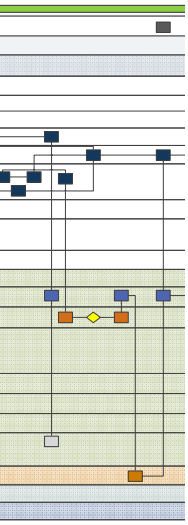
TRANSPORTATION SYSTEMS MANAGEMENT AND OPERATIONS (TSMO)



WACO DISTRICT PROGRAM PLAN

December 2020

Texas Department of Transportation

Document Control

Date	Version	Description
November 11, 2020	1.0	Draft Transportation Systems Management and Operations Program Plan
November 30, 2020	1.1	Draft-Final Transportation Systems Management and Operations Program Plan
December 14, 2020	Final	Final Transportation Systems Management and Operations Program Plan

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List of Acronyms

AASHTO	American Association of State Highway and Transportation Officials
AIMHigh	Austin area Incident Management for Highways
ATMS	Active Traffic Management Systems
BP	Business Processes
CCTV	Closed Circuit Television Camera
CMF	Capability Maturity Framework
CMM	Capability Maturity Model
CO	Collaboration
CRIS	Crash Records Information System
CU	Culture
DMS	Dynamic Message Sign
DOT	Department of Transportation
DPS	Department of Public Safety
DSR	Design Summary Report
FAST	Fixing America's Surface Transportation Act
FHWA	Federal Highway Administration
HERO	Highway Emergency Response Operator
ITS	Intelligent Transportation System
MAP-21	Moving Ahead for Progress in the 21st Century Act
MPO	Metropolitan Planning Organization
NEMA	National Electrical Manufacturers Association
OW	Organization and Workforce
PM	Performance Measurement
PSE	Planned Special Event
RWM	Road Weather Management
SEA	Systems Engineering Analysis
ST	Systems and Technology
TM	Traffic Management
TIM	Traffic Incident Management
TMC	Traffic Management Center
TMS	Traffic Management Systems
TRF	Traffic Safety Division
TSDC	Texas State Data Center
TSM	Traffic Signal Management
TSMO	Transportation Systems Management and Operations
TTI	Texas Transportation Institute
TxDOT	Texas Department of Transportation
UTP	Unified Transportation Plan
WZM	Work Zone Management

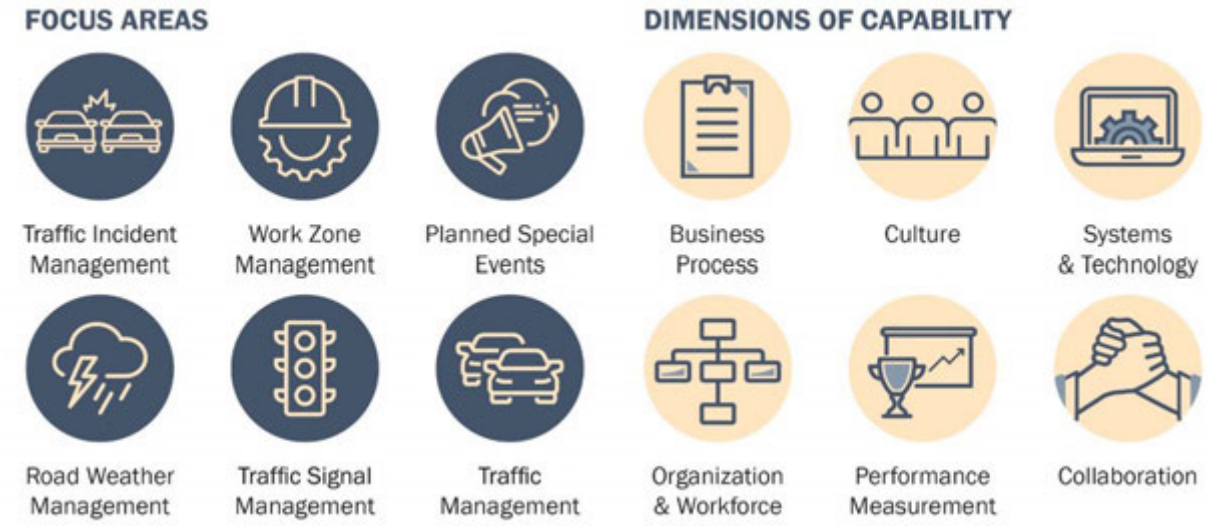
Executive Summary

What is a TSMO Program Plan?

Transportation Systems Management and Operations (TSMO) is an approach to improve mobility for all modes of transportation. TSMO uses integrated strategies that are designed to optimize the performance of existing infrastructure by preserving capacity and improving the security, safety, and reliability of the transportation system. The TxDOT Waco District has developed this TSMO Program Plan to identify actions that District staff can implement over the next five years to improve traffic operations.

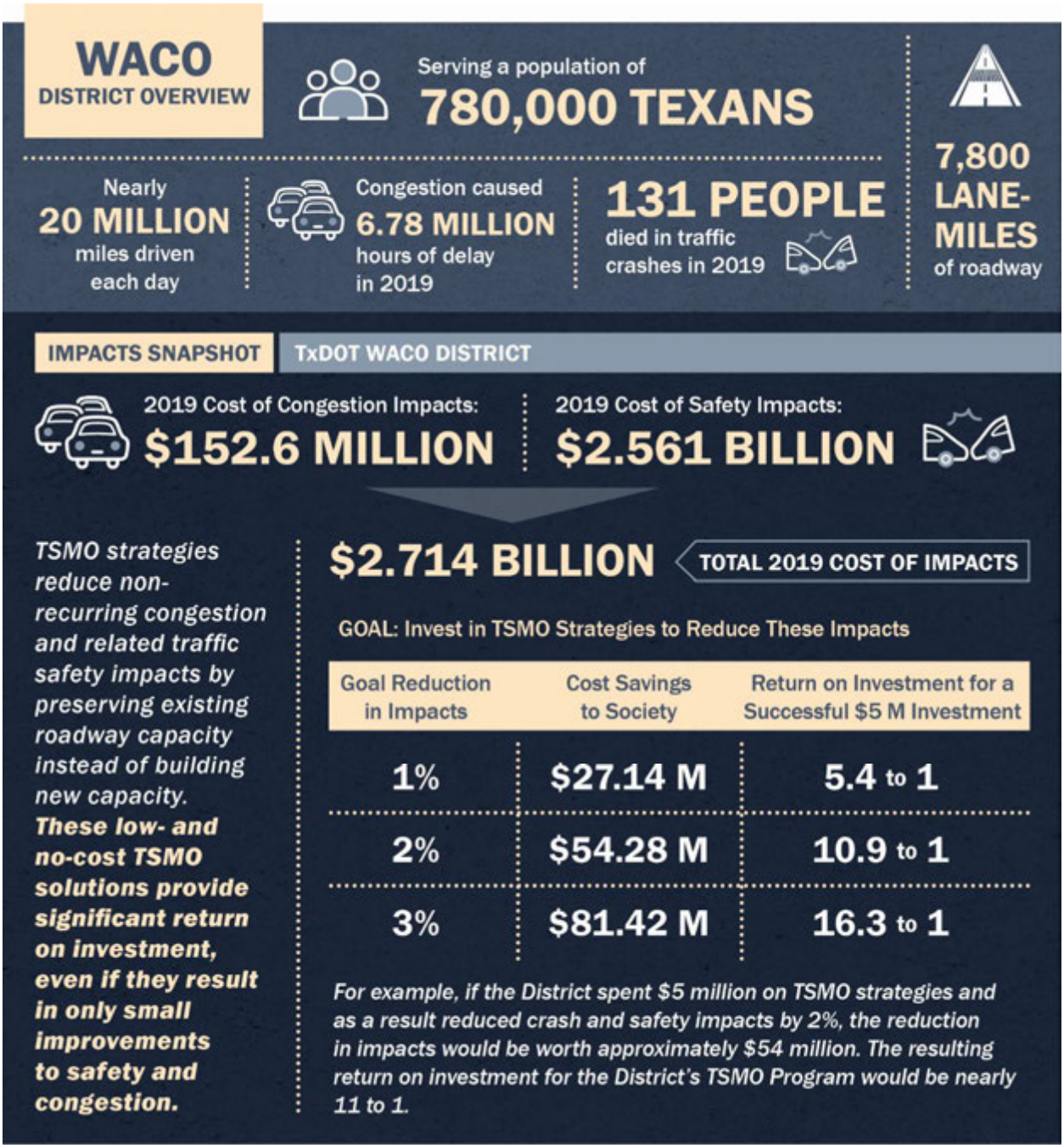
Stakeholder engagement for this TSMO Program Plan effort began in December 2019 and included outreach to District staff, local city, and county partners in traffic engineering and emergency response, both Metropolitan Planning Organizations (MPOs) within the TxDOT Waco District, and Fort Hood. Each phase of stakeholder engagement is summarized in the timeline below.

To develop this plan, the TxDOT Waco District reviewed existing data and engaged with both internal and external stakeholders through a series of meetings and workshops to identify strengths and needs related to six TSMO **Focus Areas.** From these strengths and needs, the TxDOT Waco District identified and refined a list of potential action items that could be implemented to build on existing strengths and address ongoing needs. These action items were grouped into six TSMO **Dimensions of Capability.** These TSMO focus areas and dimensions of capability are listed in the figure below.



Why Invest in TSMO Actions?

A review of congestion and safety impacts in the TxDOT Waco District revealed that traffic and crashes within the District's boundaries cost travelers more than $2.5 billion in 2019. TSMO actions have been proven to reduce congestion and crash rates at levels of investment far lower than would be required for capacity-building projects. The primer below shows how investing in TSMO actions to reduce these societal costs can provide a significant return on investment for the TxDOT Waco District. More detail is provided in the **Business Case for TSMO** section of this TSMO Program Plan.



How Should the District Invest in TSMO?

More than 30 action items to advance TSMO were identified for the TxDOT Waco District. Of these action items, there were ten identified as the highest priority that will provide significant return on investment. These action items are related to General Traffic Management, Traffic Incident Management, and Traffic Signal Management. The action items are described below and should serve as starting points for the District's TSMO activities over the next five years, with more detailed guidance found on the page numbers provided. A full list and detailed discussion of recommended action items is shown in the **TSMO Implementation Plan** section of this TSMO Program Plan.

Key Recommended TSMO Actions that Support General Traffic Management

The action items listed in the table below support the TxDOT Waco District's efforts to improve the active management of traffic along freeways and other key arterial routes within the District boundary.

Action No.	Key General Traffic Management Action Item Descriptions	Report Page #	TSMO Capability Dimension
ST-03	**Establish a Regional TMC:** Establish a regional Traffic Management Center (TMC) to support traffic incident management, traffic signal management, traveler information dissemination, and other traffic management priorities.	59	
ST-12	**Plan and Implement Upgrades to ITS Field Devices:** Develop a comprehensive implementation plan to identify and prioritize locations for new ITS deployments and to replace ITS devices approaching the end of their design life.	63	
CO-04			

Key Recommended TSMO Actions that Support Traffic Incident Management

The action items listed in the table below support the TxDOT Waco District's efforts to improve transportation incident management (TIM) and provide safe, quick clearance of traffic incidents that occur within the District.

Action No.	Key Traffic Incident Management Action Item Descriptions	Report Page #	TSMO Capability Dimension
ST-02		58	
OW-01	**Establish Recurring Regional TIM Training:** Partner with TxDOT Statewide Traffic Incident Management Coordinator to establish recurring regional TIM training in a multidisciplinary setting.	69	
CO-01			

Key Recommended TSMO Actions that Support Traffic Signal Management

The action items listed in the table below support the TxDOT Waco District's efforts to improve the management of traffic signal systems within the District boundary.

Action No.	Key Traffic Signal Management Action Item Descriptions	Report Page #	TSMO Capability Dimension
ST-01		57	
ST-10	**Implement Safety-Focused Signal Upgrades:** Implement signalized intersection safety upgrades recommended in District Safety Plan and encourage local partners to pursue similar upgrades.	62	
OW-02			
CO-03	**Conduct Quarterly Signal Technician Forums:** Conduct quarterly signal technician forums to improve collaboration, share best practices, and establish a regional competency regarding signal maintenance and operations.	73	

Which TSMO Actions Would Benefit from Further Development?

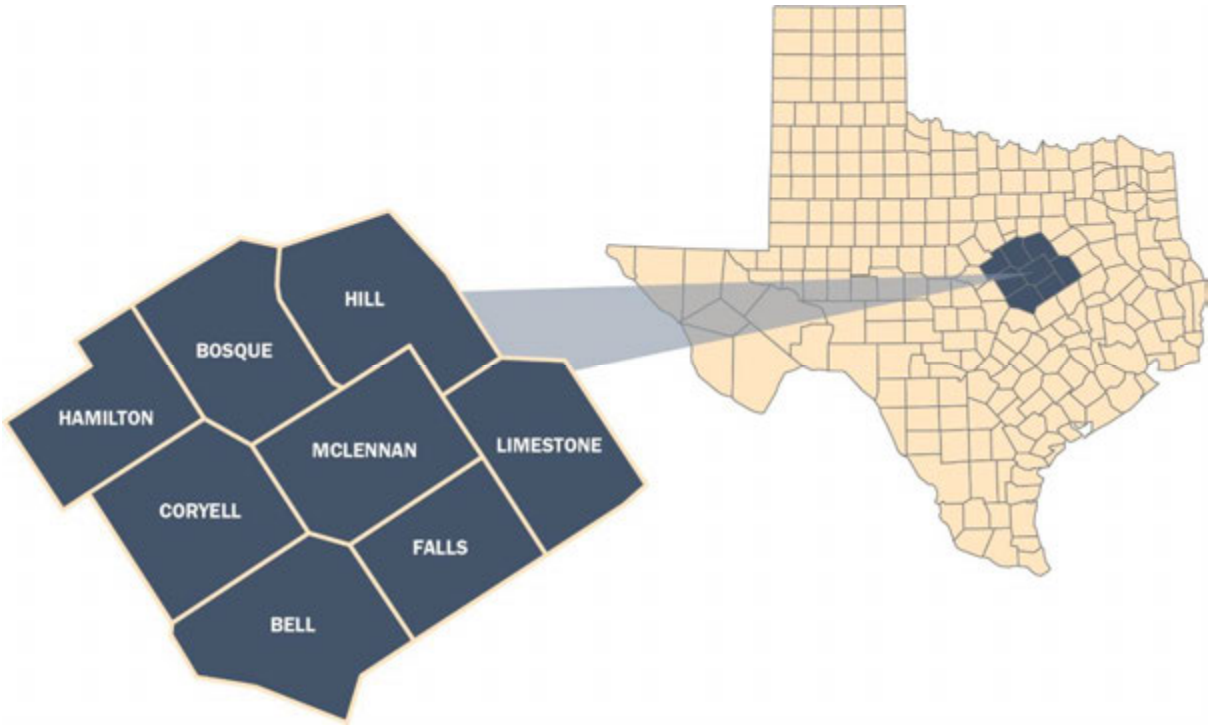
Tactical plans provide a focused look at how to implement key action items. The TSMO Program Plan identifies several recommended Tactical Plans to support priority action items. Recommended Tactical Plans considered the highest priority for the TxDOT Waco District are plans related to the Regional TMC, Safety Service Patrol Deployment, and District ITS Device Deployment. Addition information on these potential Tactical Plans, including key deliverables, is included in the table on the next page. A full list of potential tactical plans is shown in the **TSMO Tactical Plan Assessment** section of this TSMO Program Plan.

Potential Tactical Plan (with Deliverables Listed Below)	Key Internal and External Partners	Expected Return on Investment for District
Regional TMC Concept Development - Concept of Operations and Systems Engineering Analysis - Phased Staffing Plan - TMC Device Testing and Verification Plan	WAC District Engineer, WAC Operations Department, Local Transportation Agencies, Local Public Safety Agencies	**Highest**
Safety Service Patrol Deployment - Concept of Operations and Phased Deployment Plan	WAC District Engineer, WAC Operations Department	**Highest**
District ITS Device Deployment - TxDOT WAC District ITS Master Plan - Regional Signal Corridor Plan	WAC District Engineer, WAC Operations Department, WAC Construction Department, Local MPOs, Local Transportation Agencies	**Highest**

Introduction

The TxDOT Waco District, shown in Figure 1, is developing and implementing a Transportation Systems Management and Operations (TSMO) program. TSMO is an approach to improve mobility for all modes of transportation using integrated strategies that are designed to optimize the performance of existing infrastructure. TSMO achieves this optimization by preserving capacity and improving the security, safety, and reliability of the transportation system.

Figure 1: TxDOT Waco District Map



TSMO is defined specifically in federal legislation, including the Moving Ahead for Progress in the 21st Century Act (MAP-21), as well as the Fixing America's Surface Transportation (FAST) Act. Many state departments of transportation (DOTs) across the United States have developed or are in the process of developing Statewide TSMO plans to improve the operational efficiency of their respective transportation networks. In Texas, TxDOT developed a Statewide TSMO Strategic Plan in 2018 that identifies statewide goals, objectives and strategies for advancing TSMO in Texas.

In comparison to other state DOTs, TxDOT is largely decentralized. Each of TxDOT's 25 districts has a unique set of operational challenges and constraints. As a result, in addition to the Statewide TSMO Strategic Plan each TxDOT district is developing its own TSMO Program Plan which will reference and conform to the Statewide TSMO Strategic Plan and related guidance that was finalized by the TxDOT Traffic Safety Division (TxDOT TRF) in 2018. Even with consistency across each of the District TSMO plans, the business case, roles and partnering approaches, and implementation strategies will be uniquely tailored to the individual district's transportation challenges and needs.

The Federal Highway Administration (FHWA) generally recommends that state DOT TSMO planning elements include the three levels of planning components listed below. This report corresponds to the second level of TSMO planning in this hierarchy:

1. TSMO Strategic Plan/Guidance – This plan is statewide in scope. It provides the overarching statewide vision and strategy for TSMO, and it establishes a framework for each TxDOT district to conduct its own TSMO program planning efforts.
2. TSMO Program Plan – This plan is developed for a specific TxDOT district or region within a state. In Texas, a TSMO Program Plan will be developed for each TxDOT district. A district's TSMO Program Plan defines the goals, resources, performance measures, and institutional arrangements that will enhance traffic operations in the respective district.
3. TSMO Tactical Plans – Tactical Plans are developed for a specific operational focus area within a district. The TSMO Program Plan may include recommendations to develop one or more TSMO Tactical Plans. These plans include a deeper analysis of current strengths and opportunities to improve a specific operational focus area such as Work Zone Management (WZM), Traffic Incident Management (TIM), Road Weather Management (RWM). Tactical Plans function as deployment plans by providing additional details, responsibilities, and cost estimates to further the integration and prioritization of specific mobility strategies with existing district efforts.

The TxDOT Statewide TSMO Strategic Plan was completed in 2018 as the first component of the TxDOT TSMO planning initiative. TSMO activities have been taking place throughout the state on an ad-hoc basis for decades. The TxDOT Statewide TSMO Strategic Plan defines processes to conduct TSMO consistently across the state. It also identifies the roles and responsibilities of each TxDOT Division and of individual TxDOT Districts for implementation of a statewide TSMO program.

Following the development of this framework, the second component of the TxDOT TSMO planning initiative is to develop district-level TSMO program plans. The Austin District was the first of the 25 TxDOT districts to develop a TSMO Program Plan, which was completed in June 2018. All other TxDOT districts began development of their TSMO Program Plans in 2019 and 2020. Each District's TSMO Program Plan focuses on strategies that can be implemented within the next five years, after which the Program Plan should be updated to assess progress and to identify new focus areas and strategies. Potential TSMO Tactical Plans will be identified for the TxDOT Waco District as a part of this TSMO Program Plan. The structure of the TxDOT Waco District TSMO planning initiative is shown in Figure 2.

Figure 2: Waco District TSMO Structure

The development of the TxDOT Waco District TSMO Program Plan involved individual agency outreach meetings and group workshops with both internal TxDOT stakeholders and external local and regional agency partners such as city transportation staff, law enforcement and emergency response officials, and staff from neighboring TxDOT districts. These partners were asked to provide initial input on regional operational challenges, to give feedback on existing regional capabilities to address those challenges, and to participate in work sessions to develop strategies to improve those regional capabilities. The stakeholder engagement timeline for this effort is shown below in Figure 3, and a detailed list of participants is included in Appendix A. Due to travel restrictions related to the COVID-19 pandemic, all outreach completed after February 2020 was conducted virtually.

Figure 3: Waco District TSMO Stakeholder Engagement Timeline

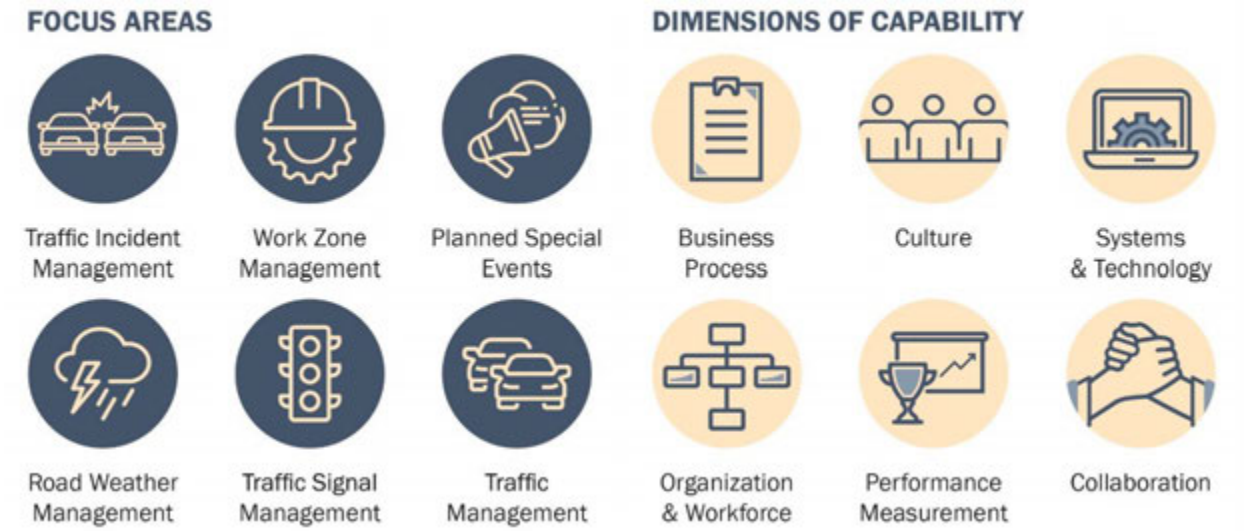
Program Plan Format

Following this section, the TxDOT Waco District TSMO Program Plan establishes a business case for adopting TSMO priorities throughout the District. This business case reviews available district metrics on congestion and safety to assess existing societal costs related to delay and crashes within the district, respectively. This information is analyzed alongside available funding sources for the district and a discussion of some of the regional operational challenges that TxDOT Waco District staff and external partners identified. Finally, the business case describes how TSMO strategies might reduce societal costs and address funding and operational challenges that the TxDOT Waco District has identified as a priority.

The following section introduces the Statewide TSMO Vision and Mission, both of which were developed as part of the 2017 TxDOT TSMO Strategic Plan. The section then lists the TSMO goals and objectives that were specifically developed for the TxDOT Waco District as part of this program planning process.

The sections titled Capability Maturity Model (CMM) and District Response to Operational Challenges provide an overview of the self-assessment process and the assessment results that TxDOT Waco District and partner agency stakeholders reported for six standard capability dimensions: Business Processes, Systems and Technology, Performance Measurement, Culture, Organization and Workforce, and Collaboration. The sections describe how each of these results and related stakeholder feedback showed the TxDOT Waco District's existing capabilities in responding to six of the most typical TSMO focus areas: Traffic Management (TM), Traffic Signal Management (TSM), Road Weather Management (RWM), Work Zone Management (WZM), Planned Special Events (PSE), and Traffic Incident Management (TIM). These capability dimensions and focus areas are shown below in Figure 4. The icons shown below are used to relate the recommended action items to each TSMO capability dimension and focus area.

Figure 4: TSMO Focus Areas and Dimensions of Capability



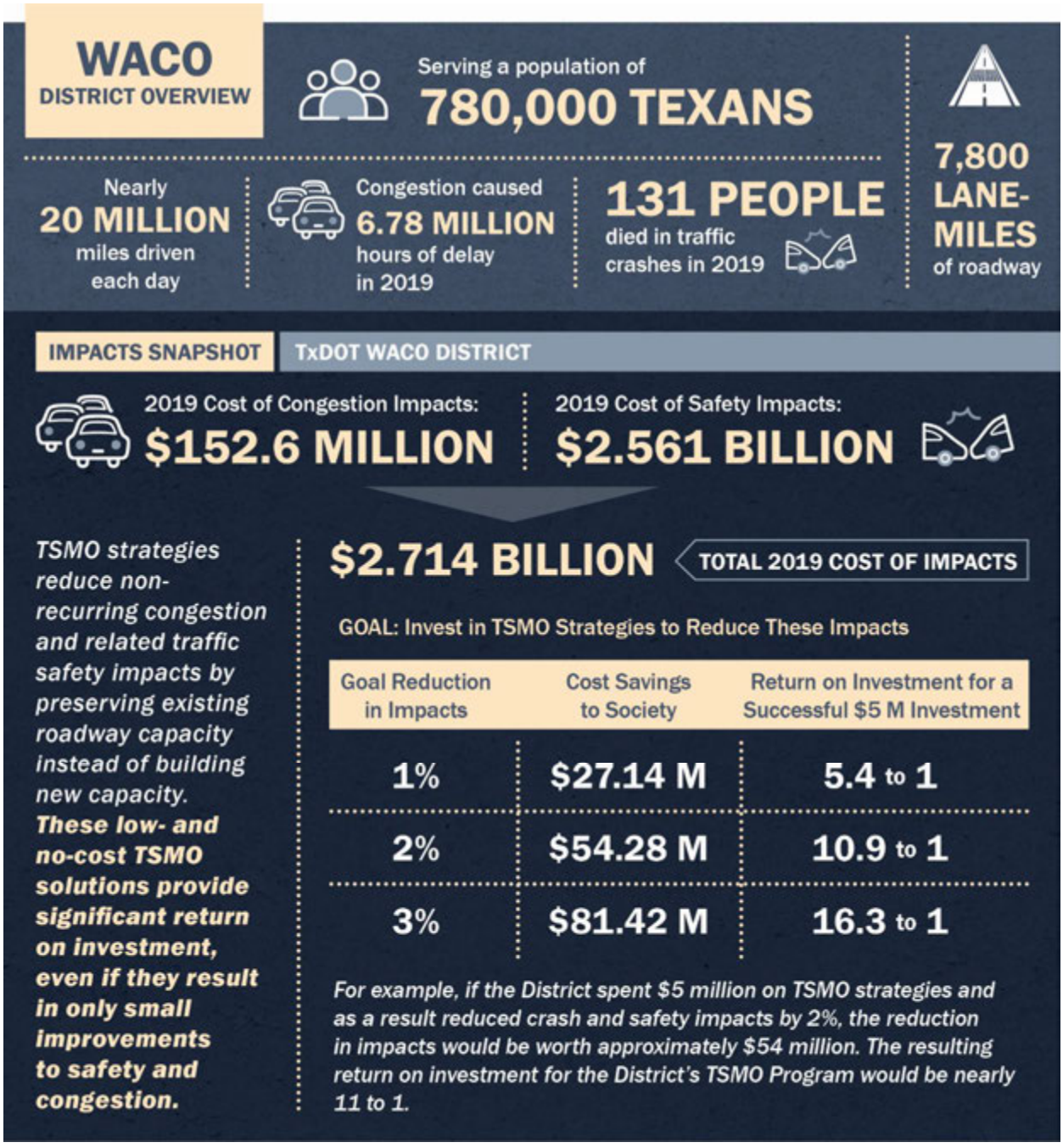
The results of the CMM process feed into the TSMO Implementation Plan, which provides an implementation schedule of recommended TSMO action items for the TxDOT Waco District to undertake for the next five years. The Implementation Plan also includes detailed descriptions of TSMO action items and relevant case studies of best practices from other TxDOT districts and state DOTs. The final component of the TSMO Implementation Plan section includes several implementation roadmaps that briefly outline how sets of related action items included within the document might be implemented in a deliberate and organized manner.

Lastly, focus areas and action items that would benefit from further planning or program development are described in the TSMO Tactical Plan Needs Assessment section. Report references and appendices are included at the end of the document.

Business Case for TSMO

Figure 5 below summarizes the business case for investing in TSMO strategies in the Waco District. A more detailed analysis and discussion is provided on the following pages.

Figure 5: TxDOT Waco District Overview and TSMO Impacts Snapshot



Funding Impacts

The number of people living in Texas has increased by more than 15 percent in the last ten years. Adding transportation network capacity and optimizing available funding have become increasingly challenging as the population of Texas continues to grow. As a result, TxDOT has emphasized transitioning transportation funding and resources from conventional capacity-adding methods to a focus on managing and operating the transportation network through investing in technology and Traffic Management Systems (TMS), as well as leveraging resources among regional partner agencies and private sector data providers.

The 2050 Texas Transportation Plan goal to **Sustainably Fund and Effectively Deliver the Right Projects** corresponds closely with addressing funding challenges using TSMO strategies.

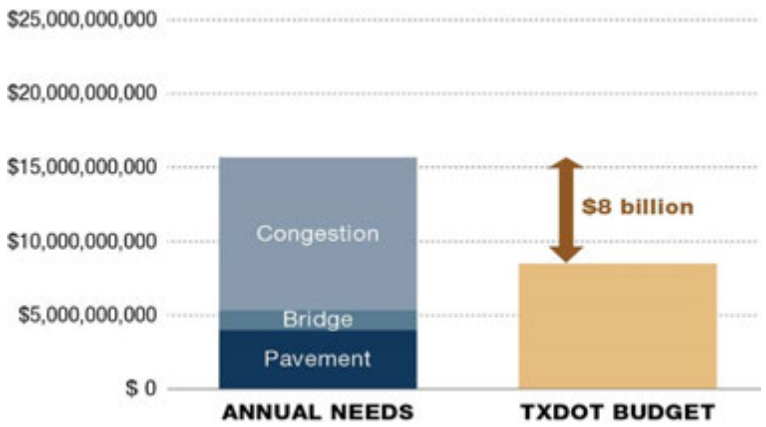
TxDOT Goal: Sustainably Fund and Effectively Deliver the Right Projects

Detailed objectives include:

- Reduce user costs
- Identify and maintain reliable funding
- Improve analytic capabilities to maximize the value of investments
- Fairly distribute transportation benefits and costs
- Strategically deploy innovative technology to increase effectiveness and efficiency of the system (keeping pace)

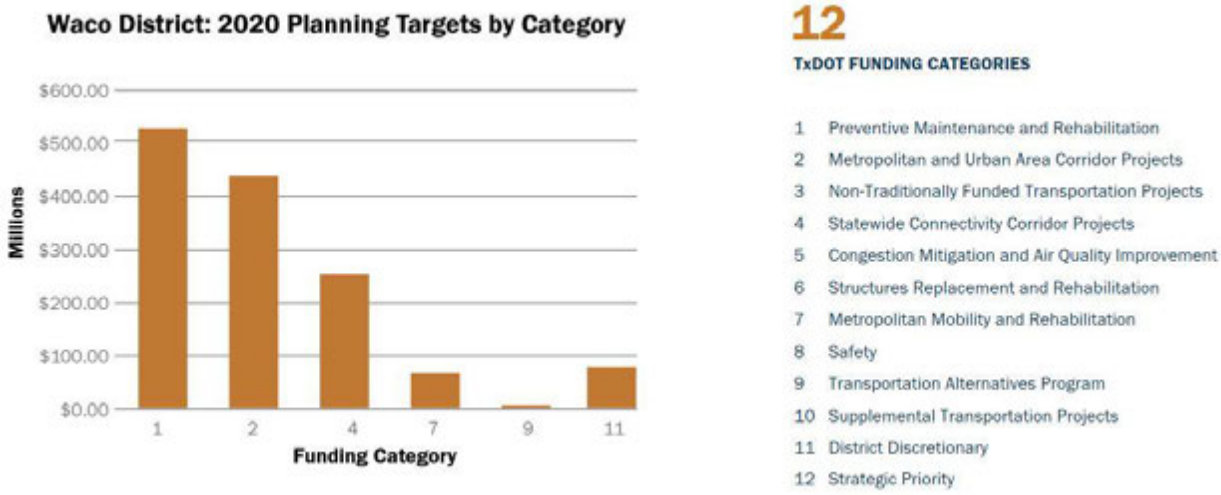
FHWA studies have shown that operational improvements to increase mobility typically have a higher benefit-cost ratio than infrastructure projects to build additional lane miles of capacity, especially when life-cycle costs are considered for both project types. With transportation demand growing, integrating TSMO into existing TxDOT Waco District processes will help TxDOT staff identify and prioritize cost-efficient operations and systems management methods to improve system reliability and safety, thus optimizing available capacity. TSMO will support projects that can bridge the gap between existing needs and available funding. This existing $8 billion annual gap is shown in Figure 6, which is taken from the 2040 Texas Transportation Plan. [1]

Figure 6: TxDOT Annual Transportation Needs and Budget



The Texas 2020 Unified Transportation Program (UTP) established a planning target of $1,179,020,000 in project funding for the TxDOT Waco District over the next 10 years.[2] The UTP also established a planning target of an additional $209,600,000 in project funding for the Waco Metropolitan Planning Organization (MPO) and $291,720,000 in project funding for the Killeen-Temple Transportation Management Area over the next 10 years.[2] A breakdown of these planning targets over the next 10 years for the TxDOT Waco District from the UTP is shown in Figure 7. Note that additional MPO target funding amounts are not included in this figure.

Figure 7: TxDOT Waco District 10-Year Planning Targets by Category



Based on these planning targets, both preventive maintenance and rehabilitation as well as metropolitan and urban area corridor projects are key investment areas that the TxDOT Waco District will focus on over the next 10 years. TSMO strategies can be applied to both investment areas, and especially to improvements focused on metropolitan and urban area corridor projects. Several of the key projects related to these investment areas are:

- IH 35 – Reconstruct Freeway – McLennan County
- SL 340 - Widen Non-Freeway - McLennan County
- IH 35 - Widen Freeway - Bell County
- US 190 Bypass – Widen Non-Freeway - Bell County
- I-14/US 190 - Widen Freeway - Bell County
- SH 6 – Widen Non-Freeway - Bosque County

Agencies that place importance on TSMO in long-range planning, project development, system completion, and system maintenance have a strong basis for devoting funding to these strategies because operations and management activities can improve congestion while minimizing or delaying the need for physical capacity improvements. Through TSMO planning, funding is reserved to include TMS in conventional construction, asset management techniques, upgrades to existing infrastructure, workforce resources, and other operational strategies.

Congestion Impacts

The 2050 Texas Transportation Plan goal to **Optimize Movement of People and Goods** can be addressed using TSMO strategies.

TxDOT Goal: Optimize Movement of People and Goods

Detailed objectives include:

- Reduce congestion through both traditional and alternative strategies
- Improve travel time reliability
- Increase travel options and connections across modes
- Ensure freight can move efficiently
- Increase access to jobs, services, and activity centers
- Leverage transportation assets to support economic growth and vitality

TSMO planning identifies strategies beyond typical capacity enhancements that reduce congestion. Since TSMO strategies are mostly focused on non-recurring congestion, they are typically more effective at improving travel time reliability when compared to capacity enhancements.

Quantifying Congestion-Related Impacts

The Texas State Data Center (TSDC) reports the population of the TxDOT Waco District has increased by 9 percent since 2010.[3] TSDC projects that the population will continue to increase by approximately 15 percent over the next 20 years.[3] In addition to local commuters, the City of Waco, TX is visited by an estimated 2.4 million tourists annually.[4] As annual vehicle miles traveled continue to increase, congestion will grow unless innovative, proactive actions are taken.

One of the keys to maintaining economic vitality within the TxDOT Waco District is effective management of commute times. The United States Census Bureau tracks average commute time data through its Journey to Work questionnaire as part of the American Community Survey. Over the past ten years, the average commute time for residents of Bell, Coryell, and McLennan counties within the TxDOT Waco District has increased by 5 percent, from 19.52 minutes to 20.43 minutes.[5]

One potential cause of an increase in average commute times is an increase in traffic congestion within the TxDOT Waco District. In 2019, the Texas Transportation Institute (TTI) estimated an annual total delay of approximately 6,783,734 passenger-hours along major thoroughfares within the district. This total is inclusive of an estimated annual freight vehicle delay of 593,924 driver-hours along those same major thoroughfares. Using state-specific user cost values, this congestion resulted in a societal cost of $152,634,000 within the TxDOT Waco District in 2019.[6]

TSMO allows for the inclusion of operations strategies that result in the improved management of incidents, work zones, weather events, and planned special events, thereby reducing the congestion impacts and related societal costs of these interferences on the transportation network.

Safety Impacts

The 2050 Texas Transportation Plan goal to **Enhance Safety** corresponds with many TSMO strategies.

TxDOT Goal: Enhance Safety

Detailed objectives include:

- Design and build infrastructure to reduce crashes and lessen crash severity
- Improve incident response times
- Promote safe driving, bicycling, and pedestrian activities
- Enhance coordination with first responders

TSMO planning identifies technologies or systems that can be incorporated into existing or planned infrastructure to improve the safety of road users, whether they be drivers, cyclists, or pedestrians. In addition to the objectives outlined in the 2050 Texas Transportation Plan, the Texas Transportation Commission adopted a Road to Zero Goal in 2019. The goal is the elimination of all deaths on Texas roadways by 2050, with a midway goal of halving the number of deaths on Texas roadways by 2035. The implementation of TSMO strategies will be essential in reducing and eventually eliminating the number of deaths on Texas roadways.

Quantifying Safety-Related Impacts

In 2019, there were 16,139 reported crashes in the TxDOT Waco District.[7] In those crashes, 131 people died and 482 people suffered an incapacitating injury. A summary of 2019 crashes in the TxDOT Waco District, including the count of certain crash types that could be targeted by strategies related to a TSMO focus area, is shown below in Table 1. Using state-specific user cost values, these crashes and associated damages resulted in a societal cost of $2,560,900,000 within the TxDOT Waco District in 2019.[8]

Table 1: 2019 Summary of Crashes by Type Within the TxDOT Waco District

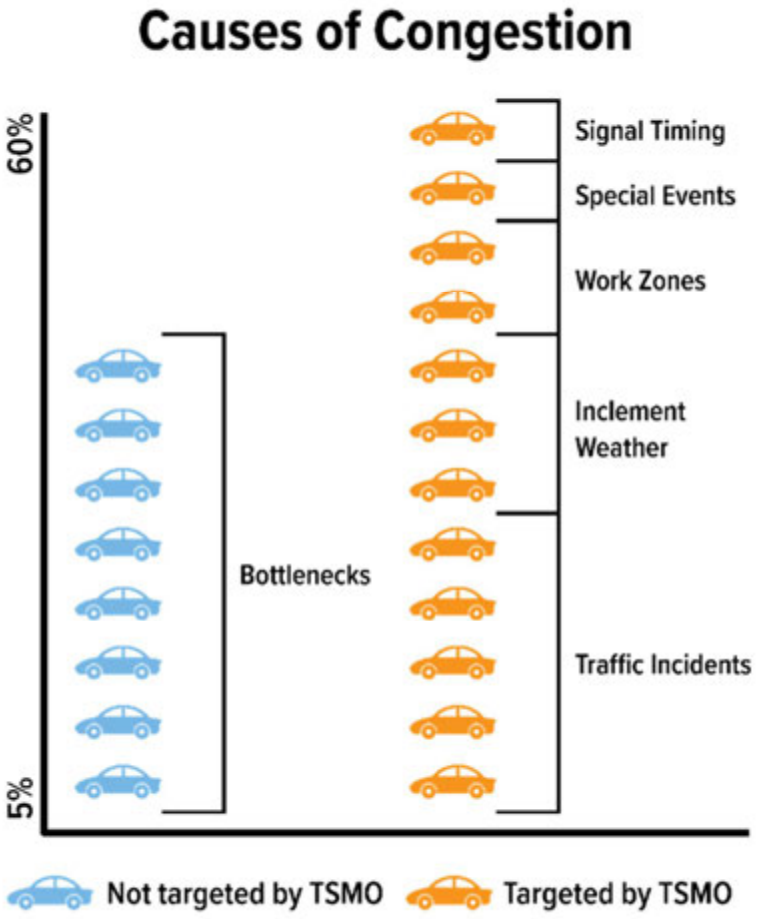
	Fatal (K)	Serious Injury (A)	Minor Injury (B)	Possible Injury (C)	No Injury (O)	Unknown Severity
Total Crashes	117	389	1876	2643	10216	898
Total Persons Affected	131	482	2563	4159	31808	898
Inclement Weather - Rain or Fog	16	31	172	278	1307	48
Inclement Weather - Winter	0	1	3	10	52	3
Work Zone Crashes	7	27	148	225	909	14
Intersection Crashes	16	123	755	1051	3269	87
Commercial Vehicle Crashes	18	34	117	157	948	16

When TSMO activities are considered in project development, such as during planning for roadway maintenance, solutions to improve safety for all modes of transportation can be identified and implemented. Furthermore, TSMO strategies aimed at reducing non-recurring sources of congestion and improving traveler information can improve driver expectancy and improve driver awareness of conditions that increase their crash risk when on the road. Finally, TSMO strategies can help protect those who spend time working in the roadway, including TxDOT employees and contractors, public safety officers, and emergency responders.

The Value of Mainstreaming TSMO

The business case for TSMO is grounded in the fact that funding for the TxDOT Waco District to solve existing congestion challenges through capacity enhancements alone is not readily available. FHWA congestion research shows that most of the congestion that road users experience in the United States is not a result of capacity bottlenecks. Instead, most congestion occurs due to non-recurring shocks to the network such as traffic incidents, inclement weather, or work zones. FHWA's breakdown of these congestion sources is shown below in Figure 8 at a nationwide level.[9]

Figure 8: Nationwide Causes of Congestion



TSMO strategies integrate TMS into the planning, design, and construction of district facilities. TMS and TSMO strategies also allow for more nimble operation and maintenance of the facilities once they are constructed. Successful integration of TMS allows agencies who maintain the transportation network to respond more quickly and to better mitigate the adverse effects of many sources of non-recurring congestion, thereby reducing congestion and making roads safer.

Building the necessary infrastructure and maintaining it have historically been the core attributes of the planning process, while operating and managing the infrastructure have traditionally not been prioritized as highly. TSMO justifies investment in technology and TMS infrastructure to facilitate the integration of management and operations into the transportation system. Promoting and formalizing TMS deployment and maintenance ensures operational asset uptime, which in turn enables regional transportation agencies to provide greater traveler information, traffic incident management, road weather management, safer work zones, and more.

TSMO planning fosters the cultural shift required to prioritize the use and dedicated funding of operational improvements and TMS in project planning. Many agencies lack a well-defined plan of action on how to develop and sustain the processes and resources that support TSMO. All the while, congestion grows, funding becomes more limited, and roadway users increasingly expect innovative solutions for managing their travel. TSMO planning establishes a framework for performance measurement and continuous improvement to enhance safety and mobility throughout the district. Ultimately, this brings TxDOT closer to achieving the TxDOT mission statement: “Through collaboration and leadership, we deliver a safe, reliable, and integrated transportation system that enables the movement of people and goods.”

TSMO Vision, Mission, Goals, and Objectives

The TxDOT Waco District TSMO Program mission, vision, goals and objectives match the items developed for the statewide TxDOT TSMO Strategic Plan. TSMO leadership at the TxDOT Waco District determined that the District TSMO vision, mission, goals, and objectives should be the same as the statewide TSMO vision, mission, goals, and objectives. These items are listed below.

Statewide and District TSMO Vision

Improve safety and mobility for all modes of transportation by integrating planning, design, operations, construction, and maintenance activities and acknowledging all opportunities for innovation.

Statewide and District TSMO Mission

Through innovation, collaboration, and performance-based decision-making, transportation facilities are developed, constructed, maintained, and operated cost-effectively, with the end user in mind.

Statewide and District TSMO Goals and Objectives

The goals and objectives for the TxDOT Waco District TSMO Program Plan identified in Table 2 are based on the TxDOT statewide TSMO goals and objectives.

Table 2: TxDOT Waco District TSMO Program Plan Goals and Objectives

TxDOT Statewide and District TSMO Goals	TxDOT Statewide and District TSMO Strategic Objectives
Safety	Reduce crashes and fatalities through continuous improvement of traffic management systems and procedures.
Reliability	Optimize travel times on transportation systems in critical corridors to ensure travelers are reaching their destinations in the amount of time they expected for the journey.
Efficiency	Implement projects that optimize existing transportation system capacity and vehicular throughput.
Customer Service	Provide timely and accurate travel information to customers so they can make informed mobility decisions.
Collaboration	Proactively manage and operate an integrated transportation system through multi-jurisdictional coordination, internal collaboration, and cooperation between various transportation disciplines and partner agencies.
Integration	Prioritize TSMO as a core objective in the agency's planning, design, construction, operations, and maintenance activities.

Capability Maturity Model

A Capability Maturity Model (CMM) is a systematic methodology in which a program or organization is evaluated to determine a level of achievement for specific attributes. The American Association of State Highway Transportation Officials (AASHTO) adapted the CMM approach, originally developed for the information technology industry, so that it could be used to gauge a transportation agency's capabilities in addressing various operational challenges related to TSMO. The CMM is a self-assessment and relies on direct input from internal and external stakeholders to assess the strengths and weaknesses across a range of different program perspectives.

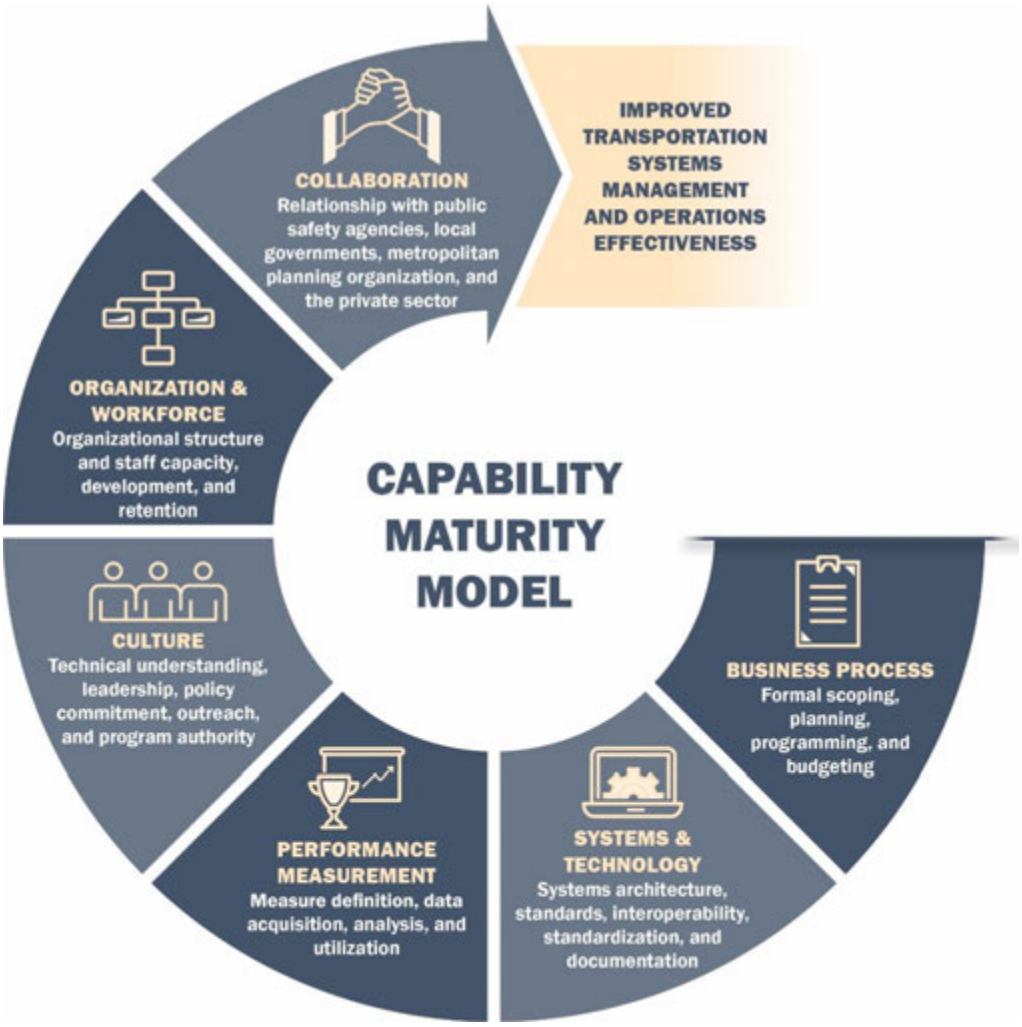
Dimensions of TSMO Capability

The CMM is based on the concept that there are six core areas, referred to as 'dimensions' that are critical for improving program efficiency and effectiveness. These dimensions, as well as processes and activities within TxDOT that correspond to each one, are shown below in Table 3 and on the next page in Figure 9.

Table 3: CMM Dimensions of TSMO Capability (Adapted from AASHTO)

CMM Dimension	Typical Related TxDOT Activities	
Business Processes	• Project Scoping • Planning	• Programming • Budgeting
Systems and Technology	• Systems Engineering • ITS Architectures	• Technology Interoperability • System Standardization
Performance Measurement	• Defined Measures and Targets • Performance Reporting • Data Acquisition	• Data Use • Informing Operations Decisions
Culture	• Technical Understanding • Leadership • Support for Improving Processes	
Organization and Workforce	• TSMO Program Status • Organizational Structure	• Training and Staff Development • Recruitment and Retention
Collaboration	• Relationships with: o Public Safety Agencies o Local Governments	• Relationships with: o Metropolitan Planning Organizations o Private Sector Providers

Figure 9: CMM Dimensions of TSMO Capability



TSMO Focus Areas

The AASHTO CMM assessed the TxDOT Waco District capabilities across the six dimensions listed in Table 3 for six different focus areas (often referred to as Capability Maturity Frameworks, or CMFs). These focus areas are:

- **Traffic Incident Management (TIM):** The institutional capability to detect, respond to, and clear traffic incidents so that normal operations can be restored safely and quickly.
- **Work Zone Management (WZM):** The institutional capability to assess and mitigate work zone impacts.
- **Road Weather Management (RWM):** The institutional capability to respond to adverse weather conditions through both maintenance and operations activities.
- **Planned Special Events (PSE):** The institutional capability to manage traffic impacts generated by events at permanent multi-use event venues, temporary venues, or ones that occur on the road network itself.
- **Traffic Signal Management (TSM):** The institutional capability to effectively design, operate, and maintain traffic signals.
- **Traffic Management (TM):** The institutional capability to manage the movement of traffic on roadways within a region, including through corridor management.

Introduction to the CMM Process

Each of the TSMO capabilities evaluated in the CMM assessment are classified as one of four levels of organizational maturity by stakeholders through a facilitated self-assessment process. The base level, or Level 1, is the Performed level. The top level, or Level 4, is the Optimized level. It is important to note that the levels are not grades, they merely reflect where the organization currently stands within a TSMO capability dimension.

As shown in Figure 10, Level 1, Performed, means the TSMO capability is completed on an ad-hoc basis, usually by one or two individual champions. Level 2, Managed, may involve more individuals on a team performing the activity and beginning to integrate into other processes; however, there is little accountability for achieving performance measures.

At Level 3, Integrated, the program dimension is part of a more formalized process, there are established performance measures, and activities are structured to work toward those performance objectives. At this stage, processes are more clearly defined and there is some recognized, organizational support for the activities, including budgets. When an organization has achieved Level 4, Optimized, the capability is largely institutionalized and formalized, with strong collaboration and recognition of roles and responsibilities by agency staff and partners. At this level, there is also a more formal commitment for performance-based improvements.

Each of the capabilities were evaluated for the TxDOT Waco District at a series of CMM virtual work sessions held with both TxDOT and partner agency staff in May 2020 via WebEx and Microsoft Teams. Capability responses were refined later through individual interviews with TxDOT staff. Figure 11 shows where the TxDOT Waco District ranked itself for each of the TSMO capabilities. Based on the CMM assessment, the District currently sees itself operating at CMM Level 2 in all CMM capabilities.

Figure 10: CMM Levels of Maturity

Figure 11: TxDOT Waco District CMM Assessment

Overall Capabilities				
TSMO Capability Dimensions	Level 1 – Performed	Level 2 – Managed	Level 3 – Integrated	Level 4 – Optimized
Business Processes		✓		
Systems & Technology		✓		
Performance Measurement		✓		
Culture		✓		
Organization & Workforce		✓		
Collaboration		✓		

Through outreach workshops, CMM workshops, and stakeholder interviews held throughout 2020, the TxDOT Waco District identified regional needs and assessed its CMM capabilities for each of the six TSMO capability dimensions. A discussion of the TxDOT Waco District's existing capabilities and needs with respect to each dimension is provided in the TxDOT Waco District State of Practice Report and in the following pages.

Business Processes

Business processes that support TSMO can vary from strategic items, like the development of agency-wide goals and objectives that focus on operations, to day-to-day items that focus on the formalization of ad hoc District activities and the development of documents such as ITS Master Plans and other project implementation documents.

Revised Project Delivery Process

Currently, the Waco District Traffic Operations group is involved in the statewide project delivery process through Design Summary Reports. The Design Summary Report (DSR) is meant to be a dynamic document throughout the project delivery timeline; it contains the record of project development and design. The DSR's goal is to ensure that the project team does not overlook potentially critical issues, which often includes traffic operations.

According to Waco Traffic Operations staff, the process does a sufficient job of catching and incorporating ITS devices, illumination, and other traffic operation items. In some cases traffic operation devices and infrastructure are not discussed or thought of initially for roadway projects. TxDOT engineers and consultants who work on these projects are primarily focused on their expertise and practice which is roadway design. Traffic Operations staff noted that the District's "Proposed Traffic Operations Elements" section could be more detailed and structured; the section is currently only a half-page of information and five total questions. There is a District desire to provide enhanced input, but action is limited due to workload levels of key staff and tight project schedules.

Planning for TSMO

The TxDOT Statewide TP&D Division emphasizes including traffic operations in planning phases of roadway projects. TP&D has partnered with the Waco District operations staff and reaches out on roadway projects to incorporate TSMO planning. The Design Summary Report's editability throughout the project allows District traffic operations staff to provide input. For example, during the Central I-35 project, Waco District staff requested that fiber be installed as part of the installation, and this request was accepted quickly and led to fiber being incorporated into the final design plans.

Effective planning for TSMO involves early identification and assessment of costs associated with deployment of technologies and services, which often includes infrastructure investments, technology purchases, staff time, and other resources. The District and state recognize the importance of planning TSMO into all projects at the earliest stage possible to account for all considerations.

Programming, Budgeting, and Funding

Each district is expected by TxDOT's Chief Engineer to ensure TSMO is included in all project planning, development, design, construction, maintenance, and operation. While statewide TSMO programming planning does occur, a greater amount of planning and budgeting takes place at the district or corridor level as evidenced by corridor projects. The responsibility falls on the districts to incorporate TSMO into their roadway and bridge project programming, budgeting, and funding. The TxDOT Waco District can use benefit-cost or other criteria analysis methods to support project prioritization and funding requests. The TxDOT Waco District currently is not experiencing programming or funding shortfalls on active projects for TSMO services or devices but there have been instances in the past where shortfalls occurred.

Continuous Improvement

Continuous Improvement can be reflected in incremental changes within the Waco District to incorporate TSMO practices and culture. Continuous improvement can be fostered by sharing information related to data collection and development of performance metrics. Improving communication and frequency of coordination with internal and external shareholders is a valuable way to ensure continuous improvement. Focusing on streamlining certain business processes can foster continuous improvement.

Systems and Technology

The systems and technology component of TSMO includes systems engineering, regional architecture, ITS procurement processes, and deployment of technology to support operations.

Systems Engineering Analysis Process

In relation to ITS, systems engineering assesses value, functionality, and life cycle of technologies incorporated into roadway and bridge projects. The Federal Highway Administration (FHWA) realized the benefit of using a systems engineering analysis (SEA) on ITS projects and, since 2001, requires that a SEA be performed on all federally funded ITS projects. States maintain flexibility in the extent of how they conduct SEA based on the project scope and scale of the project. US DOT policy specifies that the systems engineering process should include seven requirements:

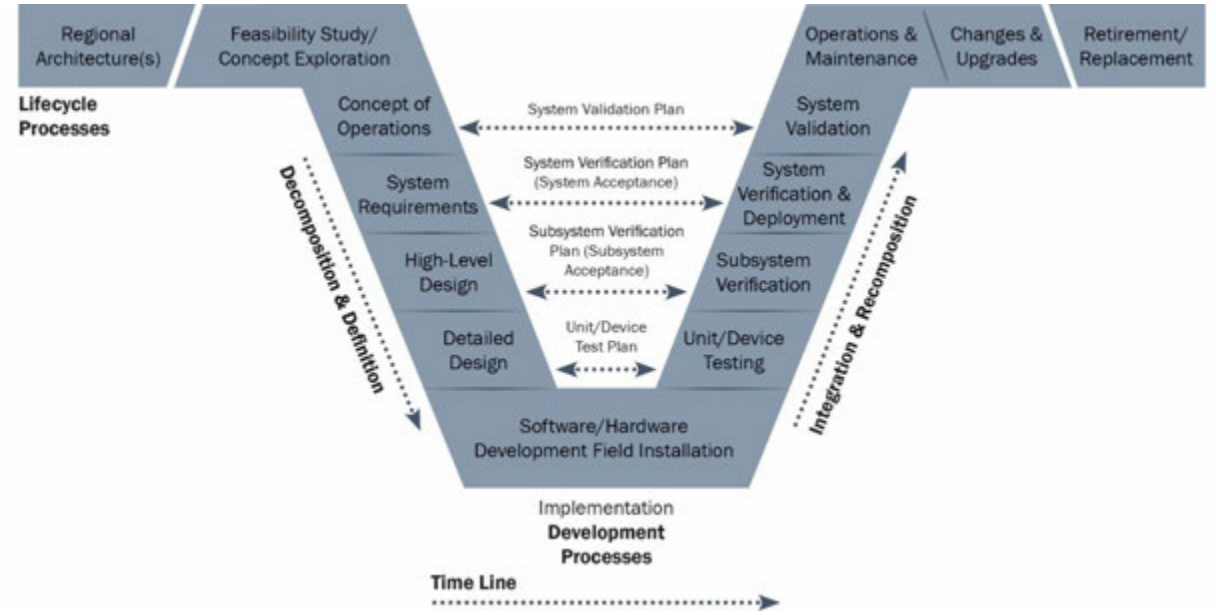
- Identification of portions of the regional ITS architecture being implemented
- Identification of participating agencies' roles and responsibilities
- Requirements definitions
- Analysis of alternative system configurations and technology options to meet requirements
- Procurement options
- Identification of applicable ITS standards and testing procedures
- Procedures and resources

The primary benefit of doing systems engineering is that it will reduce the risk of schedule and cost overruns and will provide a system of higher integrity. Other benefits include:

- Better system documentation
- Higher level of stakeholder participation
- System functionality that meets stakeholders' expectations
- Potential for shorter project cycles
- Systems that can evolve with a minimum of redesign and cost
- Higher level of system reuse
- More predictable outcomes from projects

The systems engineering process represented by the "V" model shown in Figure 12 has been broadly adopted in the transportation industry. The left wing shows the regional ITS architecture, feasibility studies, and concept exploration that support initial identification and scoping of an ITS project based on regional needs. A gap follows the regional architecture(s) step because the regional architecture is a broader product of the planning process that covers all ITS projects in the region. The following steps in the "V" are for a specific ITS project. The central core of the "V" shows the project definition, implementation, and verification processes. The right wing shows the operations and maintenance, changes and upgrades, and ultimate retirement of the system. The wings are a key addition to the model since it is important to consider the entire life cycle during project development.

Figure 12. Systems Engineering "V" Diagram



Similarly, a System Verification Plan is developed with the System Requirements so that the engineers consider how to verify each requirement as the requirements are written. The connections between the left and right are indicated by the arrows that cross the "V", showing how plans developed on the left drive the process on the right. The system hardware and software are implemented at the bottom of the V, and the components of the system are then integrated and verified in iterative fashion on the right. Ultimately, the completed system is validated to measure how well it meets the agency's needs.

TxDOT Waco District has experience with implementing different ITS elements. The District has deployed cameras, dynamic message signs (DMS), travel time monitoring systems and vehicle detection devices. On many common ITS projects, most of the equipment is provided or selected by statewide TxDOT and a detailed technology selection process is not required. However, as new technologies within the District are evaluated and tested for possible implementation, the use of the systems engineering process is encouraged to mitigate project and delivery risks and to meet user needs.

Processes to Vet Innovative Technologies

The current partnership on I-35 with TTI represents a productive partnership for the TxDOT Waco District to vet innovative technologies. Partnering with universities to research new technology is a valuable and often inexpensive method to implement technology. When implementing new technologies, Waco District should follow the systems engineering process.

Regional ITS Architecture

The Waco Regional ITS Architecture, completed in 2004, was the twelfth in the series of Regional ITS Architectures completed by TxDOT. The initiative provided a systematic approach to accommodate regional ITS needs through integrating and deploying ITS infrastructure. A Regional ITS Architecture is a framework for TMS and ITS integration in project planning and it also defines the ITS needs and existing inventory of the region.

The Regional ITS Architecture directly encourages sharing of data and regional coordination and cooperation among the area's stakeholders to improve operations. The Waco Regional ITS Architecture has not been updated since the 2004 plan. FHWA recommends that regional ITS architectures be updated on a regular basis to keep pace with changes in ITS deployment as well as changes in regional needs. It is common in many states for regions to update their Regional ITS Architecture on a four to five-year cycle in coordination with the region's long-range transportation plan update.

Performance Measurement

The success of any TSMO program is tracked through performance measures utilized to manage progress and evaluate if implemented action items are beneficial. Performance measures are defined to describe the progress and productivity of TSMO activities through a process-oriented method.

Agency Performance-Based Initiatives

The Texas Transportation Commission adopted a formal Road to Zero goal to achieve zero deaths on Texas roadways by 2050, with a midway goal to reduce fatalities in half by 2035. TxDOT is developing interim goals to show fatality reductions before 2035 and has made significant investment in safety since the Road to Zero goal was adopted.

November 7, 2020 Texas marked 20 years with a daily death every day on Texas roadways. TxDOT will continue to look for ways to improve safety on Texas roads and end the streak of fatalities. The public messaging for this initiative is #EndTheStreakTX.

District-Wide (or Project Specific) Performance Measures

The TxDOT Waco District has tracked four TMS performance metrics since FY 2017, as required per the TxDOT Chief Engineer.

1. TMS Asset Operational Uptime - Measuring how Districts maintain their traffic management equipment, is the most critical metric to improve in the short-term.
2. Incident Clearance Times - Measuring mobility on the system, driven by District incident management processes in collaboration with regional partners.
3. Level of Travel Time Reliability - An FHWA MAP-21 recommendation to measure impact on the public from traffic management strategies applied to on-system roads like work zone management.
4. TMS System Coverage - Measuring and understanding what portion of on-system roadways are adequately covered with ITS equipment and communications, or where coverage needs to be expanded.

The TxDOT Waco District reports these metrics to identify the benefits of implemented projects and serve as an update to TSMO Program Plan goals. Performance metrics are also leveraged to identify TSMO projects and to incorporate ITS into programmed roadway and bridge projects.

Regional Performance-Based Initiatives

The Waco MPO has adopted several aspirational objectives to measure the success of the Metropolitan Transportation Plan in meeting the guiding principles of the Policy Board. Those objectives are provided below:

- Objective 2-1: Eliminate all transportation related fatalities and serious injuries within the Waco Region by 2045.
- Objective 3-3: For incidents that block at least one travel lane, improve incident clearing time on expressways and arterials to an average of 30 minutes or less.
- Objective 3-5: Revisit and adopt regional Intelligent Transportation System (ITS) architecture and deploy ITS systems on regional freeways, principal arterials and selected minor arterials.

Additionally, the Killeen-Temple MPO has adopted performance measures as part of their Congestion Management Plan. Although the plan does not detail goals for these performance measures, the data collected from their initiative will translate into outlined goals in the future. The Killeen-Temple MPO performance measures cover the following:

- Corridor level-of-service
- Volume-to-capacity ratios
- Travel time included sub-measures for travel speed, average delay, and travel time index in addition to travel time
- Intersection level-of-service
- Safety including sub-measures for number of crashes along a specified corridor and at a particular intersection, type of crashes at a particular intersection, and number of crashes per million vehicle-miles over a section of roadway
- Transit including sub-measures for transit ridership, transit capacity along congested corridors, and transit availability
- Transportation options/availability of alternative modes

Culture

The statewide TSMO program aims to improve mobility and safety through coordinated mobility strategies that are supported by well-defined institutional arrangements, operating procedures, and regional partnerships. It is further aimed at influencing and nurturing a culture which recognizes traffic management systems as a core priority, supported by dedicated programs and funding. Decisions are often determined by an organization based on its culture, which is made up of the organization's values and beliefs.

Engagement Opportunities

Engagement is the major proponent to creating a strong TSMO culture within an organization. Developing engaged employees and collaborative agency processes can strengthen institutional TSMO knowledge and procedures. Waco District Leadership, with the resources and support from statewide TxDOT, are the key drivers for providing engagement opportunities.

Currently, the traffic operations leadership is focused on improving the ITS, illumination, and signal infrastructure within the District on all projects. TSMO engagement can further be improved by putting an emphasis and providing opportunities to connect engineers and technicians together within the agency and with key outside stakeholders. The TxDOT Waco District has developed relationships with external stakeholders; including elected officials, emergency responders, City Engineers, the media, and others to collect and disseminate meaningful information regarding transportation issues and conditions with transportation users; and should continue to do so. To improve TSMO engagement, discussions of action items identified in this plan should be incorporated into the Killeen-Temple and Waco MPOs' Technical Advisory Committee meetings.

Also, it is important to encourage and provide internal staff with the ability to learn TSMO processes and manage new systems and technologies. New technologies should be encouraged for use in projects and training opportunities can be organized with vendors.

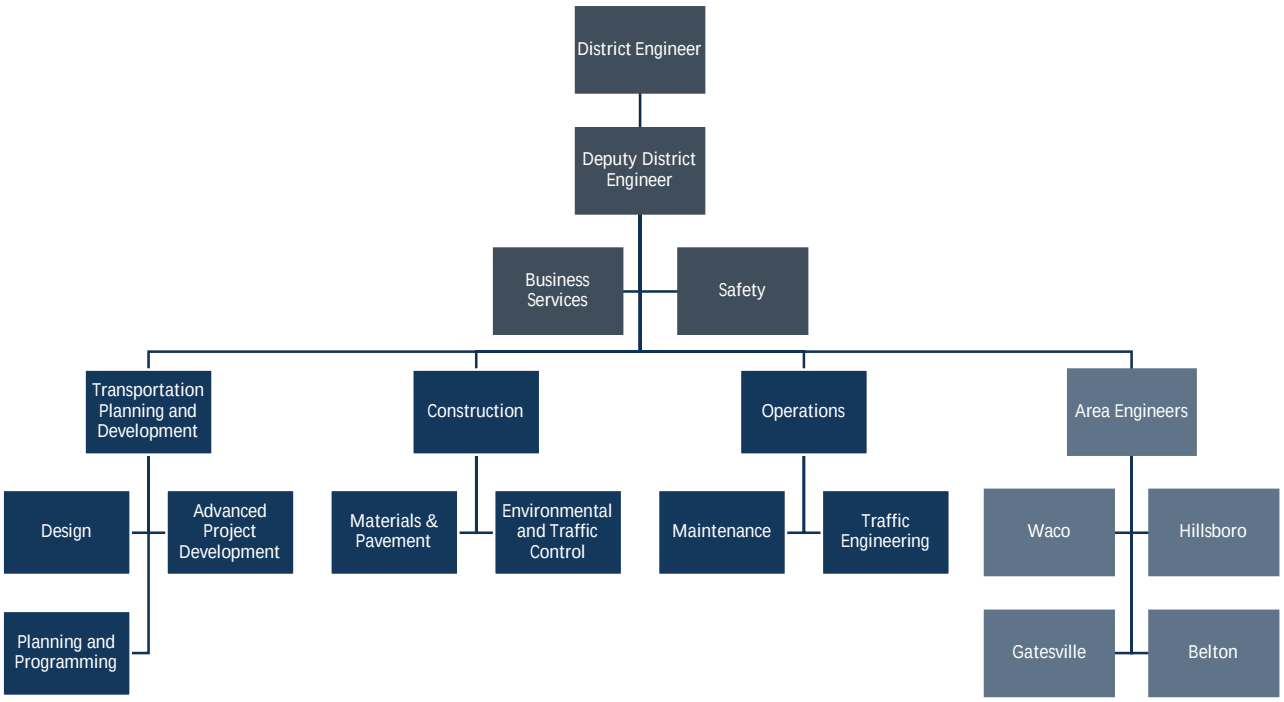
Organization & Workforce

Organization & Workforce describes Waco District programmatic elements like organizational structure, staffing and workforce needs, recruitment and retention, and training opportunities needed to support TSMO and create key TSMO roles.

Revise Organization Structure to Accommodate TSMO

Revisions to organizational structure to accommodate TSMO are specific to the organization implementing TSMO processes and practices. Reorganization can be difficult depending on the institutional practices and is most effective when existing staff is engaged and supportive of TSMO goals. A specific organizational approach to accommodate TSMO could be implemented by a District TSMO Steering Committee chaired by the District TSMO Champion or TSMO Coordinator. The TSMO Steering Committee should include staff from Transportation Planning and Development, Construction, and Operations departments.

Figure 13. Waco District Organizational Structure



Key TSMO Roles

Below are descriptions of the two key roles in the Waco District TSMO Program.

TSMO Champion (Jacob Chao) – A TSMO Champion supports TSMO outreach activities and helps to enhance their TSMO culture. This champion continually advocates for TSMO in the agency and facilitates discussion for future improvement. The position is held by someone currently at the leadership or administrative level within TxDOT.

TSMO Coordinator (Chris Pruitt) - The TSMO Coordinator facilitates and is involved with day-to-day operations, traffic, and technology elements. TSMO Coordinator is the point of contact for TSMO questions and activities.

However, success in TSMO cannot be dependent on just one champion and one coordinator. All roles within the agency have a responsibility to drive TSMO practices. Key contributors may be traffic engineers, traffic signal engineers, freeway operations engineers, arterial operations engineers, ITS design engineers, ITS planners, and transportation planners.

Staffing for TSMO Activities

In order to support operations, it is important for the TxDOT Waco District to recruit and retain staff, revise position responsibilities to accommodate TSMO activities, and provide growth opportunities.

Recruitment – TxDOT Waco District typically hires the best person, not necessarily with the most experience, and then trains them to manage the roles of the position. Finding and recruiting is more difficult for professional and technical positions. Finding experienced traffic engineers, especially in the ITS field, can be difficult. The TxDOT Waco District will need to continue to evaluate salary levels to attract qualified candidates and invest in training for staff with less than ideal experience.

Retention – TxDOT Waco District provides many training opportunities and growth opportunities within the organization. Professional development is a priority that helps retain quality employees. Continuing to offer opportunities and benefits will help retain quality staff and increase performance and productivity.

Reassigning Responsibilities - TxDOT Waco District leadership employs technicians and staff to complete many roles and take on a lot of responsibility. Although employees already work at a high capacity, this type of environment lends itself to accept new TSMO responsibilities. Additionally, emphasis from leadership and fostering of a TSMO based culture will garnish buy-in from staff.

Training Plan

The Waco District has multiple opportunities for training within the District and through state-wide resources. Currently, the Waco District has a rotation program to provide engineering staff a breadth of knowledge across different areas within the organization. The rotation program helps staff learn and engage in all stages of a project, much like what is encouraged within TSMO practices.

For training on new technologies, the Waco District takes advantage of free training and support offered from their vendors. There is also internal meetings and email threads for technicians and engineers to discuss issues, lessons learned and experience with ITS and TMS technologies.

Waco District recognizes a deficiency in experience of staff with ITS devices that could benefit from additional training. The Waco District supports statewide TxDOT training efforts, providing additional training for personnel on what operations, ITS, illumination includes. An emphasis in training in these areas could lead to better traffic management emphasis in DSRs and plans.

Additional training to support TSMO provides a basic level of understanding of TSMO and what it offers to the organization for TSMO-related functions (planning, traffic operations, maintenance, performance management, ITS), and specialized training for specific TSMO functional areas. Basic training should be developed and offered in-house as part of ongoing professional development. More specialized training can be provided in-house or obtained through outside sources such as professional organizations, universities, or FHWA workshops.

Collaboration

Proactively manage and operate an integrated transportation system through multijurisdictional coordination, and cooperation between various transportation disciplines and partner agencies.

Internal Partnerships

TSMO practices emphasize collaboration which starts with Waco District Staff, between departments and divisions. Currently the TxDOT Waco District has some interdepartmental communication where different departments share lessons learned and goals with the Waco District Engineer. Additionally, there are District wide safety calls that involve multiple departments that allow general discussion.

Growing internal partnerships can be done through the formation of teams and forums. For example, the Waco District has a goal of establishing a TIM team which allows staff to meet frequently, develop TSMO processes, and foster continual improvement through internal partnerships. Additionally, establishing a signal technician forum will improve collaboration among staff in similar roles which will improve training and develop best practices.

External Partnerships

External partnerships with MPOs, local agencies, and incident responders improve many aspects of the TSMO program. Traffic Incident Management is a primary example of a program that benefits from enhanced collaboration between organizations. The TxDOT Waco District expressed interest to improve TIM program which requires information sharing, coordination of response efforts, and timely actions between agencies. Additionally, communication with local stakeholders such as media and local jurisdictions can coordinate weather response efforts and disseminate information to a wider audience.

The TxDOT Waco District can improve coordination with key stakeholders by creating a joint operation TMC with the City of Waco. Combining resources and placing staff in a central location allows for quick dissemination of information between agencies and allows for enhanced response to traffic events and incidents.

Adjacent Districts

The Waco District currently partners with TxDOT Fort Worth District's TMC, TransVision, to help manage and operate ITS devices outside of standard business hours. This partnership is beneficial in managing roadway events and incidents that occur during these hours. TransVISION can utilize DMS and cameras within the TxDOT Waco District to alert drivers or help coordinate the traffic incident response.

Public-Private Partnerships

Public-private partnerships involve collaboration between a government agency and a private-sector company that can be used to finance, build, and operate TSMO projects and work towards completing TSMO objectives. An example is partnering with third-party navigation apps to transfer data and information so both parties provide a more valuable service for roadway travelers.

District Response to Operational Challenges

Following completion of the CMM assessment, Waco District TSMO leadership selected two of the focus areas as the subject of Capability Maturity Framework (CMF) workshops. These workshops provided an opportunity for interested stakeholders to meet and identify action items that would allow the TxDOT Waco District to advance in the CMM assessment for each capability dimension within a given TSMO focus area. The focus areas that the District chose for CMF workshops were Traffic Incident Management and Traffic Signal Management. Input from individual stakeholder meetings and CMM and CMF workshops is presented below, organized by focus area.

Traffic Incident Management District Assessment

Traffic incident management (TIM) involves the TxDOT Waco District and partner response to traffic incidents. When traffic incident management is conducted effectively, it can reduce congestion, improve travel reliability, and improve safety. The TxDOT Waco District generally performs TIM activities on an ad hoc basis since no formal TIM program exists as of June 2020. Funding is not currently allocated for TIM activities, and there is minimal involvement by agency leadership in program-level TIM decisions.

Figure 14: TxDOT Waco District CMM Assessment for Traffic Incident Management

Focus Area: Traffic Incident Management				
TSMO Capability Dimensions	Level 1 – Performed	Level 2 – Managed	Level 3 – Integrated	Level 4 – Optimized
Business Processes	✓			
Systems & Technology		✓		
Performance Measurement		✓		
Culture		✓		
Organization & Workforce		✓		
Collaboration	✓			

While there are some existing capabilities in terms of systems and technology related to performance measurement, TIM is not currently considered in planning for construction and work zones, for special events, or for weather-related events. Existing capabilities for TIM related to performance measurement include data collection of queues and delays for any given incident on I-35 as well as daily operational reviews for delays, both conducted by the Texas Transportation Institute (TTI) in partnership with TxDOT. In addition, municipalities report incidents to the TxDOT Crash Records Information System (CRIS) but are not always able to include secondary crash information, responder struck-by information, or incident and roadway clearance times.

The TxDOT Waco District has established safety-oriented TIM rules including adherence to the statewide Authority Removal Law and Driver Removal Law, and a procedure for removal of abandoned vehicles. TIM performance data is currently collected by TxDOT and the TTI on major roadways and includes incident

clearance time, secondary crashes and roadway clearance time. Some coordination does occur between the TxDOT Waco District and first responders. Currently, the Waco Fire Department can access some TxDOT video streams for assistance with incident response.

The TxDOT Waco District has self-identified a need for district-wide coordination in response to incidents and to increase accuracy of locations of reported incidents with additional video streaming to first responders. Discussions with first responder stakeholders yielded that access to incidents that occur on major roadways such as I-35 has been limited during construction, further lengthening delays and increasing response times. Additionally, stakeholders identified the need to improve response to events involving hazardous material spills, especially clearance times. While the City of Waco conducts after-action reviews following incidents, the TxDOT Waco District does not currently perform after-action reviews on a regular basis. These after-actions reviews and the creation of a formalized TIM group to coordinate local agencies would improve incident response and operations.

Opportunities for the TxDOT Waco District to consider for TSMO to enhance TIM are summarized in Table 4.

Work Zone Management District Assessment

Work zone management involves the TxDOT Waco District and partner agency management before, during, and after planned construction events. Effective Work Zone Management can reduce congestion, improve travel time reliability, and improve safety. The TxDOT Waco District is developing processes to manage work zone management activities as part of the ongoing I-35 construction project. Currently, the TxDOT Waco District coordinates construction projects internally and conducts pre-construction meetings for large projects with external stakeholders. The use of available technologies and system resources for support, such as performance measurement data collection from TTI to address work zone management needs, is institutionalized throughout the TxDOT Waco District.

Figure 15: TxDOT Waco District CMM Assessment for Work Zone Management

Focus Area: Work Zone Management				
TSMO Capability Dimensions	Level 1 – Performed	Level 2 – Managed	Level 3 – Integrated	Level 4 – Optimized
Business Processes		✓		
Systems & Technology			✓	
Performance Measurement		✓		
Culture		✓		
Organization & Workforce		✓		
Collaboration		✓		

While the TxDOT Waco District does not directly collect work zone management performance measurement data, TTI collects this data related to traffic queues and delays for I-35 construction through the TxDOT Waco

District. TTI also evaluates this data after construction is completed to identify potential improvements on existing work zone management strategies. Regular communication regarding ongoing I-35 work zone management activities has been established between TxDOT and regional municipalities impacted by the construction. For example, some public information officers in cities affected by I-35 construction are sent work zone updates to disseminate to the public.

External coordination outside of the I-35 construction project consists of regularly hosted pre-construction meetings to inform local traffic engineers of TxDOT projects planned in their cities. While these meetings are mostly extended to local municipalities when large projects are planned, stakeholders are not regularly included in discussions about more granular project details. Some of these discussions could be enhanced with input from local city staff; work zone management data collection on smaller TxDOT projects does not regularly occur across the TxDOT Waco District.

While the TxDOT Waco District distributes daily communications through text message, email, and web maps of I-35 project-related closures, the District has self-identified the need for increased communication with local and through travelers of construction delays, work zones, and detours. Both the District and external stakeholders have identified a need for formal work zone management and stakeholder engagement processes to be extended to first responders on a regular basis. The TxDOT Waco District has also identified a need for more cohesive performance measurement data collection for better comparisons and post-construction reviews.

The TSMO opportunities for the TxDOT Waco District to consider to enhance work zone management are summarized in Table 4.

Road Weather Management District Assessment

Road weather management (RWM) involves the TxDOT Waco District and partner agency response to anticipated major weather events. Ahead of winter weather events, the TxDOT Waco District has plans in place for pretreating TxDOT roads. Within the TxDOT Waco District there is limited coordination between maintenance, traffic operations, and other stakeholders to support RWM. Externally, the TxDOT Waco District has no established coordination with the local weather community. Communication of road closures, detours, or treatments in response to severe weather events occurs by TxDOT informing the media and the public through social media and other existing communication channels. TxDOT does not have an organized system in place to receive information or requests for roadway treatment from the public or from external agency partners.

Figure 16: TxDOT Waco District CMM Assessment for Road Weather Management

Focus Area: Road Weather Management				
TSMO Capability Dimensions	Level 1 – Performed	Level 2 – Managed	Level 3 – Integrated	Level 4 – Optimized
Business Processes		✓		
Systems & Technology	✓			
Performance Measurement		✓		
Culture			✓	
Organization & Workforce		✓		
Collaboration	✓			

The TxDOT Waco District has an optimized approach to strategic planning for winter storms where after-action reviews are conducted following the storm to identify areas for operational improvements. Winter weather management is handled by existing TxDOT staff who are assigned roles and responsibilities to carry out when storms or winter weather occur. The TxDOT Waco District staff with these responsibilities serve local jurisdictions by pre-treating TxDOT roads that go through their cities. Some municipalities are not aware of TxDOT's hierarchy of roadways for winter weather treatment and would benefit from TxDOT providing proactive updates regarding when roads in their area will be treated.

The TxDOT Waco District has self-identified the need for improved traveler information for weather-related roadway impacts and the need to better manage expectations of local municipalities with regards to winter weather road plowing and treatment. Discussion with stakeholders of how to respond to areas that flood frequently also led to the District identifying the need to warn drives of closed or inundated crossings.

The TSMO opportunities for the TxDOT Waco District to consider to enhance road weather management are summarized in Table 4.

Planned Special Event District Assessment

Planned special events (PSE) involve the TxDOT Waco District and partner agency response to gatherings such as local holiday events or major sporting events. The TxDOT Waco District manages planned special event activities largely through external coordination. The TxDOT Waco District coordinates with the City of Waco, Waco Metropolitan Planning Organization, and Baylor University by approving plans for large events such as Baylor University football games.

Figure 17: TxDOT Waco District CMM Assessment for Planned Special Events

Focus Area: Planned Special Events				
TSMO Capability Dimensions	Level 1 – Performed	Level 2 – Managed	Level 3 – Integrated	Level 4 – Optimized
Business Processes		✓		
Systems & Technology		✓		
Performance Measurement	✓			
Culture		✓		
Organization & Workforce		✓		
Collaboration			✓	

The TxDOT Waco District does not have designated specific personnel with formal PSE job functions for District events, although one or more individuals within each department may have planned special events transportation operations as part of their job function. There is minimal to no formal budgeting for PSE planning and no PSE data is captured or shared.

As other special events come to the TxDOT Waco District area, PSE management beyond Baylor University football will be required for events such as marathons, races, and other sporting events. The TxDOT Waco District has self-identified the need for improved traveler information about special event delays and related detour routing. In addition to related work zone management information efforts, this provides an opportunity for coordination with third-party web-based applications to distribute accurate traveler information related to special events directly to travelers in the area. The TxDOT Waco District has also identified the need for after-action reviews following the completion of PSE activities. Improved data collection around PSE activities can increase the effectiveness of after-action reviews and can allow for more targeted improvement in the management of these events.

The TSMO opportunities for the TxDOT Waco District to consider to enhance planned special event management are summarized in Table 4.

Traffic Signal Management District Assessment

Traffic signal management involves the TxDOT Waco District's management of its traffic signal system. The District system includes all signals in the District except those operated by the City of Waco, City of Temple, and the City of Killeen. However, this District assessment also considers how these cities manage their own signal systems. The TxDOT Waco District and City of Waco have recently improved signal timing operations and traffic progression along high-volume corridors in the region. In addition, the District is in the process of deploying an asset management program for signals and ITS.

Figure 18: TxDOT Waco District CMM Assessment for Traffic Signal Management

Focus Area: Traffic Signal Management				
TSMO Capability Dimensions	Level 1 – Performed	Level 2 – Managed	Level 3 – Integrated	Level 4 – Optimized
Business Processes	✓			
Systems & Technology		✓		
Performance Measurement	✓			
Culture		✓		
Organization & Workforce		✓		
Collaboration	✓			

The TxDOT Waco District currently conducts traffic signal management planning activities on an ad hoc basis. The primary means of identifying operations issues or service disruptions is through user complaints. The TxDOT Waco District does not currently have the ability to remotely manage signal operations and as a result no advanced troubleshooting is conducted before crews arrive on site. Signal technology and systems in place are often outdated and do not support certain signal timing strategies that could improve operations. Signal control technologies that are installed on newly constructed TxDOT signals are not consistent with technologies that local cities use, so controllers are often replaced if the traffic signal is turned over to a local agency for operation.

Since communication technology on traffic signals is not ubiquitous throughout the region, there is not a consistent method for collecting traffic signal data or tracking this data remotely. No TSM data is captured from traffic signals in the area. The TxDOT Waco District has self-identified the need for continued deployment of modern signal controller and communications technology to support signal operations and asset management in the region. The TxDOT Waco District is beginning to address this need with the development of an asset management program for signals and ITS. As municipalities are looking into signal improvements, safety-related signal enhancements should conform to the TxDOT Waco District's 4-Year Safety Plan.

Stakeholders identified that maintenance conducted by signal technicians unfamiliar with coordinated signal systems has caused signals to go out of coordination with the rest of the corridor. The District identified the need for improved signal technician trainings for the region's municipal agency partners to standardize installation and maintenance techniques. The District also identified a need to develop standard operating procedures that technicians can follow to adhere to best practices when responding to signal malfunctions or outages, including response time goals, traffic control standards, and how to triage when an event impacts a group of signals.

Many corridors in the region are operated on one end by municipalities and on the other end by TxDOT. Stakeholders identified issues with providing efficient service when signal maintenance is required at an intersection in certain locations where there is a lack of understanding regarding the agency that is responsible

for maintenance. It is important that regular meetings occur for review of municipal maintenance agreements to prevent confusion regarding maintenance responsibilities, to expedite maintenance on signals during incidents or special events, and to keep knowledge of agreements within an organization if staff turnover occurs.

The TSMO opportunities for the TxDOT Waco District to consider to enhance traffic signal management are summarized in Table 4.

General Traffic Management District Assessment

Traffic management (TM) involves the TxDOT Waco District management of traffic conditions throughout the region. The TxDOT Waco District generally conducts internal traffic management planning and programming to meet agency goals and objectives, but the District does so with limited coordination and communication with local jurisdictions. There is support from the District Engineer and dedicated champions for traffic management operations within the TxDOT Waco District.

Figure 19: TxDOT Waco District CMM Assessment for Traffic Management

Focus Area: Traffic Management				
TSMO Capability Dimensions	Level 1 – Performed	Level 2 – Managed	Level 3 – Integrated	Level 4 – Optimized
Business Processes		✓		
Systems & Technology		✓		
Performance Measurement		✓		
Culture		✓		
Organization & Workforce		✓		
Collaboration		✓		

Much of the existing collaboration within the TxDOT Waco District is between the District and TTI on the I-35 construction project. The implementation and operation of smart work zones through this collaboration has improved traffic management operations through work zones. Through this partnership, TTI collects traffic management performance measurement data along I-35. On other District roads performance measurement is conducted periodically, but most local agencies do not have the resources to easily measure transportation network performance. Currently, there is no facility for regional traffic management operations where municipalities, TxDOT, and emergency management services can collaborate to improve traffic operations in the region.

The TxDOT Waco District has self-identified the need for improved collaboration across the region for better traffic management, preferably through the establishment of a regional TMC. Stakeholders established that there is a need for better performance data collection outside of the I-35 corridor. In addition, stakeholders identified a need for established procedures to share traffic management performance data across the region

once it has been collected. The District has sought to prioritize maintaining ITS device asset uptime above 90 percent in accordance with statewide goals established by the TxDOT Traffic Safety Division.

The TSMO opportunities for the TxDOT Waco District to consider to enhance general traffic management are summarized in Table 4.

Summary of Recommended Action Items

Table 4 summarizes action items included as part of the TSMO Program Plan. These action items were developed based on the needs demonstrated by the TxDOT Waco District and other regional stakeholders. These action items build upon the existing TSMO capabilities that the region's stakeholders shared as a part of the CMM survey.

The TxDOT Waco District TSMO Program Plan is an unconstrained planning document focused on near-term implementation priorities. While all action items listed below potentially could be implemented within the next five years, no funding is currently allocated for any of these action items unless otherwise specifically stated in this document. Action items will be implemented as District resources permit.

Table 4: TxDOT Waco District TSMO Recommended Action Items

CMF Focus Area	CMM Capability Dimension	Action Item Description
Traffic Incident Management 	**Business Processes**	**Consider TIM Impacts Prior to Beginning Construction:** Develop relationships and protocols for incident management at the beginning of new construction contracts.
		Share TIM Data with Region: Identify the best methods to share incident data between law enforcement, TxDOT, and cities.
	Systems & Technology	**Establish Freeway Safety Service Patrol:** Establish a freeway safety service patrol along key routes to respond to minor incidents and traffic disruptions, and to assist in response to larger incidents.
		Establish Link to TIM Response Dispatch Information: Establish connection with 911 public safety answering points to share computer-aided dispatch traffic incident information with TxDOT in real time.
	Performance Measurement	**Improve TIM Data Collection:** Improve incident management-related data collection, with a focus on location data accuracy as well as regional collection of roadway clearance time, incident clearance time, and secondary crash data.
	Organization & Workforce	
	Collaboration	**Establish a Formal Regional TIM Team:** Establish a formalized TIM Team that meets regularly and includes all relevant jurisdictions and roles.
Work Zone Management 	**Business Processes**	
		Conduct Post-Construction Event Reviews: Conduct post-construction event reviews to determine what worked and what can be improved upon.
	Systems & Technology	
		Expand Work Zone Technology Deployments: Deploy work zone technology throughout the Waco District to support improved work zone monitoring, localized real-time traveler information, and end of queue warning.

CMF Focus Area	CMM Capability Dimension	Action Item Description
Work Zone Management (Continued)		
	Culture	**Prioritize Communicating Work Zone Information to Local Partners:** Prioritize communication with local agencies regarding both initial construction notices and subsequent construction plan or schedule changes.
Road Weather Management 	**Systems & Technology**	
		Improve Quality of Weather-Related Information for the Public: Improve level of detail, timeliness, and accuracy of weather-related roadway information communicated to local and regional travelers.
	Collaboration	
Planned Special Events 	**Business Processes**	**Conduct Post-Special Event Reviews:** Conduct post-special event reviews to determine what worked and what can be improved upon.
	Systems & Technology	
	Performance Measurement	**Measure Event-Related Travel Time Delay:** Develop the capacity to measure travel time delay along key routes during special events.
Traffic Signal Management 	**Business Processes**	
	Systems & Technology	**Implement Safety-Focused Signal Upgrades:** Implement signalized intersection safety upgrades recommended in District Safety Plan and encourage local partners to pursue similar upgrades.
		signals along detour and other priority routes to allow monitoring and real-time adjustments during traffic incidents, special events, and major construction.

CMF Focus Area	CMM Capability Dimension	Action Item Description
Traffic Signal Management (Continued)		
	Organization & Workforce	**Provide TxDOT Waco District Training Opportunities to Local Staff:** Provide TxDOT Waco District internal signal technician training opportunities to local agency traffic signal technicians.
	Collaboration	**Conduct Quarterly Signal Technician Forums:** Conduct quarterly signal technician forums to improve collaboration, share best practices, and establish a regional competency regarding signal maintenance and operations.
Traffic Management 	**Business Processes**	
	Systems & Technology	**Establish a Regional TMC:** Establish a regional traffic management center to support traffic incident management, traffic signal management, traveler information dissemination, and other traffic management priorities.
	Performance Measurement	**Establish Districtwide Traffic Operations Performance Measures:** Establish Districtwide traffic operations performance measures that expand upon current data collection and performance measurement efforts along the I-35 corridor.
	Culture	
	Organization & Workforce	**Identify and Fulfill Staffing Requirements for TMC Operation:** Implement a phased staffing approach for TxDOT's operating and managing the regional TMC.

CMF Focus Area	CMM Capability Dimension	Action Item Description
Traffic Management (Continued)	**Collaboration**	**Conduct Semi-Annual Regional Traffic Operations Forums:** Conduct semi-annual regional traffic operations forums with staff from traffic operations agencies throughout the Waco District.
		Identify Candidate Partners for Joint Operation of a Regional TMC: Identify traffic operations, public safety, and emergency management agencies to involve in the operation of a potential jointly managed TMC.

TSMO Implementation Plan

This section lays out a plan for advancing TSMO priorities in the TxDOT Waco District over the next five years. Its contents are based on the existing strengths and needs that the Waco District and regional stakeholders identified over the course of the TSMO Plan's development. The Implementation Plan is based on the Action Items identified in Table 4, but presents them based on the CMM capability dimensions such as Business Processes and Systems & Technology. The Implementation Plan is shown in Table 5 and in the schedule on the following pages shown in Table 6.

Action No.	Business Processes (BP) Action Item Descriptions	Program Plan Page #	Action Lead	Supports District Goals		
				Safety	Reliability	Efficiency
BP-01	**Consider TIM Impacts Prior to Beginning Construction:** Develop relationships and protocols for incident management at the beginning of new construction contracts.	53	WAC Director of Construction	✓		✓
	Develop relationships and protocols for incident management at	53	WAC Director of Construction	✓		✓
BP-02		54	WAC Director of Operations	✓		
BP-03	**Establish Work Zone Accessibility Criteria for First Responders:** Establish general work zone TIM accessibility criteria and incorporate criteria into the Waco District's project development processes.	54	WAC Director of Transportation Planning & Development	✓		✓
	Establish general work zone TIM accessibility criteria and incorporate criteria into the Waco District's project development	54	WAC Director of Transportation Planning & Development	✓		✓
BP-04		54	WAC Director of Construction		✓	✓
BP-05	**Conduct Post-Special Event Reviews:** Conduct post-special event reviews to determine what worked and what can be improved upon.	55	WAC Director of Operations		✓	✓
	Conduct Post-Special Event Reviews: Conduct post-special event reviews to determine what worked and what can be improved	55	WAC Director of Operations		✓	✓
BP-06		55	WAC Area Engineers			
BP-07	**Establish Regional Traffic Data Sharing Procedures:** Establish procedures for sharing collected traffic data among TxDOT, MPOs, and local agencies.	56	WAC Director of Operations		✓	
	Establish procedures for sharing collected traffic data among TxDOT, MPOs, and local agencies.	56	WAC Director of Operations		✓	

Table 5 includes the following information for each recommended action item:

- **Action Number:** An identifier for each recommended action item, organized by CMM capability dimension: Business Processes (BP), Systems & Technology (ST), Performance Measurement (PM), Culture (CU), Organization & Workforce (OW), and Collaboration (CO).

- **Action Description:** Provides a brief description of the action, which may include multiple steps.
- **Program Plan Page Number:** A reference to TSMO Program Plan page number with relevant discussion.
- **Action Lead:** Identifies the individual at the TxDOT Waco District who will take ownership of the action and will oversee that implementation progresses as planned.
- **Supports District TSMO Goals:** Identifies which of the District's TSMO goals the action item supports: Safety, Reliability, Efficiency, Customer Service, Collaboration, or Integration.
- **Partners:** Identifies TxDOT staff and external stakeholders that will contribute to implementation of the recommended action item.
- **Cost:** Provides a semi-quantitative opinion of the level of fiscal resources that TxDOT would need to commit to implement the recommended action item.
- **Effort:** Provides a semi-quantitative opinion of the level of effort that TxDOT would need to dedicate to implement the recommended action item.
- **Related Action Items:** Lists the Action Numbers of related action items that could be implemented either concurrently or subsequently if the District chose to focus on specific program areas or further developing relationships with specific stakeholders.

Separately, the implementation plan schedule provides a year-by-year roadmap for implementing each recommended action item. All action items are shown with recommended timeframes at a half-year level of detail for Fiscal Years 2021 through 2025.

The TxDOT Waco District TSMO Program Plan is an unconstrained planning document focused on near-term implementation priorities. While all action items listed could potentially be implemented within the next five years, no funding is currently allocated for any of these action items unless otherwise specifically stated in this plan. Action items will be implemented as District resources permit.

Table 5: TxDOT Waco District Recommended TSMO Action Items

Action No.	Business Processes (BP) Action Item Descriptions	Program Plan Page #	Action Lead	Supports District TSMO Goals					Partners	Cost	Effort	TSMO Focus Area	Related Action Items
				Safety				Integration					
BP-01	**Consider TIM Impacts Prior to Beginning Construction:** Develop relationships and protocols for incident management at the beginning of new construction contracts.	53	WAC Director of Construction	✓		✓		✓	WAC Construction Department, WAC Operations Department, WAC Area Engineers	$			BP-03, ST-06, PM-01
BP-02	**Share TIM Data with Region:** Identify the best methods to share			✓				✓		$			
BP-03	**Establish Work Zone Accessibility Criteria for First Responders:** Establish general work zone TIM accessibility criteria and incorporate criteria into the Waco District's project development processes.	54	WAC Director of Transportation Planning & Development	✓		✓		✓	WAC Transportation Planning & Development Department, WAC Construction Department, WAC Operations Department, DPS and Local Public Safety Agencies	$			BP-01
BP-04	**Conduct Post-Construction Event Reviews:** Conduct post-				✓	✓		✓		$			
BP-05	**Conduct Post-Special Event Reviews:** Conduct post-special event reviews to determine what worked and what can be improved upon.	55	WAC Director of Operations		✓	✓		✓	WAC Construction Department, WAC Operations Department, WAC Area Engineers, Local Transportation Agencies, Event Organizers	$			PM-01, PM-03
BP-06	**Improve Local Partner Knowledge of Existing Agreements:** Improve local agency institutional knowledge of, and access to,	55	WAC Area Engineers				✓	✓	WAC Operations Department, Local Transportation Agencies	$			
BP-07	**Establish Regional Traffic Data Sharing Procedures:** Establish procedures for sharing collected traffic data among TxDOT, MPOs, and local agencies.	56	WAC Director of Operations		✓		✓	✓	WAC Operations Department, Local Transportation Agencies, Local MPOs	$			PM-04, CU-02, CO-04

Table continued on next page.

Action No.	Systems & Technology (ST) Action Item Descriptions	Program Plan Page #	Action Lead	Supports District TSMO Goals						Partners	Cost	Effort	TSMO Focus Area	Related Action Items
				Safety	Reliability	Efficiency	Customer Service	Collaboration	Integration					
ST-01	**Upgrade Signals to Quickly Adjust Timings in Response to Events:** Upgrade signals along detour and other priority routes to allow monitoring and real-time adjustments during traffic incidents, special events, and major construction.	58	WAC District Transportation Engineering Supervisor	✓	✓	✓	✓	✓	✓	WAC Operations Department, Local Transportation Agencies	$$$			ST-11, CO-03, CO-04
ST-02				✓	✓	✓			✓		$$$			
ST-03	**Establish a Regional TMC:** Establish a regional traffic management center (TMC) to support traffic incident management, traffic signal management, traveler information dissemination, and other traffic management priorities.	60	WAC Director of Operations	✓	✓	✓	✓	✓	✓	WAC Operations Department, WAC District Engineer, Local Transportation Agencies, Local Public Safety Agencies	$$$			ST-12, PM-04, OW-04, CO-05
ST-04	**Establish Link to TIM Response Dispatch Information:** Establish connection with 911 public safety answering points to share computer-aided dispatch traffic incident information with TxDOT in real time.	61	WAC Director of Operations	✓				✓	✓	WAC Operations Department, TxDOT Traffic Safety Division, WAC Public Information Office, Local Public Safety Agencies	$			PM-01
ST-05	**Provide Closure Information Through Third-Party Apps:** Partner with third-party navigation apps to provide accurate work zone closure information for travelers through the Waco District.	61	WAC Public Information Officer		✓		✓	✓	✓	Private Third-Party Providers, WAC Operations Department, WAC Construction Department	$			
ST-06	**Expand Work Zone Technology Deployments:** Deploy work zone technology throughout the Waco District to support improved work zone monitoring, localized real-time traveler information, and end of queue warning.	61	WAC Director of Construction	✓		✓	✓	✓	✓	WAC Operations Department, WAC Area Engineers, WAC Construction Department, TxDOT Construction Division	$$			BP-01, PM-02
ST-07	**Deploy Flood Warning and Closure Devices:** Implement technology for closing roads or warning drivers in areas that frequently flood.	62	WAC Director of Operations	✓			✓		✓	WAC Operations Department, WAC Area Engineers	$$			ST-08, CO-02
ST-08	**Improve Quality of Weather-Related Information for the Public:** Improve level of detail, timeliness, and accuracy of weather-related roadway information communicated to local and regional travelers.	62	WAC Public Information Officer	✓	✓	✓	✓		✓	WAC Operations Department, WAC Public Information Office, WAC Area Engineers	$			ST-07, CO-02
ST-09	**Share Event-Related Road Impacts with Third-Party Apps:** Partner with third-party navigation apps to provide accurate special event-related closure and routing information for travelers through the Waco District.	63	WAC Public Information Officer		✓		✓	✓	✓	Private Third-Party Providers, WAC Operations Department, WAC Public Information Office, Event Organizers	$			
ST-10	**Implement Safety-Focused Signal Upgrades:** Implement signalized intersection safety upgrades recommended in District Safety Plan and encourage local partners to pursue similar upgrades.	63	WAC District Transportation Engineering Supervisor	✓	✓	✓		✓	✓	WAC Operations Department, WAC Area Engineers, Local Transportation Agencies, Local MPOs	$$$			CU-02, CO-03, CO-04

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Action No.	Systems & Technology (ST) Action Item Descriptions *(Continued)*	Program Plan Page #	Action Lead	Supports District TSMO Goals: Safety	Reliability	Efficiency	Customer Service	Collaboration	Integration	Partners	Cost	Effort	TSMO Focus Area	Related Action Items
ST-11	**Improve Communications Link to Signals in Rural Areas:** Upgrade communications capabilities at rural TxDOT traffic signal locations to improve ability to monitor and respond to conflicts, outages, and other signal issues.	63	WAC District Transportation Engineering Supervisor	✓	✓	✓			✓	WAC Operations Department, WAC Area Engineers	$$			ST-01
ST-12	**Plan and Implement Upgrades to ITS Field Devices:** Develop a comprehensive implementation plan to identify and prioritize locations for new ITS deployments and to replace ITS devices approaching the end of their design life.	64	WAC Director of Operations	✓	✓	✓	✓	✓	✓	WAC Operations Department, WAC Area Engineers	$$$			ST-03

Action No.	Performance Measurement (PM) Action Item Descriptions	Program Plan Page #	Action Lead	Supports District TSMO Goals: Safety					Integration	Partners	Cost	Effort	TSMO Focus Area	Related Action Items
PM-01	**Improve TIM Data Collection:** Improve incident management-related data collection, with a focus on location data accuracy as well as regional collection of roadway clearance time, incident clearance time, and secondary crash data.	65	WAC Director of Operations	✓	✓	✓		✓	✓	TxDOT Traffic Safety Division, DPS and Local Law Enforcement, WAC Operations Department	$			BP-01, BP-04, BP-05, ST-04
PM-02	**Measure Work Zone Travel Time Delay:** Develop the capacity to measure travel time delay through work zones throughout the				✓	✓			✓		$$			
PM-03	**Measure Event-Related Travel Time Delay:** Develop the capacity to measure travel time delay along key routes during special events.	66	WAC Director of Operations		✓	✓			✓	WAC Operations Department, Local Transportation Agencies, Event Organizers	$$			BP-05
PM-04	**Establish Districtwide Traffic Operations Performance Measures:** Establish Districtwide traffic operations performance measures that expand upon current data collection and performance			✓	✓	✓		✓	✓		$			

Table continued on next page.

Action No.	Culture (CU) Action Item Descriptions	Program Plan Page #	Action Lead	Supports District TSMO Goals						Partners	Cost	Effort	TSMO Focus Area	Related Action Items
				Safety	Reliability	Efficiency	Customer Service	Collaboration	Integration					
CU-01	**Prioritize Communicating Work Zone Information to Local Partners:** Prioritize communication with local agencies regarding both initial construction notices and subsequent construction plan or schedule changes.	68	WAC Public Information Officer	✓			✓	✓	✓	WAC Area Engineers, WAC Construction Department, WAC Public Information Office	$			
CU-02	**Incorporate TSMO Discussion Topics into MPO Committee Meetings:** Incorporate discussions of action items identified in this plan into the Killeen-Temple and Waco MPOs' Technical Advisory Committee meetings.	69	WAC Director of Operations					✓	✓	WAC Operations Department, Local Transportation Agencies, Local MPOs	$			BP-07, ST-10

Action No.	Organization & Workforce (OW) Action Item Descriptions	Program Plan Page #	Action Lead	Supports District TSMO Goals						Partners	Cost	Effort	TSMO Focus Area	Related Action Items
				Safety					Integration					
OW-01	**Establish Recurring Regional TIM Training:** Partner with TxDOT Statewide Traffic Incident Management Coordinator to establish recurring regional TIM training in a multidisciplinary setting.	70	WAC Director of Operations	✓	✓		✓	✓	✓	TxDOT Statewide TIM Coordinator, WAC Area Engineers, WAC Operations Department, Local Transportation Agencies, Local Public Safety Agencies	$			BP-01, BP-04, BP-05, ST-04
OW-02	**Provide TxDOT Waco District Training Opportunities to Local Staff:** Provide TxDOT Waco District internal signal technician training			✓	✓		✓	✓	✓		$			
OW-03	**Improve Access to Available Specialized TxDOT Signal Training:** Improve local agency traffic signal technician access to signal-related trainings offered by the TxDOT Traffic Safety Division.	71	WAC District Transportation Engineering Supervisor		✓		✓	✓		TxDOT Traffic Safety Division, WAC Operations Department, Local Transportation Agencies	$			BP-05
OW-04	**Identify and Fulfill Staffing Requirements for TMC Operation:** Implement a phased staffing approach for TxDOT's operating and					✓		✓	✓		$$$			

Table continued on next page.

Action No.	Collaboration (CO) Action Item Descriptions	Program Plan Page #	Action Lead	Supports District TSMO Goals						Partners	Cost	Effort	TSMO Focus Area	Related Action Items
				Safety					Integration					
CO-01	**Establish a Formal Regional TIM Team:** Establish a formalized TIM Team that meets regularly and includes all relevant jurisdictions and roles.	74	WAC Director of Operations	✓	✓	✓	✓	✓	✓	TxDOT Statewide TIM Coordinator, WAC Area Engineers, WAC Operations Department, Local Transportation Agencies, Local Public Safety Agencies	$			BP-02, ST-02, OW-01
CO-02	**Better Communicate Road Weather Impacts to Local Partners:** Improve communication with local stakeholders regarding TxDOT weather-related road closures and ice prevention operations.	74	WAC Public Information Officer	✓	✓	✓	✓	✓	✓	WAC Public Information Officer, Local Transportation Agencies, Local Public Safety Agencies	$			ST-07, ST-08
CO-03	**Conduct Quarterly Signal Technician Forums:** Conduct quarterly signal technician forums to improve collaboration, share best practices, and establish a regional competency regarding signal maintenance and operations.	74	WAC District Transportation Engineering Supervisor				✓	✓	✓	WAC Area Engineers, WAC Operations Department, Local Transportation Agencies	$			ST-01, ST-10, OW-02
CO-04	**Conduct Semi-Annual Regional Traffic Operations Forums:** Conduct semi-annual regional traffic operations forums with staff from traffic operations agencies throughout the Waco District.	75	WAC Director of Operations				✓	✓	✓	WAC Area Engineers, WAC Operations Department, Local Transportation Agencies	$			BP-07, ST-01, ST-10
CO-05	**Identify Candidate Partners for Joint Operation of a Regional TMC:** Identify traffic operations, public safety, and emergency management agencies to involve in the operation of a potential jointly managed TMC.	76	WAC Director of Operations				✓	✓	✓	WAC Operations Department, Local Transportation Agencies, Local Public Safety Agencies	$			ST-03, OW-04

Figure 20: Implementation Schedule for Recommended Action Items

Task Name	2021		2022		2023		2024		2025	
	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2
BUSINESS PROCESSES										
BP-01: Consider TIM Impacts Prior to Beginning Construction			Ongoing							
BP-02: Share TIM Data with Region									Ongoing	
BP-03: Establish Work Zone Accessibility Criteria for First Responders										
BP-04: Conduct Post-Construction Event Reviews					Ongoing					
BP-05: Conduct Post-Special Event Reviews					Ongoing					
BP-06: Improve Local Partner Knowledge of Existing Agreements			Ongoing							
BP-07: Establish Regional Traffic Data Sharing Procedures										
SYSTEMS & TECHNOLOGY										
ST-01: Upgrade Signals to Quickly Adjust Timings in Response to Events										Ongoing
ST-02: Establish Freeway Safety Service Patrol										Ongoing
ST-03: Establish a Regional TMC										Ongoing
ST-04: Establish Link to TIM Response Dispatch Information										
ST-05: Provide Closure Information Through Third-Party Apps		Ongoing								
ST-06: Expand Work Zone Technology Deployments										
ST-07: Deploy Flood Warning and Closure Devices										
ST-08: Improve Quality of Weather-Related Information for the Public										
ST-09: Share Event-Related Road Impacts with Third-Party Apps			Ongoing							
ST-10: Implement Safety-Focused Signal Upgrades										Ongoing
ST-11: Improve Communications Link to Signals in Rural Areas										
ST-12: Plan and Implement Upgrades to ITS Field Devices										Ongoing
PERFORMANCE MEASUREMENT										
PM-01: Improve TIM Data Collection										
PM-02: Measure Work Zone Travel Time Delay										
PM-03: Measure Event-Related Travel Time Delay										
PM-04: Establish Districtwide Traffic Operations Performance Measures										
CULTURE										
CU-01: Prioritize Communicating Work Zone Information to Local Partners			Ongoing							
CU-02: Incorporate TSMO Discussion Topics into MPO Committee Meetings			Ongoing							
ORGANIZATION & WORKFORCE										
OW-01: Establish Recurring Regional TIM Training					Ongoing					
OW-02: Provide TxDOT Waco District Training Opportunities to Local Staff					Ongoing					
OW-03: Improve Access to Available Specialized TxDOT Signal Training										
OW-04: Identify and Fulfill Staffing Requirements for TMC Operation										
COLLABORATION										
CO-01: Establish a Formal Regional TIM Team			Ongoing							
CO-02: Better Communicate Road Weather Impacts to Local Partners										
CO-03: Conduct Quarterly Signal Technician Forums				Ongoing						
CO-04: Conduct Semi-Annual Regional Traffic Operations Forums					Ongoing					
CO-05: Identify Candidate Partners for Joint Operation of a Regional TMC										

Detailed Recommendations – Business Processes

Within the CMM, business processes refer to an agency's activities and tasks that allow it to meet its TSMO goals. Considerations include how an agency plans, programs, and budgets for TSMO projects. Business processes may also refer to how an agency follows its internal protocol to implement specific TSMO projects. Table 6 shows the recommended Business Processes action items for the TxDOT Waco District.

Table 6: TxDOT Waco District Action Items - Business Processes

CMM Capability Dimension	Action Item Number	Action Item Description
Business Processes	BP-01	**Consider TIM Impacts Prior to Beginning Construction:** Develop relationships and protocols for incident management at the beginning of new construction contracts.
	BP-02	**Share TIM Data with Region:** Identify the best methods to share incident data between law enforcement, TxDOT, and cities.
	BP-03	**Establish Work Zone Accessibility Criteria for First Responders:** Establish general work zone TIM accessibility criteria and incorporate criteria into the Waco District's project development processes.
	BP-04	**Conduct Post-Construction Event Reviews:** Conduct post-construction event reviews to determine what worked and what can be improved upon.
	BP-05	**Conduct Post-Special Event Reviews:** Conduct post-special event reviews to determine what worked and what can be improved upon.
	BP-06	**Improve Local Partner Knowledge of Existing Agreements:** Improve local agency institutional knowledge of, and access to, current Municipal Maintenance Agreements.
	BP-07	**Establish Regional Traffic Data Sharing Procedures:** Establish procedures for sharing collected traffic data among TxDOT, MPOs, and local agencies.

Action Item BP-01: Consider TIM Impacts Prior to Beginning Construction

The TxDOT Waco District is nearing completion of a decade-long reconstruction project along the Interstate 35 corridor through the District. While incident responders have been invited to pre-construction meetings prior to the beginning of each project phase, these stakeholders cited continued challenges with accessing incidents that occur within the work zone.

As a part of the planning process for upcoming major construction efforts, the District should formalize an approach of identifying and engaging with relevant incident management stakeholders to discuss any concerns related to incident access and ease of response, and develop project-specific protocols to address those

concerns to the extent possible. Ideally, this discussion would take place early enough that minor changes to work zone design could still be made to improve first responder access in areas of concern. These protocols might also involve resource sharing discussions, such as providing first responders access to TxDOT camera feeds or identifying locally relevant resources or other assistance that TxDOT maintenance sections or contractors could provide to assist with traffic control in an incident influence area.

Action Item BP-02: Share TIM Data with Region

Action Item PM-01 recommends that agencies within the region focus more on collecting data related to traffic incident management response, including roadway clearance time, incident clearance time, and occurrence of secondary incidents and incidents where responders are struck. The only agency in the region that is formally collecting and reporting this data for all incidents as part of its business processes is the Texas Department of Public Safety. The TxDOT Traffic Safety Division is advocating for the inclusion of these fields in crash reporting paperwork that is completed by law enforcement agencies statewide.

In anticipation of this TIM performance data being collected for larger numbers of incidents in the Waco District, law enforcement, TxDOT, and other local agencies and MPOs should discuss how that data can best be processed and shared to track TIM performance as a region. In other parts of Texas, the MPO or TxDOT District may act as a data repository for this information and produce annual reports that summarize TIM performance metrics for either their own agency or a group of agencies that have agreed to provide their own TIM performance data. If crash reporting paperwork is standardized across the state to include these TIM performance metrics, using that established data framework will make it easier to integrate data received from multiple agencies.

Action Item BP-03: Establish Work Zone Accessibility Criteria for First Responders

Several stakeholders noted a need to improve emergency responder access to incidents that occur within work zones, noting that at times responders had needed to park vehicles on the frontage road as far as a half mile away when responding to incidents in certain locations along the Interstate 35 main lanes. The TxDOT Waco District should establish work zone accessibility requirements to incorporate into its project development process in the planning and design phases. Feedback from first responders can help the District identify these requirements so that they are incorporated into project designs and are understood by all parties before construction begins.

Action Item BP-04: Conduct Post-Construction Event Reviews

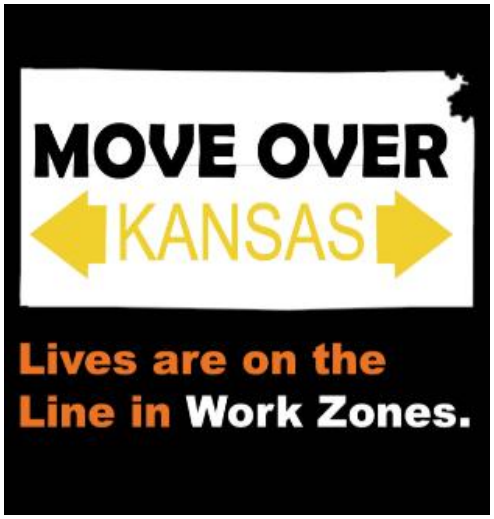
Major construction activities require coordination among TxDOT, contractors, cities, information outlets, and public safety officials, among others. Decisions that these entities make impact how traffic flows through and around a work zone. Other state DOTs have begun to facilitate safety and operations-focused reviews of work zones either during or after the construction phase of a project to assess performance. These reviews focus on both work zone design and operations.

The TxDOT Waco District should establish a process for organizing and leading multidisciplinary post-construction event reviews for construction events that exceed a preset impact threshold. These reviews

should involve TxDOT construction and operations personnel, TxDOT public information staff, city engineering staff, and public safety officials. These event reviews would provide an opportunity to revisit and assess the impact of operations-focused items that were discussed in preconstruction meetings, such as traffic incident management preparations, signal timing adjustments, construction messaging plans and public information campaigns, and contract mechanisms used to preserve lane capacity in the work zone. Reviews would also provide an opportunity to look at delay and crash data collected from the work zone to identify areas for operational improvement during future construction events.

Strategy and Best Practice

The Kansas Department of Transportation (KDOT) has implemented into their processes a Work Zone Review Team responsible for performing an onsite scan of project work zones throughout the state. As they scan the work zones, participants list positive and negative aspects of the operation. The review team analyzes all work zone collision data in the State for each year and documents the contributing circumstances. KDOT also has a Traffic Control Review Team that randomly selects construction and maintenance work areas on the State Highway System to determine if improvements are needed to the agency's traffic control procedures.



Action Item BP-05: Conduct Post-Special Event Reviews

Planned special events are often operationally similar to major road construction events in that they involve coordination and design as they reroute traffic around an impacted area. Certain roads are often closed in one or both directions, and other routes are often experiencing much higher volumes of traffic than normal as they are transformed into key detours.

Like the reviews described in Action Item BP-04, the TxDOT Waco District should establish a process for organizing and leading multidisciplinary post-special event reviews with the purposes of revisiting traffic operations items discussed during special event planning and identifying areas for improvement to traffic operations for recurring special events. Reviews should include TxDOT operations and public information personnel, local city engineering staff if the event impacted local roads, public safety officials, and representatives from the event organizer. Topics discussed might include ingress and egress challenges, effectiveness of detour plans, emergency response access, and event messaging. Reviews would also provide an opportunity to look at delay and crash data collected from the special event impact area to identify areas for operational improvement during future special events.

Action Item BP-06: Improve Local Partner Knowledge of Existing Agreements

At times, the TxDOT Waco District and local agency partners encounter points of contention tied to a lack of awareness at the local agency of existing interlocal agreements in place that detail each agency's maintenance responsibilities with regards to traffic signals, street lighting, and other assets located on State right-of-way.

Many of these agreements are more than 20 years old, and in some cases, agencies do not have local copies of their agreements with TxDOT readily available when staff turnover occurs. The result is that city engineering staff will at times assume that TxDOT is operating and maintaining items that the city is responsible for.

The TxDOT Waco District should offer to meet with local agency partners to confirm that each agency is aware of and has copies of existing municipal maintenance agreements, review the details of agreements that apply to each city, and to identify whether any of the existing agreements might need to be updated or renegotiated. Following the initial set of these meetings, the District should conduct follow-up meetings on an as-needed basis when staff turnover occurs in leadership roles of local city engineering or public works departments. The District should also inventory its existing interlocal agreements and target reviews and updates to each agreement on a 20-year cycle, unless changes to deployed infrastructure necessitate more frequent updates.

Action Item BP-07 Establish Regional Traffic Data Sharing Procedures

The TxDOT Waco District should make traffic operations data that is collected available to partner agencies throughout the region and should identify data that other agencies could provide to assist TxDOT in decision making. Data points such as travel time reliability and link travel speeds are helpful to share with MPOs in the region that are seeking to incorporate more discussions about TSMO into their Technical Advisory Committee meetings. In addition to sharing this data, many city agencies expressed interest in establishing access to the District's CCTV camera feeds.

Detailed Recommendations – Systems & Technology

Systems and technology refer to an agency's systems engineering, regional architectures, and procurement processes that allow the agency to increase the value and functionality of a high-technology project, service, or system. Considerations include how an agency integrates ITS components regionally so that TSMO projects and services are deployed in an organized manner. Table 7 shows the recommended Systems and Technologies action items for the TxDOT Waco District.

Table 7: TxDOT Waco District Action Items – Systems & Technology

CMM Capability Dimension	Action Item Number	Action Item Description
Systems & Technology	ST-01	**Upgrade Signals to Quickly Adjust Timings in Response to Events:** Upgrade signals along detour and other priority routes to allow monitoring and real-time adjustments during traffic incidents, special events, and major construction.
	ST-02	**Establish Freeway Safety Service Patrol:** Establish a freeway safety service patrol along key routes to respond to minor incidents and traffic disruptions, and to assist in response to larger incidents.
	ST-03	**Establish a Regional TMC:** Establish a regional traffic management center (TMC) to support traffic incident management, traffic signal management, traveler information dissemination, and other traffic management priorities.
	ST-04	**Establish Link to TIM Response Dispatch Information:** Establish connection with 911 public safety answering points to share computer-aided dispatch traffic incident information with TxDOT in real time.
	ST-05	**Provide Closure Information Through Third-Party Apps:** Partner with third-party navigation apps to provide accurate work zone closure information for travelers through the Waco District.
	ST-06	**Expand Work Zone Technology Deployments:** Deploy work zone technology throughout the Waco District to support improved work zone monitoring, localized real-time traveler information, and end of queue warning.
	ST-07	**Deploy Flood Warning and Closure Devices:** Implement technology for closing roads or warning drivers in areas that frequently flood.
	ST-08	**Improve Quality of Weather-Related Information for the Public:** Improve level of detail, timeliness, and accuracy of weather-related roadway information communicated to local and regional travelers.
	ST-09	**Share Event-Related Road Impacts with Third-Party Apps:** Partner with third-party navigation apps to provide accurate special event-related closure and routing information for travelers through the Waco District.

CMM Capability Dimension	Action Item Number	Action Item Description
	ST-10	**Implement Safety-Focused Signal Upgrades:** Implement signalized intersection safety upgrades recommended in District Safety Plan and encourage local partners to pursue similar upgrades.
	ST-11	**Improve Communications Link to Signals in Rural Areas:** Upgrade communications capabilities at rural TxDOT traffic signal locations to improve ability to monitor and respond to conflicts, outages, and other signal issues.
	ST-12	**Plan and Implement Upgrades to ITS Field Devices:** Develop a comprehensive implementation plan to identify and prioritize locations for new ITS deployments and to replace ITS devices approaching the end of their design life.

Action Item ST-01: Upgrade Signals to Quickly Adjust Timings in Response to Events

Centralized control of traffic signal timing and monitoring capabilities for traffic conditions provides opportunity to react quickly to traffic events. Currently, timing adjustments cannot be completed remotely when there are traffic incidents or construction work occurring on the roadways. For special events or planned detour routes, signal timing plans need to be planned before the event and then are difficult to adjust if traffic plans are not as expected. In many planned events, DPS or local law enforcement is stationed at the intersection traffic signal controller to control the signal phasing in the field.

The benefits of upgrading signals include:

- Maximizes progression, minimizes stops
- Provides enhanced signal timing adaptivity
- Allows implementation of flush timing plans for traffic events
- Reduces congestion, air pollution, fuel consumption
- Saves staff time and user delay

To accomplish this action item, in field technology deployment and upgrades to the District Traffic Operations Center are required. Field technology improvements could include vehicle detection, controller cabinet and controller, and communication link. Upgrades to the Traffic Operations Center are needed for the central computer system and communication link.

An arterial management case study conducted by the Florida DOT referenced an average benefit-cost ratio of 10.05:1 on six of their corridors. (https://ops.fhwa.dot.gov/publications/fhwahop14032/fhwahop14032.pdf)

Action Item ST-02: Establish Freeway Safety Service Patrol

Safety service patrols on freeways provide a traffic management tool; providing a swift response to incidents, effective temporary traffic control, and quick clearance practices. Service patrol functions include performing minor repairs, assisting motorists, removing debris, providing fuel, providing first aid, pushing vehicles out of travel lanes, and assisting emergency services at vehicle crash scenes. An effective services patrol program requires highly trained personnel who use specially equipped vehicles and tools to systematically patrol congested highways searching for and responding to traffic incidents.

Service patrols can also reduce the chance of secondary accidents and bottlenecks which works towards TxDOT's Vision Zero Goal. To establish an effective patrol, TxDOT Waco District should conduct a safety audit of their roadways first to determine the roadways with high crash possibility factors; which may include speed, volume, roadway geometry, and collision data. Understanding locations with high crash risks can help identify safety corridoes for safety service patrol deployment. Due to the high volume and speeds on I-35, is a strong candidate for the first freeway safety service patrol in the Waco District. Waco District leadership will need to consider funding and staff needs for an effective Freeway Safety Service Patrol and should consider a phased implementation for the selected high priority corridors.

The CAMPO Regional Incident Management Strategic Plan and Performance Assessment, completed in 2018, showed the TxDOT Austin District HERO Program had a benefit-cost ratio as high as 34:1 in urban areas. On less congestion freeway that the program was considering for expansion the benefit-cost ratio was still shown to be at least 5:1 or greater.

Identifying a continuous funding source for the program will be necessary for successful implementation. Other TxDOT Districts around the state have partnered with local MPOs to share costs for safety service patrol programs using Category 7 funding. This funding option is currently available to KTMPO and may also become available to the Waco MPO as population within the MPO boundary is projected to continue increasing. Agencies in other states have successfully secured safety service patrol funding through highway safety improvement program grants, and TxDOT has committed hundreds of millions of dollars to safety improvements over the next several years. In some cases, private vendors such as insurance providers will provide cost-sharing options for a safety service patrol in exchange for branding of service patrol vehicles.

Strategy and Best Practice

The TxDOT Austin District, in partnership with Capital Area Metropolitan Planning Organization, operates the Highway Emergency Response Operator (HERO) service patrol program to assist stranded motorists, clear minor crashes, and provide traffic control for major crashes. HERO trucks are equipped with emergency lighting and bed-mounted arrow boards to provide visible warning and direction to motorists approaching an incident or end of queue. The fleet consists of 26 trucks and two trailers.

Action Item ST-03: Establish a Regional TMC

Currently, the TxDOT Waco District operations staff is able to monitor CCTV cameras and other ITS device information from a video wall in the District Office. Staff have access to TxDOT's Lonestar Advanced Traffic Management System (ATMS) to control ITS field devices, and outside of normal business hours the TxDOT Fort Worth District TransVISION TMC monitors and operates the Waco District's ITS assets. The TxDOT Waco District has expressed interest in expanding the role it serves in active traffic management throughout the region, and staff have had exploratory discussions to establish a TMC that allows the District to further develop that capability.

The TxDOT Waco District should consider whether there might be local partners that could jointly manage the TMC to further their own traffic management initiatives, and the District will need to develop a plan for how the TMC would be staffed. These two aspects of development are described in Action Items OW-04 and CO-05, respectively.

This recommended action item could be implemented at varying levels of cost and effort, depending upon the TMC concept that is ultimately selected for implementation. One lower-cost option might involve the TxDOT Waco District building out space and investing in additional technology at the District Office to establish a small TxDOT Waco District TMC that would allow staff to passively monitor conditions on District freeways during standard business hours (and after hours as needed) from a video wall. Higher cost options might involve the District leasing or building a new space where District staff and potentially partner agency staff could monitor traffic conditions. This space could double as a dispatch center or emergency operations center for the region, and could be staffed around the clock if the District identified overnight operation of the TMC as a priority.

Additional steps in TMC concept development would include:

- Completing a systems engineering analysis and concept of operations document to identify TMC needs, objectives, and functional requirements for successful implementation
- Identifying a location for the TMC that meets space and communications connectivity requirements
- Developing a budget to cover up-front construction costs and ongoing TMC operations costs
- Constructing the TMC, installing needed communications equipment, and verifying that all elements are operating as designed

Depending upon its design, the TMC could allow the TxDOT Waco District to:

- Detect or verify traffic incidents more quickly in locations with CCTV camera coverage
- Actively supervise operations for planned construction and special events and use traveler information tools to inform drivers of conditions in real time
- Actively manage traffic signal corridors and dynamically adjust timings in response to changing traffic conditions
- Maintain a centralized dispatch and operations center for a potential freeway safety service patrol
- Coordinate directly with collocated traffic engineering and public safety partner agency staff

Strategy and Best Practice

The City of Lubbock and the TxDOT Lubbock District operate a joint TMC. The City of Lubbock TMC was first installed through a partnership with Texas Tech University in 2007. In addition to daily traffic monitoring operations, the TMC continues to provide real-time highway video feed to dispatchers and first responders. Through this partnership, the TMC is an integral part of coordination for incident response by providing accurate location and incident information to emergency management services.

Action Item ST-04: Establish Link to TIM Response Dispatch Information

Currently TxDOT Waco District detects incidents with cameras or after first responders request assistance, but this request may not arrive until responders are already on scene and they've received notice or see emergency vehicle lights on cameras. To accomplish this action item and improve incident management, TxDOT needs to gain access to emergency response dispatch data so that they are aware firsthand of incidents and can better assist in response.

Action Item ST-05: Provide Closure Information Through Third-Party Apps

Third-party navigation apps continue to claim an increasing share of the traveler information market as smart phones become tools used by everyone across the country. Several of the largest apps by market-share, including Google Maps, Apple Maps, and Waze, have established "trusted provider" programs that allow transportation agencies to communicate planned impacts to the road network so that these apps can broadcast that information to their users. Several TxDOT Districts have already established these connections and have assigned roles to staff to share construction-related or special event-related closure information. Once shared, users navigating via these apps will have closures show up on the app's map, and the app will route users around scheduled road closures. The District should establish this connection with third-party navigation apps and should instruct staff to pass along closure information related to construction and special events.

Action Item ST-06: Expand Work Zone Technology Deployments

In recent years, the construction industry has relied more on technological innovations and applications in safety management; and road work zone safety is no exception. Studies have found benefits associated with implementing technologies in work zones, since high vehicle speed and inattentive driving are both primary causes of collisions within work zones. Technologies and processes aim to mitigate these causes to improve the overall safety of road workers. Technology can also be leveraged to manage the traffic impacts work zones have on the roadway, queue detectors and Bluetooth technology measuring travel times provide information on the work zone activities traffic impacts. This data can be used to actively manage the traffic to encourage detour routes, adjust lane closures, or provide planning information on how or when closures should be handled in the future. These technologies are currently being used on the I-35 project and should expand to other construction projects in the District.

The District should implement proven technologies to expand work zone management and safety technologies to more projects. For example, technologies such as drone radar and radar speed displays are effective highway work zone speed enforcement measures. Moreover, emerging automated technologies such as autonomous truck mounted attenuators and automated intrusion detection systems can be incorporated into a smart work zone system to enhance decision making around the work zone and provide workers and drivers with valuable real-time information.

Action Item ST-07: Deploy Flood Warning and Closure Devices

There are many FM roadways near or in floodplains, often in rural areas that have longer response times in the event of an emergency. Locations further from a nearby maintenance location may be prioritized for an automated detection system to warn drivers of weather events. A High Water Detection System has two major components; detection and warning. The detection equipment should be reliable and accurate for detecting water levels on the roadways and then communicate to warning equipment and the traffic operations center. Warning equipment can be a small sign structure with activated flashing beacons, dynamic message sign, activated roadway gates or a combination.

Strategy and Best Practice

The TxDOT San Antonio District installed 26 High Water Detection Systems (HWDS). One unit was installed in the metro areas and the remaining units were installed in rural areas which are subject to flash flooding due to the region's topography. The cost is approximately $75,000 per unit. The water level is transmitted to a cabinet near the stream crossing which activates flashers on warning signs. The device also transmits system status and water elevation to the central software application at the traffic operations center.

Action Item ST-08: Improve Quality of Weather-Related Information for the Public

TxDOT Waco District during CMM workshop expressed a need to share better information regarding weather impacts on road closures. There is additional need for TxDOT to provide information to the public about the Districts response in terms of pre-treating, plowing, or clearing roadways.

The public availability of road weather information improves the public's understanding of driving conditions and enables them to make safer choices regarding travel. The District PIO should work towards sharing up-to-date road condition information via a public-facing website or on social media platforms. Information should be shared and communicated with adjoining District and local municipalities PIO's.

Other Districts currently maintain communication with the National Weather Service (NWS) to receive advance warnings of major weather events. Waco can make this connection to have better advanced warning of events as well. The TxDOT Waco District should invest in publicizing their website and increasing awareness of this

valuable public information resource. The District should also focus on communicating weather-related road conditions information via traditional outlets, such as local print and news media.

Action Item ST-09: Share Event-Related Road Impacts with Third-Party Apps

Third-party navigation apps continue to claim an increasing share of the traveler information market as smart phones become tools used by everyone across the country. Several of the largest apps by market-share, including Google Maps, Apple Maps, and Waze, have established "trusted provider" programs that allow transportation agencies to communicate planned impacts to the road network so that these apps can broadcast that information to their users. Several TxDOT Districts have already established these connections and have assigned roles to staff to share special event-related closure information. TxDOT Waco District should assign staff under the District PIO to disseminate information to the third-party for events within the District. Once shared, users navigating via these apps will have closures show up on the app's map, and the app will route users around scheduled event road closures. The app can provide a suggested detour route or will assign a new route based on live traffic patterns and data. The District should establish this connection with third-party navigation apps and should instruct staff to pass along closure information related to special events.

Action Item ST-10: Implement Safety-Focused Signal Upgrades

To push along Texas's Vision Zero and support the TxDOT Waco District 4-Year Safety Plan, Waco District wants to deploy signal upgrades to improve intersection safety. TxDOT Waco District will prioritize signalized locations based on observed and predicted crash frequencies. Depending on observed crash types at the identified intersection, traffic operations staff should determine the most effective countermeasure.

Key signal safety countermeasures to consider:

- *Flashing Yellow Arrow* - Proven to have fewer left-turn crashes than with traditional signals and can provide more flexibility for signal operations.
- *Yellow Change Interval* - Since red-light running is a leading cause of severe crashes at signalized intersections, it is imperative that the yellow change interval be appropriately timed.
- *Backplates with Retroreflective Borders* - Signal heads that have backplates equipped with retroreflective borders are more visible and conspicuous in both daytime and nighttime conditions

Action Item ST-11: Improve Communications Link to Signals in Rural Areas

Traffic signals with remote communication capabilities allow for traffic managers to operate those signals efficiently through both the active management of traffic progression and through the ability to quickly identify signal outages to minimize congestion and maintain a higher level of safety. Communication is a critical part of a traffic management system to deliver traffic data and video from intersections back to the District Office TMC where the management and operation activities take place. Completing systemwide traffic signal modem deployment is essential for managing the entire Districts signal system. In addition, a signal status dashboard with automated notifications of malfunctions can be established to provide quick response to signals that are lost or damaged.

Action Item ST-12: Plan and Implement Upgrades to ITS Field Devices

Develop a comprehensive ITS implementation plan to identify and prioritize locations for new ITS deployments and to replace ITS devices approaching the end of their design life. The plan should consider the existing and needed communication systems, identify devices for deployment including CCTV cameras, DMS, vehicle detection systems, and road weather detection systems. A review of existing devices and plans for replacement at the end of life should also be considered. The plan should include IH-35, IH-14, and other state routes in the TxDOT Waco District. Prioritization of the deployments should be included to develop a phased approach to deployment. A review of upcoming construction and maintenance projects should also be included to take advance of any planned construction and maintenance as a cost-effective opportunity to deploy ITS devices or communication upgrades.

The District should also adhere to FHWA's systems engineering analysis process as it plans for, designs, and installs devices along the corridor. Adhering to this process reduces the risk of cost overruns during construction and, through documenting all intended use cases and requirements, reduces the likelihood of needing to modify the system once installed. Key steps include identifying functional requirements of the system and a device testing and system verification plan to confirm that all elements are operating as intended once installed.

Detailed Recommendations – Performance Measurement

TSMO programs are tracked by agencies through performance measures to manage progress and assess benefits of implemented projects and processes. Well-defined performance measures help make informed decisions and prioritize projects. Performance measures drive the success of TSMO programs by allowing agencies to realize and quantify improvements in the short-term through the effective use of TSMO strategies. Table 8 shows the recommended Performance Measurement action items for the TxDOT Waco District.

Table 8: TxDOT Waco District Action Items – Performance Measurement

CMM Capability Dimension	Action Item Number	Action Item Description
Performance Measurement 	PM-01	**Improve TIM Data Collection:** Improve incident management-related data collection, with a focus on location data accuracy as well as regional collection of roadway clearance time, incident clearance time, and secondary crash data.
	PM-02	**Measure Work Zone Travel Time Delay:** Develop the capacity to measure travel time delay through work zones throughout the Waco District.
	PM-03	
	PM-04	**Establish Districtwide Traffic Operations Performance Measures:** Establish Districtwide traffic operations performance measures that expand upon current data collection and performance measurement efforts along the I-35 corridor.

Action Item PM-01: Improve TIM Data Collection

Traffic incidents put travelers' and emergency responders' lives at risk and cause congestion that can lead to secondary crashes. TIM programs plan for and coordinate response among agencies to improve safety and reduce incident duration and the congestion impact. Low-cost, often off-the-shelf, technologies can be used to collect data that helps agencies enhance TIM programs. FHWA encourages agencies to initially adopt three key national TIM performance measures: roadway clearance time, incident clearance time, and number of secondary crashes. With better data and analytics, agencies can quantify program performance, demonstrate program effectiveness, and improve TIM planning and resource management.

The Waco District staff and stakeholders identified that TIM data is sometimes reported inaccurately, especially when the collision occurred outside the vision of a CCTV. Measuring roadway clearance time, incident clearance time, and secondary crashes should be standardized within DPS and local law enforcement to get consistent data. DPS should be used as the primary data source for the following metrics since they already track this information.

- *Roadway Clearance Time* is defined as the time between the first recordable awareness of an incident (detection, notification or verification) by a responding agency and first confirmation that all lanes are available for traffic flow.
- *Incident Clearance Time* is defined as the time between the first recordable awareness of the incident and the time at which the last responder has left the scene.
- *Secondary Crash* is defined by defined as any collision that occurred within a defined time frame and defined distance upstream of a known primary incident

The Waco District can utilize Lonestar to input, store and collect incident data; TMC operators should complete this during any event occurring during their shift. TxDOT Waco District can also encourage other public safety agencies to request ability to report incident data and additional information through CRIS.

Action Item PM-02: Measure Work Zone Travel Time Delay

TxDOT Waco District has teamed with the Texas A&M Transportation Institute (TTI) to provide independent technical support for the effort. TTI is helping by operating a traveler-information system developed by TTI for the I-35 project. The system integrates several methods for capturing data, forecasts congestion along the construction route, and provides that information to travelers and businesses through social media, including Twitter, and TxDOT's My35.org website in the form of a dynamic traffic map. The data is collected by a series of smart work zone technologies; Bluetooth collects travel time information, Wavetronix sensors collect traffic volumes, and end-of-queue warning systems that collect vehicle speeds and backup information.

The TxDOT Waco District should build upon the I-35 project and expand this data collection capability to other construction projects in locations where large delays may be anticipated. TxDOT can continue to collect data through TTI's existing program or through a combination of probe-based data and their own smart work zone deployments in project locations.

As smart work zone deployment technology becomes used more frequently on roadway projects within the District, goals should be set for each individual project in terms of back-up length, delay, and segment travel time.

Action Item PM-03: Measure Event-Related Travel Time Delay

TxDOT Waco District actively participates in event traffic management for large scale events in the District such as Baylor Football Games. During the CMM workshops, stakeholders and staff expressed more interest in tracking traffic performance for these events. The TxDOT Waco District in coordination with Baylor University and the City of Waco should utilize modern technologies, such as those being used in smart work zones, to gather data related to delay increases, bottlenecks, and queue lengths on nearby roadways. Data can also be collected through third party applications; these data sources have an advantage because traffic data can be sourced at any time to review past events which then can be easily compared to non-event traffic data. Third party data can be validated by TMC operators with placement of CCTVs at key intersections.

Collected data is valuable to actively manage future planned events and help develop informed traffic control plans and detour routes; minimizing delays, maximizing the available road network, and enhancing event attendee experience. Developing post-event reports can summarize lessons learned, identify problem intersections or roadways, and help continually improve the event traffic management plan. As understanding increases for reoccurring event's traffic, goals should be set in terms of user delay and event egress clearance times.

After TxDOT Waco District and key partners establish these best practices they can then be applied to other events such as Baylor University basketball games, Waco Silobration, running road races, and other events.

Action Item PM-04: Establish Districtwide Traffic Operations Performance Measures

In order to identify TSMO success, TxDOT Waco District should establish management and operations metrics that are outcome-driven and performance based. Performance measures help determine progress toward specific defined traffic operations objectives This includes both quantitative evidence (such as the measurement of travel times and reliability) and qualitative evidence (such as the measurement of traveler satisfaction and perceptions). Data is currently collected and reported on I-35 through partnership with TTI; this data can be leveraged to establish baseline traffic operations goals for I-35 and then in the future, other roadways.

TxDOT Waco District Traffic performance metrics should include travel time and travel time reliability along freeways and key arterials in urban areas. To achieve a level of uniformity and implementation, TxDOT TRF expects Districts to track ITS asset uptime and meet a goal of 90%.

This data could be analyzed and reported on at the TOC or it could be recorded and collected by operations staff.

Detailed Recommendations – Culture

TSMO culture within an agency is dependent on engaged staff who adhere and implement TSMO goals. Staff can positively improve TSMO culture by critically analyzing daily activities to adhere to and meet program objectives. Considerations involved in creating a TSMO Culture include a technical understanding, strong leadership, outreach, and buy-in of program authority. Table 9 shows the recommended Culture action items for the TxDOT Waco District.

Table 9: TxDOT Waco District Action Items - Culture

CMM Capability Dimension	Action Item Number	Action Item Description
Culture	CU-01	**Prioritize Communicating Work Zone Information to Local Partners:** Prioritize communication with local agencies regarding both initial construction notices and subsequent construction plan or schedule changes.
	CU-02	**Incorporate TSMO Discussion Topics into MPO Committee Meetings:** Incorporate discussions of action items identified in this plan into the Killeen-Temple and Waco MPOs' Technical Advisory Committee meetings.

Action Item CU-01: Prioritize Communicating Work Zone Information to Local Partners

One recurring piece of feedback from local partner public information officers was that cities in the Waco District were often unaware of the TxDOT Waco District's construction or maintenance activities that would be occurring on state routes within that city's jurisdiction. While TxDOT involves local city partners and their constituents in preconstruction meetings and other public engagement events, several city representatives noted that communication of schedule changes as construction began was often inconsistent. One city representative provided an example of a TxDOT contractor requesting to switch the order of work as they completed a Districtwide striping contract. While TxDOT approved the change, this change was never communicated to the local cities that were impacted, so the city public information officer was advertising that lane closures were occurring based on the initially planned schedule. The lane closures did not occur that week, so the city removed notice, and lane closures instead began the following week without any public communication from TxDOT or from the city that was impacted.

The TxDOT Waco District should view maintaining this line of communication regarding construction impacts as a key aspect of their ongoing partnership with local agency partners. While there are formal processes for outreach ahead of construction activities, the District can improve the way it communicates construction progress updates and any changes to schedule or lane impacts. While the District's public information officer will generally capture and share these changes via an email list, many city staff may not be aware of this function or may need more direct and active communication from a TxDOT project manager to be able to pass along accurate information to others in their jurisdiction.

Action Item CU-02: Incorporate TSMO Discussion Topics into MPO Committee Meetings

The TxDOT Waco District contains two MPOs: the Waco MPO, which covers McClennan County, and the Killeen-Temple MPO, which covers Bell County and small portions of Coryell and Lampasas Counties. These MPOs are responsible for allocating federal transportation funds for regionally important projects, and traditionally these projects have focused on capacity building and corrective traffic safety improvements. Comparatively much less funding is allocated for operating and maintaining the capacity of the existing transportation network.

Each MPO has a Technical Advisory Committee, referred to as a TAC, that is composed of city staff in engineering or public works departments. The TAC provides professional opinions regarding transportation initiatives and shares these opinions with the MPO's elected officials who can vote on whether the MPO adopts those initiatives. The TxDOT Waco District should partner with the Directors of the Waco MPO and Killeen-Temple MPO to encourage more discussion of TSMO concepts as a part of each MPO's monthly TAC meetings. Making these discussions more common will help to increase regional understanding of the importance of operations initiatives to support other capacity enhancements and safety improvements.

Detailed Recommendations – Organization & Workforce

The organization and staffing component of TSMO planning addresses how the program will be delivered through institutional and organizational changes. There are many ways to structure TSMO and not all agencies will require major changes to existing organization and staffing. Agencies are encouraged to evaluate each possible solution and select the organizational structure that will work best with the desired outcomes for their TSMO program. Considerations involved in determining organizational structure include program status, organizational structure, workforce capability, staff development and recruitment, and retention. Table 10 shows the recommended Organization & Workforce action items for the TxDOT Waco District.

Table 10: TxDOT Waco District Action Items – Organization & Workforce

CMM Capability Dimension	Action Item Number	Action Item Description
Organization & Workforce	OW-01	**Establish Recurring Regional TIM Training:** Partner with TxDOT Statewide Traffic Incident Management Coordinator to establish recurring regional TIM training in a multidisciplinary setting.
	OW-02	**Provide TxDOT Waco District Training Opportunities to Local Staff:** Provide TxDOT Waco District internal signal technician training opportunities to local agency traffic signal technicians.
	OW-03	**Improve Access to Available Specialized TxDOT Signal Training:** Improve local agency traffic signal technician access to signal-related trainings offered by the TxDOT Traffic Safety Division.
	OW-04	**Identify and Fulfill Staffing Requirements for TOC Operation:** Implement a phased staffing approach for TxDOT's operating and managing the regional TMC.

Action Item OW-01: Establish Recurring Regional TIM Training

Multidisciplinary training on traffic incident management and response is one of the core components of a successful TIM program, according to FHWA research. The TxDOT Traffic Safety Division has been partnering with TxDOT Districts and TIM working groups across Texas to identify opportunities to conduct this training. Training typically involves representatives from TxDOT, police, fire, EMS, local city transportation staff, and other staff such as TMC or service patrol operators. Often cited benefits of these training opportunities include a better understanding of each agency's roles and capabilities when responding to incidents, the ability to discuss and talk through response strategies using tabletop exercises that resemble real life situations, and the establishment of a baseline competency regarding incident management in the region.

The TxDOT Waco District should partner with the TxDOT Traffic Safety Division's statewide TIM coordinator to schedule a regional TIM training session that involves all parties involved in incident response. This training

can occur in concert with Action Item CO-01 as one or more regional TIM working groups are forming within the District. This multidisciplinary training would supplement training that public safety officials receive from their own agency. Separately, the region should identify staff interested in TIM "Train the Trainer" courses that would build the region's capacity for conducting its own TIM training as needed when new staff or stakeholders increase their presence in incident management.

Strategy and Best Practice

In the Dallas-Fort Worth Region, the North-Central Texas Council of Governments (NCTCOG) provides a free TIM training course. The multi-disciplinary course supports a common, coordinated response to traffic incidents that builds partnerships, enhances safety for emergency personnel, reduces secondary crashes, increases reliability, and improves air quality in the Dallas-Fort Worth region by shortening response and clearance times. Specific courses have been designed for first responders, traffic managers, and executive level policy makers.

Action Item OW-02: Provide TxDOT Waco District Training Opportunities to Local Staff

The TxDOT Waco District provides signal training to each of its signal technicians. The training provides technicians with tools to improve their familiarity with the various signal controller technologies that are deployed at traffic signal locations throughout the District, to diagnose and troubleshoot signal problems more efficiently, and to safely stage a work area while addressing issues in the field.

Several cities in the TxDOT Waco District, including the cities of Killeen, Temple, and Waco, each operate and maintain their own signals since their city populations exceed 50,000 residents. Other smaller cities may also operate and maintain small numbers of signals that are not located on TxDOT roads. These cities may often employ only one or two signal technicians to maintain the entire signal inventory, and staff retention was a noted issue for signal technicians in certain cities. Most cities do not have developed trainings for when new technicians are integrated into staff, so knowledge transfer is dependent upon a combination of on-the-job training and attendance at National Electrical Manufacturers Association (NEMA) in-person or online training courses when budget allows.

The TxDOT Waco District should expand signal technician training opportunities to include local agency partners, potentially in tandem with the establishment of quarterly signal operations forums described in Action Item CO-03. Since many of the signals maintained by city staff are designed and constructed by the TxDOT Waco District, TxDOT's existing in-house signal technician training programs would likely cover content that would be relevant to local agency signal technicians as well.

Action Item OW-03: Improve Access to Available Specialized TxDOT Signal Training

In addition to training offered to signal technicians in the TxDOT Waco District, the TxDOT Traffic Safety Division offers more specialized or advanced training opportunities to TxDOT staff. Staff from several cities have shown

interest in participating in several of these training opportunities, but these staff shared that there was not clear guidance on how staff from agencies outside of TxDOT could get their names onto class lists. The TxDOT Waco District should work with the TxDOT Traffic Safety Division to identify advanced training opportunities that would be open to external partners and should pass news of opportunities along to interested local agencies within the District.

Action Item OW-04: Identify and Fulfill Staffing Requirements for TMC Operation

Action Item ST-03 outlines the approach for developing a regional TMC to support traffic management throughout the TxDOT Waco District. In addition to the physical requirements of such a TMC, the TxDOT Waco District will need to consider how the TMC would be staffed and managed once it is operational. Questions to consider would include:

- How many staff would be required to operate the TMC to meet the needs of the region?
- Would the TMC always be staffed and operational, or just for portions of the day?
- Would the TMC be jointly managed or staffed by partner agencies with collocated employees?
- What qualifications and training would be necessary for staff at each role in the TMC?

Once a vision for the regional TMC is established, the District should develop a staffing plan that addresses the questions above. This staffing plan constitutes an important part of the systems engineering analysis that should be completed as the TMC is designed. The TxDOT Waco District should then use that plan to fulfill staff requirements to allow for the TMC to operate as designed.

Detailed Recommendations – Collaboration

The TSMO collaboration component is vital to emphasize the importance of partner agencies and stakeholders to work together to meet regional transportation goals. Collaboration should take place in every aspect of TSMO programming; from early in developing TSMO strategic elements such as vision, mission, goals, and objectives to throughout implementation of projects, programs, and services. Considerations should include partnerships among different levels of government, stakeholder collaboration, partnerships with public safety agencies, internal agency collaboration and partnerships with private sector. Table 11 shows the recommended Collaboration action items for the TxDOT Waco District.

Table 11: TxDOT Waco District Action Items - Collaboration

CMM Capability Dimension	Action Item Number	Action Item Description
Collaboration 	CO-01	**Establish a Formal Regional TIM Team:** Establish a formalized TIM Team that meets regularly and includes all relevant jurisdictions and roles.
	CO-02	**Better Communicate Road Weather Impacts to Local Partners:** Improve communication with local stakeholders regarding TxDOT weather-related road closures and ice prevention operations.
	CO-03	
	CO-04	**Conduct Semi-Annual Regional Traffic Operations Forums:** Conduct semi-annual regional traffic operations forums with staff from traffic operations agencies throughout the Waco District.
	CO-05	

Action Item CO-01: Establish a Formal Regional TIM Team

Several metropolitan areas across Texas, including Austin, Dallas-Fort Worth, El Paso, Houston, and San Antonio, have established one or more formal TIM working groups. These working groups, sometimes referred to as "TIM Teams", consist of incident management stakeholders from throughout the region that meet on a regular basis to discuss current initiatives and challenges related to TIM in the region. These working groups will often conduct after-action reviews of high-impact incidents and may feature guest presenters to showcase cutting edge technology or resources that incident managers could potentially incorporate into the way they do business.

The TxDOT Waco District should partner with TIM stakeholders in the region to establish TIM working groups. Stakeholders participating in the TSMO planning process generally preferred that separate TIM working groups be established for the Waco Region and for the Killeen-Temple Region. To maintain momentum and establish a routine of these working groups meeting regularly, the TxDOT Waco District should designate a staff member to champion the meeting effort by sending out invitations and developing agendas and engaging discussion items for each meeting instance.

Strategy and Best Practice

The Austin-Area Incident Management for Highways (AIMHigh) Team in Austin, TX meet bimonthly to discuss TIM challenges, accomplishments, and resource needs. Meetings are facilitated by a contractor who encourages participation from first responders and other partners in the region. The team includes representatives from Federal, State, and local transportation agencies; State and local law enforcement agencies; fire and rescue agencies; EMS; the local towing association; and the regional metropolitan planning organization (MPO).

Action Item CO-02: Better Communicate Road Weather Impacts to Local Partners

Several local agency stakeholders gave TxDOT feedback during the TSMO planning process that they had received questions from their constituents during previous snow and ice events regarding when TxDOT-maintained roads within the city's boundaries would be plowed. The TxDOT Waco District already has an established hierarchy for plowing roads so that key routes are plowed first, and while the District should not deviate from that hierarchy, staff can more effectively partner with local agencies by providing the city public information officers with information about when roads in their community will likely be plowed following a winter weather event. City staff can then be better prepared to answer questions from constituents. Information pertaining to road closures should also be communicated to city public information officers.

Action Item CO-03: Conduct Quarterly Signal Technician Forums

Signal technicians working both for the TxDOT Waco District and for cities within the District's boundaries often manage signals that are very similar to one another in terms of technology deployed and configurations used, but capability of technicians from agency to agency is largely dependent upon each agency's institutional

knowledge regarding signal maintenance and existing capability to train and retain their technicians. The District and several of the larger cities in the region expressed interest in organizing quarterly signal technician forums that would provide an opportunity for technicians representing different agencies to meet one another and discuss common challenges related to traffic signal operations and maintenance.

These quarterly forums could be held to provide basic training and hands-on exercises for technicians throughout the region, with the goal of increasing capabilities of signal technicians regionwide and building relationships between agencies that maintain signals so that technicians can share experiences and solutions with one another as they run into challenges while troubleshooting the traffic signals that they maintain. City traffic engineers and TxDOT operations staff may also attend certain forums to discuss topics that may involve coordination among both technicians and engineers.

Other activities that might occur at signal technician forums could include:

- Scheduled time for equipment vendors to conduct training on device maintenance and upkeep,
- Reviewing and discussing updates to TxDOT or municipal specifications for signal design and signal controller technologies,
- Hands-on signal cabinet field training to review common issues that technicians might encounter,
- Scenario-based temporary traffic control training to enhance technician safety when in the field, and
- Facility tours to allow technicians from different agencies to show partners how their agency operates and maintains signal shops and other facilities that support traffic signal operations and maintenance.

Strategy and Best Practice

The Utah Department of Transportation (UDOT) provides on-going technical training for maintenance and signal operations personnel, engineers, and technicians. UDOT conducts quarterly signal meetings to discuss best practices in terms of techniques, operations, and processes. Additionally, every two months the signal maintenance technicians will cross-train for a day with signal maintenance technicians from a different region. UDOT also invites other agencies to participate in training so the transportation network is more seamless.

Action Item CO-04: Conduct Semi-Annual Regional Traffic Operations Forums

In addition to signal technician forums, traffic engineers from cities within the Waco District expressed interest in establishing a standing meeting to occur twice per year as a “Regional Traffic Operations Forum”. Where the signal technician forums would focus on issues specific to traffic signal cabinets, controllers, and related maintenance work. The regional traffic operations forum would provide an opportunity for engineering staff to provide updates on citywide initiatives related to traffic and safety. As cities identify key corridors to focus operations efforts, these forums would also provide an opportunity to share these plans with neighboring cities

so that these corridors can be cooperatively managed by multiple jurisdictions throughout the region. While the regional TMC described in Action Item ST-03 goes from concept to operation, this forum could also serve as an opportunity to share project progress and explore ideas such as developing interagency agreements to share camera access or collected traffic operations data, as discussed in Action Item BP-07.

Action Item CO-05: Identify Candidate Partners for Joint Operation of a Regional TMC

The TxDOT Waco District has expressed interest in establishing a regional TMC to monitor operations on the District's freeways and other key routes. There are potentially other local agencies that could jointly manage the TMC in cooperation with TxDOT so that their city staff are able to more actively modify signal timings and more quickly verify and respond to traffic incidents. The TxDOT Waco District should identify candidate partner transportation agencies and public safety agencies that have expressed interest in enhanced traffic management capabilities. Ideally, partner agencies could contribute to the TMC's successful deployment in one or more ways, including:

- Providing fiscal support for the TMC's development,
- Providing a space to house TMC equipment and staff,
- Collocating staff in the TMC to more easily allow for collaborative response to traffic events, and/or
- Sharing access to city-specific traffic management or incident management systems to increase the amount and quality of data and active control capabilities available to TMC operators.

TSMO Tactical Plan Assessment

TSMO Tactical Plans allow the TxDOT Waco District to establish greater detail in how to act upon some of the high priority recommended action items included in the TSMO Program Plan. Tactical Plans can establish project details, assign responsibilities, and include cost and staff estimates for specific initiatives. Often, Tactical Plans establish further direction regarding a specific TSMO capability dimension (for example, performance measurement), focus area (for example, traffic incident management), or a service within the scope of a TSMO focus area (for example, winter road management, within the Road Weather Management focus area).

Tactical Plan Criteria

Based on the transportation challenges in the region, and priorities identified by regional stakeholders, several Tactical Plans are recommended for the TxDOT Waco District. These recommended Tactical Plans are shown below in Table 12. Plans are displayed according to the following criteria:

- Alignment with the TxDOT Waco District TSMO Goals: Safety, Reliability, Efficiency, Customer Service, Collaboration, and Integration
- Stakeholder partnerships required for successful implementation
- Level of anticipated initial and ongoing costs anticipated for successful implementation
- Level of District staff support anticipated for successful implementation
- Expected return on investment anticipated, pending successful implementation
- Action items from this TSMO Program Plan within the Tactical Plan's scope

Tactical Plan Components

The following components are typically included in TSMO Tactical Plans:

- A detailed account of existing activities within the District and region, including who is responsible, a schedule of when and how the activities are executed, and other considerations
- Recommendations for new activities, or changes to existing activities that would support the aim of the Tactical Plan
- A description of how the recommended activities will be integrated with existing business processes
- A detailed schedule for up-front and ongoing recommended activities
- Up-front and ongoing cost estimates for implementation of recommended activities
- Performance measures that would allow for tracking the progress of recommended activities

Recommended Tactical Plans

Recommend TSMO Tactical Plans are included on the next page in Table 12.

Table 12: TxDOT Waco District Potential TSMO Tactical Plans

Potential Tactical Plan (with Deliverables Listed Below)	Supports District TSMO Goals						Key Internal and External Partners	Expected Ongoing Cost	Expected Ongoing Level of Effort	Expected Return on Investment for District	TSMO Action Items Addressed
	Safety					Integration					
Regional TMC Concept Development - Concept of Operations and Systems Engineering Analysis - Phased Staffing Plan - TMC Device Testing and Verification Plan	✓	✓	✓	✓	✓	✓	WAC District Engineer, WAC Operations Department, Local Transportation Agencies, Local Public Safety Agencies	$$$		**Highest**	ST-03, OW-04, CO-05
Safety Service Patrol Deployment - Concept of Operations and Phased Deployment Plan	✓	✓	✓	✓			WAC District Engineer, WAC Operations Department	$$		**Highest**	ST-02
District ITS Device Deployment - TxDOT WAC District ITS Master Plan - Regional Signal Corridor Plan			✓	✓	✓	✓	WAC District Engineer, WAC Operations Department, WAC Construction Department, Local MPOs, Local Transportation Agencies	$$		**Highest**	ST-01, ST-03, ST-11, ST-12
Ongoing Operations Stakeholder Engagement - Incident, Traffic Signal, and Regional Operations Forum Support - Regional TIM Training Development and Outreach	✓	✓	✓	✓	✓	✓	WAC Operations Department, Local Transportation Agencies, Local Public Safety Agencies	$		**High**	BP-04, BP-05, OW-01, OW-02, OW-03, CO-01, CO-03, CO-04
Regional ITS Architecture - TxDOT WAC District ITS Architecture Update					✓	✓	WAC Operations Staff, Local MPOs, Local Transportation Agencies, FHWA	$		**High**	ST-03, ST-12
Regional Operations Data Collection and Sharing - TIM and Traffic Operations Data Integration Plan and Support	✓	✓			✓	✓	WAC Operations Department, Local Transportation Agencies, Local Public Safety Agencies	$$		**Moderate**	BP-02, BP-07, PM-01, PM-04

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Appendix A – Stakeholder Involvement Database

TxDOT Waco District TSMO Program Plan Stakeholder Contact and Participation Database						
Organization	Name	Position/Role	Outreach Workshop/ Meeting Participant	CMM Workshop Participant	CMF Traffic Incident Workshop Participant	CMF Traffic Signal Workshop Participant
Belton	Jon Fontenot	Fire Chief			✓	
CDM Smith	Charlie Sullivan	Senior Transportation Planner	✓			
Copperas Cove	Scott Osburn	Public Works Director	✓			
Copperas Cove	James Mullen	Streets Department Superintendent	✓			
Copperas Cove	Michael Neujahr	Fire Chief			✓	
Coryell County	Roger Miller	Judge	✓			
FHWA	Millie Hayes	Safety and Operations Specialist		✓		
Fort Hood	Robert Adams	Chief of Operations	✓			
Fort Hood	Michael A Love	FH-DPW-RPPD	✓			
Fort Hood	Victor Hage	Antiterrorism Security Specialist	✓			
Fort Hood	Kevin Moore	Fort Hood DES	✓			
Fort Hood	John Spivey	Veterans Service Representative	✓			
Gatesville	Rene Ochoa	City Planner	✓			
Gatesville	Liz Reinhardt	Flood Plan Manager	✓			
Harker Heights	Kristina Ramirez	Assistant public works director	✓	✓		
Harker Heights	Joseph Molis	Director of Planning and Development	✓	✓		
Harker Heights	Paul Sims	Fire Chief	✓			
Harker Heights	Mark Hyde	Public Works Director	✓			
Harker Heights	Jerry Bark	Director of Public Relations	✓			
Harker Heights	Betiale Hawkins	Police Department	✓			
Harker Heights	Randy Stefer	Police Department	✓			
Jarrell	Jordan Moyer	City Planner for City of Jarrell	✓			
Killeen	MD Hossain	City Engineer	✓			
Killeen	Caesar Arizpe	Project Engineer	✓			
Killeen	Billy Stottler	Traffic Superintendent				✓
KTMPO	James McGill	Regional Planner	✓		✓	✓
KTMPO	Kendra Confal	Planning Services Manager	✓		✓	

Organization	Name	Position/Role	Outreach Workshop/ Meeting Participant	CMM Workshop Participant	CMF Traffic Incident Workshop Participant	CMF Traffic Signal Workshop Participant
KTMPO	Uryan Nelson	Planning & Regional Services Director			✓	
McLennan County	Zane Dunnam	McLennan County Engineer		✓		
North Fort Hood	Robert Reister	DPTMS, IMCOM, Ft Hood Garrison Command	✓			
Robinson	Tracy O'Connor	Police Department	✓	✓		
Robinson	Craig Lemin	City Manager	✓			
Robinson	David Kauffman	Public Services Director	✓			
Robinson	Justin French	Director of Planning and Community Development	✓			
Robinson	Destiny Delillo	Assistant to the City Manager	✓			
Robinson	Matt Troup	Police Department		✓		
Temple	Kenny Henderson	Transportation Director	✓	✓	✓	
Temple	Michael Phillips	Traffic Signal Manager	✓		✓	✓
Temple	Don Bond	Director of Public Works	✓			
Temple	Jonathan Christian	Fire Department			✓	
Temple	Shawn Reynolds	Police Chief			✓	
TTI	Robert Brydia	TTI Senior Research Scientist Program Manager	✓	✓	✓	
TTI	John Habermann	TTI Research Engineer/Program Manager			✓	✓
TxDOT TRF	Barbara Russell	TRF - TSMO	✓	✓		
TxDOT TRF	David McDonald	TxDOT Statewide TIM Coordinator			✓	
TxDOT Waco District	Chris Pruitt	Project Manager	✓	✓	✓	✓
TxDOT Waco District	Holly Metzke	Waco District Operations	✓			
TxDOT Waco District	Jacob Chau	Director of Operations	✓			
TxDOT Waco District	Gilberto Aguirre	Waco Maintenance & Traffic	✓			
TxDOT Waco District	Brigida Gonzalez	TxDOT-TPP	✓			
TxDOT Waco District	Stephen Kasberg	Belton Area Engineer	✓			
TxDOT Waco District	Brenton Lane	Waco TP&D	✓			
TxDOT Waco District	Michael Bolin	Deputy District Engineer	✓			
TxDOT Waco District	Solomon Thomas	Area Engineer	✓			

Organization	Name	Position/Role	Outreach Workshop/ Meeting Participant	CMM Workshop Participant	CMF Traffic Incident Workshop Participant	CMF Traffic Signal Workshop Participant
TxDOT Waco District	Stanley Swiatek	Waco District Engineer	✓			
TxDOT Waco District	Joseph Hunt	TRF-TSMO		✓	✓	
TxDOT Waco District	Anel Rivera Rosado	District Operations Staff		✓		
TxDOT Waco District	Jason Duncan	Hillsboro Area Engineer		✓		
Waco	Amy E. Burlarley-Hyland	Interim Director of Public Works	✓	✓	✓	✓
Waco	Christine Miller	Traffic Engineer	✓	✓	✓	✓
Waco	Mark Norcross	Police Department	✓		✓	
Waco	Jim Reed	Public Works Streets Division Manager	✓			
Waco	Paul Cain	Assistant City Manager	✓			
Waco	Denise Rodriguez	Streets Department	✓			
Waco	Kevin McGee	Fire Chief	✓			
Waco	Ryan Holt	Police Chief	✓			
Waco	Kody Petillo	Assistant Director of Solid Waste	✓			
Waco	Jake Krall	GIS Coordinator	✓			
Waco	Elizabeth Thomas	Emergency Management	✓			
Waco	Melett Harrison	Economic Development	✓			
Waco MPO	Chris Evilia	MPO Director	✓	✓	✓	✓
Waco Transit	Joseph Dvorsky	Director of Service Development	✓			
Woodway	Mitch Davison	Director of Communication Services	✓			

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