CHAPTER FOUR:
EXISTING TRANSPORTATION MANAGEMENT

4.1 Transportation Management Systems

Prior to 1991, the Missouri Department of Transportation (MoDOT) had begun development of several independent management systems. Major systems included pavement, bridge, safety, congestion, and traffic monitoring. During 1991, MoDOT undertook a major effort to coordinate and automate these independent systems. MoDOT had begun development of these systems before the Intermodal Surface Transportation Efficiency Act (ISTEA) mandate, and recognizing the long-term benefits of these programs, continued to develop them after the mandate was lifted.

In 1995, this coordinated effort became Transportation Management Systems (TMS). TMS is not a project, an office, or a functional unit, but a means of obtaining and analyzing data for use in sound engineering decision-making. It crosses many boundaries, including other State agencies, external planning agencies, districts, and functional units.

The process to convert existing department data, recreate required existing programs and products and develop the new functions necessary for business today has been massive. Hundreds of files have been converted. Hundreds of applications have also been developed. The groundwork has been established and it is only now that the department can begin to realize the benefits of the system that has been developed.

Much of the TMS data (bridge and pavement condition, crash data, location referencing data and roadway features, etc.) are being shared with the Regional Planning Organizations for the development of Regional Transportation Plans (RTPs). The Regional Planning Commissions are also giving the latitude to use the data and overlay other local data sources that meet their needs.

It is the responsibility of each Regional Planning Commission to make its Regional Transportation Plan its own and to make it a dynamic and useful planning document. While MoDOT's Transportation Planning Framework allows the public to see the process by which state transportation decisions are made, the RPC's Regional Transportation Plan justifies and documents recommendations that go forward from the region to the state's planning framework process. It also encourages county and city leaders to look at their individual transportation systems, how they interact with other systems and consider ways to improve these networks in order to provide an efficient and safe movement of goods and people, and to do so in the most cost-effective means possible.

MoDOT, through the development of these Regional Transportation Plans, is providing system management data and mapping information to each Regional Planning Commission. The intent is for RPCs to analyze this information from a regional perspective, develop different scenarios using the data that may generate new information, consider issues that may have been overlooked in the past and consider local perspectives when deciding what information to analyze. It is up to each RPC to decide what information is needed and what type of analysis is needed to allow them to make the best transportation recommendations for its region.

4.2 Available Management Systems

Location/referencing system (LRS). Prior to TMS, many functional units and districts at MoDOT had unique methods of collecting and storing data. A standard method of referencing data was necessary if a fully relational department wide database was to be established. The LRS allows all information in the database to be viewed together. This effort combined Bridge Management System, Pavement Management System, Safety Management System and Traffic Management System into TMS. This means that every segment of roadway has data linked to it through a Geographical Information System (GIS).

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 Management System also allows for each district to track their Signal, Lighting and Flasher inventories in one database instead of each district keeping a separate database. The traffic data collected includes such items as traffic volumes (both vehicular traffic and truck traffic), Level of Service (congestion condition) and vehicle classifications. This data is used to understand traffic patterns and identify locations of need. Another data element of roadways is the functional class.

Functional and Access Management. (Please refer to Appendix B—Missouri Department of Transportation Access Management Guidelines of September 12, 2003)

Functional classification is the process by which streets and highways are grouped into classes or systems according to the character of service they provide. Functional classification (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 functional classification 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:

Area Definitions

Small Urban—Areas designated by the Bureau of the Census having a population of five thousand (5,000) or more and not within and urbanized area.

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.

Table 4-1 **Roadway Classifications**	
Classification	**Characteristics**
Arterial	Provides the highest level of service at the greatest speed for the longest uninterrupted distance, with some degree of access control.
Interstate/Freeway	4, 6, or 8 travel lanes with a minimum of 400 feet of right of way. A limited access roadway with full grade separated interchanges. Access on and off the roadway is accomplished by ramps connecting frontage roads or interchanges. Access limited to interchanges and driveways on frontage roads.
Expressway	4 or 6 travel lanes with a minimum of 250 feet of right-of-way. Arterial roadway with widely spaced signalized intersections at minor intersections or other forms of traffic control such as cross-over geometrics on divided highways.
Principal Arterial	4 or 6 lanes with 90 to 150 feet of right-of-wayHigh volume roadway with at-grade street intersections and regulated driveway access. Signalized intersections with priority given to the arterial through movement.
Minor Arterial	2 or four lanes with 90 to 120 feet of right-of-way.A secondary arterial facility to provide access to major arterials or limited access roadways. Serves localized circulation and access needs. The roadway may be divided or undivided and typically supports the access requirements of concentrations of commercial or residential development.

Collector Major Collector Minor Collector	Provides a less highly developed level of service at a lower speed for shorter distances by collecting traffic from local roads and connecting them with arterials. 2 or 4 lanes with 90 to 120 feet of right of way. Lower capacity roadway to provide local access and circulation to the arterial network. 2 lanes with up to 66 feet of right-of-way. Low volume, low speed roadway to provide access for local residential traffic to the collector and arterial network.
Local	Consists of all roads not defined as arterials or collectors; primarily provides access to land with little or no through movement.

Management systems are designed to improve or maintain the safe and efficient flow of traffic. An important aspect in maintaining roadway capacity is the effective control of driveway and street access to arterial roadways.

The functional classification for roadways is based on the movement versus access concept. Arterial streets are primarily intended for the movement of through traffic. Local streets provide access to individual tracts at the expense of through traffic movement. Freeways and expressways are designed with limited access to provide entirely for the efficient movement of traffic. Collector streets, residential or commercial, provide equal service to the access and through movement functions. However, uncontrolled land access often produces conflicts that compromise the movement function of a roadway system.

Although arterials are designed for higher speeds and serve longer travel distances than do collectors or local streets, they often become heavily used for short distance trips as well. The higher traffic volumes are attractive to commercial interests, especially if driveway access is available to the property fronting the arterial. Uncontrolled driveway access for commercial land uses significantly reduces the capacity of an arterial to carry traffic. Depending upon the number of turning movements, number of travel lanes and the arterial traffic volumes, a driveway permitted access to an arterial street will reduce roadway capacity by up to 25%. The movement function of the arterial is quickly degraded to that of a collector street.

Bridge Management System. Historically, bridge information was stored in and reported by means of the mainframe computer system. Using this system was difficult and cumbersome. The new system eliminates reliance on the mainframe computer. It also adds the functionality necessary to collect more detailed element level inspection data necessary to run bridge management software, and to more accurately predict bridge maintenance costs. TMS has become the single source for all bridge data in the department, replacing separate databases previously maintained in bridge and bridge maintenance operations.

MoDOT personnel inspect state maintained bridges and culverts on a two-year inspection cycle. Bridges and culverts that are rated “serious” to “poor” or bridges with unique structural features such as, major truss structures, are inspected on an annual basis. Bridges and culverts that are not state maintained are referred to as “Off-system Bridges.” They are inspected by a variety of personnel. These personnel include MoDOT staff, city and county staff and some by consultants.

Bridge condition ratings have been supplied to the Regional Planning Commissions 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. MoDOT bridge inspection staff inspects the ratings for state system bridges.

These bridge condition ratings are used to describe the in-place bridge as compared to the as-built condition. Evaluation is for the materials-related, physical condition of the deck, superstructure and substructure components of a bridge.

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 or concrete 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.

The following general condition ratings are used as a guide in evaluating the deck, superstructure and substructure:

Bridge 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 members. 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 CONDITION – major deterioration or section loss present in critical structural members or obvious vertical or horizontal movement affecting structure stability. Bridge is closed to traffic until corrective action is completed.
0	FAILED CONDITION – out of service – beyond corrective action

The deck, superstructure and substructure are each rated separately. If any of the three structures rate a 2 or lower, the bridge is typically closed. From a planning and comparison perspective, the overall condition of the bridge is the lowest rating of the three structures. For example, if Bridge 123 has a deck rating of 6, a substructure rating of 4 and a superstructure rate of 3, the overall condition of the bridge is considered a 3.

Crash Data. Previously, Missouri State Highway Patrol (MSHP) and MoDOT both input and stored crash data. Currently, all MoDOT crash reporting and browsing is done through TMS applications, thus eliminating the mainframe programs and duplication of data entry. Another benefit of the new system provides scanned electronic images of the accident reports to be included in the database, rather than paper or microfilmed images. In 2002 the STARS (Statewide Accident Reporting System) of the MSHP was implemented into TMS. MSHP data entry clerks are now entering crash reports directly into the TMS database.

The crash data is utilized to identify where crashes occur and include other information such as type of crash, contributing circumstances, and severity of the crash.

Pavement Management. This is the management system that provides information and data relating to the riding surface of state maintained roadways. The Pavement Condition score includes distresses (cracking, rutting, spalling, etc.) that are present in the pavement.

Pavement Condition

The range for the condition score is 0 –20 with 20 indicating pavement in perfect condition. The first table shows the pavement condition score for National Highway System roadways and non- National Highway System roadways and the classification of the pavement condition (“good”, “fair”, “poor”, etc.) The relationship between pavement condition and the planning framework prioritization score (percent of Total Point Value) is shown in the last column of the table.

Table 4-2
National Pavement Condition Scoring

Condition Classification	Condition Score		Score (% TPV)
	NHS	Non-NHS	
Very Good	18.9 - 20	18.9 - 20	0%
Good	17.8 - 18.8	17.7 - 18.8	25%
Fair	16.4 - 17.7	15.9 - 17.6	50%
Poor	15.3 - 16.3	14.3 - 15.8	75%
Very Poor	0 – 15.2	0 - 14.2	100%

Pavement Smoothness

Smoothness is measured by the International Roughness Index (IRI). The IRI varies from approximately "0" to "300", with "0" indicating a perfect roadway. The measurement for IRI used and how the ratings are scored in the prioritization process is shown in the table below.

Table 4-3
Smoothness Rating

Smoothness Rating	IRI	Score (% TPV)
Very Good	< 60	0%
Good	60 – 94	25%
Fair	95 – 170	50%
Mediocre	171 – 220	75%
Poor	> 220	100%

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 at specific locations such as Interstate ramps, signalized intersections and bridges. Congestion in the metro area lasts less than 30 minutes in the morning and evening.

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 in unable to flow freely, often times because of accidents 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 trips by time of day, travel purpose
   Delay added to average person trip by place of residence
   Delay to transit vehicles Number of accidents 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

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

Level of Service A describes primarily free flowing operations at average travel speeds, usually about 90 percent of the free flow speed for the arterial class. Vehicles are completely unimpeded in their ability to maneuver within the traffic stream. Stopped delay at signalized intersections is minimal.

Level of Service B represents reasonably unimpeded operations at average travel speeds, usually about 70 percent of the free flow speed for the arterial class. The ability to maneuver within the traffic stream is only slightly restricted and stopped delays are not bothersome.

Level of Service C represents stable operations. However, ability to maneuver and change lanes in mid-block locations may be more restricted than in LOS B, and longer queues and/or adverse signal coordination may contribute to lower average travel speeds of about 50 percent of the average free flow speed for the arterial class.

Level of Service D borders on a range on which small increases in flow may cause substantial increases in approach delay and, hence, decreases in arterial speed. This may be due to adverse signal progression, inappropriate signal timing, high volumes, or some combination of these. Average travel speeds are about 40 percent of free flow speed.

Level of Service E is the point at which the roadway has reached its maximum capacity. Traffic operations are unstable, speeds and flow rates fluctuate, and there is little independence for driver speed selection or maneuvering.

Level of Service F characterizes forced flow at extremely low speeds below one-third to one-quarter of the free flow which will drop to zero at times. Intersection congestion is likely at critical signalized locations, with high approach delays resulting. Adverse progression is frequently a contributor to this condition.

Transportation Demand Management. Transportation demand management (TDM) 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 are available to reduce congestion and may include methods to increase vehicle occupancy and promote alternative modes of transportation. Approaches may include:

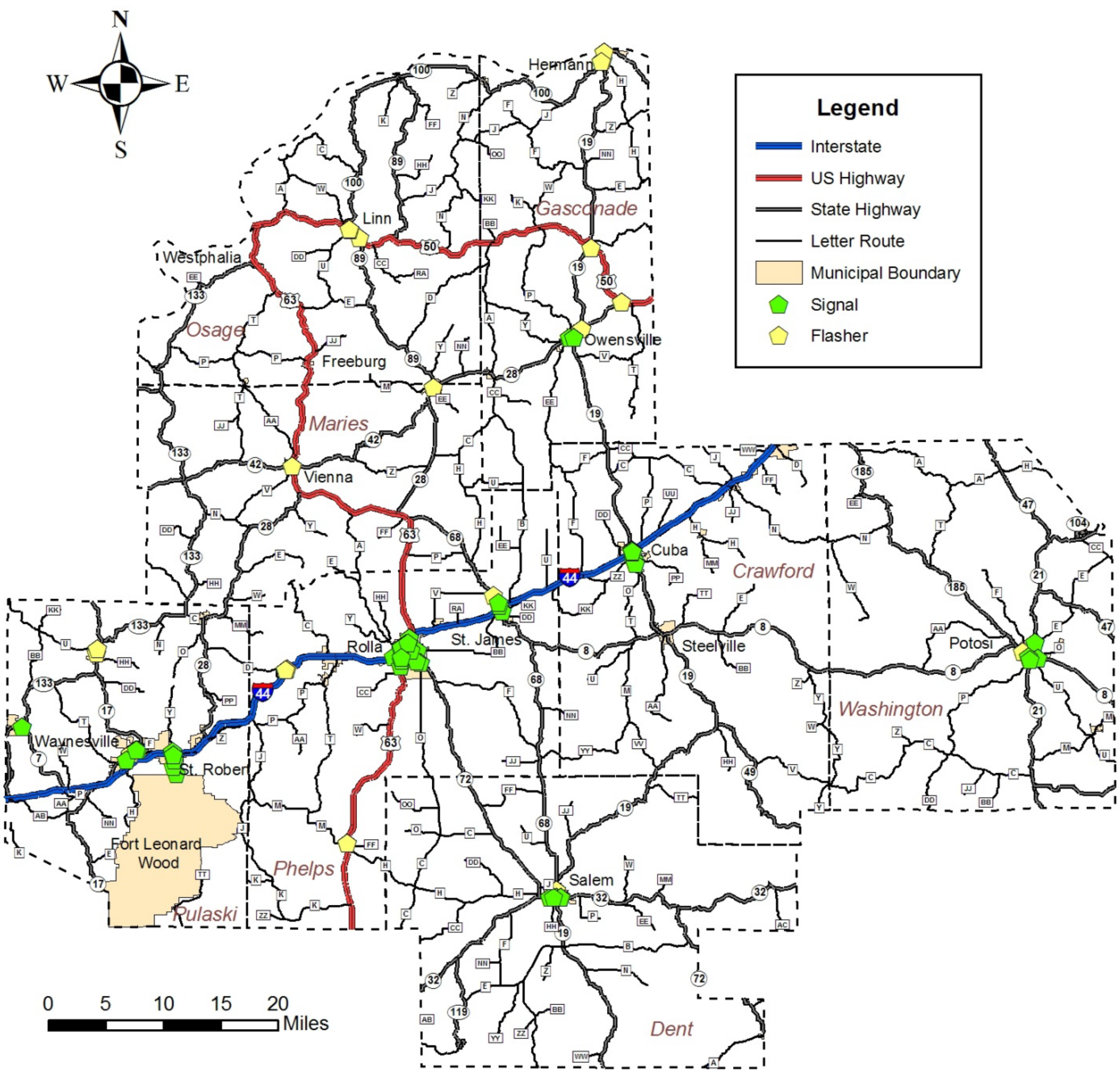
a. Ridesharing programs, local and regional
b. Transportation management associations which coordinate opportunities and incentives for shared travel, usually through employers or business associations.

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 are necessary to allow the safe movement of vehicles on and off a heavily traveled roadway or 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. There are three basic strategies available to contend with intersection delays; 1) construct a grade separated interchange, 2) construct a new roadway to divert traffic from the congested intersection, and 3) accept the delay and provide mitigation to improve safety and access.

MoDOT's Transportation Management System inventories the signalized intersections on the state's system. Signalized intersections in the Meramec Region are shown on Map 4. There are a total of 177 flashers and 169 signals in the Meramec Region, most of which are located along Interstate 44. *Map 4: Signalized Intersections* shows the location of these intersections.

Signalized Intersections



Meramec Region Regional Transportation Plan	Created by Meramec Regional Planning Commission 4 Industrial Drive St. James, MO 65559 in partnership with the Missouri Department of Transportation	Map 4
Signalized Intersections	To the best of the author's knowledge the data presented here is true and correct. However, no responsibility is assumed by the author.	June 30, 2006

Billboard Management. TMS was approached in 1999 to develop an application that would automate the process used to locate and maintain data on billboards. While not in the original scope of development, it was determined that a generic features application could be developed that could then be used for other similar types of information. This application was highly successful for billboards, handling all their data needs, integrating their system with FMS and automating the billing process.