CHAPTER 37
ATDM: SUPPLEMENTAL

CONTENTS

LIST OF EXHIBITS

1. INTRODUCTION

Chapter 37 presents additional information about the following aspects of active traffic and demand management (ATDM):

- An overview of typical ATDM strategies for managing demand, capacity, and the performance of the highway and street system;
- Guidance on analyzing shoulder lane, median lane, and ramp metering strategies using the *Highway Capacity Manual* (HCM); and
- Guidance on designing an ATDM program.

Chapter 11, Freeway Reliability Analysis, and Chapter 17, Urban Street Reliability and ATDM, provide methods for analyzing the effects of ATDM strategies on freeway and urban street operations, respectively.

2. TYPES OF ATDM STRATEGIES

OVERVIEW

More in-depth and up-to-date information on ATDM strategies is available at the Federal Highway Administration's website: http://www.ops.fhwa.dot.gov/atdm.

This section provides brief overviews of typical ATDM strategies for managing demand, capacity, and the performance of the highway and street system. The strategies described here are intended to be illustrative rather than definitive. ATDM strategies constantly evolve as technology advances.

ROADWAY METERING

Roadway metering treatments store surges in demand at various points in the transportation network. Typical examples of roadway metering include freeway on-ramp metering, freeway-to-freeway ramp metering, freeway mainline metering, peak period freeway ramp closures, and arterial signal metering. Exhibit 37-1 illustrates a freeway ramp-metering application.

Exhibit 37-1
Freeway Ramp Metering, SR-94, Lemon Grove, California

Source: FHWA (*1*).

Roadway metering may be highly dynamic or comparatively static. A comparatively static roadway metering system would establish some preset metering rates on the basis of historical demand data, periodically monitor system performance, and adjust the rates to obtain satisfactory facility performance. A static metering system, unlike a dynamic system, would not generally be considered an ATDM strategy. A highly dynamic system may monitor system performance on a real-time basis and automatically adjust metering rates by using a predetermined algorithm in response to changes in observed facility conditions. Preferential treatment of high-occupancy vehicles (HOVs) may be part of a roadway metering strategy.

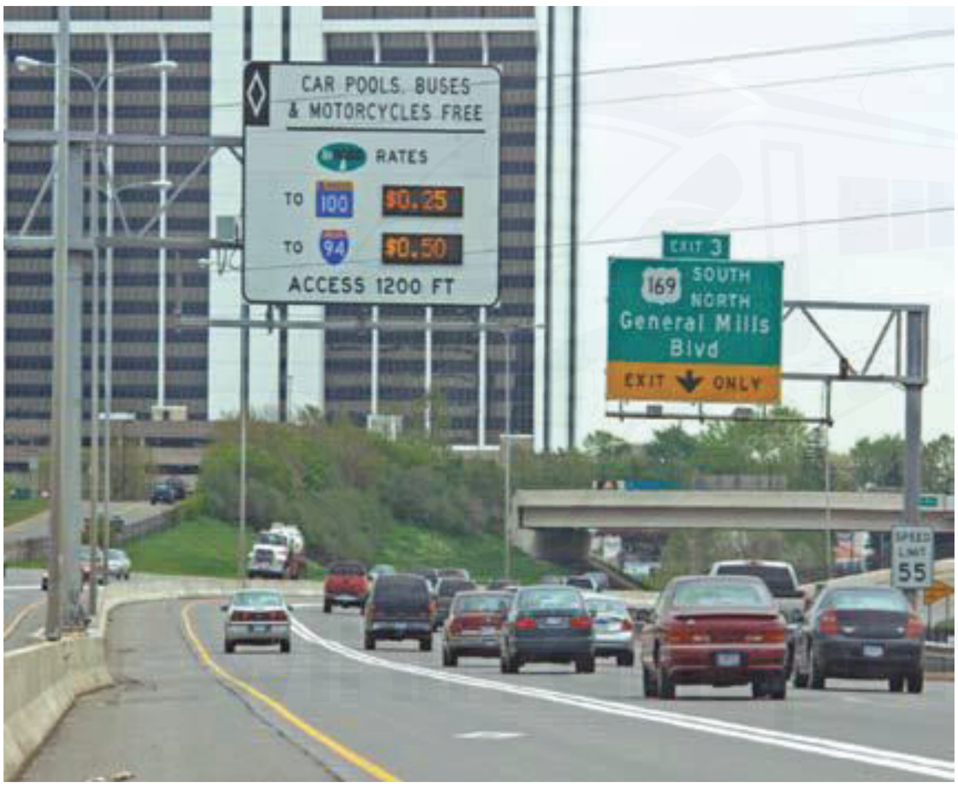
Roadway metering may be applied on freeways or arterials. On arterials, metering might be accomplished through "gating," in which an upstream signal is used to control the number of vehicles reaching downstream signals. Surges in demand are temporarily stored at the upstream signal and released later when the downstream signals can better serve the vehicles.

CONGESTION PRICING

The objective of congestion pricing is to preserve reliable operating speeds on the tolled facility.

Congestion or value pricing is the practice of charging tolls for the use of all or part of a facility or a central area according to the severity of congestion. The tolls may vary by distance traveled, vehicle class, and estimated time savings. The objective of congestion pricing is to preserve reliable operating speeds on the tolled facility with a tolling system that encourages drivers to switch to other times of the day, other modes, or other facilities when demand starts to approach facility capacity. Exhibit 37-2 shows an example of congestion pricing in Minnesota.

Exhibit 37-2
Minnesota Dynamic Pricing for HOT Lanes



Source: FHWA (*2*) (courtesy of Minnesota Department of Transportation).

Congestion pricing may use different degrees of responsiveness and automation. Some implementations may use a preset schedule under which the toll varies by the same amount for preset times during the day and week. The implementation may be monitored on a regular schedule and the pricing adjusted to achieve or maintain desired facility performance. An ATDM-based implementation of congestion pricing may monitor facility performance much more frequently and use automatic or semiautomatic dynamic pricing to vary the toll on the basis of a predetermined algorithm according to the observed performance of the facility.

High-occupancy toll (HOT) lanes (also called express lanes) are tolled lanes adjacent to general purpose lanes. HOT lanes allow motorists to pay tolls to enter the lanes to avoid congested nontoll lanes. HOVs may be allowed to enter the lanes for free or at a reduced toll rate.

Central area pricing is an areawide implementation of congestion pricing.

Central area pricing and dynamic parking pricing are examples of an areawide implementation of congestion pricing. Central area pricing imposes tolls on vehicles entering or traveling within a central area street network during certain hours of certain days. The fee varies by time of day and day of week or according to real-time measurements of congestion within the central area. The toll may be reduced or waived for certain vehicle types, such as HOVs, or for residents of the zone.

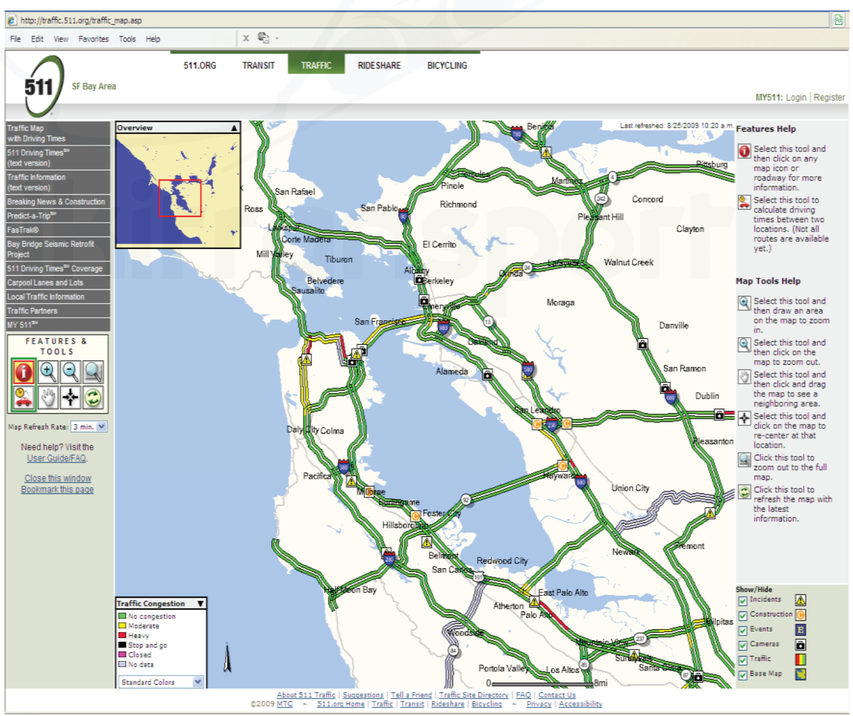
TRAVELER INFORMATION SYSTEMS

Traveler information is an integration of technologies allowing the general public to access real-time or near-real-time data on incident conditions, travel time, speed, and possibly other information. Traveler information enhances awareness of current and anticipated traffic conditions on the transportation system. Traveler information may be tailored to one or more specific modes of travel, such as auto, truck, bus, bicycle, or pedestrian.

Traveler information can be grouped into three types (pretrip, in vehicle, and roadside) according to when the information is made available and how it is delivered to the driver.

Pretrip information is obtained from various sources and transmitted to motorists before the start of their trip through various means. Exhibit 37-3 illustrates Internet-based dissemination of travel information.

Exhibit 37-3
San Francisco Bay Area Traffic Map



Source: © 2009 Metropolitan Transportation Commission (http://traffic.511.org).

In-vehicle information may involve route guidance or dissemination of incident and travel time conditions to the en route vehicle. Route guidance involves Global Positioning System–based real-time data acquisition to calculate the most efficient routes for drivers. This technology allows individual vehicles and their occupants to receive optimal route guidance via various telecommunications devices and provides a method for the transportation network operator to make direct and reliable control decisions to stabilize network flow.

Roadside messages consist of dynamic message signs (also called changeable or variable message signs) and highway advisory radio (also called traveler advisory radio) that display or transmit information on road conditions for travelers while they are en route.

MANAGED LANES

Managed lanes include reversible lanes, HOV lanes, HOT lanes, truck lanes, bus lanes, speed harmonization, temporary closures for incidents or maintenance, and temporary use of shoulders during peak periods (see Exhibit 37-4). HOT lanes are described above under congestion pricing, and speed harmonization is described in the next section.

HOV lanes assign a portion of the roadway capacity to vehicles that carry the most people on the facility or that in some other way meet societal objectives for reducing the environmental impacts of vehicular travel. HOV lanes may operate 24 hours a day, 7 days a week, or they may be limited to the peak periods when demand is greatest. The minimum vehicle-occupancy requirement for the HOV lanes may be adjusted in response to operating conditions to preserve uncongested HOV lane operation.

Exhibit 37-4 HOV Lane

Source: FHWA (*3*).

Reversible lanes provide additional capacity for directional peak flows depending on the time of the day. Reversible lanes on freeways may be located in the center of a freeway with gate control on both ends. On interrupted-flow facilities, reversible lanes may be implemented through lane-use control signals and signs that open and close lanes by direction.

The temporary use of shoulders during peak periods by all or a subset of vehicle types can provide additional capacity in a bottleneck section and improve overall facility performance. Part-time shoulder use by buses in queuing locations can substantially reduce bus delays by enabling them to proceed along the roadway without having to wait in the mainline queue.

SPEED HARMONIZATION

The objective of speed harmonization is to improve safety and facility operations by reducing the shock waves that typically occur when traffic abruptly slows upstream of a bottleneck or for an incident. The reduction of shock waves decreases the probability of secondary incidents and reduces the loss of capacity associated with incident-related and recurring traffic congestion.

Changeable speed limit or speed advisory signs are typically used to implement speed harmonization. Exhibit 37-5 shows an example of variable speed limit signs used for speed harmonization in the Netherlands. The speed restrictions may apply uniformly across all lanes or may vary by lane. The same lane signs may be used to close individual lanes upstream of an incident until the incident is cleared (this practice is not strictly speed harmonization).

The variable speed limit may be advisory or regulatory. Advisory speeds indicate a recommended speed, which drivers may exceed if they believe doing so is safe under prevailing conditions. Regulatory speed limits may not be exceeded under any conditions.

Exhibit 37-5
Variable Speed Limit Signs, Rotterdam, The Netherlands

Source: FHWA Active Traffic Management Scan, Jessie Yung.

TRAFFIC SIGNAL CONTROL

Signal timing optimization is the single most cost-effective action that can be taken to improve a roadway corridor's capacity and performance (*4*). Signal timing is as important as the number of lanes in determining the capacity and performance of an urban street.

Traffic signal timing optimization and coordination minimize the stops, delay, and queues for vehicles at individual and multiple signalized intersections.

Traffic signal preemption and priority provide special timing for certain classes of vehicles (e.g., buses, light rail vehicles, emergency response vehicles, and railroad trains) using the intersection. Preemption interrupts the regular signal operation. Priority either extends or advances the time when a priority vehicle obtains the green phase, but generally the priority is within the constraints of the regular signal-operating scheme.

Traffic-responsive operation and adaptive control provide for different levels of automation in the adjustment of signal timing due to variations in demand. Traffic-responsive operation selects from a prepared set of timing plans on the basis of the observed level of traffic in the system. Adaptive traffic signal control involves advanced detection of traffic, prediction of its arrival at the downstream signal, and adjustment of the downstream signal operation based on that prediction.

SPECIALIZED APPLICATIONS OF ATDM STRATEGIES

ATDM strategies are often applied to the day-to-day operation of a facility. Incident management and work zone management are example applications of one or more ATDM strategies to address specific facility conditions. Employer-based demand management is an example of private-sector applications in which traveler information systems may be an important component.

Incident Management

Traffic incident management (TIM) is "the coordinated, preplanned use of technology, processes, and procedures to reduce the duration and impact of incidents, and to improve the safety of motorists, crash victims and incident responders" (*4*). An incident is "any non-recurring event that causes a reduction in capacity or an abnormal increase in traffic demand that disrupts the normal operation of the transportation system" (*4*). Such events include traffic crashes, disabled vehicles, spilled cargo, severe weather, and special events such as sporting events and concerts. ATDM strategies may be included as part of an overall incident management plan to improve facility operations during and after incidents.

Work Zone Management

Work zone management has the objective of moving traffic through the working area with as little delay as possible consistent with the safety of the workers, the safety of the traveling public, and the requirements of the work being performed. Transportation management plans are a collection of administrative, procedural, and operational strategies used to manage and mitigate the impacts of a work zone project. The plan may have three components: a temporary traffic control plan, a transportation operations plan, and a public information plan. The temporary traffic control plan describes the control strategies, traffic control devices, and project coordination. The transportation operations plan identifies the demand management, corridor management, work zone safety management, and the traffic or incident management and enforcement strategies. The public information plan describes the public awareness and motorist information strategies (*4*). ATDM strategies can be important components of a transportation management plan.

Employer-Based Demand Management

Employer-based demand management consists of cooperative actions taken by employers to reduce the impacts of recurring or nonrecurring traffic congestion on employee productivity. For example, a large employer may implement work-at-home or stay-at-home days in response to announced snow days; "spare the air" days; or traffic alerts concerning major construction projects, incidents, and highway facility closures. Another company may contract for or directly provide regular shuttle van service to and from transit stations. Flexible or staggered work hours may be implemented to enable employees to avoid peak commute hours. Rideshare-matching services and incentives may be implemented by the employer to facilitate employee ridesharing.

Employers may use components of a traveler information system to determine appropriate responses to changing traffic conditions. Employees can use traveler information systems in their daily commuting choices.

3. EFFECTS OF SHOULDER AND MEDIAN LANE STRATEGIES

This section provides details on the free-flow speed and capacity adjustments associated with temporary shoulder and median lane strategies.

OPEN SHOULDERS AS AUXILIARY LANES BETWEEN ADJACENT ON- AND OFF-RAMPS

This strategy involves opening a shoulder lane for use by all vehicles entering at the upstream on-ramp or exiting at the downstream off-ramp. Some through vehicles may temporarily use the auxiliary lane to try to jump ahead of the queue.

The capacity of an auxiliary lane is assumed by the Chapter 10 freeway facilities method to be the same as that of a regular lane; however, utilization of the auxiliary lane may be lower than that of a through lane. In addition, the freeway method does not provide a capacity for shoulder lanes. Until the HCM has specific information on the capacities of auxiliary shoulder lanes, this procedure assumes that the capacity of an auxiliary shoulder lane is one-half that of a normal freeway through lane.

Because the freeway facilities method does not recognize individual lane capacities, computation of an average capacity for freeway sections with auxiliary shoulder lanes across all lanes is necessary.

$$AveCap(s) = \frac{CapShldr(s) + CapMFlanes(s) \times MFlanes(s)}{1 + MFlanes(s)}$$

Equation 37-1

where

$AveCap(s)$ = average capacity per lane for section s (veh/h/ln),

$CapShldr(s)$ = capacity per shoulder lane for section s (veh/h/ln),

$CapMFlanes(s)$ = capacity per mixed-flow lane in section s (veh/h/ln), and

$MFlanes(s)$ = number of mixed-flow lanes in section s (integer).

The number of lanes on the freeway segments between adjacent on- and off-ramps is increased by one for the shoulder lane.

Until the HCM has more specific information for shoulder lanes, free-flow speeds on auxiliary shoulder lanes are assumed in this procedure to be the same as for regular through lanes.

OPEN SHOULDERS TO BUSES ONLY

This strategy involves opening a shoulder lane to buses only. The same procedure and assumptions as described above for auxiliary shoulder lanes are used to compute freeway section capacities, lanes, and free-flow speeds where buses are allowed on shoulders, with the following exception: the capacity of the shoulder lane is the number of buses per hour using the shoulder lane or the user-specified capacity, whichever is less (the user can override the default capacity).

OPEN SHOULDERS TO HOVs ONLY

This strategy involves opening a shoulder lane to buses, vanpools, and carpools (HOVs) only. The same procedure and assumptions as described above for auxiliary shoulder lanes are used to compute freeway section capacities, lanes, and free-flow speeds where HOVs are allowed on shoulders, with the following exception: the capacity of the shoulder lane is the number of HOVs per hour using the shoulder lane or the user-specified capacity, whichever is less.

OPEN RIGHT SHOULDERS TO ALL TRAFFIC

This strategy involves opening a shoulder lane to all vehicles. The same procedure and assumptions as described above for auxiliary shoulder lanes are used to compute freeway section capacities, lanes, and free-flow speeds where all vehicles are allowed on shoulders, with the following exception: the capacity of the shoulder lane is as specified by the user.

OPEN MEDIAN SHOULDER TO BUSES ONLY

This strategy involves opening a median lane to buses only. The same procedure and assumptions as described above for auxiliary shoulder lanes are used to compute freeway section capacities, lanes, and free-flow speeds, with the following exception: the capacity of the median lane is the number of buses per hour using the shoulder lane or the user-designated capacity, whichever is less.

OPEN MEDIAN SHOULDER TO HOVs ONLY

This strategy involves opening a median lane to HOVs (buses, vanpools, carpools) only. The same procedure and assumptions as described above for auxiliary shoulder lanes are used to compute freeway section capacities, lanes, and free-flow speeds, with the following exception: the capacity of the median lane is the number of HOVs per hour using the shoulder lane or the user-designated capacity, whichever is less.

OPEN MEDIAN SHOULDER TO ALL TRAFFIC

This strategy involves opening a median lane to all traffic. The same procedure and assumptions as described above for auxiliary shoulder lanes are used to compute freeway section capacities, lanes, and free-flow speeds, with the following exception: the capacity of the median lane is as designated by the user.

4. EFFECTS OF RAMP-METERING STRATEGIES

This section provides details on the capacity adjustments associated with ramp-metering strategies.

CAPACITY OF RAMP-METERED MERGE SECTIONS

A capacity adjustment factor of 1.03 is recommended to be applied to freeway merge segments in the Chapter 10 freeway facilities method for those times when ramp metering is in operation (*5*).

LOCALLY DYNAMIC RAMP METERING

For locally dynamic ramp metering, an adaptation of the ALINEA algorithm (*6*) is used to estimate the ramp-metering rate for each analysis period for each scenario:

$$R(t) = \frac{(CM - VM(t))}{NR}$$

Equation 37-2

subject to

$$MinRate < R(t) < MaxRate$$

$$R(t) > \frac{VR(t) + QR(t-1) - QRS}{NR}$$

where

$R(t)$ = ramp-metering rate for analysis period t (veh/h/ln),

NR = number of metered lanes on ramp (integer),

CM = capacity of downstream section (veh/h),

$VM(t)$ = volume on upstream section for analysis period t (veh/h),

$VR(t)$ = volume on ramp during analysis period t (veh/h),

$QR(t-1)$ = queue on ramp at end of previous analysis period $t-1$ (veh),

QRS = queue storage capacity of ramp (veh),

$MinRate$ = user-defined minimum ramp-metering rate (veh/h/ln) (default value is 240 veh/h/ln), and

$MaxRate$ = user-defined maximum ramp-metering rate (veh/h/ln) (default value is 900 veh/h/ln).

5. PLANNING AN ATDM PROGRAM

ATDM strategies are combined into an overall ATDM program to address challenges to the efficient operation of the highway system. The ATDM program will have different plan elements to address specific challenges to the system:

- The travel demand management (TDM) plan element will address how demand management will be used to address recurring congestion on the facility.
- The weather traffic management plan element will identify the ATDM strategies to be used during weather events. The weather traffic management plan will have a TDM component targeted to special weather events.
- The TIM plan element will identify the ATDM strategies to be used for incidents. The TIM will have a TDM component for managing demand on the facility during incidents.
- The work zone traffic management plan element will identify the ATDM strategies to be used for work zones. The work zone traffic management plan will have a TDM component for managing demand while work zones are present.
- Facilities located next to major sporting and entertainment venues may also have a special event management plan with ATDM strategies identified to support management of traffic before and after major events.

TRAVEL DEMAND MANAGEMENT PLANS

FHWA's Travel Demand Management Toolbox is available at http://ops.fhwa.dot.gov/tdm/toolbox.htm.

The Federal Highway Administration's (FHWA) Travel Demand Management Toolbox website provides resources to help manage traffic congestion by better managing demand. These resources include publications, web links, and training offerings. Demand management strategies include the following (*7*):

- Technology accelerators:
  - Real-time traveler information,
  - National 511 phone number, and
  - Electronic payment systems;
- Financial incentives:
  - Tax incentives,
  - Parking cash-out,
  - Parking pricing,
  - Variable pricing,
  - Distance-based pricing, and
  - Incentive reward programs;
- Travel time incentives:
  - HOT lanes,

  - Signal priority systems, and
  - Preferential parking;
- Marketing and education:
  - Social marketing and
  - Individualized marketing;
- Mode-targeted strategies:
  - Guaranteed ride home,
  - Transit pass programs, and
  - Shared vehicles;
- Departure time–targeted strategies:
  - Worksite flextime and
  - Coordinated event or shift scheduling;
- Route-targeted strategies:
  - Real-time route information,
  - In-vehicle navigation, and
  - Web-based route-planning tools;
- Trip reduction–targeted strategies:
  - Employer telework programs and policies and
  - Compressed workweek programs; and
- Location- and design-targeted strategies:
  - Transit-oriented development,
  - Live near your work, and
  - Proximate commute.

FHWA's guide on this topic (*7*) should be consulted for more information on designing the TDM element of an ATDM program.

WEATHER-RESPONSIVE TRAFFIC MANAGEMENT PLANS

Weather-responsive traffic management involves the implementation of traffic advisory, control, and treatment strategies in direct response to or in anticipation of developing roadway and visibility issues that result from deteriorating or forecast weather conditions (*8*).

Weather-responsive traffic management strategies include the following:

- Motorist advisory, alert, and warning systems;
- Speed management strategies;
- Vehicle restriction strategies;
- Road restriction strategies;
- Traffic-signal control strategies;
- Traffic incident management;

- Personnel and asset management; and
- Agency coordination and integration.

FHWA's report on this topic (*8*) should be consulted for additional information on the design and selection of weather-responsive traffic management strategies.

TRAFFIC INCIDENT MANAGEMENT PLANS

An FHWA handbook (*9*) provides information on the design of TIM plans.

TIM is "the coordinated, preplanned use of technology, processes, and procedures to reduce the duration and impact of incidents, and to improve the safety of motorists, crash victims and incident responders." An incident is "any non-recurring event that causes a reduction in capacity or an abnormal increase in traffic demand that disrupts the normal operation of the transportation system" (*10*). Such events include traffic crashes, disabled vehicles, spilled cargo, severe weather, and special events such as sporting events and concerts. ATDM strategies may be included as part of an overall TIM plan to improve facility operations during and after incidents.

An agency's incident management plan documents the agency's strategy for dealing with incidents. It is, in essence, a maintenance of traffic plan (MOTP) for incidents and unplanned work zones. The responses available to the agency are more limited for incident management and by definition must be real-time, dynamic responses to each incident as it presents itself. The agency's incident MOTP ensures that adequate resources are prepositioned and interagency communications are established to respond rapidly and effectively to an incident. The TIM plan may include measures in effect 24 hours a day and 7 days a week, weekdays only, weekday peak periods, or any other periods of time or days of the week that are the focus of the TIM plan.

Incidents Defined and Classified

An incident is an unplanned disruption to the capacity of the facility. Incidents do not need to block a travel lane to disrupt the capacity of the facility. They can be a simple distraction within the vehicle (e.g., spilling coffee), on the side of the road, or in the opposite direction of the facility.

Incidents can be classified according to the response resources and procedures required to clear the incident. This classification helps in identifying strategic options for improving incident management.

Section 6I.01 of the 2009 *Manual on Uniform Traffic Control Devices* (MUTCD) (*11*) classifies incidents according to their expected duration:

- *Extended-duration* incidents are those expected to persist for more than 24 h and should be treated like work zones.
- *Major* incidents have expected durations of more than 2 h.
- *Intermediate* incidents have expected durations of 0.5 h up to and including 2 h.
- *Minor* incidents are expected to persist for less than 30 min.

Stages of Incident Management

Incident management is the systematic, planned, and coordinated use of human, institutional, mechanical, and technical resources to reduce the duration and impact of incidents. Incident management has several stages:

- Detection;
- Verification;
- Response;
- Motorist information; and
- Site management, consisting of
  - Traffic management,
  - Investigation, and
  - Clearance.

Detection is the first notice the agency receives that there may be an incident on the facility. Detection may occur via 911 calls, closed-circuit TV cameras, or detector feeds to a transportation management center or to maintenance or enforcement personnel monitoring the facility.

Verification confirms an incident has occurred; collects additional information on the nature of the incident; and refines the operating agency's understanding of the nature, extent, and location of the incident for an effective response.

A *response* is selected after an incident is verified, and the appropriate resources are dispatched to the incident. A decision is also made as to the dissemination of information about the incident to the motoring public.

Motorist information informs drivers not at the site about the location and severity of the incident to enable them to anticipate conditions at the site and give them the opportunity to divert and avoid the site.

Site management refers to the management of resources to remove the incident and reduce the impact on traffic flow and safety. This stage involves the following three major tasks:

- *Traffic management*, which is the control and safe movement of traffic through the incident zone;
- *Investigation*, which documents the causes of traffic incidents for safety evaluation and legal and insurance purposes; and
- *Clearance*, which refers to the safe and timely removal of any wreckage or spilled material from the roadway.

An incident management plan has the following strategic and tactical program elements (*9*):

- Management objectives and performance measurement;
- Designated interagency teams' membership, roles, and responsibilities;
- Response and clearance policies and procedures; and
- Responder and motorist safety laws and equipment.

Incident Response and Clearance Strategies

The incident management plan will designate the responder roles and responsibilities, establish an incident command system with a unified command across agencies, identify who is responsible for bringing which equipment and resources to the incident site, establish response and clearance procedures by responding agency and by incident type, and identify state and local laws that apply to incident clearance procedures.

Exhibit 37-6 presents a menu of possible incident management strategy improvements that an agency may wish to evaluate by using the ATDM analysis procedure (*12*). The expected effect of each class of strategies on highway capacities and speeds is included in this exhibit.

Exhibit 37-6
Possible Incident Management Strategies

Strategy	Description
Improved detection and verification	Closed-circuit TV, routine service patrol, or other continuously monitored incident detection system to spot incidents more quickly and verify the required resources to clear the incident. Enhanced 911, automated positioning systems, motorist aid call boxes, and automated collision notification systems are included.
Traveler information system	511 systems, traveler information websites, media partnerships, dynamic message signs, standardized dynamic message sign message sets, and usage protocols to improve the information available to travelers.
Response	Personnel and equipment resource lists, towing and recovery vehicle identification guide, instant tow dispatch procedures, towing and recovery zone–based contracts, enhanced computer-aided dispatch, dual or optimized dispatch procedures, motorcycle patrols, equipment staging areas or prepositioned equipment.
Scene management and traffic control	Incident command system, response vehicle parking plans, high-visibility safety apparel and vehicle markings, on-scene emergency lighting procedures, safe and quick clearance laws, effective traffic control through on-site traffic management teams, overhead lane-closure signs, variable speed limits, end-of-queue advance warning systems, alternate route plans.
Quick clearance and recovery	Abandoned-vehicle laws, safe and quick clearance laws, service patrols, vehicle-mounted push bumpers, incident investigation sites, noncargo vehicle fluid-discharge policy, fatality certification and removal policy, expedited crash investigation, quick clearance using fire apparatus, towing and recovery quick clearance incentives, major incident response teams.

Source: Adapted from Carson (*12*).

WORK ZONE TRANSPORTATION MANAGEMENT PLANS

Work zone management has the objective of moving traffic through the working area with as little delay as possible, consistent with the safety of the workers, the safety of the traveling public, and the requirements of the work being performed. Transportation management plans are a collection of administrative, procedural, and operational strategies used to manage and mitigate the impacts of a work zone project.

The work zone MOTP may have three components: a temporary traffic control plan, a transportation operations plan, and a public information plan. The temporary traffic control plan describes the control strategies, traffic control devices, and project coordination. The transportation operations plan identifies the demand management, corridor management, work zone safety management, and the traffic and incident management and enforcement strategies. The public information plan describes the public awareness and motorist information strategies (*10*). ATDM strategies can be important components of a transportation management plan (*13*).

The work zone MOTP codifies the agency's management strategy. It has the following elements:

- *Construction approach*: staging, sequencing, lane and ramp closure alternatives, alternative work schedules (e.g., night, weekend).
- *Traffic control operations*: a mix of dynamic (ATDM) and static measures consisting of speed limit reductions, truck restrictions, signal timing (coordination and phasing), reversible lanes, and physical barriers.
- *Public information*: a mix of dynamic (ATDM) and static pretrip and en route information (e.g., 511, newspapers, meetings, websites, closed-circuit television over the Internet), plus on-site information signing such as static signs, changeable or variable message signs, and highway advisory radio.
- *TDM*: employer-based and other incentives (in addition to public information) for use of alternative modes of travel, including park-and-ride.
- *Incident management and enforcement*: generally, ATDM measures specified in an incident management plan (i.e., an incident MOTP), such as traffic management centers, intelligent transportation systems, emergency service patrols, hazardous materials teams, and enhanced police enforcement. A particularly aggressive incident MOTP may be put in place for work zones.

Construction Approach

The work zone MOTP must consider several alternative construction approaches (including traffic maintenance) and recommend the construction approach that best meets the agency's objectives for the construction project.

Traffic maintenance approaches to be considered in the work zone MOTP include the following:

1. Complete closure of the work area for a short time versus partial closure for a longer time,
2. Nighttime versus daytime lane closures, and
3. Off-peak versus peak hour lane closures.

Traffic Control Operations

The traffic control element of the MOTP specifies work zone speed-limit reductions, signal timing changes (if needed), reversible lanes (e.g., flagging), and the locations of physical barriers and cones. The traffic control elements may be dynamic, responding in real time to changing conditions, or they may be more static, operating at prespecified times of the day.

MUTCD Section 6G.02 defines work zone types according to duration and time of day (*11*):

- *Duration Type A*: long-term stationary work that occupies a location more than 3 days;
- *Duration Type B*: intermediate-term stationary work that occupies a location more than one daylight period up to 3 days, or nighttime work lasting more than 1 h;
- *Duration Type C*: short-term stationary daytime work that occupies a location for more than 1 h within a single daylight period;
- *Duration Type D*: short-duration work that occupies a location up to 1 h; and
- *Duration Type E*: mobile work that moves intermittently or continuously.

Work zones are further categorized by MUTCD Section 6G.03 according to their location on the facility. Work zones within the traveled way (Location Type E) are further subdivided by facility type (*11*):

- *Location Type A*: outside the shoulder (Section G6.06);
- *Location Type B*: on the shoulder with no encroachment (Section G6.07);
- *Location Type C*: on the shoulder with minor encroachment, leaving at least a 10-ft lane (Section G6.08);
- *Location Type D*: within the median (Section G6.09); and
- *Location Type E*: within the traveled way of
  - A two-lane highway (Section 6G.10),
  - An urban street (Section 6G.11),
  - A multilane non-access-controlled highway (Section 6G.12),
  - An intersection (Section 6G.13), or
  - A freeway or an expressway (Section 6G.14).

Each work zone type has an associated typical application of temporary traffic controls. They are described in MUTCD Section 6H-1 (*11*).

Public Information Element

The public information element is intended to provide the public with pretrip and en route information and with preconstruction and during-construction information on the work zone so the public can plan accordingly. The intent is to encourage travelers who can to reschedule or reroute their trip to avoid the work zone during periods of peak closures. Public information includes 511 alerts; press interviews; public information meetings; project update websites; and on-site web-accessible closed-circuit cameras, variable message signs, and highway advisory radio.

Travel Demand Management Element

In coordination with the public information element, the TDM element identifies incentives, such as park-and-ride lots, that will be provided for travelers using alternative modes. The public information element and the TDM element differ in that the public information is neutral, leaving it to the traveler to choose how to respond. The TDM element provides monetary and service incentives to encourage a particular subset of choices.

Incident Management and Enforcement Element

Incident management includes the development of incident management plans for the work zone. The plans describe coordination with traffic management centers, the use of intelligent transportation systems devices, deployment of emergency service patrols in the work zone, and enhanced police enforcement. Enforcement may be strengthened with speed limit feedback signs and other devices.

SPECIAL EVENT MANAGEMENT PLANS

Special event management deals with moving people and traffic to and from special event locations, such as a sports stadium, concert hall, or arena. The objective is to get people and traffic onto and off of the site with minimal backups onto the public transportation system and in a reasonable time. Traffic control officers, temporary cones and signs, reversible lanes, and special signal control plans are often part of a special event management plan (*14*).

A special event management plan typically has the following components:

- Preevent ingress control,
- During-event access control, and
- Postevent egress control.

The special event management plan will deploy a combination of temporary signing, lane controls, signal timing plans, and personnel to move traffic into and out of the event venue, much like a short-term work zone.

6. REFERENCES

Many of these references are available in the Technical Reference Library in Volume 4.

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