

Congestion Management Toolbox Update

final

report

prepared for

Mid-America Regional Council

prepared by

Cambridge Systematics, Inc.

with

Shockey Consulting Services Olsson Associates

December 31, 2013

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1.0 Introduction

FHWA recommends the following steps in managing congestion for a region (Figure 1.1):

- Congestion management **objectives** should be developed with meaningful stakeholder participation and an understanding of the needs and desires of the public related to congestion. Ideal objectives should be SMART: Specific, Measureable, Agreed, Realistic, and Time-bound
- Define the geographic boundaries and the system components/network of facilities. Although the CMP has traditionally focused primarily on the road network, the **network** should consider the transit, bicycle, and pedestrian networks as well as their interface with the highway network
- **Performance measures** should be developed and used at the regional level to measure the performance of the system and the local (corridor, segment, intersection) level to identify specific locations with congestion problems and measure the performance of individual segments and system elements. They may be adapted and adjusted over time.
- Numerous agencies must collaborate to **collect data and monitor system performance**.
- Raw data is translated into meaningful measures of performance to **analyze congestion problems and needs**. The analysis should include locations of major trip generators, seasonal traffic variations, time-of-day traffic variations, and separation of trip purpose.
- The data and analysis can then be used to **identify and assess CMP strategies** to effectively manage congestion and achieve congestion management objectives. Important considerations include contribution to meeting regional congestion management objectives, local context, contribution to other goals and objectives, and jurisdiction over CMP strategies.
- Next, these strategies should be **programmed and implemented**. This occurs on system/regional, corridor, and project levels.
- After implementation, agencies should **evaluate strategy effectiveness** through system-level performance evaluation and strategy-effectiveness evaluation.



Figure 1.1 Elements of the Congestion Management Process

Effective congestion management goes beyond capacity expansion. Capacity expansion can be the most expensive solution, and may not be an effective long term solution despite the costs. Additionally, other regional goals and objectives may be incorporated into the planning and programming decisions that result in implementation of various congestion management strategies.

Therefore, congestion management is not just individual technical solutions: it is an overall approach, built on strong working partnerships amongst stakeholder agencies.

Why manage congestion? Businesses attempt to adapt to increasing congestion, but these adaptations incur costs due to increased travel time and vehicle operating costs. This results in goods and services that are more expensive and economic productivity is reduced. While truck traffic represents only 5 percent of the total vehicle miles, the freight sector experiences about 27 percent of congestion costs.¹ Ultimately, this can also affect global economic competitiveness.

¹ AASHTO, Effective Practices for Congestion Management, 2008

This report provides a set of tools in the form of a Congestion Management Toolbox to assist the MARC region and its constituent agencies in making investments that effectively manage congestion over the long-term, facilitating the "Identify and Assess Strategies" element of the process in Figure 1.1. This report provides:

- Local context and national practice in congestion management toolboxes and types of strategies;
- An assessment of the effectiveness of several implemented strategies in the MARC region, and a description of the assessment methodology so that it can be duplicated for other projects in the future; and
- A Congestion Management Toolbox of strategies for the MARC region.

The new set of strategies can be found in tables beginning on page 4-3. The strategies are categorized as:

- Access Management
- Active Transportation
- Highway
- Transportation Operations and Management
- Land Use
- Parking
- Regulatory
- Transit
- Transportation Demand Management (TDM)

In these tables, readers will find:

- A list of the projects and strategies;
- How they reduce congestion and how they should be analyzed in specific locations;
- Tools that can be used to do this evaluation;
- Order-of-magnitude cost estimates to assist in selecting the best strategy; and
- Suggestions regarding which strategies are complementary and in what situations they are best used together.

2.0 Local Context and National Practice

2.1 LITERATURE REVIEW

Existing CMP Policy in the MARC Region

On December 18, 2001, the MARC Board of Directors adopted a Congestion Management System (CMS) policy to be compliant with the Federal regulations adopted as part of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). In 2005, the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) transportation bill was signed into law. Along with this, various changes were made to the Federal regulations pertaining to metropolitan planning, including a change in requirements from MPOs having a CMS to having a Congestion Management Process (CMP). In MARC's 2009 Triennial Certification Review, the U.S. Department of Transportation (USDOT) identified the need for MARC to update the region's CMP. As a result, MARC adopted a new CMP policy on May 24, 2011.

Congestion Management Process (CMP) Policy

Federal regulation 23 CFR 450.320 requires that a congestion management process shall be developed, established, and implemented as part of the metropolitan transportation planning process. The development of a congestion management process should result in multimodal system performance measures and strategies that can be reflected in the metropolitan transportation plan (MTP) and transportation improvement program (TIP). The 2011 CMP policy provides a framework for how MARC will address the Federal CMP requirements and meet the unique needs of the Kansas City metropolitan area. It defines the relationship of CMP to the regional LRTP, TIP, corridor studies, and regional Intelligent Transportation Systems (ITS) architecture. As part of the regional architecture development process, and subsequent updates, outreach is conducted to a range of agencies in the region. These include state, regional and local transportation agencies as well as first responders and emergency management agencies. This provides an opportunity to identify projects for the CMP that may not otherwise be included. In addition ITS projects must be included in the regional architecture in order to be eligible for Federal funding.

The CMP policy also describes an eight-step regional CMP framework consistent with the official guidance issued by the USDOT:

- 1. Develop congestion management objectives
- 2. Identify area of application

- 3. Define system/network of interest
- 4. Develop performance measures
- 5. Institute system performance monitoring plan
- 6. Identify and evaluate strategies
- 7. Implement selected strategies and manage transportation system
- 8. Monitor strategy effectiveness

For step six – identify and evaluate strategies--the CMP policy refers to the CMP toolbox, which contains in detail a wide range of congestion reduction strategies applicable to the Kansas City region.

Previous Congestion Management Toolbox

In 2001, coinciding with the adoption of CMS policy, an Enhanced Congestion Management System (CMS) was developed for the Kansas City region. A CMP toolbox was developed as a component of the CMS to provide a reference of alternative strategies to consider in corridor studies and NEPA documents. A wide range of congestion reduction strategies applicable to the Kansas City region is documented in the toolbox, organized in the following eight categories:

- 1. Highway projects;
- 2. Transit projects;
- 3. Bicycle and pedestrian projects;
- 4. Transportation Demand Management (TDM) strategies;
- 5. ITS and Transportation System Management (TSM) strategies;
- 6. Access management strategies;
- 7. Land development strategies; and
- 8. Parking management strategies.

Under each of the categories, a list of strategies and projects are provided, as well as their potential for congestion reduction, implementation cost, schedule, and analysis method. This toolbox facilitates a systematic process when planning roadway capacity projects. Agencies can use this toolbox to quickly go through a wide variety of strategies, eliminating strategies that are not appropriate for a certain transportation facility and identifying the ones with potential to be carried further as alternatives to adding capacity to the roadways.

Relevant Local Examples

As part of its efforts to reduce congestion and improve multi-modal performance, MARC takes part in a number of transportation programs and projects in the Kansas City region, including: Operation Green Light, Kansas City Scout, I-35 corridor studies, RideShare program, SmartMoves, special

transportation, bicycle and pedestrian programs, a complete streets program, MetroGreen project, and others. While a ride range of projects were considered for use as examples, the three selected represent a range of improvements, different modes and facilities and use of different tools. Operation Green Light, Kansas City Scout and the I-35 Operational Study are described in more detail here.

Operation Green Light

Operation Green Light is a regional effort to improve traffic flow and reduce vehicle emissions. Operation Green Light is coordinated among Federal, State, and local agencies. The objective is to develop and implement a system that will improve traffic signal communication and coordination between traffic signal equipment across jurisdictional boundaries and optimize signal timing plans. Phase I of this project started in 2002, providing new communication equipment, replacing some signal controllers, supplying traffic signal coordination software, and developing and installing new timing plans on a network of more than 600 intersections in 20 jurisdictions. The capital cost of the project was \$13.1 million; and its initial annual operation cost is \$1.2 million. The system currently includes 22 partner agencies and operates 684 signals through a central software system. OGL owns the communications system, which is primarily wireless with use of some fiber-optic technology. The OGL budget is currently \$1.1 million annually including \$610,000 for operations and \$490,000 for maintenance.² The improvement in travel speed along the Phase I corridors after deployment of Operation Green Light Phase 1 was predicted to be 17%. Evaluations have been conducted for some individual corridors and these have shown improvements in the ranges predicted. Delay reductions do vary by time of day. On the Noland Road corridor, for example, signal timing improvements implemented by OGL resulted in delay reductions of 2% in PM Peak, 15% in mid-day and 21% in AM peak.

² MARC, Operation Green Light Strategic Plan, 2013-2016



Figure 2.1 Operation Green Light Buildout Communication Plan

KC Scout

KC Scout is Kansas City's bi-state (KDOT and MoDOT) traffic management system. It is designed to reduce traffic congestion by improving rush-hour speeds; increase safety by decreasing the number of rush-hour crashes; and improve emergency response to traffic situations. KC Scout manages traffic on more than 125 miles of continuous freeways in the greater Kansas City metropolitan area. KC Scout uses cameras to monitor the highways from its traffic management center in Lee's Summit, relies on sensors to gauge traffic flow, uses large electronic message boards to send urgent traffic notices to drivers along the freeways, and activates a highway advisory radio system that motorists in Missouri can tune to in the event of a freeway incident (Figure 2.2).



Figure 2.2 KC Scout Traffic Management Components

The capital cost of the project was \$43 million. Of that amount, the Federal Highway Administration (FHWA) contributed 80-90 percent of the project cost. KDOT and MoDOT shared the remaining cost. At \$43 million for an initial 75-mile project, KC Scout's deployment costs average \$573,000 per mile. That compares with a conservative \$3-\$6 million cost per mile for a single, new lane of roadway.

The KC Scout program has a very high overall benefit-to-cost ratio. For every dollar spent, the program provides approximately \$8 in benefits to transportation system users and system management agencies (Figure 2.3). These benefits equate to reduced travel times and congestion, lower crash rates, savings in fuel and other operating costs, and cleaner air from reduced carbon emissions.



Figure 2.3 KC Scout Program Benefits

I-35 Corridor Studies

I-35 is a critical corridor running north-south through the heart of Kansas City. Both KDOT and MoDOT have conducted several studies for the I-35 corridor in the past.

In 2011, MoDOT completed an I-35 Operational Study, in which a 2.5-mile section of I-35 from 12th Street to the Kansas state line was studied. This study was intended to determine the current and future operational needs of the existing I-35 corridor; develop improvement concepts for addressing those needs; and recommend a range of concepts to meet identified needs in the I-35 corridor. Based on the review of the corridor, access to amenities near the corridor and mobility on or around the interstate were identified as the key operational issues. To address these issues, a range of concepts was developed and divided into three categories based on estimated implementation costs. The lower-cost concepts include restriping lanes, improving signage systems, ramp metering, and streetscape; the medium-cost concepts include ramp modifications and interchange modifications; higher-cost concepts include interchange reconstruction and adding new ramps.

In 2012, KDOT and MARC conducted a I-35 corridor study known as "I-35 Moving Forward". The study team was comprised of KDOT, MARC and an advisory group comprised of Federal Highway Administration (FHWA), as well as state, city, county and private industry representatives. The study examined options to keep traffic moving safely and reliably for now and in the future. The study investigated innovative ways to address I-35's congestion issues through Johnson and Wyandotte counties. This study recommended short, medium, and long-term improvements for I-35 through 2040 and beyond. The study team identified an initial list of more than 70 strategies but ultimately reduced it to five recommended practical and preferred strategies after technical analysis and feedback from the advisory group. They are:

- 1. Intelligent transportation system (ramp metering, advanced traveler information, traffic incident management and arterial dynamic message signs);
- 2. Multi-modal (bicycle and pedestrian improvements, transit improvements including Bus on Shoulder, park and ride lots and express transit routes);
- 3. Fixing key bottlenecks (focused on I-35 bottleneck improvements such as interchange and auxiliary lane improvements);
- 4. Shoulder running (restricted peak hour and incident use to some combination of transit, HOV, HOT) in concert with crash investigation sites and active traffic management lane control; and
- 5. Managed lanes (priced managed lane with supporting ITS of a toll collection system).

Cost estimates were developed at a planning level for this study as shown in Table 2.1.

	Capital Cost	O&M Cost	Total Cost
Short-Term (2013-2020)	\$30M	\$39M	\$69M
Mid-Term (2020-2040)	\$304M	\$45M	\$349M
Long-Term (2040+)	\$614M	\$89M	\$703M

Table 2.1Recommended I-35 Improvements: Summary Costs (2012
Dollars)

Source: I-35 Moving Forward

National Studies

Two national level studies were reviewed as part of this task: The Congestion Management Process: A Guidebook and Effective Practices for Congestion Management: Final Report.

The Congestion Management Process: A Guidebook

The Federal Highway Administration's (FHWA) developed *The Congestion Management Process: A Guidebook to advance the Congestion Management Process* in April 2011. This guidebook provides information on how to create an objective-driven, performance-based CMP. It provides practitioners with an understanding of the individual elements of a CMP and includes practical examples of how to implement a successful process based on lessons learned from MPOs across the country. This guidebook describes a flexible framework of 8 actions that should be included in the development of a CMP. It also highlights the role of the CMP in addressing multiple objectives, including livability, multimodal transportation, linkages with environmental review, collaboration with partners and stakeholders, demand management and operations strategies, and effective practices for documentation and visualization. It summarizes a wide range of congestion management strategies grouped in the following categories:

- Demand Management Strategies
 - Promoting Alternatives
 - Managing and Pricing Assets
 - Work Patterns
 - Land Uses
- Traffic Operations Strategies
 - Highway/Freeway Operations
 - Arterial and Local Roads operations
 - Other Operations Strategies
- Public Transportation Strategies
 - Operations Strategies
 - Capacity Strategies
 - Accessibility Strategies
- Road Capacity Strategies

This guidebook provides a couple of examples of MPOs developing a "toolbox" of strategies for consideration by local governments. The New York Metropolitan Transportation Council (NYMTC) has a CMP toolbox that identifies strategies in nine categories. It highlights congestion, mobility benefits, and costs and impacts of each strategy. The Grand Valley Metro Council in Grand Rapids, Michigan refers to its approach as a "Cafeteria Plan,", which also identifies a list of strategies along with their benefits. Some areas have also developed a hierarchy of strategies, drawing on policy goals or principles.

This guidebook also suggests techniques for evaluating and selecting strategies including the use of committees or group consensus, the refinement of standard strategies based on local characteristics, and staff-level technical analysis.

Information collected through monitoring of implemented strategies can be most helpful in evaluating the success of individual strategies and targeting specific strategies to applications where they have demonstrated success.

Effective Practices for Congestion Management: Final Report

In 2008, as part of National Cooperative Highway Research Program (NCHRP) Project 20-24, a national research study entitled *Effective Practices for Congestion Management* was conducted with the intent to develop a succinct review of current knowledge and thinking about the relationship among transportation congestion, economic activity and growth at regional and national levels, and about congestion mitigation strategies that can be posed as models for wide adoption in metropolitan areas. Congestion mitigation strategies are organized into four broad categories addressed at reducing highway congestion:

- Category A Adding capacity/physical improvements;
- Category B Using existing capacity more efficiently/operational improvements;
- Category C Reducing demand for vehicle travel; and
- Category D Reducing congestion on transit vehicles.

Within these broad categories, 32 strategies are identified and evaluated on their effectiveness (local and areawide), extent of application (current and potential future), implementation issues (cost, non-cost barriers, and timeframe), and potential solutions to the implementation issues. In addition, interactive effects of some strategies are also identified and discussed in this report. Based on the evaluation of this report, the current most commonly implemented strategies are loading zone management, traffic signal timing and coordination, and roadside electronic screening/clearance program for commercial vehicles; the strategies estimated to have more extensive application in the future, in addition to the three existing ones, include ramp metering, incident management, traveler information system, vehicle infrastructure integration, road pricing, transit enhancements, transit capacity expansion, and transit peak-period pricing.

Other Regional Practices

As part of this task, a number of CMP toolbox applications in other states and regions, such as New York, Denver, Salt Lake City, and Oregon DOT, were reviewed. The review was focused on the following aspects:

- Use of toolboxes as a concept and types of information included in the toolbox;
- Types of strategies; and
- Impacts of strategies and evaluation methodologies.

New York Metropolitan Transportation Council (NYMTC)

The New York Metropolitan Transportation Council's Congestion Management Toolbox is modeled similarly to MARC's previous effort.³ The congestion management toolbox is included as part of an overarching process and includes strategies for mitigating congestion. The toolbox comprises measures for use in planning additional congestion reduction strategies. The toolbox is divided into eight categories: highway strategies, transit strategies, bicycle and pedestrian strategies, travel demand strategies, intelligent transportation systems (ITS) and transportation supply management (TSM) strategies, access management strategies, land use strategies, parking strategies, and regulatory strategies. NYMTC first released a congestion management system in 2005 with updates in 2008 and 2013.

As part of its CMT, NYMTC includes congestion and mobility benefits as well as information related to costs and impacts. Strategies included in NYMTC's toolbox that are not currently addressed by MARC are heavily focused on transit and include employer incentive programs, electronic payments systems/universal farecards, intelligent transit stops, transit signal priority, enhanced transit amenities, dedicated rights of way for transit, and improved bicycle and pedestrian facilities at transit stations. Other potential new strategies include bike sharing programs, service patrols, one-way streets, and turn restrictions.

Denver Regional Council of Government (DRCOG)

Denver Regional Council of Governments' (DRCOG) congestion mitigation toolkit, released in June of 2008, is part of the region's overall congestion mitigation program. This program is heavily related to the region's travel demand management program, the DRCOG Way To Go Program (commuting solutions program), the traffic signal program, and the ITS, Management, and Operations Program.

The toolkit consists of three overarching categories: active roadway management, travel demand management/alternative travel modes, and physical roadway capacity. Active roadway management strategies are described by DRCOG as strategies that usually include implementation ITS infrastructure and operational controls. Strategies or projects include signal timing, installation of traffic management technologies such a cameras, vehicle detectors and variable message signs, and development of traffic management centers. Travel demand management and alternative travel mode strategies promote and encourage the use of travel alternatives to reduce the demand for single occupant vehicle (SOV) trips. Examples include transit operational improvements, educational and marketing programs, and the provision for bicycle and pedestrian facilities.

³ http://www.nymtc.org/project/CMS/cms.html

Colorado DOT has also published a separate Transportation Demand Toolkit for these types of efforts. Physical roadway capacity strategies involve construction within a roadway right-of-way and typically include adding travel lanes and/or improving roads, intersections or alternative mode features. These types of projects are immediately noticeable to the public.

DRCOG's toolkit consists of 34 strategies housed within one of the three aforementioned categories. The toolkit provides a one-page overview of each strategy, with visuals and figures when applicable. The toolkit encourages implementation of modest, small-scale projects that will reduce traffic delay and increase mobility, perhaps delaying or avoiding higher cost roadway expansion projects. Each strategy is comprehensively covered with a description, applicable locations/situations, cost (low-moderate-high as well as a description and/or estimate), timeframe(short-term, medium-term, long-term), benefits, related strategies, and other factors or considerations.

Strategies of note that are not included in MARC's existing toolbox include acceleration/deceleration lanes, hill climbing lanes, grade separated railroad crossings, electronic toll collection, cordon area congestion fees, and roundabout intersections.

Maricopa Association of Governments (MAG)

The Maricopa Association of Governments toolkit and screening tool are part of their overarching congestion management process. Figure 2.4 presents the "Results" tab of the screening tool. Blue indicates projects with the greatest potential to mitigate congestion (i.e., a higher score), while red indicates projects with the least impact on congestion (i.e., a lower score). In the example shown below, Project 3 would have the greatest impact on congestion, while Project 9 would have the least impact.



Figure 2.4 MAG Screening Tool Results Tab

The CMP toolbox is a key component to the screening tool and can be used as a starting point when MAG and its members are selecting and screening alternation transportation solutions (Step A), selection and analysis tool if the detailed analysis approach is selected (in Step C), and in selection performance measures for quantitative criteria (Step E). The toolbox includes congestion impacts, a description of potential implementation costs, implementation timeframe (short-term, medium-term, long-term), as well as suggested analysis tools.

The CMP analysis and screening process that the toolbox feeds into is an approach to project evaluation that combines performance analysis with an assessment of how well each potential project supports stated policy goals and objectives. The MAG CMP Analysis and Screening Process can be used to screen and prioritize potential projects based on their effectiveness in mitigating congestion in the region.

The tool is designed for flexibility so the user can adjust values, criteria, and weighting to be consistent with committee priorities and other available information. The tool is in spreadsheet format and calculates scores for both quantitative and qualitative criteria as well as an overall ranking of each project entered by the user based on user defined weights and scores using the CMP objectives and toolbox strategies.

Strategies of note that are not included in MARC's existing toolbox include rideshare and vanpool programs and bicycle and pedestrian education programs.

Wasatch Front Regional Council (WFRC)

The Wasatch Front Regional Council (WFRC) in Salt Lake City has a congestion management process that identifies a variety of strategies available to the region in order to mitigate congestion. Although no congestion management toolbox is developed to facilitate the CMP, the region has made available a list of air quality improvement strategies and implementation information pertaining to these strategies. Due to the close relationship between air quality improvement and congestion mitigation, these strategies were also reviewed as part of this task. The air quality improvement strategies are divided into the following categories: operational, behavioral changes, alternative transportation modes, financial mechanisms, land use development, and vehicle efficiency and technology. This includes a category for parties primarily responsible for implementation.

Strategies of note that are not included in MARC's existing toolbox include public education campaigns, dynamic speed control ("go slow to go fast"), and user fees (e.g., parking, registration, fuel tax, HOT fees).

Oregon DOT

Oregon DOT creates a Greenhouse Gas Reduction Toolkit (GHG Toolkit) following Oregon Senate Bill 1059 (SB 1059) to provide a comprehensive list of actions and programs that local governments in Oregon' metropolitan areas could implement to reduce transportation-related GHG emissions. The toolkit is a database with query capabilities and actions and strategies organized by strategic categories, much like many congestion management toolkits. Strategy categories include: bicycle and pedestrian, capacity expansion/bottleneck relief, fleet, land use and built environment, multimodal freight, operational/ITS, pricing, and public transportation. Each strategy includes the following: description, effectiveness at reducing GHG emissions, cost effectiveness, time required to implement, time required to become effective, degree to which certain strategies require authority to implement beyond the authority available at the local government level, and information about the types of actions or programs that complement each other and yield synergistic or enhanced effects. The toolkit serves both as a general resource as well as a guide for the scenario planning process.

Strategies of note that are not included in MARC's existing toolbox are heavily related to pricing and taxation policies that reduce congestion by changing travel behavior or affecting land use and transportation supply. These include congestion pricing, traditional and non-traditional toll roads, Vehicle Miles Travelled (VMT) fees, traffic impact fees, and pay-as-you-drive insurance.

South Florida Commuter Services (SFCS) Program

South Florida Commuter Services' (SFCS) mission is to reduce roadway congestion by promoting alternatives to single-occupancy vehicle travel through free transportation programs and services such as carpool/vanpool

ride-matching, transit trip planning, I-95 managed lane ("95 Express") education and assistance, and the Emergency Ride Home Program. SFCS helps commuters decrease the number of trips taken on the roadways, thereby lessening congestion. Based on the program's report in 2008⁴, the total program budget for FDOT District 4 and District 6 was close to \$2.9 million in FY 2008. This covers the operational costs (\$1.7 million), marketing (\$1.1 million), and Emergency Ride Home program. The observed benefits of the program were:

- 24% increase in calls received
- 40% increase in website hits
- 34% increase in sign-ups for the carpool and vanpool programs (from 23,421 to 31,368)

The I-95 managed lanes opened in December 2008, which coincides with the reported benefits. The opening of the managed lanes should have also contributed to the increase in sign-ups for carpool and vanpool programs.

Education is one of the key elements of this program; education also appears as a strategy for air quality improvement with the WFRC. However, education was not included in the last MARC toolbox.

2.2 STAKEHOLDER INTERVIEWS

To gain insight into current congestion management practices, a series of stakeholder interviews were conducted. The interviews addressed each agency's role in congestion management, the congestion management tools used and how they were evaluated, and how the CMT might be improved to better serve the region. Table 2.1 shows the participants that were interviewed as a part of this assessment and their relevant organizations.

Interviewee	Organization
Dennis Randolph	City of Grandview, Missouri
Tim Green	City of Lenexa, Kansas
Steve Schooley	City of Lenexa, Kansas
Shannon Jeffries	City of Lee's Summit, Missouri
Michael Park	City of Lee's Summit, Missouri
Wei Sun	City of Kansas City, Missouri

Table 2.2 Stakeholder Interviews

⁴ South Florida Commuter Services Annual Report 2008

Srinivasa Veeramullu	City of Kansas City, Missouri
Thomas Dow	City of Olathe, Kansas
Mark Sherfy	City of Shawnee, Kansas
Fred Backus	Unified Government of Wyandotte County, Kansas City, Kansas
Bill Heatherman	Unified Government of Wyandotte County, Kansas City, Kansas
Lideana Laboy	Unified Government of Wyandotte County, Kansas City, Kansas
Dave Northup	Unified Government of Wyandotte County, Kansas City, Kansas

Participants were asked:

- 1. What is your agency's role in the congestion management process?
- 2. How have you identified:
 - a. The locations where a strategy should be implemented?
 - b. The best strategies for those locations?
- 3. What types of strategies have you used to mitigate congestion?
- 4. Which of these strategies have been most effective? How did you evaluate the effectiveness? Why do you think they were so effective?
- 5. Which have been least effective? Why?
- 6. Have you used the Congestion Management Toolbox published by Mid-America Regional Council (MARC) as a reference?
- 7. What additional tools or information would be helpful for your agency to better do its job? Tools could include additional ideas and technologies for congestion management strategies, and other information could include things such as sketch evaluation techniques, better data, etc.

A record of all the surveys can be found in Appendix A, but they are summarized in the sections below.

Agency Role in Congestion Management

Generally, the city staff is charged with traffic signal timing, safety analysis, signal design, maintenance, coordination with developers, traffic impact studies, and similar roles.

Project and Strategy Identification

Most of the jurisdictions respond to complaints in addressing many congestion issues. However, some have more resources than others. Olathe, Kansas has a full traffic operations center, while Kansas City, Missouri has a center but could benefit from additional staff.

Lee's Summit, Missouri is very proactive in addressing congestion. The City tries to address the issues on a system wide approach. They evaluate the top

10 crash areas each year and consider the traffic congestion in those areas. Additionally, they do a sign audit of the entire system every five to seven years.

Strategies Used to Mitigate Congestion

Use of specific congestion management strategies was identified as follows:

- The communities in Johnson County place considerable emphasis on access management. However, they acknowledge that sometimes it is difficult for the policy makers to understand the need for such strategies.
- Each jurisdiction mentioned Operation Green Light as an effective congestion management strategy.
- The Unified Government of Wyandotte County/Kansas City, Kansas (UG) acknowledged that transit is an important element for their community. The other jurisdictions, however, indicated that transit was not generally considered as a strategy within the context of congestion management.
- Many of the communities discussed the need for more focused land development strategies in which people would not have to use cars to travel between their homes and places of business and recreation.
- Lee's Summit considers parking management. It indicated that it hoped to have shared parking within its downtown.

Most Effective Congestion Management Strategies

While the success of the strategies is dependent on the situation, successful strategies most often cited are access management, signal timing, and adequate consideration of the traffic impacts with new development or redevelopment. None of the communities had a systematic way in which they evaluate effectiveness of strategies after implementation.

Least Effective Strategies

Participants said that in some instances, decisions made in the course of approving new development can cause greater congestion rather than mitigate it. No one strategy, however, stood out as the least effective.

Use of MARC's Congestion Management Toolbox

None of the agencies interviewed used the congestion management toolbox as a reference. However, they did suggest ways in which it might be developed so as to increase its application around the region:

• Provide case studies of best practices from across the region;

- Use language with which staff can effectively communicate issues and solutions to policy makers and the public; and
- Minimize text and use graphics.

Other Tools To Consider

Some suggestions regarding other useful tools were provided:

- Identify how certain strategies can be applied in certain locations;
- Provide best practices from across the nation;
- Provide information regarding how to prioritize projects; and
- Call out strategies that new development can use.

3.0 Effectiveness of Implemented Strategies

3.1 EVALUATION OVERVIEW

A variety of data and tools exist in the MARC region to help evaluate the effectiveness (or potential effectiveness) of congestion management strategies. This could include travel demand model outputs, which can be used to illustrate the location, duration, and extent of congestion for the region at baseline conditions; the travel demand model can then be used to forecast congested conditions assuming currently programmed TIP projects. These model outputs can in turn be used as inputs into the ITS Deployment Analysis System (IDAS), the Tool for Operations Benefit/Cost (TOPS-BC), and/or other tools to calculate a variety of performance measures, to evaluate the impacts of many of the types of strategies in the Toolbox, and to help allocate benefits to subregions. These data can include changes in travel time, speed, mode share, or trip reduction, for example, that can either directly measure or indirectly measure the CMP performance measures for the no-build and build conditions.

As part of the congestion management toolbox update, three MARC region local congestion management strategies were evaluated to demonstrate techniques and provide a framework for evaluating benefits and costs of toolbox techniques. The purpose of this exercise was to provide examples of how available data can be used to estimate the benefits of several strategies.

3.2 SELECTION OF STRATEGIES FOR EVALUATION

Three individual strategies that have been implemented in recent years in the Kansas City region were evaluated. Strategies were considered that:

- Represent a cross section of several different types of congestion management strategies;
- Represent a geographic cross section across the region;
- Represent more than one mode and functional classification;
- Were completed in the last 5 years;
- Have available either before or after data, or both; and
- Can be analyzed with available tools in a way that can be replicated by MARC and local agencies in the future.

Possible projects that have been implemented were identified by MARC and through stakeholder interviews. Ultimately, the following three projects were selected for evaluation:

- Lee's Summit Arterial Signal Coordination
- I-435 Ramp Metering
- I-35 Johnson County Transit Bus on Shoulders

3.3 POTENTIAL ANALYSIS TOOLS

TOPS-BC is one of several benefit/cost tools that can be used to evaluate operational and ITS improvements. An early generation of spreadsheet tools were developed by either FHWA or state and local agencies for targeted analysis and include SCRITS⁵ and CAL-B/C⁶. Following these initial efforts, FHWA developed the ITS Deployment Analysis System (IDAS), which included a network-based model able to incorporate regional and statewide travel demand models. The major benefit of IDAS is that by using existing travel demand models, it incorporates the same set of assumptions used for other regional planning activities. The inclusion of an assignment module also allows analysts to account for traffic shifts that may result from operational and ITS deployments. As a network model, however, IDAS has a steeper learning curve than spreadsheet tools and may require a level of effort beyond what is feasible for a relatively limited improvement.

TOPS-BC⁷ essentially reflects the incorporation of IDAS into a spreadsheet format, which is accessible to a wider range of users and provides relatively quick assessments of ITS and operational projects with limited data. The tool is supported by the U.S. DOT's benefit⁸ and cost⁹ databases, allowing users to access and incorporate national experience in impact measurement.

Two separate versions are available: the Standard Version and the Development Version. The Standard Version, available online, is used in this study. The TOPS-BC User's Manual provides more instructions on how to use the tool, along with some case studies. More detail is provided in Appendix B.

Due to the characteristics described above, TOPS-BC is recommended as a key congestion management toolbox component for MARC and Kansas City

⁵ <u>http://www.fhwa.dot.gov/steam/scrits.htm</u>

⁶ <u>http://www.dot.ca.gov/hq/tpp/offices/eab/LCBC_Analysis_Model.html</u>

⁷ http://ops.fhwa.dot.gov/publications/fhwahop12028/index.htm

⁸ <u>http://www.itsbenefits.its.dot.gov/</u>

^{9 &}lt;u>http://www.itscosts.its.dot.gov/its/benecost.nsf/ByLink/CostDocs</u>

stakeholders, and it was used for the evaluation of two of the strategies below. It provides the following features:

- The ability to investigate the expected range of impacts associated with previous deployments and analyze many transportation system management and operational strategies;
- A screening mechanism to help identify appropriate tools and methodologies for conducting a benefit-cost analysis based on analysis needs;
- A framework and default cost data to estimate the life-cycle costs (including capital, replacement, and continuing operating and maintenance costs) of various transportation system management and operational strategies; and
- A framework and suggested impact values for conducting simple sketch planning level benefit-cost analysis for selected transportation system management and operational strategies.

3.4 EVALUATION METHODOLOGIES AND RESULTS

Lee's Summit Arterial Signal Coordination

Evaluation Approach

In 2010, using America Recovery and Reinvestment Act funds from an Energy Efficiency and Conservation Block Grant (EECBG) through the U.S. Department of Energy, the City of Lee's Summit began an innovative effort to reduce traffic congestion, fossil fuel consumption and CO2 emissions using smart traffic signal technology. The City of Lee's Summit worked with MoDOT District 4 to purchase and install the InSync adaptive traffic control system and necessary communications backbone for multiple corridors and 15 intersections that crossed both jurisdictions as shown in Figure 3.1.¹⁰

¹⁰ Real-Time Adaptive Traffic Control on Chipman Road in Lee's Summit, MO



Figure 3.1 Arterial Project Area: Lee's Summit

On the Chipman Road corridor, five goals were established for the InSync deployment including:

- 1. Minimize travel time for motorists along Chipman Road by synchronizing traffic signals.
- 2. Minimize the number of vehicle stops along Chipman Road by synchronizing traffic signals.
- 3. Maintain north/south progression along Pryor Road.
- 4. Maintain north/south progression along Blue Parkway.
- 5. Provide a reliable and accessible communications network to all intersections.

Speed and delay runs conducted after the installation of InSync showed the following improvements:

- During the AM peak period, travel time was reduced by 43-55% and average speed increased 39-50%;
- During the midday period, travel time was reduced by 35-42% and average speed increased 43-47%; and
• During the PM peak period, travel time was reduced by 28-45% and average speed increased 17-33%.¹¹

These improvements were a result of improved signal coordination which results in a higher percentage of vehicles arriving at green lights and thus fewer overall stops. It does not mean that driving speeds between signalized intersections increased. Where data are missing, default data provided in the TOPS-BC tool are used. Some assumptions were also made in the analysis.

Results

The primary change driving the results is an increase in average speed along the corridor of 38%. A calculation was made that approximately 20% of the time gained was lost due to additional delay on side streets The benefits are realized primarily in reduced travel time with an annual value of just under \$7 million. Due to the higher speeds achieved there are slight increases in fuel consumption and in the cost of crashes but these are more than offset by the value of travel time savings. When annualized, capital expenses are relatively low and operations could largely be absorbed by existing personnel and resources. As a result, a very high benefit/cost ratio is achieved but one that is not unusual for this type of timing improvement. Table 3.1 summarizes the results.

Benefit/Cost Component	Annual Value
Benefits	
Travel Time	\$3,604,932
Travel Time Reliability	\$0
Energy and Air Quality	\$110,735
Safety	\$0
Total	\$3,715,667
Costs	\$806,663
Net Benefits	\$2,909,004
Benefit/Cost Ratio	4.61

Table 3.1 Benefit/Cost Summary for Arterial Improvements

¹¹ Summit Fair Traffic Impact Analysis Report - Addendum, June 2006

I-435 Ramp Metering

Evaluation Approach

KDOT and MoDOT designed Kansas City Scout (KC Scout) to provide drivers in the Kansas City Metropolitan area with less highway congestion, fewer rush hour crashes, improved rush hour speeds, quicker emergency response times, and much more to help them navigate their way along a safer, smoother, and smarter journey.¹² In March 2010 KC Scout added ramp meters to I-435 between Metcalf Avenue and the Three Trails Memorial Crossing, an 8-mile corridor with 7 interchanges and 12 on ramps at the cost of approximately \$30,000 per on-ramp in order to:

- Decrease the number of sudden weaving and braking moments that happen as vehicles merge onto the freeway from the on-ramps;
- Allow more cars to smoothly drive along the freeway; and
- Reduce accidents (Figure 3.2).



Figure 3.2 I-435 Ramp Meters

Source: KC SCOUT, Ramp Metering 2011 Evaluation Report

The following data collection processes were implemented before and after implementation of ramp metering to evaluate the benefits of ramp metering:

- Observed the ramp meters in action on-site at the on-ramps and off-site using the KC Scout CCTV cameras;
- Collected traffic data for a 12-month period after the meters were in operation, spanning from April 2010 to March 2011;

¹² Maximizing the Flow, Ramp Metering 2011 Evaluation Report, KC SCOUT

- Compared the "after" findings to traffic conditions on I-435 based on an average of the conditions between April 2008 2009 and March 2009 2010 before the meters were installed and turned on;
- Talked with transportation professionals and law enforcement staff to better understand their experiences with the meters after turn-on; and
- Conducted a survey to gather feedback from the general public about KC Scout in general and the I-435 ramp meters specifically.

In addition to the data collection effort, public education and outreach to first responders were both incorporated as key elements of the program. Results of the evaluation showed a 64% reduction in total crashes and a reduction in the percentage of crashes caused by merging. Nearby construction activity made the impact on travel times less clear, but in general travel times and the travel time index (ratio of average travel time to free flow travel time) were reduced. Slight increases in waiting time were experienced on the ramps but these were more than offset by faster travel times on the mainline. Table 3.2 summarizes the benefit/cost analysis for this project.

Benefit/Cost Component	Annual Value
Benefits	
Travel Time	\$2,160,292
Travel Time Reliability	\$0
Energy and Air Quality	\$5,174,488
Safety	\$200,566
Total	\$7,535,346
Costs	\$377,380
Net Benefits	\$7,157,966
Benefit/Cost Ratio	19.97

Table 3.2 Benefit/Cost Summary for Ramp Meter Improvements

Results

TOPS-BC was used to attempt to replicate the results of the ramp metering data collection exercise, using the base condition data as the starting point. This technique can be applied to evaluate ramp metering potential in other corridors. A detailed list of process steps is included in Appendix B.

I-35 Bus on Shoulder

Evaluation Approach

Johnson County Transit initiated a bus shoulder running program in 2012 on I-35 in order to improve travel times and schedule adherence on four express bus

routes (Figure 3.3).¹³ During the course of the year the shoulder was used on 472 bus runs with a total mileage of 1,348. Usage increased significantly from the beginning of the program in January (7 runs) to December (81 runs). Analysis of ridership showed that the four express routes using the shoulder experienced a 10.4% increase, compared to a 7.3% increase for Johnson County Transit's other routes.

Results

For this analysis a custom spreadsheet was developed that can be replicated for future analysis of projects that improve transit travel time. In some cases, reduction in travel times may enable the agency to make the same number of runs with fewer buses, resulting in operating cost savings and higher productivity. In this scenario, only travel time savings were counted as a benefit. No additional costs were incurred. The spreadsheet is documented in Appendix B and shows a travel time savings of approximately \$5,700 for the first year of operation. The spreadsheet provides a method for developing detailed estimates of time savings for future projects.

¹³ FY 2012 Review of Bus-on-Shoulder Operations, Johnson County Transit, January 10, 2013



Figure 3.3 I-35 Bus on Shoulder Operations (Jo Xpress)

Source: http://www.thejo.com/pdf/resources/Xpress_fact_sheet.pdf

Congestion Management Toolbox Update

4.0 Congestion Management Toolbox

4.1 INTRODUCTION: USING THE TOOLBOX

We envision that, when local agencies in the region find themselves considering roadway capacity projects, they will use the Toolbox like a checklist. They will consider each item in the Toolbox and, in turn determine whether a strategy (or package of strategies) and the relevant actions/projects have a reasonable potential for providing benefit to the corridor or study area being evaluated. If a strategy shows promise, it can be evaluated in detail using the regional model and applicable post-processing tools suggested in the toolbox.

The MARC CMP describes an eight-step regional CMP framework consistent with the official guidance issued by the USDOT:

- 1. Develop congestion management objectives
- 2. Identify area of application
- 3. Define system/network of interest
- 4. Develop performance measures
- 5. Institute system performance monitoring plan
- 6. Identify and evaluate strategies
- 7. Implement selected strategies and manage transportation system
- 8. Monitor strategy effectiveness

Figure 4.1 presents a broader look at the transportation planning process. The CMP is integrated into the establishment of goals and objectives, identification and evaluation of alternative strategies, and then developing the LRTP and TIP.

However, there are other ways in which the CMT can be used by agencies in the Kansas City region at a more localized level:

- Identify alternative strategies for addressing local congestion issues, and select the most appropriate of these strategies for the specific issues based on the information in the toolbox;
- After identifying the best strategies for a particular need based on this initial screen, perform more analysis using some of the tools identified; and
- Present national best practices and typical outcomes experienced in other cities to stakeholders, the public, government officials, developers, and others.



Figure 4.1 CMP and the Overall Planning Process

Source: FHWA

To select the right types of strategies, an agency must have an understanding of the nature of the need. Figure 4.2 identifies the different dimensions of congestion: what is the issue that needs to be solved? Next, what is the agency trying to accomplish through a strategy: what are the goals and objectives? What would be the measure of success after the strategy has been implemented? Is the focus of the agency long or short term in relation to the need being addressed?

Figure 4.2 Different Dimensions of Congestion

Spatial

How much of the system is congested? The image presents an example of a metropolitan highway network with 20 percent of all miles congested.





4.2 STRATEGIES

Table 4.1 provides a summary of the types of strategies described in the toolbox. Each strategy type is described in greater detail below, and the strategies themselves are detailed in Tables 4.2 through 4.10.

For each of the projects and strategies, the potential for congestion reduction benefits is indicated, along with a recommended analysis method to help with location-specific assessment and prioritization. This includes the tools needed to evaluate the congestion reduction potential of each strategy or project. Tools include the TDM Evaluation Model, IDAS, TOPS-BC, the MARC regional travel model, and others. In some cases, benefits may be more qualitative for selected strategies. For these strategies, the Toolbox indicates the relative level of expected benefits for a variety of benefits classes for each strategy.

The congestion reduction impacts are defined qualitatively by indicators such as the potential reduction of single occupant vehicles (SOV), improved travel times, and reduced delay. This includes both recurring delay – delay that occurs on a regular basis, such as that due to daily peak congestion – and non-recurring delay – delay that occurs unexpectedly, such as due to crashes or special events. About half of all congestion is non-recurring. A description of magnitude is provided where this can be generalized for a strategy. Order-of-magnitude cost estimates also help in selecting between strategies. National cost data built into the TOPS-BC software, IDAS, and other national practices are used to provide this estimate. Therefore, these costs may vary for the Kansas City region. The implementation costs and schedules consider design and maintenance costs, interjurisdictional agreements, and implementation timing over short-term (one to five years), medium-term (five to 10 years), and long-term (over 10 years).

Finally, the Toolbox indicates strategies that are complementary, and in what situations they are best used together.

Access Management Strategies

Access management is a broad concept that can include everything from curb cut restrictions on local arterials to minimum interchange spacing on freeways. Restricting turning movements on local arterials can reduce crashes and prevent turning vehicles from impeding traffic flow; this can then make it easier to effectively apply ITS and TSM Strategies. Similarly, eliminating merge points and weaving sections at freeway interchanges increases the capacity of the facility. Tradeoffs exist in limiting access to individual properties and increasing system mobility, and many communities assign different access restrictions to different functional classifications of roadway (Figure 4.3). The access management strategies listed in Table 4.7 are applicable to Kansas City, and can be used in either the modification or original design of a facility.





Source: FHWA, Introduction to Access Management Principles

Active Transportation

Investments in non-motorized modes of transportation, such as biking and walking, can increase safety and mobility in a cost-efficient manner, while providing a zero-emission alternative to motorized modes (Figure 4.4). The strategies listed in Table 4.4 can be implemented in the Kansas City area with relatively little cost, but tend to have local rather than systemwide impacts. The effectiveness of an investment in non-motorized travel depends heavily on coordination with local land use policies and connections with other modes, such as transit, for longer distance travel. Safety and aesthetics should also be emphasized in the design of bicycle and pedestrian facilities in order to increase their attractiveness.



Figure 4.4 Active Transportation: Bicycle Lanes and Sidewalks

Source: www.peopleforbikes.org

Highway Strategies

Table 4.4 presents the potential highway infrastructure strategies that may be applicable for the Kansas City region. These are often higher-cost strategies that also tend to have larger congestion benefits in the short term. These strategies can sometimes be paired with ITS and TSM strategies. Several highway strategies can increase the effectiveness of certain transit strategies: managed lanes can facilitate express buses or bus rapid transit, for example.

Land Use Strategies

Land development strategies have been used in some areas to manage transportation demand on the system, and to help agencies meet air quality conformity standards. Land development strategies can include limits on the amount and location of development until certain service standards are met, or policies that encourage development patterns better served by public transportation and non-motorized modes. These strategies may help decrease the number and length of trips made (Figure 4.5). Table 4.5 presents the land development strategies that may be applicable for the Kansas City region. These are often paired with Parking Strategies and can complement Bicycle and Pedestrian Strategies.



Figure 4.5 Vehicle Miles Traveled versus Residential Density

Source: Best Practices in Transportation Demand Management, Seattle Urban Mobility Plan

Parking Strategies

Parking management is most often used to decrease automobile trips for both work and non-work purposes, although in the context of enforcement it may also be used to improve traffic flow (Table 4.6). Often, policies implemented by local governments and directed towards the private sector must be accompanied by incentives in order to ensure their effectiveness. These are often closely linked with Land Use Strategies and TDM Strategies.

Regulatory Strategies

Regulatory Strategies, shown in Table 4.7, are low- or no-cost policy decisions that affect each of the strategy categories above. This could include pricing, vehicle restrictions, insurance schemes, and others.

TDM Strategies

Transportation demand management (TDM) strategies are used to reduce travel during the peak commute period. They are also used to help agencies meet air quality conformity standards, and are intended to provide ways to provide congestion relief and mobility improvements without high cost infrastructure projects by focusing on the demand, rather than supply, side. Pricing strategies, such as congestion pricing, are included in this group (Figure 4.6). Table 4.8 presents the TDM strategies that may be applicable for the Kansas City region.



Figure 4.6 TDM Strategies: Congestion Pricing

Source: Minnesota Department of Transportation

Transit Strategies

Transit services and infrastructure projects have traditionally been implemented in regions to provide an alternative to automobile travel potentially reducing peak-period congestion and improving mobility and accessibility for commuters. Table 4.9 presents the transit projects that may be applicable for the Kansas City region. These projects tend to reduce systemwide VMT in relatively small increments but do improve corridor and systemwide accessibility, improve roadway travel times, and decrease congestion on the roadway system: successful treatments can greatly increase the people transported within a given roadway (Figure 4.7). Transit Strategies are more effective when paired with effective transportation system management, Pedestrian, and Land Use Strategies.

Figure 4.7 Impacting Congestion Through Mode Shift

Amount of space required to transport the same number of passengers by car, bus or bicycle.



Source: City of Muenster Planning Office, 2001

Transportation Operations and Management

Intelligent transportation system (ITS) and transportation system management (TSM) strategies have traditionally focused on improving the operation of the transportation system without major capital investment and cost. While ITS strategies may be costly compared to more traditional TSM strategies, their relative congestion-reduction impacts can be significant. These strategies also tend to be complementary. Table 4.10 presents the ITS and TSM strategies that may be applicable for the Kansas City region. The strategies can build upon current ITS initiatives in the Kansas City region such as the Kansas City Scout Program and Operation Green Light.



Figure 4.8 Transportation Operations and Management: Sample Active Traffic Management Tools

Source: FHWA, ATDM Program Brief

Major Categories	Number of Strategies	Benefits	Costs	Examples
Access Management	11 strategies identified	Increase capacity, efficiency, and mobility, reduce travel time	Vary from low to high and include, design, implementation, and maintenance costs	Turn restrictions, turn lanes, frontage roads, roundabout intersections
Active Transportation	8 strategies outlines	Decrease auto mode share, reduce VMT, provide air quality benefits	Low to moderate	New sidewalks and bike lanes, improved facilities near transit stations, bike sharing, and exclusive rights of way
Highway	11 strategies identified	Increase capacity, mobility, and traffic flow	Vary from low to high depending on strategy. Constructing new ROW results in higher cost than design improvements.	HOV lanes, super street arterials, highway widening, acceleration and deceleration lanes, design improvements
Land Use	6 strategies identified	Decrease SOV trips, increase walk trips, increase transit mode share, air quality benefits	Low to moderate and involve establishing ordinances and may require economic incentives to encourage developer buy-in	Infill, TOD development, densification
Parking	7 strategies identified	Increase transit use, reduce VMT, generate revenue	Low to moderate but require economic incentives to encourage developer buy-in	Preferential parking for HOVs, park and ride lots, advanced parking systems
Regulatory	10 strategies identified	Decrease VMT, air quality benefits, increase safety, generate revenue	Vary	Carbon pricing, VMT fee, pay as you drive insurance, auto restriction zones, truck restrictions
TDM	11 strategies identified	Reduce peak period travel, reduce SOV VMT	Low to moderate	Alternative work hours, telecommuting, road pricing, toll roads
Transit	19 strategies identified	Shifting mode share, increasing transit ridership, reduce VMT, provide air quality benefits	Vary from low to high depending on strategy. Constructing new transit travelways is higher cost than improving service frequencies.	Increasing coverages and frequencies, new fixed guideway travelways, employer incentive programs, signal priority, intelligent transit stops (tech improvements)
Transportation Operations and Management	20 strategies identified	Reduce travel time, reduce stops, reduce delays, increase safety	Vary but tend to be low to moderate. Large scale projects involving new infrastructure and devices higher cost.	Signal coordination, ramp metering, highway information systems, service patrols

Table 4.1 Summary of Congestion Management Strategies

Table 4.2 Access Management Strategies

Strategies/Projects	Congestion and Mobility Benefits	Costs and Impacts	Implementation Timeframe	Analysis Method	Grouping	Example
Left Turn Restrictions; Curb Cut and Driveway Restrictions	Increased capacity, efficiency on arterials					
Turning vehicles can impede traffic flow and are more likely to be involved in crashes.	 Improved mobility on facility Improved travel times and reduced delay for through traffic Fewer incidents 	Low to moderate: Implementation and maintenance costs vary; range from new signage and striping to more costly permanent median barriers and curbs.	Short-term: 1 to 5 years (includes planning, engineering, and implementation)	 Localized Analysis 	Operations and Management strategies	MARCNYMTC
Turn Lanes and New or Relocated Driveways and Exit Ramps	Increased capacity_efficiency		Obert terre 4 to 5 we are			
In some situations, increasing or modifying access to a property can be more beneficial than reducing access.	 Improved mobility and safety on facility Improved travel times and reduced delay for all traffic 	Low to moderate: Additional right-of-way costs, design, construction, and maintenance costs	(includes planning, engineering, and implementation)	 Localized Analysis 	Operations and Management strategies	MARCNYMTC
Interchange Modifications	Increased canacity efficiency			IDAS		
Conversion of a full cloverleaf interchange to a partial cloverleaf, for example, reduces weaving sections on a freeway.	 Improved mobility on facility Improved travel times and reduced delay for through traffic Fewer incidents due to fewer conflict points 	Moderate: Design and construction costs	Short- to Medium-term: 1 to 10 years (includes planning, engineering, and implementation)	 Regional Travel Model Interchange Management System 	Operations and Management strategies	MARCNYMTC
Minimum Intersection/Interchange Spacing	Increased capacity, efficiency					
Reduces number of conflict points and merging areas, which in turn reduces incidents and delays	 Improved mobility on facility Improved travel times and reduced delay for 	Low: Part of design costs for new facilities and reconstruction projects.	Medium-term: 5 to 10 years (includes planning, engineering, and	 Localized Analysis 	Operations and Management strategies	MARC NYMTC
	 Fewer incidents	······ ,	implementation)			
Frontage Roads and Collector-Distributor Roads	Increased capacity, efficiency					
	Improved mobility on facility	Lich, Additional right of way apota	Medium-term: 5 to 10 years (includes planning, engineering, and implementation)			
Frontage roads can be used to direct local traffic to major intersections on both super arterials and freeways. Collector-distributor roads are used to separate exiting, merging, and weaving traffic from through traffic at closely spaced interchanges.	 Improved travel times and reduced delay for through traffic 	design, construction, and maintenance costs		Regional Travel Model	Operations and Management strategies	MARCNYMTC
	Fewer incidents due to fewer conflict points					
Roadway Restrictions	Increase capacity, efficiency on arterials					
Closes access during rush hours (AM and PM peak hours) and aids in the	Improve mobility on facility	Low to moderate: Implementation and	Short-term: 1 to 5 years	 Localized Analysis 	- Operations and Management	
increase of safety levels through the prevention of crashes at problem intersections. This measure may be effective along mainline segments of a highway, which operate at poor service levels.	 Improve travel times and decrease delay for through traffic 	maintenance costs vary	engineering, and implementation)	Simulation Model	• Operations and Management strategies	NYMTC
	Fewer incidents					
Access Control to Available Development Sites	Increase capacity, efficiency on arterials					
	Improve mobility on facility	Low to moderate: Implementation and	Short-term: 1 to 5 years	 Localized Analysis 	- Operations and Management	
Coordination of access points to available development sites allows for less interference in traffic flow during construction and/or operation of new developments	 Improve travel times and decrease delay for through traffic 	maintenance costs vary	engineering, and implementation)	Simulation Model	Operations and Management strategies	NYMTC
	Fewer incidents					
Intersection Turn Lanes Additional left-turn or right-turn lanes that separate turning vehicles from through traffic	 Greater number of vehicles can pass through the intersection in given amount of time, resulting in a lower level of travel delays and stopped time 	Low to moderate: depends on right-of- way needs.	Medium-term: 5-10 years (agencies must be sure to plan for possible time needed to	 Localized Analysis 	Operations and Management strategies	DRCOG
	Can reduce the likelihood of rear-end crashes		obtain right-of-way)			

Roundabout Intersections An intersection modification that does not use traffic signal or stop sign controls. Provides continuous movement via entrance and exit lanes to/from a typically circular distribution roadway	 Greater capacity than traditional 3- or 4-way intersections in many situations Fewer crashes over time Lower air pollutant emissions due to fewer stopped vehicles 	Moderate: Cost affected by the amount of right-of-way needed.	Medium-term: 5-10 years (completion time for a replacement roundabout is related to the amount of planning and public outreach time needed and the right-of- way acquisition process)	 Localized Analysis 	 Access management for the approach roadways and adjacent properties should be done Operations and Management strategies
New Grade-Separated Intersections An overpass or underpass for one roadway to avoid intersecting with a cross street	 Increase capacity, efficiency on arterials Improve mobility on facility Improve travel times and decrease delay for through traffic Fewer incidents 	High: Cost depends on the amount of right-of-way needed and the scale of construction impediments.	Medium- to long-term: 5-15 years (includes planning, engineering, and implementation)	 Localized Analysis 	Operations and Management strategies DRCOG

Table 4.3 Active Transportation

Strategies/Projects	Congestion and Mobility Benefits	Costs and Impacts	Implementation Timeframe	Analysis Method	Grouping	Example
New Sidewalks and Designated Bicycle Lanes on Local Streets Enhancing the visibility of bicycle and pedestrian facilities increases the perception of safety. In many cases, bike lanes can be added to existing roadways through restriping. Use of bicycling and walking is often discouraged by a fragmentary, incomplete network of sidewalks and shared use facilities. Constructing new facilities, such as bike lanes on arterials and/or connecting existing facilities, will encourage greater use of walking and bicycling.	 Increase mobility and access Increase nonmotorized mode shares Separate slow moving bicycles from motorized vehicles Reduce incidents 	 Low/Medium Design and construction costs for paving, striping, signals, and signing ROW costs if widening necessary Bicycle lanes may require improvements to roadway shoulders to ensure acceptable pavement 	Short-term: 1 to 5 years (includes planning, engineering, and construction)	 TDM Evaluation Model 	 Other Active Transportation strategies Land Use strategies 	 MARC NYMTC MAG DRCOG
Improved Bicycle Facilities at Transit Stations and Other Trip Destinations Bicycle racks and bike lockers at transit stations and other trip destinations increase security. Additional amenities such as locker rooms with showers at workplaces provide further incentives for using bicycles.	 Increase bicycle mode share Reduce motorized vehicle congestion on access routes 	Low. Capital and maintenance costs for bicycle racks and lockers, locker rooms.	Short-term: 1 to 5 years (includes planning, engineering, and construction)	TDM Evaluation Model	 Other Active Transportation strategies Land Use strategies Transit strategies 	MARC NYMTC
Design Guidelines for Pedestrian-Oriented Development Maximum block lengths, building setback restrictions, and streetscape enhancements are examples of design guidelines that can be codified in zoning ordinances to encourage pedestrian activity.	 Increase pedestrian mode share Discourage motor vehicle use for short trips Reduce VMT, emissions 	 Low Capital costs largely borne by private sector; developer incentives may be necessary Public sector may be responsible for some capital and/or maintenance costs associated with right-of-way improvements Ordinance development and enforcement costs 	Short-term: 1 to 5 years	 TDM Evaluation Model Regional Travel Model 	 Other Active Transportation strategies Land Use strategies 	MARCNYMTC
Improved Safety of Existing Bicycle and Pedestrian Facilities Maintaining lighting, signage, striping, traffic control devices, and pavement quality, and installing curb cuts, curb extensions, median refuges, and raised crosswalks can increase bicycle and pedestrian safety.	 Increase nonmotorized mode share Reduce incidents 	 Low Increased monitoring and maintenance costs Capital costs of sidewalk improvements and additional traffic control devices 	Short-term: 1 to 5 years	 TDM Evaluation Model Regional Travel Model 	 Other Active Transportation strategies Land Use strategies 	MARCNYMTC
Exclusive Non-Motorized Rights-of-Way Abandoned rail rights-of-way and existing parkland can be used for medium- to long distance bike trails, improving safety and reducing travel times.	 Increase mobility Increase nonmotorized mode share Reduce congestion on nearby roads Separate slow-moving bicycles from motorized vehicles Reduce incidents 	Low/Medium ROW Costs Construction and Engineering Costs Maintenance Costs 	Medium-term: 5 to 10 years (includes planning, engineering, and construction)	 TDM Evaluation Model Regional Travel Model 	 Other Active Transportation strategies Land Use strategies 	MARCDRCOG
Bike Sharing Programs Short-term bicycle rental program supported by a network of automated rental stations	 Increase non-motorized mode share Discourage motor vehicle use for short trips Reduce VMT 	Low/Medium. Capital and maintenance costs for bicycles and rental stations	Short-term: 1 to 5 years		 Other Active Transportation strategies Land Use strategies Transit strategies 	• NYMTC

Congestion Management Toolbox Update

Promoting Bicycle and Pedestrian Use Through Education and Information Dissemination Bicycle and pedestrian use can be promoted through educational programs and through distribution of maps of bicycle facility/multi-use path maps. This may be supported by the public sector, but often could be employer-based.	Increase non-motorized mode share	 Low First-year implementation costs for private-sector Second-year costs tend to decline Requires interagency and private sector coordination Requires public agency support & coordination 	• EPA Commuter Model	 Other Active Transportation strategies Land Use strategies
Adopting and Implementing a Complete Streets Policy Policy that takes into account all users of streets rather than just autos, with a goal of completing the streets with adequate facilities for all users. A "Complete Street" is one designed and operated to enable safe access for all users including pedestrians, bicyclists, motorists, and transit riders of all ages and abilities.	 Increase safety by improving the overall (pedestrian and bicycle) transportation system environment Reduce congestion Provide cost savings by reducing longer distance travel, increasing shorter distance travel, and use by non-motorized modes Provide travel time savings to users of the system Increase access to and use of non-auto modes Protect natural environment through sound land use and transportation sustainability policies 	Low for policy development; low/medium for implementation.	Short-term: 1 to 5 years	 Land Use strategies Transportation Demand Management strategies Operations and Management strategies Transit strategies

Table 4.4Highway Strategies

Strategies/Projects	Congestion and Mobility Benefits	Costs and Impacts	Implementation Timeframe	Analysis Method	Grouping	Example
Increasing Number of Lanes without Highway Widening Takes advantage of "excess" width in the highway cross section used for breakdown lanes or median.	 Increase capacity, reducing congestion in the short term Long-term effects on congestion depend on local conditions Reduced traffic and congestion on parallel streets 	Low to Moderate (capital costs depend on extent of modifications needed; maintenance costs increase)	Short-term: 1 to 5 years (includes planning, engineering, and implementation)	Regional Travel ModelIDAS	Active traffic management strategies (Transportation operations and management strategies)	MARCNYMTC
Geometric Design Improvements						
Includes widening to provide shoulders, additional turn lanes at intersections, improved sight lines, auxiliary lanes to improve merging and diverging. Interchange modifications to decrease weaving sections on a freeway, paved shoulders and realignment of intersecting streets. Adding turning lanes or through lanes at an intersection, realignment of intersection streets, intersection channelization, or modifying intersection geometrics to improve overall efficiency and operation.	 Increase mobility Reduce congestion by improving bottlenecks Increase traffic flow and improve safety Decrease incidents due to fewer conflict points 	Low to High (Design, implementation, operations and maintenance costs vary by type of design)	Short-term: 1 to 5 years (includes planning, engineering, and implementation)	Regional Travel Model	Other highway strategies	MARCNYMTCMAG
HOV Lanes	Reduce regional VMT					MARO
Increases corridor capacity while at the same time provides an incentive for single-occupant drivers to shift to ridesharing. These lanes are most effective as part of a comprehensive effort to encourage HOVs, including publicity, outreach, park-and-ride lots, and rideshare matching services.	 Reduce regional trips Increase vehicle occupancy Improve travel times Increase transit use and improve bus travel times 	Moderate to High (depends on extent of additional ROW costs, barrier separation costs; operations and enforcement costs)	Medium-term: 5 to 10 years (includes planning, engineering, and construction)	 Regional Travel Model TDM Evaluation Model IDAS 	 Active traffic management strategies BRT or Express Bus Congestion pricing 	 MARC NYMTC DRCOG MAG SLC WFRC
Super Street Arterials	 Increase capacity, reducing congestion in the short term 		Madium tama Eta 10 anna (includes		Transportation	
Converting existing major arterials with signalized intersections into "super streets" that feature grade-separated intersections.	 Long-term effects on congestion depend on local conditions Reduced traffic and congestion on parallel streets 	High (Construction and engineering substantial for grade separation)	planning, engineering, and implementation)	Regional Travel Model	operations and management strategiesAccess management	MARC NYMTC
Highway Widening by Adding Lanes	_					
Traditional adding of lanes by widening roadway surface.	 Increase capacity, reducing congestion in the short term Long-term effects on congestion depend on local conditions Reduced traffic and congestion on parallel streets 	High • Costs vary by type of highway constructed; in dense urban areas can be very expensive • Can create environmental and community impacts	Long-term: 10 or more years (includes planning, engineering, and construction)	Regional Travel Model	 Transportation operations and management strategies Access management 	MARCNYMTCMAG

Congestion Management Toolbox Update

Acceleration/Deceleration lanes	 Slower-moving turning or exiting vehicles are removed from through-lanes resulting in fewer delays for upstream traffic Accelerating vehicles are provided more distance to reach the speed of through traffic, resulting in fewer delays caused by merging and weaving vehicles In certain situations, can greatly reduce delays (caused by braking) for upstream vehicles during peak traffic flow periods 	Low to moderate (Cost is relatively low if right-of-way or bridge widening is not required)	Medium-term: 5 to 10 years	 Regional Travel Model IDAS 	Hill climbing lanes	• DRCOG
Hill Climbing Lanes Additional lanes provided for a short distance to allow slower- moving vehicles (e.g., trucks and recreational vehicles) to move to the right and allow faster-moving vehicles to pass	 Major travel time savings for vehicles on rural highways, especially those with peak levels of recreational traffic Safety benefits due to fewer frustrated drivers making dangerous passing maneuvers 	Low to moderate (Cost is relatively low unless right-or-way, major rock- cuts or environmental mitigation is required)	Short- to medium-term: 1 to 10 years (Shorter segments with no right-of way needs can be done in a short time)	 Simulation model or HCM software 	Acceleration/deceleration lanes	• DRCOG
Grade separated railroad crossings Roadway underpass or overpass of a railroad line	 Significant reduction in travel delays at high volume locations Likely elimination of car-train crashes 	High (Cost is very high to provide either a roadway or railroad bridge or tunnel)	Medium- to long-term: 5 to 10+ years (Implementation requires significant negotiation with railroads and local communities)	Simulation model	Other highway strategies	• DRCOG
New Freeways		High				
Construction of new, access-controlled, high-capacity roadways in areas previously not served by freeways.	 Reduce arterial street network congestion Reduce travel times & delay 	 Costs vary by type of highway constructed; in dense urban areas can be very expensive Can create environmental and community impacts 	Long-term: 10 or more years (includes planning, engineering, and construction)	Regional Travel ModelSimulation Model	 Transportation operations and management strategies 	• MAG
New Arterial Streets						
Construction of new, higher-capacity roads designed to carry large volumes of traffic between areas in urban settings.	 Provide connectivity Carry traffic from local & collector streets to other areas Increase capacity, reducing congestion in the short term Long-term effects on congestion depend on local conditions 	Moderate to High • Construction and engineering costs substantial (grade separate, other design features) • Maintenance variable based on urban region • Can create environmental and community impacts	Medium-term: 5 to 10 years (includes planning, engineering, and construction	Regional Travel ModelSimulation Model	 operations and management strategies Access management strategies Consider incorporating transit treatments, as appropriate 	• MAG
New Collectors and Local Streets						
Construction of new roadway along separate right-of-way to serve newer developed or developing areas	 Increased capacity to serve developing areas Reduced traffic and congestion on parallel streets due to vehicles diverted to the new road and increased access/connectivity to local destinations 	Moderate to High (Cost depends on amount of right-of-way needed and the scale of construction impediments)	Medium-term: various, but likely around 5 years (includes planning, engineering, and construction	 Regional Travel Model Simulation Model 	 Access management strategies Consider incorporating transit treatments, as appropriate Land use practices 	• DRCOG

Table 4.5 Land Use Strategies

Strategies/Projects	Congestion and Mobility Benefits	Costs and Impacts	Implementation Timeframe	Analysis Method	Grouping	Example
Mixed-Use Development		Low/Moderate				
Allows multiple land use types within a single development or district, rather than completely segregating land uses. It facilitates the reduction of trip length and increase of walking trips.	 Increase walk trips Decrease SOV trips Decrease VMT Decrease vehicle hours of travel 	 Public costs to set up and monitor appropriate ordinances Economic incentives used to encourage developer buy-in Regional savings in reduced new infrastructure development 	Short- to long-term: development can begin immediately as long as regulations and zoning allow, but requires longer period to reach full development.	 Regional Travel Model TDM Evaluation Model 	 Transit strategies Active transportation strategies 	MARCNYMTC
Infill and Densification		Low/Moderate				
	 Decrease SOV trips Increase transit, walk, and bicycle trips 	Public costs to set up and monitor appropriate ordinances	Short- to long-term: development can begin immediately as long as	Regional Travel Model	 Transit strategies Active transportation strategies 	MARCNYMTC
Takes advantage of existing infrastructure by encouraging development on vacant or underused parcels in already developed areas; this avoids requiring new	Decreases VMI per household Medium/high vehicle trip reductions	Economic incentives used to encourage developer buy-in	regulations and zoning allow, but requires longer period to reach full	TDM Evaluation		SLC
construction of infrastructure on the fringes of the urban area.	 Medium/nigh vehicle trip reductions Air quality improvements 	Regional savings in reduced new infrastructure development	development.	Model	Strategies	WFRC
Transit-Oriented Development		Low/Moderate				
This clusters housing units and/or businesses near transit stations in walkable communities.	 Decrease SOV trips Increase transit trips Decrease VMT 	 Public costs to set up and monitor appropriate ordinances Economic incentives used to encourage developer buy-in 	Short- to long-term: development can begin immediately as long as regulations and zoning allow, but requires longer period to reach full	 Regional Travel Model TDM Evaluation Model 	 Transit strategies Active transportation strategies 	 MARC NYMTC MAG SLC
		Regional savings in reduced new infrastructure development	development.			WFRC
Trip Reduction Strategies	_	Low				
Plans, policies, and regulations instituted to reduce the use of SOVs for commuting;	Reduce VMTReduce SOV trips	First-year implementation costs for private-sector (per employee equipment)	Short-term: 1 to 5 years	EPA Commute	Transit strategiesActive transportation	• MAG
often linked to air quality planning and employer-based.	 Increase transit and non-motorized mode share 	Second-year costs tend to decline		WIDGEI	strategies	
	snare	Requires interagency and private sector coordination				
Transportation Management Associations	_	Low				
Nonprofit, member-controlled organizations that provide transportation services in a particular area, such as a commercial district, mall, medical center, or industrial park.	Reduce VMTReduce SOV trips	First-year implementation costs for private-sector (per employee equipment)	Short-term: 1 to 5 years	EPA Commuter Model	 Transit strategies Active transportation 	 MAG
businesses with local government support.	Increase transit and non-motorized mode	Second-year costs tend to decline		woder	strategies	
	snare	Requires interagency and private sector coordination	ires interagency and private r coordination			

Table 4.6Parking Strategies

Strategies/Projects	Congestion and Mobility Benefits	Costs and Impacts	Implementation Timeframe	Analysis Method	Grouping	Example
On-Street Parking and Standing Restrictions	Increase peak period capacity	Low Design construction and				
Enforcement of existing regulations can substantially improve traffic flow in urban areas. Peak-period parking prohibitions can free up extra general purpose travel lanes or special use or HOV "diamond" lanes.	 Reduce travel time and congestion on arterials Increase HOV and bus mode shares 	maintenance costs for signage and striping; Rigid enforcement of parking restrictions.	Short-term: 1 to 5 years (includes planning, engineering, and implementation)	 IDAS Regional Travel Model 	Highway strategies	MARCNYMTC
Employer/Landlord Parking Agreements						
Employers can negotiate leases so that they pay only for the number of spaces used by employees. In turn, employers can pass along parking savings by purchasing transit passes or reimbursing non-driving employees with the cash equivalent of a parking space	 Reduce work VMT Increase non-auto mode shares 	Low. Economic incentives used to encourage employer and landlord buy-in	Short-term: 1 to 5 years	TDM Evaluation Model	Transit strategies	MARCNYMTC
Preferential or Free Parking for HOVs and Parking Management					Land Use and Built	
Strategies include reducing the availability of free parking spaces, particularly in congested areas, or providing preferential or free parking for HOVs. This provides an incentive for workers to carpool. A strategy could include a downtown employee parking payroll tax (e.g., all downtown workers pay for parking, \$5/day average for users not already paying). Other strategies include dynamic pricing, higher fees on free parking lots, parking permits (see strategies above for Parking Pricing).	 Reduce work VMT Increase vehicle occupancy 	Low. Costs, primarily borne by the private sector, include signing, striping, and administrative costs	Short-term: 1 to 5 years (depends on political factors)	TDM Evaluation Model	 Environment (e.g., Combined land use and transportation strategies) Transportation Demand Management Operations and Management (e.g., traveler information) Public Transportation Active Transportation (e.g., pedestrian and bicycle improvements 	 MARC NYMTC Oregon DOT
Location-Specific Parking Ordinances				Designal Travel	Transit strategies	
Parking requirements can be adjusted for factors such as availability of transit, a mix of land uses, or pedestrian-oriented development that may reduce the need for on-site parking. This encourages transit-oriented and mixed-use development.	 Reduce VMT Increase transit and non-motorized mode shares 	Low. Economic incentives used to encourage developer buy-in	Short-term: 1 to 5 years (depends on political factors)	Regional Travel Model TDM Evaluation Model	 Land use strategies Active transportation strategies 	MARCNYMTC
Park and Ride Lots						
Park-and-Ride lots provide parking in areas that are convenient to other modes of transportation, and are commonly located adjacent to train stations, bus lines, or HOV lane facilities	Increase transit use and ridesharingReduce VMT	Low-Moderate. Land acquisition, construction and maintenance are necessary for park-and-ride lots.	Short-term: 1 to 5 years		Transit strategies	• NYMTC
Advanced Parking Systems					Increasing transit/bus route	
Helps drivers find or reserve parking using real-time information about the status of parking availability	 Reduce congestion on local streets Some peak-period travel and shift to non-auto modes 	Low-Moderate. Costs vary based on system complexity	Short-term: 1 to 5 years		coverage and frequencyIntelligent transit stopsEnhanced transit amenities	NYMTC
Local and Regional Excise Taxes					Land Use and Built	
A flat fee-per-space on parking spaces provided by businesses designed to discourage automobile-dependent development, encourage more efficient land use, and - to the extent the fees are passed on to parkers - encourage non-motorized and transit choices. The revenue generated by such a tax (on parking spaces, not their use) could be used for transit and other transportation investments not eligible for highway dollars.	 Generate revenue to maintain system and to address transportation improvements regionwide Reduce congestion Increase non-auto mode shares 	Minimal	Short-term: 1 to 5 years (depends on political factors)		 Environment (e.g., Combined land use and transportation strategies) Transportation Demand Management Operations and Management (e.g., traveler information) 	Oregon DOT

Parking Facility Management Information Signs					
Signage to notify travelers of the remaining number of unoccupied parking spaces at a public (e.g., park-and-ride) or private parking lot, guiding them to available parking.	•	Decreased total travel delay and miles wasted driving around to find a parking spot Improves convenience of transit if used at park-and-ride lots.	Low (Simple parking management systems can be as inexpensive as \$20,000, whereas more sophisticated management programs can cost more than \$250,000 to purchase and implement)	Short-term: 1 to 3 years	

 Active Transportation (e.g., pedestrian and bicycle improvements) Public Transportation 		
 Transit strategies (Park- and-ride) Operations and Management 	•	DRCOG

Table 4.7 Regulatory Strategies

Strategies/Projects	Congestion and Mobility Benefits	Costs and Impacts	Implementation Timeframe Analysis Method	Grouping	Example
Trip Reduction Ordinance Draws commuters to use other ways to travel to work besides driving alone. Requires employers to promote commute alternatives.	 Improve air quality Decrease traffic congestion Minimize energy consumption 	Minimal	Short-term	 Bike/Ped strategies Transit strategies Carpool, vanpool, and ridesharing Telecommuting/Telework 	NYMTC
Congestion Pricing Controls peak-period use of transportation facilities by charging more for peak-period use than for off-peak. Congestion pricing fees are charged to drivers using congested roadways during specific times of the day. This strategy is evaluated in order to maintain a specific level of service on a given road or all roads (areawide systems) in a region. For example, an average fee of \$0.65 cents/mile could be applied to 29 percent of urban and 7 percent of rural vehicle miles traveled (VMT) to better manage travel demand and the resulting congestion for a roadway	 Decrease VMT Increase transit and nonmotorized mode shares 	Low to Moderate. Implementation and maintenance costs vary	Medium-term	 Land Use and Built Environment (e.g., Mixed use developments) Operations and Management (e.g., traveler information) Public Transportation Transportation Demand Management 	NYMTCOregon DOT
Auto Restriction Zones (Pedestrian Malls) The most common form of an auto-restriction zone (pedestrian zones) in large cities is the pedestrian mall. Pedestrian malls generally consist of a storefront-lined street that is closed off to most automobile traffic. Emergency vehicles would have access at all times, while delivery vehicles may be restricted to limited delivery hours or entrances on adjacent back streets. Provides commercial access for pedestrians and non-car users.	 Increase capacity Decrease travel times Increase safety Improve bicycle and pedestrian- friendly roadways 	Low to Moderate. Design, construction, and maintenance costs	Short- to Medium-term	 Active Transportation Strategies 	• NYMTC
Truck Restrictions Aims to separate trucks from passenger vehicles and pedestrians. Prohibits trucks from traveling on certain roadways, and may call for weight restrictions on certain bridges.	 Increase capacity Decrease travel times Increase safety Improve bicycle and pedestrian- friendly roadways 	Low. Implementation and maintenance costs vary	Short-term		• NYMTC
Arterial Access Management Involves the application of local and state planning, and regulatory tools in efforts to preserve and/or enhance the transportation functions of roadways. Includes land use ordinances and techniques, corridor preservation, transportation improvements, and techniques in finance. Actual implementation of physical access management improvements are in Table 4.2 above.	 Increase capacity Decrease travel times Increase safety Improve bicycle and pedestrian- friendly roadways 	Low. Implementation and maintenance costs vary	Medium-term	 Land Use Strategies Transportation Management and Operations Access Management Strategies (actual implementation of physical improvements) 	• NYMTC

Carbon Pricing /Motor Fuel Tax				
Carbon pricing considers an economy wide or system strategy set either as a fuel tax or as a result of a cap-and-trade system. Motor fuel taxes, currently the primary source of revenue for highways, would increase to higher levels to generate more revenue to highways. Very high levels of either carbon prices or motor fuel taxes may affect fuel efficiency or fuel types, as well as travel demand. Carbon pricing strategies, while not implemented, consider: • Environmental levy on the carbon content of fuels; and • Dedicated fuel consumption tax to support development and maintenance of new and existing transportation systems. State DOTs with federal (U.S. DOT, FHWA) agency support have been assessing the potential for implementing carbon pricing strategies. An example pricing strategy could include an allowance price of \$30-50 per ton in 2030, or similar carbon tax.	 Generate revenue to maintain system and to address transportation improvements regionwide Reduce congestion in corridors and systems Provide incentive to use transit, bike, or walk 	Minimal	Long-Term	
Emissions-based vehicle registration fees				
Fees are levied based on the carbon dioxide emission levels of a car while it is operating.	 Generate revenue to maintain system and to address transportation improvements regionwide Reduce congestion in corridors and systems Provide incentive to use transit, bike, or walk Provide incentive to purchase and use efficient vehicles 	Minimal	Medium-Term	
VMT fee				
A VMT Fee is charged based on how many miles a car is driven. Odometer readings determine the exact fee charged. A city or county could modify the structure of the fee to include a carbon fee (see Carbon Pricing/Motor Fuel Tax). VMT fees can be layered to be higher or lower based on the fuel economy of cars and also layered based on urban and rural usage . Specific VMT fees of 2 to 5 cents per mile have been tested. VMT Fees consider distance-traveled charges levied to users based on the amount a vehicle uses a road system, while Congestion Pricing/Road User fees are levied to system users during congested periods of the day.	 Generate revenue to maintain system and to address transportation improvements regionwide Reduce congestion in corridors and systems Incentive to use transit, biking, and walking Provide incentive to purchase and use efficient vehicles 	Minimal	Medium-Term	
Traffic Impact Fee				
A charge on new development to cover the full cost of the additional transportation capacity, including transit, required to serve the development. While fee strategies may vary, in most cases, only those new developments that result in an increase in vehicle trips would be charged. Traffic impact fees can be structured as a single fee for the entire region, multiple fees for individual geographic areas, or multiple fees for specific corridors. Traffic impact fees vary based on the expected new development impact on the transportation system and are often structured with lower fees for developments that promote mixed use development, reduce single occupant vehicle use, and encourage transit and non-motorized travel use.	 Generate revenue to maintain system and to address transportation improvements regionwide Provide Incentive to purchase and use efficient vehicles 	Minimal	Short-Term.	

 Land Use and Built Environment (e.g., Mixed use developments) Transportation Demand Management Operations and Management (e.g., traveler information) Public Transportation Bicycle and Pedestrian (e.g., pedestrian and bicycle improvements) 	•	Oregon DOT
 Land Use and Built Environment (e.g., Mixed use developments) Transportation Demand Management Operations and Management (e.g., traveler information) Public Transportation 	•	Oregon DOT
 Land Use and Built Environment (e.g., Mixed use developments) Transportation Demand Management Operations and Management (e.g., traveler information) Public Transportation 	•	Oregon DOT
 Land Use and Built Environment (e.g., Mixed use developments) Transportation Demand Management Operations and Management (e.g., traveler information) Public Transportation Bicycle and Pedestrian (e.g., pedestrian and bicycle improvements) 	•	Oregon DOT

Pay-As-You-Drive (PAYD) Insurance (state level)	-			
PAYD insurance considers charging drivers insurance premium costs based in part on annual vehicle miles travelled. Other insurance rating factors still apply to insurance rates, so high risk drivers pay more than lower risk drivers. All drivers have the opportunity to save money (reduced insurance fees) by driving fewer miles. The state could require insurance companies to offer PAYD insurance at lower rates and require companies to offer higher rates to encourage fewer vehicle miles travelled.	 Reduce congestion in corridors and systems Promote transit, biking and walking 	Minimal	Short-Term.	

Oregon DC

Table 4.8 TDM Strategies

Strategies/Projects	Congestion and Mobility Benefits	Costs and Impacts	Implementation Timeframe	Analysis Method	Grouping	Example
Alternative Work Hours This allows workers to arrive and leave work outside of the traditional commute period. It can be on a scheduled basis or a true flex-time arrangement. Can also include a compressed work week. Telecommuting	 Reduce peak-period VMT Improve travel time among participants Reduce peak-period SOV trips 	Minimal (No capital costs; Agency costs for outreach and publicity; Employer costs associated with accommodating alternative work schedules)	Short-term: 1 to 5 years	 TDM Evaluation Model Regional Travel Model 		MARC NYMTC MAG
This involves employees to work at home or regional telecommute center instead of going into the office. They might do this all the time, or only one or more days per week. Also include teleconferencing and videoconferencing: the live exchange of information among several persons and machines linked by telecommunications; includes telephone conferencing and videoconferencing.	 Reduce VMT Reduce SOV trips Lower commuting costs 	Minimal (First-year implementation costs for private-sector for employee equipment; Second-year costs tend to decline)	Short-term: 1 to 5 years	 TDM Evaluation Model Regional Travel Model 	Other TDM strategies	 MARC NYMTC DRCOG MAG SLC WFRC
Ridesharing	-					
This is typically arranged/encouraged through employers or transportation management agencies (TMA), which provides ride-matching services. Programs to promote carpooling and vanpooling, including ridematching services and policies that give ridesharing vehicles priority in traffic and parking.	 Reduce work VMT Reduce SOV trips Lower commuting costs 	Low (Costs per year per free parking space provided; Administrative costs)	Short-term: 1 to 5 years	 TDM Evaluation Model Regional Travel Model 	 Other TDM strategies Transit strategies Active Transportation strategies Highway strategies (HOV lanes) 	 MARC NYMTC DRCOG MAG SLC WFRC
Guaranteed Ride Home Policies						
Provides a guaranteed ride home at no cost to the employee in the event an employee or a member of their immediate family becomes ill or injured, requiring the employee to leave work	Reduce work VMTReduce SOV trips	Low (Requires administrative support from employers; costs variable)	Short-term: 1 to 5 years		 Other TDM strategies Transit strategies Active Transportation strategies 	NYMTC
Alternative Travel Mode Events and Assistance						
Variety of events that promote, encourage and educate people about alternative travel modes (e.g. Bike to Work Day, RideSmart Thursdays and employer transportation fairs). Can include programs that provide free or low- cost transit services (e.g. EcoPass) or other incentives	Reduce SOVsLower commuting costs	Low (depends on the level of participation from employers and sponsors)	Short-term: 1 to 5 years		 Other TDM strategies Transit strategies Active Transportation strategies Highway strategies (HOV lanes) 	• DRCOG

Public Education Campaigns	_					
Education related to driving habits, trip chaining, idle reduction, jackrabit starts, Clean the Air Challenges, and others.	• Various, depending on campaign	Low	Short-term: 1 to 5 years		 Other TDM strategies Transit strategies Active Transportation strategies Highway strategies (HOV lanes) 	SLC WFRC
Traditional Toll Roads						
Payment charged for passage on roads, bridges or ferries that carry cars. Primary use as a revenue generator to help pay for building new facilities and maintaining infrastructure. Often associated with bonding for infrastructure.	Reduce tripsReduce SOVs	High (high capital costs for new construction of entire facility, lower costs if converting an existing facility; operating and maintenance costs may be partially recovered through toll revenues)	Medium- to Long-term: (5 to 10+ years) for implementation	 Regional Travel Demand Model IDAS 	 Operations and Management strategies (ETC) 	Oregon DOT
Non-traditional Toll Roads						
Usually these roads, or portions of roads, are referred to as "Managed Lanes" – A toll lane or lanes designed to increase freeway efficiency through a combination of operational and design actions. This may include High Occupancy Vehicle (HOV) toll (HOT) lanes that allow a limited number of low- occupancy vehicles to use the lane if a fee is paid.	 Reduce SOVs Increase reliability Shift traffic to off-peak times 	High (high capital costs for new construction of entire facility, lower costs if converting an existing facility; operating and maintenance costs may be partially recovered through toll revenues)	Medium- to Long-term: (5 to 10+ years) for implementation	 Regional Travel Demand Model 	 Transit strategies (express bus, BRT) Operations and Management strategies 	Oregon DOT
Car Sharing						
 Program in which automobile rental services are used to substitute private vehicle use and ownership. Programs are designed to be accessible to residences, affordable, follow easy check-in/out processes, and reliable. Peer to peer car sharing, also known as Personal Vehicle Car-Sharing (PVCS) enables private car owners to make their vehicle available on a temporary basis to a private carsharing company for rental. In return, the vehicle owner gets a substantial portion of the rental revenue from the carsharing company. When not rented, the vehicle owner can continue to use their car as before. Commercial Car Sharing, run by private firms, maintain a fleet of vehicles that are deployed regionally (neighborhoods) for rental and use. 	 Provide cost savings to users May increase non-auto mode share 	High (costs may be privately funded; revenues may recover most costs over time)	Short- to Medium-Term: Implemented within 1 to 2 years or between 3 to 10 years depending on the level of service changes and magnitude of project.		 Other Transportation Demand Management strategies Transit strategies Active Transportation strategies Land Use strategies 	Oregon DOT

Table 4.9 Transit Strategies

Strategies/Projects	Congestion and Mobility Benefits	Costs and Impacts	Implementation Timeframe	Analysis Method	Grouping	Example
Reducing Transit Fares						
Encourages additional transit use, to the extent that high fares are a barrier to transit.	 Reduce daily VMT Reduce congestion Increase ridership 	Low to Moderate (Operating subsidies needed to replace lost fare revenue; total operating costs may increase if ridership increases).	Short-term: Less than one year	Regional Travel ModelTDM Evaluation Model	Other transit strategiesLand use strategies	MARCNYMTC
Increasing Bus Route Coverage or Frequencies	Increase transit ridership					
Provides better accessibility to transit to a greater share of the population. Increasing frequency makes transit more attractive to use. May require investment in new buses which would create a capital cost per passenger trip. May also include new routes or	 Decrease travel time Reduce daily VMT Improved convenience and travel reliability Reduced traffic congestion due to trips awitched from driving along to transit 	Low to Moderate (New bus purchases likely; increased operating costs)	Short-term: 1 to 5 years (includes planning, engineering, and construction)	TDM Evaluation ModelRegional Travel Model	Other transit strategiesLand use strategies	 MARC NYMTC DRCOG MAG
extensions to existing routes. Park-and-Ride Lots	 Reduce regional VMT (up to 0.1 percent) Increase mobility and transit efficiency Reduce SOV trips 	Low to Moderate (Structure costs for transit stations: Land acquisition	Medium-term: 5 to 10 years (includes	TDM Evaluation Model	Other transit strategiesHOV lanes	MARC NYMTC
Can be used in conjunction with HOV lanes and/or express bus services. They are particularly helpful for encouraging HOV use for longer distance commute trips.	 Increase transit boardings and mode share Decrease congestion by increasing vehicle occupancy rate 	costs)	planning, engineering, and construction)	Regional Travel Model	 Active transportation strategies 	MAG SLC WFRC
Light, Heavy, and Commuter Rail	_				Land use strategies	
Exclusive guideways (e.g., light rail, heavy/commuter rail) and street travelways (e.g., 16th Street Mall, bus rapid transit (BRT)) devoted to increasing the person-carrying capacity within a travel corridor	 Reduce daily VMT More consistent and sometimes faster travel times versus driving Reduce SOV trips Increased person throughput capacity within a corridor due to people switching from single occupant motor vehicles to transit Stimulation of efficient mixed-use or higher-density development 	 Moderate to high Implementation cost will vary, but cost could be high due to acquisition of rights-of-way, materials and infrastructure. New systems require large upfront capital outlays and ongoing operating costs 	Medium- to long-term: Development and implementation of a rail project is a major undertaking that can take 10 or more years from initial planning phases through NEPA studies to an opening day.	Regional Travel Model	 (TODs) Parking strategies Other transit strategies TDM strategies HOV lanes Active transportation strategies Highway pricing strategies 	DRCOGMAG
Employer Incentive Programs	Increase transit ridership	Low to Moderate (Cost of incentives			TDM	
Encourages additional transit use through transit subsidies of mass transit fares provided by employers	Decrease travel timeDecrease daily VMT	to employers offering employee benefits for transit use)	Short-term: 1 to 5 years		 Other transit strategies 	NYMTC
Electronic Payment Systems and Universal Farecards Equipment that allows riders to electronically pay a transit fare by using credit, debit and magnetic fare cards. Interchangeable smartcard payment system (including RFID) can be used as a fare payment method for multiple transit agencies throughout the region	 Increase transit ridership Decrease travel time Decrease operating costs 	 Moderate to High (Implementation costs vary based on system design and functionality) The cost to purchase and implement electronic fare collection equipment can be high depending on the technology used. An initial surge in the maintenance and repair of electronic fare equipment can be expected due to the need for highly trained personnel. 	Short-term: 1 to 5 years		Other transit strategies	NYMTCDRCOG

Realigned Transit Service Schedules and Stop Locations						
Service adjustments to better align transit service with ridership markets	Increase transit ridershipDecrease daily VMT	Low	Short-term: 1 to 5 years	Regional travel model	Other transit strategies	NYMTC
Intelligent Transit Stops	_					
Ranges from kiosks, which show static transit schedules, to real-time information on schedules, locations of transit vehicles, arrival time of the vehicle, and alternative routes and modes	 Decrease daily VMT Decrease congestion Increase ridership 	Low to Moderate (Capital and operating costs for new infrastructure and technology)	Medium-term: 5 to 10 years (includes planning, engineering, and construction		Other transit strategies	NYMTC
Transit intersection queue jump lanes and signal priority						
Additional travel lane at a signalized intersection that allows buses to proceed via their own "green-time" before other vehicles. Done by restriping within existing road footprint or may require construction.	 Reduced bus travel delays due to traffic signals and traffic congestion Improved operational efficiency of transit service within a corridor Increased ridership and reduced congestion due to time savings Safer driving conditions for all vehicles due to fewer severe and sudden lane changes by buses 	Low to moderate • Installation and operation cost of queue jump lane and signal equipment is low. • Constructing a new designated transit lane has a higher cost • Implementation costs vary based on system design and functionality and type of equipment	Short-term: 1 to 5 years (All phases– planning, engineering and implementing– a queue-jump lane can be reasonably completed in less than one year; Longer time is needed if new lane must be constructed)	Localized analysisSimulation model	 Other transit strategies Can be incorporated into some highway strategies 	DRCOGNYMTC
Enhanced Transit Amenities						
Includes vehicle replacement/upgrades and better shelters or stations, which furthers the benefits of increased transit use	 Decrease daily VMT Decrease congestion Increase ridership 	Low to Moderate	Short-term: 1 to 5 years (includes planning, engineering, and construction)		Other transit strategies	• NYMTC
Dedicated Rights-of-Way for Transit					Other transit strategies	
Reserved travel lanes or rights-of-way for transit operations, including use of shoulders during peak periods	Increase transit ridershipDecrease travel time	Low to Moderate (Costs vary by type of design)	Medium-term: 5 to 10 years (includes planning, engineering, and construction)	Simulation model	 Can be incorporated into some highway strategies 	NYMTC
Bus Rapid Transit (BRT)					Other transit strategies	
High-capacity, highly efficient bus service designed to compete with rail in terms of quality of service.	 Reduce VMT Reduce SOV trips Increase transit ridership & mode share 	Moderate to High (Depends on elements of BRT implemented)	Long-term: 10 or more years (includes planning, engineering, and construction)	 Regional Travel Model EPA Commuter Model 	 Can be incorporated into some highway strategies Operations and maintenance 	• MAG
Express Bus Service	_					
Bus service with high-speed operations, usually between two commuter points.	 Reduce VMT Reduce SOV trips Increase transit ridership & mode share 	Low to Moderate (may require new bus purchases)	Short-term: 1 to 5 years (includes planning, engineering, and construction)	 Regional Travel Model EPA Commuter Model 	 Other transit strategies Operations and maintenance 	• MAG

Congestion Management Toolbox Update

Local Circulator						
Fixed-route service within an activity area, such as a CBD or campus, designed to reduce short trips by car.	 Reduce VMT Reduce SOV trips Increase transit ridership & boardings 	Low to Moderate (may require new bus purchases)	Short-term: 1 to 5 years (includes planning, engineering, and construction)	Regional Travel ModelEPA Commuter Model	Other transit strategies	• MAG

Table 4.10 Transportation Operations and Management

Strategies/Projects	Congestion and Mobility Benefits	Costs and Impacts	Implementation Timeframe	Analysis Method	Grouping	Example
Traffic Signal Coordination and Modernization						
 This improves traffic flow and reduces emissions by minimizing stops on arterial streets. Enhancements to timing/coordination plans and equipment to improve traffic flow and decrease the number of vehicle stops. May include: Modern technology that provides for real-time traffic and transit management Equipment that may permit immediate knowledge of malfunctions Responsive control that allows traffic signals to alter timing in response to immediate traffic flow conditions, rather than at predetermined times Transit signal priority system that can extend "green-time" a few seconds to allow buses to progress through an intersection 	 Improve travel time Reduce the number of stops Reduce VMT by vehicle miles per day, depending on program Reduce vehicle-hours traveled Reduce air pollution, fuel consumption and travel time Increase "capacity" of an intersection to handle vehicles 	Low to moderate (Costs include initial investment of equipment, software, and communication network and connections, and O&M costs per signal. Varies depending on required equipment)	Short-term: 1 to 5 years (includes planning, engineering, and implementation)	 IDAS Regional Travel Model TOPS-BC Microsimulation models 	 Other Operations and Management strategies Transit strategies 	 MARC NYMTC DRCOG MAG SLC WFRC
Reversible Traffic Lanes				Designed		
These are appropriate where traffic flow is highly directional. Can entail a variety of different types of movable barriers, signage, and signaling.	 Increase peak direction capacity Reduce peak travel times Improve mobility 	Moderate to high (depends on barrier separated costs and operation costs per mile)	Short-term: 1 to 5 years	 Regional Travel Model Microsimulation models 	Other Operations and Management strategies	MARCNYMTC
Freeway Incident Detection and Management Systems		Moderate to high (canital costs				MARO
This is an effective way to alleviate non-recurring congestion. Systems typically include video monitoring, dispatch systems, and sometimes roving service patrol vehicles.	 Reduce accident delay Reduce travel time Decrease vehicle-hours traveled 	variable and can be substantial; also annual operating and maintenance costs)	Medium- to Long-term: likely 10 years or more	 IDAS Regional Travel Model 	Other Operations and Management strategies	MARCNYMTCDRCOG
Ramp Metering This allows freeways to operate at their optimal flow rates, thereby speeding travel and reducing collisions. May include bus or high-occupancy vehicle bypass lanes. May require ramp widening to avoid extensive vehicle queuing.	 Decrease travel time Decrease merging and weaving related crashes Improve traffic flow on major facilities Improved speed on freeway Decreased crash rate on freeway 	Moderate (capital costs variable, can be significant costs associated with enhancements to centralized control system; also annual operating and maintenance costs)	Medium-term: 5 to 10 years	 IDAS Regional Travel Model TOPS-BC Freeval (specialized ramp metering tool) Microsimulation models 	 Other Operations and Management strategies 	MARCNYMTCDRCOGMAG
Highway Information Systems				• IDAS		
These systems provide travelers with real-time information that can be used to make trip and route choice decisions.	 Reduce travel times and delay Some peak-period travel shift to off- peak 	Moderate (capital and operating and maintenance costs)	Medium-term: 5 to 10 years	Regional Travel Model TOPS-BC User surveys	Other Operations and Management strategies	• MARC
Advanced Traveler Information Systems	_			• IDAS		• MARC
This provides an extensive amount of data to travelers, such as real time speed estimates on the web or over wireless devices, and transit vehicle schedule progress. Provides travelers with real-time information that can be used to make trip and route choice decisions. Information accessible on the web, dynamic message signs, 511 systems, Highway Advisory Radio (HAR), or handheld wireless devices.	 Reduce travel times and delay Some peak-period travel and mode shift to non-peak and non-auto modes 	Moderate (capital and operating and maintenance costs; Private sector data increasingly available for purchase)	Medium-term: 5 to 10 years	Regional Travel Model TOPS-BC User Surveys	Other Operations and Management strategies	NYMTCDRCOGMAG

Congestion Management Toolbox Update

Service Patrols		Levels mederate (Oceta very based or				
Service vehicles patrol heavily traveled segments and congested sections of the freeways that are prone to incidents to provide faster and anticipatory responses to traffic incidents and disabled vehicles	 Reduce incident duration time Restore full freeway capacity Reduce the risks of secondary crashes to motorists 	Low to moderate (Costs vary based on the number of vehicles used by the patrol, number of routes that the patrol operates, and the population of the area in which the program operates)	Short-term: 1 to 5 years	IDASTOPS-BC	 Other Operations and Management strategies (Freeway Incident Detection and Management Systems; Highway Information Systems) NYMTC DRCOG 	
Restricting Turns at Key Intersections	Increase capacity efficiency on					
Limits turning vehicles, which can impede traffic flow and are more likely to be involved in crashes	 Improve mobility on facility Improve travel times and decrease delay for through traffic Decrease incidents 	Low (Implementation and maintenance costs vary; range from new signage and striping to more costly permanent median barriers and curbs)	Short-term: 1 to 5 years (includes planning, engineering, and implementation)	 Localized analysis 	• NYMTC	
Converting Streets to One-Way Operations				a Bagianal		
Establishes pairs of one-way streets in place of two-way operations. Most effective in downtown or very heavily congested areas	Increase traffic flow	Low (Conversion costs include adjustments to traffic signals, striping, signing and parking meters)	Short-term: 1 to 5 years (includes planning, engineering, and implementation)	 Regional Travel Mode Microsimula models 	on NYMTC	
Targeted and Sustained Enforcement of Traffic Regulations				Mieroeiroule		
Improves traffic flow by reducing violations that cause delays; Includes automated enforcement (e.g., red light cameras)	Improve travel timeDecrease the number of stops	Low (Increased labor costs per officer)	Short-term: 1 to 5 years	 Microsimula models TOPS-BC 	• NYMTC	
Special Events and Work Zone Management	Minimize traffic delays					
Includes a suite of strategies including temporary traffic control, public awareness and motorist information, and traffic operations	 Improve mobility Maintain access for businesses and residents 	Low to moderate (Design and implementation costs variable)	Short-term: 1 to 5 years	 Microsimula models TOPS-BC 	on NYMTC	
Road Weather Management				Maintenance		
Identifying weather and road surface problems and rapidly targeting responses including advisory information, control measures, and treatment strategies	 Improve safety due to reduced crash risk Increased mobility due to restored capacity, delay reductions, and more uniform traffic flow 	Low to moderate (Design, implementation, and operating and maintenance costs variable)	Short-term: 1 to 5 years	Decision Support System (MDSS) software	• NYMTC	
Traffic Surveillance and Control Systems	_					
Often housed within a Traffic Management Center (TMC), monitors volume and flow of traffic by a system of sensors, and further analyzes traffic conditions to flag developing problems, and implement adjustments to traffic signal timing sequences, in order to optimize traffic flow estimating traffic parameters in real-time. Currently, the dominant technology traffic surveillance is that of magnetic loop detectors, which are buried underneath roadways and count automobiles passing over them. Video monitoring systems for traffic surveillance may provide vehicle classifications, travel times, lane changes, rapid accelerations or decelerations, and length queues at urban intersections, in addition to vehicle counts and speeds.	 Decrease travel times and delay Some peak-period travel and mode shift 	Moderate (Installation of video surveillance cameras may be less expensive than magnetic loop detectors, which require disruption and digging of the road surface)	Medium-term: 5 to 10 years	IDASTOPS-BC	• NYMTC	
Electronic Toll Collection (ETC)		Moderate to high (Initial investment in				
Equipment that electronically collects tolls from users without requiring vehicles to stop at a toll booth	 Fewer vehicle stops and less traveler delay at toll stations Cost savings due to no (or fewer) toll booth facilities or lanes Significant decrease in pollutant emissions from stop-and-go traffic at toll booths/plazas 	electronic toll collection technology can be substantial, for overhead transponder readers, surveillance and enforcement equipment; estimated annual maintenance and operational costs for an electronic toll lane are less than \$20,000, whereas a staffed toll booth lane can cost nearly \$200,000 annually)	Short- to medium-term: Physical implementation of electronic toll collection equipment can be completed in a short time period for a roadway, unless additional right-of-way is needed)	• IDAS	 Highway strategies (New or converted high-occupancy toll (HOT) lanes would also likely use ETC technology) Transit strategies (express bus) 	
	Cordon Area Congestion Fees	•	Reduced pollution and congestion			
---	--	---	---	--	---	----------------------------
	An established cordon area or zone in which vehicles are charged a fee to enter. Such a fee can be variable (by time of day) or dynamic (based on real-time congestion conditions). Should include electronic payment/collection methods using cameras or transponders	•	within the cordon area Revenues for roadway maintenance and new transit, bicycle and pedestrian facilities Overall reduced congestion due to less VMT Shift to non-auto modes	High	Medium- to long-term: Extensive time is required for the entire process including political and public discussions, possible ballot measures, construction and implementation	legi ibai ema ode
	Roadway Signage Improvements				Short-term: Production of	
	Adequate or additional signage that facilitates route-finding and the decision-making ability of roadway users. Signs with clearer/larger lettering that can be read from a greater distance	•	Reduced delay for upstream approaching vehicles Less chance of crashes caused by sudden lane changes, extremely slow- moving vehicles or sudden stops	Low	signs and installation can occur shortly after site visits and design of new signing plans. Design should follow the guidance of the Manual on Uniform Traffic Control Devices (MUTCD).	
ľ	Communications Networks and Roadway Surveillance Coverage				Madium to long to ma Croall	
	Base infrastructure (fiber, cameras, etc.) required to support all operational activities; Communications networks that allow remote roadway surveillance and system control from a TMC and provision of data for immediate management of transportation operations and distribution of information. Communication networks are essential to get the most efficiency and capacity out of the existing transportation system.	•	Increased capability for regional-level coordination of operations and traveler information.	Moderate (Cost can be reduced when done in conjunction with a larger scale construction project)	scale items and opportunistic expansion can be done quickly. Larger- scale regional network components require more time for planning and funding.	
	Transit Vehicle Travel Information	1				
	Communications infrastructure, GPS technology, vehicle detection/monitoring devices and signs/media/Internet sites for providing information to the public such as the arrival times of the next vehicles	•	More satisfied customers and increased ridership due to enhanced and reliable information sources Improved operations and management of transit service	Moderate (Costs are dependent upon communication networks, changing technologies and the number of fleet vehicles to be equipped)	Medium-term: Time is required for detailed planning, design and funding procurement	

egional or bareas travel mand odels	 Transit strategies Active Transportation strategies Other Operations and Maintenance strategies Regulatory strategies 	•	DRCOG Oregon DOT
		•	DRCOG
	• Many operations and management strategies in this toolbox require the support of roadway surveillance and communications infrastructure.	•	DRCOG
	Transit strategies	•	DRCOG

A. Interview Summaries

A.1 CITY OF GRANDVIEW, MISSOURI

Details

- **Date:** November 12, 2013
- **Time:** 1:30 p.m.
- Attendees: Dennis Randolph, Director of Public Works

Discussion

What is your agency's role in the congestion management process?

- Because Grandview straddles I-49 and 150 highway, our streets don't have a lot of congestion problems. Even the busiest streets don't have many congestion issues. Our biggest issue is when something happens on I-49 or 150 Highway. Because of that, we recommend strategies to the Missouri Department of Transportation (MoDOT).
- We are currently looking at two-way frontage roads along I-49. I-49 truly cuts the city in half, and has led to economic problems. The state has wanted to make the frontage roads one way. The City has been opposed. The commercial development along the frontage roads has been hit very hard. The problem is now the ramps for the one-way system. They don't work well for access for two-way frontage roads.

How have you identified the locations where a strategy should be implemented and the best strategies for those locations?

- At Main Street and I-49, the traffic signals are not properly timed. There is a general lack of turn around lanes over the expressway. What that results in is consistently overloading the intersections. I'm not an advocate of forcing all traffic through a limited number of crossover intersections is a problem.
- Blue Ridge, Truman, Main, 140th and 150 Highway all cross over I-49 over five miles. This causes the need for a lot of phasing. All the movements should not have been concentrated at the intersections.
- At 150 Highway, there is a problem. There is a new single point interchange there. As the traffic builds, the signal operations bog down. And there is an interchange that will hopefully have redevelopment next year. With that additional traffic, there could be problems.

• Now at Botts Road there is a diverging diamond. That will work a lot longer and better than the single point.

How do you approach future developments?

- We are looking at some low cost and some modernization ideas. The city is considering signal coordination and interconnection with each other and with the state system.
- We are not looking at capacity improvements. As a matter of fact, we're dropping a lane on Main Street. We are likely to have plenty of capacity. We are looking at a few minor connections.

What types of strategies have you used to mitigate congestion?

- Access management, operations, safety, ITS are all used in Grandview
- We should consider "Michigan lefts." They've allowed intermediate crossings or crossovers. These divert traffic from the main line. These get signals down to two-phase and you can move a lot of traffic. It's also good from a safety perspective because you are removing conflicting turns.
- The City also has six years of crash data on its GIS system that it refers to. While backups are an indicator of congestion, crashes are a better indicator.

Have you used the Congestion Management Toolbox published by MARC as a reference?

• The City has to use the highway safety manual but it's too difficult to figure out. You have to be an engineer to use that tool. Most of the problems we have could be handled by simple things.

What additional tools or information would be helpful?

- Get the universities involved to help out in the understanding.
- Write in laymen's terms.
- This needs to account for varying level of expertise. You have to acknowledge that there's not just one primary way to do something. This makes folks a lot more comfortable.

A.2 JOHNSON COUNTY COMMUNITIES

Details

- Date: October 22, 2013
- **Time:** 10:30 a.m.

• Attendees: City of Lenexa: Steve Schooley, Tim Green; City of Shawnee: Mark Sherfy; City of Olathe: Thomas Dow

Discussion

Explain how your agency approaches the congestion management process.

- Lenexa: We don't have a process. It's more complaint driven or general knowledge of what's going on.
- Shawnee: We have knowledge of where there are issues and challenges, where the growth is, but there is no modeling.
- Olathe: The city monitors the traffic congestion at all the intersections and makes adjustments to signal timing as needed based upon changing conditions. We also get a lot of complaints from citizens. We do have big construction projects that do have major impacts on traffic, especially when they take longer than we anticipate. There is a cyclical nature to traffic. It's different in the summer rather than the rest of the year.

How have you identified the locations where a strategy should be implemented and the best strategies for those locations?

- Olathe has a traffic operations center. We are not looking just at adding lanes. In Johnson County, if you build lanes, they will fill up. There is an increased interest in alternatives modes of transportation. For bike/ped, it's more of a quality of life issue, not about congestion. The same thing is true for transit. There is an increased amount of interest. There is a role, but it's not going to significantly reduce congestion.
- Lenexa: Adding lanes is helpful to reduce congestion. We will also look at access control to help reduce congestion and improve traffic operations. Signal timing is a given. We've got good communications and coordination with the signals in Johnson County. When you look at traditional neighborhoods and pedestrian activity, we are just scratching the surface at that. The amount of reduction that would be needed to eliminate a through lane likely can't be accomplished.
- Olathe: This is dependent on whether it's new or existing. In an existing area, Olathe looks at signs and pavement markings etc. for adjustments. The next step is the police speed trailer, to identify areas of high traffic speeds. The next step can request traffic calming, which could result in some measure. In new development, it's just a part of the development process.
- Lenexa: There's not a process that allows you know for sure. What is the character of the road? What type of access? What type of development? Then identify a scenario or solution we can work out.

What types of strategies have you used to mitigate congestion?

- Access Management Strategies
 - Access management is part and parcel in the Johnson County cities' development processes. Our major arterials are evenly spaced and well defined. But within sections, it's hard to get connectivity on internal streets.
 - In Shawnee, we don't have a formal access management policy. That is likely for cities under 40,000 population. We don't have anything written. Staff pushes for it but usually loses.
 - Even if you have one, it doesn't guarantee that's what's going to happen. It was a lot easier before the recession but now cities just want the development.
 - Lenexa has about 20 roundabouts. They are here to stay. They make a lot of sense as opposed to some signalized intersections. They can be a useful tool in the appropriate situation.
 - On an arterial street, you want to move traffic quickly, not slow them down.
- Land Development Strategies
- Parking Management Strategies

Which have been least effective?

- A lot of times it's a development related decision that resulted in, for example, signals are too close together.
- Median treatments would be done differently in Olathe if we were starting over. (Lenexa echoed this.) It's an issue for those motorists turning left. We now do a diagonal approach to improve sight distance.
- Flashing yellow arrows for left turns have been positive and have reduced crashes.
- Lenexa's strategies have been successful, but none of them solve all the problems. Some might have as great of an impact as anticipated. Sometimes, when you clean up the congestion, then more people go to use it.

What additional tools or information would be helpful for your agency?

- Reaffirmation of some of the things we're already doing so that it can be another place to reference. For instance, access control, which is always a challenge.
- With two states, nine counties and all the cities, it's hard to find a balance for an effective regional policy. Jurisdictions make the decisions and then go seek

funding. The regional toolbox isn't what's leading things. It's just a series of hoops to jump through.

- Best practices from across the nation would be helpful.
- Connect the CMT to connect to capital programming.
- Outlining which options in toolbox could be applied in specific locations.

Have there been larger projects that have required more planning?

- Lenexa: We do those major studies. We look at a long-range plan and separate it into three or four projects as was done on 87th Street Parkway. We are not working on one on 95th street. It will take at least 10 years to build those.
- Olathe: The city is about to do long-range citywide transportation master plan. K-7 has been recommended by a freeway. That will be difficult. We will revisit what can be done. Kansas Department of Transportation (KDOT) also has some construction phasing ideas that would close three consecutive interchanges in Olathe. That's not viable. They will have to do it over two construction seasons over one.
- Johnson County is a beacon for corridor management and corridor planning. Shawnee is a part of K-7 planning. Shawnee Mission Parkway was studied continually from 1990 to 2000. It's now very smooth. Operation Green Light has been huge; it's undersold and underused. It helps in all of our congestion.
- One of the challenges for transit in the area is the multiple transit agencies. The region has taken a look at it from a more broad perspective. We probably will find that we don't have corridors from one end to the other where we will have bus service. But we also do have bus on shoulder.
- Transit on K-10 has worked very well. There is also a study right no on I-70, linking downtown KC to Topeka.
- Olathe is looking at every school in the city and how it is affected by traffic and vice versa.

A.3 CITY OF KANSAS CITY, MISSOURI

Details

- Date: October 17, 2013
- **Time:** 10:30 a.m.
- Attendees: Wei Sun and Srinivasa Veeramullu

Discussion

What is your agency's role in the congestion management process?

- We research, identify the problem and take necessary actions to address the issues.
- When fiber is installed, the city uses MoDOT right-of-way(ROW) so that we have a common control, this is in addition to what MARC does. The city maintains a good traffic flow across the corridors.
- One-third of the 600 signals are on Operation Green light.
- There is communication to 420 signals and that is being expanded.
- The city is mostly reactive; however, it is building tools to be proactive. For example, there are now 12 miles of fiber interconnected in the Green Impact Zone area. We are not staffed enough to be proactive. We do what we can within the timeframe.

How have you identified the locations where a strategy should be implemented and the best strategies for those locations?

- The city observes and reacts to certain complaints;
- Identifies the problem;
- Consults the major street plan model;
- Tries to solicit feedback from Area Transportation Authority (ATA) and general public;
- Has an internal discussion to determine resources that are necessary
- Conducts a "fatal flaw analysis"; and
- Tests the most effective strategies using traffic simulation model.

What types of strategies have you used to mitigate congestion?

- Geometric improvements, traffic control, and land development strategies considering the traffic impact studies.
- The city does not consider transit unless it is approached by Kansas City Area Transportation Authority (KCATA).

Which of these strategies have been most effective?

- It varies by circumstance. The city doesn't have the staffing to do evaluations.
- We strive to make sure that the timing is working as they were designed to.

Have you used the Congestion Management Toolbox published by MARC as a reference?

• The city has reviewed it but has not used it.

A.4 CITY OF LEE'S SUMMIT, MISSOURI

Details

- Date: October 21, 2013
- **Time:** 11:030 a.m.
- Attendees: Michael Park and Shannon Jeffries

Discussion

What is your agency's role in the congestion management process?

• This staff is completely responsible for congestion management: all signal timing and evaluation, improvement strategies, long-range master plans, and system management. They also coordinate with KDOT, KCMO and MARC.

How have you identified the locations where a strategy should be implemented and the best strategies for those locations?

- We begin by looking at where we have responsibility and take a system approach. We ask where we have safety issues and where we have congestion issues. But we also look at top 10---frequency or rate locations..
- But we also take a system wide approach. That's where we started with an annual marking program that was begun about five years. We also do sign program, auditing on a 5-7 year cycle. We also coordinate with the school district partners. We work with them to develop better circulation patterns. As part of development, as part of access management code, developers have to do traffic impact studies. We then review those. We then hold developers to Level of Service (LOS) C.
- The access management code and LOS C have been helpful in congestion management.
- Synchro is used for intersection analysis. We evaluate that every four years and re-time signals every four years. We then provide that to developers. Otherwise we use industry best practice. We know what works because the industry has proven it.
- The thoroughfare master plan does prioritize improvements based on LOS that is congestion related.

What types of strategies have you used to mitigate congestion?

- Transit Projects: Lee's Summit is an urbanized area, but we have transferred that responsibility to KCATA. We do a demand assessment for transit every 5-10 years.
- Intelligent Transportation Systems (ITS) and Transportation System Management (TSM) Strategies: The city participates in OGL. We also have adaptive signals at 14 intersections, and MoDOT has done another nine intersections. It has worked well on Chipman Road and Blue Parkway. They are planning to try it also on Colbern Road.
- Access Management Strategies: This is the most influential. We push as hard as we can to get folks to comply with it, whether it's infill or Greenfield development. We want to better use our functional classification system.
- Parking Management Strategies: We are seeing more interest for shared parking. We are currently at occupancy rate in downtown at about 70 percent. Downtown will have to add parking to reach its potential. That will likely be in a partnership for development.

Which of these strategies have been most effective?

- The city tries to be systematic in measurement of bike/ped, transportation.
- On local roadways we have hot spots but not anything glaring. But we try to stay on top of it. We try to be proactive. The biggest issue is the state system.
- Access management has been one of the best tools.
- As we are moving into more of a redevelopment approach, we don't have the ability to widen roadways or do ITS. While we do have thousands of acres, much of it is held by the Mormon Church. There is also a push to have a more vibrant downtown. There is also a push for redevelopment zones. We want to be creative, and we are looking at what is more compatible means of development. We have to ask ourselves whether LOS D and E are acceptable? Adding a lane isn't always going to be the answer. We have caught up on our capacity needs for most thoroughfares. We are now trying to look ahead. What can we do to reduce trip generation? Shorten trips? Mixed -Use developments can help us do that. How can we be less dependent on the vehicle?
- Shared parking models in New Longview rely heavily on compatible Mixed-Uses.
- We are also considering whether we should spend local dollars on the state system.

Which have been least effective? Why?

• At one location, an adaptive signal didn't work. We used to require right turn lanes, but now we consider the volume. We have roundabouts and will have more. But you have to know its limits. At New Longview, roundabouts were designed for a more urban setting, we just aren't there yet so we modified them. It's about knowing the appropriateness of some of the tools. You have to know the practical limits of the approach. You have to understand the public education component.

Have you used the Congestion Management Toolbox published by MARC?

• Although we've helped develop some of their resources, we haven't used the toolbox. We more of a contributing resource to its development. They don't provide us new ideas that we haven't already considered. We have a great staff; some other agencies don't. You have to consider the audience you are trying to target.

What additional tools or information would be helpful for your agency?

- Identify low-cost strategies.
- Inform users how to prioritize improvements. They know the types that can make an impact but where should they best implement those strategies. Provide users a way of inventorying their issues.

A.5 UNIFIED GOVERNMENT OF WYANDOTTE COUNTY/KANSAS CITY, KANSAS

Details

- Date: October 28, 2013
- Time: 9:00 a.m.
- Attendees: Fred Backhus, Bill Heatherman, Lideana Laboy, Dave Northup

Discussion

Explain how your agency approaches the congestion management process.

- We respond to residents for projects for improvements, traffic studies for new developments to see what impacts will have in the region, events management, also working on ITS and some network communication
- Most of our residential growth had been in western Wyandotte County but that slowed down and there has been a lot of commercial investment. We are now seeing industrial redevelopment in Fairfax and Armourdale.

How have you identified the locations where a strategy should be implemented and the best strategies for those locations?

- We have an institutional knowledge, good accident history and traffic count history.
- Planning has a good understanding of where development is going to occur and why and where we have traffic capacity limitations.
- In last five years, either the corridors that would be the subject of congestion have either had redevelopment or been the focus of a capital improvement program. For example, State Avenue has had numerous projects. The UG is just finishing 78th street and State and made improvements to College and State Avenue. The UG used double left turns on 78th and State. There was another part of the project to maintain the medians.
- We also had a major investment in transit on State Avenue.
- Kansas University Medical Center (KU Med) is a big area. But there is not any room for expansion. Is there a new road that can be added? Can traffic signals be added? We try to look at big picture.
- Wyandotte County has a fairly decent backbone of arterial and collector routes. A lot of work is spot-oriented congestion. We have tremendous infill and redevelopment; corridors that have declined and not grown.

What types of strategies have you used to mitigate congestion?

- Communication infrastructure is deteriorating with age. Almost 25 percent of signals are on OGL. That provided us a way to get wireless communications where we could never get cable. We can't provide coordination at all locations because of the deterioration but we do see the need to that.
- Choices on communication are very technical and more advanced than what most cities can devote to it. Just to make a decision on what to invest in and feel good about it is difficult.
- Distributive Master is what is used in UG. But OGL excluded that. It has caused a problem in the community.
- Freight and truck movements are a big issues for this community, especially in the Fairfax and K-32 corridor areas. A key issue in these areas is that trucks move slowly; that in turn can exacerbate congestion issues that you have. But we don't necessarily address it in a different way. In Sante Fe bottoms, we were very proactive in addressing the truck traffic. When General Motors (GM) first game in to Fairfax, we also were very proactive.

Have you used the Congestion Management Toolbox published by MARC as a reference?

• The staff had never used the toolbox.

What additional tools or information would be helpful for your agency?

- The information should be easy to read.
- MARC has to do a better job of selling what they have. MARC provides a good reference for transportation planning.
- What's really handy is resources for public or commission meeting, this isn't "foreign news" this is what is happening in our region. Not lost in bureaucracy but targeted to make the case to the public and public bodies.
- OGL is a great example of a technical resource. In the bike/ped world, advocates and practitioners helped development of standards.
- Reducing congestion is Wyandotte County is not the top priority. We want to reinvest in the community and not produce sprawl. The current process still provides most funds for outside corridors. You need to be focusing on redevelopment and getting people being closer to where they live and work. We can't get over-focused on individual intersection congestion.

B. Analysis Methodology Instructions

This section provides step by step instructions to recreate the analyses used for the three strategies selected in this study.

Tool for Operations Benefit/Cost (TOPS-BC)

TOPS-BC was used for the evaluation of two of the strategies below. TOPS-BC is a spreadsheet based intuitive tool developed by FHWA that provides the following features:

- The ability to investigate the expected range of impacts associated with previous deployments and analyze many transportation system management and operational strategies;
- A screening mechanism to help identify appropriate tools and methodologies for conducting a benefit-cost analysis based on analysis needs;
- A framework and default cost data to estimate the life-cycle costs (including capital, replacement, and continuing operating and maintenance costs) of various transportation system management and operational strategies; and
- A framework and suggested impact values for conducting simple sketch planning level benefit-cost analysis for selected transportation system management and operational strategies.

The TOPS-BC application is distributed as a Microsoft Office 2007 Excel spreadsheet. Two separate versions are available: the Standard Version and the Development Version. The Standard Version, available online, is used in this study. This version is provided with some of the key worksheets and mathematical formulas in a locked mode so that they may not be altered. Locked cells include critical input parameters and analysis calculation formulas. Users may, in many cases, override the default input values if desired; however, this requires using the defined "user defined input" cells that clearly document changes made to the analysis. Use of this version, therefore, ensures that all analysis conducted in the tool is completed using the parameters, values and formulas as they were developed in the original tool or are clearly documented otherwise.

When opening TOPS-BC for the first time, users may need to select "Allow content" or "Enable this content" before proceeding with any analysis: this may include content such as ActiveX and Links. The TOPS-BC User's Manual provide more instructions on how to use the tool in general with some case studies.

Lee's Summit Arterial Signal Coordination

In 2010, using America Recovery and Reinvestment Act funds from an Energy Efficiency and Conservation Block Grant (EECBG) through the U.S. Department of Energy, the City of Lee's Summit began an innovative effort to reduce traffic congestion, fossil fuel consumption and CO2 emissions using smart traffic signal technology. The City of Lee's Summit worked with MoDOT District 4 to purchase and install the InSync adaptive traffic control system and necessary communications backbone for multiple corridors and 15 intersections that crossed both jurisdictions.

In this evaluation, data were provided mainly from the following two references:

- 1. Real-Time Adaptive Traffic Control on Chipman Road in Lee's Summit, MO
- 2. Summit Fair Traffic Impact Analysis Report Addendum, June 2006

Where data are missing, default data provided in the TOPS-BC tool are used. Some assumptions were also made in the analysis.

The following steps were taken using the TOPS-BC tool:

- 1. After opening the tool as described previously in this memo, go to the "LIST OF ALL WORKSHEETS" tab (the third tab from the left). Under "3) ESTIMATE COSTS", go to "Traffic Signal Coordination Systems" and select "Central Control". The cost estimate tab "Signal-Central" will then open. Alternately, one may find the "Signal-Central" tab and click on the tab directly.
- 2. Given that limited project capital and operations costs were provided, default unit costs for "TOTAL Infrastructure Cost" and "TOTAL Incremental Cost" in the TOPS-BC tool were used. "1" is entered as the number of infrastructure deployments (number of central control system), and "15" is entered as the number of incremental deployments (number of signalized intersections). "2010" is entered as the year of deployment. As a result, the average annual cost is \$806,663.
- 3. look for "4) ESTIMATE BENEFIT", go to "Arterial Strategies" and select "Signal Coordination". The benefit estimate tab "Signal Coord." will then open. Alternately, one may find the "Signal Coord." tab and click on the tab directly.
- 4. In order to prepare the input for this page, two new tabs ("Speed&Volumes" and "Air Pollution Eval") are added in this tool to calculate total corridor length, average speed improvements and future volumes, and air pollution impacts. The following inputs were provided:
 - a. Facility Characteristics
 - i. Change Length of Analysis Period (Hours) to 24;
 - ii. Choose "Central Control" as the Signal Timing Type;

- iii. Link length: 3 miles (linked to cell B75 of the "Speed&Volumes" tab);
- iv. Total number of lanes: assume the average number of lanes of the corridors are 4 lanes.
- b. Facility Performance
 - i. Link Volume: 15,030 (linked to cell C78 of the "Speed&Volumes" tab). Average link volumes of the corridors are calculated from the data provided to CS by MARK staff.
 - ii. Congested Speed: "22" is entered for Baseline Override; "31" is entered for Improvement Override. They are calculated based on the speed data provided in *Real-Time Adaptive Traffic Control on Chipman Road in Lee's Summit, MO.*
 - iii. Use default value provided in the tool for the rest of the parameters
- c. Impact due to strategy
 - i. Change in Capacity: 0% is entered for this one due to lack of data.
 - ii. Change in Speed: 38% is entered (linked to D45 of the "Speed&Volumes" tab). Average change in speed is calculated from the data provided in *Real-Time Adaptive Traffic Control on Chipman Road in Lee's Summit, MO.*
 - iii. Reduction in Crash Rate: 0% is entered due to lack of data.
 - iv. Use default value provided in the tool for the rest of the parameters
- d. Travel Time Increase on Side Streets
 - i. Travel time increase on side streets is not measured by the TOPS-BC tool. Some past studies showed that side street delay offsets the main street improvement by about 20-40% on a per vehicle basis. Based on this, a 30% per vehicle travel time increase is assumed for vehicles traveling on the side streets of the main corridors that implemented signal coordination. As a result VHT increase is calculated as 69 hours. This value is reflected in the calculation of "Average Person Hours of Travel Saved per Period".
 - ii. Default values are used for the remaining input on this page.
- e. Air Pollution Impact Evaluation
 - i. Air pollution impacts of the signal coordination deployment is not measured by the TOPS-BC tool. To estimate the impacts, a new "Air Pollution Eval" tab is added to the tool. This evaluation is based on

emission damage costs for HERS vehicle class at different speeds¹⁴. The calculated benefit of this project from air pollution reduction is \$16,610/year.

- 5. After completing the benefit estimates, look to the left side of the page, select "MY DEPLOYMENTS". The "Summary of My Deployments" will then open. Alternately, one may find the "Summary of My Deployments" tab and click on it directly.
- 6. On the Summary of My Deployments page, all the parameters for the signal coordination evaluation are provided under "Cost Factors". One may change the default value used in the analysis here. The Beginning Year of Analysis is changed to "2011" based on the project implementation schedule. Default values are used for the rest of the input. Under Benefit/Cost Summary, the "User Entered" benefit is changed to \$16,610 to reflect the air pollution reduction benefit calculated.
- 7. The final B/C ratio is calculated under "Benefit/Cost Comparison". The B/C ratio for this project is 4.61.

I-435 Ramp Metering

KDOT and MoDOT designed KC Scout to provide drivers in the Kansas City Metropolitan area with less highway congestion, fewer rush hour crashes, improved rush hour speeds, quicker emergency response times, and much more to help them navigate their way along a safer, smoother, and smarter journey. In March 2010 KC Scout added ramp meters to I-435 between Metcalf Avenue and the Three Trails Memorial Crossing, an 8-mile corridor with 7 interchanges and 12 on ramps at the cost of approximately \$30,000 per on ramp in order to:

- Decrease the number of sudden weaving and braking moments that happen as vehicles merge onto the freeway from the on-ramps;
- Allow more cars to smoothly drive along the freeway; and
- Reduce crashes.

Before and after implementation of ramp metering, the following data were collected to evaluate the benefits of ramp metering:

- Observed the ramp meters in action on-site at the on-ramps and off-site using the Scout CCTV cameras.
- Collected traffic data for a 12-month period after the meters were in operation spanning from April 2010 to March 2011.

¹⁴ HERS-ST Highway Economic Requirements System - State Version: Technical Report (http://www.fhwa.dot.gov/asset/hersst/pubs/tech/tech14.cfm)

- Compared the "after" findings to traffic conditions on I-435 based on an average of the conditions between April 2008 2009 and March 2009 2010 before the meters were installed and turned on.
- Talked with transportation professionals and law enforcement staff to better understand their experiences with the meters after turn-on.
- Conducted a survey to gather feedback from the general public about KC Scout in general and the I-435 ramp meters specifically.

To evaluate the I-435 ramp metering project, the following references were reviewed:

- 1. Ramp Metering 2011 Evaluation Report, Kansas City Scout, 2011.
- 2. I-435 East-West Corridor 5-County Regional Transportation Study
- 3. 2012 Kansas City District Traffic Volume and Commercial Vehicle Count Map
- 4. Summary of Traffic Engineering Analyses: I-435 Ramp Metering Project, January 25, 2008

Because limited data are provided in these documents and reports, default data provided in the TOPS-BC tool are used where real data are missing. Some assumptions were also made in the analysis, detailed in the step-by-step description of the evaluation process.

Following are the evaluation steps taken using the TOPS-BC tool:

- 1. Locate the cost estimates page: After opening the tool as described previously in this memo, go to the "LIST OF ALL WORKSHEETS " tab (the third tab from the left). Under "3) ESTIMATE COSTS", go to "Ramp Metering Systems" and select "Central Control". The cost estimate tab "RM-Central Control" will then open. Alternately, one may find the "RM-Central Control" tab and click on the tab directly.
- 2. Cost Estimates: Given that no cost data were provided for the basic infrastructure equipment, the default values were used for TMC hardware, software and labor. According to the *Ramp Metering 2011 Evaluation Report*, the capital cost per on ramp was \$30,000. To match this total cost, the cost for "Ramp Meter" was changed to \$18,250; the cost for "Loop Detectors (2)" was kept as its default value (\$11,000); and the cost for "Communication Line" was kept as its default value (\$750). The "TOTAL Incremental Cost" was summed up to \$30,000. On Row 26, 28, and 30, "1" was entered as the number of infrastructure deployments (number of central control system), and "12" was entered as the number of incremental deployments (number of on ramps). "2010" was entered as the year of deployment. Default values were used for the remaining input on this page. The resulting average annual cost was calculated as \$377,380.

FHWA Tool for Operations Benefit/Cost (TOPS-BC): Version 1.0							
WORK AREA 4 FREINATE AVERAGE ANNUAL OF	ies Not						
WORK AREA 1 - ESTIMATE AVERAGE ANNUAL COST							
Ramp Metering Systems: Central Control							
nt	Useful Life	Rej Co	Capital / placement sts (Total)	08	&M Costs Annual)	An	nualized Costs
rastructure Equipment							
MC Hardware for Freeway Control	5	\$	22,500	\$	2,000	\$	6,500
MC Software/Integration	5	\$	200,000	\$	-	\$	40,000
abor		\$	-	\$	250,000	\$	250,000
OTAL Infrastructure Cost		\$	222,500	\$	252,000	\$	296,500
ntal Deployment Equipment (per Ramp Location)							
amp Meter (Signal, Controller)	25	\$	18,250	\$	2,000	\$	5,520
pop Detectors (2)	25	\$	11,000	\$	500	\$	940
ommunication Line	25	\$	750	\$	250	\$	280
OTAL Incremental Cost		\$	30,000	\$	2,750	\$	6,740
Enter Number of Infrastructure Deployments	1					\$	296,500
Enter Number of Incremental Deployments	12					\$	80,880
Enter Year of Deployment	2010						
Average Annual Cost						\$	377,380
	A Tool for Operations Benefit JRPOSE: Estimate Lifecycle Costs of TSM&O Strateg WORK AREA 1 - ESTIMATE AVERAGE ANNUAL CO Ramp Metering Systems: Centra nt restructure Equipment WC Hardware for Freeway Control WC Software/Integration abor OTAL Infrastructure Cost tal Deployment Equipment (per Ramp Location) amp Meter (Signal, Controller) bop Detectors (2) bommunication Line OTAL Incremental Cost Enter Number of Infrastructure Deployments Enter Number of Incremental Deployments Enter Year of Deployment	A Tool for Operations Benefit/Cost (T JRPOSE: Estimate Lifecycle Costs of TSM&O Strategies WORK AREA 1 - ESTIMATE AVERAGE ANNUAL COST Ramp Metering Systems: Central Control nt Useful Life restructure Equipment WC Hardware for Freeway Control 5 WC Software/Integration 5 MC Software/Integration 5 MC Software/Integration 5 MC Software/Integration 25 MC Software/Integration 25 MC Software (Signal, Controller) 25 DOTAL Infrastructure Cost Mamp Meter (Signal, Controller) 25 DOTAL Incremental Cost Enter Number of Infrastructure Deployments 1 Enter Number of Infrastructure Deployments 12 Enter Year of Deployment 2010 Average Annual Cost	A Tool for Operations Benefit/Cost (TO) URPOSE: Estimate Lifecycle Costs of TSM&O Strategies WORK AREA 1 - ESTIMATE AVERAGE ANNUAL COST Ramp Metering Systems: Central Control Trastructure Equipment WC Hardware for Freeway Control 5 \$ MC Software/Integration 5 \$ MC Software/Integra	A Tool for Operations Benefit/Cost (TOPS-BC) URPOSE: Estimate Lifecycle Costs of TSM&O Strategies WORK AREA 1 - ESTIMATE AVERAGE ANNUAL COST Ramp Metering Systems: Central Control Trastructure Equipment WC Hardware for Freeway Control 5 \$ 22,500 WC Software/Integration 5 \$ 200,000 abor \$ - OTAL Infrastructure Cost \$ 222,500 Utal Deployment Equipment (per Ramp Location) amp Meter (Signal, Controller) 25 \$ 18,250 communication Line 25 \$ 750 UTAL Incremental Cost \$ 30,000 Enter Number of Infrastructure Deployments Enter Number of Infrastructure Deployments Enter Signal Controller Deployment Equipment Cost 12 Enter Year of Deployment Average Annual Cost	A Tool for Operations Benefit/Cost (TOPS-BC): Y JRPOSE: Estimate Lifecycle Costs of TSM&O Strategies WORK AREA 1 - ESTIMATE AVERAGE ANNUAL COST Ramp Metering Systems: Central Control mt Useful Life Costs (Total) (rastructure Equipment MC Hardware for Freeway Control 5 \$ 22,500 \$ MC Software/Integration 5 \$ 200,000 \$ sbor 5 \$ 222,500 \$ OTAL Infrastructure Cost 5 222,500 \$ mtal Deployment Equipment (per Ramp Location) amp Meter (Signal, Controller) 25 \$ 18,250 \$ pop Detectors (2) 25 \$ 11,000 \$ pommunication Line 25 \$ 750 \$ OTAL Infrastructure Cost 5 30,000 \$ Enter Number of Infrastructure Deployments 1 Enter Number of Infrastructure Deployments 12 Enter Year of Deployment 2010 Average Annual Cost	A Tool for Operations Benefit/Cost (TOPS-BC): Versio JRPOSE: Estimate Lifecycle Costs of TSM&O Strategies WORK AREA 1 - ESTIMATE AVERAGE ANNUAL COST Ramp Metering Systems: Central Control	A Tool for Operations Benefit/Cost (TOPS-BC): Version 1 JRPOSE: Estimate Lifecycle Costs of TSM&O Strategies WORK AREA 1 - ESTIMATE AVERAGE ANNUAL COST Ramp Metering Systems: Central Control Tastructure Equipment WC Hardware for Freeway Control 5 \$ 22,500 \$ 2,000 \$ WC Software/Integration 5 \$ 200,000 \$ - \$ sbor 5 - \$ 250,000 \$ OTAL Infrastructure Cost 5 222,500 \$ 252,000 \$ COTAL Infrastructure Cost 5 222,500 \$ 252,000 \$ Tatl Deployment (per Ramp Location) amp Meter (Signal, Controller) 25 \$ 18,250 \$ 2,000 \$ DOTAL Infrastructure Cost 5 200,000 \$ 2,750 \$ DOTAL Infrastructure Cost 5 200,000 \$ 2,750 \$ DOTAL Infrastructure Cost 5 30,000 \$ 2,750 \$ DOTAL Infrastructure Deployments Enter Number of Infrastructure Deployments Enter Number of Infrastructure Deployments Enter Vear of Deployment Deployment 2010 Average Annual Cost \$ 2010

- 3. Locate the benefit estimates page: After cost estimates are done, look to the left side of the page, look for "4) ESTIMATE BENEFIT", go to "Freeway Strategies" and select "Ramp Metering". The benefit estimate tab "Ramp Metering" will then open. Alternately, one may find the "Ramp Metering" tab and click on the tab directly.
- 4. Benefit Estimates: In order to prepare the input for this page, two new tabs ("Ramp Volumes" and "Air Pollution Eval") were added in this tool to calculate total ramp delay cost and emission damage cost. The following inputs were provided:
 - a. Length of Analysis Period (Hours): 24; Ramp Metering system type: Central Control;
 - b. Facility Characteristics
 - i. Freeway Link Facility Type: Urban Freeway
 - ii. Link length: 8 miles;

- iii. Total number of lanes: assume the average number of lanes of the corridors are 8 lanes.
- iv. Freeway link capacity: 150,00015
- v. Free flow speed: 65 (posted speed on I-435)
- vi. Number of metered ramps: 12
- vii. Average link length: 1 mile
- viii. Average ramp number of lanes: 2
- ix. Average ramp capacity: 12,000 (assumed 12,000 daily ramp volume)
- x. Average ramp free flow speed: 35 (default value)
- c. Facility Performance
 - i. Freeway link volume: 150,000
 - ii. Baseline congested speed: 60.6; Improvement congested speed: 61.5¹⁶
 - iii. Baseline number of crashes: 0 fatalities, 0.01 injuries, 0.16 PDO;
 Improvement number of crashes: 0 fatalities, 0.005 injuries, 0.06 PDO¹⁷
 - iv. Default values were used for the remaining input due to lack of data.

¹⁵ I-435 East-West Corridor 5-County Regional Transportation Study

¹⁶ Summary of Traffic Engineering Analyses: I-435 Ramp Metering Project, January 25, 2008

¹⁷ Ramp Metering 2011 Evaluation Report, Kansas City Scout, 2011; Summary of Traffic Engineering Analyses: I-435 Ramp Metering Project, January 25, 2008

Congestion Management Toolbox Update Appendix



- d. Impact due to strategy
 - i. Reduction in freeway crash rate: 64%
 - ii. Reduction in freeway crash duration: 32%
 - iii. Default values were used for the remaining input due to lack of data.
- e. Travel Time
 - i. Travel time reduction on the mainline is calculated used traffic volumes entered and the default input. Travel time increase on ramps, however, is not measured by the TOPS-BC tool. In order to estimate the impact of ramp meters on vehicle delay at the on ramps, a tab "Ramp Volumes" was created to. It was assumed that the average daily volumes at the on ramps with ramp meters were 15,000. According to the *Ramp Metering 2011 Evaluation Report*, the additional delay per vehicle with ramp meters was about 34 seconds/vehicle. The resulting annual delay was estimated to be 143 hours. After multiplying the number of on ramps, and average persons per vehicle, the annual average person delay on ramps for the study corridor were calculated as 2,288 hours. This number was used to

adjust the "Average Person Hours of Travel Saved per Period" on the benefit estimates page.

- f. Air Pollution Impact Evaluation
 - Air pollution impacts of the signal coordination deployment is not measured by the TOPS-BC tool. To estimate the impacts, a new "Air Pollution Eval" tab was added to the tool. This evaluation was based on emission damage costs for HERS vehicle class at different speeds¹⁸. The calculated benefit of this project from air pollution reduction is -\$8,147/year. This number was entered into the "User Entered Benefit (Annual \$'s)" at the bottom of the page.
 - ii. Default values were used for the remaining input on this page.



¹⁸ HERS-ST Highway Economic Requirements System - State Version: Technical Report (http://www.fhwa.dot.gov/asset/hersst/pubs/tech/tech14.cfm)

- 5. After completing the benefit estimates, look to the left side of the page, select "MY DEPLOYMENTS". The "Summary of My Deployments" will then open. Alternately, one may find the "Summary of My Deployments" tab and click on it directly.
- 6. On the Summary of My Deployments page, all the parameters for the ramp metering evaluation are provided under "Cost Factors". One may change the default value used in the analysis here.

The final B/C ratio for this I-435 ramp metering project is presented under "Benefit/Cost Comparison". The B/C ratio is 19.97.

I-35 Bus on Shoulder

For this analysis a custom spreadsheet was developed that can be replicated for future analysis of projects that improve transit travel time. In some cases, reduction in travel times may enable the agency to make the same number of runs with fewer buses, resulting in operating cost savings and higher productivity. In this scenario, only travel time savings were counted as a benefit. It was assumed no additional costs were incurred.

The spreadsheet provides a method for developing detailed estimates of time savings for future projects. Three tabs are included:

- "by Bus run" tab
- "Daily Total by route" tab
- "Annual Total by route" tab

The "by Bus run" tab includes the fields shown in Table B.1. Inputs for the "Annual Total by route" tab are shown in Table B.2.

According to FY 2012 Review of Bus-on-Shoulder Operations report, in 2012, a total of 472 buses used the shoulders of I-35, traveling approximately 1348 miles on the shoulder. The report estimated that each time a bus uses the shoulder for at least a two-mile segment, an average of 2.56 minutes are saved assuming that average savings per mile is 1.28 minutes. Average ridership is calculated from total ridership divided by the total number of buses for each route. For example, Bus 661/B has a ridership of 71,064 in 2012, while there are 17 661/B buses per weekday and a total of 260 week days in a year. Therefore, the average ridership of 661/B is 71,064/(260*17). This average ridership is assumed to be the average load of 661/B for the bus-on-shoulder section along I-35.

Field Name	Description	Calculation		
	Date when the bus run	Enter date when the data		
Date	data was collected	were collected		
Route Number	Bus route numbers	Enter bus route number		
Direction	Bus route Direction	Enter direction		
Length (1-way)	one-way length	Enter length		
	"Y"- used shoulder; "N" -			
Used Shoulder?	did not use shoulder	Enter Y or N		
	Document the time used	Enter travel time; alternatively a % time saving can also be used to calculate		
Travel Time with Shoulder	portion of the trip on shoulder	travel time with shoulder - as done in the example		
	Travel time for the trip	Calculated from the bus		
Travel Time	calculated from bus	schedule section (time (end		
without Shoulder	schedule	stop) - time (start stop))		
Ridership	Number of passengers on the bus	Enter average bus load between bus-on-shoulder section		
	Monetary value of travel	Enter average value of time		
Value of Time	time per passenger	of transit users		
	Aggregated travel time			
Aggregate	value of all passengers on	Calculated from average load		
Time Savings	board	and value of time		
Schedule Time	Document bus schedule. This needs to be updated if changes are made the the schedules.	Enter bus scheduled arrival time based on the most updated bus schedule.		
	Document the real bus arrival time if data are available. This field will then be used to calculate	Enter time stamp each bus		
Real Time	travel time with shoulder.	arrives at each bus stop.		
% Time Saving	If real bus travel time data are not available, an average % time saving can also be used if it's estimated.	Calculated or estimated.		

Table B.1 "By Bus Run" Tab

Field Name	Description	Calculation	Notes
	Bus route	Enter bus route	
Bus Routes	numbers	number	
	Annual total		
	number of miles		
# of Segments	(segments) each		
(approximate	bus route ran on	Enter number of miles	
miles)	shoulder	(segments)	
Travel Time	Travel time saved from running on	Enter travel time saved calculated from the "by Bus run" tab when per	If no better data are available, this can be calculated by multiplying number of miles (segments)(column B in this spreadsheet) with average time saved per mile (or
Saveu (minutes)	Shoulder		segmentj.
Average Ridership per	Average riders on	Enter the average ridership when buses	
Bus	board	operate on shoulder	
	Value of time of an average bus	Enter the average time	The value here (\$14) comes from the TOPS-BC tool. If local bus riders income data are available, local data should be used in place of the
Value of Time	rider	value of a bus rider.	value here (\$14).
Travel Time	Total monetary value of travel	The values here are calculated by multiplying travel time saved with average riders per bus with	
Savings	time savings	value of time per rider	

 Table B.2
 "Annual Total by Route" Tab