results are summarized in Table 2.5.

Table 2.5 Safety Data to Support Performance-Based Planning

Data Type	Resides
<i>Necessary Data</i>	
Crash Data	DOTs
Vehicle Miles Traveled (VMT)	DOTs
Geometric/Operational	Varies – DOTs, local agencies, 3 rd party (i.e., Google maps)
Speed	MARC
<i>Additional Potential Data</i>	
Pavement Friction/Condition	DOT for state system; some local agencies
Citations	State Highway Patrol; local police departments
Congestion/Traffic Counts	DOTs; local agencies; KC Scout; 3 rd Party
Drive/Vehicle/Demographic	Departments of Revenue
Emergency Response	Departments of Health; ambulance organizations; fire departments; KEMS
Geospatial	DOTs
Driver Education	Departments of Education
Observational Driver Behavior (i.e., seatbelt usage; distracted driving)	Highway Safety Office

Source: Cambridge Systematics

Data Definitions

As part of the implementation activities, the research team developed a data definition summary sheet to show and compare the definitions of different elements between Kansas and Missouri. The results are shown in Table 2.6.

The implications of differences in data definitions depend on the purpose of the analysis. Participants agreed if comparing data between the two states, different data definitions significantly skew results. On the other hand, participants agreed the differences in data definitions have less significance when aggregating data across the MARC counties to identify region-wide safety priorities. For example, the study team ran the safety analysis described above three times - first using data from one DOT, then the other, then a combined set. Despite the differences in definitions, the resulting emphasis areas were largely consistent. There was some variation in the exact ranking of the highest priority emphasis areas ranked, but the areas themselves were the same.

Table 2.6 Sample Data Definitions for MARC MPO

	Kansas	Missouri
Injury Type		
Disabling Injury	Any injury, other than a fatal injury, which prevents the injured person from walking, driving, or normally continuing the activities he/she was capable of performing before the injury occurred. Includes severe lacerations, broken or distorted limbs, skull or chest injuries, abdominal injuries, unconsciousness at or when taken from the accident scene, or inability to leave the accident scene without assistance.	When observed at the scene, non-fatal injuries that prevent walking, driving, or continuing activities the person was capable of performing before the accident.
Fatality	Any injury that results in death to a person within 30 days of the accident.	Dead or dies within 30 days of accident date from accident related injuries.
Crash Type		
Run-Off Road	Multiple-vehicle crashes may be either head-on or sideswipes involving vehicles moving in the same direction. Single vehicles may collide with a fixed object or flip. Such crashes typically occur away from intersections, on shoulders, roadsides or medians.	Crashes are categorized in relation to roadway at time of first harmful event.
Aggressive Driving	Driver contributing circumstance coded as aggressive/antagonistic, too fast for conditions, speeding or following too closely.	Contributing circumstance coded as speed exceeded limit, too fast for conditions, or following too close.
Seat Belt Use	Excludes occupants in vehicle body types: motorcycle, moped, farm equipment, all-terrain vehicle, bus, train, emergency vehicle, other, and unknown. Excludes airbag only, helmet, eye protection, and unknown restraint use.	Applies to drivers and occupants of vehicles subject to the seat belt law. Safety device field is coded as none or not used.

Source: Kansas DOT and Missouri DOT

Data Sharing and Analysis

Participants during the data workshop discussed roles and responsibilities for data sharing and analysis to support the proposed performance-based safety planning approach. For the pilot effort, the research team submitted data requests to MARC staff, who in turn submitted requests to both the Kansas DOT and Missouri DOT regarding their respective counties in the MPO. The research team conducted analyses with periodic consultation with MARC staff.

Going forward, participants suggested the sharing and analysis framework involve the following steps:

1. The Destination Safe Coalition discusses safety issues and problems to focus data queries;
2. The Destination Safe Data Task Team submits data requests to Kansas DOT, Missouri DOT, and other data owners as necessary;
3. The DOTs and other data owners write and run specific data queries;
4. The Data Task Team analyzes and presents data for decision making; and
5. Destination Safe Coalition discusses data analysis results and recommends safety strategies for leadership and elected officials.

Regional Safety Data Implementation Plan

Participants then discussed the development of a regional safety data implementation plan to support the sharing and analysis framework. Critical elements of such a plan would need to:

- Identify specifically who would submit data requests on behalf of the Regional Coalition;
- Identify individual points of contact for data requests at the state DOTs and other data owners;
- Define elements of a standard data request, recognizing the bulk of the requests will remain consistent with room for variation or follow up requests;
- Explore options for the DOTs to automate data queries, create standard data tables to be completed on a regular basis, and provide direct data access;
- Provide MARC staff and other regional stakeholders with training on understanding the data in addition to providing access to it; and
- Identify approaches for lessening the burden on the DOTs when asked to handle multiple data requests and multiple regional coalitions.

2.3 POTENTIAL NEXT STEPS

Participants identified the following potential next steps to advance the use of safety performance data in the planning process:

- **Update Regional Safety Blueprint using pilot study approach.** The next update of the Regional Safety Blueprint provides an opportunity to implement the performance-based planning approach tested during the pilot. The approach could be used to develop a complete set of engineering-related emphasis areas in the region and identify priority strategies that can be implemented as part of non-safety projects.

- **Use analysis, goals, and strategies from the updated Regional Blueprint to develop the safety chapter of the next Kansas City Regional LRTP.** Once the pilot approach has been conducted for a comprehensive Regional Safety Blueprint, the regional LRTP can adopt relevant elements and resulting policies to drive transportation decisions in the region.
- **Assess Destination Safety Coalition roles and responsibilities.** It was noted that 2013 is the 10-year anniversary of Destination Safe, and participants suggested this would be a good time to assess the roles and membership of the coalition. For example, the coalition could consider expanding its membership to include additional public works and safety engineering staff.
- **Explore opportunities for training.** Participants acknowledged that a lack of awareness and understanding can be a significant barrier to effectively implementing the safety policies that result from performance analysis. Providing safety training, particularly as it relates to taking a systemic or network approach rather than spot-location improvements, and discussions about standards could be a way to garner greater buy-in from those responsible for funding and implementing priority safety strategies. MARC's Government Training Institute was identified as a potential vehicle for this training.
- **Develop a regional safety data implementation plan.** This plan would clearly identify safety data required to support a performance-based safety planning process in the region, and define an approach for sharing/accessing these data items.

3.0 Maryland/D.C. Region Pilot

The Maryland/D.C. region pilot focused on how the region could work together on a common goal area, congestion, using performance data. The work addressed the use of performance data to identify multimodal hotspot locations, evaluate potential strategies, and communicate anticipated benefits. The pilot addressed multimodal hotspots (in this case, auto and bus), thereby placing increased emphasis on interagency collaboration and data sharing.

The Washington, D.C. region is complex in terms of transportation organization. For example, the Maryland, Virginia, and District of Columbia DOTs are all involved in the transportation planning process. In order to simplify the scope and complexity of this effort, the pilot focused on a single highway agency, the Maryland DOT/State Highway Administration (SHA). Other pilot participants included the National Capital Region Transportation Planning Board /Metropolitan Washington Council of Governments (TPB/COG), the Washington Metropolitan Area Transit Authority (WMATA), the Maryland-National Capital Park and Planning Commission (M-NCPPC), and Montgomery and Prince George's counties. Representatives from the Federal Transit Administration (FTA) and AASHTO also participated in the pilot activities.

3.1 BACKGROUND/EXISTING CONDITIONS

Prior to the start of the NCHRP pilot, the region's planning partners had been using performance measures to support regional planning through a variety of previous initiatives. Workshop #1, held in December 2011, provided a forum for the agencies to present to one another and share details about how they apply congestion-related measures to support regional planning. Highlights from these discussions are summarized below.

Congestion Performance Measures and Data

TPB/COG is in the process of piloting a regional congestion dashboard that reports system-level information on freeway congestion (delay per traveler) and reliability (planning time index) during the AM and PM peak periods. As summarized in Table 3.1, TPB/COG compiles congestion data from a variety of sources and has developed the Regional Integrated Transportation Information System (RITIS) that acts as a clearinghouse for roadway data collected by numerous operating agencies in the region (Figure 3.1). While the RITIS database is primarily highway-oriented now, WMATA and TPB/COG are working to add transit services alerts to it.

Table 3.1 Summary of TPB/COG Congestion Data and Performance Measures

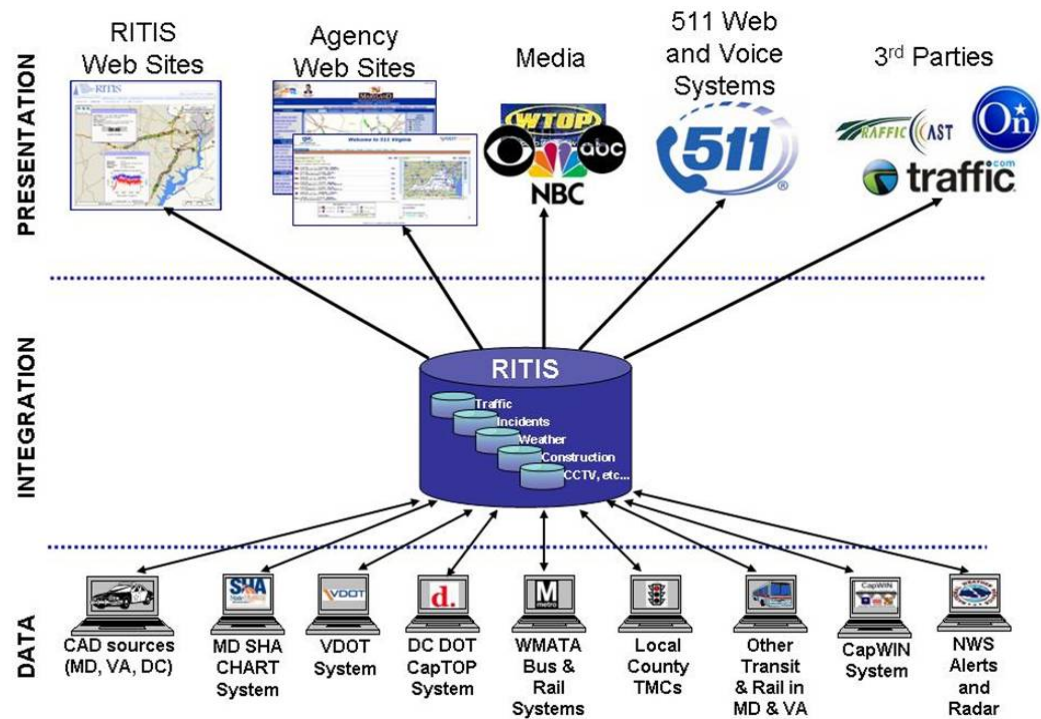
Source/Program	Directly Observed Data	Performance Measures	Challenges*/Shortcomings
TPB/COG Freeway Traffic Monitoring/Skycomp	Density	Level of service (LOS)	4 day sample (Tues, Wed and Thu), major incidents excluded
TPB/COG Arterial Traffic Monitoring	Speed Travel time	LOS	1 day sample of NHS arterial highways
TPB/COG Congestion Management Process (CMP)	Speed Travel time	Travel Time Index Planning Time Index Delay (\$ cost)	Explaining it to the public; planning implementation If person-hours of delay is calculated, integration of volume data is needed
TPB/COG HOV Facility Survey	Vehicle occupancy Vehicle classification Travel time	Average auto occupancy Person movement per lane per hour HOV lane travel time savings	Small sample size (5-9 floating car runs), only when HOV in operation
TPB/COG Airport Ground Access Travel Time Study	Speed Travel time	Travel time (from activity centers to airports) Average speed as a % of speed limit	Small sample size, only major highways studied
TPB/COG Transportation Data Clearinghouse/Maryland Traffic Monitoring System		AADT/AAWDT	
RITIS VPP Suite (a web-based congestion analysis and visualization tool)	Speed Travel time	Bottleneck (queue length, duration, frequency) Congestion scan (spatial-temporally) Travel Time Index Planning Time Index Buffer Index	Data only available for the I-95 Vehicle Probe Project
RITIS/MATOC	Incidents	Incident duration, type, etc.	

*Note: Some overall challenges include:

1. Uncertainties in future funding, availability and methodology for third-party data procurements.
2. Coordinated selection of the most appropriate corridors/locations if only a sample of data can be collected or purchased.
3. Determination of the causes of changes in monitored performance measures ("why").

Source: TPB/COG

Figure 3.1 RITIS Diagram



Source: TPB/COG

MDOT/SHA reports on congestion at two levels: at the project/corridor level and at the systematic/capital programming level. To address its mobility/economy goal, SHA reports corridor-level congestion measures in the SHA Business Plan and SHA Annual Report. These measures include reliability measures³ (average speed, buffer time, travel time index, planning time index, and number of bottlenecks), total congestion cost, and count-based measures. This information helps SHA target the portions of the highway network that are both slow and unreliable. At a systems level, the MDOT Annual Attainment Report addresses congestion performance by reporting the percent of freeway lane-miles and arterial lane-miles with average annual volumes at or above congested levels.

WMATA collects on-time performance data for every bus stop, for every route, for all hours of operation. On time performance is analyzed monthly in WMATA's *Vital Signs Report*, which addresses two questions: why did performance change, and what future actions will be taken? WMATA views on-

³ Reliability measures are newly available to the DOT due to efforts by the I-95 Coalition, technology improvements over the last two to three years, and investments in vehicle probe data.

time performance as the best indicator of bus service performance. On-time bus performance is essentially an indicator of reliability.

In addition, WMATA launched its Priority Corridor Network Plan in 2008, which identified 23 arterial bus corridors that account for roughly 50 percent of total bus ridership. WMATA conducts detailed corridor studies on a handful of these corridors each year. To identify locations for bus priority capital improvements, WMATA considers performance data such as ridership, bus speed and frequency, general purpose volume/capacity ratios, intersection level of service, reliability and on-time performance, and feasibility. To support bus operations and planning, WMATA considers congestion measures such as average bus travel speeds and bus on-time performance.

Decision Support

During Workshop #1, the participants discussed the value of using congestion data and performance measures as a way to support decision-making. TPB/COG, MDOT/SHA, and WMATA provided examples of how they are applying performance measures to identify and evaluate strategies for congested areas. This allows the agencies to identify high payoff corridors where congestion reduction strategies provide the biggest “bang for the buck.” They indicated that performance measurement provides a good method to deploy limited resources to priority corridors while integrating hotspot analysis with other agency project decisions.

Despite these advancements, the participants identified opportunities to combine roadway and transit analysis, and to improve how performance information is communicated to decision makers. They discussed the need to improve visualization in a way that brings all the data together to tell a coherent story and make the case for a particular investment.

Participants also noted that understanding what information the decision maker needs to know to make an informed decision as well as how to best communicate the information is an important element of performance-based planning that often gets overlooked. The participants stressed the importance of presenting decision makers with clear, performance-driven justification for proposed improvement projects, particularly for multimodal projects that may require participation across two or more agencies.

Data Sharing and Interagency Coordination

Given the number of transit providers and member jurisdictions in the metropolitan Washington region, interagency coordination and communication remains a challenging obstacle. For example, there are around 20 transit providers in the region, and the technologies that each agency uses to collect performance data are not necessarily the same. Similarly, examples where MDOT owns the roads, TPB/COG compiles performance data, and WMATA provides transit service underscore the importance of cross-agency collaboration

to identify multimodal hotspots and evaluate and implement congestion mitigation strategies.

The pilot participants recognized the importance of finding opportunities to share data among agencies and avoid duplicate work. The pilot's two workshops provided a venue for the region's planning agencies to present to one another, compare data availability, and identify areas of gaps and/or overlap. The participants recognized a need for better sharing and integration of data between highway and transit agencies.

3.2 PILOT IMPLEMENTATION ACTIVITIES

The implementation activities included the following tasks:

- **Identify multimodal hotspots and select two for the pilot.** This task involved coordinating with TPB/COG to obtain a list of regional bus priority hotspots identified during an on-going study. Through a collaborative process, the pilot agencies worked from this list and identified two multimodal hotspots. In this context, a multimodal hotspot is "a roadway segment or intersection at which autos and buses are experiencing significant delay." Participants discussed the desire to include bicycle and pedestrian movements in the analysis, but this was flagged as a future enhancement.
- **Develop a methodology to identify and prioritize multimodal congestion strategies.** This task involved developing a framework for identifying and prioritizing multimodal congestion strategies. The framework was refined based on one-on-one interviews with each of the participating agencies as well as feedback from a collaborative discussion during Workshop #2.
- **Analyze multimodal hotspot data to identify and evaluate strategies.** This task involved compiling highway and transit performance data from the region's planning partners to assess existing conditions and the impact of potential strategies.
- **Develop a sample performance-based project justification report.** This task involved incorporating performance measure information alongside best practice elements selected from "traditional" project justification reports to develop a template for communicating critical performance-based project information to decision makers.

The following sections summarize the work completed for each of these tasks. Throughout the pilot, the research team took the lead on facilitating and documenting the process, while the participating agencies provided the analytical support.

Identification of Multimodal Hotspots

The participating agencies, in coordination with the research team, developed an evaluation process to identify two multimodal hotspot locations that target both

transit and highway congestions needs. This process brought together regional data and built on previous efforts underway in the region, including the TPB/COG *Multimodal Coordination for Bus Priority Hotspots* study.

Regional Bus Priority Hotspots Analysis

The selection of multimodal hotspots for evaluation in the pilot began with a list of regional bus priority hotspots developed as part of TPB/COG's *Multimodal Coordination for Bus Priority Hotspots* study. This study included a comprehensive assessment of performance data for all bus routes and roadway segments in the Washington, D.C. metropolitan area operated by the region's eight core transit agencies (WMATA, Ride On, The Bus, Fairfax Connector, DASH, ART, CUE, and DC Circulator). Frequency and speed information were the primary evaluation measures for identifying and prioritizing a set of bus priority hotspot locations, although route level ridership and agency assessments of known hotspots were also considered.

The study compiled a regional database representing all of the WMATA and local agency routes and calculated the average bus speed for each segment (representing an average of WMATA and local bus speeds in the slowest of both directions). From these data, scores were developed for each segment by comparing the average segment speed to the regional average base speed (15 mph), weighted by bus frequency.⁴ The speed and frequency-based scores were then compared across thousands of roadway segments to identify the top 15 hotspot locations in each jurisdiction (District, Virginia, Maryland) for each time period (AM peak, PM peak, entire day). Segments adjacent to other top-scoring segments were combined to create hotspot corridors, where appropriate. In total, the TPB/COG study created nine priority lists, three for each jurisdiction comprised of the 15 highest scoring hotspots for the AM peak, PM peak, and entire day. The all-day hotspots list for Maryland was used as the starting point for the NCHRP pilot's multimodal hotspot selection (Table 3.2).

⁴ More detailed information on the analysis methodology is documented in the *Multimodal Coordination for Bus Priority Hotspots* "Task 2 Technical Memorandum – Development of Regional Hotspots List" prepared by for the National Capital Region Transportation Planning Board by Parsons Brinckerhoff and Foursquare Integrated Transportation Planning, January 2012.

Table 3.2 Maryland Bus Priority Hotspots – All Day

Rank	Direction	Location	Start	End	Avg. Score	Avg. Speed (mph)	Max Score	Length	Buses per Day (Core Agencies)	Comments
1	All	Loop: Willard/Western/Wisconsin	-	-	2854	8.4	3600	0.25	394	Friendship Heights Metro
2	All	Georgia Ave	13th Street	Colesville Rd	2478	7.4	6148	0.61	349	Approach to Silver Spring Metro
3	NB	River Road	Paint Branch Pkwy	-	2142	4.3	2142	0.05	253	
4	All	Veirs Mills Road	Reedie Drive	Wheaton Metro	2125	10.7	2125	0.12	600	Adjacent to Wheaton Metro
5	All	Fenton St	Sligo Avenue	Colesville Rd	2028	5.9	2480	0.52	256	Approach to Silver Spring
6	All	East-West Highway	16th Street	Georgia Ave	1794	7.4	1953	0.73	258	
7	All	Piney Branch Road	Manchester Rd	University Blvd	1636	8.9	1725	0.59	270	
8	All	Lebanon Street	MD-193	MD-650	1584	7.6	1584	0.14	215	
9	All	Monroe Street / Monroe Place	Jefferson Street	Rockville Pike	1557	7.8	1557	0.21	217	
10	WB	University Blvd W.	Dennis Avenue	Arcola Ave	1526	7.0	1796	0.72	191	
11	All	Carroll Avenue	Maple Street	Grant Ave	1464	6.6	1570	0.58	171	Approach to Takoma Metro
12	All	Baltimore Ave	Pineway	Fordham	1373	6.0	1373	0.02	153	
13	All	Hungerford Lane	Ivy League Ln	N Washington St	1306	8.0	1306	0.21	187	
14	All	Colesville Road	East-West Hwy	Capital Beltway	1236	10.1	5042	2.69	305	
15	All	Annapolis Road	Finns Lane	Riverdale Rd	1069	5.8	1377	0.39	150	To New Carrollton Metro

Source: National Capital Region Transportation Planning Board, *Multimodal Coordination for Bus Priority Hotspots, Task 2 Technical Memorandum – Development of Regional Hotspots List*, January 2012.

Agency Collaboration to Select Multimodal Hotspots

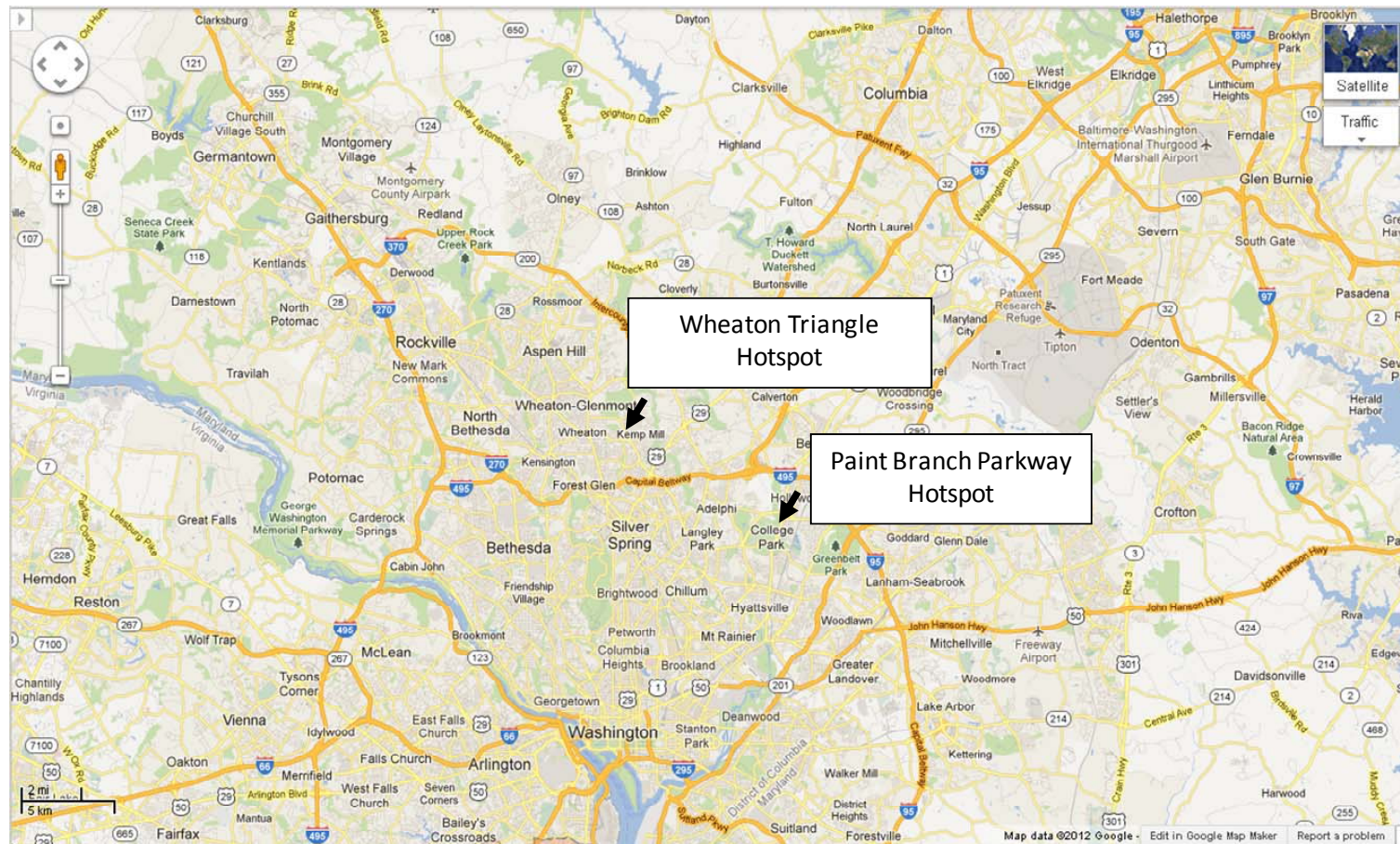
After distributing the list of the bus hotspot locations in Maryland to the pilot agencies, the research team convened a conference call with representatives from each agency to identify two multimodal hotspots from the list for further study as part of the pilot. Prior to the call, participants were asked to review the list and compare it against their agency's metrics and data to develop a list of priorities from their agency's perspective. Through a collaborative discussion, the agencies developed the following criteria for selecting two multimodal hotspots, targeting one each in Montgomery and Prince George's counties:

1. **Begin with the TPB/COG bus priority hotspots list for Maryland.** The process to identify the top 15 bus priority hotspots, summarized above, is well documented as part of the *Multimodal Coordination for Bus Priority Hotspots* study. This list provides a data-driven starting point for inter-agency discussion and collaboration.
2. **Avoid hotspots where long-term plans/projects are underway** to prevent the impression of potential postponements or project delays. For example, this consideration resulted in the elimination of a bus hotspot from the list because of its relationship to the proposed Purple Line.
3. **Assess whether the bus priority hotspots align with needs from the auto perspective.** For example, M-NCPPC develops an annual performance report that identifies and ranks intersection and segment hotspots based on vehicle probe data, corridor travel time surveys, etc.
4. **Determine whether data is available to support an assessment from the auto perspective.** For each of the 15 bus priority hotspots, TPB/COG identified the locations where vehicle probe data are available.⁵ Where speed data are unavailable, the agencies considered the availability of traffic volume and/or critical lane volume data.
5. **Extend bus hotspot termini as needed to capture important auto movements.** Some of the bus priority hotspots represent a single intersection or roadway segment. For the two multimodal hotspots, the agencies opted to extend the study areas to provide a broader view of auto movements that may be contributing to or affected by congestion or reliability issues.

Based on these criteria, the pilot agencies reached consensus on the selection of two multimodal hotspots: Wheaton Triangle and Paint Branch Parkway. These locations are illustrated in Figures 3.2 through 3.4.

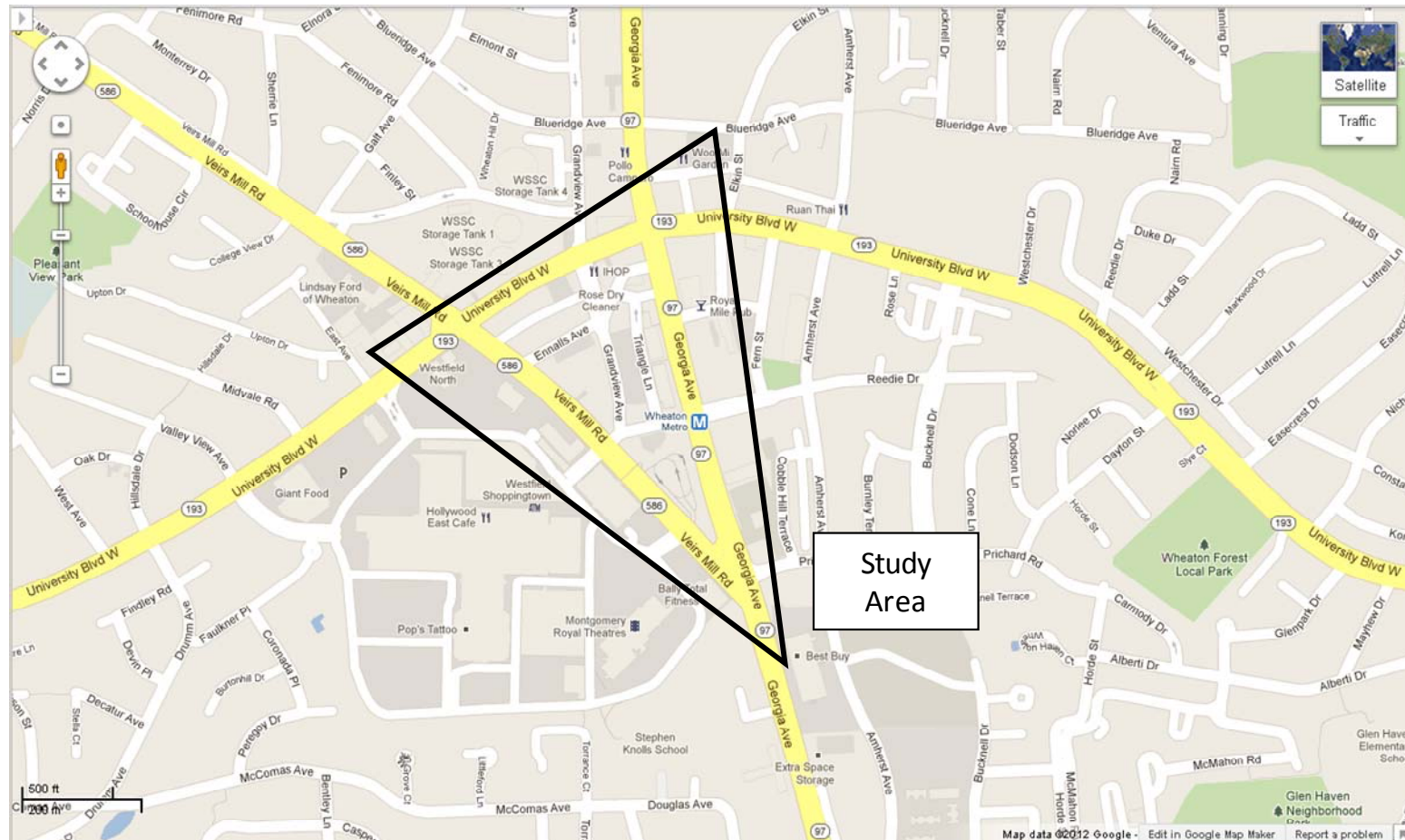
⁵ These data include general traffic speed and travel information.

Figure 3.2 Pilot Hotspot Locations



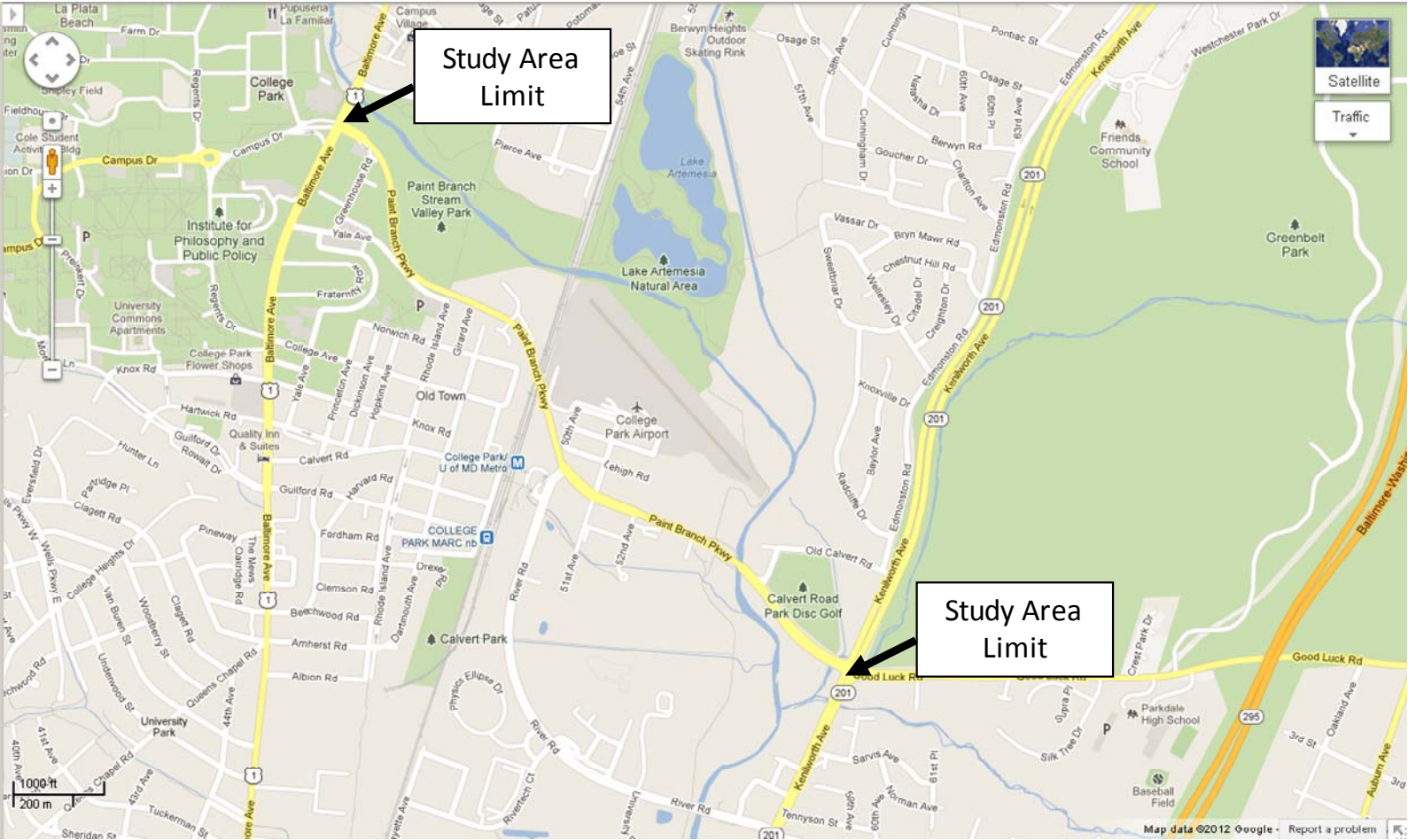
Source: Basemap – Google; Overlay – Cambridge Systematics

Figure 3.3 Wheaton Triangle Hotspot



Source: Basemap – Google; Overlay – Cambridge Systematics

Figure 3.4 Paint Brach Parkway Hotspot



Source: Basemap – Google; Overlay – Cambridge Systematics

- **Wheaton Triangle** – Located in Montgomery County, this multimodal hotspot encompasses bus and auto movements associated with the Wheaton Metro station and surrounding University neighborhood. This location has high bus frequencies. A triangular study area bounded by Veirs Mill Road, University Boulevard, and Georgia Avenue was defined to capture auto movements adjacent to Wheaton Metro.
- **Paint Branch Parkway** – Located in Prince George’s County, this multimodal hotspot is adjacent to the University of Maryland, College Park Airport, and the College Park-University of Maryland metro station. The study area was defined as the 1.7 mile segment of Paint Branch Parkway between Kenilworth Avenue to Baltimore Avenue. It was noted that the original analysis of this location by TPB/COG did not reflect data from the University, and therefore congestion at this location is likely greater than initially thought.

Methodology to Identify and Prioritize Multimodal Congestion Strategies

Prioritization Framework

Following the selection of multimodal hotspots, the research team developed a framework for identifying and prioritizing multimodal congestion strategies to address roadway and transit congestion and refined the framework based on agency feedback. As the multimodal prioritization process involves multiple agencies (state, regional, and local) and modes (roadway, transit, bike and pedestrian), the framework requires a multidimensional approach to capture the relationship between activities that are completed within an individual agency and those that must be achieved collaboratively across agencies. These relationships are illustrated in Figure 3.5.

Figure 3.5 Framework for Identifying and Prioritizing Multimodal Congestion Strategies



* Steps that involve the application of performance measures

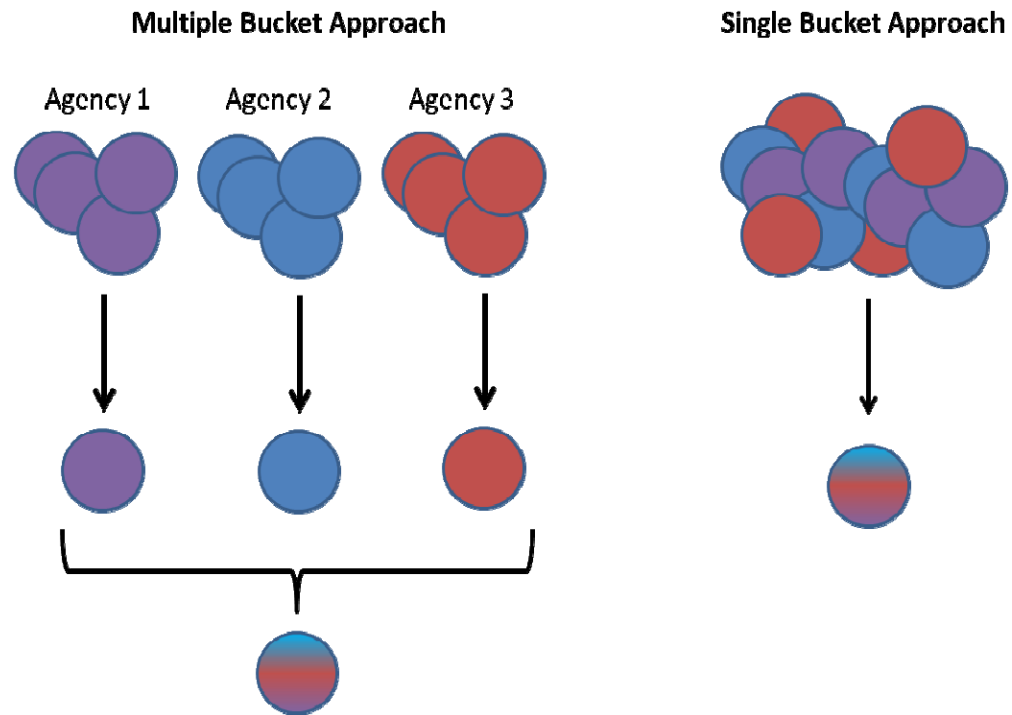
Source: Cambridge Systematics

The framework consists of the following steps:

1. **Collect Data** – Each agency collects performance data to support the operation and evaluation of their systems. The level of granularity, collection methods, and data elements vary depending on the agency's need.
2. **Identify Multimodal Hotspots** – The identification of multimodal hotspots requires an inventory of available data across agencies and a collaborative approach to identify shared priorities. As described previously, the pilot started with the results of TPB/COG's bus hotspot analysis before layering on input from the roadway agencies to consider the hotspots from a multimodal perspective.
3. **Identify Strategies** – This step involves the identification of a range of solutions to address the hotspot's congestion issues. Strategy identification may occur within agencies (e.g., WMATA's detailed corridor studies) or collectively (e.g., by developing a list of potential strategies similar to the approach used by the TPB/COG's Congestion Management Process (CMP)). Collectively, agencies provide guidance on which strategies could be viable and effective while filtering out projects that are not appropriate or possible at a specific hotspot location.

4. **Evaluate Strategies** – Working within and across agencies, this step requires agreement on the evaluation methodology, criteria, and performance measures used to compare and prioritize strategies. As shown in Figure 3.6, strategies may be prioritized within a specific mode/agency (the “multiple bucket approach”) or across modes/agencies (the “single bucket approach”).

Figure 3.6 Alternative Prioritization Approaches



Source: Cambridge Systematics

5. **Select Preferred Strategy** – Through a collaborative process across agencies, this step results in the selection of a preferred multimodal strategy based on an evaluation of expected performance and costs.
6. **Implement Preferred Strategy** – Once a preferred strategy has been identified, the appropriate implementing agency bears responsibility for programming, funding, constructing, and operating the strategy. This step will face added complexities if multiple implementing agencies are involved.

Agency Interview Themes and Implementation Issues/Opportunities

The research team conducted one-on-one interviews with each of the pilot agencies to solicit feedback on the framework described above and to identify opportunities and challenges related to cross-agency collaboration. Overall, the participants agreed that the framework seems reasonable and logical. They provided examples where significant work is being done already to support the

process, such as the development of a regional transportation data clearinghouse (RITIS).

The agencies also pointed to recent experiences (e.g., the Maryland's ongoing Base Realignment and Closure (BRAC) process) as examples of agencies working together to identify multimodal transportation improvements. The BRAC example helps to illustrate that while the challenges to collaborative planning and programming can vary by project scale, this is not necessarily true for the solutions. For example, the pilot participants noted the following success factors for the BRAC process: clear project impetus and communication of the need; creation of an implementation committee with key decision makers from all participating agencies; sustained collaborative effort in which the participating agencies met on a regular basis, and a dedicated funding source. Many of these items are discussed below as opportunities for advancing the multimodal hotspot work in the region.

Following is a summary of themes from these interviews:

- **Performance measurement** – Participants identified several opportunities to enhance performance measurement and analysis as a way to improve agency coordination. They identified an opportunity to combine roadway and transit measures to develop person-based, mode-neutral measures (e.g., delay per traveler) to facilitate the evaluation of multimodal projects. From the transit perspective, participants expressed a desire to understand the components of bus reliability (scheduling, operations, roadway issues, etc.) with the ultimate goal of developing a planning time index for buses. This would provide a comparable reliability measure to the planning time index for roadways. Similarly, there was a desire to investigate bike/pedestrian safety and reliability, and how it could be further integrated into a multimodal analysis.
- **Identify strategies (Step 3)** - Participants expressed an interest in moving toward a more location-specific model for identifying strategies as opposed to starting from a generic list. While a generic list of strategies can serve as a starting point at a regional level (such as for inclusion within a CMP) or where detailed data is lacking, the objective of the multimodal hotspot analysis should be to identify multimodal location-specific strategies. The participants also acknowledged that some strategies may be appropriate for analysis at the corridor level rather than at a point location. Although corridor-level analysis can increase the complexity of the collaborative process, it is important to capture the best strategies, regardless of their scale.
- **Evaluate strategies (Step 4) and select the preferred strategy (Step 5)** – While the multiple bucket approach to evaluating strategies (Step 4) and selecting the preferred one (Step 5) reflects current practice, many of the agencies expressed interest in evaluating projects from a more multimodal perspective, requiring a move towards the single bucket approach. This could involve framing the strategy evaluation and selection decisions around

the “total user experience” as opposed to benefits specific to each mode. Participants recognized, however, that the aggregate benefits of a project from a multimodal perspective may be different than the collective benefits of the same project from an individual modal view. They suggested securing buy-in on the process from all the planning partners at the outset is key so that everyone understands the objective and desired outcomes, and is comfortable with the preferred strategy that results at the end of the day. The participants also discussed the desire to combine roadway and transit measures for strategy evaluation and selection. Examples of potential mode neutral measures include delay per traveler, and planning time index, which is a measure of trip reliability.

- **Implement preferred strategy (Step 6)** – The participants agreed that the biggest hurdle in the process is moving from collaborative prioritization (Step 5) to agency-specific implementation (Step 6). Unless dedicated funding is available (as was the case in the region’s experience with the TIGER grant program), the preferred strategy must compete with other priorities and needs of the implementing agency as part of the regular planning and programming process. This underscores the importance of strong project justification and analysis to make the case for project implementation. The participants identified several ideas for addressing this challenge:
 - Implementing agencies could create line item programs specifically for projects identified through this collaborative process. In this approach, funding for a single line item would need to compete against other priorities, rather than multiple, potentially small individual projects.
 - Maintain a list of priorities and seek opportunities to attach improvements to large mode-specific projects that are programmed.
 - Create a sustained multimodal process in order to provide weight to the results of the collaborative process.
 - Develop techniques for communicating the performance implications of preferred strategies to decision makers in the implementing agencies (this topic is addressed in detail in a later section).
 - Include key management and technical staff (e.g., traffic engineers) from the implementing agencies early in the process. This will help to create early buy-in for collaborative priorities.

Multimodal Hotspot Data Analysis

Volunteers from TPB/COG took the lead on compiling regional data and evaluating potential strategies for the multimodal hotspot analysis. This involved inventorying the highway and transit performance data available from each agency and assessing existing and forecasted performance of the hotspots.

Roadway Performance Measurement

In coordination with the pilot agencies, TPB/COG compiled an inventory of available highway data at the two multimodal hotspot locations (Table 3.3).

Table 3.3 Summary of Regional Highway Data Compiled for Multimodal Hotspot Analysis

Source	Data	Hotspot Location	
		Wheaton Triangle	Paint Branch Parkway
TPB/COG	2010 vehicle probe travel time/speed	✓	✓
TPB/COG	2011 CLRP simulated raw AWDT volumes	✓	✓
SHA	2011 lane configuration	✓	
SHA	2011 AM and PM peaks balanced volumes	✓	
SHA	2011 AM and PM peaks LOS	✓	
SHA	2011 AM and PM peaks intersection Synchro analyses	✓	
SHA	2011 average daily turns	✓	
SHA	2008 SHA/Skycomp LOS	✓	
SHA	Hourly volume count, 2007-2012		✓
SHA	Turning movement and LOS, 2008-2012		✓
Prince George's	2007 lane configuration		✓
Prince George's	2007 peak hour volume		✓
Prince George's	2008 turning movement count		✓
Prince George's	Average daily traffic, 2009/2011		✓
Prince George's	2012 peak hour volume		✓

Source: TPB/COG

From this information, TPB/COG assessed existing congestion and reliability conditions by comparing the travel time index and planning time index for the two locations (Figures 3.7 and 3.8). These two figures indicate that the Wheaton Triangle location is much more congested and less reliable compared to Paint Branch Parkway (indicated by the overall height of the two lines in each figure). Based on this comparison, the pilot participants decided that the Wheaton Triangle location should be the higher priority of the two locations. These figures are one example of translating performance data into information that supports decisions. In addition, for both locations, the 24-hour travel time profiles can be used to identify the most congested and unreliable time periods. Combining this

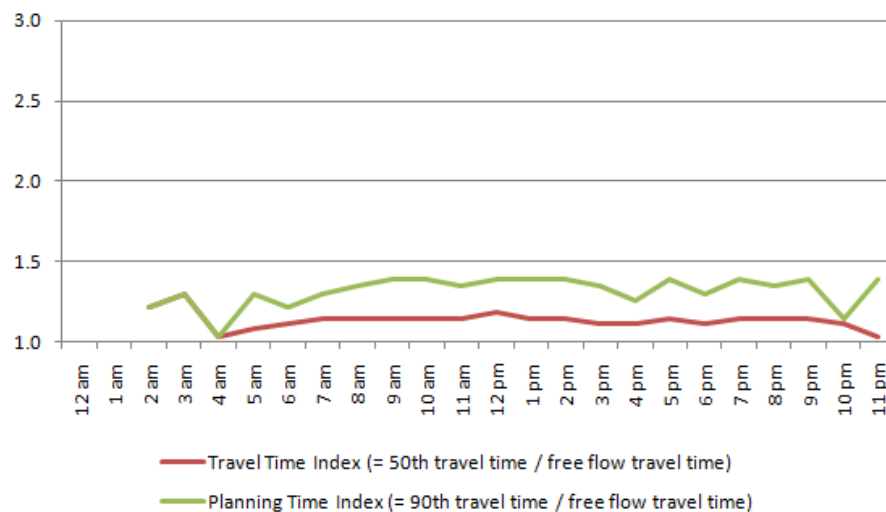
information with appropriate volume count data allows the calculation of person or vehicle delay that can be used to support a benefit/cost analysis (by monetizing travel time and reliability) and before/after analysis.

Figure 3.7 Congestion and Reliability – Wheaton Triangle at University Boulevard (Westbound)



Source TPB/COG

Figure 3.8 Congestion and Reliability – Paint Branch Parkway (Northbound from MD 201 to River Rd)



Source TPB/COG

Transit Performance Measurement

Transit agency data collection includes actual travel time, on-time performance (as compared to schedule), and passengers by stop. These data are used to track system performance, develop schedules (including scheduled run time and frequency), predict arrival times, and determine needs for bus priority improvements.

Transit travel time information in Maryland is available from automatic vehicle location (AVL) data compiled by three transit operators: WMATA, Ride-On, and The Bus. While the agencies have identified opportunities to improve the collection and reporting of these data, they are currently using the data to improve bus schedules and inform where to invest in bus priority improvements. There also are opportunities to integrate AVL data across agencies and to convert the raw data into more user-friendly formats so that they can be used to support decision making.

Combined Roadway and Transit Analysis

For the purposes of the pilot study, TPB/COG conducted a conceptual analysis to provide an example of how transit and highway performance measures could be applied to evaluate potential strategies at the Wheaton Triangle hotspot. TPB/COG presented the approach and the results to the other participating agencies during one of the pilot workshops. The participants did not agree that this approach is the one that should be used going forward in the region. However, they did agree that some quantitative, multimodal assessment of potential strategies is necessary moving forward.

The conceptual analysis was based on a potential strategy that addressed roadway configuration improvements and signal improvements. This strategy was defined previously as part of TPB/COG's *Multimodal Coordination for Bus Priority Hotspots* study.

Using current travel volumes for both modes and hypothetical capital and operating costs of two potential solutions, TPB/COG conducted a benefit-cost analysis using the methodology it developed for its recent U.S. DOT TIGER Grant application. Given that all modes are operating within the same "real estate," the analysis provides a multimodal comparison of strategies. It addresses the impact of the strategy on bus travel time, transit ridership, pedestrian volumes, and roadway congestion. TPB/COG assumed that the proposed improvements would result in a five percent improvement in bus travel time, thereby increasing transit ridership and pedestrian travel.

TPB/COG also conducted a sensitivity analysis to evaluate the sensitivity of the benefit/cost results to congestion impacts. Figure 3.9 compares the resulting benefit-cost ratio under two scenarios based on two levels of increased auto congestion. Figure 3.9 illustrates that the methodology is very sensitive to congestion impacts. While a hypothetical two percent increase in auto congestion would negate the other benefits of the strategy, a one percent increase

in auto congestion would result in a positive rate of return for the strategy. In this scenario (scenario #2), the strategy has a positive benefit-cost ratio.

Figure 3.9 Conceptual Analysis of Multimodal Hotspot Strategies

Scenario #1 - 2% more Auto Congestion		Scenario #2 - 1% more Auto Congestion	
Costs	\$519	Costs	\$519
Capital	\$485	Capital	\$485
Operating	\$878	Operating	\$878
Construction impacts	\$0	Construction impacts	\$0
Accident	\$911	Accident	\$911
Benefits	(\$1,185)	Benefits	\$746
Net Travel Time Savings	\$17	Net Travel Time Savings	\$17
Net Travel Cost Savings	\$1,255	Net Travel Cost Savings	\$1,255
Increased Access	\$634	Increased Access	\$634
Congestion Reduction	(\$3,863)	Congestion Reduction	(\$1,932)
Emissions Reduction	\$369	Emissions Reduction	\$369
Health Benefits	\$0	Health Benefits	\$0
Accident Reduction	\$402	Accident Reduction	\$402
Net Present Value	(\$1,704)	Net Present Value	\$228
Rate of Return	N/A	Rate of Return	5.1%
Benefit-Cost Ratio	-2.28	Benefit-Cost Ratio	1.44

Source: TPB/COG

Communicating with Decision Makers

A recurring theme identified by the participating agencies throughout the pilot was the need to improve the way technical information is communicated to decision makers within the implementing agencies. They indicated this is very important to assist the difficult transition from selecting a preferred strategy (Step 5) to implementing the strategy (Step 6) given that the project will face many competing priorities.

The participants felt that effective communication involves outlining the key decision points, identifying what information the decision makers need, and then determining the simplest and clearest way to communicate the information. They urged the use of a simple, visual approach that communicates performance-based information without overwhelming the intended audience with a bunch of numbers. They also reiterated the importance of emphasizing the public benefits of the project(s), particularly from a multimodal perspective if appropriate.

To assist the agencies in addressing the communication challenge, the research team investigated “traditional” project justification reports to identify best

practices and the key elements from these reports. The research team then investigated techniques for communicating and visualizing performance measure information, and ultimately combined the two tracks to develop a proposed performance-based project justification template. The result is provided in Figure 3.10 (this report is for a hypothetical project). The key elements of the template include:

- **Overall Layout** – Maintain a balance between bulleted text and graphics. Limiting the report to one page requires the project sponsor to include only the most critical information in a high-level summary format. The goal of the project justification report is to provide enough information to encourage decision makers to start asking questions, rather than trying to answer all questions up front.
- **Project Name and Sponsor** – Feature the project name and sponsor prominently at the top of the report, like a headline.
- **Problem Statement** – Provide a brief, bulleted summary of the problem that needs to be addressed and include a visual representation that depicts the issue (i.e., photograph, diagram, etc.). Also include a simple map of the project location.
- **Proposed Solution** – Describe the preferred strategy for addressing the issue using concise, bulleted language. Provide an “after” diagram to illustrate expected performance after implementation of the proposed solution.
- **Benefits** – Communicate the benefits of the project using graphical depictions of performance information, showing the expected before and after results. The performance measure(s) included in the report should be context-specific based on particular needs and issues at the hotspot location. Also, clearly identify who will be receiving the benefits (drivers, bus passengers, neighboring residents, etc.)
- **Costs** – Provide the anticipated total project cost and benefit-to-cost ratio information, if available.
- **Recommended Actions** – Provide a succinct summary that identifies the next step toward implementation. Compare the project’s overall value to other potential projects.

The participants agreed that the concept of merging performance data into traditional project justification reports is helpful, and that the template provides an excellent example of how project information could be organized and communicated. They also recognized that the content would require custom tailoring for each project. Similarly, the presentation of performance measures can be adapted to a variety of audiences based on outreach needs. This exercise provides an example of how agencies can use graphics and visualization to clearly convey project-level performance information.

Figure 3.10 Sample Performance-Based Project Justification Report

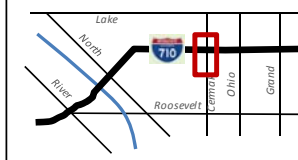
Agency Title Project Justification Report

Project: Cermak Road/I-290 Access Improvement

Sponsored by:

Sponsoring
Agency
Logo**Problem Statement**

- Intersection of Cermak and I-290 is outdated
- Current lanes cannot handle traffic volumes
- Intersection is creating safety issues and delay for drivers and transit riders

PROJECT LOCATION**Proposed Solution**

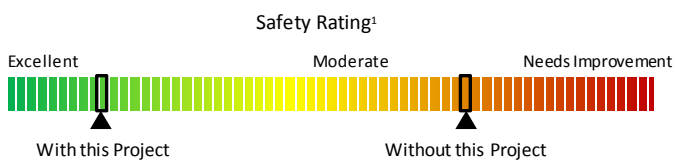
- Steps to solving the problem
 - Widen the approach to I-290
 - Add ramp metering
 - Add bicycle and pedestrian facilities
 - Add dedicated bus/carpool lane

Support for the Project

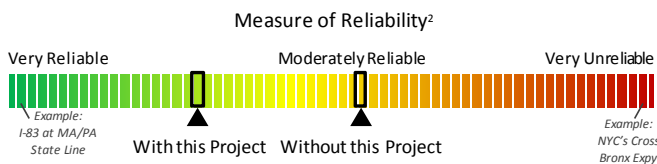
- Project is led by Cermak Transportation Alliance
- Project is supported by the State DOT, corridor planning group, and the Cities of Cermak Heights and Lombard
- Project is part of the 2040 Transportation Plan

PROJECT AT COMPLETION

Actual Image from New Jersey DOT Route 70/73 Marlton Circle Elimination Project

Benefits in Improved Safety

¹Based on an analysis of historical safety performance and projected future performance.

Benefits in Improved Reliability

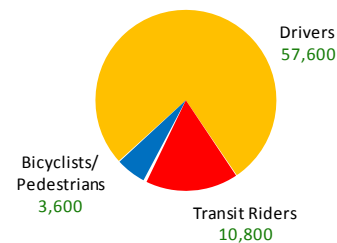
²Based on the extra time travelers need to budget in order to arrive on-time 95% of all trips.

Travelers Receiving Benefits

Annual Travelers

21.2 M

Daily Travelers by Mode



Anticipated Annual Hours of Delay Saved

1.8 M**Costs**

Anticipated Total Cost

\$6.3 M

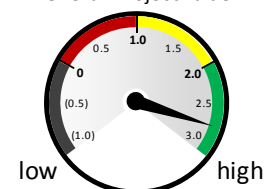
Based on the estimated Benefit-to-Cost Ratio, for every **\$1** spent on this project, travelers will get **\$2.75** in benefits.

Notes: Cost assumptions are for a full-buildout between 2016-2018.

Recommended Actions

- Advance project to preliminary engineering stage
- Include project in Transportation Improvement Plan

³Value based on Benefit-to-Cost Ratio. Projects above 1.0 are expected to have positive returns.

Overall Project Value³

3.3 POTENTIAL NEXT STEPS

Participants identified the following potential next steps to advance a performance-based multimodal hotspot analysis process:

- **Continue progress on the two pilot multimodal hotspots in order to illustrate the methodology and its benefits.** The participants would like to continue momentum by identifying and advancing high payoff projects at the two multimodal hotspot locations (starting with the Wheaton Triangle) and pursuing funding to implement the preferred strategies. This effort would provide a real-world example to illustrate the benefits of the process. The participants would then like to use the success of this work to leverage projects at additional multimodal hotspots in the future.
- **Conduct a comprehensive analysis of roadway and bus hotspots.** As part of the pilot, participants identified two initial multimodal hotspots. There is a desire to conduct a more comprehensive version of this exercise in order to identify additional multimodal locations throughout the region.
- **Improve coordination between traffic engineering staff.** Participants felt that involving traffic engineering staff throughout the entire hotspot analysis process would help to ease the transition from the collaborative prioritization process to the agency-specific project implementation process.
- **Broaden involvement to other regional planning partners.** In an effort to continue to build on the collaborative interagency relationships that have been established during this pilot and the TIGER bus priority grant implementation process, the participants expressed interest in holding a regional multimodal hotspot meeting to brief the Virginia DOT, District DOT, and other planning partners on the pilot activities and encourage their involvement in future collaborative efforts.
- **Continue efforts to improve data sharing.** The participants discussed options for further sharing of data between agencies. For example, the agencies are going to explore the use of probe data to support bus route planning, scheduling and evaluation; and the incorporation of bus ridership data into the regional data clearinghouse in order to improve multimodal analysis. They also are going to continue their efforts to incorporate transit service alerts into the RITIS database. The overall goal of these efforts is to combine data across agencies in a way that enables decision makers to understand a complete picture of transportation performance in the region.
- **Within each agency, identify steps for framing discussions around the total user experience perspective.** Planning by mode reflects the history and responsibility of each agency. However, the pilot participants recognized an opportunity to move towards a multimodal planning approach supported by person-based, mode-neutral performance measures. This evolution would require each agency to take a more multimodal approach to project prioritization and development. For example, the agencies suggested that

when articulating the benefits of a transit project, the implementing agency should coordinate with the region's planning partners to fold in auto/roadway benefits as well. The same holds true when evaluating the benefits of roadway projects. When evaluating roadway projects, their impact on transit service should be considered.

4.0 Pennsylvania Pilot

The Pennsylvania pilot focused on pavement and bridge preservation, building on a recent statewide effort to develop a consistent performance measurement framework for managing these assets. The Pennsylvania pilot was unique from the other two pilots in that it considered performance-based planning from both the statewide and regional perspectives.

Participants included representatives from the Pennsylvania DOT (PennDOT) at both the District and Central Office Bureau levels as well as some of the MPOs and RPOs from across the state. Participants from the Delaware Valley Regional Planning Commission (DVRPC), the MPO for the greater Philadelphia region, and the Southwestern Pennsylvania Commission (SPC), the MPO for the Pittsburgh region, represented the state's MPOs. Participating on behalf of the state's RPOs were the North Central Pennsylvania Regional Planning and Development Commission (North Central RPO), the Adams County Transportation Planning Organization (Adams County), and the Southern Alleghenies Planning and Development Commission (SAPDC).

4.1 BACKGROUND/EXISTING CONDITIONS

Collaboration Model

Regional planning in Pennsylvania is performed by a combination of MPOs and RPOs. From the state's perspective, the 23 MPOs and RPOs have essentially the same planning responsibilities. From time to time, as statewide planning priorities arise, working groups are formed with representatives from the MPOs, RPOs and PennDOT. These groups develop recommendations that are then presented for consideration by the other planning organizations, and eventually adopted for statewide implementation. Recently the Pennsylvania planning organizations have discussed a need to improve their process for prioritizing bridge and pavement preservation projects. This NCHRP pilot provided an opportunity to advance these discussions.

Annual Performance Reporting

In April 2011, PennDOT released its first pavement and bridge performance measures report that summarizes infrastructure condition in the state. It reports conditions by roadway category (eg., interstate, NHS Non-Interstate) and geographic region, and compares current conditions to near-term target values. Sample reports are provided in Appendix B. The complete report series includes performance measure reporting for each MPO and RPO as well as statewide performance.

Through a statewide effort, the performance measures included in the report were selected by a working group comprised of representatives from PennDOT, MPOs, and RPOs. The performance report addresses two measures for bridges:

- Structurally deficiency (SD) (by deck area and bridge count); and
- SD prevention expenditures.

It also addresses two measures for pavements:

- International Roughness Index (IRI) (reported as excellent, good, fair, and poor), and
- Overall Pavement Index (OPI), which considers pavement distress data (reported as excellent, good, fair, and poor).

The performance reports include targets for each performance measure, adjusted for each region. While the planning partners indicated that the new performance report has not yet been integrated into decision making, it provides a foundation for incorporating preservation performance into the planning and programming processes.

Predicting Future Performance

During Workshop #1, which was held in November 2011, participants noted that PennDOT and its regional planning partners lack systematic methods and tools to predict future performance in support of asset management decision making. While an asset management system is under development at PennDOT (estimated five years away), the agencies are seeking interim tools to help identify and evaluate projects that would provide the best benefits for the costs and drive performance results. Participants discussed the use of tools such as PennDOT's Bridge Risk Assessment Tool to support resource allocation decisions, but not to evaluate future performance.

Tradeoff Analysis

Participants discussed a desire to bring together bridge and pavement information and evaluate tradeoffs between them. They discussed the potential for tradeoff decisions to take place at the program level, roadway category level (e.g., Interstate vs. NHS, non-Interstate, etc.), or project level (evaluating a pavement project against a bridge project). However, without the ability to predict future performance (as described above), participants acknowledged that conducting tradeoff analysis would be difficult.

Systems View vs. Project View

Long-term planning requires a system level analysis, while project programming often entails a shorter term, bottom-up, project-by-project approach. Participants discussed the need to connect these two viewpoints to determine which

components of the system and which projects would contribute to the best long term performance results.

Project Prioritization

Participants discussed the challenge of prioritizing projects among all of the competing bridge and pavement preservation needs that have been identified. Some of the agencies are using HERS-ST. However, segment data from the Highway Performance Monitoring System (HPMS) used by HERS-ST provides incomplete information, as projects typically span multiple segments. Participants considered whether running HERS-ST with 100 percent data would produce better results. They also discussed the possibility of removing some structurally deficient bridges from the system, but would need a tool to help identify which bridges to close based on the expected impacts of those closures on the traveling public.

4.2 PILOT IMPLEMENTATION ACTIVITIES

Based on the needs identified by the participating agencies during Workshop #1, the implementation activities for the Pennsylvania pilot focused on developing interim guidance on applying performance data and other criteria to prioritize bridge and pavement projects. The framework is implementable using existing data and tools and can serve to identify potential functionality for the next iteration of asset management systems in the state. In order to develop the framework, the research team coordinated with the participating agencies on the following tasks:

- **Conduct urban and rural webinars to review prioritization approaches.** This task involved a national scan to review how other agencies prioritize bridge and pavement preservation projects. The research team conducted separate webinars with the urban and rural pilot participants to identify which approach(es) would be most appropriate for application in Pennsylvania.
- **Conduct example system-level tradeoff analysis.** This task involved conducting sample analysis to illustrate the relationship between funding and longer term condition levels, and show how the results could feed into a prioritization framework.
- **Provide guidance on identifying priority corridors.** This task involved reviewing previous efforts by PennDOT to define a core transportation system, compared them to approaches used by other states, and presented options for incorporating a priority corridor analysis as part of an overall prioritization framework.
- **Develop interim framework for prioritizing preservation projects.** This task brought together elements of the three previous tasks to incorporate system/network level tradeoffs and priority corridor elements within a

common framework for prioritizing preservation projects. The framework was designed to be flexible for customization by the state's urban and rural regional planning agencies.

The following sections summarize the work completed for each of these tasks.

Urban and Rural Webinars

To initiate the implementation work, the research team divided the Pennsylvania pilot participants into two groups – rural representatives and urban representatives – and conducted a webinar with each group. The objectives of the webinars were to:

- Present a range of approaches for how transportation agencies prioritize bridge and pavement preservation projects and discuss potential candidates for application in Pennsylvania;
- Discuss how can/should the PennDOT Performance Measures Annual Report and related data support the prioritization process;
- Brainstorm additional inventory and condition data that should be considered as part of the process; and
- Clarify the appropriate roles for PennDOT and the MPOs/RPOs in the context of a strawman prioritization approach.

Webinars were held with the urban and rural groups separately to understand the unique perspectives that MPOs and RPOs may have for prioritizing bridge and pavement needs. PennDOT participated in both groups. The remainder of this section summarizes the webinar discussions that led to the identification of subsequent pilot implementation activities.

Project Prioritization Approaches

The research team opened both webinars by presenting a range of approaches for prioritizing bridge and pavement preservation projects implemented by transportation agencies nationwide (Table 4.1). While each approach begins similarly with the identification of system preservation needs and ends with a prioritized list of preservation projects, the level of complexity and evaluation criteria used to prioritize a list of projects varies among the range of approaches (see diagram to the right).



The most simplistic of approaches, a worst-first approach, requires minimal data but ignores consideration of strategic investments from a system perspective. The most robust and comprehensive approaches optimize the lifecycle cost of the system's bridges and pavements in the context of the agency's other goals and objectives. For this approach, the ability to forecast future condition given a level of investment requires a sophisticated bridge and pavement management system. In between are a range of approaches that consider strategic investments from a risk-based or corridor-based perspective. These approaches combine condition information with other performance criteria or network factors to develop a prioritized list of projects.

Table 4.1 Prioritization Approach Comparison

Prioritization Approach	Pros	Cons
Worst First	Simple process; minimal data requirements	Ignores strategic investments from a system perspective
Classic	Incorporates other agency goals (either quantitatively or qualitatively)	Ignores strategic investments from a system perspective
Risk-based	Strategic investments from system perspective	Inability to forecast future performance
Priority corridors	Strategic investments from system perspective	Inability to forecast future performance
Lifecycle cost	Ability to forecast future performance and optimize investments	Requires sophisticated management system
Comprehensive lifecycle	Incorporates other agency goals; ability to forecast future performance	Requires sophisticated management system

Source: Cambridge Systematics

Both groups discussed what an appropriate strawman prioritization approach would look like in Pennsylvania given the current data and analysis capabilities of PennDOT and the state's regional planning partners. There was general consensus in both groups that Pennsylvania has advanced beyond the worst first and classic approaches. However, given that development of bridge and pavement management systems remain several years away, PennDOT and its planning partners do not have the capability to support the more sophisticated lifecycle approaches. As a result, both groups discussed options for pursuing a prioritization approach that integrates some of the in-between approaches, including:

- **Priority Corridors.** The rural group focused more on establishing a set of priority corridors as a way to support trade-off decisions by focusing on the most critical elements of the system. (This discussion addressed large corridors as well as specific priority bridges, for example in instances where there are multiple, parallel rivers crossings in close proximity.) There is a desire to reach consensus across the state on priority corridors. A few years ago, PennDOT began advancing the concept of a Core Pennsylvania Transportation System (CPTS) for the state's modal facilities of highest importance. However, progress stalled before reaching internal consensus or soliciting feedback from the regional planning partners. The rural group discussed revisiting PennDOT's previous work as an initial approach, coupled with best practices from other states, to facilitate discussion and refine an approach for identifying priority corridors in Pennsylvania. However, the group stressed that a priority corridor approach should also allow for identification of system priorities at the MPO and RPO level based on local factors and needs.
- **Tradeoff Analysis/Forecasting Future Performance.** Both groups, but particularly the urban group, expressed interest in leveraging existing FHWA tools to conduct system level trade-off analyses while PennDOT makes progress on advancing more sophisticated bridge and pavement management systems. A tool with the capability to forecast future performance would assist the MPOs in strategically identifying projects from a lifecycle perspective – however, this is beyond the current capabilities of PennDOT. Existing FHWA tools are capable of comparing how varying levels of preservation investment impacts system performance. This information is helpful to communicate to decision makers the consequences and performance outcomes for different funding scenarios.

Both groups agreed that either approach, or a combination of the two, would advance Pennsylvania's state-of-the-practice in the interim while working to develop lifecycle cost analysis capabilities for bridges and pavements. Regardless of the final approach, both groups underscored the importance of getting buy-in and participation from all agencies early in the process. Advancing a more robust prioritization process would also support the agencies

in effectively communicating the rationale for addressing some system needs over others.

Performance Data

The existing Performance Measures Annual Report provides summary-level performance information for bridges and pavements at the statewide, district, and MPO/RPO levels. It is a tool to establish baseline performance at a system level and by Business Plan Network.⁶ PennDOT provides more detailed bridge and segment level performance data to the MPOs and RPOs through a new Linking Planning and NEPA (LPN) program. This program is designed to improve communication and coordination between planning partners for identifying and prioritizing transportation projects.

For the pavement performance measures (IRI and OPI), PennDOT identifies thresholds for excellent, good, fair, and poor condition ratings. For bridges, PennDOT develops bridge risk scores based on condition, traffic volumes, and detour length and identifies the range of scores that are the most critical. As a way of measuring system condition, the RPOs and MPOs indicated that these performance measures are suitable for identifying needs. However, prioritizing projects beyond a worst-first approach will require additional information and evaluation criteria.

Additional Criteria for Project Evaluation

Moving beyond a worst-first prioritization process requires the use of additional criteria with which to evaluate projects. As shown to the right, example criteria may include traffic volumes, consistency with local plans/priorities, proximity to major employers, etc. The rural participants agreed that the appropriate criteria will differ by region based on local conditions and economic factors. As such, while a statewide prioritization approach may provide guidance for applying the criteria, the rural participants cautioned against

Example Evaluation Criteria

- Usage – AADT, truck volumes, etc.
- Redundancy/detour length
- Local priorities/support of local plans
- Demographic characteristics – where do people live and work
- Connectivity, especially in rural areas
- System function/functional class

⁶ The Business Plan Network is PennDOT's roadway classification system for the purpose of developing District Business Plans and system monitoring. The four roadway classifications include Interstate, National Highway System (NHS) (Non-Interstate), non-NHS $\geq 2,000$ average annual daily traffic (AADT), and non-NHS $< 2,000$.

establishing a rigid threshold for standardized application statewide.

The urban group clarified the distinction between asset-related criteria, such as usage, redundancy/detour length, and functional class versus exogenous factors – criteria related to local priorities, demographic characteristics, and system connectivity. While exogenous factors could be considered during later stages of the process, the urban group preferred to focus project prioritization on the lifecycle cost of the asset according to its usage and related characteristics. The urban group also noted that data related to the date(s) at which the facility's condition rating changed as well as the dates and types of treatments that have been applied to a facility would provide helpful information with which to make preservation decisions.

Agency Roles and Responsibilities

Pennsylvania's RPOs are directly involved with PennDOT when prioritizing bridge and pavement preservation projects. While there are differing relationships between individual RPOs and PennDOT districts, RPO involvement is generally consistent across the state. Typically the PennDOT District initiates the process by providing a prioritized list of projects to the RPO based on current conditions, engineering judgment, and familiarity with local priorities and needs. The RPO Board then considers the list and may make reprioritization recommendations to align with local perspectives. The agencies work through this iterative process until reaching agreement on which projects to program. Given the collaborative nature of decision-making, good communication between the RPOs and PennDOT is key to the process.

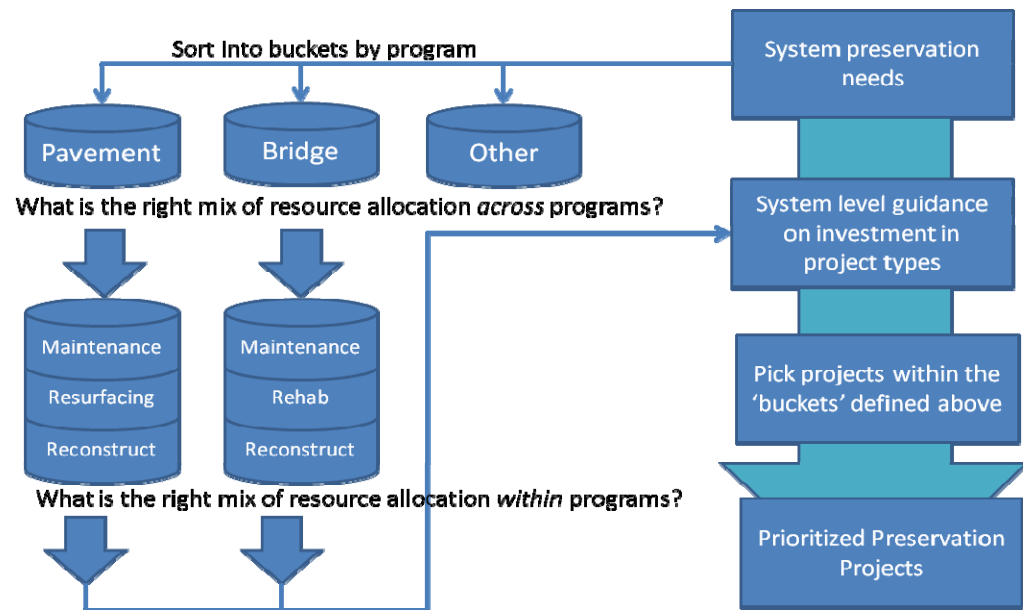
Similarly, the MPOs evaluate projects identified by the PennDOT District or counties against a set of specific criteria to determine which projects to include in the TIP. However, there is a desire among the MPOs to move toward a more systematic process that identifies the most strategic set of projects from a system perspective based on lifecycle costs.

Both groups, but especially the rural group, identified potential issues with the system focus of these investment decisions. For example, there is a concern that local bridges that carry more traffic than nearby state routes end up as a lower priority. Breaking down the barriers between system ownership (and funding) may be necessary to achieve better outcomes.

System Level Tradeoff Analysis

During Workshop #2, the research team presented a process for conducting system level tradeoff analysis as a means to evaluate the relationship between a mix of preservation investments and longer term condition levels (Figure 4.1). This process makes use of existing tools to help allocate resources across program areas and prioritize projects within programs to achieve performance targets.

Figure 4.1 Using System Level Tradeoff Analysis to Support Project Prioritization



Source: Cambridge Systematics

The research team presented six steps to implement a system level tradeoff analysis approach:

1. Define performance measures;
2. Identify potential available funding;
3. Examine relationship between funding and performance;
4. Consider tradeoffs across program areas;
5. Examine implication of preferred investment scenario for types of investment; and
6. Use system tradeoffs to structure investment decisions.

Each of these steps is described in more detail below within the context of pavement and bridge prioritization in Pennsylvania.

Define Performance Measures

The first step in a system-level tradeoff analysis is to define performance measures that can be used to evaluate and forecast the condition of the system. As described earlier, Pennsylvania has selected a set of pavement and bridge preservation performance measures for inclusion in PennDOT's Performance Measures Annual Report. Pavement measures include IRI, which captures pavement smoothness, and OPI, which considers pavement distress data. The performance report identifies the number of segment-miles in excellent, good,

fair, and poor condition for both measures. Bridge measures focus on structural deficiency (SD). The performance report identifies the percent of SD bridges by Business Plan Network and compares SD prevention expenditures to target levels.

The pilot participants discussed the adequacy of these performance measures for supporting the project prioritization process. While the measures included in the Performance Measures Annual Report are supported by available data, the agencies indicated that they are not necessarily the ideal measures with which to evaluate condition. For example, structural deficiency is a black and white measure; a bridge is either structurally deficient or it is not. As a result, the SD measure does not allow for comprehensive view of how a bridge deteriorates over time (superstructure, substructure, deck). This more detailed information would be useful when evaluating the need or timing of potential projects. Similarly, the participants indicated that the pavement measures focus more on surface quality without a means to compare structural adequacy. The performance report does identify the number of out-of-cycle segment-miles in good condition, which indicates preservation activities are extending the life of the pavement.

Ultimately, participants agreed that the measures were a good start for beginning to manage to system performance and that they would evolve and improve over time as data and tools became available.

Identify Potential Available Funding

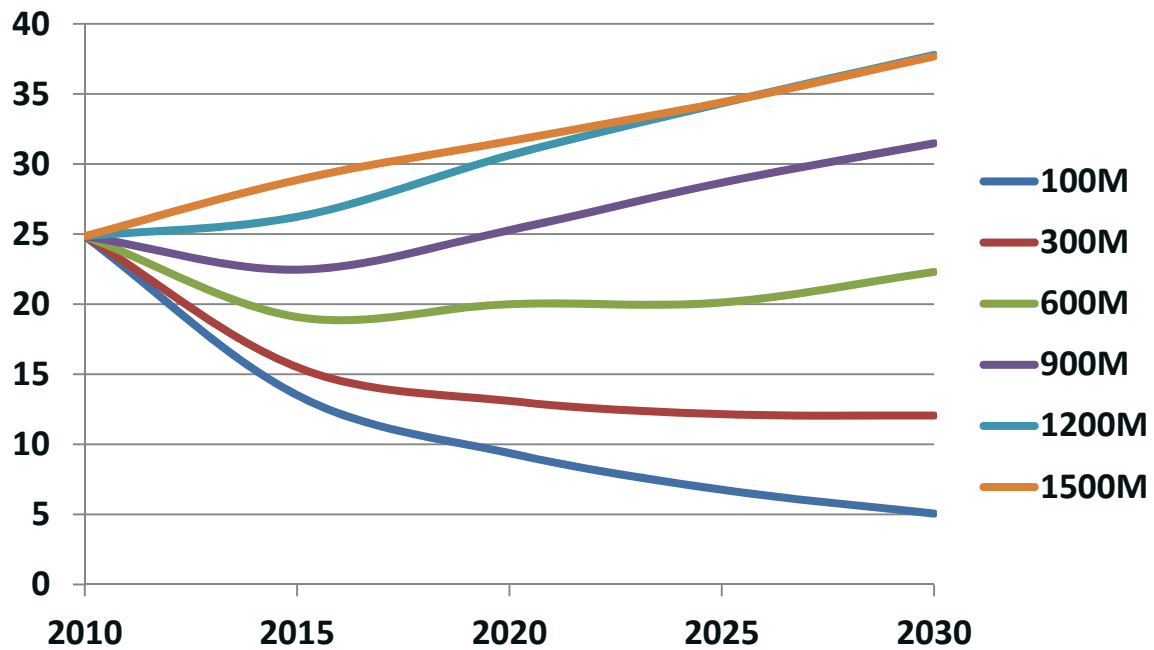
The next step in the process is to identify available funding and define a range of funding scenarios. PennDOT's Statewide Transportation Improvement Plan (STIP) includes \$10.1 billion in funding over a four-year period. Of this total, approximately \$1.8 billion is allocated to preservation projects with an additional \$1.5 billion to cover average annual maintenance expenditures. As a regional example, DVRPC developed three long-range funding scenarios for the region to support a system-level analysis of bridge condition versus investment. The three scenarios were based on a continuation of existing funding levels and high and low scenarios based on proposed reauthorization funding levels.

The participants noted one of the key challenges related to this step is identifying the proportion of available funding that is flexible, not set aside for a specific use.

Examine Relationship between Funding and Performance

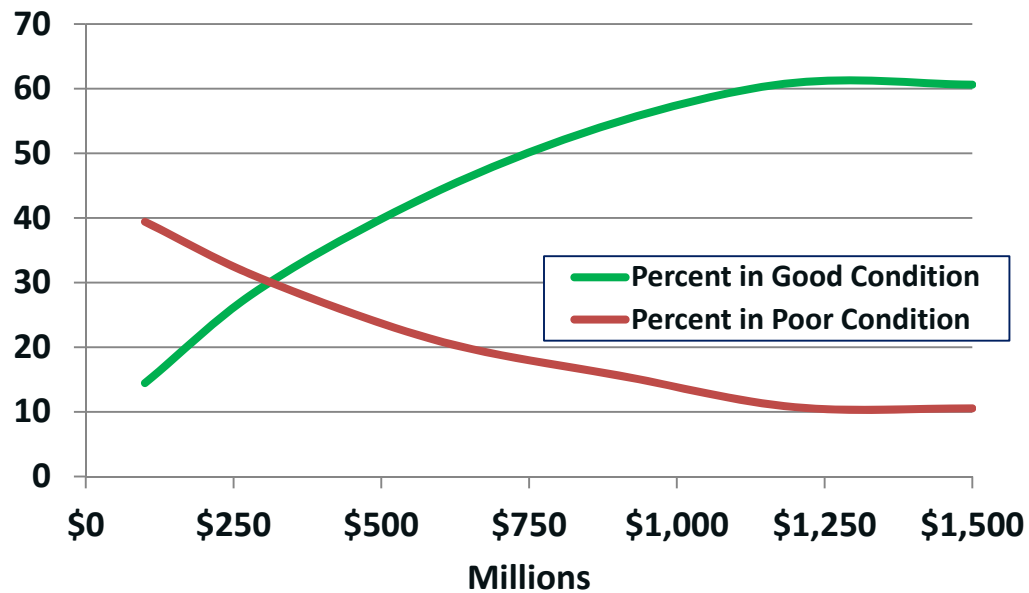
Using FHWA's HERS-ST tool, the research team applied the state's existing pavement condition data to estimate future pavement condition based on a range of funding scenarios (Figures 4.2 and 4.3). HERS-ST provides some of the capabilities of a pavement management system, particularly providing a means to assess expected system performance based on different levels of investment.

Figure 4.2 Percent of Miles in Good Condition (IRI > 95) versus Funding



Source: Cambridge Systematics

Figure 4.3 Distribution of Pavement Condition by Funding

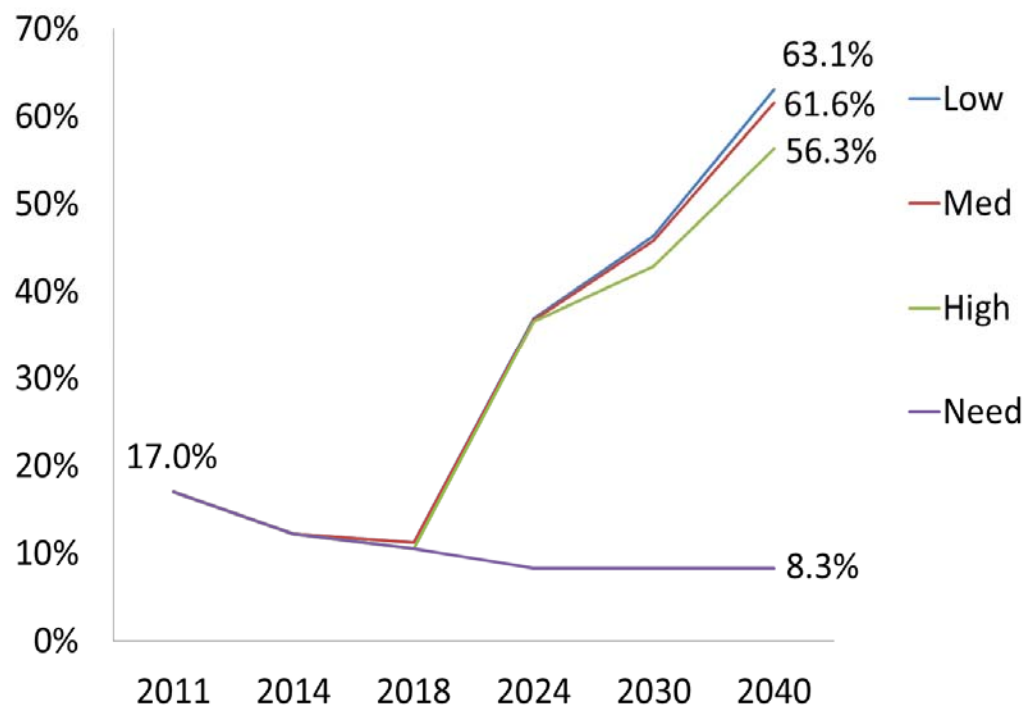


Source: Cambridge Systematics

The pilot participants discussed the potential opportunities and challenges associated with adjusting the scale of analysis to evaluate the relationship between funding and performance at the regional level. HERS-ST is most appropriately applied for system-level guidance, rather than an assessment of performance at the segment level. Limited availability of sample segment data at the local level or regions/counties with fewer route miles increases the likelihood of HERS-ST producing skewed results.

To supplement the HERS-ST pavement analysis conducted by the research team, DVRPC presented the approach it used as part of its long range planning process to investigate the relationship between future bridge condition and funding level. DVRPC developed a regression analysis based on 25 years worth of bridge inspection data to compare rates of decline and the effectiveness of preservation and rehabilitation projects. Using three regional long-range funding scenarios, DVRPC applied the regression model to forecast future structural deficiency ratings given high, medium (status quo), and low funding scenarios. This analysis shows a striking divergence between target performance levels (8.3 percent SD by 2040) and all three potential funding scenarios (Figure 4.4).

Figure 4.4 SD Deck Area for Various Funding Levels



Source: DVRPC and PennDOT, 2012

Consider Tradeoffs across Program Areas

Step 4 in the system level tradeoff analysis approach uses scenarios to examine tradeoffs across program areas. This step in the process provides a means to demonstrate the implications of key “what if” questions:

- What if overall funding increases or decreases?
- What if we shift funding to emphasize one program over another?
- What if we want to maintain existing conditions?
- What if we shift funding to preserve some types of roads in better condition than others?

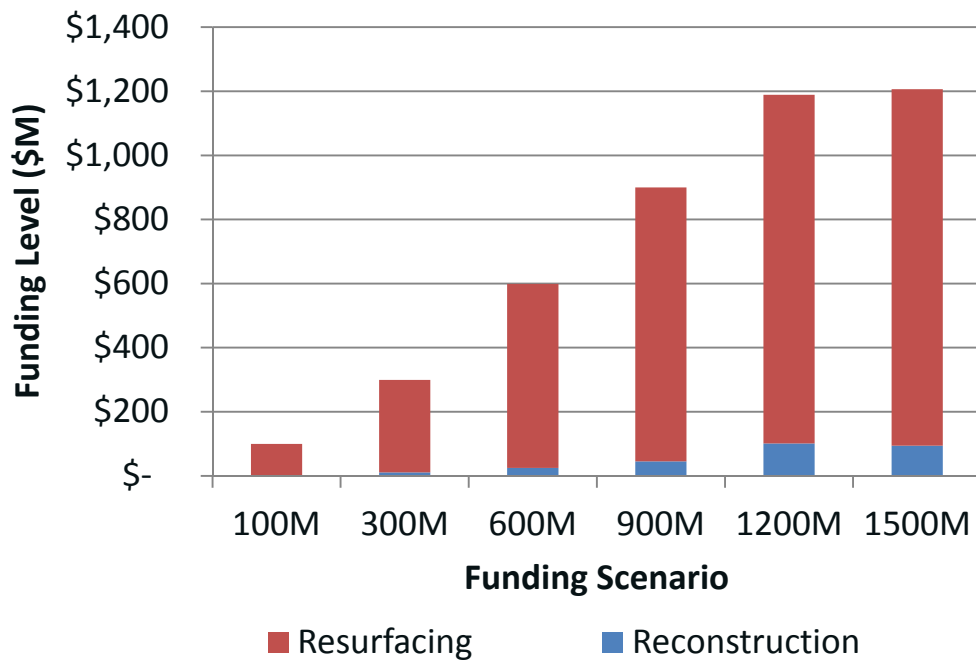
The team presented a set of hypothetical scenarios for discussion. Each scenario represented a different split of the available funds between the pavement and bridge programs. In practice, incorporating this type of tradeoff exercise is an iterative process. For example, an agency could ask decision makers in advance to define their priorities and preferred funding split, craft a small set of scenarios that illustrate key tradeoff decisions, revise the scenarios based on feedback received, etc.

The pilot participants discussed the relationship between state and regional performance targets and the implications of resource allocation across programs. While PennDOT has established statewide targets for pavement and bridge condition, the individual regional approaches for allocating funding across pavement and bridge programs may vary. The participants suggested that if regions conduct their own tradeoff analysis across programs, there will be a need to aggregate the results at the statewide level to compare against the statewide target. Adjustments at the state and/or regional levels may then be required. Ultimately, the agencies agreed that the key issue they are trying to address is how to make the best resource allocation decisions and to achieve statewide and/or regional targets regardless of ownership (i.e., local versus state system).

Examine Implication of Preferred Investment Scenario for Types of Investment

After identifying a preferred scenario for allocating resources across program areas, the next step involves determining the right mix of investments within each program (i.e., maintenance, resurfacing, reconstruction, etc.). Figure 4.5 presents sample HERS-ST output showing the optimal distribution between pavement resurfacing and reconstruction treatments based on various funding scenarios. As discussed above, it may be valuable to examine scenarios up front – i.e., focusing investments on maintenance and minimizing rehabilitation.

Figure 4.5 Pavement Treatment Distribution by Funding Level



Source: Cambridge Systematics

Use System Tradeoffs to Structure Investment Decisions

The last step in the process involves the selection of specific projects given the funding constraints for each bucket (i.e., pavement resurfacing, pavement reconstruction, bridge rehabilitation, and bridge reconstruction) established in the previous step. Projects within each bucket are then prioritized taking into account various criteria, such as condition level, corridor criticality (discussed in more detail in the following section), benefit-cost, and other evaluation factors.

Developing and Applying Priority Corridors

During the urban and rural webinars, the pilot agencies expressed an interest in exploring the use of a priority corridor network to influence the prioritization of preservation projects. Although no priority network has been officially defined or adopted in Pennsylvania, PennDOT has initiated previous efforts toward identifying a Core Pennsylvania Transportation System (CPTS) under guidance given by the Transportation Advisory Committee (TAC) and the Pennsylvania Mobility Plan.^{7,8} These efforts focused on identifying the modal facilities of the

⁷ Pennsylvania State Transportation Advisory Committee, *Defining a Core PA Transportation System – Final Report*, August 3, 2006.

highest importance for international, interstate, and interregional travel and were intended to help guide and prioritize transportation decisions at the state, regional, and local levels. While PennDOT originally focused its efforts on defining a core system for the state's highways and bridges, the scope gradually expanded to include other transportation modes (airports, rail freight, intercity passenger rail, ports and waterways, intercity bus, and transit). Prior to reaching internal PennDOT consensus on the state's core system or engaging the regional planning partners in the process, however, the most recent effort to define a multimodal CPTS stalled as the process grew overly complex.

Other states, including Florida, North Carolina, and Ohio, have defined and applied priority systems to support transportation planning and decision making. Examples include:

- **Florida Strategic Intermodal System** – Florida's Strategic Intermodal System (SIS) is a network of the state's largest and most significant multimodal transportation facilities. The highway corridor component of the SIS carries 55 percent of the state's total traffic and more than 70 percent of all truck traffic on the state highway system.
- **North Carolina Strategic Highway Corridors** – North Carolina has adopted a Strategic Highway Corridors (SHC) concept as part of its larger North Carolina Multimodal Investment Network (NCMIN) to protect and maximize mobility and connectivity on a core set of highway corridors throughout the state. The 5,400 miles of existing and proposed highways designated as North Carolina's SHC accounts for only seven percent of the state's highway system, but carries 45 percent of the traffic.
- **Ohio Macro Highway Corridors** – The Ohio DOT classified a portion of the state's highway system as Macro Highway Corridors, which include all Interstate routes and other segments that provide important interregional or intermodal connections. While the state's Macro Highway Corridors comprise only three percent of the state-owned system, they carry 28 percent of the state's daily vehicle miles traveled (VMT).

In each of these examples, the agencies followed a similar set of steps to define their priority systems and apply the system to support planning and programming decisions:

1. Establish objective selection criteria;
2. Define the priority system;
3. Use the priority system to structure resource allocation decisions; and
4. Monitor system performance.

⁸ Pennsylvania Department of Transportation, *Pennsylvania Mobility Plan*, <http://www.pamobilityplan.com/>

Each of these steps is explained in more detail below.

Establish Selection Criteria

Selection criteria are often based on quantitative measures of transportation usage and activity, such as average annual daily traffic (AADT), tons of freight, or percentage of trucks. Qualitative factors may also play a role, such as functional class and regional or multimodal connectivity. Table 4.2 summarizes the draft selection criteria used in PennDOT's most recent efforts to define a core highway system, as well as the criteria used to guide the corridor selection processes in Florida, North Carolina, and Ohio.

Table 4.2 Priority Corridor Selection Criteria

State – Priority Corridor System	Selection Criteria	Stratification
PA – Core Pennsylvania Transportation System*	Usage Regional connections	Tiered system based on AADT
FL – Strategic Intermodal System	Functional class Usage Interstate/regional connections	SIS Emerging SIS
NC – Strategic Highway Corridors	Usage Functional class Regional significance	Statewide Regional Subregional
OH – Macro Highway Corridors	Usage Functional class Regional connections	On or off system

* Draft selection criteria only. To date, no formal priority corridor system has been adopted in Pennsylvania .

Source: Cambridge Systematics

When creating a priority system, achieving acceptance and consensus on the selection criteria is one of the most important obstacles to overcome. It is important to involve planning partners, stakeholders, and the public when establishing selection criteria given the potential implications on resource allocation and project prioritization.

Define the Priority System

In each of the examples described above, the agencies applied criteria and thresholds to define a priority system. For example, the draft guidance developed by PennDOT proposed dividing the system into four tiers (Table 4.3). Tier 1 would include highways with an AADT greater than 25,000 or that provide a connection to a metropolitan statistical area (MSA) that crosses regional borders. Under this definition, Tier 1 would include approximately eight percent of the state's federal aid system (excluding the Pennsylvania Turnpike), accounting for 97 percent of the Interstate system and 45 percent of the state's National Highway System (NHS). The facilities included in

subsequent tiers would be categorized at the regional level based on traffic volumes.

Table 4.3 Conceptual Core Pennsylvania Transportation System

Tier	Selection Criteria	Total System Mileage
Tier 1	AADT > 25,000 or Facilities that connect regions	2,038 miles (7.5% of the system) 97% of the Interstate system 45% of the NHS
Tier 2	Rest of the NHS plus Next 20% of a region's federal aid network (based on AADT)	6,235 miles (22.5% of the system) 3% of the Interstate system 55% of the NHS
Tier 3	Next 30% of a region's federal aid network (based on AADT)	8,272 miles (30% of the system)
Tier 4	Remaining 40% of a region's federal aid network (based on AADT)	11,030 miles (40% of the system)

Note: Core system based on draft selection criteria only. To date, no formal priority corridor system has been adopted in Pennsylvania.

Source: PennDOT

During Workshop #2, the pilot participants discussed the process for defining a core system for Pennsylvania. While they agreed that the facilities categorized in the highest tier should include the state's Interstate highways and most heavily traveled freeways, not all regions have facilities that carry more than 25,000 AADT. To address the regional connectivity issue, there was some debate over the qualitative Tier 1 criteria for defining "facilities that connect regions." The participants suggested these connections should be developed through a bottom-up approach, where each region identifies their top employers and most heavily traveled corridors. PennDOT could then compile each region's Tier 1 facilities to develop a statewide map and assess how well the regions connect. The final Tier 1 network would then be refined through an iterative process.

Use the Priority System to Structure Resource Allocation Decisions

There are several different ways in which agencies have applied their priority systems to support planning and programming:

- **Target-setting** – This approach involves establishing different targets based on priority classification and/or tier. Agencies then allocate resources to work toward achieving the performance targets at each classification. Pennsylvania has applied this approach to its Business Plan Network by setting different pavement and bridge performance targets for each network classification. For example, PennDOT's statewide SD deficiency goal for bridges is 4.8 percent for Interstates, 5.5 percent for NHS facilities, 10.9 percent for non-NHS bridges carrying more than 2,000 vehicles per day, and

12.7 percent for non-NHS state-owned bridges carrying less than 2,000 vehicles per day.⁹ In turn, each region establishes its own targets by Business Plan Network as well.

- **Policy Level** – Some agencies choose to set policies to allocate funding specifically to the priority system. Florida’s policy, for example, is to allocate 75 percent of all discretionary funding on SIS or emerging SIS projects, leaving the remaining 25 percent for use on non-priority systems.
- **Project Selection** – Other agencies take a project-based approach by prioritizing projects that address priority system needs over non-priority facilities. For example, the Ohio DOT prioritizes major projects using a point system, and projects are awarded additional points if they are located on a Macro Highway Corridor. With this scoring system, however, a priority corridor designation does not mean that every project or need on the core system will be addressed prior to the needs on other non-core roadways.

Monitor System Performance

As with any performance-based management process, performance on a priority corridor system should be monitored and periodically updated to reflect changes in economic activity, agency goals and objectives, transportation technologies, available data, or other factors. Re-assessment may result in the inclusion of additional facilities as they become more significant in the future or a re-designation of state priorities based on a refined set of evaluation criteria. The Florida DOT, for example, has formalized a process for conducting a comprehensive statewide re-evaluation of the SIS at least once every five years, subsequent to updates of the Florida Transportation Plan. Through an inclusive process involving the DOT and its partners, the re-evaluation process includes a review of and any needed changes to SIS goals, objectives, and policies as well as corridor selection criteria and thresholds.¹⁰

Summary

Based on discussions among the Pennsylvania pilot participants, there is renewed interest in pursuing corridor prioritization as a way to support the prioritization of preservation projects at both the state and regional levels. PennDOT’s draft CPTS process provides a starting point for discussion, although input from the state’s regional planning partners will be necessary to refine the corridor selection criteria and address regional connectivity issues. This would

⁹ Pennsylvania Department of Transportation, *2010 Performance Measure Annual Report -- Bridges*, April 2011.

¹⁰ Florida Department of Transportation, *Strategic Intermodal System (SIS) Designation*, May, 5, 2011. <http://www.dot.state.fl.us/planning/sis/designationprocessdoc.pdf>

involve building consensus at both the state and regional levels on guiding principles for corridor selection criteria.

While the previous CPTS efforts have evaluated the core transportation system from a multimodal perspective, the participants expressed interest in narrowing the focus to highway preservation in the short term as a means to advance at least one element of a priority corridor system. Once established, the state's planning agencies could apply the process at both the state and regional levels and then compare the results to see where differences arise. Working collaboratively to discuss the relationship between regional and statewide priority designations, the planning partners could then develop a CPTS system that reflects both regional and statewide priorities.

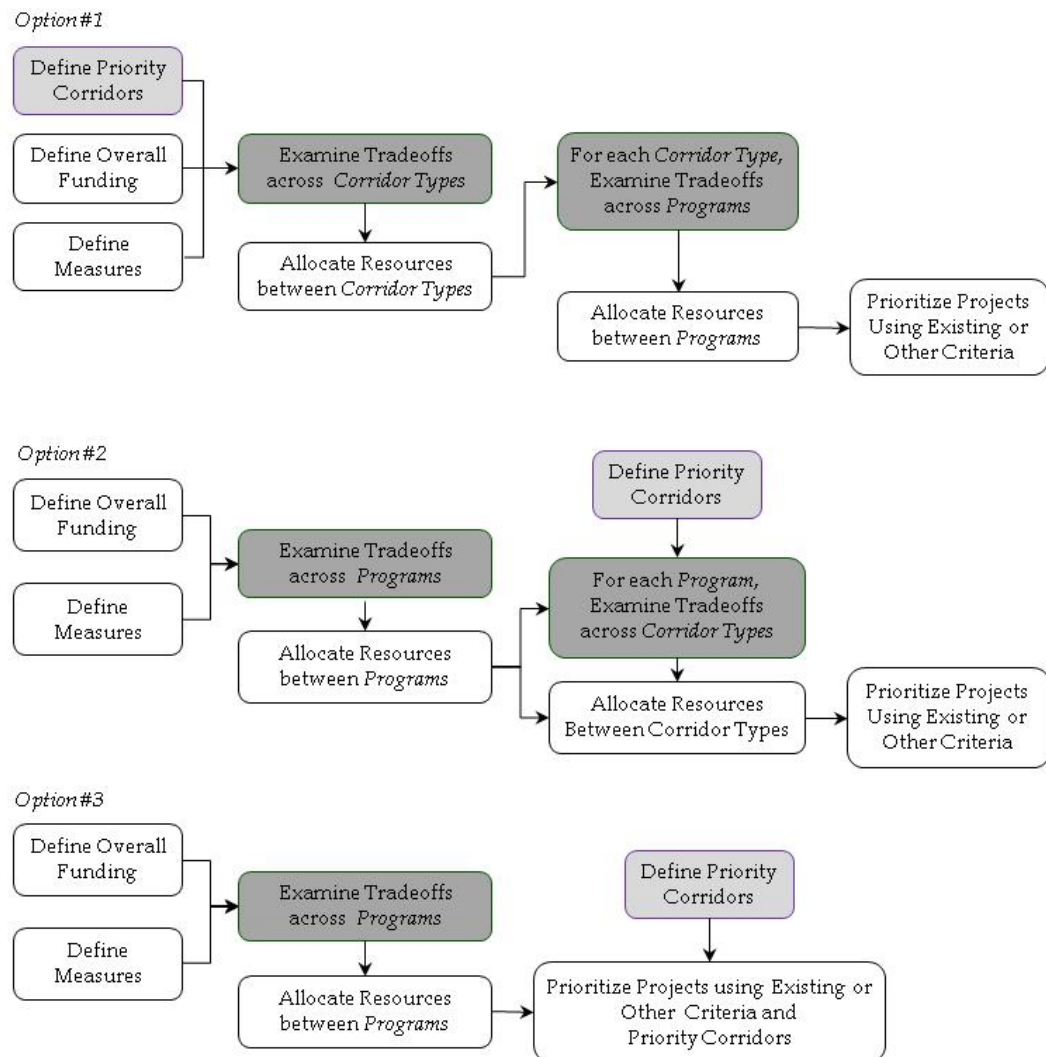
Interim Framework for Prioritizing Preservation Projects

Integrating the concepts of system-level tradeoffs and priority corridor systems described above, the research team developed three alternative frameworks to support preservation project prioritization (Figure 4.6). These potential frameworks provide three alternative approaches to support resource allocation decisions while PennDOT continues to make progress toward developing more sophisticated asset management systems. Each option incorporates priority corridor definitions and system-level tradeoff analysis alongside performance measures and funding constraints to prioritize projects, though the sequencing of activities varies:

- Option #1 involves defining priority corridors early in the process and examining tradeoffs across corridor types to allocate resources between the core system and non-core system (or tiers within system). For each corridor type, the next step involves an analysis of tradeoffs across programs (i.e., pavement, bridge, other) to allocate resources between programs. Once funding levels are established for each corridor type and program area, the agencies would apply performance measures or other criteria to prioritize projects within each corridor type and program.
- Option #2 involves program-level tradeoff analysis as the first step in the process. This process determines the allocation of funds across preservation programs (pavement, bridge, other) to achieve a particular performance target. A second iteration of tradeoff analysis involves priority corridor definitions to examine tradeoffs across corridor types within the program areas. Funding is further allocated between corridor types and then performance measures or other criteria are applied to prioritize projects within each bucket.
- Option #3 starts off similar to Option #2 by examining tradeoffs across programs and allocating resources between them. However, rather than conducting a second round of tradeoff analysis based on corridor type (core system versus non-core system), Option #3 incorporates priority corridor

definitions alongside other performance measures to prioritize projects within each program.

Figure 4.6 Interim Framework for Advancing the Prioritization of Preservation Projects in Pennsylvania



Source: Cambridge Systematics

The pilot participants discussed the pros and cons of each option, but ultimately preferred Options #2 or #3 because it helps to tell the story of transportation resource allocation. For example, it is anticipated that program-level tradeoff discussions will help to illustrate that there is insufficient funding to address all preservation needs in the state. Therefore, it will be necessary to identify priority corridors and address those needs first. The pilot participants also favored a simpler, shorter process to make it easier to explain to the public. Therefore, they proposed starting with option #3, and evolving to option #2.

4.3 POTENTIAL NEXT STEPS

The pilot participants identified the following potential next steps for advancing a more robust preservation prioritization approach.

- **Revisit the development of a priority corridor system.** The pilot participants identified several next steps for revisiting the establishment of a priority corridor system for Pennsylvania. Creating a working group would support the development of selection criteria and allow representatives from MPOs, RPOs, and PennDOT to work through the process for identifying regional and statewide priority corridors. Participants discussed focusing the priority corridor efforts on the pavement and bridge preservation programs initially, and then potentially expanding to other program areas over time. They also discussed the opportunity to use an upcoming planning workshop as the forum for discussing interregional priority corridors.
- **Incorporate program tradeoff analysis as part of the long-range planning process.** Participants noted an opportunity to incorporate program tradeoff analysis into PennDOT's upcoming long-range transportation planning effort. The tradeoffs could be conducted at the state and regional levels, and the results reconciled so that a consistent set of funding and performance targets for the pavement and bridge preservations programs could be included in the updated plan.
- **Incorporate funding and performance targets as part of the programming process.** Targets established in PennDOT's long-range plan could help to influence how preservation funds are allocated to PennDOT's regions during the programming process.
- **Explore the development of a 100 percent sample HPMS file.** As part of the pilot, the project team used HERS-ST to conduct a sample, statewide pavement tradeoff analysis. HERS-ST is an FHWA tool that requires HPMS data as input. Currently, PennDOT generates their HPMS file using a sampling approach. The participants discussed exploring the development of a 100 percent sample HPMS file using data from PennDOT's pavement management system in order to improve confidence in HERS-ST results at the regional level.
- **Communicate the disconnect between needs and available resources.** Participants discussed an opportunity to use the results of the program tradeoff analysis to help communicate the implications of current funding levels on future pavement and bridge performance. This type of analysis would help to set expectations for pavement and bridges in the state, and to strengthen the case for developing a priority corridor network and for implementing asset management tools and techniques.

5.0 Advancing Performance-Based Planning and Programming

The pilots conducted throughout this research effort addressed several aspects of performance-based planning and programming. They illustrated how a conceptual performance-based planning framework can be translated to practical, realistic processes. Each pilot involved transportation practitioners working together across agencies to discuss real world challenges. The participants also discussed and tested approaches for addressing these challenges that fit within the limitations of existing data resources, technical capabilities, and organizational structures.

From the three pilots emerged a set of common themes and lessons learned that may be applied by transportation agencies nationwide to advance the state of the practice in performance-based planning and programming. In addition, the pilot participants identified opportunities for additional national research and capacity building.

5.1 COMMON THEMES

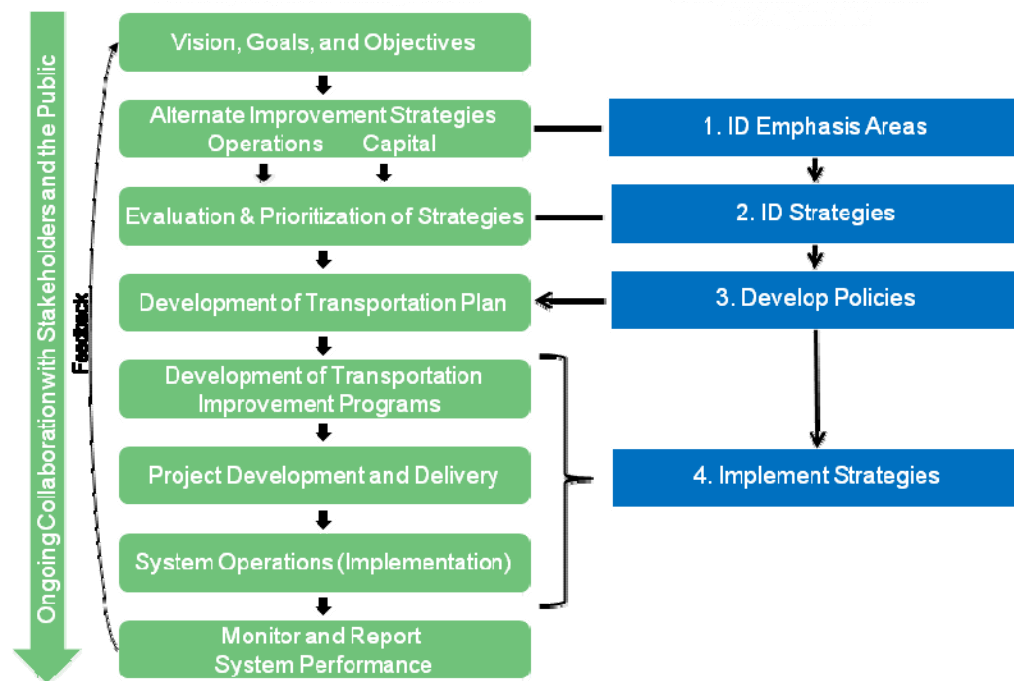
The following themes emerged from the pilots:

- There was consensus among all participating agencies regarding the benefits of performance-based planning and programming and the benefits of increased collaboration. At each pilot location, the agencies plan to keep moving forward, building from the pilot work.
- The participating agencies found the pilot workshops to be an excellent opportunity for sharing their existing planning practices, performance measures, and data efforts and identifying opportunities to coordinate more with their planning partners. In this respect, the pilots served as regional peer exchanges.
- A commonly discussed next step is to "do something concrete" so that agencies can point to a success (e.g., implementation of a project that resulted from a performance-based process, development of regional policies, identification of a priority corridor network, etc.) and build momentum. Without a sustained effort to maintain momentum and advance the state of the practice, it can become difficult to illustrate that taking a different approach leads to better decisions. The importance of building momentum suggests that incremental process improvements are better than waiting until the "ideal" comprehensive performance-based approach is possible.

- Each of the pilots addressed a different subset of the performance measures being considered for national implementation. The pilots illustrated that these measures can support performance-based planning at the state and regional levels. However, they also showed that project-level decisions may require additional data and measures. Performance measures may vary by geographic scale (network, corridor, or project). For example, the Pennsylvania pilot illustrated how IRI and SD status can be used both to evaluate network performance and to identify specific projects for individual assets. In contrast, the Kansas City pilot illustrated that while fatalities and injury measures are effective at the regional level, they are not as effective when evaluating specific locations and projects. The Maryland/DC pilot addressed the potential for multimodal reliability measures. However, these types of measures currently reflect an entire trip, not the portion of the trip that occurs along a specific segment of roadway.
- At the beginning of each pilot, data was discussed as a potential barrier to collaborative performance-based planning. However, in each case, quite a bit of work was done with existing data and tools. All work presented in this report, except for the sample performance-based project justification report, relied on existing data.
- The biggest opportunities for data improvement are in the area of data sharing between agencies. By taking the time to compare and discuss existing data resources and data needs, planning partners can identify opportunities to share data, avoid duplicate work, and incorporate additional considerations into planning and programming decisions.
- A fundamental challenge to collaborative performance-based planning is when the process moves from a group of agencies working together to prioritize strategies to when a single agency (or group of agencies) becomes responsible for funding and implementing them. At this point in the process, the results of the collaborative process need to compete with the implementing agency's other needs and priorities. Sustained coordination at the upper management and technical levels was identified as an important strategy to address this challenge. Another potential strategy is to use targeted line-item budgeting to increase the flexibility of the collaborative process without overburdening the implementing agency's processes.
- Another challenge is effectively communicating the results of performance analysis so that they can better influence decision making process. Improving the interface between technical analysis and decision making will be important for advancing performance-based planning and programming. Implementation efforts should start by asking the following question - "What information is needed in order to make better decisions?" Participants also noted the need to communicate how the public benefits from transportation expenditures rather than relying solely on performance measures. For example, why does it matter if the condition of pavements deteriorates 10 percent over the next several years?

- Silo-based planning and budgeting is a significant impediment to performance-based planning. Options discussed for addressing this challenge include increased coordination across agencies and silos, beginning network-level analysis by identifying the portion of the budget that is flexible (i.e., the portion that can be spent on any program and/or mode), and conducting tradeoff analysis assuming total flexibility and using the results to communicate the adverse implications of silo-based budgets to decision makers.
- In each pilot, the performance-based planning and programming process aligned well with the federally-required planning process. The pilot work illustrated the use of performance management techniques to enhance the steps in the federal process. For example, Figure 5.1 illustrates the relationship between the federally required process and the performance-based process illustrated during the KC region pilot. Similar figures were developed for the other two pilots as well.

Figure 5.1 Example Relationship between Performance-Based Planning and Federally Required Planning Process



Source: Cambridge Systematics

- While there are still some technical issues to address, the biggest barriers to collaborative performance-based planning and programming are organizational and institutional. Therefore, strong support from upper management can make a significant impact. An important first step within

an agency is to take an honest look at existing practices, identify specific areas where transportation decisions could be improved, and create buy-in for the use of performance management techniques to facilitate these improvements. Finally, a collaborative process requires a series of champions – one to take responsibility of the overall coordination effort, and one to take responsibility for progress within each of the participating agencies.

5.2 FINDINGS RELATED TO SPECIFIC PERFORMANCE MEASURES

The pilots also tested the application of potential national transportation performance measures at the state, regional, corridor and project levels. Lessons learned from this work include the following:

- **Fatalities and serious injuries**
 - The Kansas City region pilot illustrated how these two measures can support performance-based planning and programming. The measures could be even more effective when combined with roadway characteristic data to determine the types of facilities that are the most appropriate for systemic safety strategies.
 - The pilot also showed that variations between how two state DOT's define and compile these measures did not make a significant difference in the conclusions that were drawn from their analysis. For collaborative planning purposes, the definitions of the measures were "close enough." However, they may be a bigger concern if using the measures to make direct comparisons between the agencies.
 - Participants felt that these two safety measures were not always effective at the project level because of their sporadic nature and the desire to address safety issues proactively before crashes occur.
- **International Roughness Index (IRI)**
 - The Pennsylvania pilot illustrated that IRI can support a performance-based planning and programming process. In the pilot, IRI was used in program-level tradeoff analysis to support the allocation of funds across programs. This analysis was done with HERS-ST and PennDOT's HPMS file.
 - Participants identified the need to develop a 100 percent sample HPMS file in order to improve the confidence in HERS-ST analysis at the regional level.
 - Participants noted the desire to use a more comprehensive measure of pavement condition (such as a composite index) in the tradeoff analysis.

However, IRI was seen as an important interim measure until it was possible to project future values of the composite index.

- Participants felt that the combination of existing IRI and a composite condition index were adequate for identifying specific preservation needs and potential strategies.
- **Structurally deficient (SD) bridges**
 - The Pennsylvania pilot illustrated that SD status can support a performance-based planning and programming process. In the pilot, SD status was used in program-level tradeoff analysis to support the allocation of funds across programs. This analysis was performed by MPO staff based on an evaluation of historic National Bridge Inventory (NBI) data.
 - Participants felt that that SD status was not the ideal measure for identifying specific preservation needs and strategies because it is binary and not detailed enough. The ideal measure(s) would indicate the condition of individual bridge elements (e.g., deck, superstructure, and substructure).
- **Travel delay and travel reliability**
 - The Maryland/D.C. region pilot explored the use of a congestion measure (delay per traveler) and a reliability measure (planning time index) to identify and evaluate multimodal congestion hotspots.
 - Participants noted the difficulties in explaining planning time index and differed in their opinions regarding which of the two measures would resonate more with non-technical audiences.
 - They also noted advances in vehicle probe technology that were making reliability analysis possible, and technical challenges associated with moving beyond current reliability (e.g., understanding the impact on future reliability of potential strategies).
 - Finally, the participants noted that at the corridor and project levels, delay may be preferred over reliability because reliability is a trip-based measure that accounts for portions of trips that can occur outside of the location being analyzed.

5.3 OPPORTUNITIES FOR NATIONAL RESEARCH AND CAPACITY BUILDING

Finally, the pilot participants identified the following opportunities for national research that could help to further the practice of performance-based planning and programming:

- **Transit and pedestrian reliability** – Investigate the data requirements and analysis techniques required to develop a planning time index equivalent for transit vehicles and pedestrians. Complicating issues for transit include the role of scheduling and bus operations in addition to traffic conditions as the drivers of reliability.
- **Economic value of reliability** – Investigate ways to estimate the economic value of reliability that can feed into a benefit/cost analysis.
- **National tools** – Provide guidance on using FHWA tools such as HERS-ST and NBIAS to support performance-based planning at the state and regional levels. Identify enhancements to these tools required to better support a performance-based process. Develop sketch planning tools for safety analysis.
- **Arterial data** - Investigate opportunities to expand the collection of arterial travel time data, such as leveraging public-private partnerships. Investigate options for improving pavement condition data on non-state owned arterials. Investigate options for highway segment HPMS sampling to support regional analysis.
- **Risk management** – Investigate the relationship between performance management and risk management.
- **Safety strategies** – Investigate the implications of safety strategies (such as rumble strips) on pavement life. Develop a process for evaluating the cost effectiveness of potential systemic safety strategies (e.g., striping, guardrails, etc.).
- **Communicating benefits** – Investigate techniques for communicating performance information to non-technical audiences in terms of benefits.
- **Regional analysis peer exchanges** – Conduct peer exchanges focused on regional preservation analysis and safety analysis. These exchanges could be designed to enable MPOs to share their experiences. There also would be benefit in structuring a series of exchanges so that the MPOs in a particular state could meet with the state DOT and discuss opportunities to leverage the DOT's data and analytical capabilities.

A. Kansas City Region Safety Fact Sheets

The following fact sheets were developed by the research team as part of the KC pilot.

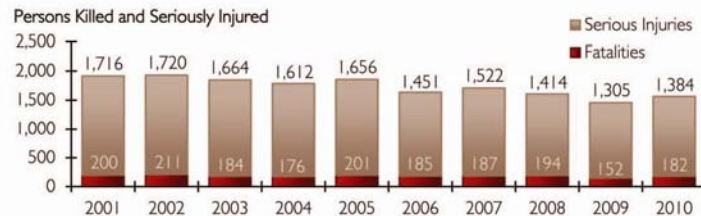
Motor Vehicle Crash Fatalities and Serious Injuries in MARC MPO



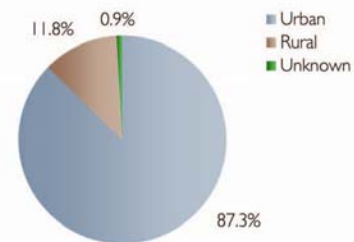
Historic Crash Trends

Crash-related fatalities in the Kansas City Mid-America Regional Council (MARC) Metropolitan Planning Organization (MPO) have decreased over the last 10 years by 8.5 percent. Over the same period crash-related serious injuries have decreased by almost 35 percent. Crash-related fatalities and serious injuries primarily occur in urban areas, with 87.3 percent on urban facilities compared to 11.8 percent on rural facilities.

Fatalities and Serious Injuries MARC

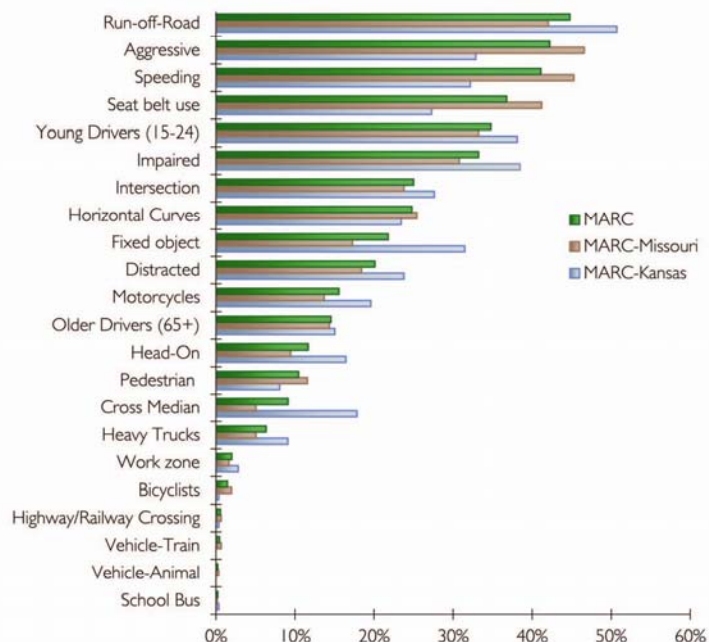


Fatalities and Serious Injuries 2006 to 2010, Urban/Rural Split



Fatalities by Crash Type

This chart provides a breakdown of the percentage of fatalities by crash type classified by total MARC MPO, Missouri MARC counties, and Kansas MARC counties for the period of 2006 to 2010. As shown, crashes identified as run-off-road represent the highest proportion of fatalities for the region overall (45 percent). However, the percentage of overall fatal crashes varies by crash types between the Missouri and Kansas counties. For example, in Kansas, the greatest proportion of fatal crashes (51 percent) involves run-off-road crashes, followed by impaired driving crashes and young driver crashes (both at 38 percent). In Missouri, the greatest proportion of fatal crashes involve aggressive driving (47 percent), followed by speeding (45 percent), and then run-off-road crashes (42 percent). Some of these discrepancies may be attributed to differences in data definitions between Kansas and Missouri (discussed separately), while others may reflect the nature of driving conditions in the two states.



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Fatalities and Serious Injuries by Crash Type and County

This table summarizes the fatalities and serious injuries by crash type in the MARC MPO classified by total MARC, Kansas MARC, Missouri MARC, urban roads, rural roads, and the individual MARC counties. The top five crash types for each location are highlighted. Again, differences may result from data differences while some areas also may experience differences in the leading factors contributing to serious crashes.

Fatalities and Serious Injuries, 2006 to 2010												
	MARC	MARC-Kansas	MARC-Missouri	Urban	Rural	Johnson (Kansas)	Leavenworth (Kansas)	Wyandotte (Kansas)	Cass (Missouri)	Clay (Missouri)	Jackson (Missouri)	Platte (Missouri)
Total	7,976	2,116	5,860	1,793	252	1,175	216	725	387	1,182	3,864	427
Infrastructure												
Run-off-Road	2,583	859	1,724	2,091	458	403	109	347	142	363	1,030	189
Intersection	3,213	615	2,598	2,984	207	404	56	155	125	510	1,872	91
Head-On	536	176	360	412	107	85	33	58	42	79	199	40
Fixed Object	1,173	574	599	959	168	270	68	236	39	98	434	28
Work Zone	185	79	106	164	16	50	5	24	6	32	57	11
Horizontal Curves	1,485	386	1,099	1,234	234	176	59	151	52	273	631	143
Highway/ Railway Crossing	6	1	5	6	0	0	0	1	0	3	2	0
Driver Behavior												
Aggressive	2,740	642	2,098	2,389	335	300	70	272	122	431	1,384	161
Speeding	2,290	542	1,748	1,965	311	217	69	256	101	313	1,189	145
Impaired	1,368	437	931	1,161	191	214	58	165	58	175	626	72
Seat Belt Use	2,243	1,035	1,208	1,901	310	627	86	322	110	257	744	97
Distracted	2,014	604	1,410	1,757	240	335	56	213	81	279	963	87
Young Drivers (15-24)	2,046	905	1,141	1,642	261	486	84	335	79	261	706	95
Older Drivers (65+)	694	298	396	606	76	163	31	104	41	91	248	16
Special User												
Pedestrian	478	103	375	457	17	51	13	39	13	38	304	20
Bicyclists	113	33	80	107	5	25	2	6	6	14	57	3
Vehicles												
Motorcycles	933	298	635	777	150	162	47	89	44	148	380	63
Heavy Trucks	332	134	198	274	55	72	14	48	19	37	118	24
School Bus	24	6	18	22	2	1	0	5	2	6	10	0
Vehicle-Train	7	0	7	5	2	0	0	0	0	3	3	1
Vehicle-Animal	58	15	43	43	15	8	4	3	5	12	21	5

Statewide Safety Plans

The table on the right compares the emphasis/ focus areas identified in the Kansas and Missouri strategic highway safety plans (SHSP). Although Kansas identifies fewer emphasis areas, they all parallel areas identified in Missouri's SHSP. Within the common infrastructure emphasis areas, run-off-road and intersection crashes fall into the top five fatal and serious injury crashes in most areas of the region. Horizontal curves does not fall into the top five crash types when all emphasis areas are considered but is high on the list for infrastructure-related crashes. Of the common driver behavior emphasis areas, impaired driving, seatbelt use, and young drivers also appear as one of the top five crash types in several locations throughout the MARC MPO.

Emphasis Area/Focus Area		Kansas	Missouri
Infrastructure	Run-off-Road	X	X
	Intersection	X	X
	Head-On		X
	Fixed Object		X
	Work Zone		X
	Horizontal Curves	X ^a	X
Driver Behavior	Highway/Railway Crossing		X
	Aggressive		X
	Impaired	X	X
	Seat Belt Use	X	X
	Distracted		X
	Young Drivers (15-20)	X	X
	Older Drivers (65+)	X	X
	Unlicensed Drivers		X
Special User	Pedestrian		X
	Bicyclists		X
Vehicles	Motorcycles		X
	Commercial vehicles	X	X
	School Bus		X

^a Horizontal curves addressed in Kansas' run-off-road emphasis area



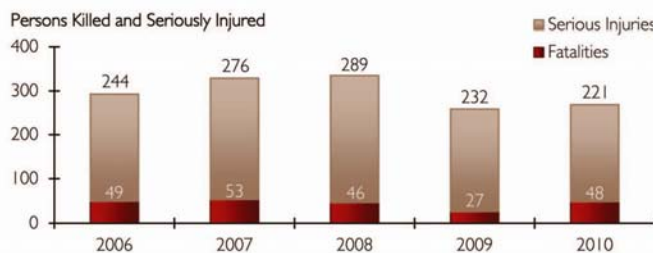
Horizontal Curve Crash Fatalities and Serious Injuries in MARC MPO



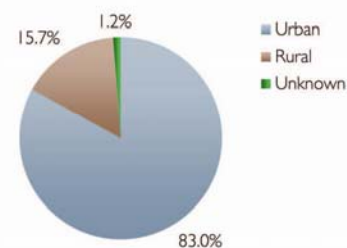
Historic Horizontal Curve Crash Fatality and Serious Injury Trends

Although there was an increase between 2006 and 2008, horizontal curve crash-related fatalities and serious injuries in the Kansas City Mid-America Regional Council (MARC) Metropolitan Planning Organization (MPO) decreased by 8.2 percent overall during the five-year period between 2006 and 2010. During this same period, 83 percent of the horizontal curve-related fatalities and serious injuries in MARC occurred in urban areas, while 15.7 percent occurred in rural areas.

Horizontal Curve Fatalities and Serious Injuries MARC



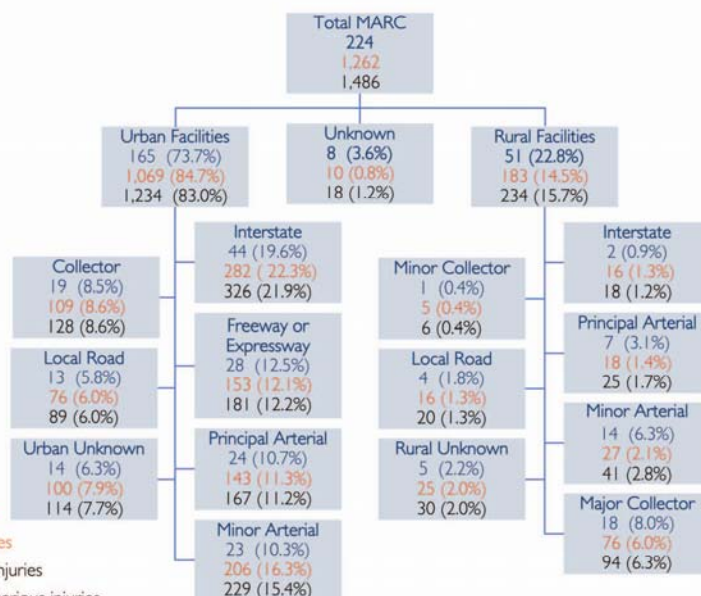
Horizontal Curve Fatalities and Serious Injuries 2006 to 2010, Urban/Rural Split



Horizontal Curve Crash Fatalities and Serious Injuries by Facility Type

The number of horizontal curve fatalities and serious injuries by urban/rural split in MARC were further disaggregated by the facility on which they occurred. Again, the vast majority of fatalities and serious injuries associated with horizontal curves occur on urban facilities. Of those, almost 30 percent occur on the roadways classified as Interstate.

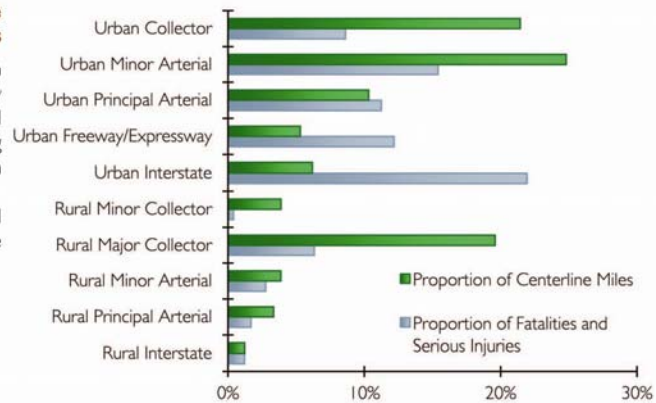
X = Number of fatalities
(X%) = Percent of fatalities
X = Number of serious injuries
(X%) = Percent of serious injuries
X = Total fatalities and serious injuries
(X%) = Percent of fatalities and serious injuries



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Comparison of Proportion of Horizontal Curve Fatalities and Serious Injuries and Centerline Miles

This figure provides a comparison of the proportion of total centerline miles associated with each roadway functional classification to the proportion of total horizontal curve fatalities and serious injuries occurring on each facility. Most notably, combined Urban Interstates and Freeways/Expressways represent 34.1 percent of fatalities and serious injuries on horizontal curves, but only 11.5 of total centerline miles within the MARC MPO.



Horizontal Curve Strategies in the Statewide Safety Plans

The Strategic Highway Safety Plans (SHSP) for Kansas and Missouri in the following table were compared to identify overlapping strategies for reducing horizontal curve fatalities and serious injuries.

Kansas Strategies	Missouri Strategies
<ul style="list-style-type: none"> Create a program that funds the deployment of low-cost safety improvements at rural or high-speed urban horizontal curves (Roadway Departure strategy). 	<ul style="list-style-type: none"> Install centerline and shoulder rumble stripes where possible. Upgrade and improve shoulder treatment (pave shoulders and eliminate edge drop-offs). Expand and maintain roadway visibility features (signing such as curve signs and pavement marking such as optical speed bars). Improve roadway structure (increase pavement friction).

Missouri's strategy to "Expand and maintain roadway visibility features (signing such as curve signs and pavement marking such as optical speed bars)" is consistent with Kansas' broader strategy of deploying low-cost safety improvements at horizontal curves. It also is worth noting, in addition to extensive research supporting the effectiveness of signage, it is included in the Federal Highway Administration's (FHWA) nine proven countermeasures as an effective approach to reducing crashes on horizontal curves.

Policy Recommendation for Addressing Horizontal Curve Crashes on MARC Roadways

Based on the preceding data analysis and seeking to align with statewide priorities and key safety strategies in both Kansas and Missouri, the following policy statement is suggested for consideration by the MARC MPO:

"MARC will coordinate with implementing agencies to expand and maintain signage where appropriate to reduce the occurrence of severe crashes on horizontal curves, with an emphasis on Urban Interstates and Freeways/Expressways."



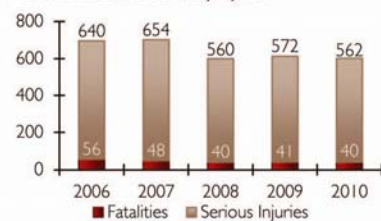


Historic Intersection Crash Fatality and Serious Injury Trends

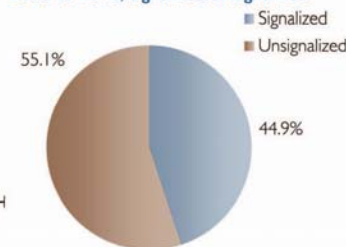
Intersection crash-related fatalities in the Kansas City Mid-America Regional Council (MARC) Metropolitan Planning Organization (MPO) decreased overall during the five-year period between 2006 and 2010. Slightly more than half (55.1 percent) of these fatalities and serious injuries occurred at unsignalized intersections. Approximately 93 percent of the intersection crash-related fatalities and serious injuries occurred at urban intersections.

Intersection Crash Fatalities and Serious Injuries MARC

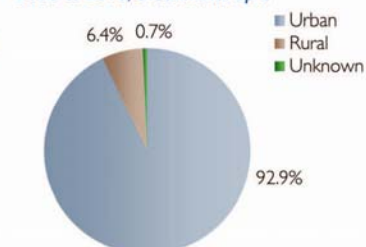
Persons Killed and Seriously Injured



Intersection Fatalities and Serious Injuries 2006 to 2010, Signalized/Unsignalized



Intersection Fatalities and Serious Injuries 2006 to 2010, Urban/Rural Split



Intersection Crash Fatalities and Serious Injuries by Facility Type

The number of intersection crash fatalities and serious injuries by signalized/unsignalized split in MARC were further disaggregated by urban/rural split and facility on which they occurred in the following table.

	Signalized Intersections			Unsignalized Intersections		
	Fatalities	Serious Injuries	Total	Fatalities	Serious Injuries	Total
Rural						
Interstate	0	0	0 (0%)	0	0	0
Principal Arterial	0	7 (0.5%)	7 (0.5%)	8 (6.0%)	53 (3.2%)	61 (3.4%)
Minor Arterial	0	3 (0.2%)	3 (0.2%)	11 (8.3%)	36 (2.2%)	47 (2.7%)
Major Collector	0	3 (0.2%)	3 (0.2%)	14 (10.5%)	47 (2.9%)	61 (3.4%)
Minor Collector	0	0	0	0	1 (0.1%)	1 (0.1%)
Local Road	0	0	0	2 (1.5%)	7 (0.4%)	9 (0.3%)
Rural	0	0	0	3 (2.3%)	13 (0.8%)	16 (0.9%)
Total Rural	0	13 (1.0%)	13 (0.9%)	38 (28.6%)	157 (9.6%)	195 (11.0%)
Urban						
Interstate	1 (1.5%)	7 (0.5%)	8 (0.6%)	0	13 (0.8%)	13 (0.7%)
Freeway/Expressway	4 (4.3%)	134 (9.9%)	138 (9.6%)	18 (13.5%)	129 (7.9%)	147 (8.3%)
Principal Arterial	33 (35.9%)	561 (41.3%)	594 (41.1%)	25 (18.8%)	380 (23.2%)	405 (22.9%)
Minor Arterial	42 (45.7%)	460 (34.0%)	502 (34.8%)	21 (15.8%)	455 (27.8%)	476 (26.9%)
Collector	6 (6.5%)	90 (6.7%)	96 (6.6%)	10 (7.3%)	176 (10.8%)	186 (10.5%)
Local Road	1 (1.1%)	36 (2.7%)	37 (2.6%)	14 (10.5%)	105 (6.4%)	119 (6.7%)
Urban	2 (2.2%)	46 (3.4%)	48 (3.3%)	4 (3.0%)	211 (12.9%)	215 (12.2%)
Total Urban	89 (96.7%)	1,334 (98.7%)	1,423 (98.5%)	92 (69.2%)	1,469 (89.8%)	1,561 (88.2%)
Unknown						
Unknown	3 (3.3%)	5 (0.4%)	8 (0.6%)	3 (2.3%)	10 (0.6%)	13 (0.7%)
Total	92	1,352	1,444	133	1,636	1,769

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Intersection Strategies in the Statewide Safety Plans

The Strategic Highway Safety Plans (SHSP) for Kansas and Missouri were compared to identify overlapping strategies for reducing intersection crash-related fatalities and serious injuries, which are identified in the following table. Overlap exists between the bolded strategies in the Kansas and Missouri plans, which include installation of roundabouts.

Kansas Strategies	Missouri Strategies
<ul style="list-style-type: none"> Develop a method (system) to define an “expected” or acceptable number of crashes in order to identify intersections with potential to be improved. Promote the use of roundabouts, both low-speed urban and high-speed rural. 	<ul style="list-style-type: none"> Improve intersection awareness (install stop-approach rumble strips; improve signage and intersection visibility; improve sight distance; install dynamic flashing beacons; install or enhance intersection lighting). Implement innovative engineering designs (install roundabouts; install J-turns; add offset turn lanes; use traffic calming strategies (narrowing lanes, etc.)). Modify signal phasing and timing (protect left-turn movement; provide adequate clearance times (ITE guidelines); provide dilemma zone protection). Upgrade signal identification to assist officers in enforcing red-light violations. Remove unwarranted signals. Use proper planning and design of access to public roadways (access management planning).

Kansas’ strategy to “Promote the use of roundabouts, both low-speed urban and high-speed rural” is consistent with Missouri’s broader strategy of implementing innovative engineering designs. It also is worth noting, in addition to extensive research supporting the effectiveness of roundabouts, it is included in the Federal Highway Administration’s (FHWA) nine proven countermeasures as an effective approach to reducing crashes at intersections.

Policy Recommendation for Addressing Intersection Crashes on MARC Roadways

Based on the preceding data analysis and seeking to align with statewide priorities and key safety strategies in both Kansas and Missouri, the following policy statement is suggested for consideration by the MARC MPO:

“MARC will coordinate with implementing agencies to consider installation of roundabouts where appropriate to reduce the occurrence and severity of intersection crashes, with an emphasis on urban principal and minor arterials.”



B. PennDOT Performance Reports

The following reports were developed by the Pennsylvania DOT outside of this research project.

2010 Performance Measures Annual Report -- Pavements

SPC MPO

Current Pavement Smoothness Summary by Business Plan Network

Business Plan Network	Total Segment Miles	IRI						Low Level Network	
		Tested Segment Miles	Excellent Seg-Mi	Good Seg-Mi	Fair Seg-Mi	Poor Seg-Mi	Median IRI	Segment Miles	Seal Coat Out-of-Cycle Seg-Mi
Interstate	488.5	482.4	275.5	103.2	85.6	18.1	65		
NHS, Non-Interstate	1,070.2	1,012.4	298.8	432.2	209.2	72.2	96		
Non-NHS, ≥ 2000 ADT	3,122.0	3,070.5	824.0	1,343.0	551.9	351.6	126	154.7	0.5
Non-NHS, < 2000 ADT	4,093.6	4,007.6	396.6	832.3	1,057.4	1,721.4	207	2,803.4	30.3
Total - Roadway	8,774.3	8,573.0	1,794.8	2,710.7	1,904.1	2,163.3		2,958.1	30.8

Current Overall Pavement Index Summary

Business Plan Network	Total Segment Miles	OPI						Surface Out-of-Cycle Seg-Mi	Pavement Age > 40 years Out-of-Cycle Seg-Mi
		Tested Segment Miles	Excellent Seg-Mi	Good Seg-Mi	Fair Seg-Mi	Poor Seg-Mi	Median OPI		
Interstate	488.5	440.9	112.5	312.5	15.9	0.0	93	40.6	6.3
NHS, Non-Interstate	1,070.2	955.3	145.3	650.8	131.8	27.4	89	270.7	213.7
Non-NHS, ≥ 2000 ADT	3,122.0	3,045.7	469.3	1,305.7	1,154.0	116.8	83	1,122.2	
Non-NHS, < 2000 ADT	4,093.6	3,998.0	575.7	2,079.7	1,046.3	296.3	75	559.1	
Total - Roadway	8,774.3	8,439.9	1,302.7	4,348.8	2,348.1	440.4		1,992.6	220.0

Interstate and NHS, Non-Interstate Goals

Goal: Reduce Poor IRI

Business Plan Network	Long Range	Target	Actual
	% IRI Seg-Mi	2011 % IRI Seg-Mi	2010 % IRI Seg-Mi
Interstate	1.5%	3.3%	3.8%
NHS, Non-Interstate	5.0%	6.7%	7.1%

Goal: Maintain % Good and Excellent OPI

Business Plan Network	Long Range	Target	Actual
	% OPI Seg-Mi	2011 % OPI Seg-Mi	2010 % OPI Seg-Mi
Interstate	96.4%	96.4%	96.4%
NHS, Non-Interstate	83.3%	83.3%	83.3%

Goal: Reduce Surface Out-of-Cycle (Fair and Poor OPI)

Business Plan Network	Long Range	Target	Actual
	% OPI Seg-Mi	2011 % OPI Seg-Mi	2010 % OPI Seg-Mi
Interstate	0.7%	0.7%	0.7%
NHS, Non-Interstate	8.6%	8.6%	8.6%

Goal: Maintain Pavement Potentially Past Design Service Life, Out-of-Cycle (Poor OPI)

Business Plan Network	Long Range	Target	Actual
	% OPI Seg-Mi	2011 % OPI Seg-Mi	2010 % OPI Seg-Mi
Interstate	0.0%	0.0%	0.0%
NHS, Non-Interstate	0.6%	0.6%	0.6%

Non-NHS Goals

Goal: Maintain Poor IRI

Business Plan Network	Long Range	Target	Actual
	% IRI Seg-Mi	2011 % IRI Seg-Mi	2010 % IRI Seg-Mi
Non-NHS, ≥ 2000 ADT	11.5%	11.5%	11.5%
Non-NHS, < 2000 ADT	43.0%	43.0%	43.0%

Goal: Maintain % Good and Excellent OPI

Business Plan Network	Long Range	Target	Actual
	% OPI Seg-Mi	2011 % OPI Seg-Mi	2010 % OPI Seg-Mi
Non-NHS, ≥ 2000 ADT	58.3%	58.3%	58.3%
Non-NHS, < 2000 ADT	66.4%	66.4%	66.4%

Goal: Maintain Surface Out-of-Cycle (Poor OPI)

Business Plan Network	Long Range	Target	Actual
	% OPI Seg-Mi	2011 % OPI Seg-Mi	2010 % OPI Seg-Mi
Non-NHS, ≥ 2000 ADT	2.5%	2.5%	2.5%
Non-NHS, < 2000 ADT	0.8%	0.8%	0.8%

Goal: Reduce Seal Coat (Low Level) Network Out-of-Cycle

Business Plan Network	Long Range	Target	Actual
	% Seg-Mi	2011 % Seg-Mi	2010 % Seg-Mi
Non-NHS, ≥ 2000 ADT	0.0%	0.3%	0.3%
Non-NHS, < 2000 ADT	0.0%	0.9%	1.1%

Note: for the Interstate and NHS, Non-Interstate Business Plan Networks, the IRI and OPI data is for 2010. For the Non-NHS Business Plan Networks, the IRI and OPI data for most recent year captured, either 2009 or 2010.

Note: Pavement Potentially Past Design Service Life, Out-of-Cycle is defined as old pavements (pre-2009 pavement age) greater than 40 years.

Note: Long-Range Goals are for 5-years (2015).

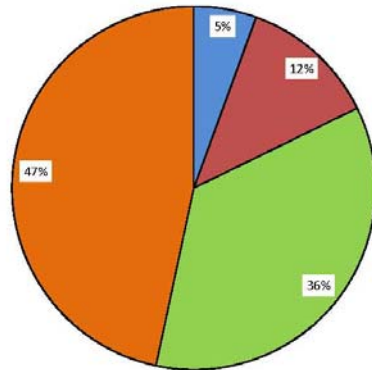
Legend

Target - Optimum Threshold
Target - Cautionary Threshold
Actual - At Optimum Threshold
Actual - At Cautionary Threshold
Actual - Not Meeting Cautionary Threshold

2010 Performance Measures Annual Report -- Pavements

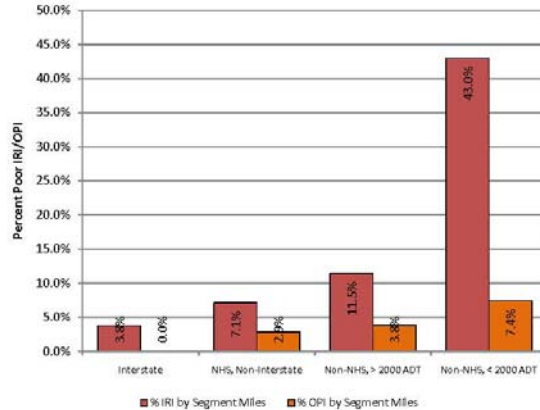
SPC MPO

Percent Segment Miles
by Business Plan Network

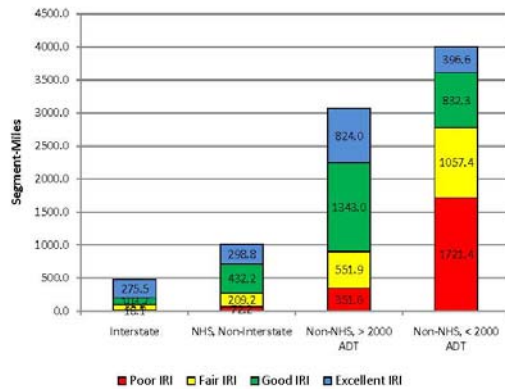


■ Interstate ■ NHS, Non-Interstate ■ Non-NHS, > 2000 ADT ■ Non-NHS, < 2000 ADT

Percent of Segment Miles with a Poor IRI
and Poor OPI by Business Plan Network

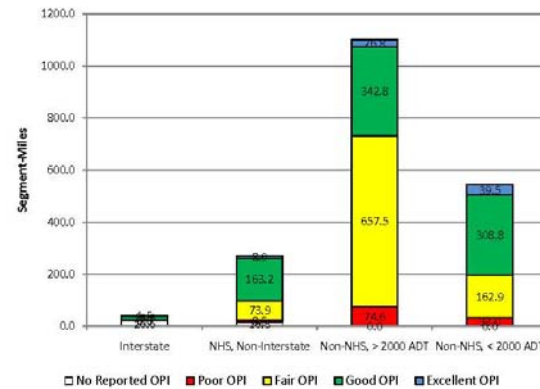


Segment Miles by Business Plan
Network with IRI Ratings



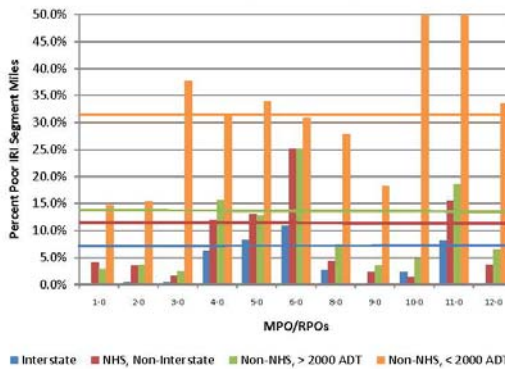
■ Poor IRI ■ Fair IRI ■ Good IRI ■ Excellent IRI

Surface Out-of-Cycle Segment Miles by
Business Plan Network with OPI Ratings



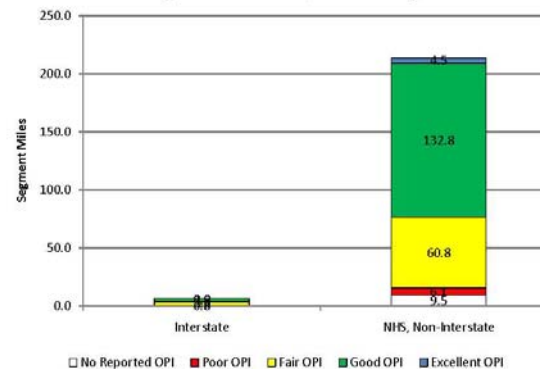
■ No Reported OPI ■ Poor OPI ■ Fair OPI ■ Good OPI ■ Excellent OPI

Percent Poor IRI by MPO/RPO, by
Business Plan Network



■ Interstate ■ NHS, Non-Interstate ■ Non-NHS, > 2000 ADT ■ Non-NHS, < 2000 ADT

Segment Miles of Pavement Potential Past
Design Service Life, Out-of-Cycle

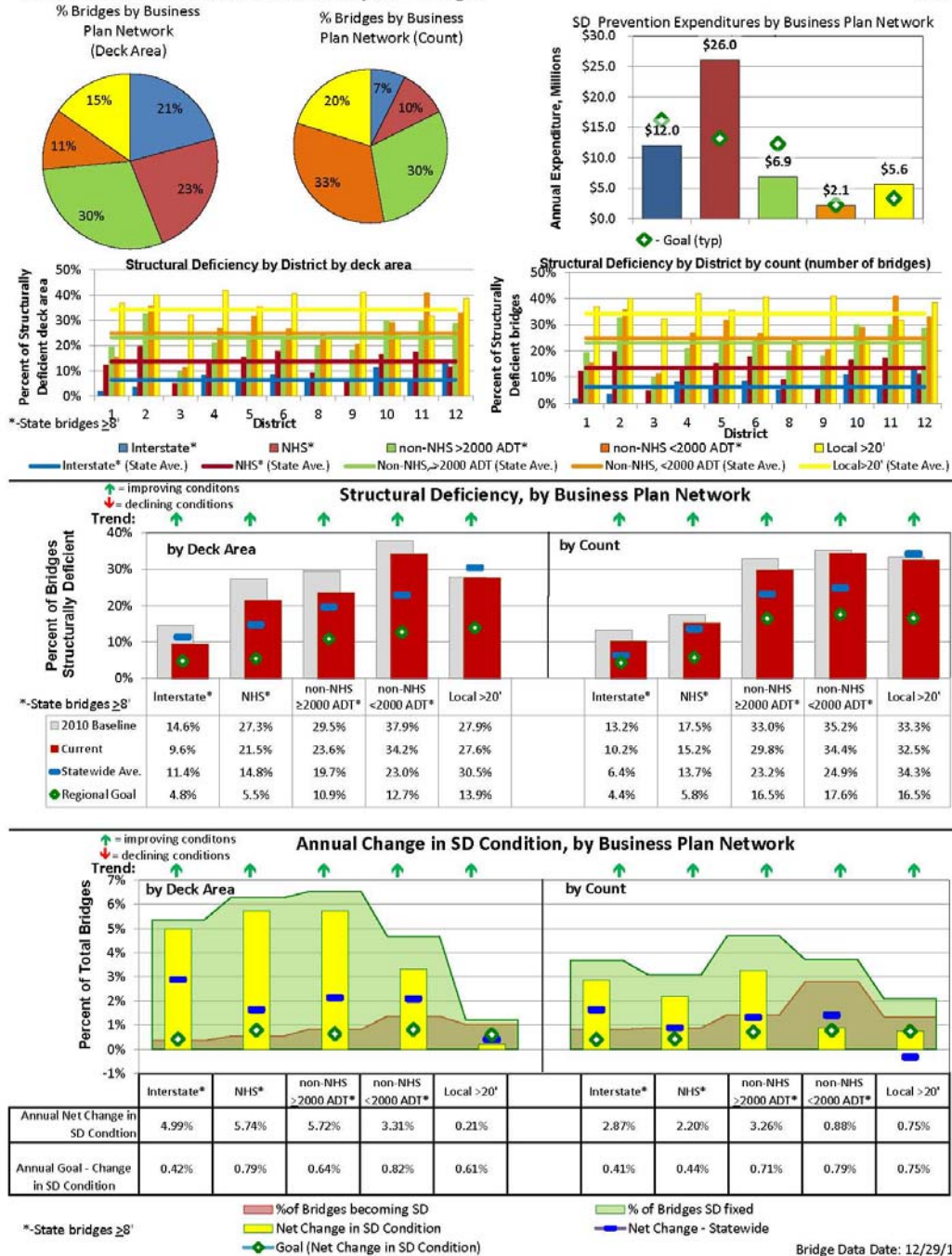


■ No Reported OPI ■ Poor OPI ■ Fair OPI ■ Good OPI ■ Excellent OPI

Version 7-MPO/RPO, 4/20/2011

2010 Performance Measures Annual Report -- Bridges

SPC



2010 Performance Measures Annual Report -- Bridges

SPC

Current Status of Bridges in Region:

Network	Total Bridge Count	Total Deck Area (Msf)	Aver. Bridge DA (sf)	Closed Bridges	Posted Bridges	Struct. Deficient Count	% SD by Count	SD-Deck Area (Msf)	% SD by Deck Area	Non-SD Bridges with a "5" Condition Rating
State ≥8'; Interstate/Ramps	488	6.2955	12,901	0	0	50	10.25%	0.6020	9.56%	122
State ≥8'; NHS (non Interstate)	683	7.0370	10,303	0	2	104	15.23%	1.5140	21.52%	190
State >8'; non-NHS >2000 ADT*	1,961	8.9479	4,563	4	43	584	29.78%	2.1140	23.63%	576
State ≥8'; non-NHS <2000 ADT	2,165	3.3996	1,570	6	165	744	34.36%	1.1641	34.24%	654
Total - State Bridges (≥8')	5,297	25.6809	4,848	10	210	1,482	27.98%	5.3941	21.01%	1,542
Local>20'	1,340	4.6279	3,454	40	421	435	32.46%	1.2760	27.57%	335

Annual Performance Measures - by SD Bridge Count									
Goals:	% SD by Count			Reducing Rate of Deterioration			Annual Net SD Reduction		
Network	Long Range Goal SD Count (max.)	Target 2011 SD Count (max.)	Actual SD Count	Max. Annual New SD Count	Max. Annual New SD Count (State-wide Ave.)	Actual Annual New SD Count (SD "on")	Min. Net Annual SD Count Reduction	Min. Net Annual SD Count Reduction	Net Actual SD Count Reduction
State ≥8'; Interstate/Ramps	21	62	50	0	2	4	2	2	14
State ≥8'; NHS (non Interstate)	40	116	104	2	9	6	3	2	15
State >8'; non-NHS >2000 ADT*	324	633	584	15	29	28	14	11	64
State ≥8'; non-NHS <2000 ADT	382	746	744	22	39	61	17	13	19
Total - State Bridges (≥8')	766	1557	1482	39	79	99	36	28	112
Local>20'	222	433	435	13	31	18	10	8	10

Annual Performance Measures - by SD Deck Area (DA)									
Goals:	% SD by Deck Area			Reducing Rate of Deterioration			Annual Net SD Reduction		
Network	Long Range Goal % SD by DA (max.)	Target %2011 SD DA (max.)	Actual %SD DA	Max. Annual New % SD DA	Max. Annual New % SD DA	Actual Annual New SD DA (SD "on")	Min. Net Annual % SD DA Reduction	Min. Net Annual % SD DA Reduction	Net Actual % SD DA Reduction
State ≥8'; Interstate/Ramps	4.8%	14.2%	9.6%	0.00%	0.90%	0.36%	0.42%	0.32%	4.99%
State ≥8'; NHS (non Interstate)	5.5%	26.5%	21.5%	0.25%	1.47%	0.53%	0.79%	0.59%	5.74%
State >8'; non-NHS >2000 ADT*	10.9%	28.8%	23.6%	0.75%	1.34%	0.82%	0.64%	0.48%	5.72%
State ≥8'; non-NHS <2000 ADT	12.7%	37.0%	34.2%	1.00%	1.38%	1.37%	0.82%	0.62%	3.31%
Total - State Bridges (≥8')	8.0%	25.7%	21.0%	0.46%	1.24%	0.70%	0.65%	0.49%	5.23%
Local>20'	13.9%	27.2%	27.6%	1.00%	1.55%	1.02%	0.61%	0.45%	0.21%

		Annual Performance Measures - SD Prevention					Legend
Goals:	SD Prevention - Expenditures			SD Prevention - Count			
Network	Min. SD Prevention (million\$)	Min. SD Prevention (million\$)	Actual SD Prevention (million\$)	Min. SD Prevention (# bridges)	Min. SD Prevention (# bridges)	Actual SD Prevention (# bridges)	
State ≥8'; Interstate/Ramps	\$16.17	\$8.09	\$12.03	12	9	17	Target - Optimum Threshold
State ≥8'; NHS (non Interstate)	\$13.19	\$6.60	\$26.04	15	11	20	Target - Cautionary Threshold
State >8'; non-NHS >2000 ADT*	\$12.27	\$6.13	\$6.87	35	26	27	Actual - At Optimum Threshold
State ≥8'; non-NHS <2000 ADT	\$2.25	\$1.12	\$2.14	26	20	16	Actual - At Cautionary Threshold
Total - State Bridges (>8')	\$43.88	\$21.94	\$47.08	88	66	80	Actual - Not Meeting Cautionary Threshold
Local>20'	\$3.35	\$1.67	\$5.62	13	10	7	

Bridge Data Date: 12/29/10