Congestion Management Toolbox Update

final

toolbox

prepared for

Mid-America Regional Council

prepared by

Cambridge Systematics, Inc.

with

Shockey Consulting Services
Olsson Associates

December 31, 2013

www.camsys.com

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115 South LaSalle Street, Suite 2200
Chicago, IL 60603

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1.0 Introduction: History of the MARC Congestion Management Process

Federal regulation 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).

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.

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 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 1.1 presents a broader look at how the CMP fits into the transportation planning process.

To go along with this updated CMP, MARC prepared this update Congestion Management Toolbox in 2013. This Toolbox builds on the one previously created in 2001. That original 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 was documented in the toolbox, organized into eight categories. This updated Toolbox expands the number of categories; adds more contemporary strategies; and includes additional information of relevance to practitioners.

Figure 1.1 CMP and the Overall Planning Process

Source: FHWA

2.0 Congestion Management Toolbox

2.1 USING THE TOOLBOX

When local agencies in the region find themselves considering roadway capacity projects, they can 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.

To select the right types of strategies, an agency must have an understanding of the nature of the need. Figure 2.2 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?

As shown in Figure 1.1 previously, the CMP is integrated into the establishment of goals and objectives, identification and evaluation of alternative strategies, and then developing the LRTP and TIP. The CMT can be used to support this process.

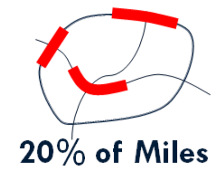
However, there are other ways in which the CMT can be used by agencies in the Kansas City region at a more localized level:

- 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 2.1 Different Dimensions of Congestion

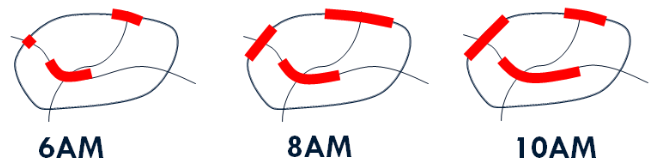
Spatial

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



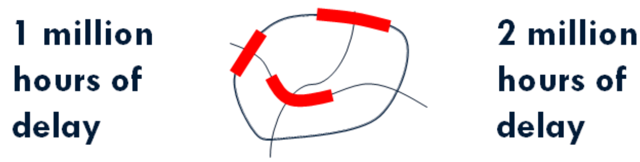
Temporal

How long does congestion last? The image presents an example of a metropolitan highway network with congestion from 6:00 a.m. through 10:00 a.m.



Severity

How much delay is there or how low are travel speeds? The image shows that for the same percentage of miles congested, the number of vehicles and total hours of vehicular delay can be different.



Variability

How does congestion change from day to day? The image shows how the severity and location of congestion can change from day to day. More variation in travel time indicates less reliable travel. A reliable system would have consistent levels of congestion from hour to hour and day to day.

2.2 STRATEGIES

Table 2.1 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 2.2 through 2.10.

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.

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 Travel Demand Management (TDM) Evaluation Model, ITS Deployment Analysis System (IDAS), Tool for Operations Benefit/Cost (TOPS-BC), the MARC regional travel model, and others. In some cases, benefits may be more qualitative for selected strategies.

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.

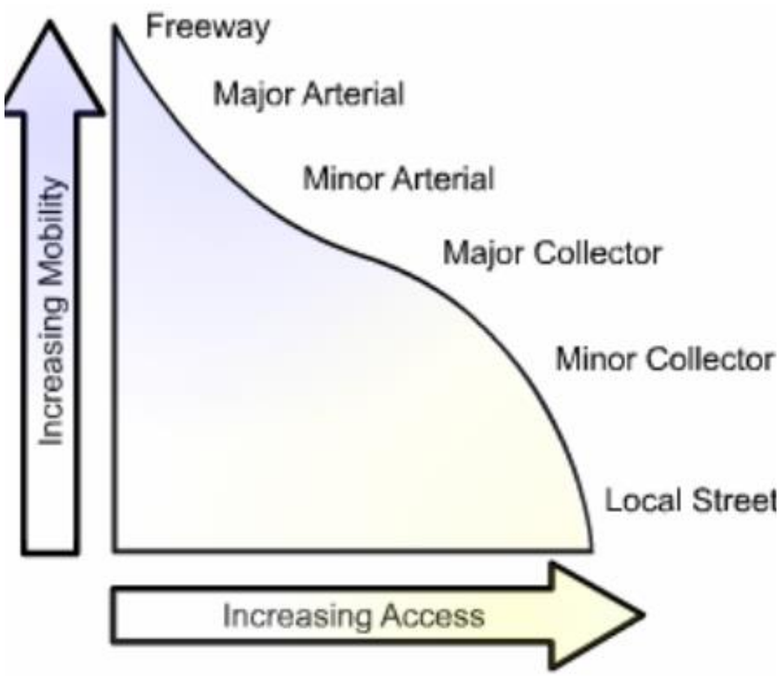
Order-of-magnitude cost estimates also help in selecting between strategies. National cost data built into the TOPS-BC software, IDAS, and other national practices are used to provide this estimate. Therefore, these costs may vary for the Kansas City region. The implementation costs and schedules consider 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 transportation system management (TSM) strategies in the Transportation Operations and Management category. 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 2.3). The access management strategies listed in Table 2.7 are applicable to Kansas City, and can be used in either the modification or original design of a facility.

Figure 2.2 Tradeoffs in Access and Mobility



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 2.4). The strategies listed in Table 2.4 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 2.3 Active Transportation: Bicycle Lanes and Sidewalks

Source: www.peopleforbikes.org

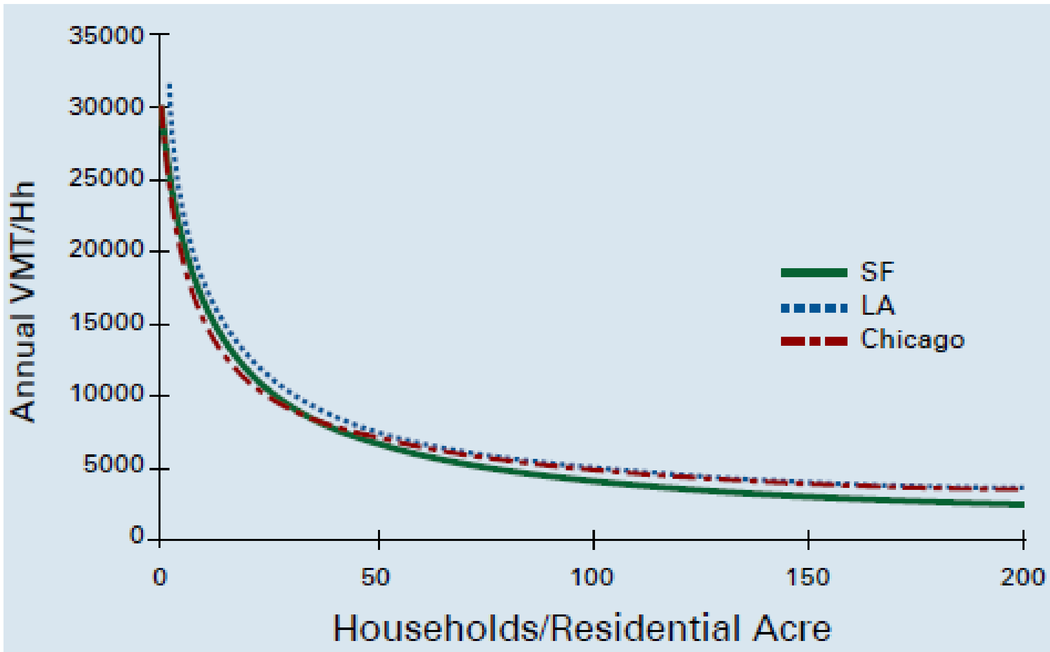
Highway Strategies

Table 2.4 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 transportation system management (TSM) strategies within the Transportation Operations and Management category. 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 2.5). Table 2.5 presents the land development strategies that may be applicable for the Kansas City region. These are often paired with Parking Strategies and can complement Active Transportation Strategies.

Figure 2.4 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 2.6). 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 Transportation Demand Management (TDM) Strategies.

Regulatory Strategies

Regulatory Strategies, shown in Table 2.7, 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 2.6). Table 2.8 presents the TDM strategies that may be applicable for the Kansas City region.

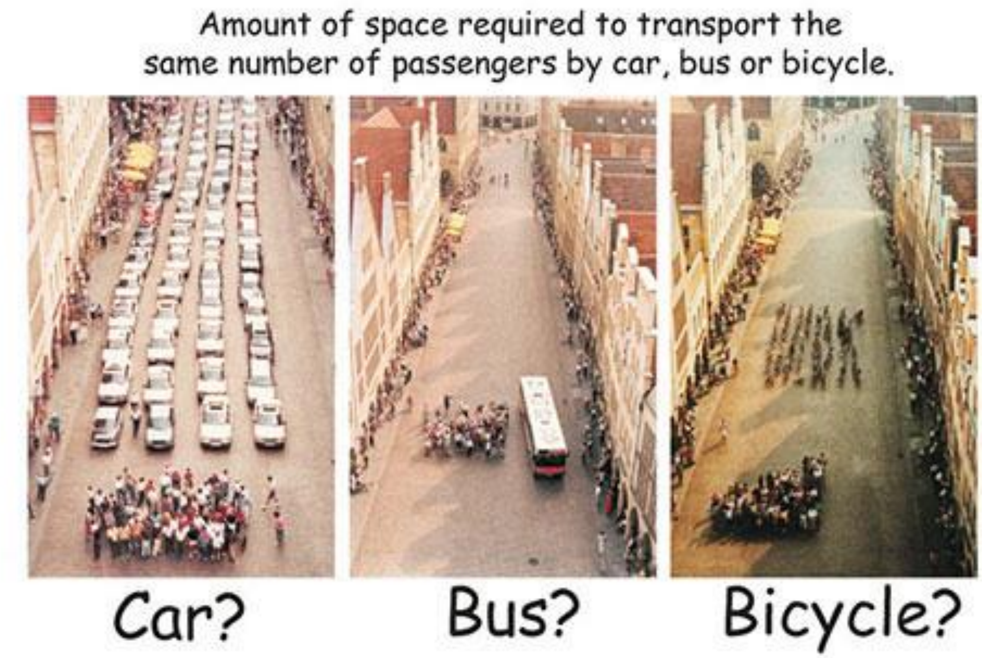
Figure 2.5 TDM Strategies: Congestion Pricing

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 2.9 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 2.7). Transit Strategies are more effective when paired with effective transportation system management (TSM) in Transportation Operations and Management Strategies, pedestrian approaches in Active Transportation Strategies, and Land Use Strategies.

Figure 2.6 Impacting Congestion Through Mode Shift

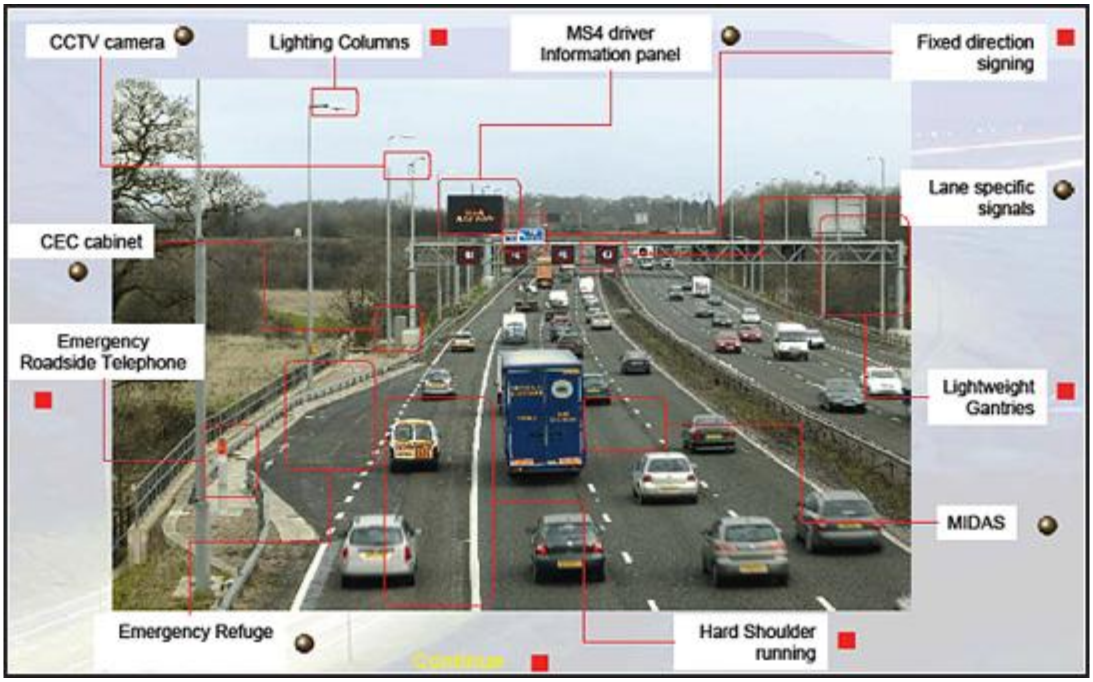


Source: City of Muenster Planning Office, 2001

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 2.10 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 2.7 Transportation Operations and Management: Sample Active Traffic Management Tools



Source: FHWA, ATDM Program Brief

Table 2.1 Summary of Congestion Management Strategies

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 2.2 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 Turning vehicles can impede traffic flow and are more likely to be involved in crashes.	• Increased capacity, efficiency on arterials • 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	• MARC • NYMTC
Turn Lanes and New or Relocated Driveways and Exit Ramps In some situations, increasing or modifying access to a property can be more beneficial than reducing access.	• Increased capacity, efficiency • 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	Short-term: 1 to 5 years (includes planning, engineering, and implementation)	• Localized Analysis	• Operations and Management strategies	• MARC • NYMTC
Interchange Modifications Conversion of a full cloverleaf interchange to a partial cloverleaf, for example, reduces weaving sections on a freeway.	• Increased capacity, efficiency • 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)	• IDAS • Regional Travel Model • Interchange Management System	• Operations and Management strategies	• MARC • NYMTC
Minimum Intersection/Interchange Spacing Reduces number of conflict points and merging areas, which in turn reduces incidents and delays	• Increased capacity, efficiency • Improved mobility on facility • Improved travel times and reduced delay for through traffic • Fewer incidents	Low: Part of design costs for new facilities and reconstruction projects.	Medium-term: 5 to 10 years (includes planning, engineering, and implementation)	• Localized Analysis	• Operations and Management strategies	• MARC • NYMTC
Frontage Roads and Collector-Distributor Roads 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.	• Increased capacity, efficiency • Improved mobility on facility • Improved travel times and reduced delay for through traffic • Fewer incidents due to fewer conflict points	High: Additional right-of-way costs; design, construction, and maintenance costs	Medium-term: 5 to 10 years (includes planning, engineering, and implementation)	• IDAS • Regional Travel Model	• Operations and Management strategies	• MARC • NYMTC
Roadway Restrictions Closes access during rush hours (AM and PM peak hours) and aids in the 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.	• Increase capacity, efficiency on arterials • Improve mobility on facility • Improve travel times and decrease delay for through traffic • Fewer incidents	Low to moderate: Implementation and maintenance costs vary	Short-term: 1 to 5 years (includes planning, engineering, and implementation)	• Localized Analysis • Simulation Model	• Operations and Management strategies	• NYMTC
Access Control to Available Development Sites Coordination of access points to available development sites allows for less interference in traffic flow during construction and/or operation of new developments	• Increase capacity, efficiency on arterials • Improve mobility on facility • Improve travel times and decrease delay for through traffic • Fewer incidents	Low to moderate: Implementation and maintenance costs vary	Short-term: 1 to 5 years (includes planning, engineering, and implementation)	• Localized Analysis • Simulation Model	• Operations and Management strategies	• NYMTC
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 • Can reduce the likelihood of rear-end crashes	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 obtain right-of-way)	• Localized Analysis	• Operations and Management strategies	• DRCOG

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	• DRCOG
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 2.3 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 quality	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	• MARC • NYMTC
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	• MARC • NYMTC
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	• MARC • DRCOG
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

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	Short-term: 1 to 5 years	• EPA Commuter Model	• Other Active Transportation strategies • Land Use strategies	• MAG
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	• Oregon DOT

Table 2.4 Highway 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 Model • IDAS	• Active traffic management strategies (Transportation operations and management strategies)	• MARC • NYMTC
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	• MARC • NYMTC • MAG
HOV Lanes 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 VMT • 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 Converting existing major arterials with signalized intersections into "super streets" that feature grade-separated intersections.	• 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 (Construction and engineering substantial for grade separation)	Medium-term: 5 to 10 years (includes planning, engineering, and implementation)	• Regional Travel Model	• Transportation operations and management strategies • Access 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	• MARC • NYMTC • MAG

Acceleration/Deceleration lanes Deceleration lane provided on a freeway just before an exit off-ramp allows vehicles to reduce speed outside the through-lanes. Acceleration lane provided as an extension of a freeway on-ramp or an arterial street turn-lane for vehicles to increase speed and merge more smoothly into the through-lane.	• 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 Construction of new, access-controlled, high-capacity roadways in areas previously not served by freeways.	• Reduce arterial street network congestion • Reduce travel times & delay	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 • Simulation 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 Model • Simulation Model	• Transportation 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 2.5 Land Use Strategies

Strategies/Projects	Congestion and Mobility Benefits	Costs and Impacts	Implementation Timeframe	Analysis Method	Grouping	Example
Mixed-Use Development 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	Low/Moderate • 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	• MARC • NYMTC
Infill and Densification Takes advantage of existing infrastructure by encouraging development on vacant or underused parcels in already developed areas; this avoids requiring new construction of infrastructure on the fringes of the urban area.	• Decrease SOV trips • Increase transit, walk, and bicycle trips • Decreases VMT per household • Medium/high vehicle trip reductions • Air quality improvements	Low/Moderate • 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	• MARC • NYMTC • SLC • WFRC
Transit-Oriented Development This clusters housing units and/or businesses near transit stations in walkable communities.	• Decrease SOV trips • Increase transit trips • Decrease VMT	Low/Moderate • 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	• MARC • NYMTC • MAG • SLC • WFRC
Trip Reduction Strategies Plans, policies, and regulations instituted to reduce the use of SOVs for commuting; often linked to air quality planning and employer-based.	• Reduce VMT • Reduce SOV trips • Increase transit and non-motorized mode share	Low • First-year implementation costs for private-sector (per employee equipment) • Second-year costs tend to decline • Requires interagency and private sector coordination	Short-term: 1 to 5 years	• EPA Commuter Model	• Transit strategies • Active transportation strategies	• MAG
Transportation Management Associations Nonprofit, member-controlled organizations that provide transportation services in a particular area, such as a commercial district, mall, medical center, or industrial park. They are generally public-private partnerships consisting primarily of area businesses with local government support.	• Reduce VMT • Reduce SOV trips • Increase transit and non-motorized mode share	Low • First-year implementation costs for private-sector (per employee equipment) • Second-year costs tend to decline • Requires interagency and private sector coordination	Short-term: 1 to 5 years	• EPA Commuter Model	• Transit strategies • Active transportation strategies	• MAG

Table 2.6 Parking Strategies

Strategies/Projects	Congestion and Mobility Benefits	Costs and Impacts	Implementation Timeframe	Analysis Method	Grouping	Example
On-Street Parking and Standing Restrictions 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.	• Increase peak period capacity • Reduce travel time and congestion on arterials • Increase HOV and bus mode shares	Low. Design, construction, and 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	• MARC • NYMTC
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	• MARC • NYMTC
Preferential or Free Parking for HOVs and Parking Management 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	• Land Use and Built 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 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	• Transit strategies • Land use strategies • Active transportation strategies	• MARC • NYMTC
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 ridesharing • Reduce 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 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		• Increasing transit/bus route coverage and frequency • Intelligent transit stops • Enhanced transit amenities	• NYMTC
Local and Regional Excise Taxes 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)		• Land Use and Built Environment (e.g., Combined land use and transportation strategies) • Transportation Demand Management • Operations and Management (e.g., traveler information)	• Oregon DOT

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

Table 2.7 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	• NYMTC • Oregon 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		• 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
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		• Land Use and Built Environment (e.g., Mixed use developments) • Transportation Demand Management • Operations and Management (e.g., traveler information) • Public Transportation	• Oregon DOT
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		• Land Use and Built Environment (e.g., Mixed use developments) • Transportation Demand Management • Operations and Management (e.g., traveler information) • Public Transportation	• Oregon DOT
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

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 DOT

Table 2.8 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.	• 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
Telecommuting 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 VMT • Reduce 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 SOVs • Lower 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, jackrabbit 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 trips • Reduce 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 2.9 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 Model • TDM Evaluation Model	• Other transit strategies • Land use strategies	• MARC • NYMTC
Increasing Bus Route Coverage or Frequencies 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 extensions to existing routes.	• Increase transit ridership • Decrease travel time • Reduce daily VMT • Improved convenience and travel reliability • Reduced traffic congestion due to trips switched from driving alone 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 Model • Regional Travel Model	• Other transit strategies • Land use strategies	• MARC • NYMTC • DRCOG • MAG
Park-and-Ride Lots 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.	• Reduce regional VMT (up to 0.1 percent) • Increase mobility and transit efficiency • Reduce SOV trips • Increase transit boardings and mode share • Decrease congestion by increasing vehicle occupancy rate	Low to Moderate (Structure costs for transit stations; Land acquisition costs)	Medium-term: 5 to 10 years (includes planning, engineering, and construction)	• TDM Evaluation Model • Regional Travel Model	• Other transit strategies • HOV lanes • Active transportation strategies	• MARC • NYMTC • MAG • SLC WFRC
Light, Heavy, and Commuter Rail 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	• Land use strategies (TODs) • Parking strategies • Other transit strategies • TDM strategies • HOV lanes • Active transportation strategies • Highway pricing strategies	• DRCOG • MAG
Employer Incentive Programs Encourages additional transit use through transit subsidies of mass transit fares provided by employers	• Increase transit ridership • Decrease travel time • Decrease daily VMT	Low to Moderate (Cost of incentives to employers offering employee benefits for transit use)	Short-term: 1 to 5 years		• TDM • 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	• NYMTC • DRCOG

Realigned Transit Service Schedules and Stop Locations Service adjustments to better align transit service with ridership markets	• Increase transit ridership • Decrease 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 analysis • Simulation model	• Other transit strategies • Can be incorporated into some highway strategies	• DRCOG • NYMTC
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 Reserved travel lanes or rights-of-way for transit operations, including use of shoulders during peak periods	• Increase transit ridership • Decrease travel time	Low to Moderate (Costs vary by type of design)	Medium-term: 5 to 10 years (includes planning, engineering, and construction)	• Simulation model	• Other transit strategies • Can be incorporated into some highway strategies	• NYMTC
Bus Rapid Transit (BRT) 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	• Other transit strategies • 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

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 Model • EPA Commuter Model	• Other transit strategies	• MAG

Table 2.10 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 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	• MARC • NYMTC
Freeway Incident Detection and Management Systems 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	Moderate to high (capital costs 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	• MARC • NYMTC • DRCOG
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	• MARC • NYMTC • DRCOG • MAG
Highway Information Systems 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	• IDAS Regional Travel Model • TOPS-BC • User surveys	• Other Operations and Management strategies	• MARC
Advanced Traveler Information Systems 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	• IDAS Regional Travel Model • TOPS-BC • User Surveys	• Other Operations and Management strategies	• MARC • NYMTC • DRCOG • MAG

Service Patrols 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	• IDAS • TOPS-BC	• Other Operations and Management strategies (Freeway Incident Detection and Management Systems; Highway Information Systems)	• NYMTC • DRCOG
Restricting Turns at Key Intersections Limits turning vehicles, which can impede traffic flow and are more likely to be involved in crashes	• Increase capacity, efficiency on arterials • 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 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 Model • Microsimulation models		• NYMTC
Targeted and Sustained Enforcement of Traffic Regulations Improves traffic flow by reducing violations that cause delays; Includes automated enforcement (e.g., red light cameras)	• Improve travel time • Decrease the number of stops	Low (Increased labor costs per officer)	Short-term: 1 to 5 years	• Microsimulation models • TOPS-BC		• NYMTC
Special Events and Work Zone Management Includes a suite of strategies including temporary traffic control, public awareness and motorist information, and traffic operations	• Minimize traffic delays • Improve mobility • Maintain access for businesses and residents	Low to moderate (Design and implementation costs variable)	Short-term: 1 to 5 years	• Microsimulation models • TOPS-BC		• NYMTC
Road Weather Management 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	• Maintenance 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	• IDAS • TOPS-BC		• NYMTC
Electronic Toll Collection (ETC) 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	Moderate to high (Initial investment in 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)	• DRCOG

Cordon Area Congestion Fees 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	• Reduced pollution and congestion 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	• Regional or subareas travel demand models	• Transit strategies • Active Transportation strategies • Other Operations and Maintenance strategies • Regulatory strategies	• DRCOG • Oregon DOT
Roadway Signage Improvements 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	Short-term: Production of 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).			• DRCOG
Communications Networks and Roadway Surveillance Coverage 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)	Medium- to long-term: Small-scale items and opportunistic expansion can be done quickly. Larger-scale regional network components require more time for planning and funding.		• Many operations and management strategies in this toolbox require the support of roadway surveillance and communications infrastructure.	• DRCOG
Transit Vehicle Travel Information 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		• Transit strategies	• DRCOG