

CHAPTER FOUR: EXISTING TRANSPORTATION MANAGEMENT

TMS is MoDOT's Transportation Management Systems software that was first implemented back in 1998. At that time, TMS consisted of four major business areas, which included Safety, Traffic, Bridge and Pavement.

Over the years, TMS has expanded to meet the needs of many business units and users. We continue to build applications and tools that assist MoDOT and our partners with decision making. Most TMS applications/maps are available from the TMS Homepage: <http://tms/home/>. Many of our Metropolitan Planning Organization/Regional Planning Commission (RPC) partners access TMS by using a virtual machine and logging into the MoDOT network. TMS originated with business areas of Bridge, Pavement, Traffic and Safety but has expanded tremendously over the years.

4.1 Bridge Management System

This system includes:

- Inventory Management
- Media Loader

TMS is the single source for all bridge data in the department. The bridge part of the system includes National Bridge Inventory (NBI) data, inspection information, as well as media for that structure. Media could include things such as photographs, plans, correspondence, inspection reports, and other data related to a bridge.

MoDOT personnel inspect state maintained bridges and culverts and the majority of all of the locally owned (referred to as non-state) bridges and culverts. A small portion of non-state bridges and culverts are inspected by local agency staff or consultant engineers. All bridges and culverts that are part of the NBI are required to have a general inspection done on a two-year inspection cycle. In addition to the general inspection, some structures require fracture critical inspections, underwater inspections, or special inspections to look at specific items. Intervals for these other inspections vary depending on what is being looked at. Structures that are in "poor" or "serious" condition may have inspections done at more frequent intervals.

Bridge and culvert condition ratings have been supplied to the RPCs for the development of their Regional Transportation Plans (RTPs). This data is being provided for the purpose of assisting the RPCs and MoDOT in identifying local needs and priorities for a region. These condition ratings are assessed by inspectors when the various types of inspections are done on a structure. These condition ratings basically describe the in-place condition of a structure. Ratings are

assigned for the physical condition of the deck, superstructure and substructure components of a bridge and an overall rating is assigned for culvert structures.

The deck is the portion of the bridge that includes the riding surface. The superstructure is the girders and other span elements of the bridge that support the deck. These superstructure elements may be comprised of structural steel, concrete or timber, depending on the design of the bridge. The substructure is comprised of those elements of the structure that support the superstructure (girders, span elements, etc.). The substructure elements are the columns, footings and beam caps that the girders rest on. The deck, superstructure and substructure are rated independently; however, the lowest rating of the three is traditionally what is considered the overall rating for a structure. Culverts are typically buried structures built out of concrete or steel. An overall condition rating is assigned for a culvert and takes into account how all of the different elements of the structure are functioning. The following general condition ratings are used as a guide in evaluating the deck, superstructure, substructure and overall culvert.

Bridge/Culvert Rating Description

- N NOT APPLICABLE
- 9 EXCELLENT CONDITION
- 8 VERY GOOD CONDITION – no problems noted.
- 7 GOOD CONDITION – some minor problems.
- 6 SATISFACTORY CONDITION – structural elements show some minor deterioration.
- 5 FAIR CONDITION – all primary structural elements are sound but may have minor section loss, cracking, spalling or scour.
- 4 POOR CONDITION – advanced section loss, deterioration, spalling or scour.
- 3 SERIOUS CONDITION – loss of section, deterioration, spalling or scour have seriously affected primary structural components. Local failures are possible. Fatigue cracks in steel or shear cracks in concrete may be present.
- 2 CRITICAL CONDITION – advanced deterioration of primary structural elements. Fatigue cracks in steel or shear cracks in concrete may be present or scour may have removed substructure support. Unless closely monitored, it may be necessary to close the bridge until corrective action is taken.
- 1 IMMINENT FAILURE COND – major deterioration or section loss present in critical structural components or obvious vertical or horizontal movement affecting structure stability. Bridge is closed to traffic, but corrective action may put back in light service.
- 0 FAILED CONDITION – out of service – beyond corrective action.

4.2 Traffic Management System

Traffic Data Acquisition System

Previously, traffic data was collected by a variety of methods. All traffic data reporting was done on the mainframe system. With the acquisition of Traffic Data Acquisition System (TRADAS), all traffic data is collected and processed uniformly. The traffic data collected includes such items as traffic volumes (both vehicular traffic and truck traffic), Level of Service (LOS) (congestion condition) and vehicle classifications. This data is used to understand traffic patterns and identify locations of need. Inventories in the Traffic Management System include:

- Flasher Inventory
- Lighting Inventory
- Signal Inventory
- District Defined Types
- Highway Capacity Interface
- Site ID Maintenance
- Traffic Information Segment Maintenance
- Traffic Segment Hourly Volume

Congestion Management

Traffic congestion and travel delay are among the most visible signs of transportation problems. Drivers experience congestion for the most part as a personal annoyance, although traffic congestion is a problem that wastes time, consumes energy resources and contributes to poorer air quality.

Traffic congestion in the urban area is typically confined to the morning and evening peak hours of travel. Delays from congestion occur on roadways with inadequate capacity or at specific locations such as interstate ramps and signalized intersections.

Congestion in the rural area can occur at any time when the roadway is unable to handle the traffic flow. This can be related to peak hours of travel, including work and holiday travel. It can also be because the typical two-lane roadway is restricted and traffic is unable to flow freely, often times because of incidents or slow moving vehicles.

Expanding the capacity of roadways is not the sole solution to congestion. The new roadways, bridges, and highways built to relieve congestion satisfy latent and shifted demand for travel. The use of alternate modes, land use regulation, access management, and improvements to intersections and traffic signals can all contribute to an overall program to manage traffic congestion.

There are two major methods of gauging congestion: facility-based measures and travel time. The facility-based congestion method focuses on the road itself and usually is based on traffic volume and capacity comparisons. Such comparisons may include volume-to-capacity ratios and

traffic volume per lane mile. The travel time method of measuring congestion indicates the same conclusion, however. These trip-based measures are tied to the individual traveler's congestion problems and oriented to the length of the trip. Average travel time to work is an example of one such measure.

A number of indicators may be used to gauge and manage congestion. These are divided into four categories.

1. Facility-based measures:

- Average vehicle speed in peak hour
- Ratio between peak volume & nominal capacity (V/C)
- Total vehicle hours of delay
- Proportion of daily travel by speed or V/C range
- Frequency and duration of incidents
- Average daily traffic (ADT) per freeway lane

2. Personal travel effects:

- Proportion of personal travel by speed range
- Delay added to average person's trips by time of day, travel purpose
- Delay added to average person's trip by place of residence
- Delay to transit vehicles
- Number of crashes due to congestion

3. Effects on the economy:

- Delay added to average commuter trip by place of work
- Percentage of truck travel by speed or V/C range
- Vehicle hours of delay to trucks/delivery vehicles
- Truck scheduling costs attributable to travel time uncertainty
- Market perceptions of congestion as an influence on economic activity

4. Environmental impacts:

- Extra vehicle emissions due to stop-and-go conditions
- Extra gas consumption due to stop-and-go conditions

LOS is defined as conditions within a traffic stream as perceived by the users of a traffic facility. MoDOT's Transportation Management System provides LOS information in the Traffic Segment Browser. In practice, LOS has been defined by measures of effectiveness for each facility type, relating more to speed, delay and density than to qualitative factors or safety. LOS is rated A, representing the best operating condition, to F, representing the worst. The following describes LOS according to the Highway Capacity Manual.

LOS A describes primarily free-flow operation. Vehicles are completely unimpeded in their ability to maneuver within the traffic stream. Control delay at the boundary intersections is minimal. The travel speed exceeds 80% of the base free-flow speed, and the volume-to-capacity ratio is no greater than 1.0.

LOS B describes reasonably unimpeded operations. The ability to maneuver within the traffic stream is only slightly restricted, and control delay at the boundary intersections is not significant. The travel speed is between 67% and 80% of the base free-flow speed, and the volume-to-capacity ratio is no greater than 1.0.

LOS C describes stable operation. The ability to maneuver and change lanes at midsegment locations may be more restricted than at LOS B. Longer queues at the boundary intersections may contribute to lower travel speeds. The travel speed is between 50% and 67% of the base free-flow speed, and the volume-to-capacity ratio is greater than 1.0.

LOS D indicates a less stable condition in which small increases in flow may cause substantial increases in delay and decreases in travel speed. This operation may be due to adverse signal progression, high volume, or inappropriate signal timing at the boundary intersections. The travel speed is between 40% and 50% of the base free-flow speed, and the volume-to-capacity ratio is no greater than 1.0.

LOS E is characterized by unstable operation and significant delay. Such operations may be due to some combination of adverse progression, high volume, and inappropriate signal timing at the boundary intersections. The travel speed is between 30% and 40% of the base free-flow speed, and the volume-to-capacity ratio is no greater than 1.0.

LOS F is characterized by flow at extremely low speed. Congestion is likely occurring at the boundary intersections, as indicated by high delay and extensive queuing. The travel speed is 30% or less of the base free-flow speed or the volume-to-capacity ratio is greater than 1.0.

Transportation Demand Management (TDM)

This is a strategic response to roadway capacity deficiencies that involves the construction of new or expanded roadways. TDM actions are calculated to reduce vehicle demand by increasing vehicle capacity or providing an alternate mode. While new construction is the most direct and effective practice to eliminate congestion, this approach may not offer a complete solution. A variety of strategies is available to reduce congestion and may include methods to increase vehicle occupancy and promote alternative modes of transportation. Approaches may include:

- a. Ridesharing programs, local and regional.
- b. Transportation management associations which coordinate opportunities and incentives for shared travel, usually through employers or business associations.

- c. Cash-out parking subsidies which allow employees to convert employer paid parking subsidies to transit subsidies or cash.
- d. Restricted availability and/or increased parking cost for single occupancy vehicles.
- e. Mixed use development of walking, cycling and transit alternatives.
- f. Transportation enhancements projects such as improved bicycle paths and pedestrian facilities to improve choices available to commuters.
- g. Staggered/flexible work hours to more evenly distribute the number of commuters.
- h. Telecommuting and home-based businesses.
- i. Electronic commerce that allows personal and business transactions electronically without physically making a trip.

Signalized Intersection Management

Signalized intersections may be necessary to allow the safe movement of vehicles through intersecting roadways. However, there is a physical limit to the number of through movements and turning movements that can be safely accommodated by a signalized intersection. When the demand for any movement at the intersection exceeds the available capacity, congestion and delays ensue, reducing the average travel speed and increasing the travel time. Roundabouts can also be constructed to facilitate the safe movement of vehicles through intersecting roadways. In some cases, roundabouts can accommodate traffic volume and movements more efficiently than traffic signals.

4.3 Safety Management System

Traffic crashes are entered into TMS by staff at the Missouri State Highway Patrol (MSHP). The crashes in the database date back to 1985, and crash images date back to 1997. MSHP enters fatal crashes into the database within 10 days of the crash. Crash data is utilized to identify where crashes occur and includes other information such as type of crash, contributing circumstances and severity of the crash. Applications in this system include:

- Crash Summary
- Crash Browser
- Intersection Expected Crash Values
- Statewide Average Crash Rates

Travelway Safety Features

This includes inventories for:

- Guardcable
- Rumblestrips
- Concrete Barrier

- Guardrail
- Soundwall
- Emergency Reference Markers
- Curfews
- Points of Interest
- Controlled Routes

4.4 Travelways Management System

The travelways management system includes applications to manage the following data:

- Asset Management (Functional class, speed limit, access category, federal system class, etc.)
- Travelway Overlapping Browser
- Location Referencing System (Travelway Selection)
- Travelway Lane Inventory

Functional Classification and Access Management

Functional classification (FC) is the process by which streets and highways are grouped into classes or systems according to the character of service they provide. FC defines the nature of this process by defining the part that any particular road or street should play in serving the flow of trips through a highway network.

Federal legislation requires the FC of roadways to determine the funding eligibility of transportation projects.

Urban and rural areas have fundamentally different characteristics as to density and land use, density of street and highway networks, nature of travel patterns and the way in which all of these elements are related in the definitions of the highway classifications.

There are three such area definitions, and they are the following:

Small Urban—Areas designated by the Bureau of the Census having a population of 5,000 (5,000 to 49,999).

Urbanized—Designated as such by the Bureau of the Census with a population of 50,000 or more.

Rural—Comprise the areas outside the boundaries of small urban and urbanized.

There are three principal roadway classifications: arterial, collector and local roads. All highways and streets are grouped into one of these classes, depending on the character of the traffic and the degree of land access they allow.

The following information was taken from FHWA's website at https://www.fhwa.dot.gov/planning/processes/statewide/related/highway_functional_classifications/section03.cfm.

To assist transportation planners responsible for determining the FC of roadways, the charts below offer a helpful tool that can make the classification process of classifying "borderline" roadways a bit easier. **Table 4.1** illustrates the range of lane width, shoulder width, AADTs, divided/undivided status, access control and access points per mile by FC categories.

Table 4.1: VMT and Mileage Guidelines by Functional Classifications - Arterials

	Arterials			
	Interstate	Other Freeways & Expressway	Other Principal Arterial	Minor Arterial
Typical Characteristics				
Lane Width	12 feet	11 - 12 feet	11 - 12 feet	10 feet - 12 feet
Inside Shoulder Width	4 feet - 12 feet	0 feet - 6 feet	0 feet	0 feet
Outside Shoulder Width	10 feet - 12 feet	8 feet - 12 feet	8 feet - 12 feet	4 feet - 8 feet
AADT¹ (Rural)	12,000 - 34,000	4,000 - 18,500 ²	2,000 - 8,500 ²	1,500 - 6,000
AADT¹ (Urban)	35,000 - 129,000	13,000 - 55,000 ²	7,000 - 27,000 ²	3,000 - 14,000
Divided/Undivided	Divided	Undivided/Divided	Undivided/Divided	Undivided
Access	Fully Controlled	Partially/Fully Controlled	Partially/Uncontrolled	Uncontrolled
Mileage/VMT Extent (Percentage Ranges)¹				
Rural System				
Mileage Extent for Rural States²	1% - 3%	0% - 2%	2% - 6%	2% - 6%
Mileage Extent for Urban States	1% - 2%	0% - 2%	2% - 5%	3% - 7%
Mileage Extent for All States	1% - 2%	0% - 2%	2% - 6%	3% - 7%
VMT Extent for Rural States²	18% - 38%	0% - 7%	15% - 31%	9% - 20%
VMT Extent for	18% - 34%	0% - 8%	12% - 29%	12% - 19%

Urban States				
VMT Extent for All States	20% - 38%	0% - 8%	14% - 30%	11% - 20%
Urban System				
Mileage Extent for Rural States²	1% - 3%	0% - 2%	4% - 9%	7% - 14%
Mileage Extent for Urban States	1% - 2%	0% - 2%	4% - 5%	7% - 12%
Mileage Extent for All States	1% - 3%	0% - 2%	4% - 5%	7% - 14%
VMT Extent for Rural States²	17% - 31%	0% - 12%	16% - 33%	14% - 27%
VMT Extent for Urban States	17% - 30%	3% - 18%	17% - 29%	15% - 22%
VMT Extent for All States	17% - 31%	0% - 17%	16% - 31%	14% - 25%
Qualitative Description (Urban)	<ul style="list-style-type: none"> • Serve major activity centers, highest traffic volume corridors, and longest trip demands • Carry high proportion of total urban travel on minimum of mileage • Interconnect and provide continuity for major rural corridors to accommodate trips entering and leaving urban area and movements through the urban area • Serve demand for intra-area travel between the central business district and outlying residential areas 		<ul style="list-style-type: none"> • Interconnect with and augment the principal arterials • Serve trips of moderate length at a somewhat lower level of travel mobility than principal arterials • Distribute traffic to smaller geographic areas than those served by principal arterials • Provide more land access than principal arterials without penetrating identifiable neighborhoods • Provide urban connections for rural collectors 	
Qualitative	<ul style="list-style-type: none"> • Serve corridor movements having trip length and travel 		<ul style="list-style-type: none"> • Link cities and larger towns (and other 	

<p>Description (Rural)</p>	<p>density characteristics indicative of substantial statewide or interstate travel</p> <ul style="list-style-type: none"> • Serve all or nearly all urbanized areas and a large majority of urban clusters areas with 25,000 and over population • Provide an integrated network of continuous routes without stub connections (dead ends) 	<p>major destinations such as resorts capable of attracting travel over long distances) and form an integrated network providing interstate and inter-county service</p> <ul style="list-style-type: none"> • Spaced at intervals, consistent with population density, so that all developed areas within the State are within a reasonable distance of an arterial roadway • Provide service to corridors with trip lengths and travel density greater than those served by rural collectors and local roads and with relatively high travel speeds and minimum interference to through movement
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1- Ranges in this table are derived from 2011 HPMS data.

2- For this table, Rural States are defined as those with a maximum of 75 percent of their population in urban centers.

Table 4.2: VMT and Mileage Guidelines by Functional Classifications - Collectors and Locals

	Collectors		Local
	Major Collector ²	Minor Collector ²	
Typical Characteristics			
Lane Width	10 feet - 12 feet	10 - 11 feet	8 feet - 10 feet
Inside Shoulder Width	0 feet	0 feet	0 feet
Outside Shoulder Width	1 feet - 6 feet	1 feet - 4 feet	0 feet - 2 feet
AADT¹ (Rural)	300 - 2,600	150 - 1,110	15 - 400
AADT¹ (Urban)	1,100 - 6,300 ²		80 - 700
Divided/Undivided	Undivided	Undivided	Undivided
Access	Uncontrolled	Uncontrolled	Uncontrolled
Mileage/VMT Extent (Percentage Ranges)¹			
Rural System			
Mileage Extent for Rural States³	8% - 19%	3% - 15%	62% - 74%
Mileage Extent for Urban States	10% - 17%	5% - 13%	66% - 74%
Mileage Extent for All States	9% - 19%	4% - 15%	64% - 75%
VMT Extent for	10% - 23%	1% - 8%	8% - 23%

Rural States³			
VMT Extent for Urban States	12% - 24%	3% - 10%	7% - 20%
VMT Extent for All States	12% - 23%	2% - 9%	8% - 23%
Urban System			
Mileage Extent for Rural States³	3% - 16%	3% - 16% ²	62% - 74%
Mileage Extent for Urban States	7% - 13%	7% - 13% ²	67% - 76%
Mileage Extent for All States	7% - 15%	7% - 15% ²	63% - 75%
VMT Extent for Rural States³	2% - 13%	2% - 12% ²	9% - 25%
VMT Extent for Urban States	7% - 13%	7% - 13% ²	6% - 24%
VMT Extent for All States	5% - 13%	5% - 13% ²	6% - 25%
Qualitative Description (Urban)	<ul style="list-style-type: none"> • Serve both land access and traffic circulation in higher density residential, and commercial/industrial areas • Penetrate residential neighborhoods, often for significant distances • Distribute and channel trips between local streets and arterials, usually over a distance of greater than three-quarters of a mile 	<ul style="list-style-type: none"> • Serve both land access and traffic circulation in lower density residential, and commercial/industrial areas • Penetrate residential neighborhoods, often only for a short distance • Distribute and channel trips between local streets and arterials, usually over a distance of less than three-quarters of a mile 	<ul style="list-style-type: none"> • Provide direct access to adjacent land • Provide access to higher systems • Carry no through traffic movement
Qualitative Description (Rural)	<ul style="list-style-type: none"> • Provide service to any county seat not on an arterial route, to the larger towns not directly 	<ul style="list-style-type: none"> • Be spaced at intervals, consistent with population density, to collect 	<ul style="list-style-type: none"> • Serve primarily to provide access to

	<p>served by the higher systems, and to other traffic generators of equivalent intra-county importance such as consolidated schools, shipping points, county parks, important mining and agricultural areas</p> <ul style="list-style-type: none"> • Link these places with nearby larger towns and cities or with arterial routes • Serve the most important intra-county travel corridors 	<p>traffic from local roads and bring all developed areas within reasonable distance of a minor collector</p> <ul style="list-style-type: none"> • Provide service to smaller communities not served by a higher class facility • Link locally important traffic generators with their rural hinterlands 	<p>adjacent land</p> <ul style="list-style-type: none"> • Provide service to travel over short distances as compared to higher classification categories • Constitute the mileage not classified as part of the arterial and collectors systems
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1- Ranges in this table are derived from 2011 HPMS data.

2- Information for Urban Major and Minor Collectors is approximate, based on a small number of States reporting.

3- For this table, Rural States are defined as those with a maximum of 75 percent of their population in urban centers.

4.5 Pavement Management System

Currently, MoDOT's emphasis is on keeping good roads good and doing the best we can with the resources available. Because resources are scarce and MoDOT desires to provide the best service possible to the most customers, we have stratified our roadways into three tiers: Major Roads, Minor Roads and Low Volume Roads. Major Roads account for almost 80% of the Vehicle Miles Traveled (VMT) on state-owned roadways. Minor Roads are other routes that are not Major but have an AADT greater than 400. Low Volume routes are all other routes with an AADT less than 400. We track performance on these routes by category. Our resulting measures are “Good” and “Not Good”. They are calculated as follows:

- Major Roads speed limit > 45 Good: IRI < 100
- Major Roads speed limit < 50 Good: Condition_Index >=7 (visual surface distress rating)
- Minor Roads Good: IRI < 140
- Minor Roads Good: IRI between 140 and 170 and Condition_Index >=6
- Low Volume Good: IRI < 170
- Low Volume Good: IRI between 170 and 220 and Condition_Index >=6

In our state of the system tables, this measurement has been calculated, and the results are maintained in the column *Tracker Condition* with the values of “Good”, “Not Good” and “NA” or null.

4.6 Additional Business Areas with TMS include the following:

Outdoor Advertising

This system includes:

- Adopt A Highway
- Outdoor Advertising °Billboard
- Junkyard
- Transfer Permit
- Media for billboards and junkyards

Routine Maintenance

- Travelway Routine Maintenance is an application containing job numbers for routes and bridges throughout the state. This application enables Routine Maintenance job numbers from the Financial Management System (FMS) to be tied to a location in TMS.

Intelligent Transportation System

SIMS (five-year Statewide Transportation Improvement Program)

Realty Asset/RW Parcel Acquisition

State of the System (yearly summarized roadway, bridge, crash and pavement data)

Traffic Permitting for Right-of-Way – this application tracks the status of permits issued for conducting work on MoDOT right-of-way.

Striping Inventory

Traveler Information System

These applications are used to keep information current on MoDOT’s Traveler Information Map. The Traveler Information Map is essential to the safety of Missouri’s traveling public. Traffic Impact

- Work Zone
- Winter Road Conditions
- Flood Condition
- OSOW Restrictions
- Traveler Information Map (TIM) Auto Editor
 - This application is used to choose and update layers which will display on the TIM.
 - This application is used only by MoDOT Communications staff.
- TIM Alert Management
 - This application will assist users in changing the alert message for the desktop TIM and the mobile TIM apps for iOS/Android mobile phones. The desktop web application only allows one message to be displayed in the upper left corner of the map. The mobile apps allow multiple messages and will display them in a list for the user. This application is used only by MoDOT Communications staff.

List of newer applications in TMS:

Stormwater

- This application helps MoDOT regulate under a National Pollutant Discharge Elimination System storm water permit. The permit requires MoDOT to develop and implement a comprehensive program to prevent pollution of surface waters resulting from storm water run-off from MODOT’s system.

Local Program Application (LPA) Locations

- The LPA is used to manage jobs located on our city streets and county roads. There is a federal mandate to assign locations to these local projects.

Emergency Operations Map

- This map is for internal use only should a natural disaster occur. It tracks the status of MoDOT roads and bridges during and after a disaster.

TMS Data Zone

This is an internal web page containing maps and other tools that allow MoDOT customers to easily retrieve data and statistics. It contains data in the following areas: Traffic, Safety, Planning, Bridge, Design, Map-21, Construction and Multimodal. The Data Zone also houses the Pavement Tool which is used for planning pavement maintenance activities and surface treatments. The intent is to eventually open this tool to the public.

For detailed information regarding MoDOT business and engineering policy, visit the Engineering Policy Guide at http://epg.modot.org/index.php?title=Main_Page.